IUFRO World Series Volume 20-IV

# Keep Asia Green

## Volume IV "West and Central Asia"

*Edited by Don Koo Lee and Michael Kleine*

AKECOP

Yuhan-Kimberly

IUFRO

IUFRO World Series Vol. 20-IV Keep Asia Green Volume IV "West and Central Asia" Vienna 2009

IUFRO Headquarters
Hauptstrasse 7
1140 Vienna, Austria
Tel: + 43-1-877-0151-0
Fax: +43-1-877-0151-50
Email: office@iufro.org
Web site: www.iufro.org

International Union of Forest Research Organizations
Union Internationale des Instituts de Recherches Forestières
Internationaler Verband Forstlicher Forschungsanstalten
Unión Internacional de Organizaciones de Investigación Forestal

## IUFRO World Series Vol. 20-IV

# Keep Asia Green
## Volume IV
## "West and Central Asia"

**Edited by** Don Koo Lee and Michael Kleine

AKECOP

Yuhan-Kimberly

IUFRO

ISSN 3-901347-55-0

ISBN 978-89-955147-4-0-93520

IUFRO, Vienna 2009

**Recommended catalogue entry:**
Keep Asia Green Volume IV " West and Central Asia", 2009.
Don Koo Lee and Michael Kleine (editors)
IUFRO World Series Volume 20-IV. Vienna, p. 300

**ISSN 3-901347-55-0**
**ISBN 978-89-955147-4-0-93520**

**Cover photos:**
1. Pistachio forests in Uzbekistan (by Nicolai Lyutsian)
2. Steppe ecosystem in Kazakhstan (by Alexey Melnikov)
3. Sand dunes stabilization in a desert of the Irano-Turanian Region (by Mohammad Darvish)

**Published by:**
IUFRO Headquarters, Vienna, Austria, 2009



**Available from:**
IUFRO Headquarters
Secretariat
c/o Mariabrunn (BFW)
Hauptstrasse 7
1140 Vienna
Austria

Tel.: +43-1-8770151-0
Fax: +43-1-8770151-50

E-mail: office@iufro.org
Web site: www.iufro.org

**Price:**
EUR 20.-
plus mailing costs

**Printed by:** Seoul National University, Seoul 151-921, Republic of Korea

# TABLE OF CONTENTS

**Foreword** **3**

**Rehabilitating Degraded Forest Landscapes in West and Central Asia – A Synthesis** **5**
Michael Kleine, Alper H. Colak, Simay Kirca, Khosro Sagheb-Talebi, Almazbek Orozumbekov and Don K. Lee

**Forest Rehabilitation in Iran** **27**
Khosro Sagheb-Talebi, Peyman Yousefi, Mona Kananian

**Forest Rehabilitation in Kazakhstan** **83**
Valeriy V. Meshkov, Sabit B. Baizakov, Anastasia V.Yeger, Almazbek Orozumbekov

**Forest Rehabilitation in Kyrgyzstan** **131**
Almazbek Orozumbekov, Turatbek Musuraliev, Biimyrza Toktoraliev, Askat Kysanov, Bakytbek Shamshiev, Ormon Sultangaziev

**Restoration, Rehabilitation and Management of Deforested and Degraded Forest Landscapes in Turkey** **183**
Alper H. Colak, Simay Kirca and Ian D. Rotherham

**Forest Rehabilitation in the Republic of Uzbekistan** **253**
Evgeniy Botman

# Foreword

This publication on forest rehabilitation and afforestation in West and Central Asia is the latest one in a series of books published within the framework of the “Keep Asia Green” Initiative. This initiative is a collaborative effort of leading forest research institutions in Asia supported by the International Union of Forest Research Organizations (IUFRO) through its Special Programme for Developing Countries and the ASEAN-Korea Environmental Cooperation Project (AKECOP). Generous financial support for the project has been provided by Yuhan Kimberly Ltd., a leading business concern based in the Republic of Korea involved in the production of high quality paper and hygiene products.

Over the last four years, forest specialists from the various sub-regions in Asia have worked together and compiled topical information on forest rehabilitation in each sub-region. The publications are intended to be a source of sound information for investors, policy-makers and the general public who are interested in the rehabilitation and restoration of forest ecosystems in the region. The work not only addresses major issues such as status of forests in Asia, causes of forest degradation, and past and current rehabilitation efforts and achievements but also critically analyses national capacities in forest rehabilitation, existing research and education programmes on forest rehabilitation, and past and future initiatives to strengthen forest rehabilitation efforts. This information is used to formulate recommendations for future policies and management strategies needed to support forest rehabilitation in the Asian region.

In the fourth and final phase of the Keep Asia Green Publication Project on West and Central Asia, forest rehabilitation issues in five countries of West and Central Asia have been addressed. The countries include Iran and Turkey in West Asia as well as Kazakhstan, Kyrgyzstan, and Uzbekistan in Central Asia. The forests in this region represent a diverse array of forest landscapes ranging from coastal forests, wetlands and lowland forests in temperate zones to arid and semi-arid ecosystems as well as watershed areas in high mountain regions. Forest rehabilitation activities and programmes take place in the context of very different ecological and socio-economic situations and include afforestation on barren land in semi-arid areas, planting of trees and ground vegetation to combat desertification, rehabilitation of forests for flood prevention and protection against avalanches, replanting in burned forests, establishment of fast growing tree plantations, stand management and improvement of fruit tree forests, and the conservation of biological diversity covering a wide spectrum of ecosystems from lowland steppe to high mountain Spruce and Juniper forests.

Considerable experience with forest rehabilitation has been gained in West and Central Asia over the past decades resulting in significant progress in re-greening the environment. However, given the rapid economic development in the region, forests remain under tremendous pressure and require additional resources and expertise for their conservation, further expansion and sustainable management. Thus, this book may assist decision-makers, investors in forest rehabilitation, environmental advocacy groups as well as forestry professionals and educators to learn from available expertise and past experiences and thereby enhance their contribution to forest rehabilitation in the region.

Finally, we would like to express our sincere thanks to the forest scientists in the different countries in West and Central Asia for sharing their knowledge and experiences, thus providing the foundation for compiling this book; to Yuhan Kimberly Ltd. for substantial financial support to this publication; to the staff of the IUFRO-SPDC Office at IUFRO

Headquarters in Vienna, Austria (Mag. Margareta Khorchidi, Mag. Renate Prüller, and Mag. Eva Maria Schimpf) for language editing and basic text and cover page lay-out as well as Dr. Yeong Dae Park (Seoul National University) and Ms. Jin A Kim (IUFRO President's Office) for workshop coordination and final production of the book. The efforts and contributions to this project are much appreciated and will beyond doubt contribute to the important work of keeping Asia green.

Editor:

Don Koo Lee
IUFRO President

Co-Editor:

Michael Kleine
IUFRO-SPDC Coordinator

# REHABILITATING DEGRADED FOREST LANDSCAPES IN WEST AND CENTRAL ASIA

## A Synthesis

Michael Kleine[1], Alper H. Colak[2], Simay Kirca[2], Khosro Sagheb-Talebi[3], Almazbek Orozumbekov[4] and Don K. Lee[5]

### 1. Introduction: The Countries and People of West and Central Asia

West and Central Asia extend from the Mediterranean Sea in the west to the mountains of the Tian Shan and Altai in the east, and the Gulf of Oman in the south to the Caucasus Mountain and Steppe of Russia in the north. This vast land forms a bridge between Europe and Asia and constitutes not only a wide range of climates, landscapes, and vegetation, but is also home of an extraordinary array of historical heritage, cultures, peoples, land-uses and economic activities. In the present publication of Keep Asia Green Volume IV forest rehabilitation in Iran and Turkey as well as in Kazakhstan, Kyrgyzstan, and Uzbekistan is described. Iran and Turkey possess the most extensive forest areas in West Asia, while Kazakhstan, Kyrgyzstan and Uzbekistan are typical examples of low-forest cover countries in Central Asia.

Geographically, West Asia is predominantly a mountainous region consisting of two extensive plateaus, namely Anatolia in Turkey and the Central Plateau in Iran. The Anatolian Plateau rises steadily towards the east and bounds to the north and south by steep mountain ranges. In the west, this plateau falls gradually to sea level, terminating in a series of promontories. Half of the land in Turkey is above 1,000 m and 10% is over 2,000 m. Further to the southeast of Turkey the mountainous lands extend into Iran forming a high central plateau which is surrounded by mountains in all four geographical directions. Almost 54% of Iran is covered with mountains reaching an elevation of 5,670 m above sea level at the Demavand Peak. The geology of the region is very varied and shows a fascinating mosaic, containing a great range of igneous, sedimentary and metamorphic rocks, including extensive areas of recent volcanic rock and numerous extinct volcanoes.

The Central Asian Region consists of both vast lowland plains mainly in the north bordering Russia as well as mountain ranges of various elevations located in the south and southeast such as the Altai, Dzungarian Ala Tau and the Tian Shan mountains at the border of Western China. The largest lowland plains are located in Kazakhstan and Uzbekistan, particularly in the north and western parts of these countries. On the contrary, Kyrgyzstan is dominated by mountainous landscapes with 85% of the country lying higher than 1,500 m and 42% higher than 3,000 m asl.

[1] IUFRO Special Programme for Developing Countries, Vienna, Austria
[2] Istanbul University, Faculty of Forestry, Turkey

[3] Forest Research Division, Research Institute of Forests and Rangelands, Tehran, Iran
[4] Centre of Innovation Technology in Agriculture of Faculty of Innovation Technology, Kyrgyz National Agrarian University, Bishkek, Kyrgyzstan

[5] Seoul National University, Republic of Korea

Given the enormous variability in topography of the landscape in West and Central Asia, a wide range of climatic conditions can be found in the region. In Turkey, the mountainous topography results in pronounced vertical and horizontal climatic differences from semi-arid to humid conditions. While the coastal areas enjoy milder climates, the inland Anatolian plateau experiences extremes of hot summers and cold winters with limited rainfall. The conditions in Iran are similarly characterized by generally Mediterranean climate with some continental influences. In addition, subtropical conditions can be found in the southern part of the country. Rainfall generally decreases from north to south and from west to east. In contrast, the climate in Central Asia is highly continental with considerably colder winters and hotter summers than in the case at the same latitudes of Eastern Europe. Generally, annual precipitation in the lowlands and foothills ranges between 80 and 500 mm while the mountain areas receive more rainfall at a level of about 1,000 mm per year. Except for the mountains, in the lowlands the annual rainfall is several times less than what could be evaporated, resulting in a considerable moisture deficit. Such a dry climate provides the conditions for the predominance of desert and semi-desert landscapes and requires artificial irrigation for cultivating agricultural crops.

As of 2008, the total population of Iran and Turkey (West Asia) is about 145 million people with half of them living in Iran and Turkey, respectively. Urbanization in the region has started in the 1950s leading to considerable migration of people to cities and townships. In Iran, for example, 65% of the population are living in cities and 35% in rural areas. Almost 50% of the country's population are below 15 years old and 70% are below 25 years old. The population growth rate is 1.2% and it is expected that the trend of population growth will decrease in the next decades. There is a slightly higher birth rate in Turkey (i.e. 1.6%). Although Turkey has seen increasing urbanization in the past, rural areas remain considerably populated with some 87,000 villages located in or near forest areas.

The population in Central Asia varies from country to country and is highest in Uzbekistan (28 million), followed by Kazakhstan (16 million) and Kyrgyzstan (5 million). About 53% of the people in Kazakhstan live in cities while urban populations in Kyrgyzstan and Uzbekistan are only 35% and 37%, respectively. Given the fact that Kazakhstan has by far the largest landmass in Central Asia, its rural areas are considerably less populated, compared to Kyrgyzstan and Uzbekistan. In addition, in both countries the population growth in rural areas is highest and estimated at 1.6% to 1.8% per annum.

## 2. Landscapes and Land-uses

### *2.1 Phytogeographical Regions and Forest Vegetation in West and Central Asia*

The countries of West and Central Asia are home to diverse ecological characteristics caused by varying topographical and climatic features. According to the Global Ecological Zones developed by FAO, Turkey and Iran are mainly separated from the Central Asian countries (Kazakhstan, Kyrgyzstan and Uzbekistan) in terms of phytogeographical characteristics and ecological regimes (Figure 1).

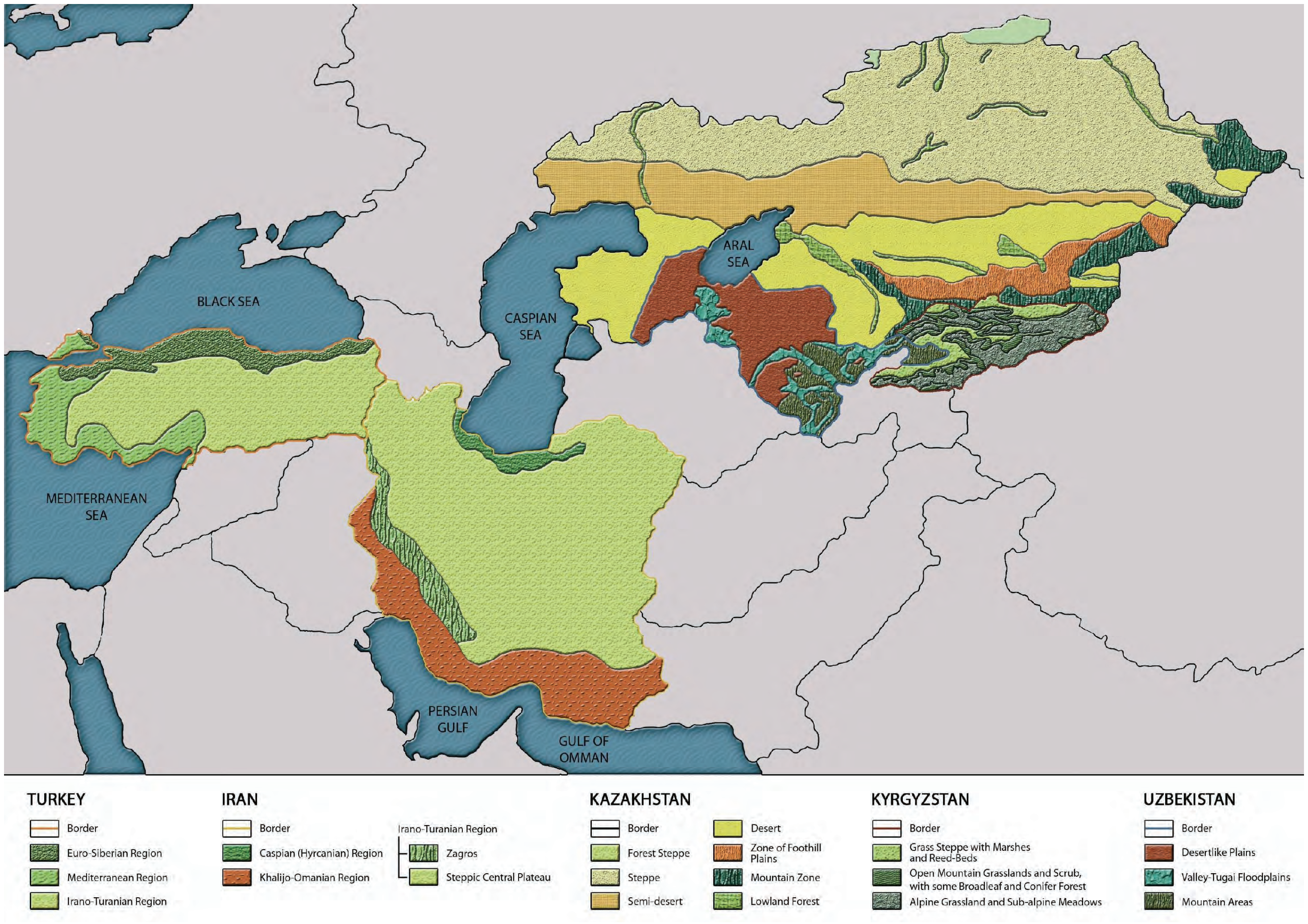



**Figure 1:** ***Phytogeographical regions in West Asia (Turkey and Iran) and Central Asia (Kazakhstan, Kyrgyzstan, Uzbekistan) (Map prepared by S. Kirca)***

Unlike other Asian countries Turkey and Iran are located at the meeting place of several phytogeographical regions such as: Euro Siberian, Mediterranean (only in Turkey), Irano-Turanian and Saharo Sindian (only in Iran), acting as a transition zone between a variety of humid to arid vegetation patterns. As a consequence, the vascular flora of Turkey and Iran contain over 9,000 and 8,000 taxa, respectively, while they are the richest of the Near East and Middle East regions. This richness is of interest for both the total number of species and especially the number of endemics, of which there are approximately 3,000 in Turkey. Thus, the Euro-Siberian Region is an important component of this diversity. At the Black Sea coast of Turkey most of the Euxinian climatic zone below the tree-line is covered with forest or by scrub vegetation where the forest has been destroyed. At lower levels, mainly deciduous species are present, often associated with evergreen shrubs, while at higher levels conifers become dominant. In the north of Iran, the Caspian coast is also characterized by the Euxino-Hyrcanian sub-humid forest vegetation of the Euro-Siberian Region. One of the most striking aspects concerning this region is that deciduous forests destroyed by glacial advances in Europe and Northern Asia survived in Iran. Therefore, the Hyrcanian forests are one of the last remnants of natural deciduous forests in the world. Within the altitudinal distribution of the vegetation, the lack of conifers is the basic indicator for the difference between the two climatic zones of the Euro Siberian Region. The Aegean and Mediterranean coasts of Anatolia are characterized by diverse numbers of geophytes, therophytes, and suffrutescent chamaephytes of the Mediterranean Region, though sclerophyllous vegetation dominates the landscape. Maquis, dominated by evergreen shrubs, covers much of the land below 1,000 m or 1,200 m a.s.l., while the upper montane zone is largely composed of conifers. The Irano-Turanian Region is also characterized by a very large number of genera, sections and species. This is by far the largest of the phytogeographical regions both in Turkey and Iran, and is confined to Central and East Anatolia in Turkey reaching the Zagros Mountains and the Central Plateau of Iran. The broad zone of *Pinus nigra* subsp. *pallasiana* forest borders Central Anatolia in the north and it is usually associated with a largely Irano-Turanian ground-flora. It meets the oak scrub in the west and the south, which is the most abundant type of vegetation on the periphery of the central Anatolian steppes. In the semi-arid vegetation of the Zagros Mountains the climax vegetation is an open xerophytic cold-resistant deciduous oak forest which dominates between 1,000 and 2,000 m elevation and accounts for almost 40% of the country's forests. The Turanian Biosphere Reserve, one of the nine Iranian biosphere reserves with an area of 1.8 million ha, is also located in the vast area of the Central Iranian Plateau. So far, 604 plant species are identified in this reserve, from which 46 are endemic species. Located in the south, the Khalijo-Omanian Region plays an important role in terms of biodiversity with its mangrove forests extending its range from east to west. Apart from these highly diverse forests, Arabian jujube (*Ziziphus spina-christi)*, Indian mesquit *(Prosopis spicigera),* Euphrates poplar *(Populus euphratica)* with various kinds of Acacias are widespread representing sub-tropical vegetation elements and have Sahara-Sindian origin.

Apart from West Asian countries, Central Asian countries mainly belong to the temperate steppe and temperate desert zones as represented FAO's ecological zoning maps. Although this region is characterized by severe winters and rather hot summers in the north and continental air under hot conditions in the southern parts, it has a unique vegetation character determined by various topographic and climatic features. As an example, the more humid north of Kazakhstan refers to the forest steppe zone, and with an increase of dryness towards the south follows steppe, semi-desert and finally the desert zone. In the northern part of the country representing a continuation of the West Siberian Lowlands, birch forests extend over a huge territory, generally scattered among croplands. Continuing to the south, pine woods are seen as the ribbon-like pine forests on the right banks of the Irtysh river. The Kazakhstan Altai covers the eastern part of the Altai range including the right sub-basins of the Irtysh river. This mountain area is covered by forests consisting of spruce, larch, pine, birch and aspen, while *Pinus sibirica* occupies the top part of the mountain slopes. The northern slopes of Tien-Shan Mountains in Kyrgyzstan are mainly home to spruce, apricot and apple tree forests, while spruce forests dominated by *Picea schrenkiana*, walnut-fruit forests (*Juglans regia*, *Malus* sp. and *Prunus* sp.) and juniper forests are present in different altitudinal zones of this mountain range. In the south of the country, where the climate is drier and protected from northern winds, forests are composed of a mix of walnut, maple, apple, cherry, plum, crataegus and almond trees. Although vertical stratification and a variety of climatic zones have caused significant diversity of tree species in Kyrgyzstan, the percentage of forest lands is low. Still, different combinations of species create a wide diversity of forest ecosystems: juniper and spruce at high altitude, walnut-fruit at middle altitude and flood-plain types at foothills. In addition to mountainous vegetation of Central Asian countries desert, semi-desert and riparian areas play an important role in terms of being important habitats for various species. Considering desert and semi-desert regions of Kazakhstan and Uzbekistan, Saxaul (*Haloxylon* sp*.)* is the major component of forests accompanied by tamarisk (*Tamarix* sp.), salt tree (*Halimodendron* sp.), kandym (*Calligonum* sp.) and saltwort (*Salsola* sp.). Riparian areas are characterized by tugai forests (woody-shrub and grassy plant communities), extending by narrow belts along the main water courses of the Amudarya and Syrdarya rivers. These forests are dominated by different species of willow (*Salix* sp.), poplar (*Populus* sp.), ash (*Fraxinus patamopholia*) and accompanying shrubs of the genera Tamarix, Berberis, Hippophae and others. There are also mountain forests present in Uzbekistan as well as other forest types located on foothills and in valleys (i.e. Tugai forests), although they are relatively small in terms of area. They are diverse by species composition, since more than 100 tree and shrub species can be found. Based on composition, the mountain forests can be divided into various types such as juniper, pistachio, almond, nut tree, apple tree, hawthorn, mixed forests, and shrubbery.

### *2.2 Land-uses*

In Iran and Turkey, agriculture represents the dominant land-use with about 10 million and 26 million ha of land under agricultural crop production, respectively. Because the region is basically mountainous, agriculture activities are confined to arable lands in plains, valleys and on slopes with sufficient soil fertility. Although basically rain-fed agriculture is practiced in both countries, un-even distribution of rainfall and partly insufficient total annual precipitation in some areas require irrigation farming. Thus, 58% of cultivated lands in Iran are supported by irrigation compared with only 17% in Turkey. In addition to crop production, most of the other land, particularly in the mountains and semi-arid and arid zones, serves as rangelands and pastures for extensive livestock rearing.

With progress made in development towards richer societies over the past 50 years more land has been used for urbanization and industrialization. An example of changing land-use are the coastal regions in Turkey along the Mediterranean Sea where rapid tourism development took place over the past 30 years. Natural coastal landscapes have been used for infrastructure constructions (e.g. hotels) and converted to other tourist facilities such as golf courses and beach resorts. In both Turkey and Iran, the industrial sector also occupies more and more land for purposes such as oil explorations, pipelines, mining, and the manufacturing industries.

In the Central Asian countries of Kazakhstan, Kyrgyzstan and Uzbekistan the landscape is largely used for agricultural production, though there are significant differences between the countries. In Kazakhstan, 82% of the total area is under some form of agricultural production, mainly large-scale grain farming and cattle breeding. On the contrary, agricultural production in Kyrgyzstan and Uzbekistan is of smaller scale because of the mountainous terrain conditions and semi-arid and arid climatic conditions. Before the collapse of the Soviet Union, large-scale farming mainly based on artificial irrigation was practiced leading to the current-day environmental degradation e.g. around the Aral Sea.

There is also considerable land in the region used for industrial and mining purposes. Large areas have been degraded through oil and gas exploitations, construction of pipelines, coal mining and other exploratory activities.

### 2.3 Urbanization and Industrialization

Rapid industrialization took place in West and Central Asian countries starting in the middle of the 20$^{th}$ century. In Iran, for example the main industries that emerged include oil and gas explorations, metallurgy and steel factories, petro-chemical and chemical industries as well as automobile manufacturing. The region is also known for the production of consumer goods such as textile, carpets and handicrafts, cement and chalk, and food and nutrient products. Over the last 20 years tourism has taken a prominent position in the development of Turkey, particularly in the Mediterranean Region, providing important opportunities for the expansion of the services sector and related industries.

In Central Asia, Kazakhstan is endowed with rich mineral resources. Of the 110 known minerals worldwide, 99 are found in Kazakhstan and about 60 are currently being exploited. Such natural resources include oil, gas, titanium, magnesium, uranium, gold and other non-ferrous metals. More recently, new gold mines have been opened in Kyrgyzstan. Given the immense water resources available in lakes and rivers on Kazakhstan, Kyrgyzstan and Uzbekistan, there is also a considerable potential for power generation which presently is only partly exploited.

Urbanization in the region was generally low before the 1950s, with large parts of the population still living in rural areas. However, with progress made in export-oriented industrial production including mining of oil and gas, power generation, as well as manufacturing of consumer goods, urban areas grew rapidly. Today, about 80% of the population of Kazakhstan live in cities while this share is only 42% in Uzbekistan. In Iran, for example, about 65% of the population reside in urban centres that have emerged mainly at the periphery of the central desert of the country. With progressing urbanization the need of green space in cities and densely populated settlements arose, thus marking the starting point for initiatives such as urban greening and urban forestry in the region.

## 3. Status of Forest and its Degradation

### 3.1 Status of Forests

#### West Asia

Following the end of the glacial period some 15,000 years ago, most of West Asia has been covered by forests or forest-like vegetation. Paleo-botanical evidence indicates that the climate became gradually dryer around 4,500 years B.C. but the region was still endowed with a thick vegetation cover adapted to warmer and dryer climatic conditions. For example, 4,000 years ago the Anatolian landscape was composed at 60% to 70% of forest and 10% to 15% of steppe while the Iranian Central Plateau was also covered with trees and shrubs.

Today, the total forest area in Turkey is around 21.2 million ha or 26%, of which almost all is 'natural' in origin and contains over 450 species of trees and shrubs. One of the reasons for the rich biodiversity is the fact that Turkey is the only country in Asia containing all features of the Mediterranean phytogeographical region. The majority of the forest area is stocked with coniferous high forest stands followed by broadleaved and mixed forests. About 30% of the forests are coppice forests. Nearly the whole forest asset belongs to the government (99.99%) while just 15,864 ha are owned by private and local entities.

The current total forest area of Iran is approximately 13.4 million ha. With a forest cover of only 8%, Iran belongs to the Low Forest Cover Countries (LFCC) according to the FAO classification. Because of its predominantly subtropical and semi-arid to arid climate, large territories are occupied by range lands, and desert-like ecosystems with large scrub and bush vegetation, particularly in the central and southern parts of the country. Given this situation, high forests for timber production are located near the Caspian Sea while the majority of forests provide predominantly environmental services such as soil protection and non-wood forest products. With 8,000 plant species, Iran is home to a rich biodiversity and represents a major centre of endemism. The government nationalized all forests in 1962. However, rural people such as farmers and herders maintain their local and customary rights and continue to take advantage of the forest resources.

***Central Asia***

Central Asia is characterised by highly continental climatic conditions shaping a typical vegetation cover made up of a variety of ecosystems such as steppe, prairies, semi-deserts and deserts as well as mountain vegetation at higher elevations. In Kazakhstan, the largest country in the region, forests cover about 12.3 million ha representing 44% of the State Forest Fund area of 27.8 million ha or 10.2% of the total territory. In the former Soviet Republics, state forest funds are government-owned territories including forests, arable lands, steppe and unproductive lands. The major ecosystems with some form of tree cover include forest steppe, steppe, semi-deserts and deserts, foothill plains, the mountain zone, and lowland forests. With more than 6 million ha, haloxylon deserts take up the major part of the forest area followed by coniferous forests and birch forests.

The Uzbekistan's State Forest Fund area extends over 8.2 million ha of which 2.9 million ha are covered with various forest types (i.e. 7.3% of the total area). More than 80% are desert-like lowland ecosystems and the rest consists of forests in mountains, floodplains and valleys. The main species in desert-like forests is saxaul, while juniper, pistachio, walnut, maple and wild fruit-bearing species can be found in mountain forest stands. The flood plain forests or Tugai contain a mix of broadleaved tree and shrub species including poplar, willows, Russian olive and tamarisks.

Among the three countries of Central Asia described in this book, Kyrgyzstan is the most mountainous one. Therefore, the major part of its 0.9 million ha of forests (i.e. 4.3% of the total area of the country) represents mountain forest ecosystems dominated by spruce and juniper, the latter reaching elevations of up to 3,200 m. In the dryer and warmer region in the south, forests are composed of a mix of walnut, maple, apple, cherry, plum, and almond trees. Similar to other countries, also in Kyrgyzstan, forests are made up of willows and poplars which can be found in valleys along major rivers.

## ***3.2 Forest Degradation***

West and Central Asia are known for their diverse ancient civilizations that have significantly shaped the landscapes and vegetation for millennia. The region has seen human activities in many different eras such as early cultures like Achemenidian and Sasaniden in Iran, Hittites, Greek and Romans in Turkey as well as the Oxus civilization and nomadic tribal cultures along the so called “silk-road” through Central Asia connecting East Asia and South Asia with the Mediterranean world. Despite of the long history, there is no exact data available about the forest area in the previous centuries. However, extensive historical evidence exists of the regular use of wood for buildings, ships and other purposes pointing to the fact that large parts of the original forest cover in the region have been reduced over the centuries. Many of the woodlands have also been utilized for long in the past on a sustainable basis for vital livelihood purposes, but more recently were significantly altered with the advent of industrialization. In the following, major natural and human-induced phenomena and causes of forest degradation are summarised providing the basis for understanding the various ongoing initiatives and future needs of forest rehabilitation in the different countries of the region.

### *3.2.1 Human-induced phenomena*

The degradation of forests in the region caused by men is the major factor for changes in forest area, structure and species composition, soil degradation, water pollution and overall loss in vital social benefits derived from forests.

#### *Expansion and intensification of agriculture*

The entire region has experienced a significant expansion of agricultural land over the past 60 years, both for agro-industrial purposes and small-holder farming. The major underlying reason is that after World War II the population has steadily increased leading to much higher food demand both in rural areas and expanding urban centres.

- Although in Iran earlier efforts were made to reduce the population growth, the number of people more than doubled from about 30 million to 70 million over the past 30 years. Only recently, the birth rate slowed down to about 1%. In Turkey, high population density combined with traditional agricultural methods, the use of steep slopes for cultivation and generally low output of land are the main causes of expanding agriculture at the expense of forest areas. In the Zagros region of Iran, for example, rain-fed shifting agriculture is one of the main causes of degradation of forests and soil resources.

- There has been a moderate to high annual population growth in Central Asia, particularly during the transition from a nomadic to a sedentary lifestyle (mainly by Kazakh and Kyrgyz people) accompanied by expansion of agriculture lands. In Uzbekistan, for example, the population increased from 4 million to almost 28 million in about 100 years while Kazakhstan and Kyrgyzstan have experienced a moderate increase in their populations. The expansion of agriculture lands took place mainly along the rivers and affected the floodplain forests in Kyrgyzstan and Uzbekistan.

- Intensification of irrigated agriculture on a large-scale in Kazakhstan and Uzbekistan during the Soviet times led to a reduction of forest riparian ecosystems and drying up of most of the surface of the Aral Sea. Withdrawal of water from the region’s rivers for artificial irrigation and power generation through the construction of large dams and operation of water storage reservoirs completely changed natural water regimes of the rivers. Because of these changes the floodplain ecosystems (i.e. mainly the poplar forest) along rivers have been negatively affected and in many areas their future is uncertain. Agricultural development of virgin lands in the north of Kazakhstan has led to a reduction of forest steppe ecosystems.

### *Overgrazing*

Over centuries, livestock has been crucial to agriculture in West and Central Asia both in nomadic and sedentary agriculture. Besides the extensive grasslands of the steppe zone and the rangelands of the semi-arid regions, forests have always played an important part as pastures for livestock rearing. In Turkey and Iran, it is estimated that current grazing levels are three or four times above what is reasonable according to normal rangeland grazing capacity. In terms of grazing capacity in Anatolia (Turkey) for example, in 1935 one animal grazed 2.2 ha, while today the amount of grazed land by one animal is 0.76 ha. Grazing in the forests causes significant damages to natural regeneration and leads to a depletion of species diversity gradually degrading the forest stand beyond the capacity of natural recovery. Although in Kyrgyzstan livestock has been reduced down to one third of original numbers before independence from the Soviet Union, grazing still poses a problem in forest areas located near farms and settlements. In addition, hay-making in the forests is conducted nearly everywhere providing an essential feed source to many livestock owners. Such activity results in the destruction of the natural regeneration of nearly all tree and shrub vegetation.

### *Overexploitation of forest resources*

A problem with the utilization of forests common to almost all regions in the world is the over-exploitation of forest resources. West and Central Asia are no exception and have seen large-scale unsustainable use in terms of commercial timber exploitation, extraction of wood for domestic purposes, and the collection of non-wood forest produce such as fruits, mushrooms, berries and medicinal plants. In Iran, for example, rural people of the Zagros region are highly dependent on forests and 80% of their fuelwood demand is supported by coppicing of oak stands. Similar pressure is put on forests in Turkey in order to gain wood based raw material leading to the destruction of valuable forests. In the first years of modern forestry, clear-cutting was applied in many forests, including mixed forests, in large areas, especially in mountainous regions.

Central Asian countries are also affected by illegal logging activities, particularly after the collapse of the Soviet Union. Current prices are often not affordable for the majority of the local population and this pushes people to fell forests, basically poplars and juniper species suitable for construction purposes. Illegal practices have also been reported from walnut forests, e.g. in Kyrgyzstan which have been heavily exploited for its valuable timber.

### *Industrialization and urbanization*

Over the past 70 years, there has been an expansion of industrial and urban areas all over West and Central Asia. Due to rapid population increase, e.g. in Turkey, within the last few decades many natural habitats have been fragmented, reduced in size, degraded or destroyed. Besides the establishment of industrial sites, an increasing threat from uncontrolled and unsustainable tourism development in Turkey can also be observed. This is largely associated with dense housing and countless luxurious hotel constructions along the coastal zones.

Similarly, in Iran with the rapid growth to reach higher living standards, the implementation of development projects has high priority. Unfortunately, communication between the government and non-governmental organizations as well as between the industrial and natural resources sectors has been limited. In protecting the natural environment, significant challenges need to be overcome in planning and implementing mining activities, establishing all kinds of industries, construction of water dams, highways and oil and gas pipe lines as well as expanding and establishing new cities and settlements. In Central Asia, large scale gas and oil explorations, construction of railways, and factories mainly in Kazakhstan and Uzbekistan had negative effects not only on the areas where such facilities are located, but also on the surrounding environment. A special issue of concern in Kazakhstan is the environmental damage caused by a former nuclear test site in the country.

***Managerial, legal and administrative issues***

A number of managerial and technical issues have also been identified in the region causing some form of forest degradation and need to be addressed in future forest rehabilitation activities.

- West Asia, particularly Turkey has seen speedy afforestation of degraded lands in the past. However, in these afforestations almost exclusively monoculture conifers were established and some of them with exotic tree species. These mistakes have later been corrected with the transformation of monocultures into mixed species forests using mostly native broadleaved species. A similar managerial issue is reported from Iran where the unique broad-leaved forests of the Caspian Region in the past 30 years were largely managed under the uniform shelterwood system in order to establish even-aged single-species stands. This silvicultural system was not suitable for the natural mixed uneven-aged broad-leaved forests and thus required a shift to the silvicultural selection method and reduction of wood harvests.

- In Central Asia, particularly Kazakhstan, damage to woodlots in the steppe zone has been caused by extensive ploughing along the edges of the forests, destroying tree roots and changing the hydrological system and soils near the forests. Also excessive clear-felling without proper regeneration resulted in low quality of next stand generations. In general, inappropriate irrigation systems, mainly characterized by unsustainable water use, have led to lower ground water tables and thus water shortage, increased salinity of soils and wide-spread physical degradation of land.

- Land tenure issues, particularly after the collapse of the Soviet Union, have also played an important role in the degradation of forests in Central Asia. In Uzbekistan, the transfer of land to farmers hampered government-operated field-protecting afforestations and required a shift to a decentralized agroforestry system with obligatory creation of field-protective forest stands. Changes in employment, e.g. in Kyrgyzstan, resulted in more people becoming dependent on agriculture and harvesting natural resources for their daily needs as well as for income generation. Inappropriate distribution of land ownership and its legal implications in Turkey, combined with a lack of coordination between institutions responsible for land-use policy and land management has resulted in unsustainable use of forests leading to severe degradation.

- Insufficient investment into forest rehabilitation has also been identified as one of the major reasons for forest degradation in Central Asia. Following the collapse of the Soviet Union, government budgets for afforestation and forest rehabilitation dried up and the newly independent states are still struggling to mobilize sufficient funding for environmental protection and rehabilitation. In West Asia, forest rehabilitation has received greater attention in government budgets over the past decades. Thus, shortage of funding was not such a severe issue compared to the situation in Central Asia.

### *3.2.2 Natural phenomena*

***Forest fire***

Uncontrolled fire in the forests can have many different natural and anthropogenic causes. However, as in many other regions with developing economies undesirable forest fires are largely caused by human activities associated with most of the underlying factors of forest degradation mentioned above. Although fire is considered to be an important component of ecosystems, particularly in the Mediterranean Region, forest fire is a symptom of unsustainable use of forest resources in most cases. As an example, in Kazakhstan, in 1998, forest fire damaged 240,000 ha of forest area and completely destroyed 4.3 million $m^3$ of standing timber. Although this has been an extreme event, forest fire is a phenomenon regularly affecting forests throughout the region.

***Desertification***

Desertification is the result of various natural and anthropogenic causes. In recent years, natural changes in climatic conditions have been compounded by unsustainable land-uses as described earlier under human-induced causes of forest degradation, mainly under semi-arid and hyper-arid conditions. Although there are at present no deserts in Turkey, there is a significant erosion risk over much of the area, with associated potential desertification risk. Moreover, agricultural lands and villages were threatened by shifting sand dunes. In Iran, the total area of deserts is estimated at 32.86 million ha or 20% of the total land area. A total of 19.5 million ha of deserts are exposed to wind erosion causing dangerous shifting sand dunes.

Desertification is considered the key issue in land rehabilitation and forest management in Central Asia. Almost two-thirds of the territory of Kazakhstan, for example, is affected by some form of desertification. As reported from Uzbekistan, anthropogenic factors outlined above combined with the effects of the drying up of the Aral Sea and a generally warmer and drier climate are responsible for progressive desertification. Indicators for desertification include more open forest stands, reduction in ground vegetation cover, and lower soil productivity.

***Pests and diseases***

Various pest and diseases are common throughout Central Asia, and without proper control and protection measures have caused severe damage to both coniferous and broad-leaved forests. In Kazakhstan, for example, hazardous organisms are responsible for damages to an annual forest area of 100,000 to 300,000 ha. The region’s valuable fruit forests with walnut, pistachio, apple and other fruit trees have been attacked repeatedly by gypsy moth and other leaf insects. Conifer forests frequently struggle amongst others with pine loopers and beetles as well as pine fungi and fir needle rust. In contrast, in Turkey, the situation in terms of pests and diseases has become less drastic. The occurring pests and disceases are a regular component of the ecosystem. However, a typical increase has been examined in recent years, with the growing anthropogenic pressure on forests.

## 4. Forest Rehabilitation and Restoration Activities

### *4.1 National Rehabilitation Policies and Targets*

In the recent past, all countries in the region have undertaken considerable efforts in afforestation and forest rehabilitation. These activities have been guided by various governmental policies and strategies, briefly summarized as follows:

In West Asia, the general objectives of forest rehabilitation identified by the governments of Iran and Turkey are to reverse the loss of natural and man-made forest cover, and to establish new forest stands on lands that were deforested a long time ago. More specifically, Turkey has determined a number of concrete outputs of rehabilitation including restoring ecosystem processes, accelerating forest productivity, enhancing environmental services, and sustaining cultural mosaics. It is estimated that to date around 10.2 million ha of forest land is still degraded or highly degraded and needs to be transformed into productive or a more natural state with the implementation of rehabilitation and restoration works. In addition, there are around 18 million ha of bare land that needs to be converted into a productive state through afforestation. The national policy on forest rehabilitation in Iran gives priority to reducing and, if possible, eliminating degradation factors in existing forests, followed by regeneration of degraded areas with native species for both timber production and the enhancement of non-wood forest products. Emphasis is also given to the establishment of nature reserves and protected areas.

The national policies on forest rehabilitation in Central Asian countries generally focus on expanding the overall forest cover and enhancing the environmental and protective functions of forests and wood lands. In Kyrgyzstan, the forest code provides the forests with an exceptional protection status giving high priority to forest functions such as soil and water protection, biodiversity conservation, and provision of wood and non-wood forest products to rural communities. Towards this end, the government plans to increase today’s total forest cover of 4.3% to about 6% by 2025. In Kazakhstan, the main focus of forest rehabilitation is on regenerating, within the shortest possible period of time, cutover stands, burned forests and open stands using economically valuable species as well as afforestation of treeless lands to increase the overall percentage of forested area in the country. Similarly, Uzbekistan has put in place a programme devoted to reforestation, enhancement of the environmental and protective forest functions and also expanding the forest area of the Republic. This needs to be achieved through rational use of state forest funding, conservation, protection and development of forest resources, and particularly through afforestation to combat desertification in arid zones.

### *4.2 Forest Rehabilitation Approaches*

Forest rehabilitation and afforestation works of considerable scale have been carried out in West and Central Asia for many decades and accumulated a wealth of approaches in terms of site-specific planning, technical and operational methods, and locally adapted organizational arrangements. In Turkey, for example, a generic structure for the implementation of forest rehabilitation has evolved including the following principles:

- Locality characteristics vary within short distances. Therefore, survey and site-specific planning is important. Implementation projects are analysed in detail for location, climate, vegetation cover, topography of site, physical and chemical characteristics of the soil, land property status, existence of social conflicts and the demands of the local community.

- Adaptation of available participatory approaches and tools for rehabilitation and restoration projects with different management objectives, socioeconomic and ecological conditions, and stakeholder groups.

- Determination of simple technical guidelines on how to design, implement and monitor efforts, incorporating participatory approaches and tools for different objectives and site conditions.

- Evaluating prospects for forest products and environmental service payments to communities. This includes the feasibility of producing high-value timber for industries; timber, fuelwood, and other forest products for local needs and markets; and payments for biodiversity and watershed at the local to national levels.

- Framework for assessing potential contribution and impact of different rehabilitation approaches to communities, in comparison with other local income-earning opportunities and alternative land-uses.

- Boosting policy, donor, and implementation support for genuine local participation and consideration of local needs in the projects.

Although outlined specifically for the conditions reigning in Turkey, major elements of the above structure combined with the required expertise can also be found in Iran, Kazakhstan, Kyrgyzstan and Uzbekistan. In the following synthesis, the rehabilitation approaches found in the region have been grouped according to major ecological regions with distinct differences in topography, local climate, forest types and predominant rehabilitation objectives.

### *4.2.1 Watershed rehabilitation in mountainous regions*

Controlling and minimizing soil erosion is one of the most important driving forces for the rehabilitation of degraded forests and bare lands in West and Central Asia. Except for the large plains in Northern Kazakhstan and West Uzbekistan, almost the entire region is mountainous and thus prone to soil erosion through surface water, if insufficiently covered with tree vegetation. Towards this end, impressive achievements in soil erosion control and reforestation of bare lands can be reported from Turkey. Already in 1935, smaller-scale reforestation activities commenced and gradually increased to more than 100,000 ha per year. By the turn of the millennium, the overall total was near to 3 million ha of land that had been reforested and/or treated with other forms of erosion control work. The methods included intensive mechanical site and soil preparations, such as land clearing, terracing and planting spot preparations, various forms of seeding and planting with subsequent maintenance and control of reforested areas. Experience has shown that successful watershed rehabilitation for erosion control and maintenance of water supplies for irrigation requires a mosaic approach, where protected areas, other protective forests, and various forms of the management of trees, grassland and agricultural crops need to be combined depending on existing needs of local people and land ownership patterns. Agreeing on the mosaic and balancing different social, economic, and environmental needs on a landscape scale requires careful planning and negotiation.

About 55% of the watershed areas in semi-arid zones in Iran are flood-prone. Uneven distribution of precipitation during the year and unexpected heavy rainfall lead to heavy floods, bringing millions of cubic meters of water onto the land in a short period of time. This huge amount of water usually destroys villages and agricultural lands along with other vital infrastructures, such as roads and dams. In order to mitigate these negative effects, Iran has developed adequate technologies and has become a pioneer among the countries of the region in preventing land degradation and controlling desertification through floodwater spreading. This approach aims at satisfying the water requirements of annual and perennial crops, range plants, shrubs and trees; removing sediment carried by floodwaters for later storage in surface reservoirs; stabilizing drifting soils, silts, clays and organic matter carried as suspended load by floodwaters; transforming land into productive farms; reducing gully erosion and controlling downstream flooding as well as preventing water logging of agricultural lands and downstream population centers.

Rehabilitation under mountainous conditions in Kyrgyzstan is primarily made with juniper and spruce forests. Both forest types can be found at middle and high altitudes of the country and play important roles in stabilizing the mountain ecosystems. Past efforts to increase the area of spruce and juniper forests been successful only partly because of various reasons. There were problems with germination and raising planting stocks of juniper, heavy demand of spruce and juniper wood for industrial purposes and the fact that large parts of the mountain forests are used for grazing thus preventing natural regeneration. However, in recent years, some moderate progress in increasing the area of these forests has been reported.

In the mountains of Uzbekistan, forest rehabilitation includes terracing of mountain slopes with forests, nut-bearing and fruit plantations, orchards and vineyards; creation of erosion control forests along ravines and on the banks of rivers and water reservoirs, and afforestation in riverbeds and temporary water streams. These forests have soil protective functions and help regulate the water regime under the prevailing semi-arid conditions. In addition, the newly established forests, particularly fruit forests and orchards, also contribute to meet the livelihood needs of the rural population. However, currently attention is given to afforestation of the dried bottom of the Aral Sea as well as to increase productivity of arid pastures by methods of forest amelioration.

Forest rehabilitation in Kazakhstan is in principle based on forest types and guided by earlier research and development works of Russian scientists. In the mountain areas, reforestation is mainly carried out by planting spruce, silver fir, and pine using various spacing arrangements and site preparations. Depending on the site conditions, also mixed fruit tree forests with apple, walnut, pistachio and almond, mainly through seeding, are established.

### *4.2.2 Combating desertification*

As a predominately semi-arid to arid region, West and Central Asian countries are permanently confronted with the problems of desertification. In the past, large tracts of lands have become unproductive due to progressive expansion of desert ecosystems made up of sand, stones and sparse vegetation. The largest areas affected by desertification are in Iran, Kazakhstan, and Uzbekistan. Thus far, considerable efforts have been made to address this problem through various land rehabilitation measures. It should be noted that gradual land degradation leading to desertification is also taking place in mountainous regions throughout West and Central Asia. In Turkey, for example, there are not any actual deserts, but there is significant soil erosion over much of the area with associated potential desertification risk. The diverse topography of the region along with deforestation, unsuitable tillage, and irrigation management, has exacerbated the rate of erosion for centuries. Measures to mitigate soil erosion in mountainous areas have been addressed by the various countries as integral part of their watershed rehabilitation programmes.

In the arid and semi-arid regions of Iran, like the Irano-Touranian and Khalijo-Omanian Regions, reforestation and enrichment of forest cover are of high priority. This is carried out by planting pioneer species on open areas, in order to create favorable conditions for the return of native species. Considering the ecological potential of these areas, natural recovery is a very promising approach. However, such projects are only successful if they are based on adequate prior ecological surveys and planning.

A common approach in combating desertification in the lowlands of Central Asia, mainly in Kazakhstan and Uzbekistan, and some areas of Iran, is the establishment of homogeneous stands of saxaul, saltwort and others. This bush-like tree is a very hardy species and suitable for extremely dry site conditions. However, the success of saxaul cultivation depends on the type of soils, degree of their salinity and ground water level. Taking into consideration the peculiar features of desert soils, soil preparation in strips is applied for homogeneous stand establishment. In addition, specific technologies have been developed for even more intensive site preparations such as those applied in Uzbekistan. These include plowing the soil down to various depths and the creation of two types of trenches for the purpose of accumulation of moisture as well as capturing shifting sand. Shifting sand dunes are a particularly serious problem concerning, for example, already about 1 million ha of land in Uzbekistan. Special methods of dune fixation through row planting of saxaul and other species in combination with the establishment of shrub and grass cover subsequently used as pastures are required.

#### *4.2.3 Land rehabilitation of the Aral Sea*

As a result of aggradation of the Aral Sea, Kazakhstan and Uzbekistan are faced with a special problem related to the rehabilitation of a newly created landscape. The retreating Aral Sea left behind a desert-like landscape extending over an area of 36,000 $km^2$ causing an ecological crisis in the region. The land is covered by a thick layer of salt and different residual chemical compounds which are moved around by strong winds over long distances of 250-300 km and more. The dried bottom land of the former lake consists of light and heavy soils as well as shifting sand dunes. Rehabilitation of these desert sites is attempted through protective strip plantings in combination with grass cover establishment, melioration plantings with shrubs and bushes for forage production, and shrub plantations for the purpose of reducing wind erosion. The rehabilitation measures are mainly directed towards stabilizing the sandy soils and reducing the contamination of its chemical compounds spreading around the region through wind erosion. Thus, these measures help improve the environmental conditions for people in adjacent cities and rural areas. Although initial success can be reported through the establishment of protective plantings, additional future efforts and investments in land rehabilitation are required to overcome the current ecological crisis of the Aral Sea region.

#### *4.2.4 Rehabilitating production forests in various ecological zones*

Depending on the ecological region and specific circumstances within the countries in West and Central Asia, various approaches are pursued to rehabilitate and improve the ecological, economic and social functions of forests. Turkey and Iran have the longest tradition of systematic forest management in the region, partly building on forestry concepts and experiences made in Central and Southern Europe. In Turkey, for example, emphasis is placed on restoring the quality of existing native forests and replacing exotic tree plantations with native species. This is the consequence of massive expansion of the forest area over the past several decades, also using exotic species largely sub-optimal for local site conditions. The restoration towards native forests takes also place in protection forests and assists in restoring natural soil and ecosystem processes. In addition, there is also a programme of restoring deadwood in native forests, in order to re-establish a critical microhabitat in the forest landscape, thus contributing to overall maintenance and enhancement of biological diversity. Furthermore, burnt forests are replanted with native species, so are coppice forests with the aim to convert these to more productive high forest stands.

Like in Turkey, Iranian production forests are also subject to systematic management and rehabilitation. In the humid Caspian region, for example, with optimal growing conditions, forests are regenerated after clear cut either by direct sowing or planting. Depending on topography and site conditions, pure or mixed stands of conifers or broad-leaved species are established. Heavily degraded sites are reforested with pioneer plantations made up of native maple and alder or exotic conifer species. Species composition in existing forests is also influenced through enrichment planting considerably raising the value of the forests. This approach follows the “close to nature” concept introduced into Iranian forest management plans promoting the use of native species. More recently, a revival of traditional agroforestry systems took place in various parts of the country integrating trees into agricultural production. In addition, the traditional system of poplar cultivation has been expanded through plantations providing wood for domestic and industrial purposes.

Production forests in Kazakhstan composed of pine and birch species are located in the northern and central parts of the country. These forests are mainly rehabilitated by artificial planting using saplings raised in tree nurseries for two to three years. On site, where natural regeneration is not an option such as glades, wastelands and burned-out forest lands, mechanized planting is carried out using heavy machinery. In the fruit-tree and broad-leaved mountain forest zone of South Kazakhstan forest cover is expanded through the establishment of homogeneous stands composed of apple trees, apricot trees, walnut, almond and pistachio. Likewise, walnut-fruit forest rehabilitation and expansion of its area is a priority in the forestry sector of Kyrgyzstan because of the significance of these forests for local people in terms of their timber and non-timber products. However, due to heavy exploitation, the forest is under pressure and suffers a considerable reduction in its area, decrease of stand density, declining natural regeneration capacity, loss of genetic diversity, and the loss of protective functions such as soil conservation and regulation of water regimes.

Riparian woodlands or tugai forests occur in the floodplains of major rivers in Southern Kazakhstan, Kyrgyzstan and Uzbekistan. Besides their role of soil and water protection, they also provide important wood products for local consumption. Depending on site conditions and level of degradation, various timber species are used for rehabilitation such as poplars, ash trees, oleaster and willows.

#### *4.2.5 Establishment of protected forest areas*

The five countries of the region described in this book have undertaken considerable efforts in placing valuable forest types under some form of protection. This recognizes the region’s rich biodiversity and forest ecosystem’s social functions, such as existence value, research and education, recreation, and tourism. Since the 1950s, a wide range of *in-situ* conservation areas have been established in Turkey, including national parks, nature parks, natural monuments, nature protection areas, wildlife conservation areas, recreation areas, gene conservation forests, seed stands and seed orchards. In this way, the total protected area has increased from 1% to about 3%.

Currently, protected areas in Iran include national parks, ecological reserves, wilderness areas and sanctuaries. The conservation of biological diversity has highest priority. In addition, the forest reserves are categorized as managed nature reserves. These protected areas consisting of 91 forest reserves with a total area of 80,628 ha, account for 0.65% of the entire forest area of the country. Furthermore, nine regions in Iran are internationally recognized as biosphere reserves under UNESCO’s Man and Biosphere Program demonstrating the development of a balanced relationship between people and nature.

Within the next decade Iran aims to declare 10% of the total forest area as protected forests. Placing forests under special protection is also a common measure taken in Central Asia with the purpose of biodiversity conservation, research, education, and recreation. In Kazakhstan, the area of specially protected natural reserves has been increased twice during the last five years and reached 22 million ha, representing 8.0% of the total territory of the country. These protected areas include 10 state wilderness areas, 9 state national nature parks, and 3 state nature forest reserves. Similarly, in Kyrgyzstan, the conservation of biological diversity and key habitats is being pursued through the creation of a network of specially protected nature reserves. Within the GEF-UNEP-WWF Project “Creation of the ECONET for the long-term biodiversity conservation within the eco-regions of Central Asia” an environmental network has been developed, which includes protected areas of different categories guaranteeing the conservation of the main natural ecosystems and extension of the protected areas to 10% of the total territory of the country. The forest policy of Uzbekistan also aims at extending the area of fully protected forests to 10% of the country’s total land mass. However, given the large portion of rural population, such an expansion requires careful planning taking into account the needs of people residing in these areas. This is important as negotiation is seen as one of the key factors for the success and sustainability of restoration and rehabilitation activities.

## 5. Capacities in Forest Rehabilitation

According to FAO’s 2005 World Forestry Report, Turkey was listed among the top ten countries that have been successful in large-scale afforestation. This would not have been possible without national capacity development including support by the Government, and participation of public institutions and the private sector. Given the severity of soil erosion in most parts of the country, national afforestation campaigns involving many public institutions and non-governmental organizations were undertaken, mobilising resources and support throughout the country. The current Action Plan (2008-2012) aims at afforestation, rehabilitation, erosion control and rangeland rehabilitation works on 2,300,000 ha.

Like in Turkey, forest rehabilitation and afforestation in Iran is also mainly driven by governmental institutions resulting in impressive achievements in the past. However, reinforced by changing macro policies the role of the private sector and the local communities in the establishment of forest plantations is gradually gaining importance and will increase even further. At present, there are 35 NGOs active in the field of natural resources management, among them is the very active NGO of Mountain Climbers concentrating on the development of forest plantations in mountainous regions.

In the Central Asian countries of Kazakhstan, Kyrgyzstan and Uzbekistan, forestry operates on a fairly stable legal and institutional basis. Under the past Soviet Regime, large-scale reforestation projects were funded and supervised by central governmental bodies. However, due to the transition to a market economy following independence, the efficiency of forest rehabilitation works suffered and at present need to be increased through enhanced governmental support to the private sector for forest plantation establishment. In addition, other types of forest rehabilitation also require participation of local communities combined with adequate benefit sharing arrangements between the government and local people.

There is clear evidence that strong research and education systems provide the necessary foundation for successful forest rehabilitation in the region. In the case of Iran and Turkey, research and education arrangements continue to adequately support ongoing and future forest rehabilitation works. However, in Central Asia, priorities have shifted to other economic sectors, making it rather difficult for institutions of forest-related research and higher learning to maintain an adequate level of scientific projects and training programmes. However, some of the issues related to forest conservation, combating desertification, and research have been addressed through international cooperation.

## 6. Lessons Learnt and Future Strategies for Effective Forest Rehabilitation

Over the past 60 to 70 years, considerable work on afforestation and forest rehabilitation has been done in West and Central Asia. Based on these programmes, each country presented in this book has seen successes and failures gaining significant experiences. The lessons learnt are mostly country-specific and include the major elements, strategies and approaches as outlined below.

***Iran***

- The long-term goals of the forestry sector in Iran include maintaining and improving forest health through soil protection and biological diversity, rehabilitation of degraded forests, combating desertification, and restoring natural ecosystems in watershed areas.

- In the humid and sub-humid north of the country both protection and production forests will be subject to further rehabilitation through enrichment and afforestation mostly establishing mixed plantations with native broad-leaved species, and plantations with fast-growing species like poplar. High priority is given to participatory approaches, expansion of recreation areas and parks and establishment of reserves.

- The main strategies of forest rehabilitation for the arid and semi-arid parts of the country include forest protection and improvement of forest health, reduction of degradation factors by improving the socio-economic conditions and living standards of rural communities, reforestation, restoration of degraded forests, improving the environmental functions of forests (water, soil and carbon sequestration), and afforestation with multi-purpose trees.

- As far as research and development strategies are concerned, major emphasis is placed on the scientific investigation of socio-economic problems of rural communities and alternatives for improving them, alternative ways for providing fuel to rural households, appropriate methods of plantation and forest rehabilitation, research on effective methods for producing healthy and high quality seedlings, methods of planting pioneer species on degraded forests at the timber line, impact of forest plantations on biodiversity, and studies on pest and disease control in various forest types.

***Kazakhstan***

- Under the present conditions in Kazakhstan, the expansion of forest area and rehabilitation of degraded forests will be financed primarily through the Government.

- Several technical issues need to be addressed for improving the efficiency of forest rehabilitation work, including improvement of forest seed production, enlargement of seed orchards as well as the expansion of production of planting stocks through enhanced nursery techniques.

- Priority will also be given to the rehabilitation of burnt forest areas, clear-cut stands, and shelterbelts to protect agricultural lands.

- Special attention will be paid to renewed efforts in combating desertification through expansion of saxaul plantations as well as reclaiming land on the dried up bottom of the Aral Sea through planting of scrub and grass vegetation.

- The coniferous forests of the country will be predominantly regenerated by natural means and also expanded through block-strip planting which are more resistant to fire and attacks by pests and diseases.

- At the policy level, framework conditions will be improved through a new land lease system, which can considerably help to expand forest areas involving various stakeholders in this business.

- All in all, the new forest policy of the Government is directed towards progressive development of the forest sector in all directions, particularly proper protection of forests, expansion of the forest area, and site-specific management and operations in order to increase the overall forest productivity.

***Kyrgyzstan***

- Kyrgyzstan's new forest policy is guided by an overall programme for sustainable human resources development, poverty alleviation, and social mobilization. The concept provides the foundation for the development of a new type of forestry with decentralisation of forest management and support by public institutions.

- This new policy pays special attention to the development of land rehabilitation activities aimed at promoting natural regeneration and the restoration of protective and soil conservation forests.

- Effective forest rehabilitation requires the organization of efficient production of seed and planting stocks in forest nurseries.

- Emphasis is given to reforestation of degraded lands irrespective of ownership forms and also includes the establishment of industrial plantations of fast growing tree species on suitable sites.

- Additional measures should be taken for the enhancement of forest biodiversity including the establishment of a network of specially protected natural territories and territories with unique natural heritage.

- An integrated management approach should be developed for all types of forests in the country.

- Organization of regular courses for forest users with the purpose of raising the level of knowledge and practical skills for proper implementation of silvicultural and forest management activities plays an important role for ensuring sustainable forest management.

***Turkey***

- A landscape-level approach should be adopted, since stand-level restoration decisions should accommodate landscape-level objectives and take into account likely landscape-level impacts. The practitioner should be encouraged to take stand-level decisions within a landscape context.

- Investments into afforestation are labour-intensive, expensive and do not lead to economic returns in a short time. Thus, careful feasibility studies and thorough planning in terms of social acceptability and technical approaches is required.

- Stakeholder – government cooperation is becoming increasingly important as land rehabilitation is moving into areas with potential for social conflicts. It should be proven to stakeholders that investments (not only financial) in the restoration programme are worthwhile with effective publicity campaigns and constant political support.

- The reasons for failure of private afforestations should be carefully examined and might be partly associated with a lack of technical support provided by the Government.

- Effective conservation management of Turkish forests is an urgent necessity, with new approaches and practical applications. Steps are being taken to organise forestry activities such as silvicultural conversion, restoration and ‘close-to-nature’ silvicultural operations by ‘naturalness zoning maps’.

- Following successful afforestation in many areas, further silviculture stand treatment was neglected. Thus, today more intensive stand management in restored forests should be undertaken.

- Although a wide range of restoration activities succeeded, many of the underlying reasons of these achievements were not identified and documented in detail. Therefore, effective monitoring systems are needed for improved technology development and learning.

***Uzbekistan***

- The prospects of successful reforestation and afforestation in Uzbekistan need to be seen in the context of the current state of the forestry sector. Forestry is under pressure to implement necessary changes in order to maintain and further improve its capacity to conserve and sustainably manage the forest resources of the country.

- Development and adoption of a new forest code and other relevant regulations, including changes to other normative documents are necessary pre-conditions for the sector to systematically face the challenges of forest rehabilitation.

- Strengthening institutional capacity of forest organisations involving organizational restructuring, transfer of authority on management of all protected natural territories, as well as forest lands to the Main Forestry Department, and improvement of working conditions of forestry employees including provision of facilities and technical equipment.

- Enhancing the capacity of forestry training institutions through revision of their programmes in accordance with the forestry development strategy.

- Improving research work on forest rehabilitation and establishing closer cooperation between the departments and research institutions, in order to better prioritize areas for research and disseminate research results and existing scientific knowledge.

- Further cooperation should be established between the Main Forestry Department and its subdivisions with interested organizations, including government agencies, NGOs, local population, private sector, schools, and media.

- Streamlining fund allocation for priority activities under the forestry programme, supporting forest activities by adequate fiscal policies as well as increasing the revenues of forestry enterprises through efficient collection and processing of forest products, land lease, sale of seedlings, recreational activities, ecotourism and hunting.

All in all, the assessment of forest rehabilitation and afforestation as described in this book, demonstrates the wide range of circumstances in terms of the ecological and socio-economic environment under which forest rehabilitation takes place in West and Central Asia. Although there are some common challenges towards expanding the forest area and improving the conditions of forests in the region, many issues are very country-specific and require solutions at the national and local levels.

# Forest Rehabilitation in Iran

Khosro Sagheb-Talebi[6], Peyman Yousefi[7], Mona Kananian[8]

## Summary

Iran is a Middle East nation located between Armenia, Azerbaijan, Turkmenistan, Afghanistan, Pakistan, Turkey, Iraq, the Caspian Sea and the Persian Gulf and the Sea of Oman. It is a mountainous land and except for the northern parts with a humid climate, it is known as an arid and semi-arid country. The population of Iran is 70 million and the population growth rate is 1.2%. The total area of natural resources of Iran, including forests, rangelands and deserts is 134.9 million ha, which covers 81.85% of the total land area. The total natural forest area of Iran is approximately 13.4 million ha, which covers only 8% of the total land area. The total man made forest area is estimated to cover about 950,000 ha.

The long history of civilization in Iran has had an important impact on natural resources. The socio-economic situation of the country and the anthropogenic pressure has led to forest degradation and desertification within thousands of years. Moreover, population growth, traditional agricultural systems, natural disasters, technical problems and some industrial and infrastructure development plans are other forest degradation causes in Iran. Despite of this, the country supports a total of around 8,000 plant species belonging to 150 families, and is one of the major centres of endemism in this part of the world. The Caspian (Hyrcanian) forests are the most important refuge and relic forests in West Eurasia, and an important biodiversity centre.

Modern scientific forest management and administration in Iran is very young and the forestry activities are in their infancy. Systematic management of forests started in the 1940s with the establishment of a Forest Department. At present, the Forest, Range and Watershed Organization (FRWO) is responsible for forest management. Among different departments, the Department of Afforestation and Parks is responsible for forest rehabilitation. The main national policy on forest rehabilitation is promoting the reduction of degradation factors, and plantation with native tree species in the forest areas and with fast-growing native or exotic species in suitable non-forest areas. Plantation of multipurpose trees has also been taken into account in this policy. The research sector should support the executive activities by carrying out basic and applied research projects in different ecological regions and by introducing new methods and clones for increasing wood production as well as for the protection of the ecosystem. The policy further encourages the education sector, NGOs, and rural communities to share their knowledge with participatory approaches playing a major role.

Future programmes will also emphasize participation of all stakeholders in forestry activities and recognition of local rights of native people. Expanding man-made forests in the country by means of afforestation, reforestation, restoration and enrichment projects of up to 12

[6] Associate Professor, Forest Research Division, Research Institute of Forests and Rangelands, Tehran, Iran

[7] Director Forest Resources, Deputy of Arid and Semi-Arid Forests, Forest, Rangeland and Watershed Organization

[8] Member of Scientific Board, Azad University, Rasht, Iran; Socio Economic and Local Communities National Consultant

million ha, and expanding plantations with fast-growing trees, mainly poplar and eucalyptus, to 500,000 ha are the perspectives for the next 15 years.

## 1. General Information

Iran is known as a main land between Inner Asia, Arabia, India and Mesopotamia, which has always been attractive because of its history, cultural richness, natural beauties and sights (Rashad, 2000). The country also serves as a connecting bridge between Asia and Europe. Iran is a Middle East nation, extending 1,648,000 km$^2$ and lies between 25$^o$ and 40$^o$ N latitude and 45$^o$30' and 60$^o$ E longitude. It shares boundary in the north with Armenia, Azerbaijan and Turkmenistan, in the east with Afghanistan and Pakistan, in the west with Turkey and Iraq, and the Persian Gulf and the Sea of Oman in the south (Anon., 2002a).

In the literature, Iran has two names: 1) Persia, which is derived from Pars region located in the central and southwestern part of the country, and 2) Iran, which is derived from the folk name Aryans who lived in this region 3,000 years ago (Rashad, 2000).

### *1.1 Geographic Information (Climate, Geomorphology, Hydrology)*

The geological past and geographical location of Iran resulted in open landscapes with vast mountain ranges, forests, wide plains, uncultivable deserts, fertile plains and large swamps. After the Iranian plateau had merged with the southern shores of the Eurasian continent in tens of millions of years, important geographical events took place and mountain ranges emerged over several periods (Darreshouri and Kasraian, 1998). Therefore, Iran is a mountainous land with a high central plateau which is surrounded by mountains in all four geographical directions. Almost 54% of the land area is covered with mountains. The highest peak, Demavand, is 5,670 m asl.

Iran's climate is generally Mediterranean with some continental influences. Rainfall generally decreases from north to south and from west to east. The Alborz Mountains begin with the Azerbaijani frontier ranges (Caucasus) in the northwest and extend northeast, not far from the border of Turkmenistan. This high mountain chain forms more or less an unbroken wall with elevations over 5,000 m, and receives most of the precipitation from the Caspian and Black Seas. Rainfall is evenly distributed over the year. The climate in the western part of the Caspian region is very humid with cold winters and without a dry period; the annual rainfall is 2,000 mm and the mean annual temperature is 15$^o$C. The eastern part is humid with mild winters and a short dry period; the annual rainfall is 600 mm and the mean annual temperature is 18$^o$C. The growing season lasts between 7 and 9 months (Sagheb-Talebi, 1990; Sagheb-Talebi and Dastmalchi, 1997). Massive sedimentary limestones and other calcareous rocks form the Alborz range, except for the small Asalem area in the northwest, with acidic bedrock. Soil types vary from rendzina and calcareous brown forest soil in good drainage sites to hydromorphic soils in very humid sites (Habibi, 1985).

The Zagros Region consists of the western and southern slopes of Zagros Mountains, which run from the northwest to southeast direction, from the Turkish border to the Persian Gulf. Elevation range from 200 to 4,500 m and mean annual precipitation varies between 250 and 800 mm. Rainfall occurs only during the winter and in spring, which causes severe summer droughts from 4 to 8 months duration. Summers are hot and winters are cold. The mean annual temperature varies here between 11$^o$C in the northwest and 25$^o$C in the southwest. Soils are of limestone origin with a pH of 7.0 to 8.5 (Mortazavi, 1994; Maroufi, 1997; Dastmalchi *et al*., 1999).

The mountain ranges along the Persian Gulf and the Sea of Oman are less high than in other parts of the country and the climate along the coasts in the south is subtropical. Rainfall is limited to the winter season and does not exceed l00 mm per year in most of this region. The rains are torrential and irregularly distributed. The summer is long and extremely hot and dry. Elevation ranges from sea level to 2,000 m. The mean annual temperature increases from southwest to southeast and the difference between the minimum and maximum temperatures is 40.3 °C and 17.1 °C, respectively. Three geological zones exist in this region: I) The southwestern plain zone mostly covered by alluvial sediments and Paleozoic and Cenozoic formations; II) the folded area zone covered by thick alluvial sediments of thousands of meters. There are low hills containing petroleum reserves in the region made of upper Miocene and Paleocene sediments lacking any volcanic activities; and III) the southeastern zone with young volcanic activities related to the Tertiary and early Quaternary. The soil in this region is mainly saline with pH values of more than 7.5. The majority of these soils are made by river path sediments resulting from water flow at rainfalls or sediments from the flooding of permanent rivers. Soil texture is light and medium, however in some areas, especially in the lowlands heavy soils are found too (Sagheb-Talebi *et al*., 2003).

The central high plateau, a former salt lake, is very dry and forms the deserts. In some parts of this region saline soil conditions are found which form the saline deserts, called Kavir. The largest Kavirs are called Dasht-e Kavir and Dasht-e Lut which cover a total area of 130,000 $km^2$. Generally, the geological and tectonic activities still continue in Iran. Therefore, earthquakes as natural phenomena are a threat in almost all parts of the country and frequently destroy vast areas of land.

Although the country is categorized as a dry country in general, there are various watersheds and main rivers, mostly in the northern and western parts of the country. While the central plateau, northeast and southeast regions are dry, the northern and western regions are endowed with sufficient water resources. Aras River, Sefidroud, Qezelowzan, Chalus, Tajan, Atrak and Gorganroud Rivers are the major river systems in the Hyrcanian region, which flow into the Caspain Sea. Zarineroud, Siminroud, Zayanderoud, Karoon, Karkhe and Arvandroud are the major river systems in the Zagros region which provide 40% of the total water resources of the country and flow into the Persian Gulf. The most important river in the Southeast is Hyrmand flowing into the Hamoon Lake at the border to Afghanistan. Mond, Mehran and Sarbaz Rivers are the major rivers in the south flowing into the Persian Gulf and the Sea of Oman. Urumia, Parishan, and Hamoun Lakes are the largest inner lakes which are located in the northwest, south and southeast of the country, respectively.

## *1.2 Demography*

Originally, various peoples associated with the great "Indo-European" family, occupied the Iranian Plateau several thousand years ago. Then, as history was dawning, a more homogenous group, the Aryans, speaking in a common language, appeared from the northeast, crossed the Oxus or Amu-Daria River and settled in Persia (Hureau, 1972).

At present, the population of Iran is some 70 million; 65% are living in cities and 35% in villages of which 51% are male and 49% female. Almost 50% of the country's population are below 15 years old and 70% are below 25 years old. The population growth rate is 1.2% and it is expected that the trend of population growth will decrease in the next decades. The distribution and population growth rate in various provinces as well as in cities and villages are not even. The population growth rate in large cities is low, but migration to the cities is high. There are large numbers of rural people who migrate to big and small cities each year. Migrants are seeking better job and living opportunities in large cities. The official religion of the country is Islam and 99% of the people are Moslem; the rest are Christian, Jewish and Zoroastrian. The official language spoken in the country is Farsi, but in some provinces Turkish, Kurdish and Arabic languages are spoken as well.

### 1.3 Natural Resources

According to the latest statistics from the Forest, Range and Watershed Organization (FRWO), the total area of natural resources of Iran, including forests, rangelands and deserts is 134,884,365 ha covering 81.85% of the total land area (Anon., 2008). The proportion of different natural resources is given in Table 1.

**Table 1:** ***Area and proportion of natural resources in Iran (Anon., 2008)***

| Natural Resources | Area (ha) | Proportion (%) |
|---|---:|---:|
| **Natural forest** | 13,364,010 | 8.10 |
| **Man-made forest** | 946,546 | 0.57 |
| **Rangeland** | 84,960,321 | 51.60 |
| **Desert** | 32,863,972 | 19.94 |
| **Bushes & woodlands** | 2,723,756 | 1.65 |
| **Total** | 134,884,365 | 81.85 |

### 1.4 Socio-Economic Situation

Most of the economic projects of the country are related to oil industries. Iran owns the second largest natural gas resources and the fifth biggest oil resources among the OPEC countries. The share of petroleum in the Gross National Product (GNP) is 31%, that of industries 22%, of services 35% and that of agriculture 10%. The per capita income was US $ 1,581 in 2001.

Like in many Middle East countries, the socio-economic situation in Iran is somehow complicated. Agriculture and livestock products are inseparably linked to forests. The very ancient and traditional relation of human to nature, in particular to forest and range, is very strong and has not changed very much for centuries. There are many local communities in all parts of the country who benefit from forests and ranges for their subsistence. These products include fodder, wood and non-wood products.

The traditional animal husbandry system is strongly dependent on natural resources. Grazing in forests and ranges has a long tradition. Five million people rely on forests and forest land and benefit from its goods and services. Accordingly, there are some 7,500 permanent and 13,000 temporary jobs in the forestry sector. There are about 107,000 people who are engaged permanently in forestry and wood industry activities. More than 25,000 households earned US $ 13 million per year by harvesting 27 different non-wood products from forests and rangeland (Anon., 2005).

The country's economy is heavily relying on the oil revenue and, therefore, most executive and development programmes are funded by oil. The country has a strong centralized government. However, recently there have been some programmes on economic decentralization and privatization. One of the strategies for reducing reliance on oil revenue is the development of non-oil exports. However, the recent low exchange rate of foreign currency has led to an increase of imports and stronger emphasis on oil commodities, thus preventing export. High interest rates charged by banks are one of the major factors of inflation and prevention of investments within the country. This situation could only be reversed through a reduction of bank interest rates, an increase of currency rate, the support of the private sector and the enhancement of international cooperation. Industrial development leads to a growth of the service sector which is going to be more important because of providing job opportunities. The consequences of developing the various economic sectors in a country may have positive or negative impacts on the forestry sector. The agricultural sector currently enjoys various subsidies and economic incentives and is likely to be confronted with some problems in the coming years. Trade liberalization could support further development of the agriculture sector, but is likely to cause intensified deforestation and forest degradation. This is mainly due to low cost agricultural production in comparison with Europe and other countries of the region. Industrial growth would probably lead to environmental pollution, whereas tourism development would have the potential to enhance forest protection.

## *1.5 Land-Use (Agriculture, Industry, Urbanization, Tourism, Protected Areas)*

### *Agriculture*

The most important agricultural products (crops) of Iran are rice, olive, tea, orange, lemon and kiwi in the northern parts and cereals (wheat, barley, etc.), maize, sugar cane, diverse fruits (walnut, apple, grape, peach, apricot, water melon, melon, etc.), vegetables and fodder in other parts of the country. Agriculture in Iran is basically rain-fed except in plains using well-equipped modern irrigation systems. The total area under agricultural activities is 10,130,000 ha; 58% are under irrigation systems while 42% have sufficient annual rainfall. The total production of diverse agricultural products is 54,100,000 ton. Animal husbandry is distributed almost in all parts of the country, except of the Kavirs in the central deserts. It is mainly distributed in ranges and mountainous grasslands. Modern animal husbandry and breeding has been expanded recently, resulting in an increase of dairy products. At present, there are 124 million cattle units in the country; 83 million of them belong to nomads and rural breeders (Yousefi, 2009). Fishery is located in the Caspian Sea, in the north, and in the Persian Gulf and the Sea of Oman in the south of the country.

### *Industry*

For 40 years, Iran has made significant progress towards developing the industrial sector. Oil industries, metallurgy and steel industries, petro-chemical and other chemical industries, and automobile manufacturing are the major industries of the country. Textile, food and nutrient industries are also active beside cement and chalk industries. Carpet knotting and handicrafts are traditional activities in Iran which have secured large international markets all around the world. Industries related to copper, zinc, lead, iron, charcoal, noble stones and salt have shown important growth rates within the last decades. Iran possesses 24 billion tons of mining goods with a total number of 2,921 industries and enterprises active in the mining business. Based on current plans, Iran boosts industrialization in the future, which would result in more environmental pollution and degradation of vegetation cover. Building new power stations and water dams have priority in industrial development programmes. One hundred sixty nine (169) dams for power generation are active at present and 82 more are planned or under construction. Although the availability of heavy and light industrial constructions in different parts of the country is more or less good, it is still not even. Many industries and factories are located around large cities, especially around the capital Tehran. The huge amount of cars circulating in the streets of Tehran has raised severe pollution problems. Therefore, air pollution in Tehran is extremely high.

### *Urbanization*

The most important large cities of Iran after the capital Tehran, are Mashad, Esfahan, Shiraz, Karaj, Kermanshah, Ahwaz, Rasht and Hamedan located in the north, west, south and east of the periphery of the central deserts. All cities are connected by roads, railways and by air lines. There are almost 30 airports all around the country.

Due to high rates of rural population growth and limitation in economic development factors (e.g. water, land and renewable natural resources) coupled with better job opportunities in the cities, urbanization has become one of the main socio-economic issues. The centres of the provinces are being over-populated and rural-urban migration has become a critical issue for policy makers. Sometimes, higher investments in rural areas aim at encouraging the settlement of people in villages or smaller cities. However, migration to cities continues and it is expected to remain also in the future. Within the last 20 years, the number of cities has increased from 374 to 899; this means that every year 21 new cities are built. The land occupied by cities is 1,200,000 ha and the population density is 42.8 persons per $km^2$. The rural-urban migration rate is very high. At present nearly 65% of the country's population are living in cities. The urbanization intensity is not equally distributed over the whole country. Urbanization in industrial and developed areas is more intensive, which has led to conversion of agricultural lands to residential areas and to a decrease of traditional green space and orchards. Therefore, the development of urban parks, greenbelts and tree plantings around the cities is urgently required (Anon., 2005; Yousefi, 2009).

Urban forestry in large cities is increasingly evolving due to further destruction of traditional green spaces which previously consisted mainly of orchards. At present, peri-urban green spaces, natural man-made forest parks, green spaces within factories and training institutions are considerably expanding. In this regard, municipalities have also encouraged green establishment. However, urban forestry is faced with several difficulties including urbanization infrastructure development, air, water, and soil pollution and high prices for land.

Green spaces are mainly created and managed around cities as greenbelts in order to decrease pollution and improve environmental and landscape quality. At present, the area of these green spaces is estimated at nearly 14,000 ha. Planting sidewalk trees has also been a traditional method to develop green space. Their landscape value in preventing air pollution and protection against high noise levels caused by traffic and factories is considered highly important.

### *Tourism*

With an offer of historic and natural sightseeing and attractions, Iran is one of the most important gates to tourism in the world. A 4,000-year old history, palaces of royal dynasties, diverse monuments, rich culture, and hospitality are the tourist attractions of Iran. Different climates offer visitors skiing in winter in the northern mountains, and swimming in the warm waters of the southern coasts of Iran in the same season, all within a one-hour flight. Recent statistics on tourism indicate that on average about 4.2 million tourists visit Iran every year.

Due to varied climates, Iran enjoys various ecosystems which play a major role in ecotourism development. Ecotourism is managed by the Natural Heritage Organization (NHO). Moreover, protection of rare wildlife species and landscape is also very important. Ecotourism development requires integrated planning and inter-sectoral cooperation. With the cooperation of the Department of Environment, which is responsible for wildlife preservation, the NHO has introduced programs for managing ecotourism.

The increasing importance of ecotourism, infrastructural investments and variety of ecosystems call for much more development. Ecotourism could be combined with sightseeing, particularly to historical places and monuments and thus enhance foreign revenues. Meanwhile, wildlife revenues including earnings from wildlife watching have increased and programmes for species protection are being undertaken (Anon., 2005).

***Protected areas and forest reserves***

According to historians, the first protected forest has come into existence in Iran when Kashayar Shah, the Achaemenian King was passing through a beautiful cypress forest on his way to Minor Asia and ordered his Royal Army to protect it. In this way, the very first protected area in the world was established in Iran centuries B.C. (Javanshir, 1999).

In Iran, the Department of Environment is in charge of managing protected areas. These areas include national parks, ecological reserves, wilderness areas and sanctuaries. The conservation of biological diversity has highest priority. The expansion of protected areas is of equal importance. Rare plant species reserves, peri-urban man-made parks and protection forests are managed by the forestry sector.

Currently, based on Krentiski's classification, the Iranian forest reserves are categorized as managed nature reserves. These protected areas consisting of 91 forest reserves with a total area of 80,628 ha, account for 0.65% of the entire forest area of the country. They are managed by the Plantations and Parks Office of the Forests, Rangelands and Watershed Organization (FRWO) aiming at the protection of unique pure stands of the following species on unique sites (Sagheb-Talebi *et al*., 2003):

*Acacia albeda, Acer monspessulanum, Amygdalus scoparia, Avicenia marina, Betula pendula, Buxus hyrcana, Castanea sativa, Celtis australis, Celtis caucasica, Corylus avellana, Cupressus sempervirens* var*. horizontalis, Dalbergia sisso, Fagus orientalis, Ficus carica, Juglans regia, Juniperus polycarpus, Myrtus communis, Olea europae, Pistacia atlantica, Pistacia vera, Platanus orientalis, Populus caspica, Prospis spicigera, Pyrus hyrcana, Quercus brantii, Quercus infectoria, Rhus coriaria, Tamarix* spp.*, Taxus baccata, Tecomelia undulate, Thuja orientalis, Ulmus boissieri, Ulmus carpinifolia, Ulmus minor, Zelkova carpinifolia* and *Ziziphus vulgaris.*

***Biosphere reserves and the red list***

UNESCO defines biosphere reserves as coastal or terrestrial regions internationally recognized to serve as a factor of stabilizing and developing a balanced relationship between people and nature under the Man and Biosphere Program. Nine regions in Iran are recognized as biosphere reserves including; Ararsbaran, Arjan Plain, Mount Geno, Golestan Forest, Mangrove Forests, Kavir Plain, Lake Urmia, Lake Miankaleh and Touran Plain.

Plant species are classified into several categories based on the UN list of conservation priority. Endangered (EN) and vulnerable (VU) are the most important categories among them. Based on this list, the two species of yew (*Taxus baccata* L.) and boxwood *(Buxus hyrcana* Pojark) are the endangered species of Iran. The vulnerable species are: *Cornus sanguinea* L., *Pyrus kandevanica* Ghahreman & Khatamsaz, *Pyrus mazenderanica* Schonbeck, *Pyrus turcomanica* Maleev, *Quercus robur* L., *Rhizophora mucronata* Poir. and *Thuja orientalis* L.

Many other Iranian species are endangered or on the verge of extinction due to the degradation intensity and other problems. Some of these species are: *Acer platanoides, Betula pendula, Castanea sativa, Dalbergia sisso, Prunus avium, Prunus mahaleb, Quercus* *iberica, Quercus magnusquamata, Sorbus aucoparia, Sorbus torminalis , Ulmus glabra* and *Zelkova carpinifolia*.

### *1.6 Land-use Pattern*

Due to the mountainous topography of the country and the existence of large deserts in the centre stretching from the northeast to the southeast, rural settlements, cities and human activities are mostly concentrated outside deserts and mountains and in places where water resources are available. Therefore, the spatial and seasonal distribution of water is uneven. The humid northern plateaus between the Alborz mountain chain and the Caspian Sea, as well as the semi-arid southern plains close to the Persian Gulf are used for agriculture and horticulture. Usually plains and less steep slopes are cultivated with agriculture crops. Sometimes, in spite of the problems, also steep slopes are used for farming. Smaller or bigger openings in degraded forests are proof of agricultural activities undertaken right in the middle of the forests, mainly near to forest villages.

In contrast to agriculture, animal husbandry is more concentrated in the mountains, rangelands and alpine meadows. The traditional system of migration of livestock by nomads is still common in many provinces. Sometimes the herds move hundreds of kilometres from south to north in summer and back in winter. Large-scale migration of herds also happens in the northern forests and rangelands from low altitudes toward higher elevations and alpine meadows during summer time. In winter, livestock is taken down in order to settle in the lowland. Nowadays, keeping cattle in stable and practicing modern animal husbandry are preferred. The modern animal husbandry complexes are usually located out of the cities and villages, close to farms.

Traditionally, trees, in particular native poplars and willows, are planted along streams and water courses building gallery stands which follow the direction of the rivers and give the landscapes of the valleys a characteristic touch. Gallery stands of Euphrates poplar (*Populus euphratica*) are common along the rivers in arid and semi-arid regions.

Usually mountains are bare and no forest exists on them, except the northern slopes of the Alborz Mountains and the Zagroz Mountains in the west covered with forests. Only the Caspian forests are used for timber production and harvested on an industrial basis. The Zagros forests are important from an ecosystem point of view and are vital for soil protection and regulation of underground water resources as well as streams and rivers. At present, 150,000 ha are under poplar plantations, managed as wood farms producing about 2 million $m^3$ of wood per year.

Cities are becoming gradually larger due to population growth and migration from smaller cities or villages. Large cities are located in the lowlands and plains, but there are also smaller cities and villages that are located at foothills or at higher elevations. The most important factor for establishing human settlements is water. Usually, industries are located close to the cities. Industrial areas are also expanding not only around cities but also into agricultural lands or even forest areas. In the south of the country, where the petroleum industries are concentrated, large areas of natural resources (forests and lowland ranges) are utilized and partially destroyed by the oil industry.

## 2. State of Forests

### *2.1 Forest Cover (Phytogeographical Information)*

From an ecological point of view, Iran is divided into three phytogeographical regions; the Euxino-Hyrcanian Province of the Euro-Siberian region in the north; the Saharo-Sindian Region in the south; and the Irano-Turanian Region in the western and central sectors of the country (Sabeti, 1976). The total area of natural forests of Iran is approximately 13.4 million ha, which covers only 8% of the total land area (Anon., 2008). Under UN and FAO definitions (Ball, 1999), Iran is a Low Forest Cover Country (LFCC). Forests are also divided into three ecological zones; the northern (the Caspian or Hyrcanian) zone with humid climate; the southern (the Khalijo-Omanian) zone with dry subtropical climate; and the Irano-Turanian zone which is divided into two zones: the western mountainous zone (the Zagros) with sub-Mediterranean characteristics and semi-arid climate; and the central plateau zone with steppic arid climate (Figure 1).

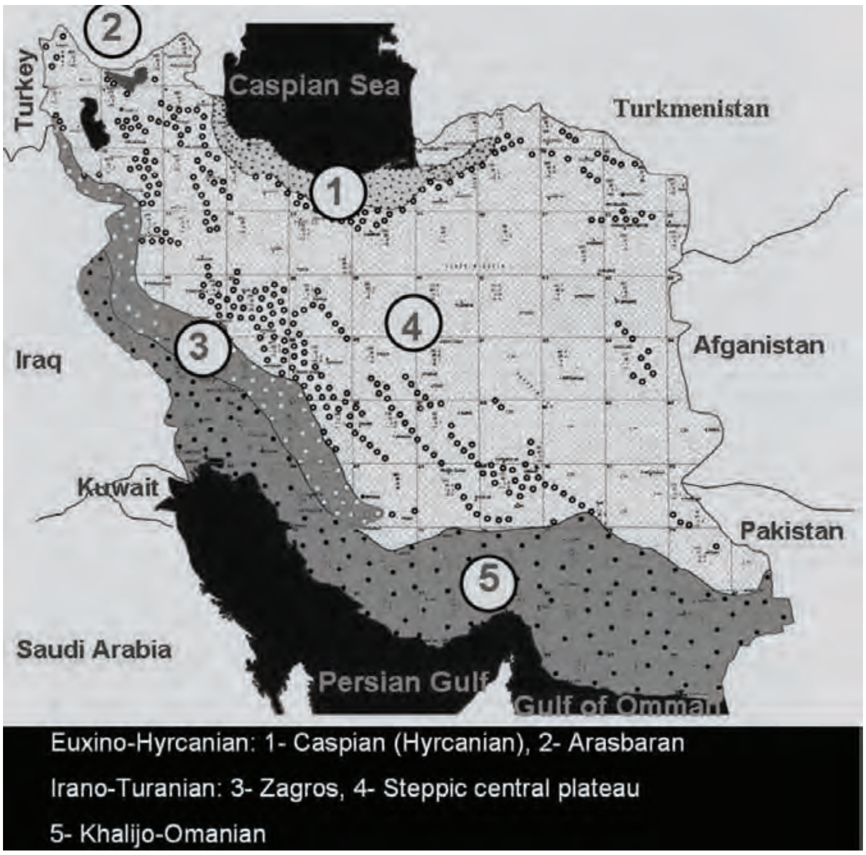



**Figure 1:** ***Phytogeographical regions of Iran***

#### *The Caspian (Hyrcanian) region*

Mesophilic (sub-humid) forest vegetation, originally of the Tertiary, called the Hyrcanian zone, characterizes the Alborz Mountains on the Caspian coast (Mobayen and Tregubov, 1970). This area is 800 km long and 110 km wide and stretches from Astara in the northwest to Gorgan vicinity in the northeast of Iran. The total area of the Caspian forests is approximately 2 million ha which extends from sea level up to an altitude of 2,800 m. The Caspian deciduous forests are representatives of forests from the Cenozoic period. Deciduous forests that were destroyed by glacial advances in Europe and Northern Asia survived in Iran. Therefore, the Hyrcanian forests are one of the last remnants of natural deciduous forests in the world. Native and endangered tree species include honey locust (*Gleditschia caspica* Desf.), false walnut (*Pterocarya fraxinifolia* Lam. [Spach.]), ironwood (*Parrotia persica* C.A.Meyer), Siberian elm (*Zelkova carpinifolia* [Pall.] Dipp.), box tree (*Buxus hyrcana* Pojark), Caspian poplar (*Populus caspica* Bornm.) and a few conifer species such as yew (*Taxus baccata* L.) and *Thuja orientalis* L. (Sagheb-Talebi, 2000).

The natural forest vegetation is of the temperate deciduous forest type (Figure 2) containing broad-leaved species such as beech (*Fagus orientalis* Lipsky), oak (*Quercus castaneifolia* C.A.M, *Q. macranthera* F. & M.), hornbeam (*Carpinus betulus* L.), maple (*Acer velutinum* Boiss., *A. cappadocicum* Gled.), ash (*Fraxinus excelsior* L.), alder (*Alnus subcordata* C.A.M., *A. glutinosa* Gaertn.), elm (*Ulmus glabra* Huds.), wild cherry (*Prunus avium* L.), wild service tree (*Sorbus torminalis* Crantz), lime tree (*Tilia platyphyllus* Scop.) and others. The main feature of the region is the lack of conifers; only relics of coniferous forests are present, which include *Taxus baccata* L., *Juniperus* spp., *Cupressus simpervirens* var. *horizontalis* L., and *Thuja orientalis* L.

In the plains, oak (*Q. castaneifolia*) is mixed with box tree, which forms the *Querco-Buxetum* community. On the lower slops below 700 m, the oak and hornbeam are increasingly mixed with ironwood (*Parrotia persica*) and form the two communities of *Querco-Carpinetum* and *Parrotio-Carpinetum*. Between 700 and 1,500 m, beech is the dominant tree species and forms the *Fagetum hyrcanum*, in pure and mixed stands with other noble hardwoods over a vast area in this cloudy zone. From its floristic composition, these beech forests are linked with European forests and with affinities to the beech forests of the Balkans. However, local conditions of aspect and edaphic factors, such as soil moisture and depth, are all important in determining the composition of the vegetation, which leads to the establishment of different beech sub-communities. Above the beech belt, oak (*Quercus macranthera*) and hornbeam (*Carpinus orientalis*) build the *Querco macranthere-Carpinetum orientalis*, forming the forest community of higher elevations up to the timberline with short trees or shrubs.

**Figure 2:** ***Caspian forests***

### *The Khalijo-Omanian region*

Comprising an area of 2,100,000 ha, this region stretches as a narrow band from Ghasr-e-shirin in the west toward the south and ends at the Iranian-Pakistani border in the east. The altitude ranges from sea level up to 2,000 m. The main vegetation elements in the region belong to sub-tropical elements and have Sahara-Sindian origin. This vegetation region is divided into two territories, namely Khaliji and Omani, due to distinct ecological differences. The Khaliji territory includes the western parts up to Hormozgan-Booshehr border, along the Persian Gulf, having calcic soils originated from Zagros mountain ranges. However, the Omani territory includes the eastern parts, which are parts of Hormozgan and Sistan-Balouchestan provinces, along the Sea of Oman, mostly having acidic soils with exotic origin. Climatic differences also exist with higher temperatures at the Omani coasts (Mobayen and Tregubov, 1970).

The main species of the Khaliji territory are: Arabian jujube (*Ziziphus spina-Christi)*, Indian mesquit *(Prosopis spicigera)* and Euphrates poplar *(Populus euphratica)* with Arabian jujube as the dominant species (Figure 3). In Omani territory the most important vegetation types are Indian mesquit and various kinds of acacia *(Acacia* spp.*).* Other trees and shrubs of this region are *Acacia nilotica*, *Acacia nubica*, *Acacia oerforta, Albizia lebbeck*, *Capparis aphyllae*, *Capparis decidua*, *Moringa peregerina*, *Nerium indicum, Parkinsonia aculeate*, *Salvadora persica* and *Tecomella undulate*. At higher altitudes, the population of these species decreases and other elements such as almonds *(Amygdalus scoparia)* and *(Amygdalus lycioides)* and pistachios *(Pistacia mutica* and *Pistacia khinjuk)* replace it (Sagheb-Talebi *et al*., 2003).

**Figure 3:** ***Arabian jujube (left) and Euphrate poplar (right) stands in Khalijo-Omanian region***

Mangrove forests are one of the most important vegetation communities in this region, extending its range from the east to the west. Iranian mangrove forests are spread throughout the southern coasts from the Guatre Gulf in the southeast to the Naiband Gulf in the southwest as small, big, continuous or discontinuous blocks, covering an area of 20,000 ha. The biggest continuous block with the highest diversity lies in Qeshm Island and Bandar-e-khamir covering an area of 10,000 ha including dense and semi-dense forests. Due to the destruction of other tree and shrub species as a result of harsh site conditions, *Avicenia marina* and *Rhizophora macronata* are the exclusive species in the Iranian mangrove forests (Figure 4). The mangrove ecosystem of Iran consists of unique fauna communities such as different crabs, shrimps, fishes (32 species), reptiles, birds and amphibians with mudskipper (*Periophtalmus* sp.) as the most important one (Safiyari, 2003).

**Figure 4:** ***Mangrove forests in the Persian Golf; Avicenia (left and right) and Rhizophora (middle)***

***The Irano-Turanian region***

The Irano-Turanian Region has always been distinguished from the adjacent Euro-Siberian and Mediterranean Regions by a series of floristic and vegetation characteristics. The local climatic and physiographic differences are responsible for the differences in the flora and vegetation of which should be looked upon as relics of a former climatic periods (Mobayen and Tregubov, 1970). Floristically, the region is characterized by a very large number of genera, sections and species. This vast region consists of two major forest zones: the western mountainous zone of Zagros and the steppic central plateau zone.

Zagros vegetation covers a vast area of Zagros mountain ranges stretching from Piranshahr in the northwest of the country to the vicinity of Firoozabad having an average length and width of 1,300 km and 200 km, respectively. Classified as semi-arid forests, Zagros forests with an area of some 6 million ha account for almost 40% of the country's forests. The main role of these forests is on water supply, soil conservation, climate alteration and socio-economical balance of the entire country. Seven first grade rivers having 34.5 billion $m^3$ of water accounting for 40% of the total ground water of the country originate in Zagros Mountains and flow into the fertile plains (Jazirehi and Ebrahimi-Rostaghi, 2003; Sagheb-Talebi *et al*., 2003).

The climax vegetation is an open xerophytic cold-resistant deciduous oak forest (*Quercus brantii = Q. persica*), the *Quercetum persicum* community (Figure 5), which dominates between 1,000 and 2,000 m elevations. Natural oak on good sites reaches a height of 12 to 15 m with a canopy cover of 50%. Stands in accessible areas, however, have been reduced to very open stands of deteriorating coppice stools, only 2 or 3 m in height. At higher elevations, scattered trees of *Juniperus excelsa* occur, and on the lower slopes a mixture of oak with almond (*Amygdalus scoparia*), pistachio (*Pistacia atlantica*), and maple (*Acer monspessulanum* L.) appears (Sagheb-Talebi *et al*., 2003).

**Figure 5: O*pen oak forests in the Zagros region***

The steppic central plateau covers an area of about 3,300,000 ha and is the largest vegetation region of the country. This region includes the whole Central Iranian Plateau stretching from Alborz's southern slopes in the north to Zagros' slopes in the west and south and to the eastern borders of Iran to Afghanistan and northeastern borders to the former Soviet Union and is extending northwestwards to Azarbaijan (Figure 1). Due to the vast extent of this zone and climatic variation, it is divided into mountainous and plain forest types. In mountainous parts, juniper (Figure 6), pistachio and almond grow while in plain parts saxaul (*Haloxylon* sp.), tamarisk (*Tamarix* sp.) (Figure 7), bean caper (*Zygophyllum* sp.) and quail bush (*Atriplex* sp.) are dominant. Summer heat along with dryness adds to the drought intensity giving the region a thirsty look with diminishing vegetation cover. The main forest utilization processes are firewood production, fruit picking and livestock grazing. The Touranian Biosphere Reserve, one of the nine Iranian biosphere reserves with an area of 1.8 million ha, is located in this region. So far, 604 plant species are identified in this reserve, from which 46 are endemic species.

**Figure 6:** ***Juniper stand in the mountainous steppic region of Iran (Photo taken by Momeni)***

**Figure 7:** ***Tamarisk (left) and saxaul (right) in the steppic plateau of Iran***

The forests of this zone are often highly degraded and sparse. They are hardly ever considered as industrial forests. A case study performed in Khebar and Roochoon National Park with an area of 169,000 ha reveals that the average crown canopy density in the entire region is 24.5% (Irannejad-Parizi, 2000). Thus, the only function of the vegetation is water and soil conservation. These forests are distributed from the altitude of 400 to 3,500 m asl. In the southern lowlands, tropical temperature-susceptible species such as *Prosopis spicigera, Ziziphus spina-christi, Dalbergia sissoo, Calotropis procera* and *Calligonum* spp. are found. At higher altitudes the vegetation greatly changes and species like *Olea* spp., *Pistacia khinjuk* and *Amygdalus* spp. replace them. Between the altitudes of 1,800 and 2,500 m trees and shrubs adapted to cold semi-arid regions such as almond *(Amygdalus lycioides)* Montpellier maple *(Acer monspessulanum)*, pistachio *(Pistacia atlantica)* and milk vetch *(Astragalus* spp.*)* are dominant. Above 2,000 m, juniper dominates. It is mixed with

Montpellier maple and pistachio. Pure stands of juniper are also reported at higher altitudes, occasionally up to 3,200 m (Sagheb-Talebi *et al*., 2003).

## *2.2 History (Past and Present)*

While most parts of Europe were covered with ice 15,000 years ago, the whole central plateau of Iran was under an immense lake. This has been defined as a humid period in the central parts of Iran. Paleobotanical evidences indicate that this region was still humid and covered with dense vegetation 7,000 to 7,500 years ago. But about 5,500 years ago, the climate changed and it became relatively dry. Archaeological research shows that humans were living here in huts made from wood and twigs 4,500 years B.C. (Javanshir, 1999). We could imagine that trees and shrubs were commonly found in the central parts of Iran.

To explain the history of forest cover in Iran, we are putting forth the following hypothesis based on the phenomena of glaciations. As has been proved by Prof. Bobek (cited in Shahsavari, 1997), the heaviest glaciations occupied only very restricted areas around some high peaks of the Elburz Mountains in Iran, while the entire Hyrcanian zone was free of glaciers. During glaciations and interglaciations there were some advances and retreats of the vegetation from the south to the north and conversely. During these changes of climate there were parallel changes of vegetation. The zone of large conifers belongs to the cold climate; thus during glaciations while the conifers advanced from the north to the south, the coniferous region that preceeded the glaciers also advanced towards the south. This phenomenon was reversed during the interglaciary periods, as the climate became warmer and dry and no longer suited the conifers and they returned towards the north. This migration took place four times during four periods and intermediary interglaciations. The general climate of Iran had never sufficiently cooled down to accommodate the zone of the northern conifers. Therefore, the Hyrcanian flora represents all the characteristics of the ancient flora and has affinities with other mesophilic floras of the boreal hemisphere of the Tertiary period, which explains the lack of large conifers (Mobayen and Tregubov, 1970).

There is no exact data available about the forest area in the previous centuries, despite of the long cultural history of Iran. We just know that the ancient civilizations in Iran, Achemenidian, Sasaniden, etc. have used wood and large trunks in their buildings, palaces and royal gardens. The large halls of the famous Persepolise were made of large stone and wooden pillars, which were from juniper, cedar and cypress trees.

Considering the old history of civilization in Iran, we can certainly state that a large proportion of natural forests in Iran has been destroyed under human impacts. Taking into account that modern scientific forest management is very recent and forestry activities are in their infancy in Iran, Prof. Saie, the very first forest engineer in Iran, has estimated the forest area of Iran to be some 19.5 million ha (Saie, 1942). Another paper estimates the forest area at about 18 million ha (Anon., 1964). Later, the forest area of the country was estimated at some 16 million ha (Mobayen and Tregubov, 1970). The most recent survey shows that the total natural forest area of Iran is approximately 13.4 million ha (Anon., 2008).

## *2.3 Forest Biodiversity (Flora and Fauna, Endemics)*

As a result of major topographical, geological and climatic variation, Iran is rich in plant diversity. The country supports a total of around 8,000 plant species belonging to 150 families, being one of the major centres of endemism in this part of the world. There has been a long history of low-intensity, traditional land management including grazing in Iran, which for most part has not conflicted with, but in many areas rather contributed positively to, the maintenance of variable populations of the species. However, increasing anthropogenic pressures, including deforestation, intensification of agriculture, drainage of wetlands and industrial development, have already had a great impact on the growth, survival and distribution of native species, in Iran, especially as regards rare and endemic species. Table 2 illustrates the number of endemic species in Iran. A total of 1,727 species are recorded as endemic in Iran, of which 432 species are vulnerable and 21 species are endangered (Jalili and Jamzad, 1999).

**Table 2:** ***Number of endemics present in different phytogeographical regions in Iran (slightly altered after Jalili and Jamzad, 1999)***

| Phytogeographical region | Total number of endemics | Average no. of endemics per million ha |
|---|---|---|
| **Hyrcanian** | 115 | 12.5 |
| **Khalijo-Omanian** | 52 | 1.1 |
| **Irano-Turanian** | 1452 | 14.0 |
| **Multi-regional endemics** | 108 | - |
| **Total** | 1727 | 10.5 |

The Caspian (Hyrcanian) forests are the most important refuge and relic forests in West Eurasia, and an important biodiversity centre. Deciduous broad-leaved forests are the natural vegetation of temperate oceanic-suboceanic regions in West Eurasia. Relics of primary undisturbed temperate broad-leaved forests are extraordinary rare all over the world and the Caspian forests partially represent the last relics of primary temperate broad-leaved forests worldwide (Knapp, 2005).

One hundred thirty (130) woody (tree and shrub) species are reported in the Hyrcanian forests. Zagros forests in Western Iran contain 170 tree and shrub species and the whole Irano-Turanian region is the habitat of 370 woody species (Djazirei, 1962; Sabeti, 1976).

Up to now, 148 mammal species (Harrington and Dareshoori, 1976) and more than 350 bird species (Scott *et al*., 1975) are reported in the country. No exact data exists about reptiles, but 56 land snake species and 5 water snakes are reported in Iran (Latifi, 2000).

## *2.4 Forest Administration and Management*

Modern scientific forest management and administration is very young and forestry activities are still in their infancy in Iran. Systematic management of forests started in the 1940s withthe establishment of a Forest Department. However, the history of some primitive forest organization goes back much further into the past to the Qhajar Dynasty. In 1905, the office of road, railway and forests was established in the Ministry of Public Benefits. In 1920, the first forest office started to work in the Ministry of Agriculture. A preliminary forest inventory and survey of the Caspian forests was started by Hans Schricker from Austria in 1923. At the time, Russian, English, French and Swedish companies were active in wood utilization from the northern forests of Iran, transporting valuable timber of boxwood, walnut, oak, elm and maple trees. In 1924, von Demhaagen, a German forest expert, was employed to provide forest management plans. In the same year, the central forest organization was established. Forty forest guards were trained for six months by von Demhaagen and Schricker in 1930. In 1937, Karim Saie, the very first Iranian forest engineer, returned to the country after his education in France and established a new forest unit. In 1948, the name of Forest Office changed to Forest Agency. Among the tasks of this reorganization were the establishment of forest nurseries, forest protection, the prevention of charcoal production and the preparation of new forest management plans for coppice stands and later for the high forests (Javanshir, 1999).

Many other foreign experts have worked in Iran. Hamilton, Austin and Mitland, British experts, who worked in India before they came to Iran to discover new wood resources for export to Europe. For a while, the French experts, Janti and Pabo, cooperated with Iranian forest and range experts. Since 1955, some American foresters took part in the forest activities. But none of them was as effective as the Austrian Schricker. He established the forest organization in Iran, lived 20 years in the country and died in Iran in 1943. He is buried in the Faculty of Natural Resources Campus of Tehran University in the city of Karaj.

In 1967, the Ministry of Natural Resources was established, but it did not exist long. In 1971, this Ministry was dissolved and merged with the Ministry of Agriculture. At present, the Forest, Range and Watershed Organization (FRWO) affiliated to the Ministry of Jihad Agriculture, is in charge of rehabilitation, protection, exploitation and development of forest, range and watershed. The head of the organization is the Deputy Minister of Forest, Range and Watershed Management Affairs. The institutional structure of FRWO is composed of the North (Hyrcanian) Forest Deputy, which is responsible for humid and sub-humid forests and the Semi-dry and Dry Forests Deputy, which is responsible for Irano-Turanian and Khalijo-Omanian regions. Land Affairs, Watershed and Financial Affairs are the other Deputies of this organization. FRWO has 32 provincial offices that are responsible for forest protection. Each office has a few sub-forestry units and each forestry unit is composed of a few ranger offices (Anon., 2005).

To plan, supervise and conduct activities, FRWO is composed of many departments including Forest Management, Afforestation and Parks, Range Management, Sand Dune Fixation and Combating Desertification, Extension and Public Relation, Training, Protection, Legal Affairs, Land Survey, Planning and Programming, and Institutional Affairs. The plans and strategies of the organization are to be approved by the High Council for Forest, Range and Soil. Subject to approval of the High Council, the forestry plans are not enforceable. Some parts of the forestry plans are prepared by the private sector and they are implemented under supervision of FRWO (Anon., 2005).

Forest management today totally differs from the past, not only in objectives but also in philosophy. At the beginning, forests were considered exclusively for the production of wood or goods. Therefore, clear cut was very common for producing charcoal and managing the forests in coppice systems in the short term. Afterwards, the uniform shelterwood system was almost the only system applied for about 30 years with the aim of producing even-aged high forest. Establishing pure homogenous plantations with fast growing tree species was the only objective.

Present-day forest management gives priority to maintaining the natural complex of forest ecosystems besides timber production. It means protecting soil, providing clean air, clean water and a healthy habitat for wildlife. Close to nature silviculture and forest management in uneven-aged mixed stands for providing biodiversity and protecting genetic resources are enhanced.

### *2.5 Forest Tenure, Legislation and Policy*

Forest legislation dates back to 1942, when the first Forest Act was enacted. It contained already regulations and amendments. Up to 1962, most forests were owned by private land holders. But there were also state forests. Aristocrats, noble families and village inhabitants owned forests and possessed their private lands. Besides, the Forest Organization owned also some parts of the forests. The Government nationalized all forests in that year. Rural people and animal holders maintained their local and customary rights and took advantage of the resources. Besides forest nationalization, the land reform began in 1962, too. Agricultural lands owned by large landholders were entrusted to farmers. Nationalization has caused problems of forest protection and governmental management of the forests because of a weakened sense of responsibility among the people and resistance of landowners. Nevertheless, the public is generally concerned about the decrease in woodland area and of trees in and around rural settlements. Forest restoration is supported and encouraged. At present, the whole forests are state-owned whereas agricultural lands are private (Sagheb-Talebi *et al*., 1999; Anon., 2005).

The national policy of 1942 was very general and aimed at protection, rehabilitation, expansion and exploitation of forests. This policy was further revised and new criteria were added, such as environmental protection and prohibition of grazing in forests, combating desertification and considering ecological limitations, conservation of biodiversity and genetic resources, sustainable productivity and community participation (Anon., 2001). Improvement of applied research on natural resources, environmental technologies and genetics as well as improvement of the education system was also emphasised (Sagheb-Talebi, 2009).

Involving people in the management of forest resources and creating an atmosphere to encourage people to share their knowledge with forestry professionals and acquire new knowledge on forestry activities as well as improving the living standards are the new policies in the country. Therefore, all possible facilities such as bank investments should be investigated for this purpose. Also the private and non-governmental sectors should be supported. Ecotourism, non-wood products and related industries as well as handicrafts are considered in this policy.

In this framework, international relations and conventions have a major role to play. Forest legislation and policy in Iran have taken into account international decisions. Some of these criteria are as follows:

The results of the International Convention on Trade of Endangered Plant and Animal Species in Washington 1973, which followed the Environment Conference of Stockholm 1972, were accepted by the Iranian Government. The Parliament prohibited the over-exploitation of forests and collection of endangered plants, in order to combat environmental degradation. According to the Convention of Wildlife Protection in London 1933, all countries should establish national parks and natural reserves and should control the settlements within these areas. International cooperation within the framework of the Montreal Protocol on substances that deplete the ozone layer, Agenda 21 after the Rio Conference in 1994 strengthening sustainable development, protection of biodiversity and forests, participatory approach, capacity building, traditional knowledge, and carrying out long-term research on the importance of biodiversity and several functions of ecosystems have also affected the national policy (Kananian, 2004).

Participation of native rural communities in decision making that have complex relations to the natural resources, as an output of the Convention on Biological Diversity held in Rio 1992, will give a chance to the forest and environment experts to design better policies and management strategies for the future. Therefore, it is essential to support rural communities, especially in arid and semi-arid regions, in their socio-economic development and rehabilitation of degraded areas. Encouraging the Government to cooperate with the private sector will facilitate the implementation of rehabilitation programmes (Kananian, 2009).

## 3. Forest Degradation

### *3.1 Understanding Forest Degradation in Iran*

Forest degradation can be explained with several natural and historical events of the country's development. Ecological and human factors are responsible for forest degradation. Long term paleo-climatic changes have influenced the climate to become warmer and drier, which caused the vegetation to become more xerophile. Therefore, tall trees became shorter and the dense vegetation cover of the land became gradually sparse and scattered. Besides, civilization in Iran is more than 4,000 years old and has greatly impacted Iranian forests. Population growth, the expansion of cities and territories as well as defence against enemies required significant amounts of natural material such as wood. More agricultural lands and farms for food could only be obtained through deforestation and expansion of agriculture. Forests were cleared for agriculture, grazing, and urban and industrial areas. Wood has been used for fuel and construction. Nearly all the natural vegetation of the valleys and cultivable plains were cleared for farming and fruit production. These fertile and easy-to-irrigate areas were traditionally used to grow rice, tea, and tree crops such as orange and kiwi in the Caspian region as well as wheat, barley, peach, apricot, almond and walnut in the Zagros region. Several historical investigations provide evidence that deforestation in Iran occurred throughout centuries and that present-day forest area is much less than its natural potential (McGregor, 1875; De Morgan, 1890; Hedin, 1910; Avad, 1944; Bahrami, 1951; Lemton, 1983; Shahmirzadi, 1993; Ramezani, 1995). Within the last century, the forest area has declined to two-thirds of the original area; from 19.5 million ha to 13.4 million ha.

### *3.2 Causes of Forest Degradation*

Besides the above mentioned ecological or natural reasons, human impact has played an important role in forest degradation in Iran. This role can be categorized as follows:

***Population growth***

In the past decades an effective control of the birth rate could be achieved but for 30 years the population has been rapidly increasing; the birth rate is estimated to be more than 3%. Within the past 30 years the population doubled and increased from 30 million to 70 million. This huge increase needed more space for settlements, more agricultural land and raw material, which resulted in more deforestation. Fortunately, the birth rate has slowed down recently to a level of about 1%.

***Socio-economic issues***

High population, traditional agricultural methods combined with the use of steep slopes for cultivation, generally low output of land, presence of livestock in the forest causing over-grazing, lack of infrastructure, low income (poverty) and low living standards are the most important socio-economic challenges in the country.

People living in towns and villages are very dependent on natural resources like range (grassland) and forest. About 78,390 families are living inside or in the vicinity of the Caspian forests. They are confronted with several economic and hygienic problems, and the lack of other services. They need land for agriculture and range for their livestock. They have a traditional migration system, in which they spend spring and summer at high altitudes and return to the lower altitudes in autumn and winter. The number of their cattle (cow, sheep and goat) is estimated at 4 million cattle units. Livestock browse on seedlings and other ground vegetation in the forests almost all the year round (Figure 8). Wood requirements for fuel and household uses of these people is about 2 million $m^3$ per year, to which 160,000 $m^3$ should be added for house or hut construction. 52,000 ha of the Caspian forests have been degraded for this purpose (Anon., 1999).

The population of the Zagros region is some 10 million; 1.5 million of which are living in the forest. This has had a great impact on the degradation of forests. The settled and nomads' cattle are 14.6 million units in this region, which browse on seedlings, ground vegetation as well as on oak tree leaves and young twigs (Figure 9). Eight hundred thousand (800,000) ha of rain-fed agricultural land with shifting systems are one of the most important degradation and soil erosion factors in the Zagros region (Anon., 2002b). People are very dependent on forests and 80% of their fuel wooddemand is supported from coppice oak stands.

**Figure 8:** ***Presence of livestock and overgrazing in forest***

**Figure 9:** ***Cutting and storing of oak leaves and twigs as winter fodder (Photo taken by Shakeri)***

***Agriculture and animal husbandry***

As mentioned above, the traditional systems of agriculture and animal husbandry are other causes of forest degradation. Clear cutting of forests, especially in the past decades, using steep slopes in the mountainous regions beside shifting cultivation, low production after some years and looking for new land increase the degradation rate. Lack of water and establishment of rain fed systems instead of using new irrigation technologies aggravate these problems.

***Natural disasters***

Forest fire, in particular in the arid and semi-arid areas, as well as heavy rainfalls and floods, and land slides are other causes of forest degradation. As a matter of fact, human impact increases the instability of the forests and thus increases soil erosion risks. Climate change and irregularity in rainfalls lead to unexpected floods and leaching of fertile soil. Therefore, natural regeneration and forest plantations have problems to establish and cover such poor and shallow soils.

***Technical problems***

Lack of forestry professionals, lack of financial support, false management of forests and overexploitation are some important technical causes of forest degradation in Iran. Actually, the only commercial forests of Iran are the unique broad-leaved forests of the Caspian region. In the past 30 years, almost all forests were managed under the uniform shelterwood system in order to establish even-aged pure stands. Whereas, the structure of these mixed uneven-aged broad-leaved forests was not suitable for this silvicultural system.

Although the annual growth of these forests varies under different ecological conditions, the mean annual volume growth of the Caspian forests is conservatively estimated at some 2 $m^3$

per ha, which makes a total of 4 million $m^3$ of annual growth for the whole area. Furthermore we should consider the rural demand and illegal wood consumption, which increase the total wood exploitation from the Caspian region. Moreover, charcoal production was a very low quality wood consumption system, which was practiced for a long time. In the past decades, the total wood harvest was two times bigger than the natural potential in the forests of Northern Iran.

Also the forest protection efforts were not very serious in the past two decades, which gave the chance to villagers and farmers to expand their deforestation activities to gain more agricultural lands (Figure 10). Moreover, wood smuggling and illegal cutting of high value rare trees caused invaluable (big) damage to forest management and rehabilitation.

Fortunately, the revision of forest management strategies has brought new ideas and improvement of the system for natural and man-made forests. Applying other suitable silvicultural systems such as the selection method in uneven-aged stands and the limitation of wood harvest to only 700,000 $m^3$ per year, besides employing some 1,200 forest guards, had a positive impact on forest management. Charcoal production is limited, and timbers are now processed further in high quality products such as veneer, MDF, plywood and particle board.

**Figure 10:** ***Deforestation activities and expanding of agricultural lands***

***Development plans***

In a developing country like Iran, with rapid growth to reach higher living standards, the implementation of development projects has high priority. In order to achieve these new high levels, good coordination between different sectors would be essential. Unfortunately, communication between the government and non-governmental organizations as well as the industrial, environmental and natural resources sectors is limited.

Although the country needs to speed up the improvement of infrastructure, priority in executing industrial projects should be given to sufficient environmental surveys and studies. Such studies would reveal the benefits and disadvantages of a project, not only from the socio-economic point of view, but also from the sustainable management and environmental perspective.

In protecting the natural environment, significant challenges need to be taken on in planning and implementing mining activities, establishing all kinds of industries, construction of water dams, highways and roads, expanding oil and gas pipe lines, planning for new waste and garbage deposits as well as expanding and establishing new cities and settlements.

### *3.3 Impacts of Forest Degradation and Loss*

Considering the fragile ecosystem and the warm and dry climate of the country, it can be concluded that forest degradation has an important impact on the loss of green area covered by all types of vegetation, soil erosion, decreasing of water penetration into the soil and increasing the risk of flooding. It also significantly contributes to the destruction of habitats of some important species of flora and fauna, and to endangering biodiversity at national and international levels.

In general, the loss of forests is threatening human well-being and health. With deforestation, many ecosystem functions will be negatively affected such as carbon sequestration, absorption of pollutants combined with oxygen production as expected in intact ecosystems. Global warming, natural hazards, deterioration and erosion of soil and lack of water will increase migration of the population from small towns and villages to large cities or new settlements within existing forest areas. This will result in higher forest degradation.

### *3.4 Desertification*

The desert as a natural ecosystem can be viewed from the following two aspects; 1) as a dry unfertile land which limits vegetation growth and human life and 2) as a real natural resource with a specific potential that could be managed in a proper way for human benefits. Generally, desertification is interpreted as a negative process, which causes more problems in arid lands and countries that are faced with climate change and loss of resources. It can also be a danger in humid regions threatening other ecosystems as well (Figure 11). Over-exploitation of ground water, poverty, over-grazing and degradation of vegetation, global climate change and long dry periods are major factors responsible for forest and rangeland degradation (Darvish, 2009).

**Figure 11:** ***Desert and sand dunes in the central arid region of Iran (Photo taken by Darvish)***

Except for the north and the highland areas of Iran, other parts of the country have arid, semi-arid and hyper-arid climates. In these areas, desertification and land degradation are very severe due to population growth for meeting a wide spectrum of human needs, unregulated grazing, and conversion of vast areas of rangelands to low-yield dry farming as well as drought and flooding. Hyper-arid zones in Iran are located mainly in the central, southern and eastern parts. Nearly 14 provinces are situated in these areas which have a key socio-economic and political role. The total area of deserts in Iran is 32.86 million ha or 20% of the total land area. About 19.5 million ha of deserts are exposed to wind erosion which causes shifting sand dunes (Anon., 2005).

Lack of precipitation and drying up of water resources as well as shifting sand dunes not only threaten agricultural lands, but also affect human life and development of settlements near deserts, leading to increasing migration rates. Rehabilitation of warm and dry areas with unfertile soils is not an easy task and requires proper policy, plans and frameworks, facilities and governmental investments and supports.

Most of the area (90%) of the country is classified under dry and semi-dry climate. This area is faced with the above-mentioned problems and the risk of human induced desertification is very high. Therefore, combating desertification is very important (Darvish, 2009). Iran has a rich history and profound knowledge of combating desertification. During three decades, the Forest, Range and Watershed Organization undertook considerable activities to restore the land. The outcome can be observed in sand dune fixation through biological, mechanical and chemical methods and establishing about 2 million ha of green space by tree and shrub species adapted to local site conditions. Using mulch for fixation of sand dunes (Figure 12) and planting of tree and shrub species resistant to harsh desert climate, like *Tamarix* spp., *Atriplex* spp., *Calligonum* spp., *Prosopis* spp. and *Haloxylon* spp., are some examples of these activities.

**Figure 12:** ***Using mulch for fixation of sand dunes in Iranian deserts (Photo taken by Darvish)***

## 4. Forest Rehabilitation

### *4.1 Targets of Forest Rehabilitation*

The general objectives of forest restoration in Iran are to reverse the loss of natural and man-made forest cover, and to establish new forest stands on sites that never before supported them, or were deforested a long time ago. Besides improving degraded natural forest ecosystems, forest restoration focuses on afforestation to restore soil fertility, control erosion, and provide services and goods no longer available from natural forests, including fuelwood, fodder, non-wood products, and industrial wood. Ideally, these new plantations will be established with a clear vision of their economic, ecological, environmental, and landscape roles. They are intended to ease human and animal pressure on the natural forest areas and contribute to global ecological benefits such as gene conservation and biological diversity, as well as carbon sequestration. Employing rural people in afforestation and reforestation activities (participatory approach) is another target of forest rehabilitation in order to improve the living standards of the rural communities, thus achieving sustainable development.

### *4.2 National Policy on Forest Rehabilitation*

The national policy on forest rehabilitation gives priority to reducing and if possible eliminating degradation factors in existing forests (i.e. first step). In the next step, degraded areas should be planted and covered with suitable tree or shrub species. Native species are preferred, but in some cases planting of exotic, fast growing species is accepted as well. Not only trees for wood production, but also for non-wood products have an important role in this policy. Hence, plantation of multipurpose trees is also considered. For this purpose, applying state-of-the-art knowledge in biotechnology, genetics and plant breeding is essential. The rehabilitation policy also provides for the establishment of nature reserves and protected areas in degraded forests. In these cases the rehabilitation process is left to nature sometimes supported by some interventions like soil preparations or seeding. The policy also emphasizes traditional forest knowledge to help sustainably manage and conserve forest ecosystems.

### *Forest issues*

In the humid and semi-humid zones, like the Caspian and Arasbaran regions, reforestation of degraded areas in low lands and also at the upper limits of the forest (i.e. timber line) is given highest priority. Due to the importance of the unique relict ecosystem of the Hyrcanian forests, plantations with native broad-leaved species are preferred. The establishment of mixed-species plantations as well as seed orchards and nurseries equipped with new technologies and instruments is recommended. On the Caspian Plateau plantations of fast growing trees like poplars and willows outside of the existing forest area are promoted aiming at the production of large quantities of wood for the pulp and paper industry. In the mountainous natural degraded forest areas, plantations of native fast growing species like alder, maple, wild cherry, elm, etc. should be considered in forest management plans. Suitable non-forest areas should be identified for afforestation projects based on ecological-environmental studies. Under special circumstances, adapted Eucalypt species, introduced by the forest research institute, could be planted as well.

In the arid and semi-arid regions, like Irano-Touranian and Khalijo-Omanian regions, reforestation and enrichment of forest cover are of high priority. This should be carried out by planting pioneer species on open areas, in order to create favorable conditions for the return of native species. Considering the ecological potential of these areas natural recovery is a very promising approach. However, such projects are only successful if they are based on prior ecological surveys and investigations.

Plantations of multipurpose trees like almond, olive, walnut, etc. are recommended. In some cases, the use of fruit trees like fig tree, wild pear and wild pistachio not only protect the soil and the ecosystem, but also can bring some benefits for rural people. The rehabilitation policy also prescribes plantations of fast growing species like poplars along the rivers. However, agroforestry systems should continue to receive attention such as plantations of poplars (*Populus alba* and *P. nigra*) around agriculture fields. Agroforestry has a long tradition in the region, but the traditional systems should be improved and in some cases replaced by new approaches using latest results of research.

### *Non-forest issues (renewable energy)*

Extensive use of fuelwood or other wood products from forests for domestic purposes is the single largest contributor to forest degradation in rural areas. Substituting wood through any kind of alternative forms of energy could help reduce forest degradation. Cheap and ecosystem-friendly alternatives include biogas, solar energy as well as the generation of electricity through wind (Figure 13).

The average potential of solar energy is estimated between 1500 and 2500 kw,hr/m$^2$ in different regions of Iran; the highest intensity of solar radiation is reported in Fars Province with 5.2 – 5.4 kw,hr/m$^2$ per day (Darvish, 2009). This is a huge potential for using solar cells and providing solar energy in the country, which could meet rural demand and serve as substitute for fuelwood.

**Figure 13:** ***Generation of electricity through wind in Rudbar region; southern slopes of Alborz Mountains***

## *4.3 Methods of Forest Rehabilitation and Restoration*

In order to restock degraded forests, to supplement natural regeneration, to improve stand quality, to change crop composition, or to control soil erosion, avalanche and floods different restoration methods have been used in the country. For selection of the appropriate restoration method a combination of various criteria are taken into account, such as climatic condition in the area, aspect and topography, soil condition, water supply, socio-economic conditions and presence of wild animals and domestic livestock. The choice of species depends also on climatic conditions, microclimate, soil condition, objectives of the plantation, growth rate of species, intended stand composition (pure or mixed stands), and type of forest products and market requirements.

Considering the above-mentioned aspects, different methods of forest rehabilitation have been applied in Iran. Both methods of sowing (direct seeding) and planting with different spacings are used in plantation projects which significantly affect plantation costs and labour requirements. The following methods are most widely used in the country:

- *Clear cut and plantation*: In the past, particularly in the humid Caspian Region with good climatic and ecological conditions, many degraded forests had been clear cut followed by artificial regeneration (planting). Most of these reforestations used exotic conifer fast-growing tree species (Figure 14). In the flat Caspian plain, conifers, poplars and eucalypt trees were planted usually in pure stands with different spacing. In the mountainous area conifers and some broad-leaved species were planted in pure or mixed stands as well. Planting container seedlings as well as bare root plantings are the most common methods. Plantings are usually either in square or triangle patterns; in the former method plants are placed in the four corners of each successive square. The number of plants per ha (N) is obtained by the following formula:

  N = 100 x 100 x (square of plant to plant distance in m)$^{-1}$

In the triangle method, plants are placed at the edges of equilateral triangles with a well defined triangle pattern emerging after completion of the plantation. The number of plants per ha (N) is obtained by the following formula:

N = 100 x 100 x 1.155 x (square of planting distance in m)$^{-1}$

**Figure 14:** ***Rehabilitation activities with conifers in the Caspian Region***

- *Site preparation*: In some cases, foresters may decide that a particular kind of treatment will create the proper environment for seedling establishment. This includes any measure that makes the physical environment suitable for survival and growth of seedlings, such as removing unwanted vegetation, slash and stumps, roots and stones. Scarification - a method of soil preparation - improves the conditions of the seedbed, and facilitates root penetration and infiltration. Foresters use soil preparation to 1) control competing ground vegetation, 2) remove or mix the litter and other upper soil horizons to improve the seedbed, 3) and alter the habitat for potentially damaging agents.

  Soil working is usually being done by manual labour, but recently also by mechanized means. Common soil working methods consist of digging of pits and trenches. The method to be adopted depends upon rainfall, mode of sowing or planting, species to be planted, soil characteristics and others. Bush clearing, weeding and soil working are always being done in advance of actual planting to reduce the weed competition and enable the soil to weather thoroughly. Effective closure and fencing is most essential for the success and establishment of plantations. The fencing is done by barbed wire or brushwood.

- *Pioneer plantations*: This method is used in several situations. On flat sites with high ground water table, planting of pioneer tree species like indigenous alder or exotic bald cypress improve soil drainage within the rooting zone. Also, where the ecosystem is heavily damaged making it hard for the native species to return, the use of fast-growing light demanding species is the first step in improving the site for further plantation with the main species. This is frequently applied in degraded stands of shade tolerant species such as beech. Maple and alder are used as pioneer stand to improve the microclimate and increase soil moisture prior to natural or artificial regeneration of beech (Figure 15).

**Figure 15:** ***Pioneer plantations of alder (left) and maple (right) in degraded beech stands***

- *Enrichment*: This method aims at both quantitative and qualitative enrichment of forest stands. In the quantitative approach, efforts are made to increase the density and extending the crown canopy, while in the qualitative enrichment method the improvement of the species composition in the stand is of highest priority. In degraded forests of semi-arid and arid regions, different species are planted to enrich the forest, which improves the ecosystem gradually. In stands with less density, planting of shrubs and small trees provide more shade and reduces the harmful high solar radiation.

- *Agroforestry*: As a new scientific approach, agroforestry has emerged recently, but as a tradition, it has been used since centuries in the region. This method combines agricultural crops with tree crops and forest trees aiming at improving the living standards of rural inhabitants (Figure 16). In different parts of the country, farmers are encouraged to participate in application and expansion of the agroforestry approach. Planting of exotic and hybrid poplars and alder is very common around rice fields in the northern plain of the Caspian Region, whereas planting of native poplars and willows is almost a tradition in semi-arid and arid and in some cold steppic regions. In special cases, planting of olive trees, walnut, almond and hazelnut (Figure 17) in addition to agricultural crops bring good income for rural families.

**Figure 16:** ***Two methods of agroforestry: planting of poplar trees and alfalfa (left) and walnut trees with wheat (right)***

**Figure 17:** ***Hazelnut plantation in Northwest Iran***

- *Watershed management; flood water spreading and afforestation with exotic species*: About 55% of the watershed basins area is flood raising, which intensifies erosion and causes destructive floods. At present, nearly 255 cities, 8,600 villages, and one million ha of arable lands are subjected to floods. By watershed operations, about 22 billion $m^3$ of surface flows and flood waters are utilized to develop and regularly irrigate agricultural lands (Anon., 2005).

  Iran is a pioneer among the countries of the region in controlling desertification through floodwater spreading. Uneven distribution of precipitation during the year and unexpected heavy rainfall lead to heavy floods, bringing millions of cubic meters of water onto the land in a short period of time. This huge amount of water usually destroys villages and agricultural lands along with other vital infrastructure such as roads and dams. Floodwater spreading is an expensive way to reduce the destructive effects of flashfloods and to produce other benefits from reclaiming eroded land. The purposes of this method include satisfying the water requirements of annual and perennial crops, range plants, shrubs and trees; removing sediment carried by floodwaters for later storage in surface reservoirs or aquifers; recharging aquifers artificially for later withdrawal; stabilizing the drifting sand by silts, clays and organic matter carried as suspended load by floodwaters; transforming of land into productive farms; reducing gully erosion and controlling downstream flooding and preventing water logging of agricultural lands and population centres which are located downstream of the floodwater spreading areas (Kowsar, 1991).

A successful example of floodwater spreading in Iran can be found in the Gareh-Bygone Plain, located in the Fars Province in the southeastern Zagros Region. The area is affected by flooding 3 to 7 times annually, with a diverted water volume ranging from 0.1 to 15 million $m^3$ per $year^{-1}$. Over a 6-year period (1983-1988), a cumulative water volume of about 38 million $m^3$ was diverted. A channel network is used to spread the flowing water onto the flat land. Channels are located 140 to 250 m apart. When floodwater reaches the end of a floodwater spreading system, it has lost most or its sediment load and is now suitable for artificial recharge or storage in surface reservoirs (Kowsar, 1991).

Plantations of fast-growing Australian species have been established on the Gareh-Bygone Plain (Mortazavi, 1994). Seedlings of *Eucalyptus camaldulensis* (Dehnh.), *E. microtheca* (F. Muell.), *Acacia cyanophylla* (Lindl.), *A. salicina* (Lindl.) and *A. victoriae* (Benth.) were planted adjacent to water channels. The planting lines were ripped to a depth of 35 cm and the seedlings are planted at 3 m spacing. A total of 30,000 seedlings were planted and protected from browsing for 9 months. Nine-month-old seedlings of quailbush (*Atriplex lentiformis* [Torr.], [Wats]) were planted at 3-m spacing in contour furrows, with a distance of 4 m between the furrows. Each seedling was irrigated with 2 liters of water immediately following planting, and the plantations were irrigated by every flood event (Kowsar, 1991). Eight years after establishment, the rate of survival of *Eucalyptus camaldulensis* was above 85% with all mortality occurred within the first year. The average height and diameter at breast height was 10.7 m and 12.2 cm, respectively. The total average yield amounted to 10 $m^3$ $ha^{-1}$ year $^{-1}$ with approximately 75% stem wood and 25% fuelwood (Kowsar *et al*., 1996).

Floodwater spreading and tree and shrub planting have transformed wasteland and stabilized drifting sands. The introduction of quailbush (*A. lentiformis*) and invasion of *A. leucoclada* (Boiss.), gray-leaved sagebrush (*Artemisia sieberi* [Besser]), and other forage species have added more palatable fodder to an already heavily grazed area. Growth of quailbush, which performs poorly on sands, was spectacular in sedimentation basins; 3-year-old bushes have grown to a height of 2 m and crown diameter of 2.5 m. The return of a few hubara bustards and gazelles to their former haunts is an auspicious sign for the total recovery of the Gareh-Bygone Plain. Human needs have been met with provision of irrigation water for 1,000 ha of cropland through 40 new and 16 old wells. The project has substantially raised the income of four farming communities in the plains and the yield of 650 ha of flood-irrigated farmland has doubled (Kowsar, 1991). With this method, the destructive power of water turns into a productive capital.

- *Qanat, an ancient irrigation system in arid lands*: Hundreds of villages subsist thanks to an old technique called "Qanat" that proved to be superior in water harvesting and conservation compared to today's technology of dams. It is not known whether the system was devised during the reign of Cyrus the Great, Achaemenian King, or before his time. Although 2,500 years old, or even more, it still performs its functions. A qanat is an underground ditch sometimes more than 100 km in length and 10, 20 or 30 m deep (Figure 18). Some are reputedly up to 50 m deep. They are 1 m wide and 1.80 m high, so that a man can stand inside. The qanat usually starts at the foot of a mountain and ends up in a village, an oasis or even a single house. Its presence is noticeable at surface level by an alignment of molehill-like humps. These correspond to man-hole or air-vents dug at regular intervals, usually every 20 or 30 m. The complex system of qanat stands out particularly clearly when seen from a plane. A large population owes its life to this system. This is the reason why villages in deserts look green. By means of this system, people have planted trees (mainly poplar) and irrigated their farms for centuries. The global output of Iran's qanat is estimated at twice that of the Rhone, France's largest river. The total qanat's length in Iran is estimated at 125,000 km (Hureau, 1972; Rashad, 2000).

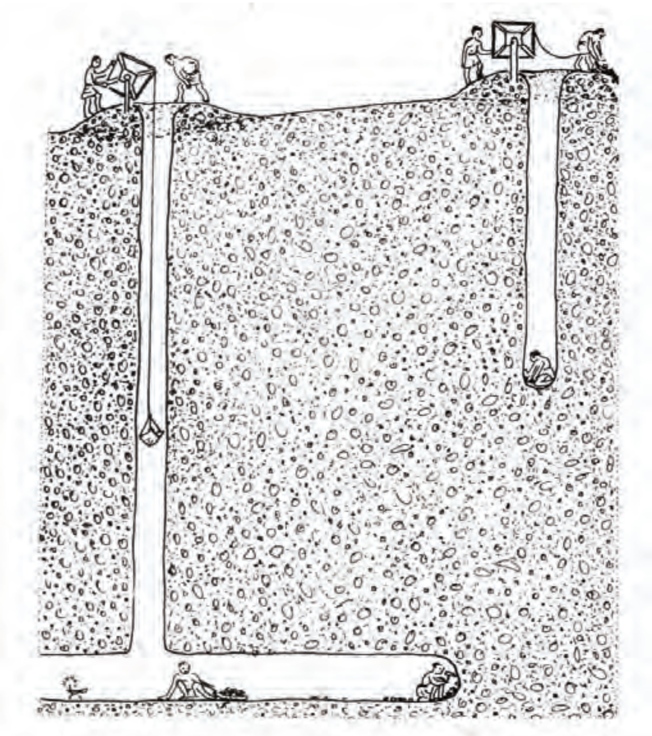


**Figure 18:** ***A Qanat system***

## *4.4 Research Projects in Forest Restoration*

Plantation establishments in Iran were initially based on traditional knowledge, but in the late 1960s and early 1970s forestry research has supported plantings with spacing experiments using native species and fast-growing exotic species, mainly pines, poplars, and eucalypts. Species selection for reforestation has been based on indigenous broad-leaves; exotic species are used for afforestation. The system of afforestation trials with exotic species consists of three phases (i.e. elimination stage, pioneer stage and final stages) beginning with 1) short-term elimination trials with 100 trees, 2) long-term growth trials consisting of 500 trees and 3) the results are used to select species to be introduced in large-scale plantations. All levels of the trial are replicated to allow statistical analysis (Webb, 1973).

A nation-wide species trial program has been carried out from 1968 to 1973 in the northern and western provinces of Iran using several exotic species. The object of the study was to investigate the introduction of suitable exotic tree species in un-irrigated plantation conditions in the humid and semi-arid zone of the country. This included about 300 different species and provenances. In 1972, about 1,000 ha of degraded hardwood forest in the northwestern Caspian Plain was replaced with several exotic plantations. Elimination (adaptation) trials in the 1960s indicated that Loblolly pine (*Pinus teaeda* L.) and *Eucalyptus viminalis* were the most promising species among the studied species for the Northwestern Caspian Plain (Figure 19), while *Cryptomeria japonica*, *Pinus sylvestris*, *Pinus elliottii*, *Eucalyptus ovata* and *Robinia pseudoacacia* showed relatively good results in some special sites. Heavy soil, bad drainage and winter frost were the most important reasons for the failure of other species (Dastmalchi and Sagheb-Talebi, 1997; Sagheb-Talebi and Dastamalchi, 1997). In the Central and Northeastern Caspain Plain, *Eucalyptus camaldulensis*, *E. viminalis*, *Pinus pinea, P. brutia,* and *P. eldarica* were the most promising species (Sardabi, 1998).

**Figure 19:** ***Two afforestation trials with exotic species, pine (left) and eucalypt (right)***

Poplars are fast-growing species suitable for afforestation on non-forest areas or former farmlands. For more than 30 years, exotic poplar species and clones (*Populus deltoides* and *Populus* x *euramericana*) were imported (Figure 20) and tested together with native poplar species (*Populus caspica* Bornm., *P. alba* and *P. nigra* ). Research in different parts of the country has examined adaptation to local site conditions, spacing, and yield of poplars and has supported a successful introduction of poplar clones to the landowners in the Caspian region. Large privately and publicly owned plantations have been established, which provide pulpwood for paper and roundwood for carpentry and other industrial purposes. Results of some research projects showed that *Populus* x *euramericana* (I-214 and I-488) are the most promising clones, with the lowest mortality and highest yield (Table 3). The highest standing volume was obtained by *Populus* x *euramericana* I-214 (408 $m^3$ $ha^{-1}$) and the mean annual volume increment after 15 years was 27 $m^3$ $ha^{-1}$ $year^{-1}$ (Ziaie-Ziabary *et al*., 1988). This has encouraged public and private managers to plant poplars and harvest them in short or long rotations.

**Table 3:** ***Quantitative characteristics of two hybrid poplar clones (Populus x euramericana I-214 and I-488) 15 years after planting in the Caspian Region***

| Clone | Spacing (m) | N $ha^{-1}$ (including mortality) | Mean DBH (cm) | Mean height (m) | Volume of mean tree ($m^3$) | Yield ($m^3$ $ha^{-1}$) | Volume increment ($m^3$ $ha^{-1}$ $year^{-1}$) |
|---|---|---|---|---|---|---|---|
| **I-214** | 2∗2 | 2000 | 17.8 | 20.1 | 0.204 | 407.6 | 27.2 |
| | 4∗4 | 500 | 25.6 | 25.6 | 0.552 | 276.1 | 18.4 |
| **I-488** | 2∗2 | 2000 | 15.2 | 19.8 | 0.168 | 336.0 | 22.4 |
| | 4∗4 | 500 | 22.6 | 23.5 | 0.441 | 220.5 | 14.7 |

**Figure 20:** ***Two poplar plantation trials in northern (left) and western (right) Iran***

Research on poplar plantations with native species, black poplar and white poplar also had some good results in central, western and northwestern parts of the country. Investigations on productive clones of poplar managed in a four-year short rotation system showed that *Populus nigra* had the highest survival rate and a production of 16,400 kg $ha^{-1}$ dry material within four years (Modir-Rahmati and Baghery, 2006). Trials with 10 black poplar clones in Kermanshah Province, Western Iran, revealed that the mean diameter of the promising clones varied between 20.7 and 21.9 cm after nine years. The mean height and mean annual volume increment of the same clones varied between 15.2 and 16.9 m, and 23.3 and 39.2 $m^3$ $ha^{-1}$ $year^{-1}$, respectively (Noori *et al*., 2007). Black poplar clones also represent a good survival rate (89%) and height growth (4.5 m) after two years in the central parts of the country (Daneshvar *et al*., 2009).

The spacing trials with black poplar showed that a very high wood production (50 $m^3$ $ha^{-1}$) could be expected within spacing of 1 m x 2 m (Figure 21), although the stem dimensions are low; whereas larger dimensions and 25 $m^3$ $ha^{-1}$ volume could be achieved in spacing of 2 m x 4 m (Hemmati and Modir-Rahmati, 2005).

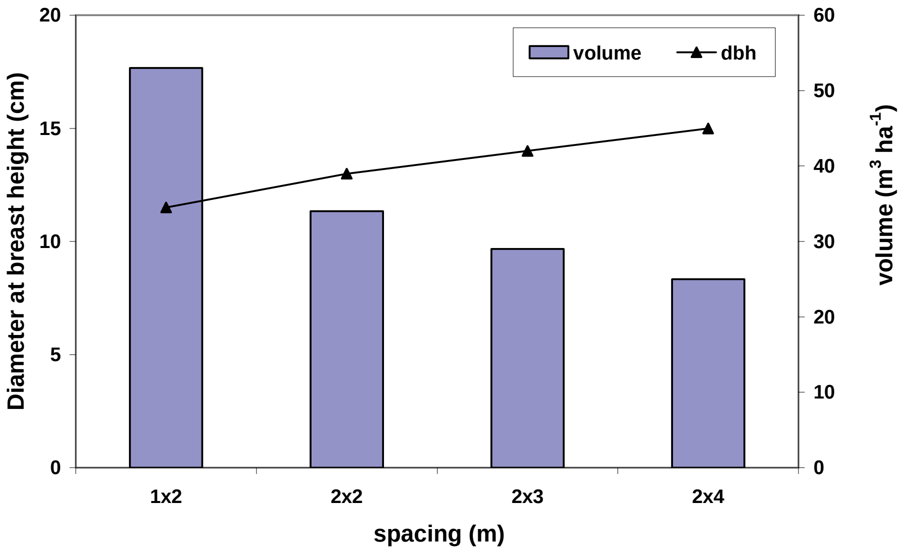



**Figure 21:** ***Comparison of diameter at breast height and volume of Populus nigra at different spacing***

Degraded alluvial forests around the cities in the Caspian Plain are very suitable for plantation and rehabilitation programs. Several restoration research projects have been carried out here with planting of different exotic and native tree species in the form of pure and mixed trials. In most cases, plantations of alder, maple, cypress and poplar showed interesting results. The mixed plantations formed two-storied stands, with poplars in the upper layer and alder or cypress in the understory. These mixed plantations were the most productive with a standing volume of 238 $m^3$ $ha^{-1}$ and an annual volume increment of 12 $m^3$ $ha^{-1}$ $year^{-1}$ (Sagheb-Talebi, 1996). Compared to similar natural vegetation cover, the production of these plantations is three times higher.

Several afforestation research projects with fast-growing, industrial tree species and provenances are still ongoing in the plains and mountainous parts of the Caspian Region. Different treatments and their replications are distributed from west to east and from lowland to higher elevations. Different results are obtained from research projects introducing most adapted species after 15 to 20 years of growth (Gholizadeh, 2001; Siahipour *et al*., 2003; Mohammadnejad, 2003; Sadati and Mostafanejad, 2008; Hemmati *et al*., 2009).

In the western part of the country, in the Zagros Region, different elimination trials showed different results. *Celtis australis*, *Robinia pseudoacacia*, *Eleagnus angustifolia*, *Cupressus arizonica* and *Pyrus syriaca* were the most promising species in the semi-arid zone with cold winters of northwestern Zagros (Maroufi, 1997; Dastmalchi *et al*., 1999; Sarkarat and Gheisy, 1999). In the warmer and drier Central Zagros, *Acacia modesta, A. pendula, Eucalyptus microtheca, E. camaldulensis, E. ochrophloia, Celtis australis, Robinia pseudoacacia, Fraxinus syriaca* and *Cupressus arizonica* showed promising results (Hemmati, 1996 and 1997). In the far southern Zagros with semi-arid and warm winters the elimination trials with 44 Eucalypt species indicated that *E. camaldulensis, E. microtheca, E., intertexta* and *E. gillii* were more adapted, while the first two species are economically very important (Mortazavi, 1994).

Since a few years, with recent international trends and development of new ideas on ecosystem approach as well as close to nature silviculture and forest management, Iranian foresters and researchers have also revised their strategies in order to maintain the natural forest ecosystem and pursue close to nature management. At present, higher priority is given to planting native species, with priority given to rare and noble native broad-leaved species, over exotics. As a matter of fact, when planting different species in different ecological regions, preference is given to indigenous trees. Recent research projects are focused more on this subject and several research stations in different parts of the country are working on it. Highest attention is given to native fast-growing tree species which have adapted to different sites within hundreds of years. In cases where the forest ecosystem has been heavily degraded and rehabilitation of the natural ecosystem with original species composition is very hard to achieve, planting of pioneer, and even exotic species is recommended as a first step for ameliorating the site for further silvicultural activities.

### *4.5 Analysis of Past and Current Rehabilitation and Restoration Activities*

Tree plantation in Iran has a long history and goes far back into ancient times considerably rooted in the national-religious beliefs. Planting of fruit and multipurpose trees started with the advent of civilization in Iran more than 2,500 years ago. Royal paradises and poplar and cypress gardens are the evidences for the long tree planting culture in Iran (Javanshir, 1999).

Before the Forest and Range Organization (FRO) initiated systematic management of forests in 1960, forests were exploited in an uncontrolled manner and there was very limited regeneration. Prior to this date, some plantations have been established in different parts of the country. The first official forest plantation took place in the north of Iran using oak and Siberian elm in 1947, followed by plantations in Tehran in 1950 (Hedayati, 2005). In 1965, FRO initiated a considerable program of non-irrigated plantations in rural areas and irrigated plantations around large towns and cities. A good example is the greenbelt around Tehran using drought-resistant conifers (Figure 22) and deciduous species (*Pinus eldarica* Medw., *Cuppressus arizonica* Greene, *Ailanthus altissima* (Mill.) Swingle and *Fraxinus rotundifolia* Mill.). Except for the semi-dry and dry steppic areas and deserts in the central part of the country, most of the recent plantations are concentrated in the northern and western parts of Iran.

**Figure 22:** ***Plantation of Pinus eldarica and Cupressus arizonica around the city of Tehran***

Degraded forests in the Caspian Region of about 600,000 ha are potentially available for reforestation or afforestation, of which about half has been restored, including reforestation on 240,000 ha. Afforestation of 50,000 ha includes 30,000 ha planted with poplar species in the Caspian Plain. Thirty five (35) permanent and temporary, private and governmental nurseries produce 40 million seedlings annually. Depending on tree species, both bare root and container stocks of different sizes and ages are used. Usually, containers with sizes of 10 cm x 30 cm or 20 cm x 40 cm support 1- or 2-year-old seedlings. Vegetative propagation schemes of fast-growing species such as poplars have introduced new trees species or clones for widespread planting on suitable sites.

Some of the species produced in nurseries and planted in the Caspian Region include *Acer velutinum, Acer cappadocicum, Alnus subcordata, Alnus glutinosa, Eucalyptus* spp., *Fraxinus execlsior, Juglans regia, Populus deltoides* Marsh. (several clones), *Populus x euramericana* Dode (Guinier) (several clones), *Quercus castaneifolia*, *Abies* spp., *Cedrus deodara* G. Don, *Cryptomeria japonica* D. Don, *Cupressus arizonica, Cupressus simpervirens, Juniperus excelsa, Juniperus virginiana* L., *Larix deciduoa* Mill., *Picea abies* Karst., *Pinus eldarica, Pinus elliottii, P. nigra* (several provenances), *P. ponderosa* Douglas ex Lawson, *P. radiata, P. sylvestris* L., *P. taeda* L. and *Taxodium distichum* L.C.Rich. In the Zagros Region, the main species are *Ailanthus altissima, Amygdalus* spp., *Cupressus arizonica, C. simpervirens, Eucalyptus* spp., *Juglans regia, Pinus brutia* Ten., *Pinus eldarica, P. nigra* (several provenances), *Platanus orientalis* L., *Populus alba* L., *Populus nigra* L., *Quercus brantii* and *Robinia pseudoacacia* L. In the Persian Golf region, the main species are *Acacia* spp., *Albizzia lebbeck, Avicenia marina, Azadirachta indica, Dalbergia sisso, Eucalyptus* spp., *Podocarpus* sp., *Prosopis juliflora*, *Rhizophora macronata* and *Ziziphus spina-christi* (Sagheb-Talebi, 2005; Keneshloo, 2001).

Sometimes, seedlings are transplanted directly from the nursery bed into the plantation (1-0 or 2-0 stock). More commonly, seedlings are moved from the seedbed to a transplant bed for one or two growing seasons, after which they are lifted and planted out in early to late winter time. Direct sowing on forest sites may be used to fill gaps or to stabilize the soil against landslides (i.e. using maple or alder). Soil preparation works, consisting of weeding and digging pits, usually are done manually. The method to be employed depends on rainfall, mode of sowing/planting, species to be planted and soil characteristics. The general surface topography is usually improved by contouring, terracing, and leveling in steep terrain. Soil structure is improved in some cases in order to promote drainage or improve potentials for root penetration, as well as enabling sufficient water supply in sub-humid or sub-dry sites. On flat sites with a high water table in the Caspian Plain, pioneer planting with indigenous alder or exotic bald cypress is used to improve soil drainage within the rooting zone. This alters many important hydrologic characteristics of a site and changes the vegetation community to species that grow in better-drained soils. Spacing depends on species, growth rates, and light demands (shade tolerance). Planting pattern is varied, as line, square, and triangle patterns are all used. Plantations are both pure and mixed, in line and block mixture. Usually, fencing encloses the plantation area to exclude livestock and game and to protect the seedlings and young plants from grazing.

Water supply is one of the important limiting factors that affect the success of plantations, in particular in semi-arid and arid areas. From a quantitative point of view, restoration activities are usually very good, but frequently lack sufficient quality. Most of the plantations suffer from lack of water. Another important factor is grazing; in several cases the presence of livestock in the rehabilitation areas has had negative impacts on the success of the plantations. This is more obvious in the first years of planting, when the seedlings are short and the terminal bud is damaged because of grazing.

Not all experiments with exotic species proved satisfactory. Foresters have seen new problems developing with exotic plantations. Establishment of single or limited species mixture (monocultures) over extensive areas may intensify some local pest problems, primarily if the homogeneous conditions would encourage a rapid buildup of some pest populations to dangerously high levels. This happened in the large-scale monocultures of exotic pine species (*Pinus elliottii* Engelm. and *P. radiata* D. Don) in the Western Caspian Plain, which were totally damaged through the outbreak of *Limantria dispar*. Therefore, foresters are careful when selecting exotic species and avoid large plantations of those not previously tested in the region.

We should also mention here the strength of rehabilitation and restoration activities in the country. Using private sector and participatory approach had brought several good results. This was more successful when using multi-purpose trees for providing fodder as well as fruit for increasing the income of rural society. Banking facilities have supported the rural community for expanding plantations with fast-growing tree species, especially poplars, which could also produce raw material for the related industries. Besides, providing fuel (oil, gas, etc.) by the government has had a positive impact, and it resulted in a decrease of forest degradation rates as well as less destruction of new plantations. Almost one million ha has been planted in the country in the last 40 years, including 419,000 ha in different ecological regions and 531,000 ha for combating desertification and planting of saxaul (Anon., 2008). Figure 23 shows the plantation statistics of 12 years in the arid and semi-arid regions.

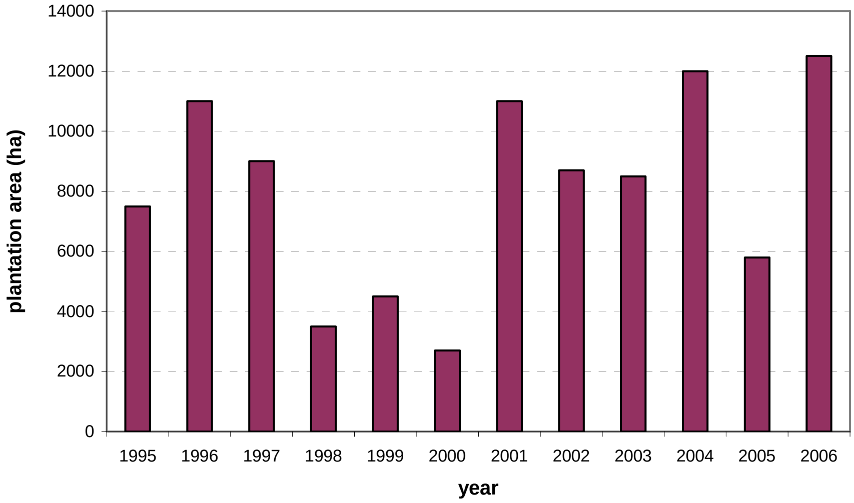



**Figure 23:** ***Plantation area of the past 12 years in the arid and semi-arid regions of Iran***

Using mulch for site preparation followed by plantation of *Haloxylon*, *Tamarix, Calligonoum* and *Calotropis* has brought excellent results in combating desertification and fixing sand dunes (Figure 24). The use of ton vases is an effective irrigation system for plantations in deserts which significantly reduces the overall water consumption. The history of such activities goes back to sand dune fixation of 100 ha of desert land in Sabzevar in the 1960s. The annual statistics of previous decades shows 9,300 ha of spreading mulch, 50,000 ha planting of seedlings and trees, and 128,000 ha of direct seeding (Darvish, 2009). Some other statistics include: preparation of desertification control plans for 9 million ha, management plans of man-made forests in deserts covering 185,000 ha, planting of seedlings on 2 million ha, dispersing of seed and direct seeding on 4.6 million ha, spreading mulch on an area of 220,000 ha, and protected areas totalling 7.5 million ha.

**Figure 24:** ***Successful Haloxylon plantation after using mulch in the desert***

### *4.6 Forest Rehabilitation Outputs and Future Directions*

All rehabilitation programmes in the country resulted in 950,000 ha of plantations and 670,000 ha of new forests for combating desertification. These programmes have had several outputs related to human welfare such as fixation of sand dunes and protection of villages and settlements, soil protection and preventing of wind and water erosion, improvement of micro climate and increasing of ground water supply, producing wood for industries as well as fuelwood for rural people.

It is estimated that 3 million $m^3$ of wood per year is produced from 190,000 ha plantations of poplar, eucalypt and willow. This is only 25% of the capacity for plantation with fast-growing tree species (wood farming) in the country. Twenty years ago the wood production of poplar plantations was 10 to 15 $m^3$ per year, whereas nowadays the annual production of poplar plantations has increased to 25 to 30 $m^3$ through the use of productive clones. Eucalyptus plantations produce 20 to 25 $m^3$ a year. The future direction aims to expand the wood farming area to 500,000 ha and to increase the wood production to 12.5 million $m^3$ per year (Modir-Rahmati, 2009).

Water regulation, creating parks and recreation areas for people tired of living in large cities, flourishing of ecotourism, and carbon sequestration are other important outputs of forest rehabilitation in the country. Investigations showed that the amount of carbon sequestrated by 30-year old *Eucalyptus camaldulensis* plantations in Southwestern Iran varied between 1.13 and 7.8 ton $ha^{-1}$ $year^{-1}$. This figure in 28-year old *Acacia salicina* plantations amounts to 1.5 ton $ha^{-1}$ $year^{-1}$ (Bordbar and Mortazavi, 2006). This leads to a reduction of $C0_2$ in the atmosphere mitigating negative greenhouse effects in semi-arid regions of the country.

Rehabilitation activities have also improved biodiversity and ecosystem quality in comparison to the adjacent degraded forests. Investigations of Mohammadnejad Kiasari (2009) in 18-year old plantations of maple, alder and oak showed that the biodiversity among ground vegetation, litter and soil invertebrates were higher than the adjacent degraded stands.

It is important to also consider the socio-economic effects of forest rehabilitation, in particular regarding job creation and increasing income of rural people working in afforestation and reforestation programmes. A participatory approach has also found a suitable level within rehabilitation activities.

In general, considering different aspects of forestry in the country, future directions lead us to continue rehabilitation programs by planting native broad-leaved species within the natural forest areas and planting native as well as exotic fast-growing tree species outside forest areas and on sites with suitable soil and water conditions for extensive wood farming.

## 5. Capacities in Forest Rehabilitation

### *5.1 Institutional Capacities*

#### *Execution*

This part has been addressed briefly in the section Forest Administration and Management. The Department of Afforestation and Parks is responsible for the rehabilitation and restoration of forests in the whole country. This Department is active under two previous mentioned Deputies for Humid and Sub-humid as well as Dry and Semi-dry Regions. At present, 42 forest experts, among whom are forest engineers (B.Sc.), senior forest engineers (M.Sc.) and professionals with Ph.D. that are employed in the Central Office. At provincial level, or ecological regions, 160 forest experts are working in the Hyrcanian region, 72 forest experts in the Khalijo-Omanian Region and 410 forest experts in the Irano-Turanian Region.

***Education and Training***

The country's universities are actively involved in forestry education and training. There are 11 natural resources faculties in the country offering education in forestry, range management, watershed and desert management, wood science and fishery. One of these faculties is located in Karadj; University of Tehran, four in the northern, three in western, two in the central and one in the southern part. There are B.Sc., M.Sc. and Ph.D. courses in the field of renewable natural resources management. Many students also go abroad to continue their education. In recent years, the renewable resources faculties have developed cooperation with partner faculties in other countries.

***Research***

The Research Institute of Forests and Rangelands (RIFR) is an independent organization, affiliated with the Deputy Minister of Training, Research and Extension of the Ministry of Jihad Agriculture, which was established in 1969. Parallel to the executive tasks of the FRWO, the major role of RIFR involves basic and applied research in renewable natural resources management considering FRWO requirements. Some tasks of RIFR include research and studies to identify, preserve, restore, utilize forest resources including sustainable management of forests, rangelands and deserts of Iran. This includes plants, habitats, biotic and abiotic environmental factors, medicinal and poisonous by-products. RIFR is composed of 6 research divisions and 4 research departments. RIFR has also 32 provincial research centres and 79 research stations throughout the whole country. The research divisions of RIFR are as follows:

- Forest Research Division,
- Range Research Division,
- Desert Research Division,
- Division of Botany,
- Medicinal Plants and By-Products Research Division, and
- Wood Science and Forest Products Research Division.

Departments are:

- Department of Poplar and Fast Growing Trees,
- Department of Forest and Range Protection Research,
- Department of Biotechnology Research, and
- Department of Mechanization.

The Forest Research Division (FRD) was established in 1969. The strategy of forest research in Iran is to conduct research projects for studying the site demands of native forest tree species, the structure of pure and mixed forest stands, different methods of forest tree plantations for increasing and improving wood production, as well as preparing data and information in order to introduce close to nature silviculture and sustainable forest management. FRD comprises the following five departments:

- Forest Ecology and Silviculture,
- Forest Plantation and Tree Improvement,
- Forest Management and Socio-economic Issues,

- Biometry and Utilization, and
- Forest Soils.

The Department of Forest Plantation and Tree Improvement deals with research on the introduction of exotic species, examination of plantation methods and spacing trials, preparation of seedbed and nursery techniques, water and fertilizer requirements of species, evaluation and protection of genetic resources, and stress impact on trees and seedlings (Anon., 2006). At present, 98 forest experts (B.Sc., M.Sc. and Ph.D.) are working in the Forest Research Division of RIFR, of which 63 are members of the scientific board. Fourteen (14) forest researchers are employed in the central office located in the capital city. At provincial and regional level, 28 forest researchers are working in the Hyrcanian Region, 28 in the Khalijo-Omanian Region and 18 in the Irano-Turanian Region.

### *5.2 Civil Society Involvement*

The role of the private sector in forest management is gradually gaining importance and it is anticipated that its importance will increase even further. The private sector is actively involved in the fields of study and preparation of forestry plans, implementation of forestry projects, including rehabilitation, restoration, and plantation projects, and even planning and supervision. Recently, macro-policies have reinforced private sector involvement. Also the local communities and NGOs recently have actively participated in the preparation and implementation of forestry projects, in particular plantation projects. At present, there are 35 NGOs active in the field of natural resources management (Anon., 2005), among them is the very active NGO of Mountain Climbers that concentrates on forest plantations in mountainous regions.

### *5.3 Education in Forest Rehabilitation*

Iran's education in forest management has three levels; four years of B.Sc., two to three years of M.Sc., and three to four years of Ph.D. degrees. In the first four years, students are educated and trained as a general forest engineer. Within the M.Sc. period, students can select their field of study and specialization. In this period, they can have extra courses in afforestation, reforestation and forest restoration. They should prepare a master thesis within 12 or 18 months. For Ph.D. studies, usually completed within 2 to 3 years, students can also choose their thesis on topics related to forest rehabilitation. Many students select their field of study for M.Sc. and Ph.D. in this subject and work in nurseries or plantation areas in different ecological regions of the country.

### *5.4 R&D Needs in Forest Rehabilitation*

It is expected that future forest rehabilitation research will concentrate on specific sites and stations located in the various ecological regions. For this purpose, priorities will be given to provinces according to their natural potentials and capacities. Not all provinces will participate in these projects with an equal share. Preliminary studies showed that only 12 provinces have highest priority for general forest rehabilitation research, while in 15 provinces poplar research would be urgently needed.

The main research and development needs in forest rehabilitation can be summarized as follows:

- *Financial support*: For the next five-year development program, US $150 million is needed for afforestation and reforestation projects with forest tree species, US $ 750 million for wood farming with poplars and other fast-growing species and US $ 190 million for establishing and improving of forest parks; in addition to financial needs of the research sector. Support should be given by the public and private sectors.

- *Forest experts and trained man-power*: Twenty nine (29) forest experts with B.Sc., M.Sc., and Ph.D. degrees are needed for the central office and 758 for all the provinces to work as executive managers. These experts should be involved in forestry activities, especially rehabilitation projects. Training forest researchers with subsequent employment in the sector has utmost priority.

- *Research projects*: Several applied and basic projects will be prepared and carried out in cooperation of forest managers and researchers. Among them are investigations on appropriate methods of plantation and forest rehabilitation, improving of nursery techniques, investigation in different productive poplar clones and different short rotation systems for increasing wood production per area unit, and investigations on the role of rural people in plantations of multi-purpose trees species.

- *International relations*: Participation in different international and regional meetings, seminars, and conferences plays an important role for improving the quality of forest experts, particularly for obtaining up to date information on progress made in forest rehabilitation in other countries and regions.

### *5.5 International and Regional Cooperation in Forest Rehabilitation and Restoration*

Since 1981, forest dwellers' cooperatives have been established, in order to give priority to forestry activities over animal husbandry. The cooperatives represent a kind of social forestry approach, because they are directly managed by local communities. The cooperatives are mainly engaged in the management, rehabilitation and protection of degraded forests. Therefore, they urgently need public financial support. At present, 63 cooperatives are involved in the forestry sector (Anon., 2005).

Bilateral collaboration with other countries has increased in recent years. There is an extensive cooperation with Japan in the field of watershed management and biological rehabilitation of water catchments, exemplified by the 27 million ha of the Karoon Water Catchments Project with JICA in five provinces. Cooperation with Germany in the field of rural development and biological diversity includes planting of trees by rural people and improving agroforestry systems. Cooperation with France includes forest park development and ecotourism, and cooperation with China emphasizes desertification control. In addition, there is ongoing cooperation with Turkmenistan and Kyrgyzstan on plantation of saxaul and sand dune fixation.

FRWO and the Department of Environment are enhancing their collaboration with international organizations as well. There are some joint projects with GEF, UNDP and IUCN; for example the carbon sequestration project in South Khorasan Province. Iran is technically supported by FAO. Also RIFR has some relations to IUFRO and the Iranian forest researchers share their knowledge and cooperate with other forest experts and researchers in different parts of the world, in particular with European countries. A recent joint project on fast-growing tree species, like *Abies grandis*, is being implemented as cooperation of the University of Göttingen in Germany and RIFR in Iran. There are also some contacts to the Centre for International Forestry Research (CIFOR).

## 6. Future Steps

The vision of the new forest strategy is to achieve sustainable forestry at national level. The aim of the strategy is to achieve ecological sustainability of forests. The long-term goals of the forestry sector are to:

- maintain forest health through soil protection and biological diversity,
- utilize forest products and services on a sustainable basis,
- restore degraded forests,
- develop forest resources at national level,
- combat desertification and land degradation, and
- protect and restore natural ecosystems in watershed basins.

In order to achieve these long-term goals, the forestry sector observes the following principles in planning, management and implementation:

- expand plantations and green space,
- develop participation of all stakeholders in forestry activities,
- provide fuel and energy for rural people,
- improve living standard and sustainable livelihood of rural people,
- observe local rights of native people,
- training and raise public awareness,
- preserve biological diversity,
- maintain and develop functions of forest ecosystems,
- use all potentials of forest ecosystems in watershed basins, and
- monitor and assess all plans and projects.

Recently, a team of experts in forest management (FRWO), research (RIFR) and forest education (Sagheb-Talebi, 2009) has compiled an outlook study for the entire country outlining the main principles, strategies and approaches in forestry for the next 20 years. With focus on forest rehabilitation, these issues are divided into managerial and research sections, which will be presented for the following phytogeographical regions:

**Hyrcanian (the humid and sub-humid region)** ***Management strategies and approaches***

The main strategies of forest rehabilitation for the humid and sub-humid northern part of the country are forest protection, improvement of the socio-economic situation, reduction of degradation factors, reforestation, restoration of degraded forests, and production of wood and cellulose by plantation of fast-growing tree species (wood farming) and improvement of parks and recreation areas.

The major approaches for achieving the aims of these strategies are: improvement of forest legislation, developing and training of forest guards, combating illegal wood harvesting, organizing new settlements for inhabitants of villages in the lower altitudes, improvement of animal husbandry and livestock systems, shifting from wood to biogas and solar energy, improvement of nurseries and seed orchards, enrichment and reforestation of degraded areas in mountainous areas at the timber line, establishing mixed plantations with native broad-leaved species, and plantations with fast-growing species like poplar (wood farming). High priority is given to participatory approaches, expanding of recreation areas and parks and establishing of reserve areas. Also decreasing wood harvest and importing wood instead could have a positive effect on forest protection for some decades. Table 4 illustrates the strategy of several five-year development programmes for the northern part of the country for the next 17 years.

**Table 4:** ***Strategic program for the Hyrcanian region for the next three five-year development programs***

| Period | 2009-2010 | 2011-2015 | 2016-2020 | 2021-2025 | Total |
|---|---|---|---|---|---|
| **Settlement of livestock out of forest (livestock unit)** | 315,000 | 2,000,000 | 960,000 | - | 3,275,000 |
| **Settlement of forest inhabitants (family)** | 1,000 | 5,000 | 2,900 | - | 8,900 |
| **Restoration and enrichment (ha)** | 34,000 | 90,000 | 100,000 | 110,000 | 334,000 |
| **Reforestation and afforestation (ha)** | 15,000 | 45,000 | 50,000 | 56,000 | 166,000 |
| **Wood farming (ha)** | 15,000 | 35,000 | 35,000 | 35,000 | 120,000 |
| **Improvement of parks and recreation area (ha)** | 5,000 | 15,000 | 15,000 | 15,000 | 50,000 |

***Research strategies and approaches***

Principles and priorities of the research sector by carrying out basic and applied research projects can be summarized as follows:

Investigation on principles of socio-economic problems and alternatives for improving it, investigation on alternative methods for providing fuel and improving living conditions of rural people, investigation on appropriate methods of plantation and forest rehabilitation, investigation on improving nursery techniques and providing quality seeds, investigation on effective methods for producing healthy and high quality seedlings, study on the importance and role of mycorrhiza and rizobiomes on seedling health, methods of planting of pioneer species on degraded forests at the timber line, impact of forest plantation on biodiversity (micro- and macro-organisms over ground and under ground), investigation on propagation methods and on stress behaviour of trees, using different productive poplar clones and different short rotation systems, and entomological studies in various stands and determination of pests and diseases.

**Irano-Turanian and Khalijo-Omanian (the arid and semi arid regions)** ***Management strategies and approaches***

The main strategies of forest rehabilitation for the arid and semi-arid parts of the country include forest protection and improvement of forest health, reduction of degradation factors by improving the socio-economic conditions and living standards of rural communities, reforestation, restoration of degraded forests, improving the environmental functions of forests (water, soil and carbon sequestration), and afforestation with multi-purpose trees. In some cases, where there is less water shortage, plantation with some poplars (wood farming) could be also taken into account.

The major approaches for achieving the aims of these strategies are: improvement of forest legislation, improvement of agricultural, horticultural and animal husbandry systems, change of the fuel system from wood to natural gas, biogas and solar energy, improvement of nurseries, establishment of reserve areas, expansion of recreation areas and parks, enrichment and reforestation of degraded areas, encouragement and training of people for participatory approach, raising public information, establishing plantations with drought resistance species and those with fast-growing species like poplar (wood farming) and giving high priority to participatory approaches. In this context, planting of multi-purpose trees (walnut, almond, hazelnut, pistachio, fig trees, jujube tree, wild pear, etc.) could bring more benefits for local communities. Table 5 illustrates the rehabilitation strategy of fiver-year development programs for the western, central, and southern parts of the country for the next 17 years.

**Table 5:** ***Rehabilitation program for the Irano-Turanian and Khalijo-Omanian regions for the next three five-year development programs***

| Period | 2009-2010 | 2011-2015 | 2016-2020 | 2021-2025 | Total |
|---|---|---|---|---|---|
| **Restoration and enrichment (ha)** | 300,000 | 2,500,000 | 4,200,000 | 4,800,000 | 11,800,000 |
| **Afforestation (ha)** | 100,000 | 475,000 | 520,000 | 550,000 | 1,645,000 |
| **Wood farming (ha)** | 20,000 | 100,000 | 100,000 | 100,000 | 320,000 |

***Research strategies and approaches***

Principles and priorities of the research sector by carrying out basic and applied research projects in the arid and semi arid regions can be summarized as follows:

Investigation on principles of socio-economic problems and alternatives for improving it, studies in protected areas, investigation on alternative methods for providing fuel and improving living standards of rural people, investigation on appropriate methods of plantation and forest rehabilitation, investigation on the improvement of nursery techniques, study on different methods of direct seeding, seedling planting, and using of shrubs as shelter, methods of planting of pioneer species in degraded forests, investigation on propagation methods and on stress behaviour of trees, studies on symbiosis of micro- and macro organisms in soils, investigation on multi-purpose trees and on different poplar clones suitable for short rotation systems, and bio-ecological research and entomological studies in various stands including determination of pests and diseases.

## 7. References

Anonymous. 1964. Natural Resources of Iran. Forest and Rang Organization, Engineering office, 37p.

Anonymous. 1999. Qualitative and quantitative characteristics of the northern forests of Iran. Forest and Rang Organization, Technical office, 102p.

Anonymous. 2001. Complex of Laws for Natural Resources. Forest and Rang Organization, 856p.

Anonymous. 2002a. Atlas of Iran. Gitashenasi Cartographic & Geographical Institute, Tehran, 256p.

Anonymous. 2002b. Management plan of natural resources in Zagros region. Forest and Range Organization, Office of dry and semi-dry areas, 34p.

Anonymous. 2005. Forestry Outlook Study for West and Central Asia. The Draft Country Outlook Paper of Iran. Forest, Rang and Watershed Organization, 33p.

Anonymous. 2006. An Overview of Research Institute of Forests and Rangelands. Research Institute of Forests and Rangelands. Iran, 42p.

Anonymous. 2008. Natural resources of Iran. Forest, Rang and Watershed Organization, Engineering office, 52p.

Bahrami, T. 1951. History of agriculture in Iran. University of Tehran press, 242p.

Ball, J. 1999. Overview of low forest cover countries in developing region. *In*: Mirsadeghi, S.M. (Ed.), Proceedings of International Meeting on Special Needs and Requirements of Developing Countries with Low Forest Cover and Unique Types of Forests. Forest & Range Organization, Tehran October 4-8: 39-56.

Bordbar, S.K. and S.M. Mortazavi 2006. Carbon sequestration potential of *Eucalyptus camaldulensis* Dehnh. and *Acacia salicina* Lindl. Plantations in western areas of Fars province. Pajouhesh-va-Sazandegi (Research and Construction) in natural resources, 70: 95-103.

Daneshvar, H.A., A.R. Modir-Rahmati, and M.T. Feizi. 2009. Growth characteristics of different polar clones in Esfahan province. Iranian Journal of Forest and Poplar, 17(1): 10-24.

Dareshoori, F. and N. Kasraian. 1998. Nature of Iran. Rouzaneh Kar, Tehran, 198p.

Darvish, M. 2009. Strategic priorities in desert researches. *In*: Assareh. M.H. and Akhlaghi, S.J.S. (Eds.). Strategic framework for developing and promoting natural resources research in I.R.Iran. Principles, Strategies, Approaches. Research Institute of Forests and Rangelands, Tehran, Tech. pub. No. 408: 171-181.

Dastmalchi, M. and K.H. Sagheb-Talebi. 1997. Results of elimination trials (Needle-leaved species) in Gilan Province, Part II. Research Institute of Forests and Rangelands, Tehran, Tech. pub. No. 168: 76-136.

Dastmalchi, M., S. Gheisy, and K.H. Sagheb-Talebi. 1999. Results of elimination and pioneer trials with tree species in West-Azarbeidjan. Research Institute of Forests and Rangelands, Tehran, Tech. pub. No. 203. Forest and Poplar Research, 1: 1-68.

De Morgan, J. 1890. Geography de west de l'Iran. Translated by Vadiie, K., 1960. Chehr press, Tehran.

Djazirei, M.H. 1962. Formations Forestières de l'Iran. Ministère de l'Agriculture, Consei Superior de Recherches Agricoles, Bull. No. 1, 44p.

Gholizadeh, M.N. 2001. Preliminary results of elimination trial with needle-leaved species in Mazandaran (Nowshahr). Iranian Journal of Forest and Poplar Research, 4: 53-88.

Habibi, H. 1985. Les Sols des hêtraies des forêts Caspiennes et leur rôle sur les différents types de hêtraies. Iranian Journal of Natural Resources, 38: 1-17.

Harrington, F.A. and F. Dareshoori. 1976. A Guide to mammals of Iran. Department of the Environment. Tehran, 93p.

Hedayati, M.A. 2005. Expansion and restoration of the Caspian forests; 20 years outlook. Department of afforestation and parks. Forest, Range and Watershed Organization, 37p.

Hedin, S. 1910. Deserts of Iran. Translated by Rajabi, P., 1976. Tukan press, Tehran.

Hemmati, A. 1996. Final report of species trials of Eucalyptus and Acacia species in Kermanshah province (Qasr-e-Shirin). Research Institute of Forests and Rangelands, Tehran, Tech pub. No. 152, 64p.

Hemmati, A. 1997. Final results of adaptation trials for various tree and shrub species at non-irrigated condition in Lorestan province. Research Institute of Forests and Rangelands, Tehran, Tech. pub. No. 173, 88p.

Hemmati, A., B. Khanjani-Shiraz, and B. Ghaderi Vangah. 2009. Elimination trial on some of important conifers in Asalem forests. Iranian Journal of Forest and Poplar Research, 17(1): 64-72.

Hureau, J. 1972. Iran today. Editions Jeune Afrique, Paris, 285p.

Irannejad-Parizi, M.H. 2000. Structure and vegetation diversity in Khabr and Roochun national park. Ph.D. thesis, University of Tehran, 244p.

Jalili, A. and Z. Jamzad. 1999. Red Data Book of Iran. A preliminary survey of endemic, rare and endangered plant species in Iran. Research Institute of Forests and Rangelands, Tehran, Tech. pub. No. 215, 748p.

Javanshir, K. 1999. History of the Natural Resource Science of Iran. The Academy of Sciences of I.R.Iran and Ministry of Agriculture. 470p.

Jazirehi, M.H. and M. Ebrahimi Rostaghi. 2003. Silviculture in Zagros. University of Tehran press, 560p.

Kananian, M. 2004. Study and determine dependence of local livelihoods on natural resources for Forest Sustainable Management. M.Sc. thesis, Faculty of Natural Resources, University of Tehran. 170p.

Kananian, M. 2009. Participatory planning for forest watersheds through Sustainable livelihood approach. Ph.D. thesis, Free University of Iran, Science and Research Campus (Unpublished).

Keneshloo, H. 2001. Forest Plantation in Arid Zones. Research Institute of Forests and Rangelands, Tehran, Vol. 1, Tech. pub. No. 263, 516p.

Knapp, H.D. 2005. Die globale Bedeutung der Kaspischen Wälder. *In*: Nosrati, K., Marvie Mohadjer, R., Bode, W. And Knapp, H.D. (eds.). Schutz der Biologischen Vielfalt und integriertes Management der Kaspischen Wälder (nordiran). Bundesamt für Naturschutz, Germany: 45-70.

Kowsar, A. 1991. Floodwater spreading for desertification control: An integrated approach. An Iranian contribution to the Implementation of the Plan of Action to Combat Desertification. Desertification Control Bulletin (UNEP), 19, 3.

Kowsar, A., S.M. Mortazavi, and M. Niazi Ardakani. 1996. Eight-Year Performance of *Eucalyptus camaldulensis* in Waterspreaders in a Sandy Desert. Desertification Control Bulletin (UNEP), 29, 35.

Latifi, M. 2000. Snakes of Iran. 3rd. edition. Department of the Environment. Tehran, 478p.

Lemton, A.K.S. 1983 (translated by Manuchehri, A.). Land owner and farmer in Iran. Centre of scientific and cultural publication of Tehran.

Maroufi, H. 1997. Tree species growth trial in un-irrigated condition in Sanandaj (West-Iran). Research Institute of Forests and Rangelands, Tehran, Tech. pub. No. 172, 52p.

McGregor, S.M. 1875. A trip to Khorasan province. Translated by Mehdizade, M. Astan-e Ghods press, vols. 1 & 2, Mashad.

Mobayen, S. and Tregubov, V. 1970. Guide pour la carte de la vegetation naturelle de l'Iran. Bull. no. 14, Universite de Tehran. Projet UNDP/FAO, IRA 7. 20p.

Modir-Rahmati, A.R. 2009. Strategic priorities wood farming researches. *In*: Assareh. M.H. and Akhlaghi, S.J.S. (Eds.). Strategic framework for developing and promoting natural resources research in I.R.Iran. Principles, Strategies, Approaches. Research Institute of Forests and Rangelands, Tehran, Tech. pub. No. 408: 210-220.

Modir-Rahmati, A.R. and R. Bagheri. 2006. Determination of adaptive and productive clones of poplar at four-year short rotation system. Iranian Journal of forest and Poplar Research, 14(2): 100-115.

Mohammadnejad Kiasari, Sh. 2009. Impact of plantation (softwoods & hardwoods) on biodiversity of vegetation components and macro organisms in Darabkola forests (Mazandaran Province). Ph.D. thesis, Free University of Iran, Science and Research Campus. (Unpublished) 153p.

Mohammadnejad Kiasari, Sh., M. Dastmalchi, S.A. Mousavi Garmestani, and B. Jafari. 2003. Preliminary results of elimination trial with needle-leaved species in Mazandaran forests (Vanamak). Iranian Journal of forest and Poplar Research, 11(2): 285-318.

Mortazavi, S.M. 1994. Results of Eucalyptus species elimination trials in Fars province (southern Iran). Research Institute of Forests and Rangelands, Tehran, Tech. pub. No. 99, 71p.

Noori, F., A.R. Modir-Rahmati, and A. Hemmati, A. 2007. Elimination trial of 10 Poplar clones (*Populus nigra*) in Kermanshah province. Iranian Journal of Forest and Poplar Research, 14(4): 278-291.

Ramezani, A. 1995. Ten thousand years history of Iran. Eghbal press, 4 vols. Tehran.

Rashad, M. 2000. Iran; Geschichte, Kultur und lebendige Traditionen – antike Stätten und islamische Kunst in Persian. DuMont Buchverlag, Köln. 400p.

Sabeti, H. 1976. Forests, Trees and Shrubs of Iran. Ministry of Agriculture and Natural Resources of Iran, Research Organization of Agriculture and Natural Resources. 810p.

Sadati, S.E. and S.R. Mostafanejad, S.R. 2008. Qualitative and quantitave investigation on plantations of lime tree (*Tilia platyphyllos*) and Cappadocian maple (*Acer cappadocicum*) in Chemastan experimental station, northern Iran. Iranian Journal of Forests and Poplars, 16(3): 408-418.

Safyari, Sh. 2003. Mangrove forests. Vol.2, Mangrove Forests of Iran. Research Institute of Forests and Rangelands, Tehran, Tech. pub. No. 314, 539p.

Sagheb-Talebi, Kh. 1990. Climatological Condition of Noshahr District. Pazhoohesh, Research in Science and Technology, 9 (18): 17-26.

Sagheb-Talebi, Kh. 2000. Hyrcanian Forests (North of Iran), the Unique Ecosystem in Near East Region. Presented at XXI World Congress- Forests and Society: The Role of Research. Kuala Lumpur, August 7-12, 8p.

Sagheb-Talebi, Kh. 2005. Rehabilitation of temperate forests in Iran. *In*: Stanturf, J., Madsen P. (eds.), Restoration of Boreal and Temperate Forests. CRC press, New York, Chapter 26: 397-407.

Sagheb-Talebi, Kh. 2009. Strategic priorities in forest researches. *In*: Assareh. M.H. and Akhlaghi, S.J.S. (Eds.). Strategic framework for developing and promoting natural resources research in I.R.Iran. Principles, Strategies, Approaches. Research Institute of Forests and Rangelands, Tehran, Tech. pub. No. 408: 75-124.

Sagheb-Talebi, Kh. and M. Dastmalchi. 1997. Results of elimination trials (Broad-leaved species) in Gilan Province, Part I. Research Institute of Forests and Rangelands, Tehran, Tech. pub. No. 168: 1-75.

Sagheb-Talebi, Kh., Sardabi, H., and Ball, J. 1999. Role of Planted Trees and Forest Plantations in Low Forest Cover Countries (LFCC). *In*: Mirsadeghi, S.M., (ed.), Proceedings of the International Meeting on Special Needs and Requirements of Developing Countries with Low Forest Cover and Unique Types of Forests, Forest & Range Organization, Tehran: 86-99.

Sagheb-Talebi, Kh., Sajedi, T. and Yazdian, F. 2003. Forests of Iran. Research Institute of Forests and Rangelands, Tehran, Tech. pub. No. 339, 28p.

Saie, K. 1942. About the forests of Iran. Forestry office, Ministry of Agriculture, Tehran.

Sardabi, H. 1998. Eucalypt and pine species trials on the Caspian littoral and lowlands of Iran. Research Institute of Forests and Rangelands, Tehran, Tech. pub. No. 193, 133p.

Sarkarat, M. and S. Gheisy. 1999. Elimination trials with broad-leaved and needle-leaved tree species in two sites of East-Azarbeidjan. Research Institute of Forests and Rangelands, Tehran, Tech. pub. No. 203. Forest and Poplar Research, 1: 93-142.

Scott, D., H. Moravej Hamadani, and A. Adhami Mirhosseyni.1975. The Birds of Iran. Department of the Environment. Tehran, 410p.

Shahmirzadi, S. 1992. Fauna and flora of Kevir surroundings in 7000 years ago. Proceedings of conference deserts in Iran. Research centre for deserts, University of Tehran, Vol.1: 253-268.

Shahsavari, A. 1997. The Hyrcanian province phytogeographical and paleobotanical studies of the south of Caspian Lake. Research Institute of Forests and Rangelands, Tehran, Tech. pub. No. 125, 48p.

Siahipour, Z., T. Rostami, Kh. Sagheb-Talebi, and K. Taheri. 2003. An investigation on Picea abies (L.) Karst growth in Guilan afforestations. Iranian Journal of Forest and Poplar Research, 10: 1-55.

Yousefi, P. 2009. Analysis of agricultural and natural resources statistics. Forest, Range and Watershed Organization, Deputy of arid and semi-arid regions. 36p.

Webb, D.B. 1973. The introduction and trial of exotic tree species in the semi-arid zone of Iran. Internal report, Research Institute of Forests and Rangelands, Tehran, 180p.

Ziaie-Ziabary, S.F., Y. Gorji-Bahri, and Kh. Sagheb-Talebi. 1988. Impact of spacing in production of poplar plantation. *Kimia, Journal of Iranian Chemical and Cellulosical Industries*, 1 (9): 31-35.

***Maple (Acer velutinum) plantation in the Caspian Region***
***(Photo taken by Khosro Sagheb-Talebi)***

***Elimination trials of exotic conifer species in the Caspian Region***
***(Photo taken by Khosro Sagheb-Talebi)***

***Elimination trials of exotic conifer species in the Caspian Region (Photo taken by Khosro Sagheb-Talebi)***

***A view on the Caspian forests and degradation caused by agricultural activities (Photo taken by Khosro Sagheb-Talebi)***

***Reforestation with pine (Pinus eldarica) and cypress (Cuppressus sempervirens) in dry-Mediterranean zone of the Caspian Region (Photo taken by Khosro Sagheb-Talebi)***

***Saxaul (Haloxylon sp.) plantation over sand dunes in the central deserts of the Irano-Turanian Region (Photo taken by Khosro Sagheb-Talebi)***

***Saxaul (Haloxylon sp.) plantation over sand dunes in the central deserts of the Irano-Turanian Region (Photo taken by Khosro Sagheb-Talebi)***

***Saxaul (Haloxylon sp.) plantation over sand dunes in the central deserts of the Irano-Turanian Region (Photo taken by Mohammad Darvish)***

# Forest Rehabilitation in Kazakhstan

Valeriy V. Meshkov[9], Sabit B. Baizakov[10], Anastasia V.Yeger[11], Almazbek Orozumbekov[12]

## 1. General Information on the Country

### *1.1 Location, Population and Natural Resources*

Kazakhstan is a country with a rich historical and cultural past. Situated in the centre of Eurasia, Kazakhstan found itself at the cross road of the earliest civilizations of the world with social and economic, cultural and ideological connections between East and West, South and North, between Europe and Asia. The geographical centre of the European and Asian subcontinents is located exactly in Kazakhstan, in the epicentre of Semipalatinsk, the former Soviet nuclear test site.

Kazakhstan is roughly the same size as all of Western Europe. Its territory extends over 2.73 million km$^2$ (or 1.48 million square miles). By its area Kazakhstan is in the ninth place in the world, i.e. it is among the world's top ten countries with large territories. The seven largest countries of Europe such as France, Spain, Sweden, Germany, Finland, Italy and Great Britain or Asian countries such as Pakistan, Turkey, Iraq, Japan and Vietnam rolled into one could be located on the lands of Kazakhstan.

Kazakhstan borders Russia in the east, north and northwest (the length of the border is 6,477 km), Central Asian countries – Uzbekistan (2,300 km), Kyrgyzstan (980 km) and Turkmenistan (380 km) in the south and China (1,460 km) in the southeast. The total length

9 Director, Kazakhstan Forest Seed Centre, Almaty, Kazakhstan
10 Forest Scientist, National Academy of Science, Kazakhstan
11 Director, Zhasyl el Kazakhstan, Almaty, Kazakhstan
12 Forest Scientist, Centre of Innovation Technology in Agriculture, Kyrgyz National Agrarian University, Bishkek, Kyrgyzstan

of the borders of Kazakhstan is almost 12,200 km including 600 km along the Caspian Sea (in the west).

Kazakhstan extends from north to south over approximately 2,000 km and runs west to east for 3,000 km. Almost unbroken plain lands occupy the largest part of the territory. Lowlands are located mainly in western, northern and south-western regions, while highlands are located in the central regions and mountains in the southeast. In the west, the Caspian Sea is enclosed by the Caspian Plain, in the north there is the Turanian Plain and in the north and northeast there is the West-Siberian Plain. These plains enshrine – like the shape of a horseshoe - the central part of Kazakhstan which is dominated by hills and low-hill terrains, jointly called Kazakh Upland or Kazakh Folded Country. The high-mountain ranges of Altai, Dzungarian Ala Tau and Tien Shan are standing out in the east and southeast. Zaisan, Balkhash-Alakol, Ili and Chu-Talas valleys lie between or adjacent to them. Sandy deserts Saryishikotau and Muyunkum spread in Balkhash-Alakol and Chu-Talas basins.

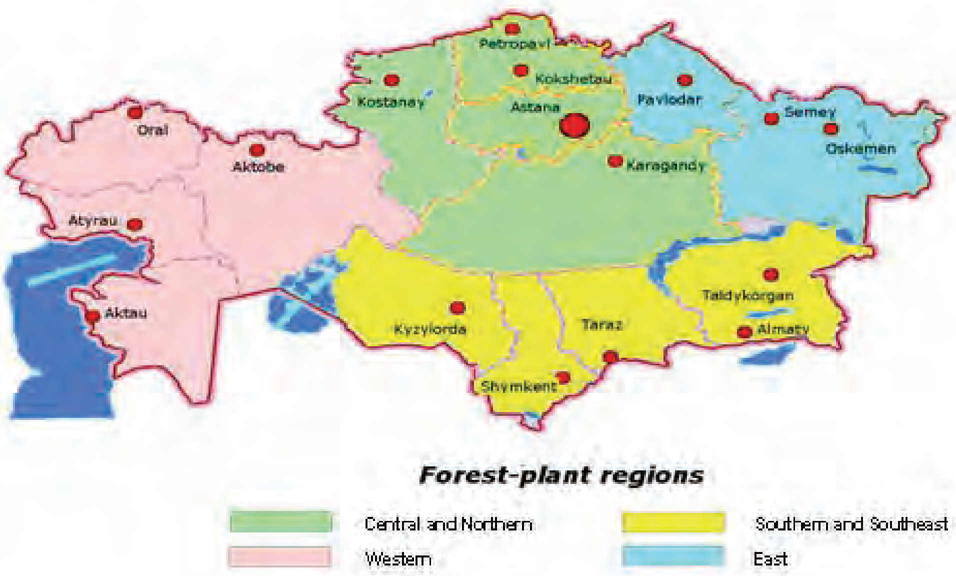



**Figure 1:** ***Administrative division and forest vegetation zones of Kazakhstan***

Kazakhstan consists of 14 provinces with Astana established as the capital city of the Republic. The largest province is Karaganda Province occupying an area of 428,000 km$^2$ with a population of 1.3 million or 3.1 people per km$^2$. The provinces in the south of Kazakhstan are the most populated areas with 2.3 million people and a density of 19.8 people per km$^2$.

### *1.1.1 Climate*

The diversity of geological and geomorphologic climatic and vegetative-ground conditions of Kazakhstan's territory provides a variety of landscapes. Natural vegetation zones (i.e. forest steppes, prairies, semi-deserts and deserts) occur with an increase in solar radiation from north to south proportionate to the decrease in rainfall. The territory of Kazakhstan in the south is part of the "Variable Zone". The climate is highly continental with considerably colder winters and hotter summers than is the case at the same latitudes of Eastern Europe. The coldest month is January and the warmest one is July. There is little precipitation, especially in the southern regions. There is 100 mm of annual precipitation in the south and 300-500 mm in the north. In Kazakhstan (except for its mountain part) the annual rainfall is several times less than what could be evaporated, resulting in a considerable moisture deficit. Such a dry climate provides the conditions for the predominance of desert and semi-desert landscapes and requires artificial irrigation for cultivating agricultural crops.

The average temperature in January, the coldest month, varies between -5°C in the extreme south and -20°C in the north. In the plains of Kazakhstan the average July temperature varies between +18°C in the north and +29°C in the south.

### *1.1.2 Hydrography*

The Republic of Kazakhstan has a deficit of water resources due to its geographical position in the steppe of Central Asia. Specific water consumption per head of population is 37,000 $m^3/km^2$ or 6,000 $m^3$ per year. Large areas are classified as landlocked inland drainage basins of inner lakes.

There are 48,262 lakes in the Republic of Kazakhstan, 45,248 of them have areas less than 1 $km^2$. There are 21 large lakes each having a size of more than 100 $km^2$. Kazakhstan is endowed with large lakes such as the Caspian Sea and the Aral Sea. Besides, one of the largest lakes of the world, Balkhash, is also situated in Kazakhstan. The lakes are spread all around the territory of Kazakhstan. In the northern part there are 45% of all lakes, in the central and southern parts 36% while only 19% are located in the rest of the country. The total surface area of Kazakhstan lakes measures up to 45,002 $km^2$. Overall water volume is 190 $km^3$.

Apart from mountain regions, atmospheric precipitation is insignificant. Kazakhstan has six rivers with a river flow rate of 100 $m^3$/sec to 1,000 $m^3$/sec, seven rivers with a flow rate of 50 $m^3$/sec to 100 $m^3$/sec and 40 rivers with a flow rate of 5 $m^3$/sec to 50 $m^3$/sec. There are more than 7,000 rivers in Kazakhstan with a length of over 10 km.  All in all, there are 39,000 perennial and temporary streams in the Republic of Kazakhstan. Most rivers belong to the continental basins of the Caspian and the Aral Seas, and the lakes of Balkhash and Tenghiz and only the rivers Irtysh, Ishim and Tobol carry their waters to the Kara Sea of the Arctic Ocean.

The total water resources of rivers amount to 101 $km^3$, 57 $km^3$ of which are formed in Kazakhstan. The remaining capacity comes from the neighboring states: Russia – 8 $km^3$, China – 19 $km^3$, Uzbekistan – 15 $km^3$, Kyrgyzstan  - 3 $km^3$.

## *1.2 Demography*

Linguistically, the native population (Kazakhs) belongs to the Kipchak group of Turkic languages. At the end of the last century, Russian and other nationalities moved in considerable quantity to Kazakhstan from Central Russia, the Volga region and other regions of the former Soviet Union for the purpose of industrial development as well as for the cultivation of virgin and fallow lands. As of May 1, 2009 the Republic’s population is about 15.8 million people including 8.4 million (53.4%) urban population and 7.4 million (46.6%) living in rural areas. Kazakhstan is a multi-ethnic country. The largest ethnic groups include Kazakhs – 46%, Russians – 34.7%, Ukrainians – 4.9%, Germans - 3.1%, Uzbeks – 2.3%, and Tatars – 1.9%. The national language is Kazakh with Russian being the international language.  Kazakhstan has various religions such as Islam (47%) and Orthodox Christianity (44%).

## 1.3 Natural Resources

Environmental conditions such as solar radiation, climate, topography and natural resources, minerals, water, plant and land resources, as well as animals have a significant effect on the development of the economy. Depending on predominance of natural resources, people have at all times developed different production sectors such as industry, agriculture, animal husbandry, fishery and forestry. Considering the natural environment of Kazakhstan (the combination of natural conditions and natural resources) in the context of economic development, it can be said that it is exceptionally rich and diverse.

There are significant reserves of many types of valuable mineral resources, large areas of productive arable lands, and vast grasslands. These natural resources often occur together and create a natural basis for the development of a diversified and large scale national economy. However, it should be noted that the severe extremely continental natural conditions of Kazakhstan such as dry climate and shortage of fresh water in large territories of the country complicate the exploration of natural resources. It should be taken into consideration that the land and its subsoil assets, waters, flora and fauna and other natural resources are the exclusive property of the Republic of Kazakhstan, thus forming the basis of its independent statehood.

### 1.3.1 Agro-industrial complex resources

Kazakhstan is an agricultural country with considerable agricultural potential. Until recently, 38% of the national income was produced by the agricultural sector using only 16% of the country's labor force. This demonstrates the presence of extensive mechanization and relative effectiveness of the agricultural production. Out of its total land area, 222.5 million ha (82%) are agricultural lands.

It is known that the leading agricultural activity is grain production. Among other cereal crops, Kazakhstan is a top producer of wheat (71.3% of cereal production). Summer wheat is under cultivation in the north, and in the south winter wheat is grown. Kazakhstan has tremendous land resources for grain production and thus can meet not only its own needs but can export wheat also to neighboring countries. The increase of overall yield of high quality cereal crops is a powerful resource needed for the economic stabilization of Kazakhstan including food security for future population growth and prosperity. The Republic ranks sixth in the area of cropland in the world (over 36 million ha). Production of cereal and pulse crops per head of population is 1,702 kg.

Kazakhstan has been and remains the only country of the former Soviet Union exporting grain. Top-grade wheat (hard and strong wheat) is produced here. However, the average yield capacity of grain and other agricultural crops in Kazakhstan is one of the lowest in the world. With a crop yielding capacity of 1,220 kg per ha, Kazakhstan occupies the 142$^{nd}$ place in the world which is comparable with crop yields in Mongolia, Mali and Greece. Alongside with serious deficiencies in the agricultural industry, there are considerable and almost annual variations in the volume of its production depending on weather conditions.

Grain production in Kazakhstan is rather unstable because the main areas under crops are located in zones of higher risks for farming. This is exemplified by the fact that in 1990 the production of cereal crops was 28.5 million tons, while in the much drier year of 1998 it was only 6.4 million tons. The bioclimatic capacity of the agricultural zone of Kazakhstan is 2.5 times lower than that in Western Europe. The potential yield of cereal crops is one of the lowest in the world. On average, in the period between 1990 and 1994 it was 0.97 t/ha, from 1995 to 1999 only 0.52, and from 2000 to 2004 it fell to 1.05 t/ha. In comparison, during the last five years, the average yield production in Russia and Ukraine was between 1.5 and 2.0

t/ha, while in some countries of Western Europe it was 7.0 t/ha. In the 1990s, there was a sharp drop in animal husbandry and production of cereal crops due to the conversion of cultivated areas to other land-uses. During the last years grain production has come to a standstill as far as the growth of cultivated areas and application of new soil and moisture saving farming technologies is concerned. According to preliminary data, Kazakhstan will produce 15 million tons of wheat in 2009.

#### *1.3.2 Animal husbandry*

Animal production is the leading branch of farming in Kazakhstan. Collective farms and state farms grow strong spanker horses, Persian and Lincoln sheep, angora goats and camels on steppe grasslands, the area of which exceeded 170 million ha. Animal production has been a key economical activity of Kazakhstan throughout many centuries and remains a major source of employment, food and income of the rural population. The vast grasslands of Kazakhstan provide an important production base, whereas the improved local and global economic environment creates possibilities for further developing the animal production sector especially for small and medium enterprises. Before the transition period, animal production contributed about 60% of the gross domestic agriculture product. Today, this sector has declined to 42%. The income from cattle-breeding accounts for 76% of agricultural income of the local population, which is 15% of the total family income, according to a survey on private household income conducted in 2006.

Sheep breeding is the main branch of farm animal production of Kazakhstan. Sheep and goats are forage unpretentious animals. They can pasture out at grass all year round, including high-mountain alpine and sub-alpine meadows (jailau). In the beginning of the 1990s, there were over 35 million heads of sheep and goats in the country. Sheep and goats are raised mostly in the south, west and east where grasslands of different seasons successfully go together on plains, foothills and uplands. Fine wool breeds are prevailing in the south and east and coarse-wool and semi-coarse-wool fat-tailed breeds are widespread in the west.

North Kazakhstan, the main stock-rearing region is agriculturally the most cultivated part of the Republic. About 50% of the total cattle stock is concentrated in this region. Another important stock-rearing region is located in the foothills of South and East Kazakhstan with up to 30% of the total cattle stock. Among cattle breeds raised in Kazakhstan, breeds such as Red Steppe breed, Alatau, Talas dairy-beef and Kazakh white-headed beef-and-dairy can be distinguished.

Among other developed sectors of cattle breeding in Kazakhstan, there are horse-breeding, camel husbandry, pig breeding and poultry. Horses are raised in all regions of the Republic and camels prevail in most desert areas of Atyrau, Manghistau, Kzyl-Orda and South Kazakhstan provinces. Poultry state-farms and pig-breeding farms can be found around many large cities.

Following the disintegration of the Soviet Union at the beginning of the 1990s, the livestock sector of Kazakhstan had undergone fundamental changes. Auxiliary structures of the cattle-breeding branch disintegrated, the infrastructure was destroyed and the lands were reallocated. The reduction of governmental control over the grazing lands lead to infrastructure collapse: roads to alpine summer pastures were no longer maintained for regular use; cattle yards and winter huts were destroyed; agricultural equipment was not repaired; enclosures were broken or removed; mechanical wells for watering cattle on grazing lands became unserviceable. As a result of these changes the total cattle stock in Kazakhstan dropped considerably. However, as a result of governmental reforms intended to support agricultural development (land reform, credit-finance system and other), the livestock cut-down on a national basis was stopped and tendency to its increase surfaced as cattle-breeders and farmers started adjusting to new economical conditions.

At present, the agricultural sector, the main component of the agro-industry, is represented by more than 5,000 agricultural entities based on private property and asset ownership. They include 5,296 peasant (farm) holdings, 172 enterprises with different forms of management: production cooperatives, joint stock companies, and business partnerships. 1.8 million ha of farmland and 570,000 ha of croplands are managed by agricultural enterprises. Peasant holdings occupy 7.6 million ha of farmland and 709,000 ha of cropland. As per the beginning of the current year over 102,000 landowners have used 7.6 million ha of farmland out of which 4.6 million ha are cropland.

### *1.3.3 Fossil minerals*

Kazakhstan is endowed with large reserves of mineral resources. According to estimates of the world's leading scientists, Kazakhstan is the world's sixth country measured by the reserves of natural resources though still it can not use this advantage with maximum effect for itself. According to calculations, the explored mineral resources of Kazakhstan are estimated at approximately 10 trillion US dollars.

Kazakhstan obtains rich mineral resources as evidenced by the fact that out of 110 elements of the Mendeleyev Table 99 are found in Kazakhstan, 70 of which are already explored (known or studied) but meanwhile 60 of those elements are being extracted and used. Kazakhstan is one of the richest countries in the world by its resources of oil, gas, titanium, magnesium, stannum, uranium, gold and other non-ferrous metals.

The leading branches of the industry are non-ferrous and ferrous metallurgy, chemicals, consumer and food industries. During the last period, oil engineering and production of building materials are in significant progress. Considerable parts of the world's reserves of copper and complex ores, nickel, wolfram, molybdenum and many other rare and rare-earth metals can be found in Kazakhstan. The country's known deposits of iron, manganese and chromite ores are of global significance.

Large deposits of copper, lead, zinc, rare metals, coal, iron and manganese ores are concentrated in the central part of the Republic. The known deposits of copper are located in Kounrad, Sayak, and Bozshakul. Besides Karaganda, the coalfield at Ekibastuz, supplying fuel for power generation is operated as open-pit mines and therefore is very cheap. The Pavlodar-Ekibastuz fuel and energy facility has been established on the basis of these deposits.

The main regions of non-ferrous metallurgy are Central Kazakhstan and Rudny Altai. Copper melting is concentrated in Balkhash, Karsakpai and Irtysh plants as well as in Dzhezgazgan. Kazakh Altai is well-known for its copper-lead-zinc ores, deposits of gold, stannum and rare metals. Major complex deposits are Leninogorsk, Zyryanovsk and Belousovsk.

The iron industry is represented by the Temirtau plant, Aktobe ferro-alloy plant, Karaganda steel works, Sokolovsk-Sarbai mining and the concentration complex in the Kustanai region. Iron ores are extracted in the south of Atasu in the Karazhal mine. Manganese ores are extracted in the village of Marganets.

The Transural regions of Kazakhstan are characterized by chromite, copper and asbestic mineralization. The Cis-Ural Region near Aktyubinsk is famous for its phosphorites and high-quality nickel ores. The south of Kazakhstan has considerable deposits of phosphorites.

Lead-and-zinc ores are also extracted here, especially in the Mirgalimsai, Baizhansai and Achisai minefields.

Kazakhstan is also rich in reserves of chemical raw materials: there are lucrative deposits of potassium and other salts, borates, compounds of bromine, sulfates, phosphorites which are the most diverse raw materials for the paint and varnish industry. Titanic deposits of sulphur ores as part of the complex ores are also found here.

The consumer goods industry is represented mainly by the processing sector of agricultural raw materials (leathers, wool and cotton). The largest centers of the leather industry are Semipalatinsk, Almaty, Pertopavlovsk, Uralsk, Zhambyl and Kzyl-Orda.

The Caspian Plain is associated with tremendous deposits of sodium and potassium salts. They are confined to salt-dome structures breaking out of loose sedimentary cover (for instance near the lake of Inder). Solar salt lakes are also known in other regions such as the Irtysh River region, Sub-Aral and Balkhash areas.

Crude oil production in Kazakhstan is mainly concentrated in the Atyrau region (on the valleys of rivers Emba and Sagyz) and partially in the Aktyubinsk region. Annual crude production is 1.6 million tons. Thus, taking into consideration the actual reserves and indicated resources ashore, the expert oil reserves in the country amount to more than 6.1 billion tons, gas supplies are 6 trillion of $m^3$, out of which the biggest annual extraction is only 26.6 million tons of crude and 8.2 billion $m^3$ of gas (in 1991). The other resources of Kazakhstan comprise mineral, medical and thermal waters, which have not had a widespread application yet.

### *1.3.4 Plant resources*

Forests and grasslands of Kazakhstan play an important role and are considered as national resources, providing important environmental services such as climate regulation, soil and water protection, and sanitary and hygienic functions. They are also the leading force in the economy of the country, supplying its population with forage, food, fuel (combustible), drug plants and are also used by people for recreation.

The state forestry fund includes not only forests but also grazing land, open forest stands, hayfields and other lands. The total area of the state forest fund is 27.8 million ha (according to an inventory of the forest land as of 01.01.08), including a forested area of 12.3 million ha, representing 4.5% of the total land area (272.5 million ha) of the Republic. In terms of area size it takes the third place among the countries of Europe and Central Asia.

Traditionally, with total reserves of standing timber stocks equal to 380.7 million $m^3$ Kazakhstan lags behind the countries of Europe and Central Asia which are rich in forests (only one third as compared with Romania) but its level corresponds to that of South Africa, Vietnam or the Philippines. The production potential of such forests is rather low (average forest stocking density per 1 ha is 42 $m^3$), which is partly due to low temperatures, extremely continental climate and small amounts of rainfall.

Native steppe grasslands constitute over 60% of the total territory of Kazakhstan. The country is the sixth in the world by the size of grazing area. Grasslands are the main forage resources for cattle breeding under the conditions of dry and hot climate of Kazakhstan with limited water resources. As of 2004, the grassland area in Kazakhstan has constituted about 189 million ha or 85% of all agricultural lands. However, during the last years only some 30% of grasslands have been used for cattle grazing due to lack of water, remoteness from population centers, reduction in livestock as well as owing to incompleteness of land reforms.

The productivity of sand plain grassland used during the cold period of the year varies between 0.10 and 0.25 t/ha, i.e. 2-2.5 times. The typical yield of the piedmont plain grasslands ranges from 0.5 to 0.26 t/ha in the spring season and from 0.9 to 0.45 t/ha in autumn, while that on sand plains from 0.07 to 0.14 t/ha. In many cases unrestricted grazing mainly confined to watering places results in pastoral digression which is accompanied by a reduction of the soil projective vegetation cover, lowering of biological and grazing capacity as well as reduction in biological diversity.

Economic return of wooded lands and grasslands is an important motivation for stable control of ecological systems as well as it can result in considerable economical and social losses in case of desertification and other forms of sudden degradation of lands. About 300,000 people depend directly on the forest sector including those residing in forest areas or using forests for the purpose of harvesting of fuel wood, cattle forage and other forest products. According to estimations, 4-5 million people (40% of the population) directly or indirectly depend on these resources for their livelihood, thereat many of them live in poor conditions. Most of the grassland areas are dry lands with average level of rainfall of 100-300 mm per year and temperatures of above 30℃ in summer and below -25℃ in winter. Some of these lands, in particular saxaul forests in Betpakdala and Moyunkum represent unique resources in terms of landscape and ecological systems. Moreover, the rangelands of Kazakhstan are important for the global carbonic balance as they retain considerable reserves of carbon.

## 2. Status of Forests

### *2.1 Phytogeographic Information*

The forests in Kazakhstan belong to different phytogeographical zones. The more humid north refers to forest steppe zone, and with an increase of dryness towards the south follow steppe, semi-desert and finally the desert zone as shown in the zoning map in Figure 2.

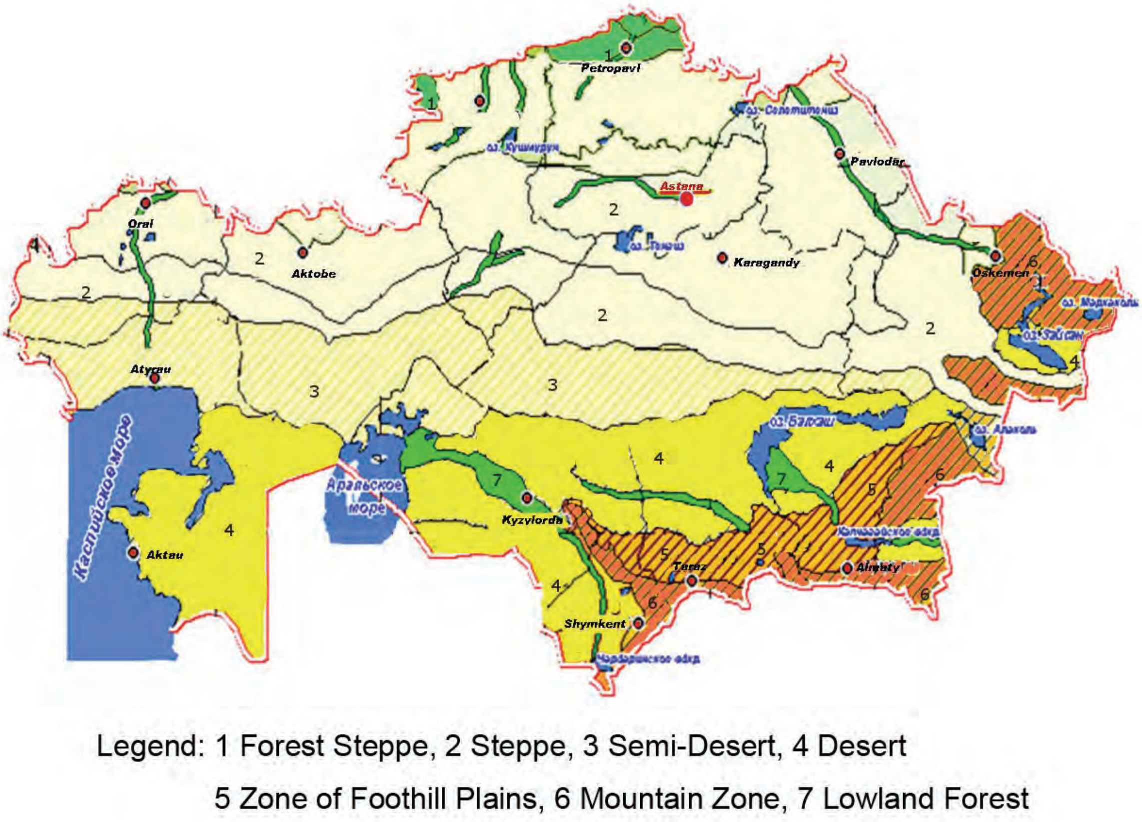



**Figure 2: *Natural vegetation zones***

Depending on soil type and topography there are intrazonal (riparian woodlands, saxaul woods in deserts, etc.) and azonal (meadows and bogs) vegetation types interspersed within the typical phytogeographcial zone. The extensiveness of Kazakhstan's territory and unique character of its geographical position lead to a great diversity of natural conditions and flora and fauna composition. The present-day flora of Kazakhstan includes 68 species of woody plants, 266 species of shrubs, 433 species of bushes, dwarf sub shrubs and semi-grasses, 2,598 species of perennial and 849 of annual grasses.

The main forest-forming species are conifers – Scots pine (*Pinus silvestris*), Schrenk's spruce (*Picea Schrenkiana*), Siberian spruce (*Picea obovata*), Siberian fir (*Abies sibirica*), Siberian larch (*Larix sibirica*), Siberian pine (*Pinus sibirica*); softwood broad-leaved – white birch (*Betula pubescens*), European birch (*Betula verrucosa*), aspen (*Populus tremula*); hardwood broad-leaved – English oak (*Quercus robur*), European white elm (*Ulmus laevis*), Pinnate-branch elm (*Ulmus pinnato-ramosa*), oleaster (*Elaeagnus angustifolia*); black saxaul (*Haloxylon aphyllum*), white saxaul (*Haloxylon persicum*).

The country's forests can be subdivided into birch separated forest stands of the northern provinces, island pine forests of the northwest, pinewoods of Kazakhstan's hummocky topography, ribbon-like relict pine forests of the Irtysh River banks, mountain forests of Altai and Saur, Dzhungarskiy Alatau, and Tien-Shan, saxaul forests, riparian woodlands and flood-plain intra-zonal forests.

In the northern part of Kazakhstan, on a huge territory being the continuation of the West Siberian Lowland (Kostanai, North-Kazakhstan, Aktyubinsk and Pavlodar provinces) there are birch forests (*Betula*). These forests are scattered in small areas (from 0.5 ha up to several dozens of ha) generally among croplands. Sometimes, birch is mixed with aspen (*Populus tremula*) in small amounts, and with pine (*Pinus*) in drier upland places. Being natural moisture accumulators birch forest stands play a big forest-ameliorative role, thus protecting agricultural crops from dry hot winds and dust storms.

Pine woods of the Kazakhstan hummocky topography are situated in Akmolinskaya and Karagandinskaya provinces. Typically, these forests grow on shallow soils above granite, rocky slopes, in cracks between bare rocks and stones. Thanks to previous intensive weathering processes the relief of the region exhibits bizarre forms. Therefore, the forests of the area are sometimes called Aeolus pine woods. The production potential of these forests is not high (II-III growth classes in degradations and Va- Vb- on peaks of mountain ridge tops and on slopes) and are mostly used for recreational purposes (e.g. resorts, rest houses, sanatoriums, etc.).

The ribbon-like pine forests grow along the right bank of the river Irtysh. Here, pine woods (*Pinus*) in the form of long and narrow ribbons grow on sandy soils. Generally, they are pure pine woodlands of III-V growth classes, with average stand density around 0.4 (i.e. open stands). Due to the dry climate, site conditions are unfavorable. The main types of forests are therefore classified as dry pine woods.

Apart from pines there are birch and aspen trees. In the recent past, ribbon-like pine forests were actively cut down and after disastrous fires of 1997-1998 they suffered from unprecedented illegal cutting of which the total damage could not be ascertained so far.

Kazakhstan Altai covers the eastern part of the Altai including the right sub-basins of the Irtysh river. This mountain area is covered by forests consisting of spruce (*Picea*), Silver fir (*Abies*), larch (*Larix*), Siberian pine (*Pinus sibirica*), pine (*Pinus*), birch (*Betula*) and aspen (*Populus tremula*).

Siberian pine (*Pinus sibirica*) occupies the top part of mountain slopes; larch (*Larix*), fir (*Abies*) and spruce (*Picea*) grow at lower altitudes. Pines (*Pinus*) grow alongside the Kalbin range and on its spurs; it can be met in the valley of the river Ulba and in the valley of the river Ulba by separate woodlots. As a rule, coniferous trees grow on northern slopes while southern slopes are mostly covered by shrub vegetation.

During many decades in the past the Altai forests have suffered from intensive clear felling with the cleared areas quickly developing into grass or bush land. Within the last years, final felling operations have been performed in violation of forest legislation with regard to felling distribution, their intensity (number of trees harvested), cutting cycles, slash removal, protection of young re-growth leading to fast-moving decline in forest cover.

Forest cover of North Tien-Shan is mainly represented by spruce (*Picea*), apricot (*Prunus Armeniaca*) and apple tree (*Malus*) forests. Sometimes, Siberian fir (*Abies sibirica*), which rarely forms high productivity forest stands, can be met on the northern and western slopes of the Dzungarian Ala Tau. Mountain forest types are distributed according to altitudinal zones and grow mainly on northern slopes.

The lower slopes of the mountains are covered by different bush formations followed uphill by plantations of apple and apricot trees, with woodlots of broad-leaved forests (aspen) in between. At the height of 1,300 m asl the broad-leaved species are mixed with Schrenk's spruce which, from 1,500 up to 2,800 m, form pure fir stands. Above this zone, fir is substituted by juniper (*Juniperus*) progressively changing to alpine meadows at higher altitudes. Schrenk's spruce regeneration is generally poor and planting is successful only on rare occasions.

The Schrenk's spruce (*Picea Schrenkiana*) has not been seen in the forests of West Tien-Shan. In canyons and valleys fruit tree forests prevail consisting of apple, apricot, pistachio, alycha, sea-buckthorn, currant, raspberry, barberry, honeysuckle, dog rose and almond. Juniper (Juniperus) brushwoods can be seen throughout the zone between 2,000 and 3,000 m asl.

Saxaul (*Haloxylon* sp.) forests grow in deserts around the Aral Sea, in Kyzylkum along the Syrdaiya River, in Muyunkum along the Chu River, along the banks of Balkhash Lake in Saryishukitau Desert, in Alakol Valley along the river Ili, and in Zaisan Valley along the river Black Irtysh. This zone occupies almost 50% of the Republic's territory (Almaty, Zhambyl, Kzyl-Orda and South Kazakhstan provinces) and has an area of 140 million ha. Apart from black (*Haloxylon aphyllum*) and white (*Haloxylon persicum*) saxaul, zaisan saxaul (*Haloxylon ammodendron*) also grow in the Zaisan valley. Among shrubs growing in deserts there are also tamarisk (*Tamarix*), salt tree (*Halimodendron*), calligonum (*Calligonum*), acacia (*Acacia*). Saxaul forests are traditionally used as pastures and saxaul wood is serving as fuel.

Riparian woodlands grow along the southern rivers: Syr-Daiya, Chu, Ili, Karatal, Lepsy and others – and consist mainly of oleaster (*Elaeagnus*), willow (*Salix*), poplar (*Populus*), tamarisk (*Tamarix*), salt tree (*Halimodendron*), calligonum (*Calligonum*), as well as barberry and goat's-wheet (*Berberis*). They seem to butt into and cut the desert zone into several parts. A special type of poplar, the Asiatic poplar (*Populus diversifolia*) as well as the relict moisture-loving ash-tree or sogdiana ash-tree (*Fraxinus sogdiana*) can also be found here.

Lowland forests grow along the northern rivers: Irtysh, Ishim, Tobol and Ural. In general, broad-leaved tree species such as willow, aspen, poplar, European white elm, birch, bird cherry and alder are represented. Lowland forests have to fulfill important water protection and water regulation functions.

### *2.2 Forest Area and Condition*

The total area of state and private forestry funds as of 01.01.2009 is 27.8 million ha or 10.2% of the Republic's territory. The land covered with forests occupies 12.3 million ha or 44.2% of the total forest estate lands. The percentage of forest lands amounts to 4.5%.

The area of the forestry fund is divided among various governmental departments as follows. About 4.7 million ha or 17.1% of the total forestry fund land comes under the jurisdiction of the Committee of Forest and Hunting Industry. They include:

- 10 State Wilderness Areas (hereinafter - SWA) with a size of 1.2 million ha;
- 9 State National Nature Parks (hereinafter - SNNP) – 1,73 million ha; and
- 3 State Nature Reserves (hereinafter - SNR) – 1.7 million ha.

Apart from the above-mentioned specially protected natural reserves (hereinafter - SPNR), the Committee has the responsibility for two forest plant breeding centers – 1,600 ha and one training and production forest management enterprise – 25,900 ha as well as around Astana City the forest nursery of the Republican State Enterprise (RSE) "Zhasyl Aymak" with a total area of 45,800 ha.

The other committees are in charge of:

- One hundred twenty three (123) government forestry management enterprises coming under the jurisdiction of Akimats (executive committees) of the regions, managing 22.9 million ha or 82.3% of total forestry fund area;
- SNNP “Burabai” - 83,500 ha of the Presidential Property Management Department;
- Scientific and Production Center (SPC) of Forestry Management (FM) JSC “KazAgroInnovatsiya” of the Ministry of Agriculture – 14 ha (forest nursery);
- State Nature Park “Medeu” of Akimat (executive committee) of Almaty city – 53 ha; and
- Public Utility Company (PUC) “Astana Ormany” of Akimat of Astana city – 15.7 ha and plantings on railway and highway “right off ways” land of the Ministry of Transport and Communications – 82,400 ha including JSC “National Company Kazakhstan Temir Zholy” - 62,100 ha; Committee of Automobile Roads – 20,300 ha.

According to Article 44 of the Forestry Code of RK, there are additional specially protected forest areas which include the categories of the state forestry fund being part of state forestry fund institutions of regional Akimats. These are the state forest natural monuments, forest areas with scientific importance including forest genetic reserves, outstanding woodlands and forests and fruit tree plantings. The total area of these categories of the state forestry fund (SFF) is 49,400 ha.

The area of the most valuable forest plantings in the forestry fund comprises 9.2 million ha (out of which 8.2 million ha or 89.1% is under the jurisdiction of the Akimats in the regions).

Forming part of forest estate lands forest cover 67.9% or 18.9 million ha (Figure 3).

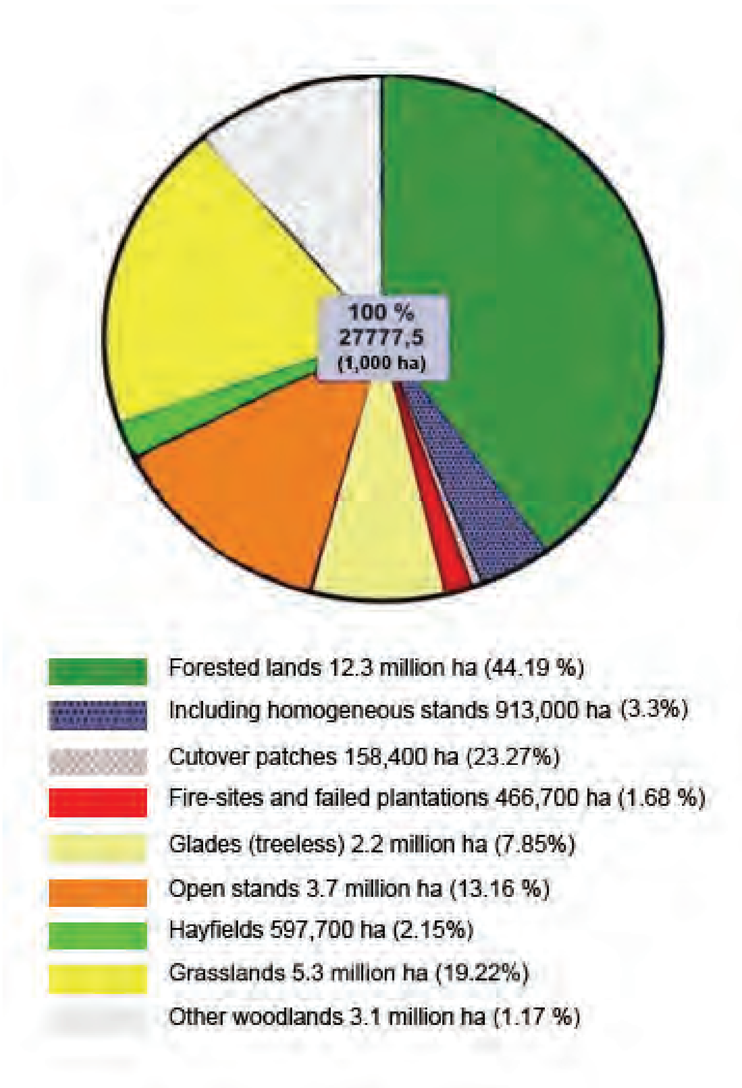



**Figure 3:** ***Forestry fund lands according to current stocking conditions***

The total area is 27.8 million ha (100%) including:

Homogeneous stands are 3.3% or 913,000 ha, of which 113,500 ha or 0.4% is artificial plantings below the age of woodlands. Forest nurseries in the forestry fund area cover 4,300 ha.

Being part of non-forested land comprising 23.3% or 6.5 million ha of the total forestry lands, fire-sites and failed plantations occupy 466,700 ha (1.7%), failed areas are 2.2 million ha (7,9%), open stands are 3.7 million ha (13.2%). Felling areas where forests have not been restored yet are 158,400 ha. Non-forest areas represented by pastures (5.3 million ha or 19.2%), hayfields (352,700 ha or 1.3 %), arable lands (0.45%), bogs (0.41%), sands (1.4%), waters, glaciers and other areas constitute 32.1% or 8.9 million ha.

When analyzing the changes in the extent of forestry fund lands of the last 10 years, it should be noted that there was a considerable increase (1998 – 25.6 million ha and 2008 - 27.8 million ha) (Table 1). The increase by 2.2 million ha is the result of the inclusion of agricultural lands covered by shrub vegetation, which once were registered as forested lands (1.2 million ha) and about 1 million ha of degraded desert grasslands allocated for forest rehabilitation.

**Table 1:** ***Changes in forestry fund lands in the period of 1966 to 2008***

| Forest land | Changes for the period, in thousand ha | | | | | |
|---|---|---|---|---|---|---|
| | **1966** | **1988** | **1993** | **1998** | **2000** | **2008** |
| **Forested** | **7,993.3** | **9,309.9** | **10,273.7** | **11,067.8** | **11,080.6** | **12,274.2** |
| *Including:* | | | | | | |
| Artificial stands | 160.1 | 917.2 | 1,029.3 | 1,052.5 | 1,122.0 | 913.0 |
| Unclosed stands | 208.9 | 282.2 | 253.9 | 165.5 | 121.6 | 113.5 |
| **Unforested** | **7,595.6** | **5,787.0** | **6,169.2** | **6,743.8** | **6,802.6** | **6,464.3** |
| *Including:* | | | | | | |
| Failed areas | 4,579.5 | 3,805.9 | 3,858.8 | 3,934.1 | 3,928.8 | 3,654.7 |
| Fire-sites, failed plantations | 45.4 | 129.1 | 86.1 | 180.6 | 226.6 | 466.7 |
| Fellings | 210.2 | 261.8 | 333.7 | 434.7 | 473.3 | 158.4 |
| Glades, wastelands | 2,766.2 | 1,590.2 | 1,890.6 | 2,194.4 | 2,173.9 | 2,184.5 |
| **Total forest lands** | **15,798.2** | **15,384.2** | **16,701.0** | **17,982.0** | **18,009.9** | **18,859.2** |
| Total forestry fund lands | 20,849.3 | 20,760.5 | 23,974.0 | 25,565.0 | 25,654.4 | 27,777.5 |

The total area damaged by forest fire, vermin pestholes and other forest diseases increased by 286,100 ha, while there was a decrease of 276,300 ha in forest areas affected by the moratorium for main timber felling in haloxylon deserts and in fir forests. At the same time, the area of open stands increased by 279,400 ha. This was caused by intense timber cutting intended to harvest mature trees followed by natural regeneration.

The areas of glades and wastelands remained practically unchanged, which indicates the lack of natural forest rehabilitation processes as well as the lack of special measures on artificial regeneration of these former forest areas.

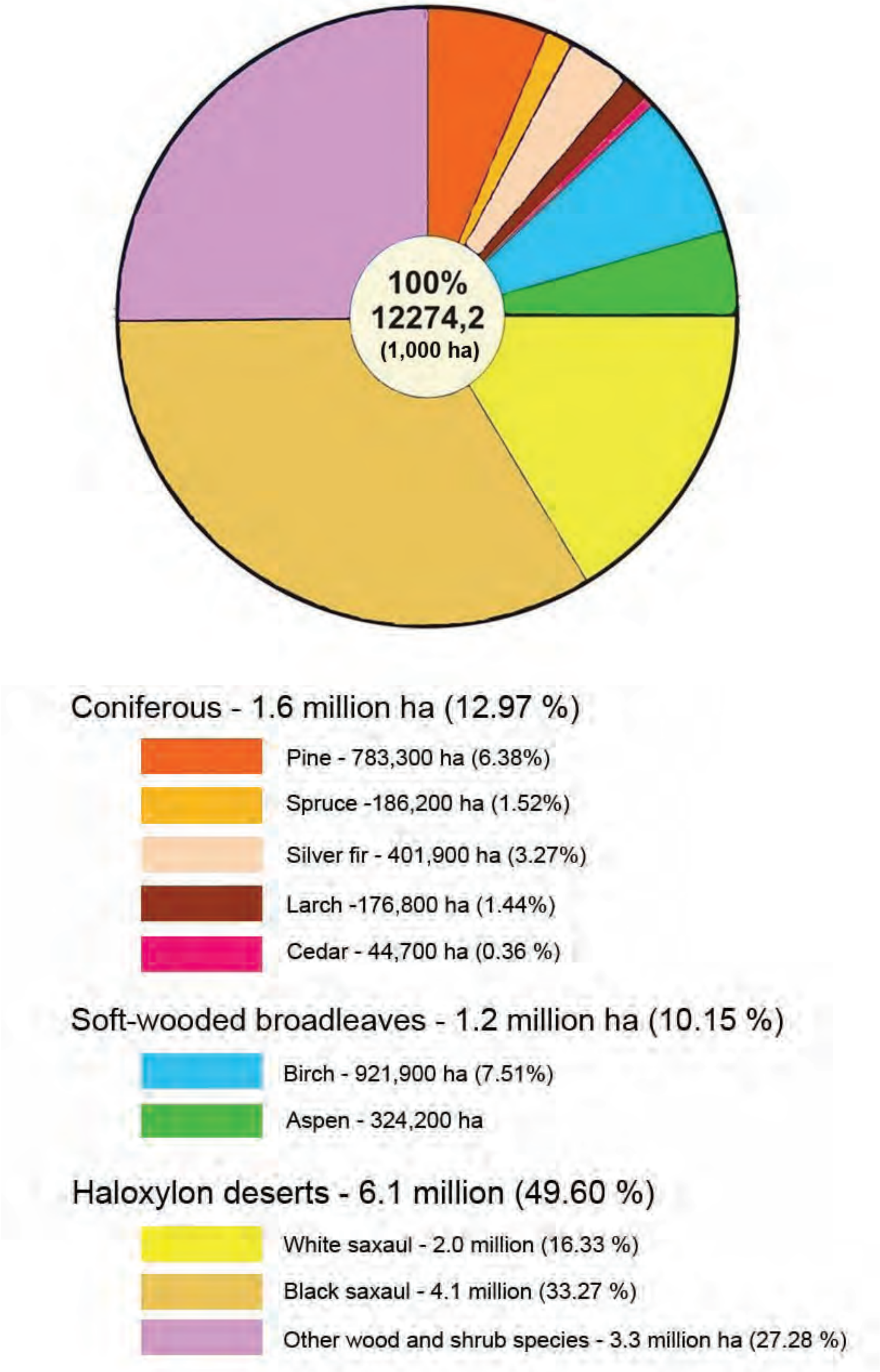



**Figure 4:** ***Distribution of dominant species on state forestry fund lands of the Republic of Kazakhstan***

As part of the forested land, haloxylon deserts cover the largest area. White and black saxaul plantings grow on 6.1 million ha thus constituting nearly half the area of all forests of the Republic (49.6%), followed by the area of shrubs – 24.1% (3.3 million ha). Considerably smaller areas are occupied by woody species plantations such as coniferous – 13.1% (1.6 million ha) and soft-wood broad-leaved species – 10.15% (1.2 million ha).

According to area, saxaul plantings cover by far the largest portion of the land. However, based on stocking density the haloxylon deserts constitute only 3.9% (14.93 million $m^3$) of the total growing stocking of planted forests. Because of the harsh environmental conditions saxaul forests show a very low forest density per ha.

Coniferous forest stands make up 61.8% of the total growing stock (235.35 million $m^3$) including pines, which have a share of 27.5% (104.71 million $m^3$). Soft-wood broad-leaved forests represent a total growing stock of 112.64 million m3 or 29.6%, dominated by birch grooves constituting 21.9% (83.26 million $m^3$) of the total growing stock of all forest plantations (Figure 5).

The plant community in the forests of the forestry fund lands is represented by a wide array of species, in particular with regard to shrubs (up to 40 species), and other kinds of woody plants (up to 15 species). Their ecological distribution ranges from the snow line (fir tree, larch, Siberian pine) to the arid conditions of the Kyzylkum hot deserts (saxaul).

**Total volume - 380.7 million $m^3$**

**(100%) including:**

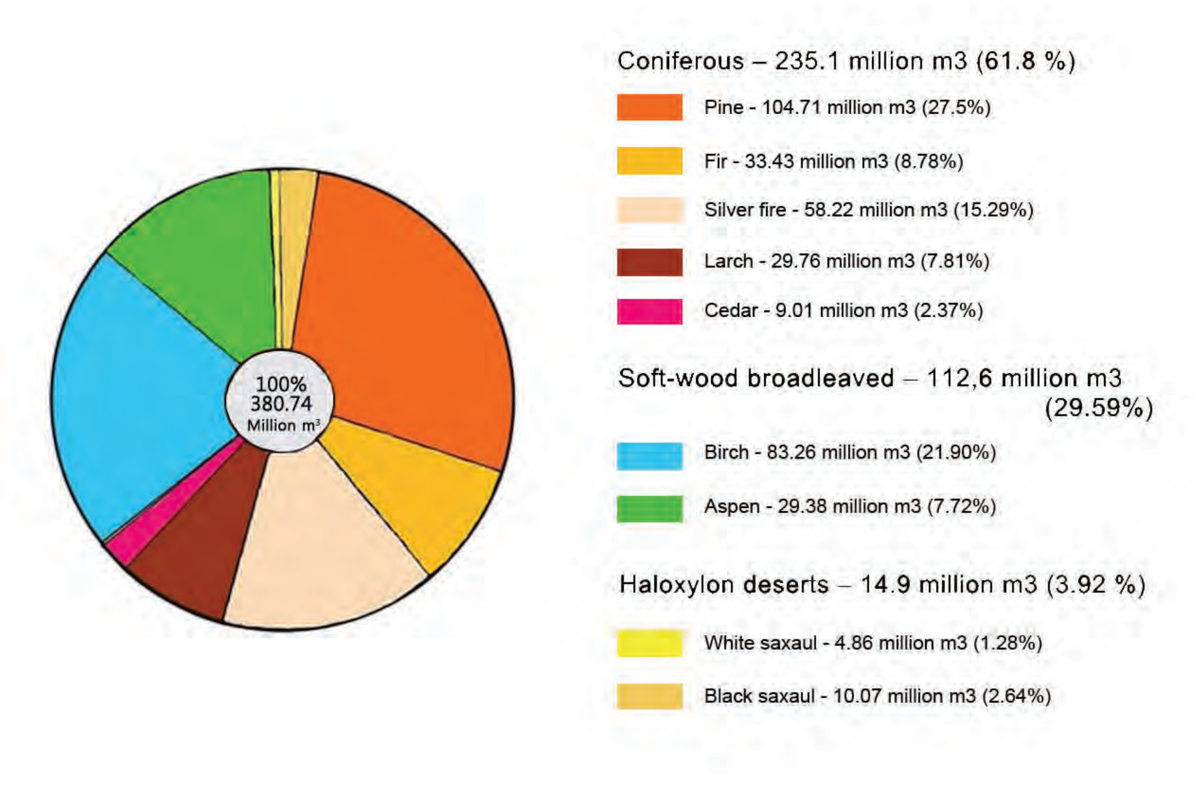



**Figure 5:** ***Distribution of total growing stock according to main tree species***

The age-class distribution of Kazakhstan's forests (Table 2) shows that most of the forests represent middle-aged plantations representing 3.0 million ha (33,1%), while mature and over-mature forests cover an area of 2.8 million ha (31,3%). However, the current extent of regeneration forests of 2.0 million ha (22.2%) and young forests of 1.2 million ha (13.4%) is obviously insufficient for sustainable development of the forests in the country. Thus, sustainable, qualitative development of forest ecosystems requires an even distribution of all age classes. Otherwise, irreversible degradation of forests will occur with dramatic increase in mature and over-mature forest stands that are less resilient to anthropogenic and natural factors.

**Table 2:** ***Age-class distribution of Kazakhstan forests***
(Numerator: data of 1998; denominator: data of 2008)

| No. | Dominating composition of plantations | Forest areas (1000 ha) | Including by age groups (%) | | | |
|---|---|---|---|---|---|---|
| | | | Young forests | Middle-aged | Mature | Mature/ over-mature |
| 1. | **Saxaul, including** | 5,305.5 | 10.7 | 29.7 | 29.6 | 30.0 |
| | | 6,088.0 | 11.0 | 32.7 | 24.3 | 32.0 |
| | **Black haloxylon deserts** | 3,679.8 | 14.8 | 38.9 | 27.7 | 18.6 |
| | | 4,083.8 | 12.8 | 44.6 | 20.8 | 21.8 |
| | **White haloxylon** | 1,625.7 | 1.8 | 8.8 | 33.7 | 55.7 |
| | **deserts** | 2,004.2 | 7.4 | 8.5 | 31.1 | 53.0 |
| 2. | **Soft-wood** | 1,371.5 | 20.6 | 39.9 | 18.1 | 21.4 |
| | **broadleaved** | 1,378.1 | 19.3 | 27.3 | 21.5 | 31.9 |
| 3. | **Hard-wood broad-** | 98.0 | 47.0 | 49.0 | 1.9 | 2.1 |
| | **leaved** | 99.0 | 29.2 | 61.8 | 5.2 | 3.8 |
| 4. | **Other broad-leaved** | 82,5 | | | | |
| | | - | - | - | - | - |
| 5. | **Coniferous** | 1,687.3 | 23.8 | 28.2 | 17.4 | 30.6 |
| | | 1,605.8 | 16.6 | 37.6 | 16.0 | 29.8 |
| | **Total** | 8,544.8 | 15.0 | 31.3 | 25.1 | 28.6 |
| | | 9,170.9 | 13.4 | 33.1 | 22.2 | 31.3 |

## *2.3 History*

Until the middle of the 20th century there was no systematic forest management in the territory of what today is Kazakhstan and the forests were used by the local population mainly as pasture land, area to over-winter domestic livestock and for forage production. During those days, in most cases, the Kazakh population did not build stationary houses and in rare cases they used wood as firewood. For heating and cooking they more often used brushwood (dead branches of trees and shrubs), salt grape (stalks of dried grass), reed (cane stalks) and dung (dried excrements of domestic animals). Needless to say that the lack of forest management was not just because of the people's attitude towards the forests but also the local population did not have appropriate tools, instruments, and experience in storing, processing and transportation of woody materials (Andriyevskiy, 1914, 1915). All lands and other natural resources were in possession of Kazakh clans joined into Kazakh zhuzes governed by khan powers. "Zhuz" (horde) is defined as a certain alliance of tribes belonging to the Kazakh nation and populating a part of all-Kazakh land set by tradition. After inclusion of all Kazakh lands into Russia (1867), all steppe areas and natural resources of these territories were declared governmental property. From that moment onwards, measures were taken to control, safeguard and use these forests. Certainly, the main influence on forestry in Kazakhstan was from Russia, a powerful empire having borders with it in the north and west for many thousands of kilometers.

First wildlife reserves were established and separated from local forests. Later on, the most valuable forests were declared as “treasury possessions” while those of lesser value were managed jointly by the “treasury and nomad population”. Further on, independent “forest ranger stations” were created on the basis of those wildlife reserves and their management was handed over to professional foresters from Russia.

A total of 24 forest ranger stations were functioning by 1920, each of them had its own forest nursery to raise new planting stocks. By 1912 there were 54 forest ranger stations and by 1917 this number had increased to 75 units. In total, 405 forest workers and 1,255 forest guards were employed in these ranger stations. By that time, the total forest fund area comprised 23.84 million ha, out of which 9.53 million ha were covered by forests.

Initially, the activity of forest workers was oriented towards the protection of forests, regulation of timber removal and cattle pasture. Then, more attention was given to the study of ecology and growth of natural forests, experimental work on raising planting stocks, and planting of new forest stands. Tree plantings mainly aimed at creating forests for recreation, afforestation in treeless areas and beautification of cities and other human settlements. As a matter of fact, amenity plantings stimulated the development of other forms of green cultivations because people at all times wished to decorate streets and their gardens with flowers, bushes and trees.

There is reliable information that in the territory of present-day Kazakhstan, by order of Dzhangir Khan (1823), dense woodlots of pine and other trees species had been created in the sandy plains of the Naryn River around Khan’s settlement. These forests have survived until today by means of natural regeneration.

In the south, in the Semirechensk Province, two wildlife reserves were established in 1853 on an area of 2,200 ha, consisting of English elm trees planted by Chinese people (tarangs and dungans). The city of Almaty (formerly called Verny) founded in 1854 and former capital city of Kazakhstan became one of the centers of afforestation and landscape beautification in Kazakhstan. All efforts on planting stock supply and forest cultivation in Semirechye were led by the famous professional forester E.O. Baum. The “Vernenskaya Grove”, a small forest plot planted under the direction of E.O. Baum on an area of 315 ha, still extending over 130 ha today, is named after him.

In the western regions of the Republic silvicultural planting (1884) was carried out under the direction of M.K. Savich. He organized the Ural steppe forestry activities aimed at reducing unfavorable effects of dry eastern winds on the European part of Russia. On the lands of Aktyubinsk Province wildlife reserves (1889) were established by Ch. Shtromberg and F. Derting. In 1908 N.V. Androsov planted 5,000 seedlings of pine on sandy soils of Bolshiye Barsuki in the same area. Trial plantations and forest plantings were also carried out in the northern regions of Kazakhstan.

Before 1914-1917, forest planting in the territory of present-day Kazakhstan had mainly experimental character and therefore the total area of established homogeneous forests (apart from landscaping around centers of population, small woodlots and roadsides) did not exceed 5,000 ha. After all, their planning was based only on enthusiasm and personal initiative of forest lovers and specialists and very often it was carried out without strict plans and lacking financial resources from the government.

After the Russian October Revolution (1917) forest management capacities were almost entirely lost until 1931. By then, alongside with revisions of timber felling at the rate of annual growth and development of protective forest plantations, the provision was made for the implementation of personnel training "institutes" by opening new institutions for higher education in agriculture and forestry. In addition, considerable extension of the number of secondary technical schools was made by the Regulation of the Soviet Government "On organization of forestry and division of forests into wood-and-paper production and silvicultural zones". This gave rise to the implementation of scheduled silvicultural operations in Kazakhstan.

The first scheduled reforestations based on specially designated government budgets did not exceed several dozen ha, but were carried out practically all over the forest territory of the Republic. Step by step, the area of forest plantings expanded as follows: 1935 - 496 ha, 1936 – 1,786 ha and by 1939 the area reached 2,000 ha.

The Great Patriotic War (1941-1945) crippled the economy of the Republic irretrievably and many projects on forestry development were minimized for a long time. However, in spite of the tough situation in the country, in 1943, the Soviet government decided to categorize the forests depending on their economic value and forest coverage in the regions. Alongside these lines, the forest sector and the forest industry were divided according to their specialization. In 1946, the Ministry of Forest Sector (MFS) of Kazakh SSR was established, thus initiating the development of forest management in Kazakhstan.

From 1947 to 1977, the forest sector and forest management have progressively been developed in Kazakhstan. All forests including the ones of forest industry agencies, communication lines, internal affairs, iron industry, cellulose and paper industry, woodlands of state farms, recreation enterprises, other ministries and departments apart from governmental national parks, which were under the command of a special department affiliated to the government were placed under the control of the Ministry of Forestry. At the beginning of 1948, 24.64 million ha or 95.6% of all forest resources were brought under the jurisdiction of the Ministry of Forestry. Its remaining part (1.14 million ha) was within the limits of national land reserves (717,200 ha), national parks (213,600 ha), some state farms (140,000 ha) and other land users (69,500 ha). The forest sector administration was created including the Ministry – regional departments of forest sectors administrations – forest farms – forest districts, which maintained its structure until today. Only their names and functions were changed.

The establishment of a separate ministry opened great perspectives for accelerated development of the forest sector. At that time, priority was given to agricultural afforestation, implementation of rotational grazing, construction of ponds and water reservoirs in order to provide high and sustainable yields in steppe and forest steppe regions (1948) as well as taking urgent measures on protection of soil from water and wind erosion (1967).

Thereat, the leading role was given to afforestation of agricultural land. Apart from protection and recreation of forests in national forest reserves the forest sector was also given the responsibility of protecting forest plantings grown for different purposes on land of agricultural enterprises. During seven years, 60,700 ha of such forests were planted in Kazakhstan. One of such a valuable project (national forest belt "Cherry Mountain – Caspian Sea") was carried out within the West-Kazakhstan Region.

From around 1953 to 1967, problems related with forest planting and forest rehabilitation were given very low priority because of the establishment of corn growing farms on virgin lands. After 1967, when the problem of immediate soil protection against water and wind erosion became especially acute, attention was given again to the issues of agricultural afforestation. Within two years (1968-1970), forest farms created 124,200 ha of erosion-preventive field-protective tree belts.

The work on creation of artificial crops in the state forestry fund continued. Artificial stands were created mainly by planting (58%). The crops of black saxaul (*Haloxylon aphyllum*) were established by seeding (42% of total rehabilitation volume). Preservation of young forests reached a share of 71.5%. By 1968, the total area of artificial crops in the Republic was brought to 720,000 ha, out of which 33% were occupied by coniferous, 41% by saxaul and 20% by hardwoods.

Before 1995, about 2.0 million ha of forest crop were created in Kazakhstan by planting and seeding methods, 45-50% of which were lost due to different reasons at different development stages and the rest has been shifted to official forest area categories. As a result, forest areas in Kazakhstan grew up to 1.0 million ha by means of artificially created plantings and their share in total structure of lands covered by forests constituted 10%. Besides, by the start of reforms out of the existing 245,000 ha of unclosed forest stands, 110,300 ha were transferred to the official forest area. Thus, there were about 1.92 million ha of artificial forests in Kazakhstan together with the existing protective plantings (323,000 ha), state forest strips (16,800 ha), protective plantings along railroads (70,000 ha) and highways (60,000 ha) and plantings on the dry floor of the Aral Sea. Nowadays, forest management in the country including the system of forest exploitation and forest restoration is gradually changing to new terms of a market economy.

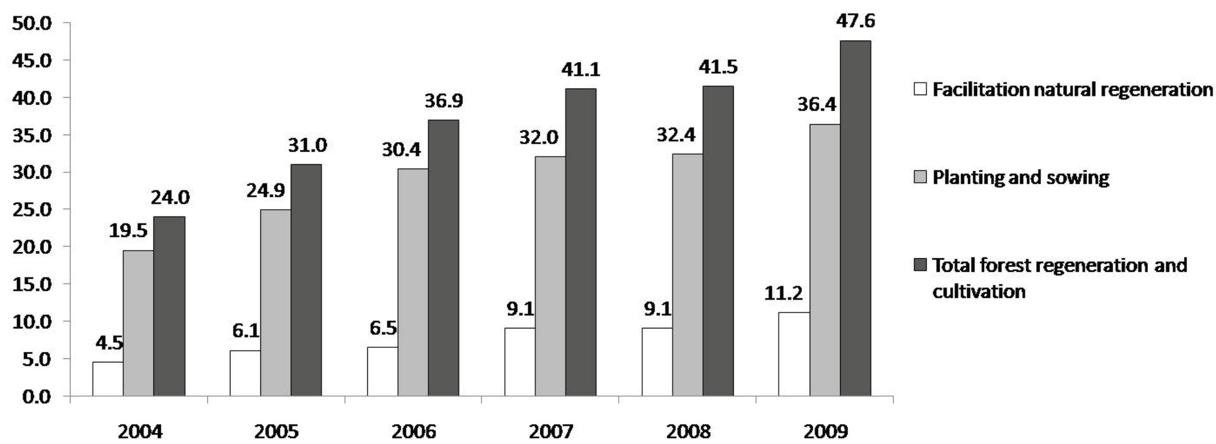



**Figure 6:** ***Forest regeneration and afforestation in Kazakhstan***

During the last years, specific large-scale measures have been undertaken for the preservation of forests in Kazakhstan and for increasing forest cover. A distinct state forest management policy has been introduced, a new Forestry Code adopted, new programs such as “Forests of Kazakhstan” and “Zhasyl yel” have been developed and implemented, as well as regulatory and legal acts on forest management improved. State forest establishments are financed by means of governmental and local budgets. The main forest management policy of Kazakhstan determined by the Forestry Code of the Republic is regulating ownership and allocation of forests in order to ensure the conservation of forests, their rational and non-exhaustive use, their protection and regeneration.

At present, forest nurseries in the country produce about 23 million of seedlings of coniferous, broadleaved and fruit and berry species, which are still insufficient for achieving the forest rehabilitation targets. Six hundred twenty three (623) permanent forest-and-seed plots, 323 plus trees, 39 ha of seed orchards are managed for the improvement of seed production. About 38,478 ha of genetic reserves have been put under special protection, 9 ha of archived clones, 6 ha of stock plantations of alien crops, 93 ha of provenance trial (provenance trial is established with local woody species of the former Soviet Union for verification and adaptation to the environment of Kazakhstan) and other test species have been established.

Given the above, the current principle challenge of the Republic's forest management is rehabilitation of forest resources towards close-to-nature forests and increase of their productiveness using natural and artificial methods of forest regeneration.

The basic principle of forest rehabilitation remains valid representing the obligation to replant clear-cut areas, fire-affected sites, and open stands by economically valuable species within the shortest period of time. In addition, rehabilitation also includes the regulation of afforestation efforts on bare lands in order to increase the size of woodland.

Decisions on a reasonable proportion between natural and artificial methods of forest rehabilitation should be based upon sound site-specific scientific analysis. However, natural processes should play a dominant role in order to ensure success and quality of forest rehabilitation by means of progressive cutting methods and technologies, preservation of young growth on harvested areas, protection of crops from destruction by cattle, and supplementary seeding of areas intended for natural reforestation.

### *2.4 Biological Diversity of Forests*

In spite of the fact that the forests of Kazakhstan occupy a small territory of the country and the amount of woodland in separate areas varies between 15.5 and 0.2%, a maximum concentration of biological diversity including 70% of all types of higher plants and more than 75% of hunting species of animals can be observed.

The following red-listed rare species of animals can be met in the forests:

**Mammals**: snow leopard, Menzbir marmot, red dog, Tien Shan brown bear, European mink, marbled polecat, pine marten, rock marten, Central Asian lynx, argali
**Birds**: Altai snow cock, black stork, ibis-bill, bearded vulture, golden eagle, booted eagle, fish-hawk, Pallas' sea eagle, vulture (neophron), saxaul desert jay, whistling thrush, paradise flycatcher, tit-warbler
**Reptile**s: slender racer
**Amphibians**: Ranodon sibiricus (only in the softwood forest belt of Dzungarian Ala Tau)

Natural forests and artificial plantations form an invaluable ecological resource deserving all kinds of protection, conservation and expansion. The species composition of the forests is extremely diverse. Woody plants and brushwood are represented by 622 species, whereby shrubs dominate by number of species (82%). The majority of trees and shrubs species lives in discontinued natural forest areas and interchange with meadows and steppe vegetation. Coniferous forests in the north are represented by pines, silver fir, and larch, while spruce and Siberian pine forests grow in the east and southeast. Among soft-wood broad-leaved species birch is the most commonly encountered and saxaul is the most abundant among hardwood broad-leaved ones.

In Kazakhstan, there are about 600 species of rare and endangered plants which are subjected to special protection. A considerable proportion of them is included in the Red

Book of the Republic of Kazakhstan. There are 287 flowering plants such as *rhaphidophyton, spiraeoideae, pastinacopsis, nedzwedzkia, cancriniella, dorema karataviense, ferula sugatensis, artemisia cina* and others. The Red Book contains 2 species of gymnosperms (elfin form of *Pizla Schrenkiana, Juniperus seravschanica*); 3 species of ferns (shield-fern of *mynzhylki*, maidenhair, and southern maidenhair); 3 species of mosses (*sphagnum teres*, large-leaf *pahiphissindense* and *orthotrichum laevigatum*); 1 species of lichen (*cladina rangiferina*); and 10 species of fungi (*phellorinia strobilina*, champignon de table, steppe sponge mushroom and others). Harvesting of plants having economic value, such as soaproot, roseroot and other is prohibited or limited. *Ostrowskia magnifica, pskem onion,* and *Pyrethrum kellerii* are protected in conservation parks and wildlife reserves.

According to the Forestry Code of the Republic of Kazakhstan, all forests are classified as protective ones and have great ecological, scientific and other values. Besides, they are unique by their significance and represent valuable resources and natural habitat of animals and plant genes. Depending on their designated purpose, forests are divided into corresponding protection categories. Each category has a strictly defined mode of use and combination of measures on preservation of biological diversity.

Thanks to the measures taken on strengthening protection of state natural reserves during the last five years, the area of specially protected natural reservations (SPNR) has been increased twice and reached 22 million ha, of which the area of SPNR having status of legal entity is 4.8 million ha. Altogether, the area of SPNR of different categories constitutes 8.0% of the total territory of the Republic. The Committee of Forest and Hunting Management is in charge of 10 state wilderness areas (hereinafter called SWA) – 1,224,300 ha, 9 state national nature parks (hereinafter called SNNP) – 1,730,700 ha; and 3 state nature forest reserves (hereinafter called SNR) – 1,707,000 ha. During the coming three years it is planned to create one wilderness area, two national parks, and one reserve as well as enlarge territories of two wilderness areas and one national park. After these measures the extent of specially protected nature areas will amount to 23.2 million ha (Figure 7).

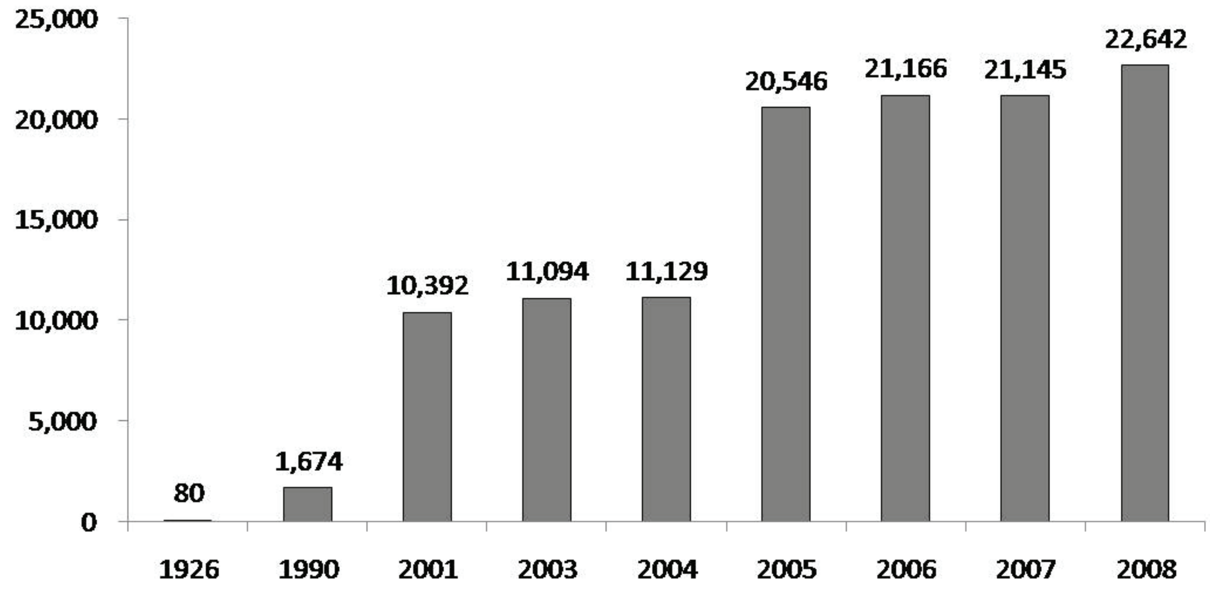



**Figure 7:** ***Specially protected areas (in thousand ha)***

On July 7, 2008 at the 32nd Session of the Committee of World Heritage a decision was taken to include the “Sary-Arka – Steppes and Lakes of North Kazakhstan” into the List of World Heritage of UNESCO. “Nursumand”, “Korgalshyl” state wilderness areas became the first protected territories in Kazakhstan and Central Asia obtaining recognition as World Heritage objects. This is the result of the law on specially protected natural territories established on July 7, 2006 regulating the creation, enlargement, protection, recreation, stable use and management of specially protected nature forest reserves (SPNR) and state nature reserve fund objects of special ecological, scientific, historical-cultural and recreational value. As depicted in Figure 8, total financing of protected areas in Kazakhstan has significantly increased in recent years.

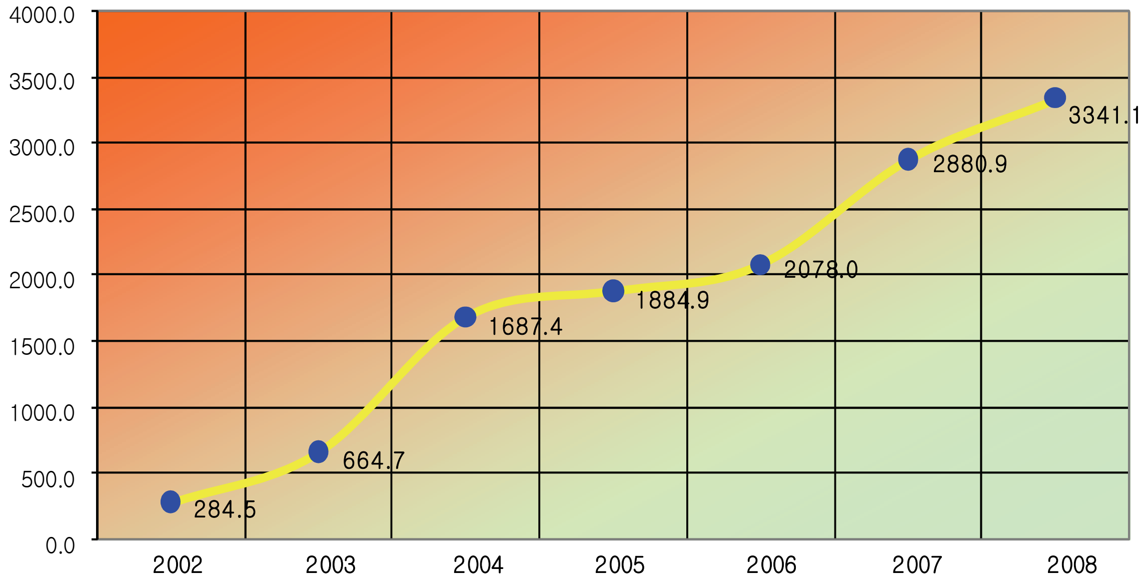



**Figure 8:** ***Financing of specially protected natural areas (in million Tenge)***

## *2.5 Land ownership, legislation and policy*

The Forestry Code of the Republic enacted on June 8, 2003 regulates public ownership, use, and the disposal of the forestry fund. It also provides the legal foundation for the protection, rehabilitation and improvement of forests and their rational use (Article 2). Thereat, it is determined that forests are one of the most important components of the biosphere having global ecological, social and economic significance.

Basic principles of the forest legislation are as follows:

- Recognition of the value of forests for the Republic performing important functions such as regulating local climate, protecting agricultural fields and soils, water protection, sanitary and environmental hygiene, as well as their sustainable development (steady increase of forests);
- Conservation of biological diversity of forests as important resource for the state nature-reserve fund, and cultural heritage;
- Multipurpose use of forests including rational, continuous, and sustainable utilization of forest resources generating economic returns;

- Implementation of forestry operations and monitoring functions in the field of protection, maintenance and use of the forestry fund area, forest rehabilitation and afforestation;
- Reparation of damages caused by violation of the forest legislation; and
- Accessibility of information on forest condition as well as participation of society and public organizations in the protection and preservation of the forestry fund.

All forests of natural and artificial origin and lands not covered by forest plantations necessary for the development of forest management form the integrated forest fund consisting of state and privately owned forests (Article 6).

The State Forestry Fund of the Republic of Kazakhstan refers to governmental property and is under Republican ownership. Hereunder, the land is assigned for permanent land-use (Article 22), offered to forest institutions and other governmental establishments of the authorized body (Committee of Forest and Hunting Management (CFHM)) for the protection and maintenance of the forestry fund, rehabilitation of forests and afforestation, organization of multiple-use of forest resources as well as for the purposes connected with the activity of SPNR.

Ownership, use and allocation of private forestry fund lands shall be exercised by private land owners who must maintain forest management and forest use by ecologically appropriate means and methods, protection and maintenance, and improvement of sanitary conditions of forests including fire protection provided for by the forest legislation. Besides, they must provide SPNR with the relevant reports on forest resources monitoring including area control and health status of forests (Article 27).

### *2.6 Forest Management and Administration*

At present, the state administration in the field of protection, maintenance and use of forestry fund, forests recreation and forestation (Article 11 of the Forestry Code) is executed by the Government of the Republic of Kazakhstan, the authorized agency (CFHM) and its territorial bodies (regional inspections providing control over forestry activity) as well as by local executive bodies (regional administrations of natural resources and environmental control).

Measures on protection, maintenance, recreation of forests and forestation, rational use of forest resources, maintenance of permanent seed plantations and seed plantings, processing and storage of seeds as well as other forest activities is carried out by governmental enterprises (GE) of forest and hunting management, which are directly subordinated to the local executive bodies – regional departments of natural resources and environmental control of Akim of the provinces.

SPNR (wildlife areas, national parks, state natural reserves and other environmentally protected sites) are under the direct control of the Committee of Forest and Hunting Management (CFHM).

The activity of CFHM and regional departments of natural resources and environmental control is coordinated and controlled by the Ministry of Agriculture of the Republic of Kazakhstan, which is the executive body of state administration in the field of protection, maintenance and use of the forest fund, recreation of forests and forestation.

The CFHM and its regional territorial bodies (management) carry out functions of governmental control in the field of protection, maintenance and use of the forest fund, recreation of forests and forestation by means of controlling compliance with the forest legislation.

In accordance with the Forestry Code, controlling forest legislation in the field shall be carried out by the governmental forest inspectors on the basis of the following aspects:

- Upon the result of scientific research and monitoring of the state forestry fund when proving negative consequences in the field of protection, maintenance and use of the forest fund, recreation of forests and forestation;
- According to the work plan of the authorized and territorial bodies not more than once a year;
- By the extent of forest fires in the state forestry fund;
- By appeal of persons and legal entities; and
- For the purposes of controlling corrective actions for the elimination of violations discovered during regular checks within the terms specified in the instructions.

Regarding discovery of violations of forestry legislation the following measures shall be taken: a protocol on administrative violations of law shall be drafted; instructions on elimination of violations of the legislation requirements shall be issued; a resolution on calling guilty persons to administrative responsibility and, if necessary, on withdrawal of the harvested forest resources, means of transport, tools for their extraction, for temporary storage until rendering of a judicial decision shall be elaborated. The issues related to measures on elimination of violations of the legislation, calling guilty persons to account, consideration and execution of administrative offence cases are particularly regulated within the Instructions approved by the Order No. 457 issued by the Minister of Agriculture on August 29, 2003. In specially protected nature reserves CFHM carries out functions of both control and management of activities.

## 3. Degradation of Forests

### *3.1. Understanding Forest Degradation in Kazakhstan*

Despite work undertaken in the field of protection, maintenance, rehabilitation and rational use of forests, and preservation of their biological diversity, there is an observed tendency of degradation of forest ecosystems in the country. Destruction of forests and reduction of their areas cause considerable changes in biological diversity.

According to the existing terminology degradation of forests is a slow process of loss of productivity and dying-off of growing stock under the influence of anthropogenic or natural factors resulting in the deterioration of the forest environment. The meaning of the term degradation in the ecological dictionary (lat. degradatio – reduction, movement back, deterioration) is a gradual lowering of energy potential and system capacity, which is practically irreversible on a real time basis. Degradation means deterioration of organisms', population's or ecosystem's adaptability from one generation to another, caused by unfavorable conditions of existence, inbreeding or illnesses.

### *3.2. Causes of Forest Degradation*

In Kazakhstan, each type of forest has its own set of factors causing forest degradation. The forests of the forest steppe zone (birch stands mixed with aspen and willow) suffer from reduction in area because of extensive agricultural cultivation of steppe land around woodlands. In most cases plowing was carried out up to the very forest edge and woodlots with small areas were completely uprooted and destroyed. This resulted in a change of the hydrological regime and soil formations on which these forests were formed. In addition, clear cuttings in birch forests over many decades followed by natural re-growth without systematic tending operations resulted in the formation of low-quality stands.

For the last 10 years the forested lands of pine forests of the Irtysh region in the East-Kazakhstan and Pavlodar regions have been reduced to 162,400 ha with timber stocks decreasing to 16.8 million $m^3$. Large-scale illegal cutting became more frequent.

Steppe pine forests have been over-logged suffering from large forest fires in the past. According to up-to-date satellite image interpretation ribbon-like relict pine forests of the Irtysh region (Pavlodar and East-Kazakhstan regions) are destroyed by forest fires and damaged by depredators practically on half of their area, comprising over 300,000 ha. Furthermore, they were permanently affected by radio nuclides as a result of nuclear tests at the Semipalatinsk nuclear test base in earlier times. However, this influence on forests has not been well studied yet.

For two centuries, large areas of pine woods have been destroyed entirely in the Turgai region as well as in a number of other regions of Central Kazakhstan. Mountain forests were under pressure by excessive cattle grazing, which lead to degradation of ground cover and destruction of natural regeneration. Unregulated cuttings in mountain forests, particularly in East-Kazakhstan and forest fires resulted in a reduction of tree species diversity and substitution of coniferous species by the less valuable broad-leaved and shrub species.

During the last 100 years the lower boundary of spruce forests location in the Zailiyskiy Alatau Mountains of the Northern Tien Shan have risen by 100-150 m up the hill slopes, therefore the range of spruce forests distribution shortened. The same happened in the mountains of Dzungarian Alatau, where the range of Silver fir shortened almost by three times. From 1966 to 1993, the productive capacity of softwood forests decreased by 7% (from 161 to 150 $m^3$/ha), the area of Silver fir stands representing a special value due to its location at the edge of the natural area was reduced by 16% (from 459,000 to 384,000 ha).

Here, in the foothills the Severs apple tree grows on an area of 20,000 ha. Apple-tree forests, the traces of which are found in earth deposits of the Middle Cretaceous, represent a unique and worldwide renowned genetic resource. It is generally recognized that Severs apple trees commonly grow in wild fruit forests of Kazakhstan. The tree is the progenitor of current graded diversity of this most important fruit culture, its intra-specific polymorphism is of great importance for further selection and maintenance of this important fruit. Species of common apricot, hawthorn, barberry, honeysuckle, ash berry, wild rose, sea buckthorn and currant are also growing here and are equally important for genetic selection.

The distribution of wild fruit forests has decreased drastically during the last century. The main factors of degradation of these forests are the economic activities of people. First of all there are excessive cattle grazing, fires and negative impact of harmful organisms (depredators and illnesses). Degradation symptoms include reduction or absence of second growth, ageing of plantations or change of age structure, and steppification of forest land.

Lowland forests and riparian woodlands are subject to degradation in connection with the breakdown of hydrological regimes as a result of unjustified river control and breakdown of prevailing environmental conditions for their growth. Riparian woodlands have suffered from extremely strong negative effects in connection with withdrawal of a considerable amount of their areas for agricultural purposes during the reformation of the country’s economy.

The condition of oak woods along the floodplains of the Ural River is of special concern. It is the only natural forest of this species in Kazakhstan. In spite of the fact that English oak (*Quercus robur*) is included in the Red Book of the Republic and any type of felling apart from sanitary cutting is prohibited, the area of its distribution has gradually decreased year by year. According to forest fund records of 2008, nowadays the area of oak woods is 2,600 ha, whereby 100 ha (3.8%) are occupied by young growth, 700 ha (27%) by middle aged plantations, 100 ha (3.8%) by ripening and 1,700 ha (65.4%) by mature and over-mature (old) stands. Uneven distribution of forest crops by age composition combined with the absence of young regeneration and principal plantings are already old demonstrating irreversible degradation of oak woods.

The condition of saxaul forests being considerably damaged by illegal logging and excessive cattle grazing also gives reason for concern. Organization of forest management in these forests in many cases does not take into account that these haloxylon deserts are the only source of pastures for local people of this region. During the design of forestry measures in these forests the carrying capacity and degree of their stability for the use as grazing areas are not sufficiently considered.

As a whole, the amount of desert zone forests (haloxylon deserts) in Kazakhstan decreased from 10 to 6 million ha. The lowering of saxaul grassland density (crown closure) is indicative of their degradation. It has been established that during the last 30 years stocking density decreased from 0.52 to 0.47. In recent years, haloxylon deserts have lost their ability of natural regeneration, as a result of which young growth is now only present on 11% of their total area. Low density and unsatisfactory progress in natural regeneration of this species and reduced artificial regeneration and afforestation due to insufficient investment clearly cause soil erosion by wind and total growing stock degradation on the dominant part of deserts such as Kyzylkum, Muyunkum sands and Sariyesik-Atyrau. Owing to their intensive use, the haloxylon deserts continue to degrade which results in massive desertification. Nowadays, 66% of the Kazakhstan territory is exposed to this process. Consequently, the problem of inventory and integrated assessment of haloxylon deserts' biodiversity as well as taking measures on their preservation is particularly urgent.

From 1997 to 1998, 3,308 forest fires occurred in the territory of 240,000 ha of forest area by damaging and completely destroying 4.3 million $m^3$ of standing timber. During 1999, a total of 937 large natural fires were detected of which 946 were forest fires. The area affected by forest fires amounted to 26,500 ha.

Fires are especially catastrophic for coniferous woods. During the last years, the damage caused by forest fires increased ten times. The total sum of damage caused to forest management by fires was estimated at over 900 million Tenge only for the last three years. The largest forest fires were registered in the East Kazakhstan, Pavlodar and Kostanai regions. Up to 70% of all forest fires on forestry fund lands were caused by people.

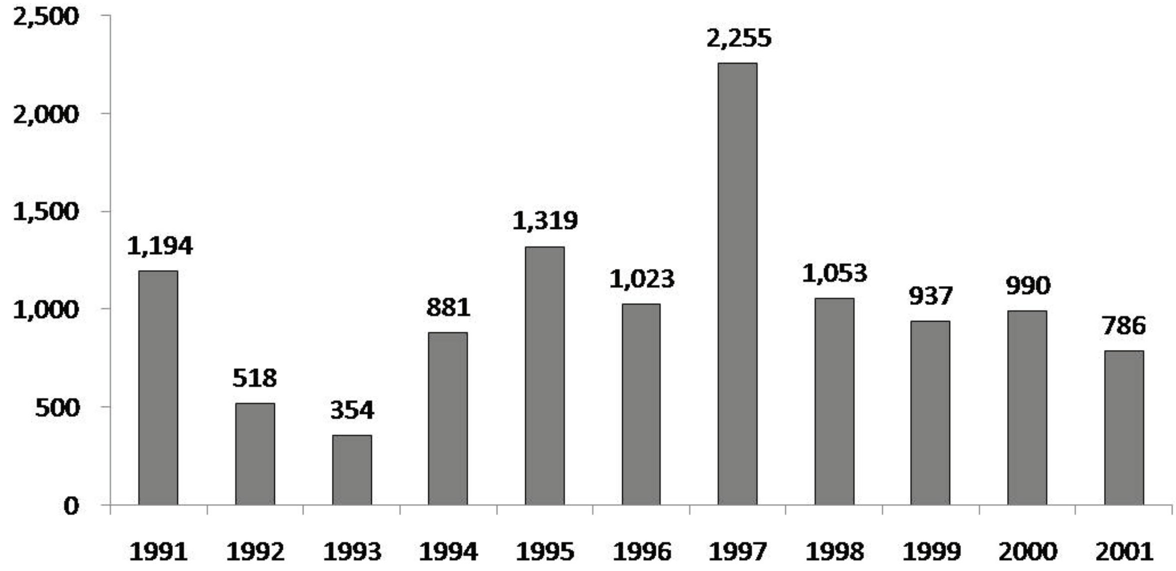



**Figure 9:** ***Frequency of forest fires in the period 1991-2001***

Fires cause considerable damage to forests. In the past, fires destroyed either totally or partially 250,000 ha of wood land (Figure 9). In 1997 alone, an area of 204,000 ha was affected by fire.

Insect attacks and illnesses have a destabilizing influence on forest ecosystems and their stability. Annually, centers of contamination by hazardous organisms are registered on an area of 100,000 to 300,000 ha. Alongside with that, weakening of sanitary and forest-protection measures during the last years as a consequence of shortage of funds for these purposes have resulted in the loss of many thousand ha of forests (Figure 10).

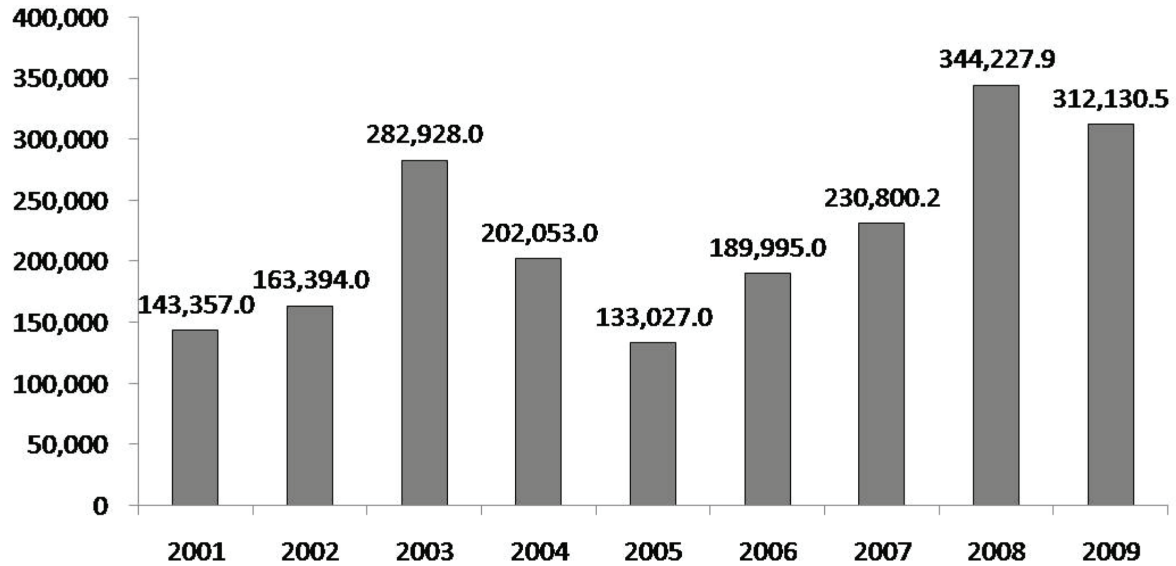



**Figure 10:** ***Forest areas affected by diseases and depredators***

The most severe hazards in the forests are caused by destructive insects (Figure 11) such as gypsy moth (*Lymantria dispar*), pine looper (*Bupalus piniarius*), under-bark bugs (*Aradus cinnamomeus*), European pine sawfly (*Neodiprion sertifer*), apple-leaf moth (*Hyponomeuta malinellus*), leaf-roller moth (*Cacoecia*) and seedworm (*Cydia pomonella*); and illnesses such as cancer, pitch streak (*Cronartium flaccidum*), pine fungus (*Fomitopsis annosa*), cenangios (*Cenangium femtginosum*), and fir-needle rust (*Chrysomyxa ledi*).

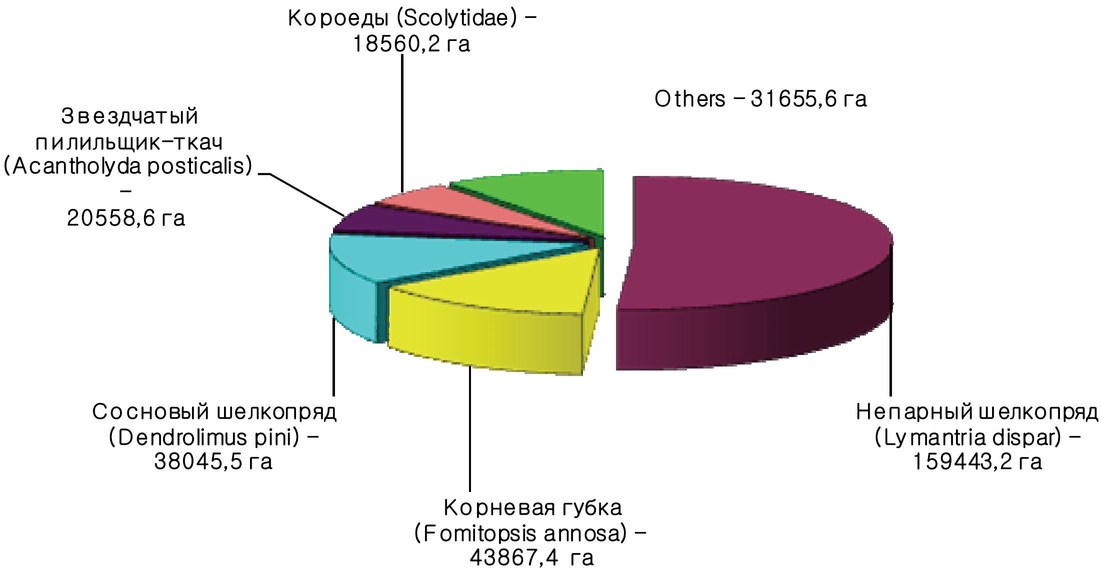



**Figure 11:** ***Forest disease and depredator centers as of January 2009 (in ha)***

During the last years yellowing of coniferous forests has been observed caused by a number of reasons such as lowering of ground water, drought, and fires. Forests are seriously affected by air pollution resulting in decline of their biological functions and destruction. One example is the die-back of relict Ridder pine wood in the city of Leninogorsk in the East-Kazakhstan province.

### *3.3. Impacts of Forest Degradation and Loss*

Fundamental and applied scientific research substantially contributes to the assessment of the current status of forests and performance in the conservation and sustainable use of biological diversity. However, due to considerable shortage of funds during the last decades, applied scientific research in the field of conservation and sustainable management of biological diversity of forests has been insufficient.

No attention is paid to ecological and environmental education and training. Such training requires the development of national educational standards for different training levels and retraining of specialists in the field of environmental protection including the area of conservation and use of biological diversity.

Consumer attitude towards forests prevailing in the Republic during the last years led to a decline of its exploitable timber volume and considerable loss of vital protective functions. As wood is an important commodity in the market and a means to become rich, illegal cutting and arsons are widespread. In addition, the production of seeds and planting stocks practically stopped as many tree nurseries ceased their operations and thus the extent of silvicultural work drastically declined. The annual volume of new plantings (or seeding) did not exceed 9,000 ha.

The process of desertification of land increased as a result of intensive resource utilization and increasing anthropogenic impact. Especially, wild-fruit tugai and lowland forests were subject to strong degradation.  During the last 35 years over 100,000 ha of these forests were destroyed in the Kyzylorda region alone.

Valuable coniferous forests of the Irtysh river regions and Kazakhstan Altai have been exhausted by timber cutting and fires. Continuous felling of forests in the river basins of Bukhtarma and Uba in the East-Kazakhstan region is responsible for the considerable loss of water in the Irtysh River. Because of the increasing demand for energy fire-wood, harvesting by people considerably increased. Consequently, in the South-Kazakhstan Region, clear-cut areas increased by 3000 ha during the last three years. During the last decades, the area of forest stands of turanga, oleaster and willow in the lowlands of Syrdariya, Ili, Karatal and other rivers were reduced by three times.

### *3.4. Desertification*

Desertification is a significant global ecological and socio-economic problem. In the second half of the 20$^{th}$ century and with the rapid increase of the world's population, the absolute exploration of productive land and unprecedented rise of technological pressure on the natural environment, desertification became the main threat to social and economic safety and survival of mankind.

According to the UN Convention to Combat Desertification, desertification is defined as "*land degradation in arid, semi-arid and dry sub-humid areas resulting mainly from adverse human impact*".

The territory of Kazakhstan is practically entirely part of the arid zone and two thirds of it is already exposed to different levels of desertification. In 1994, the Republic of Kazakhstan signed and on July 7, 1994 ratified the UN Convention to Combat Desertification. Within the framework of assumed obligations a program of actions on desertification control has been developed. The document has been prepared by a multidisciplinary team under the jurisdiction of the Ministry of Natural Resources and Environmental Protection of the Republic of Kazakhstan, consisting of leading scientists, specialists of ministries, departments, scientific and survey institutions.

The reasons for the current desertification process in Kazakhstan are determined by a combination of natural conditions and specific aspects of use of land, water and forest resources. The landscapes of Kazakhstan as a whole differ by low tolerance of human impact. In the medium and long-term, an additional impulse to desertification is given by a wide range of climatic factors. Moderate intensity of anthropogenic impacts does not result in desertification and degradation of the environment. This occurs only in case of loss of self-regeneration capacity.

All in all, desertification processes are highly diverse, but in spite of this, the most common determining factors can be distinguished as follows:

- Destruction of vegetation cover due to the unsustainable use of pastures;
- Reduction of biological diversity, degradation of vegetation and wildlife species;
- Depletion, soil salinization and pollution of ground water and drying up of water sources;
- Strengthening of erosion of arid lands by heavy use for agricultural purposes without considering characteristics of soil cover; destruction of vegetation and soil cover for road and industrial construction, geological prospecting work, resource development, construction of population centers and irrigation structures;
- Destruction of forests;
- Destruction of fragile soil cover by heavy motor transport;
- Repeated salinization, alkalization and flooding of irrigated land; and
- Social and professional degradation related to culture and education of local population, loss of traditional forms and methods of management.

## 4. Forest Rehabilitation

### *4.1. Aims Pursued with Forest Rehabilitation*

The situation of forest rehabilitation and afforestation in Kazakhstan has become critical due to a significant increase of non-afforested cutover stands, burned-out forests, and artificial open stands in the forestry fund area as well as poor financing of forest restoration work. Ongoing forest degradation poses a challenge to professional foresters of the Republic. Therefore, the main objectives of forest regeneration in the Forest Code of RK (Article 71) are defined as the timely forest rehabilitation on cutover stands, burned-out forests and other state forestry fund areas previously occupied by forests, improvement of forest species composition, and increase in their productivity.

Furthermore, Article 73 specifies that "measures on forest reproduction on the state forestry fund lands should be taken on the basis of the ecological and sanitary and epidemiologic requirements, by methods that ensure the establishment of highly productive and sustainable stands in the shortest possible period taking into consideration forest site conditions and economic feasibility. Therefore, the major long-term task of the forest management is rehabilitation of forest resources, increasing their capacity and nature protection characteristics using natural and artificial methods of forest rehabilitation. Overall, the obligation to rehabilitate cutover stands, burned-out forests and open stands of artificial origin by economically valuable species within the shortest possible period of time as well as controlled afforestation of treeless lands to increase the percent of forested area of Kazakhstan remains the main principle of the forest rehabilitation process.

### *4.2. National Policy on Forest Rehabilitation*

Several long-term, medium-term and short-term concepts and programs for the forest industry sector development have been prepared in the Republic since 1992. However, none of them has been accepted by the Government of Kazakhstan due to the lack of necessary budgetary funds.  Unfortunately, an appropriate forest policy which would include the system of long-term measures and principles, rules and regulations aimed at sustainable development of all types of forest work including forest reproduction has still not been developed in the country.

Forest scientists such as S.Baizakov, A.Medvedeva, S.Iskakova and others, proposed to the Government to develop a project for a new national forest policy until 2020. The proposal has been accepted and recently work on the program document has begun. The following fundamental principles on the forest rehabilitation program are offered to be introduced into the national forest policy:

Forest reproduction and enlargement of forest lands on the forestry fund area shall be financed by the Government as outlined in the plans. Special attention shall be paid to the issues of improving forest seed production, enlargement of seed orchards, and rehabilitation of tree nurseries as well as the application of new technologies (such as container cultivation of the ball-rooted planting stock under controlled environmental conditions, and on degraded areas – with the use of mycorrhiza) for enhancement of the quality and volumes of plantings, sowing and natural regeneration processes. Priority should be given to forest rehabilitation on burned areas and cut-over lands including in the ribbon-like relict pine forests of the Irtysh region (625,000 ha), the Kazakh upland (Akmola and Karaganda Provinces), plain forests of Kostanai Province, and saxaul forests in the south and southeast of the Republic.

### *4.3. Methods of Forest Rehabilitation*

Forest rehabilitation methods in Kazakhstan are in principle based on forest types. The forest type classification has been developed in line with research by the great Russian forest scientist G.F. Morozov promoting the approach of matching species composition and the type of forest planting with habitat conditions.

According to Article 73 of the Forest Code, forest reproduction on forestry fund areas should be carried out subject to ecologic, sanitary and epidemiologic requirements by methods that ensure highly productive and stable plantations within the shortest possible period of time. Accordingly, all regulatory and legal documents on forest management consider natural forest regeneration (without human intervention) as a priority both after timber cutting and for forest rehabilitation after fires, windfalls and other harmful interferences.

Seeding after mechanical soil scarification is undertaken in areas with poor natural regeneration insufficient for a complete rehabilitation. In case these measures are not enough, forest plantations (homogeneous stands - HS) are created by seed sowing or planting stock (i.e. 5-8 year-old trees with root balls) raised in tree nurseries.

A permanent tree gene bank (PTGB) has been established during the last five years to produce seeds with valuable hereditary characteristics and high genetic merits. These selected strains represent the basis of the seed plantations and mother-tree archives. In natural forests they separate the special-quality trees and forest plots as well as genetic reserves for preservation of the Republic’s plants genetic material and its further use as genetically valuable material for forest rehabilitation. At present, this work is in progress and as of 01.01.09 the forest lands in different regions contain permanent seed plantations (164 units/2130.4 ha); temporary seed plantations (351 units/9275.6 ha); mother-tree archives (9 units/57.0 ha); plus trees (851 units); quality plantations (82 units/2096.0 ha); and genetic reserves (70 units/69620.0 ha). However, PTGB does not provide the forest management with genetically valuable seeds in full as yet. Therefore, they concentrate mainly on natural enclosures with high and mean productive capacity for certain forest sites, i.e. in normal stands.

### ***North and Central Kazakhstan***

Rehabilitation of pinewoods and birch forests in the northern and central parts of the country is carried out mainly by artificial plantings which are cultivated in tree nurseries during two to three years. Depending on the individual peculiarities of relief and soils as well as the availability of natural young growth of the principal species, homogeneous stands are created on the overall tillage or band tillage, i.e. by leaving inter-band spaces. The planting plans are very diverse and mostly depend on the growing conditions, used machines and mechanisms for soil preparation, method of planting and technology of protection against weeds and other undesirable vegetation. Mechanized plantings are carried out on areas accessible for machines and where natural forest rehabilitation processes are not feasible, mainly on glades, wastelands and burned-out forest lands. In open stands and cutover lands, which do not recover by natural means with the main species, artificial planting is carried out manually on partly prepared soils such as spots, furrows, holes and others. The main plans of homogenous stand creation presume the planting of 3,000 to 8,000 young plants on one ha. After 5 to7 years, 60% of stocking density is considered to be sufficient for establishment purposes.

### ***Mountain areas of Kazakhstan***

In the mountain areas of Kazakhstan Altai, North and West Tien Shan rehabilitation of fir tree (*Picea*), pine tree (*Pinus*), Silver fir (*Abies*), larch (*Larix*) and Siberian pine (*Pinus sibirica*) stands is carried out with 2 to3-year-old seedlings (for Siberian pine 5-year-old seedlings are used):

- <u>In spots</u> with dimensions of 1 x 1 m (600-800 spots for 1 ha), where plants are set out in clusters of five pieces;
- <u>In furrows</u> (with a slope ratio of up to 20 degrees) 0.6 to 0.7 m in width, which are carried out along the slope (cross-slope) 2.5 to 3.0 m distance from one another, the distance of plants in a furrow is 0.6 to 0.7 m, thereat one ha is set out with 4,000 to 4,700 plants;
- <u>By terraces</u> (the slope ratio is 20 to 30 degrees) 3.4 to 4.0 m in width, the distance between the terraces is 6.8 to 8.2 m. Planting is performed in two rows, 1.5 m between rows, 0.7-0.8 m in a row, one ha is set out by 4.0 to 4.6 pieces.

Homogeneous stands of apple tree (*Malus*), apricot tree (*Armeniaca*), Persian walnut (*Juglands regia*), almond *(Amygdalus*) and pistachio (*Pistacia*) plantations are established in the sub-zone of fruit-and-broadleaf mountain forests in South Kazakhstan. The area of these forests is rather inaccessible and therefore homogenous stands are established only on an area of 100-200 ha per year. Persian walnut and pistachio plantations are established by seed sowing and almond plantations by planting of two-year-old seedlings. Thereat soil preparation is carried out mainly by mechanical methods (spots, terraces), and manual planting. One ha contains 600-700 spots, where 5-10 seeds are sown or 5-6 seedlings are planted.

### ***Desert regions***

In the desert region of the country homogeneous stands of *Saxaul haloxylon* are established. The success of saxaul cultivation depends on the type of soils, degree of their salinity and ground water level. Taking into consideration the peculiar features of desert soils, strip soil preparation is applied for homogeneous stand establishment. At a strip-width of 1.4 m the inter-strip space equals to 2.8 m. Other spacing such as 2.8 X 2.8 m, 4.2 X 5.6 m is also used. The soil is worked at the depth of 25-27 cm. Sowing is carried out in autumn in the year of seed harvesting, particularly for seeds that do not stand long-time storage and thus would loose germination power soon. About 2.5 – 5.0 kg of seeds is sown on one ha depending on quality class. The weight of 1,000 seeds is five grams on average. The highest (100%) survival rate of plantings is achieved with 1,100 viable germinating seedlings on one ha. Every year, 20,000 to 35,000 ha of homogeneous stands are created by this method. However, the survival rate of such species is very low (25-30%) due to the harsh natural climatic conditions, and sometimes all young seedlings perish due to late spring frosts.

***Lowland forests***

Rehabilitation of lowland forests along rivers such as the Ural, Irtysh, Ishim, Tobol is aimed at strengthening their water protection properties. The array of species for homogeneous stand establishment is very diverse and rehabilitation is carried out with the main tree species or shrubs depending on the habitat conditions:

- along the flood bed of the river Ural – English oak (*Quercus robur*), poplar white (black) (*Populus sp.*), white willow (*Salix sp.*), and
- along rivers such as Irtysh, Tobol and Ishim – balsam poplar (*Populus balsamifera*), weeping birch (*Betula pendula*), march elder (*Salix sp.*) and others.

Planting shall be made in spring by 1 to 2-year-old seedlings of annual rooted cuttings (willow, poplar). At overall tillage, spacing shall be 3 m between the rows and 1 m within a row, 3,000 to 3,500 pieces of plants shall be planted out on one ha. On the second (upper) river terrace on the shrub plots, the soil is prepared by spots with a size of 1.5 x 1.5 m. In each of the prepared 500 to 600 spots four seedlings are planted per one ha, corresponding to a density of 2,000 to 2,500 plants per ha.

Riparian woodland (tugai) rehabilitation along the floodplains of the rivers Syrdariya, Chu, Ili, Karatal, Aksu, Charyn and Lepsy which flow in the desert zone, aims at the preservation of the intra-zonal (i.e. within the forest site zone) vegetation performing important soil protection and water-protective functions. These forests consist of different shrubs such as willow (*Salix sp.*), tamarisk (*Tamarix sp.*), salt tree (*Halimodendron sp.*) and other timber species such as Asiatic poplar (*Populus diversifolia*) and oleaster *(Elaeagnus angustifolia*) as well as along the Charyn River – sogdiana ash tree (*Fraxinus sogdiana*). Riparian forests have been considerably damaged by fires and destructive insects. Their rehabilitation strongly depends on floods during the spring period. Thereat, the shrub vegetation rehabilitates considerably faster than tree vegetation requiring several decades for their recovery. Therefore, rehabilitation measures in these forests focus on the enrichment of the species composition by introducing fast growing and high-productive tree species such as poplar – *Populus*, tree-like willow - *Salix caprea* and other timber species.

Plantings were made on partially treated (furrow) areas as well as spots with the size of 1.5 m x 1.5 m. One-year-old rooted cuttings (poplar, willow) or one-year-old seedlings of oleaster and ash tree are mostly used for this purpose. About 2,000 to 2,500 plants were set out on one ha.

## *4.4. Forest Reclamation*

Apart from forest rehabilitation, the work on forest cultivation, the so called forest reclamation, is also carried out in the country. Forest reclamation means creation of protective plantings (PP) on the land not forming part of the state forestry fund. According to their protective properties, these plantings are divided into:

- Field-protective forest belts (i.e. shelterbelts) of 9 to 12 m in width located on plains and on watershed areas for protection of fields from harmful effects of dry hot winds, snowstorms and wind erosion;
- Water regulation forest strips up to 15 m in width located on arable slopes for regulation of surface water (moisture) flow, reduction of soil erosion and improvement of environmental conditions of agricultural fields;
- Ravine forest belts (natural relief micro degradations) and gully forest belts (the result of water erosion of soils) are created with 15 to 21 m in width alongside the draws and ravines as well as inside them for protection from water erosion and for improvement of the environment on adjacent fields;
- Forest strips on irrigated lands alongside irrigation and water collection channels for evaporation control, lowering of ground water level, protection of fields from hot dry winds and dust storms;
- Forest strips and plantings on pasture lands to increase the carrying capacity as well as to protect animals from wind and hot weather;
- Coulisse (in strips) and massive (unstriped) forest ranges on sandy soils degraded by excessive grazing unused in the agricultural sector for sand stabilization and transformation of these lands into productive agricultural lands;
- Forest strips along the roads for protection from snowing and sanding;
- Protective and decorative plantings in and around rural settlements for environmental improvement; and
- Forest range on pit bings for their reclamation.

Generally, forest improvement plantations represent a system of different types and locations of forest strips (blown, partially blown, thick – i.e. not blown and other), which depend on tree and shrub distribution, species range and topography. The range of trees and shrubs is very diverse and is determined by the forest site of the planting zone, biological properties of timber species and the purpose of the protective planting.

One of the most important projects of forest reclamation is implemented in the dried bottom of the Aral Sea (DBAS). Intensive and irrational growth of irrigated agriculture in the past and aimless river flow withdrawal led to the loss of water and salt balance of the Aral Sea. Starting from 1961 the flow of water to the sea considerably decreased. In 1965, it was only 30 $km^3$/year and further declined to 3.5 to 7.9 $km^3$/year in the period 1980 to 1990. In some years the flow of river waters of the Syrdariya and Amudariya (in Uzbekistan) did not reach the sea at all. Consequently, the water level has decreased continuously until reaching 22 m at present. Nowadays, the Aral Sea has ceased to exist as a historically integrated water reservoir. In 1986, the Small Sea was completely separated from the Big Sea and later on, a number of separated water reservoirs were formed as illustrated below.

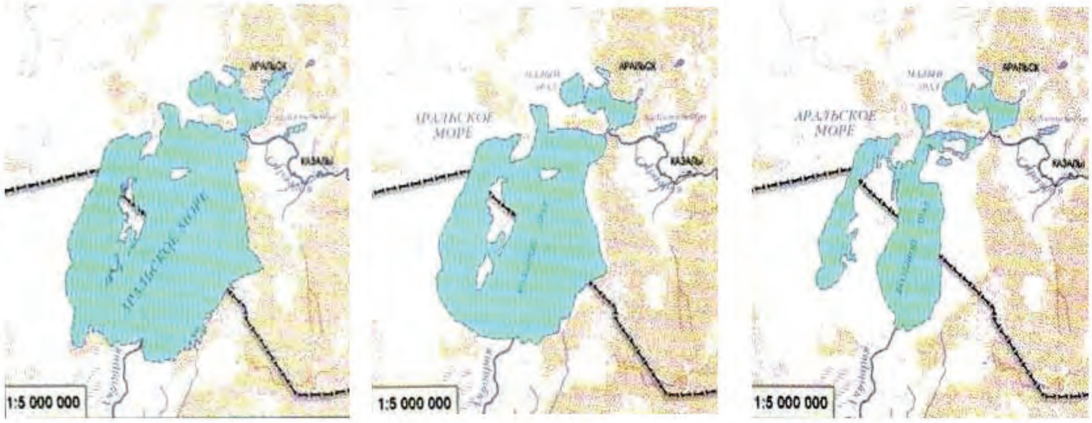



**Figure 12:** ***Progressive aggradation of the Aral Sea***

The retreating Aral Sea leaves behind a desert-like landscape (depicted in the images below) extending over an area of 36,000 $km^2$ causing an ecological crisis in the region. The land is covered by a thick layer of salt and different residual chemical compounds which are moved around by strong winds over long distances of 250-300 km. This has an adverse effect on agricultural crops, natural plantations, air quality and water and health of people and animals. Every year, 75-100 million tons of toxic salt and dust is removed from the DBAS.

**Figure 13:** ***Saline lands on the bottom of the Aral Sea (left picture); salinization of former croplands (right picture) (Photos taken by Z.B. Novitskiy)***

Under these conditions, a specific hydro-geological environment is gradually developing. A new ground water table with a depth between 0 to 3 m develops. The high salt content of the soil of 50 to 100 g/l gradually comes down along with the simultaneous soil detachment as one moves towards the original sea line. Timber and shrub vegetation can be met here only at 15-20% of the total area of the DBAS, out of which 36,500 ha are occupied by saxaul (*Haloxylon sp.*). They are mainly open stands at the age of 12-18 years with few trees per unit area.

In spite of the fact that every year there is no lack of seeds in such plantations, there is no natural colonization of saxaul due to shifting of seeds through wind and dryness during the spring period. This makes human intervention necessary in order to accelerate the process of forest reclamation by creating stable, multi-year and productive tree and shrub communities using native wild species of plants resistant to stress, dry conditions and extreme salt content. From 1988 on, 54,000 ha of artificial protective plantings (APP) have been established on the lands of the DBAS. Their survival rate was very low (5-10%). However, at the age of 3-5 years individual surviving plants started to bear fruits thus supporting natural regeneration.

The main objective of forest reclamation work on DBAS is the prevention or considerable reduction of soil erosion processes. This was achieved by massive planting of 1-2 years old seedlings of saxaul (*Haloxylon sp.*), tamarisk (*Tamarix sp.*) and sarsazan (*Halocnemum sp.*) in rows with a distance of 5-6 m between rows and a distance of seedlings within rows of 1.0-1.5 m. First, the areas with sand and sabulous deposits were reclaimed. The content of ready soluble salts at a depth of soil layer of 5-30 cm should not exceed 45 g/l and groundwater depth should be between 1.5-2.0 m. In a next step, reclamation should be made on the lands of bottom deposits with wind-shifted sands and soils of higher salt content (50g/l). Further on, it is possible to establish reclamation plantings on the fine-textured bottom deposits with the wind-shifted sand layer with a soil depth of more than 10 cm and a maximum salt content of up to 60 g/l. Favorable forest site conditions (i.e. soils of primary development) allow the establishment of reclamation plantings by sowing of seeds of black saxaul, tamarisk and halocnemum. The strategies of their establishment are similar to those explained for planting homogenous stands.

### *4.5. Research and Development for Forest Rehabilitation*

Until the 1930s, there were no scientific organizations in Kazakhstan addressing forest management problems. Therefore, the first research on forest reclamation and forest rehabilitation and afforestation was carried out by Russian scientists. Further on, several forest experimental stations were established in the country such as in Lebyazhinskaya oblast and Semipalatinskaya oblast. However, because of limited capacities for decision-making in all arising forest management problems, special laboratories and departments were organized at the newly created research and development and educational institutions of the country (Departments of Agriculture, Water and Forest Management, Botany, Forest Faculty under the umbrella of the Kazakh Agricultural Institute, 1948). In these institutions, systematic scientific research on forest management, planning and the establishment of homogenous stands was undertaken.

In 1975, the Kazakh Research and Development Institute for Forest Management and Agriculture (KazRDFMAI) was established. As a consequence, there was a significant progress in research work on forest cultivation and rehabilitation including the development of new types of homogeneous forest stands adapted to the specific site conditions of Kazakhstan. The development also included investigations on protective forest cultivation, especially on the establishment of shelterbelts in agricultural fields and introduction of new timber and shrub species.

Nowadays, scientific support to forest management is provided by the Scientific and Production Center (NPC) of Forest Management (former KazRDFMAI) as well as the Forestry Department of the Kazakh National Agriculture University (KazNAU).

On the basis of the scientific recommendations approved by the Committee of Forestry and Hunting Management (CFHM), a specialized organization called “Kazforestproject” has been charged with the task to carry out extensive fieldwork (forest inventory) in certain forestry enterprises with focus on the establishment of homogenous stands for a ten-year period. Based on the results obtained in forest inventory, the Republican State Enterprise (RSE)

“Kazgiproleshoz” will carry out design and exploration works for homogenous stand establishment taking into consideration the necessary expenses for each specific area. Scientific research, forest inventory and planning are financed by funds of the State Republican budget.

### *4.6. Evaluation of Past and Current Forest Rehabilitation*

The increase of forest cover of Kazakhstan owing to homogenous stand establishment by sowing and planting of forest crops and protective afforestation generally occurred in the middle of the last century, notably during the 1970s and 1980s. During that period, the annual volume of work on forest rehabilitation varied between 80,000 and 88,000 ha including sowing and planting of forest crops on 70,000 to 76,000 ha and support to natural regeneration on 9,000 to 12,000 ha. These achievements were made possible because of sufficient financing, close interaction within several Union Republics, mutual exchange of scientific information and practical experience and certainly also increased capacity of professional staff.
From the mid 1990s onwards, efforts towards forest rehabilitation and afforestation, particularly planting of protective forests, almost stopped due to lack of funds. In addition, the homogenous stands on lands of the State Forestry Fund were reduced by more than 10 times (from 70,000/75,000 ha in the 1980s to 5,800 ha in 2000). The general provisions, plans, concepts, feasibility studies and other program documents concerning forest rehabilitation and afforestation pursuant to the directives and governmental regulations were generally not financed and thus not implemented.

Starting from 2003, forest rehabilitation and afforestation have regained momentum because of the new Forest Code and forest management programs as well as corresponding funding made available by the government.

At present, the regulatory and legal provisions for forest management continue to improve. Forest enterprises are financed by means of the Republican and local budgets. The programs “Forests of Kazakhstan” and “Zhasyl Yel” are being implemented based on the main policy on forest management of Kazakhstan determined by the Forestry Code of the Republic of Kazakhstan. This code regulates the ownership and command over the forests aiming at increasing ecological and resource potential of forests, rational use and sustainability of the forest resources, their protection, safeguarding and rehabilitation.

One of the resolutions of the Government of the Republic of Kazakhstan (No. 17, dated 10.01.2001) “On the approval of the sectoral program of the greenbelt creation around Astana city for 2002-2010” assists in mitigating negative climatic conditions around the capital city and creation of comfortable conditions for the life and recreation of the population. A green zone will be established by planting homogenous stands on 25,000 ha, whereby 20,300 ha will be newly established while on 4,700 ha measures for tending and maintenance of previous years’ plantations will be carried out.

### *4.7. Summary of the Work on Forest Rehabilitation and Further Instructions*

There is no doubt that the measures on forest rehabilitation and afforestation in the Republic implemented over a period of more than one hundred years deserve recognition. During this period, an excellent theoretical basis (regulatory, legal and methodological) has been created including typology of forests and scientific investigations allowing for a rational and sustainable forestry. On the basis of this inventory, works assessed the condition of forests and the necessity of artificial rehabilitation of those areas, where there was not enough regeneration. In order to regenerate these areas through artificial forest cultivation, arrangements were put in place such as tree nurseries for the production of planting stock, special tools (ploughs, harrows, cultivators, etc.) and mechanisms like seed sowing machines, planting machines and other equipment. The major work on forest rehabilitation and afforestation was carried out in accordance with forest management plans.

However, based on the analysis of forestry activity and the condition of the existing homogeneous stands, the quality of the work performed in many ways depended on timeliness and total volume of available funds. In practice, forest management had always been funded below the required level and achieving of planned quantitative targets "by all means" did not encourage the quality of forest restoration work. Unfortunately, at present, this attitude still occurs as a survivor of the past. For example, there is a saying that "first you should provide a meal to people and then plant a forest".

All in all, further success related to the forest rehabilitation problem in Kazakhstan should proceed from the scientific basis of natural and artificial methods of forest rehabilitation. Thereat, emphasis should be placed on natural processes of forest rehabilitation which may be achieved by the implementation of progressive tree cutting methods allowing a high rate of survival of young growth on the cutting areas, its protection from damage or destruction by cattle and hazardous organisms as well as by seeding of areas intended for natural forest regeneration.

## 5. Possibilities in Forest Rehabilitation

### *5.1. Possibilities of Institutional Capacity*

Forest administration, forest management and exploitation are performed today on a sufficiently stable legal basis. Nevertheless, for increased legal and institutional efficiency for forest rehabilitation it is reasonable to put in place procedures providing:

- Governmental support to private entrepreneurs cultivating forests (plantations) for different purposes at a level similar to that enjoyed by rural manufacturers; and
- Incentives to forest owners (state reimbursements) using genetically improved (highly productive, resistant to depredators and illnesses, etc.) seeds and planting material for forest rehabilitation and afforestation.

Forests and forest management will continue to be predominantly based on the governmental system of management. However, since it is considerably more difficult to manage large forestry enterprise areas, it will be necessary to down-size the areas to a level similar to that of forest management units in European countries.

### *5.2. Civic Engagement*

In Kazakhstan, forest recreation and afforestation are generally managed by governmental institutions financed from state budgets. Their interrelation with private enterprises has not been observed hitherto.

Private initiatives are mainly limited to tree planting in gardens including small fruit trees, taking place on summer cottage (garden) plots allocated to people in suburban zones of large cities. Promotion of tree planting in cities and villages is often organized by social organizations such as “Tabigat” association, Public Fund “Zhasyl yel Kazakhstan - XXI” and others, as well as by large enterprises and educational institutions. The work is mainly performed within the framework of actions planned by the local government bodies and financed from the local budget or more rarely by means of a separate project.

Unfortunately, separate projects are not always supported by local authorities and sometimes these initiatives are even discouraged. An example of this is the attempt to establish an industrial poplar plantation on using waste waters of the “Sorbulak” sewage pond round Almaty which failed because of the lack of timely financing.

Civic engagement into forest cultivation can be effective provided there is governmental support to promote forest product markets in this sector. At present, only the wealthy people can cultivate forests as far as this process requires long-term (not less than 10-15 years) investments. One of the approach of civic engagement in forest cultivation is the land lease (family contract) already approved in agriculture or leasing forests for a long-term period gradually being introduced in forest management. It is necessary to support private forest cultivation and to direct such investments to all forest areas, particularly for the production of timber for local resources. The natural and ecological potential of regions will improve and this will guarantee employment of the local population thus improving the standards of living at village level.

### *5.3. Education on Forest Rehabilitation*

Soviet academic institutions traditionally focus their education in forestry on fundamental knowledge and forest management questions such as forest fire protection, forest pest and disease control, production of planting stocks in tree nurseries, establishment of homogenous stands and forest reclamation, forest regulation and rational use of other forest values. During the soviet period, higher education was well organized and professional, basically connected with substantial practical training conducted at field level.

At present, the situation is quite different. The standard educational programs of special disciplines in forestry do not meet the up-to-date requirements of forest sector development. In this context, the readiness of graduates to successfully implement field activities is weak, the material and technical facilities in educational institutions have become outdated, the quantity of materials, equipment, practical training aids are insufficient and the scientific and methodological literature is incomplete. There is also a shortage of skilled teachers in special disciplines.

In order to improve training of forest sector specialists it is necessary to:

- optimize the network of specialized secondary and higher educational institutions in the field of forest management;
- develop the content of educational programs taking into consideration recent scientific achievements and forest management demands as well as state-of-the-art methods in wood products manufacturing;
- develop the innovative technologies, forms and methods of training including distance education;
- develop the educational and methodological basis and information support of educational programs corresponding to the best national and foreign standards; and
- monitor current and long-range demand in specialists in the forest sector and carry out analysis of graduates’ employment.

### 5.4. Demand for Research and Development Activities

In order to improve the forest rehabilitation process and increase the amount of forests in the Republic, the scientific support of the forest sector should be directed to the following tasks:

- development of an integrated and environmentally safe system of forest fire protection, prevention of illegal cuttings and other forest damages, forest protection from depredators, diseases and other man-made impacts based on site-specific and regional ecological land characteristics;
- preservation of forest biodiversity by the monitoring of forest health and careful use of forest resources, development of forest seed genetic stock and the electronic database of selected and seed production facilities;
- development of selected genetic and biotechnological investigations, cellular engineering and micro-clonal propagation, crop variety testing and breeding of ligneous plants;
- improvement of the existing methods and technologies of forest planting on degraded lands of the ribbon-like relict pine forests of the Irtysh region, the Ural river lowland, in the wild-fruit belt of North and West Tien Shan and in the desert zone of the country, as well as planting of stable homogenous stands on the dried bottom of the Aral Sea;
- development of new methods and technologies for the establishment of industrial plantations of fast-growing trees; and
- investigations in the field of landscaping in cities and populated localities as well as protective plantings (greenbelts) around them, taking into consideration diversification of woody plants and brushwood and application of high technologies in planting of ball-rooted planting stock and mycorhiza.

### 5.5. International and Regional Cooperation in Forest Rehabilitation

At present, the Republic implements six international forest-related projects:

- World Bank Project "Preservation of Forests and Increase of the Amount of Forests in the Republic" (2006-2011), the purpose of which is preservation and rehabilitation of biomes of the ribbon-like pine forests of the Irtysh river region and saxaul plantations of Kyzylorda region, maintenance of the forestry-based industry of the Republic, development and adoption of ecological standards of grazing in haloxylon deserts and improvement of the overall forestry management system;
- GEF/UNEP Project "Establishment of Training Center Network for SPNR Staff by Using Available Experience" (2006-2008);
- UNDP/GEF Project "Preservation and Sustainable Use of the Biological Diversity of the Kazakhstan Part of the Altai-Sayanskiy Ecoregion" (2007-2011), the purpose of which is preservation of the globally valuable biological diversity in this part of the country;
- GEF Project "Complex Preservation of High-Priority Globally Valuable Wetlands as Habitat of Migratory Birds with demonstration on the ground in the following three areas: Alakol-Sasykkol and Tengiz-Kurgaldzhinskaya Lakes and the Ural River Estuary" for the purpose of elaboration and demonstration of new approaches to conservation and sustainable use of biological resources of the globally valuable wetlands;
- Joint participation project of Russia, China, Kazakhstan and the Islamic Republic of Iran with the support of the International Program of Environmental Conservation (UNEP, 2005-2010) "Development of Wetland Flyways for the Preservation of the Siberian Crane and Other Water Birds in Asia" for the protection of flyways of the

Siberian white crane and other water bird populations, the fly-lines of which run through the Asian countries including Kazakhstan; and
- Project of the Government of RK/GEF/UNDP “Preservation of *In-Situ* Mountain Agrobiodiversity in Kazakhstan” (2006-2011) for the purpose of *in-situ* conservation and sustainable use of biological diversity of the mountain wild-fruit apple tree (Malus), apricot (Armeniaca) and other wild-fruit tree forests.

International cooperation in the field of forest management and forest rehabilitation in particular are determined by the multipurpose character of the management of forests and the importance of their role in the improvement of environmental conditions. Therefore, the priority in international cooperation should be directed towards existing agreements signed by the Kazakhstan Republic with regard to sustainable development, protection and use of plant and animal life, water bodies, the atmosphere and specially protected nature reserves. Such agreements include the UN Convention on the Conservation of Biological Diversity, the UN Convention to Combat Desertification, the UN Framework Convention on Climate Change and others.

However, many values of forests are exterritorial and can have positive or negative effects on the ecology of neighboring countries, particularly through forest fires, depredators and diseases as well as desertification processes. Therefore, Kazakhstan should establish agreements with neighboring countries on the following issues:

- Protection and prevention of near-border forests from fire and spread of harmful forest organisms;
- Joint monitoring of near-border forests with respect to their sanitary state and regular sharing of information on the current forest fire and phytosanitary situation;
- Joint establishment of trans-border specially protected zones and nature reserves; and
- Organization of a Coordination Council on ODAM issues; i.e. development of a feasibility study and the international program on desert reclamation, addressing the specific problems of forest reclamation of deserts within the transboundary region of the adjoining Republics of Kazakhstan and Uzbekistan.

## 6. Future Steps

The expanded reproduction of forests and growth of forest areas within the forestry fund will be financed by the Government. Thereat, special attention will be placed on the improvement of forest seed production, enlargement of seed orchards, the renewal of the tree nurseries system employing new technologies (e.g. container for growing ball-rooted planting stock under controlled environmental conditions), to the quality and volumes of plantings and sowing, and support to natural forest regeneration. As a matter of priority, there will be considerably intensified work on the afforestation of burned areas and cutover lands (625,000 ha) in the ribbon-like pine forests of the Irtysh river region, Kazakh upland and the plain forests of Kostanai region, and in the saxaul plantations in the south and southeast of the Republic.

For the establishment of homogenous forest stands with coniferous species, preference will be given to the block-strip method with sufficient inter-block spaces. Plantations established by this method are less sensitive to fires and are more resistant to diseases and depredators. In addition, the process of forest recovery and ecological development by means of natural regeneration will be promoted, thus considerably reducing the investments needed for forest rehabilitation.

With respect to the rehabilitation of haloxylon deserts, an array of methods such as natural seed and vegetative propagation, annual artificial plantings and sowings will be employed.

Corresponding measures in supporting market relations in the field of forest cultivation will be taken. Thereat, the land lease system will be approbated, which can considerably help to expand forest areas involving various stakeholders in this business. The experience of the state support of manufacturers which is currently successfully applied in the agriculture sector of Kazakhstan will be used in private forest breeding and forest plantation of fast-growing species. Priority will be given to the south and southeast of the Republic possessing cheap labor forces, irrigated areas and unfavorable natural climatic conditions. Private forest plantations will be turned into one of the most important entrepreneurial business aimed at considerably expanding forest areas and local timber resources, improvement of natural and ecological quality of the regions, guaranteeing employment of local people and thus raising the living standards in the country.

All in all, the new forest policy of the Government is directed towards progressive development of the forest sector in all directions, particularly proper protection of forests, expansion of the forest area, and site-specific management and operations in order to increase overall forest productivity. Thus, in Kazakhstan the forest sector strives to improve existing preconditions for successful forest rehabilitation and cultivation comprising the presence of sufficient land for forest expansion, the provision of a sufficiently large labor force, adequate planting stock production, as well as sufficient financing. Generally, in the years to come, the implementation of programs on extended forest reproduction and expansion of forest areas alongside with their proper protection should be considered as the main focus of progressive development in the forestry sector.

## 7. References


Andriyevskiy, A. 1914. Semirechye forests and their role in the region life . The excerpt from the Forest Magazine, the Magazine of St. Petersburg city administrator, p. 16.

Anuchin, V.A. 1982. Society and nature interaction. Socialism and nature. M. Publishing house “Mysl”, pp.13-36.

____________ 2006. Aral Sea. Republic of Kazakhstan, Vol. 1. Natural environment and resources. Almaty. pp. 270-277.

Baizakov, S.B. 1981. Economical evaluation of forest resources. Almaty, Kainar, p.15.

Baizakov, S.B., A.N. Medvedev, S.I. Iskakov, and B.M. Mukanov. 2007. Forest crops in Kazakhstan: (Volumes 1 and 2), Almaty, KazNAU.

Baizakov, S.B. 2009. “Project of National forest policy of the Republic of Kazakhstan until 2020” (materials of International scientific-and-practical meeting devoted to 100 anniversary of S.N. Uspenskiy), Almaty.

Beresin, E.L. 1967. Breeding valuation of plantings, selection of positive trees and separation of Shrenk fir-tree seed-plots, Alma-Ata.

Besschetnov, P.P. 1956. Oak cultivation in the South Kazakhstan. International Agricultural Exhibition of KazSSR, Alma-Ata.

Besschetnov, P.P. and S.I. Iskakov. 1990. Recommendations on poplar cultivation in south and south-east regions of Kazakhstan. Ministry of forest management of KazSSR. Kazakh Agricultural Institute (KazAI), Alma-Ata.

Bozrikov, V.V., I.A. Lagov, A.I. Lagutina and others. 1975. Recommendations on cultivation of birch, pine and larch in the tree nurseries of North Kazakhstan. Ministry of Agriculture of KazSSR. Publishing house “Kainar”, Alma-Ata.

Gudochkin, M.V. and P.S. Chaban. 1958. Forests of Kazakhstan, Alma-Ata.

Glazov, U.A. 1966. Mycorrhiza of saksaul. Collection of "Scientific-and-production conference on forest management issues". KazAI, Alma-Ata.

Gribanov, L.N. 1965. Pine forests of Kazakhstan and biological principles of economical activities therein (report on total works). The Institute of Biology of the Ural Branch of USSR Academy of Science, Sverdlovsk.

Iralina, T.A. 2008. On personnel training for the forestry sector, (collection of materials of the International scientific and practical conference “Actual problems of forest management and staffing of forest sector of Central Asia countries economy”, Astana.

Iskakov, S.I.1969. Cultivation of poplars in the conditions of the South-East of Kazakhstan. Author paper of candidate thesis. KazAI.

Kentbayeva, E.Zh. and B.A. Kentbayeva. 2008. Trees and shrubs of Kazakhstan for forest cultivation, Almaty.

Koval, I.A. 2007. Project of forest preservation and growth of forested area of Kazakhstan for the period of 2007-2012. Contemporary state of the forest management and landscaping in the Republic of Kazakhstan: problems, methods of their decision and perspectives. Almaty, pp. 20-25.

Kushlin, A., Ch. Veyen, and U. Satton. 2003. Stabilization of saline rises. – Technical document of the World Bank. pp. 42-43.

_____________ 2003. Forest Code of the Republic of Kazakhstan, Almaty, JURIST.

Galym, S.B., A.A. Baizakov, A.A. Gurskiy, A.K. Amanbayev, and Zh.N. Toktasynov. 1996. Forests and forest management of Kazakhstan: (condition, dynamics and valuation methods). Almaty.

_____________ 2008. Materials of forestry fund enumeration in the Republic of Kazakhstan as of 01.01 2008. Almaty.

_____________ 2004. Materials of International Scientific Conference “Strategy of scientific support of agroindustrial complex in farming, crop production and gardening sectors: reality and perspectives” (books 1 and 2). Almaty.

_____________ 2003. Materials of International scientific-and-practical conference “Forests and forest management in market conditions: problems and perspectives of sustainable development” (books 1 and 2). Almaty.

Meshkov, V.V., G.A. Nam, and E.V. Rakhimova. 2009. Use of mycorhiza forming fungi for forest rehabilitation and cultivation in Zailiyskiy Alatau (collection of materials of VII International conference “Problems of forest plant pathology and mycology”, Perm.).

____________ Report on the activity of the Committee of forest and hunting management of RK Ministry of Agriculture for 2008.

____________ On adoption of the program "Zhasyl Yel" for 2005-2007 years. Government Resolution of the Republic of Kazakhstan dated June 25, 2005, No. 632.

____________ Collection of regulatory legal acts on forestry management, specially protected natural reservations and wildlife (1 and 2 volumes), Astana, 2005.

____________ Technical specifications on the inventory of forestry crops, protective forest belts, tree nurseries, Goskompleks USSR, Moscow, 1990.

Tekhneraydnov, A.V. 1957. Some particular properties of pine second growth in steppe pine forests on sandy soils. Author paper of candidate thesis. KazAI. Alma-Ata.

***Mountains and foothills in Kazakhstan (Photo taken by Stanislav Kuznetsov)***

***Mountain forests at Lake Kolsay, Kazakhstan (Photo taken by Stanislav Kuznetsov)***

***Steppe ecosystem in Kazakhstan (Photo taken by Alexey Melnikov)***

# Forest Rehabilitation in Kyrgyzstan

Almazbek Orozumbekov[13], Turatbek Musuraliev[14], Biimyrza Toktoraliev[15], Askat Kysanov[16], Bakytbek Shamshiev[17], Ormon Sultangaziev[18]

## 1. General Information

### *1.1 Geographic Information*

The territory of the Kyrgyz Republic is 19.99 million ha (4.3% are forests, 4.4% - water surface, 54.0% - agricultural lands and 37.3% - other lands). Almost 95% of the territory is mountainous at more than 1500 m asl. The average elevation is 2,750 m asl with the highest point at 7,439 m and the lowest one at 401 m. Fifty eight percent (58%) of all human settlements in the country are located within the elevation of 1,000-2,000 m (35% of the total population) while 5% live above 2,000 m asl.

Nearly 90% of the total territory of Kyrgyzstan lies at altitudes of 1,500 m asl and higher (Abdymomunov 2001a) and more than 40% above 3,000 m asl (von Maydell, 1983).

The Kyrgyz Republic is bordered by the Republic of Kazakhstan, the People's Republic of China, the Republic of Tajikistan and the Uzbek Republic. Located at the intersection of three large soil-climatic zones (i.e. Eurasia-Turanian, Western-Asian and Central Asian), Kyrgyzstan's climate shows a variety of climates.

The Kyrgyz Republic is located at the junction of two mountain systems (the Tien Shan and the Pamir). The highest points of the Republic in the Tien Shan Mountains are Victory Peak (Pobedy) (7,439 m) and Khan-Tengri (6,995 m). The lowest lying area is a transboundary crossing of the Naryn River at 480 m asl. The average elevation of the territory of the Republic is 2,630 m asl. About 93% of its territory lies at an elevation higher than 1,000 m; 85% lies higher than 1,500 m and about 42% is higher than 3,000 m asl. The variety of climatic and natural conditions and the mountainous landscapes of Kyrgyzstan can be classified into four climatic zones as follows:

- The valley-sub mountain zone (from 900 to 1,200 m) is characterized by hot summers, and snow-less and mild winters with significant lack of precipitation. The total cumulative positive temperatures for this zone are ranging from 3,600 to 4,900°C.
- The mountain zone (from 900 – 1,200 to 2,000 – 2,200 m) has a typical temperate climate with warm and relatively sufficiently damp summers, and temperate, cold

[13] Almazbek Orozumbekov, Associate Professor, Centre of Innovation Technology in Agriculture of Faculty of Innovation Technology, Kyrgyz National Agrarian University, Bishkek, Kyrgyzstan
[14] Turatbek Musuraliev, Expert in Forest management and Policy, Bishkek, Kyrgyzstan
[15] Biimuza Toktoraliev, Professor, Osh Technological University, Osh and National Academy of Sciences of Kyrgyz Republic
[16] Askat Kysanov, State Agency of Environmental Protection and Forestry under the Government of Kyrgyz Republic
[17] Bakytbek Shamshiev, Professor Osh Technological University, Osh, Kyrgyzstan
[18] Ormon Sultangaziev, Department of Forestry, Kyrgyz National Agrarian University, Bishkek, Kyrgyzstan

stable and snowy winters. The total accumulated positive temperatures for this zone are in the range between 2,700 and 4,000°C.

- The high-mountain zone (from 2,000 – 2,200 to 3,000 – 3,500 m) has cool summers and cold winters without much snow. Temperature in July is about 11 - 16°C. Extended winters last from November to March. In January, the temperature is 8-10°C below zero, and the other cold months of the year have temperatures of minus 3-7°C. In the upper part of this zone a frost-free period is reduced to three to four months and even less. The frost free period can be reduced to zero if we move higher up, i.e. there is also some frost during the warmest summer days here. The total accumulated positive temperatures in this zone are 600 – 2,600°C.

- The nival belt zone (from 3,500 m and higher) has severe and very cold climate. This is a belt of snowfields, rocks and glaciers, as well as a belt of moisture accumulation. Even in the lowest parts of this zone the average July temperatures do not exceed 4-7°C, while January temperatures go down to 19-22°C below zero. The total accumulated positive temperatures for this zone range between 600 and 800°C.

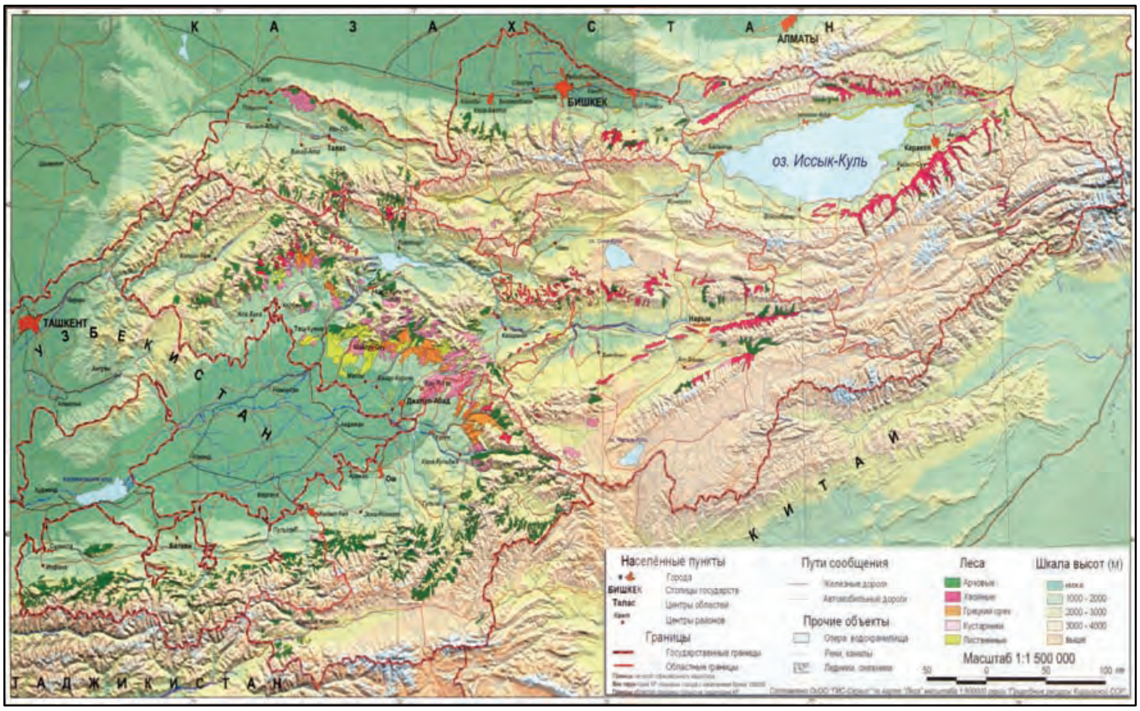
Only 20% of the territory of the Republic can be classified as an area for comfortable habitation. The majority of the population lives here and its economic activities takes place in this area. About 50% of the territory is classified as uninhabitable. Only mining enterprises run their activity here on a permanent basis, while other economic activites are only of seasonal type.

The averaged readings of the total annual precipitation in all climatic regions are quite similar: northwestern region - 456 mm, northeastern region – 421 mm and southwestern region – 521 mm. The higher readings in the southwestern climatic region reflect the higher moister transfer by western air streams. Low annual precipitation in the inner Tien-Shan area (294 mm) is explained by the location of the region within the wind shadow of the northwestern moisture-laden air flows (UNDP, Bishkek, 2009).

Being a mountainous country, climatic conditions in Kyrgyzstan are significantly influencing the living conditions and daily activities of people. Kyrgyzstan occupies the main part of the Tien Shan mountain and, according to its height marks (average height of ridge line of many mountain ranges is 3.4-5 km and more), takes the fifth place among the highest mountainous ranges in the world, connecting to the Himalayas, Karakorum, Hindukush and Pamir mountain ranges (National Academy of Sciences of Kyrgyz Republic, Bishkek, 2007).

The Kyrgyz Republic is of special interest for the whole Central Asian region because most of the region's water resources originating in this country concentrate in its glaciers, lakes, rivers and underground reservoirs. In 2000, the total glacier volume was estimated at 417.5 $km^3$. There are 1,923 lakes with a total water surface of 6,836 $km^2$. The largest ones are Issyk-Kul (6,236 $km^2$), Son-Kul (278 $km^2$), and Chatyr-Kul (171 $km^2$). The longest rivers are Naryn (535 km), Chatkal (205 km) and Chu (221 km). The water of the Issyk-Kul Lake is salty and cannot be used for human consumption.

There are about 5,000 rivers in the Kyrgyz Republic, related to eight hydrological basins. The hydrological basins belong to the rivers Syr-Darya, Amu-Darya, Chui, Talas, Ili (Kar-Kyra), Tarim and two closed lakes – Issyk-Kul and Chatyr-Kul. All basins except for the last two are transboundary basins. The long-term average annual river flow from the territory of the Republic is about 48.6 $km^3$, as estimated in the year 2000 (UNDP, Bishkek, 2009).



Cartography: GIS-Service Bischkek 2003; Grundlage: Natürliche Ressourcen der Kirg. SSR: Wälder (1:500.000)

**Figure 1:** ***Forest map of the Kyrgyz Republic***

### *1.2 Demography*

Kyrgyz people are one of the most ancient people of Central Asia. The first record of Kyrgyz people was found in Chinese chronicles more than 2,000 years ago. Since then, the Kyrgyz State has experienced rises and downturns, multiply wars and interminable years of starvation, disease and drought. The history also includes large-scale escape of people from cruel invaders and long-time migrations in search for a better lot, and other events that considerably influenced the life and size of the population.

Nevertheless, the first records of the more or less precise number of Kyrgyz people are contained in the results of the Russian's population census of 1987, for the first time recognizing Kyrgyz people as an ethnic group (for a long time in Russian history, the "Kyrgyz ethnic group" was mistakenly related to Kazakh people). The number of people in the country has almost doubled over the past century. Certainly, many geopolitical events that happened over 100 years have influenced - to a greater or lesser extent - the size of this nation.

It is commonly known that after the transition from a nomadic to a settled life style the number of Kyrgyz people started sharply to increase. Before that transition almost half out of 10 born infants did not survive. A strong social policy during the Soviet period played some positive role in the increase of population. At that time, infant mortality rates decreased considerably.

The Kyrgyz Republic has a population of 5.2 million people (as at 1 January 2006). The urban population makes 35% while 63% out of this number are able-aged people (men aged 16 to 59, women aged 16 to 54). The rural population makes 65% with 55% of this number are able-aged people. In 2005, the natural increase of population made 11.7 people per 1,000 people in urban areas, and in rural areas it was 15.5 people. There are more than 90 ethnic groups living in the Kyrgyz Republic. In the beginning of 2006, there were 68.4%

ethnic Kyrgyz people, 14.3% - Uzbeks, and 9.5% - Russians. The amount of Hui (Dungans, or Chinese Muslims), Uighur and Tajik ethnic groups was about 1% each. Other ethnic groups were represented with less than 5%. The average annual increase of the resident population of the Republic was 0.94% during the period 2001 – 2006 (UNDP, Bishkek, 2009).

Kyrgyz and Uzbek are Turkic ethnic groups, Sunni Muslim and speak related Turkic tongues. Traditionally, the Kyrgyz lived as nomadic herdsmen and horsemen, while the Uzbek have a sedentary tradition. The vast majority of Uzbek in Kyrgyzstan live in the lower parts of the fertile Fergana valley in the south of the country.

Due to topographic conditions the majority of the population is concentrated in the south of the country. More than half the population lives in the densely populated Fergana Valley. The ethnic composition of the population has changed considerably over the past decades. The emigration of Russians and other Slavic nationalities began in the late 1980s (Heleniak 1997), and increased dramatically in the early 1990s at the height of the economic crisis to reach its peak in 1993 (UN, 2003a, p. 40).

### *1.3 Natural Resources*

Land and water resources are the most significant natural resources in Kyrgyzstan. However, benefiting from these resources depends on the prevailing climatic conditions which are not everywhere favorable. There are 0.247 ha of plough land per capita in the Kyrgyz Republic, of which 0.167 ha are irrigable lands. Because of the complex mountain topography and interaction of many natural factors there is great diversity in soil formations.

The quality of soil differs from grey-brown desert type to chernozem-forest type in spruce forests. Foothill valleys and inter-mountain valleys are areas of permanent residence and economical activity; the soil here belongs primarily to various types of grey soils and grey-brown desert type soils of the mountain-valley classification. Here, the humus content of the soil ranges from 0.8 to 2.5%. Only the eastern area of the Issyk-Kul Valley has mountain-valley type of light-brown soils with a humus content of 2.6 to 3.4% and dark-brown soils with a humus content up to 6%.

The socio-economic transformation processes are, of course, intimately connected with changing land-use systems and often environmental degradation. In different economic times, it is easy for environmental issues to be seen as a “frill” and to be relegated to a future agenda. The generally adverse state of the natural environment in the former Soviet Union, largely resulting from outmoded, inefficient, and polluting industrial enterprises, military activities, as well as from waste and inefficient use of natural resources, has been well known for over two decades (cf. Pryde 1995; Stadelbauer, 1996, 1998).

The adoption of subsistence strategies for sustaining livelihoods in the newly independent states such as Kyrgyzstan suggests that the pressure on locally available natural resources might be reduced and that the adopted model might ease the competition for access to environmental wealth and the threat on biodiversity conservation. Large areas of agriculture lands are currently inadequately managed and therefore less productive. According to the results of a land inventory, 8,000 ha of irrigated tillage have been out of use for the last five years.

## *1.4 Water Resources*

Water resources of the Kyrgyz Republic are used for irrigation, industrial and residential water supply, and for power generation. The water resources are accumulated in glaciers, lakes, rivers and as underground water.

The territory of the Kyrgyz Republic is part of a closed cut off basin in Central Asia. Having considerable water reserves made up of more than 50 $km^3$/year of surface river flow, 13 $km^3$ of fresh underground water, and 700 $km^3$ in glaciers the Kyrgyz Republic uses only 12 to 17% of the surface flow for its needs (National Academy of Sciences of the Kyrgyz Republic, 2007).

In the year 2000, the total glacier volume has been estimated at 417.5 $km^3$. According to data of mathematic-cartographic modelling performed in the middle of the 1970s the glaciers lost about 15% of their volume by the end of the century.

The Tien Shan Mountains have wide and levelled intermountain troughs located at 3,000 m asl and higher, showing typical glacier-accumulative relief. The permafrost zone starts at this altitude; the relief here has thermokarst features. Tien Shan Mountains have 1,677 small, high altitude lakes at elevations above 3,000 m.

There are 1932 lakes with a total area of water surface of 6,836 $km^2$ on the territory of the Kyrgyz Republic. The largest are Issuk-Kul Lake (mirror area is 6,236 $km^2$), Son-Kul (mirror area is 275 $km^2$) and Chatur-Kul (mirror area is 175 $km^2$). Currently, 24 reservoirs with common displacement of 24 $km^3$ are operated in the Kyrgyz Republic. There are 200 basins of decade and seasonal regulation with a total volume of 105 million $m^3$ of water. The reservoirs are subdivided into mountain, sub-mountain and flat categories, depending on their location.

The mountainous topography has formed well developed river networks. There are more than 3,000 rivers in the Kyrgyz Republic, relating to eight hydro geological basins and belonging to the rivers Syr-Darya, Amu-Darya, Chui, Talas, Ili (Kar-Kyra), Tarim and two closed lakes – Issyk-Kul and Chatyr-Kul.

The total long-term average annual river flow from the territory of the Kyrgyz Republic has equalled 48.6 $km^3$ for many years. The average annual river flow has increased by 2.9 $km^3$ (6.4 %). The mean percentage of river flow during the vegetation period is 74% and 26% during fall-winter and early spring seasons. About 20–25% of the river flow is used for domestic water consumption while the rest of the river flow goes to the territories of the neighbouring states: Uzbekistan, Kazakhstan, Tajikistan and China.

Potential fresh water underground reserves of the Kyrgyz Republic are estimated at 13 $km^3$. These underground reserves are located in intermountain troughs, the most economically developed areas of the country.

Useful ground water resources under the commercial recovery classification make 16 million $m^3$ a day or more than 5 $km^3$ a year.  The total ground water withdrawal for consumption makes up about 5% of the resources.

## *1.5 Hydropower Resources*

Water is a strategic resource for the Kyrgyz Republic, a source for food and power generation. The Republic possesses huge resources of surface waters as outlined above.

Due to changes in the surface water flow a short-term increase in capacity by 5 -10% can be expected by 2020 – 2025. During this period and in accordance with the State program on "The Main Areas for Prospective Development of Power Energy in the Kyrgyz Republic till 2025" it is planned to add another 2,660 to 3,660 MW to the existing power generating capacity.

Providing inhabitants living in remote mountainous areas located far away from basic energy sources such as hydro power plants and thermal energy is a major problem today. The Institute of Water and Hydro Power of the National Academy of Sciences of the Kyrgyz Republic therefore proposes to consider the use of local hydro power resources and to create the technical means for improving the living conditions of the mountain populations.

Under the National Energy Program, it is planned to restore 39 small power stations that have existed before and also to build new ones. As of 2008, there were more than 10 micro-hydro power stations operational in the Kyrgyz Republic (UNDP, Bishkek, 2009, National Academy of Sciences of Kyrgyz Republic, Bishkek, 2007).

## *1.6 Forest Resources*

As of January 2003, the total area of the State forest was 3.32 million ha, of which 0.865 million ha or 4.32% was forested land (State Forest Service Fund, 2003). The total forest growing stock is estimated at 28.84 million $m^3$. There are four types of forests: spruce forests the dominant species of which is *Picea schrenkiana*; walnut-fruit forests (*Juglans regia*, *Malus* and *Prunus* sp.); juniper (Artcha) forests (*Juniperus* sp.) growing up to 3,200 m under extremely dry conditions; and shrubs and riverside forests mainly made up of various species of willows, *Salix* sp.. juniper forests cover the largest area – 172,300 ha, followed by spruce forests, which cover 116,500 ha. In the north of Kyrgyzstan, forests are mainly composed of spruce, poplar and willow trees, while in the south of the country, where the climate is drier and protected from northern winds, forests are composed of a mix of walnut, maple, apple, cherry, plum, crataegus and almond trees.

The general average annual increment in 2003 was 0.44 million $m^3$ with 64.9 $m^3$ of standing stock per ha of forested land. In age composition, mature and over mature stands prevail, (44.2% of forests area). The share of under-storey trees is 9.9%. Because of government forestation efforts from 1999 through 2003, the creation of new forests reserve areas, and the transformation of former agricultural lands into state forests has brought the total area of State forest reserves to 259,700 ha. This is augmented by 262,100 ha of national nature parks. In total, 16,400 ha were reforested between 1998 and 2003.

Vertical stratification and a variety of climatic zones have caused significant diversity of tree species in the forest reserves, on one hand, and a low percentage of forest lands in the country on the other hand. Different combinations of species create a wide diversity of forest ecosystems: juniper and spruce at high altitude, walnut-fruit at middle altitude and flood-plain types at foothills. The long-term objective for the State Agency of Environmental Protection and Forestry is to increase the forest cover up to 6% by 2025 - 2030, which means expanding the forest areas by 289,000 ha compared to the forest cover in 2003.

### *1.7 Socio-Economic Situation*

The break-up of the Soviet Union, with the subsequent political and economic transition has resulted in an economic crisis across the former Soviet block. Since 1991, economic, social and political reforms have taken place in the Kyrgyz Republic.
Highest priority in the state's policy is given to social development and more than half of the annual state budget is needed for this area. The main focus is on poverty reduction, effective systems of social security and expanding human capacity. The breakdown of the Soviet Union's integrated economy and the sudden stop of direct and indirect subsidies from the central Soviet budget had dramatic consequences for all sectors of the economy in newly independent Kyrgyzstan. The country embarked early on what is seen as the most ambitious economic reform program among the former Soviet Republics in Central Asia, including price liberalization, privatization, agricultural and land reforms, and an early introduction of its own currency. The country gained considerable support for its determined reform agenda from the international community.

During the first years of independence, from 1991 until 1995, the country experienced drastic reductions in output and income in all sectors of the economy. The industrial sector virtually collapsed and agriculture again became the dominant sector in the early 1990s.

The social and economical development of the Kyrgyz Republic can be broken down into two phases – the first phase covers the years from 1991 to 1995 and the second – from 1996 to 2006. The first phase was a period of significant fall of economic activity, and of industrial activity, in particular. It led to an abrupt decline of GDP in 1995 when GDP made 50.7% of the 1990 level (expressed in prices of 1990). That decline included the fall of industrial production down to 33%, agriculture – to 45%, transport – to 88%, services – to 61% of 1990 GDP. The second phase was a period of GDP growth in real terms (prices of 1990).

After a first macroeconomic stabilization, the country's economy recovered from 1996 until 1998. However, this recovery was mainly based on growth in a few sectors (notably agriculture, gold mining and energy). High budget and balance of payment deficits made the economy extremely vulnerable (World Bank, 2001b, p 11). In late 1998, the country slid into a financial crisis mainly triggered by the Russian ruble crisis, from which it recovered only in 2000 when economic growth resumed. It is estimated that in 2002 the GDP reached about 70% of its level in 1990 (UN, 2003b, p. 11).

By 2005, the GDP achieved 80% of the respective level of 1990. At the same time, the gross industrial product reached 53.9%, construction – 46%, agriculture –103.8% and transport – 130.9%. The services sector made 6.5 times as much compared to 1990. The second phase was a period of economic stabilization (UNDP, Bishkek, 2009).

The economic contribution of the forest sector in monetary terms - equity of forestry (leskhozes) – is about 50.0 million Som (USD 1.2 million), which is approximately 0.05% of the country's GDP (102.8 billion Som or USD 2.5 billion). However, forests and forest resource management play a major role in the protection of watersheds and biodiversity resources within fragile mountainous ecosystems, and this contribution is excluded from the available estimates. Timber exports from Kyrgyz Republic are limited to products of exceptional value (e.g. walnut timber) but the volumes of such products are small as they are extracted as by-products of activities such as sanitary harvesting. However, because of poverty and other social problems, people in the rural areas experience difficulties in covering the increased cost of principal energy sources such as electricity, gas, coal, and firewood.

As a result, people in the remote areas are forced to use illegally harvested firewood. In urban areas, fuel wood is not consumed in large quantities. If gas and central heating are unavailable, the most common alternative is electricity, and thermal energy from coal combustion. The government provides poor families with free-of-charge allocations of coal (World Bank, 2005). Any purposeful changes regarding prosperity of people, conservation of natural resources, ecological safety should be implemented with the participation of the local population. Social mobilization is one of the instruments for involvement of local residents into the process of resources conservation and their proper management.

## 1.8 Land-use

### 1.8.1 Agriculture

Today, the agricultural sector plays a key role in Kyrgyzstan's economy. In 2002, it was responsible for more than one third of GDP and employed half of the economically active population. It has to be stressed that within the country there are important regional disparities between economically more dynamic regions, such as the capital Bishkek and its surroundings in the north of the country, and remote rural regions mainly in the south and in the centre of the country. Rural areas have often relapsed into subsistence agriculture and a non-cash economy.

The agriculture sector is an important factor of food security. Between 1990 and 2005, the share of agriculture in the GDP was about 30%. Plant cultivation made up 54.4% of the agriculture input into GDP, and cattle-breeding provided 43.9%. The share of services, forestry and hunting in agriculture input was insignificant.

Furthermore, it is important to note that the informal sector, not included in official statistics, plays an important role in the country. Despite some success of the various reforms, the Kyrgyz economy still faces a number of crucial challenges, including diversifying its economy, reducing the heavy burden of external debt, strengthening governance, expanding exports, increasing investments, developing small and medium businesses and agriculture (UN, 2003a; World Bank, 2003a), particularly in marginalized rural areas.

Agriculture is a business that depends to a large extent on the prevailing climate. Its productivity of plant cultivation depends on annual climatic conditions such as total precipitation and humidity, seasonal distribution of precipitation and moisture levels during the vegetation period. Therefore, agriculture productivity can be negatively affected by drought, hail, strong winds, and other weather phenomena. That is why productivity varies from year to year. At the same time, the dynamic of gross output indicates the tendency of agriculture growth.

Today, about 150,000 ha of irrigated land is affected by salinization and about 140,000 ha is insufficiently drained. The reasons for salinization and swamping are irrational water use for irrigation, reduction of capital investment and lack of technical maintenance and rehabilitation of irrigation and drainage systems. Plastering of solonetzic soil was terminated because of shortage of funds although this technology was once the most efficient approach of rehabilitating agricultural land.

For timely identification of harmful technologies applied in the agriculture sector, their assessment, prevention and elimination, the Government of the Kyrgyz Republic approved the Regulation on Monitoring of Agricultural Land of the Kyrgyz Republic through Resolution №115. The State Register ("Gosregistr") of the Kyrgyz Republic is a governmental body for the monitoring of arable land and pastures, their state and use, regulation of land relations, land market development, and surveying of agriculture lands including forest shelter-belt areas.

All agricultural lands, regardless of type of property and economic activity, are subjected to close monitoring. Results of systematic observations, surveys, studies, inventory, archive data and other data on qualitative and quantitative information on the status of land are the basis for monitoring. The Government of the Kyrgyz Republic has developed and adopted the State Program on “Land”, which has been implemented in three stages (1998, 1999-2000, 2001-2005). Within this program, the “Gosregistr” carries out soil examination and salt analysis of agricultural lands. This evaluation involves an assessment of the natural soil fertility and other local and site-specific parameters for defining the quality of the agricultural lands. These are key criteria for calculating the land tax levied for land-use and market promotion in rural areas. As an outcome of this work, a land cadastre plan for land reclamation works will be introduced and recommendations for proper land management options be elaborated, thus protecting land from negative impacts.

### *1.8.2 Industry*

The period between 1990 and 1995 displayed not only a significant reduction of industry input into the GDP of the Kyrgyz Republic, but also drastic restructuring of the industrial production. Before 1990, the main part of the industrial production was represented by machinery construction, production of electrical equipment and electronics, while the production of the light and processing industry played only an auxiliary role.

The economy stabilized after 1995, when the top position in the production of industry products was taken by the light and processing industry. After having put the newly established Kumtor gold-mining processing complex into operation, the contribution of the metallurgical industry to the national economy increased significantly.

The current state of industrial production can be described as unstable due to low product diversification. Three quarters of the industrial output are produced by the following industries – metallurgy (mainly gold production), electrical power, natural gas, food items, beverages and tobacco production. Advanced technology products of machinery, electrical equipment and electronics make less than 5% of the gross industrial production. There has not been any noticeable development trend in the industrial production of the Kyrgyz Republic within the recent five years.

The power generating industry in the industrial sector has experienced only minor alterations. The production basis of the power sector consists of 17 power stations. This number includes 15 hydro-power stations of 2.95 million kW of installed capacity, two heat and power plants of 0.73 million kW and more than 70 thousand km power lines of 0.4ч500 KV. Power consumption is at a level of 1,351 kWh per capita (UNDP, Bishkek, 2009).

### *1.8.3 Tourism*

Landlocked, sparsely populated and mountainous, there is a great potential for the development of nature based tourism in the Kyrgyz Republic. Furthermore, several sites of the Kyrgyz Republic have adequate facilities for visitors, as they served as resort and spa facilities in the Soviet times for visitors from other USSR Republics. With the UN designation of 2002 as the “Year of Mountains” and Kyrgyzstan’s participation in the Mountain Forum Council, the country is well situated to expand tourism, especially since nature based tourism is the fastest growing sector of international tourism. To this end, the Government has made tourism development an economic priority and is working towards creating favorable conditions for the expansion of tourism. There are some other programs on tourism development in the Kyrgyz Republic related to the regions, projects, and studies, such as the proposals on comprehensive tourism development in the Issyk-Kul Region designed by the Aga-Khan Development Foundation.

Due to the involvement of private entrepreneurs in tourism, some promotional activities have been carried out in Kyrgyzstan. Existing initiatives on voluntary participation of the tourism sector and NGOs are directed towards development of sustainable tourism and biodiversity conservation. However, main obstacle to successful introduction is a lack of a supporting policy and legal framework complementing the voluntary promotional efforts.

The Government of the Kyrgyz Republic adopted a marketing strategy towards 2010 on sustainable development of the tourism industry called “Hospitable Kyrgyzstan”. The master plan aims to develop a marketing strategy for tourism products at foreign markets and improve the image of Kyrgyzstan as a friendly tourist destination (UNPD, Bishkek, 2005).

According to the Centre of Economic Research of the National Academy of Sciences of the Kyrgyz Republic (2007), mountain tourism is one of the successful projects supported by international organizations. The development of international tourism in the country is fast progressing as there is growing interest in adventurous tourism shown by the market’s main clients, support by the WTO through the global tour called “Silk Way”, cooperation among tourism operators and the public sector, and unique traditions and attributes of the nomadic way of life of the Kyrgyz people. All this will allow to develop mountain tourism and to attract investments that favorably influence the economic efficiency of the tourism industry.

### *1.8.4 Protected Areas*

An important activity in the conservation of biological diversity is the creation of a network of specially protected nature territories. Specially protected nature territories are specific areas, waters (defined areas of water) including nature complexes or separate objects of nature for which the special regime of protection and use shall be established. In the Kyrgyz Republic, the Law on Protected Areas was adopted. It entered into force in May 1994. The Law on Specially Protected Nature Territories defines six types of protected areas: reserves, national nature parks, botanical, zoological, geological and natural areas of public health significance (Table 1). Many of these areas fall into one of three main types of protected areas identified in the international classification system of the World Conservation Union (IUCN), Strict Nature Reserves (Category Ia), National Parks (Category II), and Wildlife/Habitat Reserves (Category IV) (IUCN, 1994).

During the Soviet time, botanical and dendrological gardens had been established for very specific purposes. Some of these areas may be important for the conservation of flora and fauna, but most of them are small and may contain a number of exotic plants for aesthetic reason. Thus, more than half of the designated protected areas in the Kyrgyz Republic do not confirm to IUCN guidelines (1994), but are nonetheless important for the cultural and historical integrity of the country (Heinen *et al.,* 2001).

The system of protected areas of different categories is a basis for biodiversity conservation. In the first place, it should ensure the protection of natural complexes in general, and rare species in particular. In the Kyrgyz Republic, 84 diversity hotspots were included into the protected area network. The establishment of a network of specially protected nature territories was started in 1948 by the creation of the first protected area of Issyk-Kul (total area 19,086 ha) and in 1959 by the creation of the biosphere reserve Sary-Chelek (total area 23,868 ha).
Today, the specially protected nature territories include nine state reserves with a total area of 1,048,512 ha, representing 5.2% of the total territory of the country, as well as one

biosphere territory (4,314,400 ha) including all territories of Issyk-Kul Oblast (UNDP, Bishkek, 2008).

Today's policy is not to increase the number of protected areas but to establish a unified "Environmental Network", main components of which are not withdrawn from the nature management, but combine functions of nature protection and economic development.

Today, the WWF has developed an ecological network of the Central Asian states which helps reconcile nature conservation and economic development. This is achieved by supporting environmental corridors and by creating valuable areas with sustainable alternative land-use and nature management within productive landscapes beyond existing systems of protected areas. In the framework of the project implementation, an approach has been proposed, which included the setting up of environmental corridors between the protected areas along with development of specific environmentally sustainable forms of land-use. To define such areas, a comprehensive analysis of biological diversity and the social-economic situation was conducted (UNDP, Bishkek, 2005).

State reserves shall be created with the purpose of protection and research on the genetics of animals and plants, typical and unique ecological systems and landscapes, the creation of conditions for undisturbed natural processes, and developing the scientific basis for the protection of nature. The following tasks shall be carried out in State reserves:

- Conservation of complex natural ecosystems;
- Conservation and rehabilitation up to an ecologically stable level in terms of number of rare animals and plants, and species of animals and plants under the threat of disappearance, support to maintaining biological diversity;
- Conducting scientific investigations and monitoring of all aspects of the biosphere, preparation of scientifically sound recommendations on improvement of the protection and use of natural ecosystems;
- Assistance in the education of scientific researchers and specialists in the sphere of nature protection and reserve management; and
- Dissemination of ecological knowledge.

Biosphere territories are model regions of sustainable land-use in which - together with the inhabitants living and working there – the concepts of conservation, maintenance and development are being developed and put into action. They can be distinguished from other protected areas by the fact that the people living in the cultural landscapes and their use practices are explicitly part of the biosphere reserve concept. In order to meet nature conservation needs as well as to integrate the use function of the area, four different zones – corresponding to the impact of human activity - are designated in a biosphere territory: core zone; buffer zone; transition area and rehabilitation zone.

In 1998, the entire Issyk-Kul Region has been declared biosphere territory. The total area of the biosphere territory is 4,314,400 ha. In September 2001, the Biosphere Territory "Issyk-Kul" was officially recognized by the UNESCO and has been included into the list of the World Network of Biosphere Reserves.

National nature parks shall be created for the protection of nature complexes which have special ecological, historical-cultural and aesthetic importance, and shall be intended for the use in nature-preservative, recreational, educational, scientific purposes by nature conservation and recreational institutions. The following basic tasks shall be assigned to the national nature parks:

- Protection of standard and unique nature complexes and nature objects;
- Conservation of cultural and nature heritage (archeological, historical, ethnographic and other objects, and also unique landscapes); and
- Ecological education and public awareness.

Within the GEF-UNEP-WWF Project "Creation of the ECONET for the long-term biodiversity conservation within the eco-regions of Central Asia" an environmental network scheme has been developed, which includes the protected area of different categories guaranteeing conservation of the main natural ecosystems and extension of the protected area size to 10% of the total territory of the country. At the moment, the Pamir-Alay transboundary protected territory (Kyrgyz Republic – Tajikistan) is being created. In order to reserve territories of the Kyrgyz Republic having international significance, both the Issyk-Kul Reserve and Isyk-Kul Lake Reserve were included into the list of the International Wetland Ramsar Convention.

The walnut-fruit forest areas of Tien Shan Region were presented to UNESCO for nomination as World Nature and Cultural Heritage by initiative of the State Agency of Environmental Protection and Forestry of the Government of the Kyrgyz Republic (order from 12.04.2007, № 82-p).

Also, the State Reserve "Syrmatash" and National Natural Park "Sarkent" were additionally presented to the Government of the Kyrgyz Republic for inclusion into the list of protected areas in the country.

**Table 1:** ***Dynamics of area of special protected natural territories***

| **Special protected natural territories** | **Area change of special protected natural territories (ha)** | | | | | |
|---|---|---|---|---|---|---|
| **Years** | **1990** | **1995** | **2000** | **2005** | **2007** | **2008** |
| State reserves | 164,857 | 236,937 | 236,937 | 354,760 | 377,760 | 377,760 |
| National nature parks | 11,172 | 13,458 | 23,870 | 25,920 | 24,200 | 24,200 |
| Reserves (zakazniki) | 288,900 | 288,900 | 251,063 | 291,017 | 289,,448 | 289,448 |
| Buffer zones of reserves | | | | | | 139,246 |
| Nature monuments | 60 | 60 | 60 | 60 | 60 | 60 |
| **Total area** | **464,989** | **539,355** | **511,870** | **905,034** | **909,265** | **1,048,512** |
| **% cover area of country** | **2.3** | **2.6** | **2.5** | **4.5** | **4.6** | **5.2** |

## *1.9. Land-use Pattern*

The total area of natural pastures is 9.2 million ha and includes spring-autumn pastures (2.8 million ha) winter pastures (2.4 million ha), and natural hayfields (219,000 ha). By economic activity: pure pastures - 14% of total pasture area, stony pastures - 24%, shrubbery pastures - 12%, weeded - 32%, overgrazed - 18%. Most of the pastures are located in mountain areas forming watersheds of the Aral Sea Basin. Their state has impact on water flow regime and desertification processes in Kyrgyzstan as well as in Central Asia, in general.

Pastures of the Fergana Valley were used in a similar way. At present, the livestock which was considerably reduced during 1990-1995 to a more stable level, is pastured the whole year round on the spring-to-autumn pastures. Therefore, pressure on the spring and autumn pastures has increased by 5-6 times, resulting in pasture degradation. At the same time, outrun and winter pastures are not used efficiently. Small farms are not able to organize their livestock for moving to remote pastures due to economic problems.

Urban forestry is important for forest-based recreation in and around cities. At present, gardening of cities and inhabited localities is a major element of town planning. Annually, approximately 100 species of trees and bushes are planted on streets, boulevards, gardens and parks. Urban forestry is under the jurisdiction of the city administrations with centers of accomplishment and union of parks.

Roads are the main objects of infrastructure of any country (automobile, railways, etc). Road construction in mountain terrain is often very difficult. According to the Ministry of Transport and Communication, in the Kyrgyz Republic, 97% of all transportation is ensured by motor transport. The general extent of motorways in the country is 18,800 km, of which 5,500 are with asphalt or concrete surface. The transport networks of the Kyrgyz Republic have modern types of transport – railway, automobile and aviation.

Although Kyrgyzstan is a mountainous country, the transport sector has the potential to become an important part of the economy, because of the country's location between Europe and Asia. An increase in the transport volume will have positive effects on other economic sectors and overall GDP (National Academy of Sciences of Kyrgyz Republic, 2007).

## 2. State of Forests

### *2.1 Forest Cover*

In 2005, the forest cover of the Kyrgyz Republic was estimated at 869,300 ha representing 4.5% of the country's total land area (FAO, 2006). Other wooded lands cover another 312,800 ha (FAO, 2006). Planted forests cover approximately 66,000 ha representing 7.6% of the total forest area (FAO, 2006). The remoteness from human settlements and inaccessibility provide opportunities for forest plantations. Lack of adequate forest management of these plantations resulted in largely over-mature forest stands which are increasingly susceptible to pests and diseases.

Forests are the national wealth of the Kyrgyz Republic. They are all property of the State and in spite of their small size, forests play an important role in the development of the economy and improvement of the environment.

In ecological terms, the Kyrgyz Republic is a very rich country. Although the forest area is rather small, it supports rich floral and faunal diversity. The forests can be grouped into four main types (Musuraliev, 1988):

***Walnut-fruit-forests***

The walnut-fruit forests of Kyrgyzstan are located on the western and southwestern slopes of the Fergana and Chatkal mountain ridges. These forests represent the biggest remaining area of this particular forest type worldwide and are therefore considered to be of global significance for biodiversity conservation. Walnut-fruit forests play an important protective role, as they protect mountain slopes from erosion, regulate drainage systems, and raise the water level in the rivers.

All walnut-fruit forests of the Kyrgyz Republic are formed by one species of *Juglans regia*, although a significant variety of tree species co-exists in these forests, the most valuable of them being *Juglans regia*. Under the term walnut-fruit forests, a range of forest ecosystems dominated by fruit bearing woody species have been subsumed, including walnut (*Juglans regia* L.), apple (*Malus* spp.), hawthorn (*Crataegus* spp.), plumb (*Prunus* spp.), rose species (*Rosa* spp.) almond (*Prunus amygdalus* Stokes), and pistachio (*Pistacia vera* L.). Forest stands of walnut and accompanying species exist in valleys and on hills in altitudes between 800 and 2,400 m asl, whereas pistachio forests and almond stands grow in dryer, lower parts of the hills.

Long-term forest inventory data revealed that the area of walnut-fruit forests significantly decreased in the period from 1932 to 1966 from 44,000 ha to only 25,700 ha, because of excessive timber felling. Today, the total area is stable at about 40,000 ha.

***Spruce forests***

Spruce forests have important economic and nature protection values. Located on steep slopes of mountain ridges, they prevent and reduce the severity of erosive processes, such as mud and land slides, regulate mountain rivers and improve water infiltration into the soil.

Spruce forests (*Picea schrenkiana* Fisch. et May.) occur in the west, in the centre of the country and at higher locations of the ranges north of the Fergana Valley, mainly at altitudes between 1,700 and 3,000 m asl. Small areas of stands with the endemic Semenov fir (*Abies semenovii* B. Fedtsch.) can be found in the very west of the country. The main species of spruce forests occurring in the Kyrgyz Republic is *Picea schrenkiana*. In the period 1896 to 1929, the total area of spruce forests amounted to 218,500 ha, and in 1956, it had decreased to 113,200 ha or 46.2%. The reason of this reduction in spruce forests can be attributed to industrial felling whereby 5.95 million $m^3$ of wood was cut. From 1993 to 2003, the total area of spruce forests increased. This trend has continued until reaching the size of 124,100 ha today. This increase has taken place basically because of the establishment of artificial forest plantations and in part it has been due to natural regeneration.

***Juniper forests***

Archa (Juniper) is the local name of tree and bush forms of the junipers growing in the Central Asian region. Juniper forests, establishing on steep slopes of mountains, play important roles in water regulation and water storage in soils, protect the ground from erosion and counteract formations of mud flows. If unchecked, such events would cause disaster and destruction. In addition, these forests improve water infiltration and thus protect the numerous brooks and large rivers such as the two major waterways of Central Asia - the Syr-Darya and Amu-Darya rivers.

Junipers grow under arid conditions or in very high altitudes up to 3,500 m asl either in the very south of the country or dispersed in small stands in other parts of Kyrgyzstan. These forests are typically open stands, formed by tree and crawling forms of juniper. The dynamics of the juniper forest area over the last 10 years shows an increase, because of transfer of lands to the State Forest Fund and natural regeneration.

***Flood Plain Forests***

In the mountain regions, flood plain forests are located along the Naryn, Chy, Tup, Talas, Sysamur, Djergalan, Yassu rivers, and many other small rivers, where they play a role in the regulation of water supply and protection against soil erosion. The types of the flood plain forests depend on the environmental conditions and species interactions. They are composed of various species such as *Populus nigra*, P. *diversifolia*, *Salix alba*, *S. cinerea*, *Eleagnus angustifolia*, *Tamarix laxa*, *Hippophae rhamnoides* and *Ulmus* spp.

In 2003, the State Forest Fund estimated that the flood plain forests were composed of 2,100 ha of Salix wood, 24,500 ha of Salix shrubs, 7,900 ha of *Populus* spp., and 6,300 ha of *Hippophae* spp. Human pressures have significantly decreased the density of wood in the flood plain forests.

**Table 2:** ***Previous and current trends in forests and forestry in the country***

| No. | The State Forest | 1993 | 1998 | 2003 |
|---|---|---|---|---|
| **1** | **Total area (Under management of the Forest Fund)** | 2,861,300 | 3,163,200 | 3,321,500 |
| **2** | **Area covered with forests** | 843,000 | 849,500 | 864,900 |

**Note:**

- In 2005, the forest cover of the Kyrgyz Republic was estimated at 869,300 ha representing 4.5% of the country's total land area (FAO, 2006).
- Other wooded lands cover another 312,800 ha (FAO, 2006). Planted forests cover approximately 66,000 ha representing 7.6% of the total forest area (FAO, 2006).

| National Forest Categories | Area (1000 hectares) | | |
|---|---|---|---|
| | 1993 | 1998 | 2003 |
| **Natural forests** | **793.4** | **794.1** | **801.5** |
| • Non-exploitable forest zone | 238.0 | 238.2 | 240.5 |
| • Forest exploitation zone | 555.4 | 555.9 | 561.0 |
| | | | |
| **Planted forests** | **49.6** | **55.4** | **63.4** |
| • Protective planted forests | 29.4 | 35.7 | 40.1 |
| • Forest fruits producing stands | 20.2 | 19.7 | 23.3 |
| **Total forest area (natural and planted forests)** | 843.0 | 849.5 | 864.9 |

## *2.2 History*

Before World War II, the country had around twice the amount of forested area compared to today. The main reasons for the reduction have been unsustainable logging, overgrazing, fuel wood collection, and fires.

Forest resources are very important for the Kyrgyz economy and sustainability of mountain ecosystems. Therefore, since 1948 more than 200,000 ha of forests have been planted throughout the Republic in a concentrated effort to conserve, reforest and expand the nation's forested areas (Table in 2.2.1 on dynamics of forest area).

Government reforestation efforts from 1999 to 2003, the creation of new forests reserve areas, and the transformation of former agricultural lands into State forests have increased the total area of State forest reserves to 259,700 ha. This is augmented by 262,100 ha of national nature parks. In total, 16,400 ha have been reforested from 1998 until 2003.

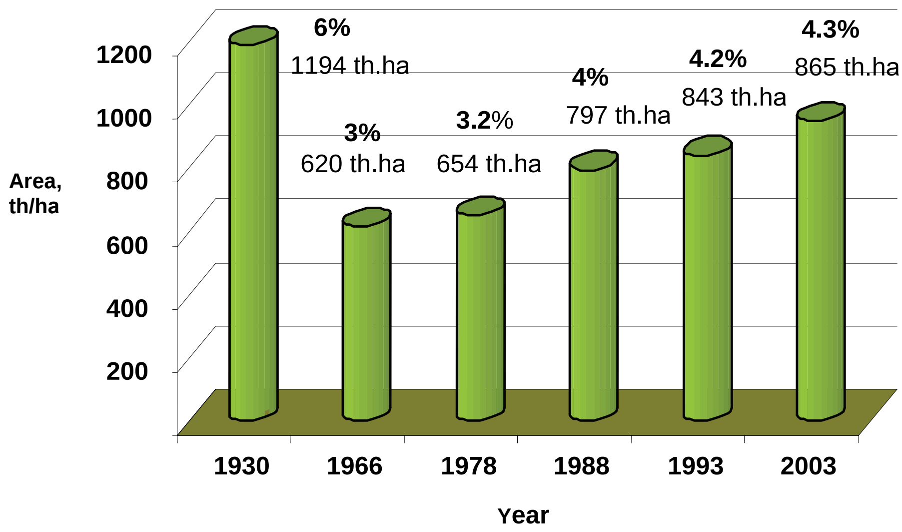



**Figure 2:** ***Dynamics of forest cover in Kyrgyzstan from 1930 to 2003***

## *2.3 Forest Biodiversity*

The area of the Kyrgyz Republic contains a wealth of biodiversity resources in terms of species, ecosystems and landscapes. Although by land mass a small nation, the country displays a wide variation in elevations and geological formations, leading to a broad range of habitats reflected in a high diversity of species. The ecosystems represented in the country range from high mountains to lowland fertile plains and large fresh water systems.

The ecosystems of the Kyrgyz Republic are of great economic, recreational, aesthetic and functional importance. These ecosystems have a strong spiritual importance for the nation, which has strong traditions regarding the relationship between man and nature.

Biodiversity reproduction capacity depends on the state of natural ecosystems. There are 20 ecosystem classes in Kyrgyzstan including one man-made ecosystem. In general, grass ecosystems are poorer compared to forest ecosystems and they have more endangered species than the forests. Consequences of overgrazing strongly impacted on their ability to maintain a high level of biodiversity on a sustainable basis, in spite of the fact that for 20 years considerable parts have been free of pasturing due to strong reduction in the number of livestock. The most complex coniferous forests among the forest ecosystems are mixed and have less endangered species compared to broad-leaved forests.

Not only do the Central Asian countries share a recent political legacy, watersheds and mountain ranges, but they also share many similar issues and problems regarding nature conservation, environmental protection, rural development and the sustainable use of natural resources.

In Central Asia, a vast and varied region with generally relatively low forest cover, tree species are of great value in defining forest ecosystems and providing resources such as fuelwood, timber, fruits and nuts. In fact, the genetic diversity of fruit and nut trees within the region is of outstanding global significance. The mountains of Central Asia are a recognized global biodiversity hotspot (Davis *et al*., 1995), supporting over 300 wild fruit and nut species. These include wild species of apple (four species), almond (8–10 species), cherry (8–10 species), plum (4–5 species), and walnut (one species) as well as many domesticated varieties. The rich diversity of fruit and nut species in the region led the Russian geneticist and plant breeder N.I. Vavilov to propose this area as one of the world's eight centres of crop origin and domestication (Hawkes, 1998).

There are a number of key ecosystems within the Kyrgyz Republic as defined by their rarity, such as walnut-fruit forests. The territory of Kyrgyzstan is characterized by a high level of biodiversity concentration on ecosystem level as well as on species level. Despite its small size, the Kyrgyz Republic is notable for its high concentration of plant and animal species and also good conservation of natural landscapes and ecosystems. Kyrgyzstan possesses 2% of the world's flora and fauna, despite accounting for only 0.03% of its land area. In 2007, the second edition of the Red Data Book of Kyrgyz Republic included 4 fungi species, 83 plant species, one spider species, 17 insect species, 7 fish species, 2 amphibian species, 8 reptile species, 57 bird species, and 23 mammals.

The many wild tree-crop relatives found in these forests are of exceptional commercial importance, yet 11 of these tree species are now critically endangered. Only 30,000 ha of this forest remain, which is less than 5% of its original area. The flora comprises 5,000 species, of which 180 are trees, including many local endemics.

The Kyrgyz Republic ratified the Convention on Biological Diversity in 1996, and in support of its implementation, developed a National Biodiversity Strategy and Action Plan, in which fruit and nut forests are identified as one of two key priorities. The National Biodiversity Strategy and Action Plan note that these forests have declined by 50% in recent decades, as a result of unsustainable land-use practices.

The high diversity of forest types, tree and shrub species points to the significance of Central Asian forests for the conservation of woody biodiversity and to the vital role of forest ecosystems as habitats for flora and fauna to be preserved. A particular feature of forests and woodlands in all parts of Central Asia, is the presence, in some forest types even dominance, of fruit bearing woody species, amongst which also species and relatives of species of eminent commercial interest worldwide, such as apple, pear, pistachio or walnut. The genetic diversity of their wild relatives growing in Central Asian forests is of global importance. The fruit and nut species are wild relatives of domesticated cultivars with exceptional commercial importance. Yet many are now under severe threat of extinction.

These forests are the source of many domesticated fruit and nut trees that are cultivated widely in temperate countries, including apple. The area is referred to as 'Eden' in a recent account (Deakin (2008), 'Wildwood'), reflecting the uniquely high diversity of edible fruit and nut species, together with their extraordinary role in human history and culture, involving dispersal along the Silk Road in antiquity. Many of these species are endangered or vulnerable, particularly wild apricot Armenica vulgaris (EN), which is threatened by unsustainable harvesting and over-collection by national and international plant-breeding companies.

Two wild apple species, *Malus niedzwetzkyana* (EN) and *Malus sieversii* (VU) are still found in the fragmented fruit and nut forests of Central Asia and are threatened by habitat degradation, mainly from agricultural development and over-grazing. For walnut, the experts have taken a precautionary approach until further evidence becomes available, because of the global significance of the walnut-fruit forests in Central Asia and their importance as an international genetic resource (Eastwood *et al*., 2009).

The successful biological conservation of the walnut-fruit forests will require both ecological and biological knowledge of the forest ecosystem and social acceptance and change (Hemery, *et al*., 1998; Kolov, 1998; McMgranahan, 1998; Musuraliev, 1998; Orozumbekov, 2008).

**Table 3:** ***Biodiversity of Kyrgyzstan***

| Group | World | | | Kyrgyzstan | | |
|---|---|---|---|---|---|---|
| | Number of species in the world | Number of species per 1 thousand km$^2$ | Number of species in country | % of world number of species | Number of species per 1 thousand km$^2$ | Number of species in Red Data List of KR |
| **Ultramicrobe (virus), bacteria, protozoan** | 5,760 | 0.011 | 261 | 0.05 | 1.32 | 4 |
| **Inferior plants** | 73,883 | 0.145 | 3,676 | 4.98 | 18.57 | 5 (0.1 %) |
| **Higher plants** | 248,428 | 1.666 | 3,786 | 1.52 | 19.12 | 84 (2.2 %) |
| **Worms** | 36,200 | 0.071 | 1,282 | 3.54 | 6.47 | 0 |
| **(*Spisula*) dipper** | 50,000 | 0.098 | 168 | 0.34 | 0.85 | 0 |
| **Arthropods** | 874,161 | 5.860 | 10,242 | 1.17 | 51.72 | 18 (0.2 %) |
| **Fish** | 19,056 | 0.041 | 75 | 0.39 | 0.38 | 7 (9.3 %) |
| **Amphibians** | 4,184 | 0.023 | 4 | 0.09 | 0.02 | 2 (50 %) |
| **Reptiles** | 6,300 | 0.047 | 33 | 0.52 | 0.15 | 8 (24.2 %) |
| **Birds** | 9,040 | 0.062 | 368 | 4.07 | 1.86 | 53 (14.4 %) |
| **Mammals** | 4,000 | 0.027 | 83 | 2.07 | 0.44 | 24 (28.9 %) |

**Case Study: Community Conservation of the Walnut-Fruit Forests in Kyrgyzstan**

Fauna and Flora International (FFI, UK) is working with local partners in Kyrgyzstan to improve the conservation of walnut-fruit forests by promoting the involvement of local communities in forest management.

Threats to forest integrity include: limited natural regeneration because of grazing pressure and hay-making within the forest; illegal cutting of trees and collection of firewood; over-harvesting of fruits and nuts; pests (such as gypsy moth) and disease.

In recent times, local people have had little opportunity to engage in forest management and planning, although they do have access to forest resources through the leasing of forest plots.

These fruit and nut forests are a vital resource for local people, providing fuelwood, food, fodder and grazing for livestock, as well as an important income from the walnut harvest.

The project is initially working in Kara Alma, bringing together community representatives, the local forest service and other stakeholders for open discussions on key issues, resulting in a collaborative conservation management plan for the sustainable use of the forest.

In addition, following a participatory needs assessment, training and essential equipment are being provided to the local forest service to increase their capacity to work with local communities to protect and manage the forest.

Through the provision of small grants and associated training, local people are being supported to adopt environmentally sustainable livelihood options to reduce socio-economic pressures on the forest. These small-scale income generation initiatives have included bee keeping, fruit preservation, and various small workshops.

***Liesje Birchenough**, Eurasia Programme Manager, Fauna & Flora International*

### *2.4 Ex- and In -Situ Conservation of Endemic Tree Species*

One of the main tasks of the countries that joined the Convention on Biological Diversity is the conservation of components of biodiversity in their natural habitat (*in-situ*). For this purpose, it is necessary to expand networks of especially protected natural territories with the new approaches of *in-situ* conservation of biodiversity. For example: creation of biosphere territories, both at national level and as transboundary parks.

Since 1998, in the territory of Kyrgyzstan new methods of *in situ* conservation of biodiversity have been introduced, i.e. creation of biosphere territories. Biosphere territories are model regions of sustainable land-use, in which - together with the inhabitants living and working there - concepts of conservation, maintenance and development are being developed and put into action.

They can be distinguished from other protected areas by the fact that the people living in the cultural landscapes and the use thereof are explicitly part of the biosphere reserve concept. In order to meet the nature conservational needs as well as to integrate the use function of the area, four different zones – corresponding to the impact of human activity are designated within the biosphere territory: core zone; buffer zone; transition area and rehabilitation zone. The Global Environmental Facility (GEF) Project "*In situ*/on farm agrarian biodiversity conservation (fruit cultures and wild fruit species) in Central Asia" was developed in order to improve partnership among stakeholders and define an optimal and sustainable use of agricultural biodiversity for improved welfare of the rural population.

A review of the status of the region's botanical gardens, gene bank facilities and ex situ tree collections needs to be undertaken. This should be coupled with a review of the ex situ collections held outside the region. Once the state of these institutions is known, a program of institutional capacity building, possibly with the formation of a regional network of ex situ conservation facilities, should be initiated. Botanical gardens are institutions holding documented collections of living plants for the purposes of scientific research, conservation, display and education (Wyse Jackson and Sutherland, 2000). The majority of State conservation agencies and research institutions are severely under-resourced and are unable to conduct baseline surveys, let alone regulate and manage forest resource use. In turn, botanical gardens and germplasm banks lack the staff and basic equipment to maintain globally important ex situ collections of threatened tree species.

Representatives of the 44 threatened tree species not yet conserved in ex situ collections should be established as soon as possible to act as an insurance policy against extinctions in the wild (Eastwood, Lazkov, and Newton 2009). The increasing agricultural lands of the Kyrgyz Republic represent their own contribution to biodiversity, including a variety of races of livestock and cultivated plants. Furthermore, the botanical diversity of the Kyrgyz Republic represents important genetic resources for plant breeding.

As explained earlier in this paper, the walnut-fruits in the southern part of Kyrgyzstan are of global conservation importance and particularly valuable. Their high diversity of fruit- and nut-bearing tree species, including walnut, apple, pistachio, almond, pear, cherries and plums is considered to be one of the main centres of origin for cultivated fruit plants. Thus, this ecosystem represents an extremely valuable "storehouse" of genetic resources.

### *2.5 Conservation of Wild Apple Populations in Kyrgyzstan*

Population of wild apple trees in nut and fruit forests is presented by two forms – *Malus sieversii* and *Malus niedzwetzkyana* with great diversity of forms, including economic value. Fruits of the best forms of the wild apple tree do not yield adequate quality in some regions. The gene pools of wild apple trees can be the basis for formation of winter and drought-resistant eco-types. Unfortunately, presently this unique genetic diversity is under threat of disappearance, caused by the lack of natural seed reproduction, willful economic activity of people, pasture of cattle, lack of protective and regeneration measures. Under such conditions, it is essential to preserve existing diversity in the forests through genetic material in order to derive benefits not only for the sake of natural evolution and provision of consumers, but also for breeders and researchers.

*Malus niedzwetzkyana* is registered in the Red Book of the Kyrgyz Republic. The amount of apple units and area is being reduced year after year and the plant has almost disappeared. Branches are with dark purple bark. Annual shoots are black. Leaves are close with reddish tint, inversely egg-shaped, elliptical, oblong, and have denticulated margnins. Later they become villous only below. Petioles are long, thick and villous. Flowers are purple on thin white felt pedicles. Apples are violet-dark red, with red pulp. Blossoming is in April-May. Trees are with dark purple bark with purple flowers and violet-dark red fruits, spread in Talas, along the Basin of Chatkal River. Many authors think that *Malus niedzwetzkyana* is a form of

*Malus sieversii.* However, the basis of this taxonomic decision is rather small and suffers from specimen expansion among populations of *Malus sieversii* and also insufficient genetic insurability from the latter. Thus, there is a large variety of intermediates. Further, genetic research is required to clarify whether or not *Malus niedzwetzkyana* is independent of *Malus sieversii.*

Wild stands of apple in Central Asia have received global interest because they represent a reservoir of genetic diversity from which domestic cultivars may be drawn (Miller 2006). The species *Malus sieversii Lebed* is native to Central Asia and has been recognized as a major progenitor of the domesticated apple, M. x domestica Borkh. It is likely that, in ancient times, apple seeds and trees were transported from Central Asia into both China to the East and to Europe to the West through the Silk Route (Forsline *et al*., 2003). Phylogenic studies show that wild apple (*Malus sieversii*) from Central Asia is quite similar to domesticated apples, and that several other Malus species are nearly indistinguishable (Juniper, 2007). Another important Central Asian apple species is *Malus niedzwetskayana* which is considered an endangered species. Because of the potential importance of *M. niedzwetskyana* as a genetic resource, it is paramount to preserve it and other wild apple species from Central Asia.

In Kyrgyzstan, Malus species is mainly spread in Chatkal mountain range (Sary-Chelek reserve, gorge rivers- Karasu and Aflatun), and the Fergana mountain range (tracts - Ak-Terek-Gava, Kara-Alma and so on). In Kazahstan, it can be found in the Syrdaria Karatau mountain range (Berkara gorge), western spurs of Talas mountain range (mountains – Daubaba and Mashat), and Zailiiskii Alatau mountain range. In Uzbekistan, it is present in the Kuraminskii, Ugamskii, and Pskemskii mountain ranges. Outside the former USSR, it has been identified in Western China (Sintszjan). The apple species is registered in different Red Books, such as the Red Book of the USSR (1978), the Red Book of Kazakh SSR (1981), the Red Book of the Kyrgyz SSR, in 1985 as well as in 2007. For long-term conservation purposes, it is necessary to establish a reproduction farm for cultivating and regenerating the existing varieties of apple.

**Case Study: Conserving Eden: Participatory Forest Management in the Tien Shan Region - a Project Funded by the Darwin Initiative (2009 – 2012)**

**This project will comprise the following activities:**

**Institutional capacity building.** Capacity to undertake research is currently limited in Kyrgyzstan, because of a lack of financial and institutional support. This will be addressed through a programme of institutional strengthening, and through a programme of collaborative research, detailed below, involving partners from the UK and Kyrgyzstan.

**Training.** Training will be provided on forest survey techniques, monitoring and participatory management approaches, both in the UK and in Kyrgyzstan.

**Research.** A collaborative research programme will be developed focusing on the sustainable management of fruit and nut forests. This will be achieved by a field survey supported by forest simulation modelling, to identify sustainable harvesting thresholds and management recommendations.

**Outreach.** Results of the research will be used to develop plans for sustainable management of fruit and nut forests; and (ii) to identify implications for policy-makers at both local and national scales, to support the sustainable management of fruit and nut forests.

The project will also provide: a community outreach programme to be developed in the study area, to raise awareness of the need for sustainable land-use practices; a workshop supported by policy briefs to present policy recommendations to relevant stakeholders, including national government agencies and CBD national focal point; an interpretation facility at the national Botanic Gardens, supported by a campaign in the national media, with the aim of raising public awareness of the national and international importance of fruit and nut forests; scientific publications.

The project will be aimed directly at implementing the ecosystem approach, by supporting the development of forest management strategies that promote conservation and sustainable use in an equitable way. The integral role of humans in these ecosystems will be addressed through the development of participatory management approaches.

***Adrian Newton,*** *Centre for Conservation Ecology and Environmental Change*
*Bournemouth University, UK*

## *2.6 Forest Tenure, Legislation and Policy*

The forests of the Kyrgyz Republic are the property of the State and form a unified State Forest Fund (hereinafter SFF). According to the Decree of the Government №315 dated July 3, 1960, the forests have been attributed to the first group, and the Forest Code of 1999 has assigned to them full nature protection status pursuing mainly ecological, sanitary and hygienic functions and other protective purposes with prohibition of industrial wood production.

In the case of pastures outside of forest farms (leshoze), rights of use are granted in the form of leases, for which fees are collected by the village government (Ail Okmot) and shared with the regional (Rayon or Oblast) authorities (Brylski *et al*., 2001). The leases for pastures are typically annual, but can also be of longer term (ibid). In the case of forests and pastures within leshozes, the leshoz is responsible for management and can allow access through sub-leases.

Leases within leshozes are also provided for farming plots. Again, the lease period is variable, and there are now a number of different types of leases, and a variety of arrangements apply. For example, in the leshozes with walnut-fruit forests, leases allow people to collect a certain amount of fuel wood, to obtain agricultural plots, to collect hay or to harvest walnuts or fruits for sale. In exchange for access to forest resources, they are usually expected to pay a share of the walnut harvest (40-70%), a set amount of walnuts depending on the size of the family (100-400 kg), payment in cash, or carry out certain tasks for the leshoze, such as collecting seeds or preparing and planting of seedlings. In some cases, in exchange for labour implemented for the leshoze, a person can use forest resources free of charge (Fisher *et al*., 2004).

Current legislature related to forest preservation and use in the Kyrgyz Republic contains the following components:

The Constitution of Kyrgyz Republic is the highest legal form where values, institutes and norms of constitutional formation and bases of State-legal regulations of qualitative social communications and attitudes of the State to power are officially established. The Code is a law containing all or a general mass of norms regulating a certain area of social relations in detail. In the Kyrgyz Republic, there are five codes including the Forest Code which establish the legal basis of rational use, preservation, defense and reproduction of forests and increase of their ecological and resource potential. In 1993, the first Forest Code was adopted, in 1999, alterations and additions were included and at present it is undergoing revision.

The Law is a legislative act adopted by Chambers of Jogorku Kenesh of the Kyrgyz Republic according to established procedures or by referendum and it regulates the most important issues of public and social activity. Aiming at the improvement of ecological conditions in the Kyrgyz Republic, the government established the National Program "LES" for the period 1995-2000. The focus of this program is on the preservation of forests, wild animals and plants, increase in the forest cover and specially protected territories, greening of cities, roads, channels and other economic objects. The program features the following four sections:

- Goal and tasks of the National Program "LES".
- The basic directions of radical improvement of reproduction and a qualitative condition of forests (forest recover, protective forest growing, forest planting, measures of assistance to natural reforestation, cultivation of planting material, forest-seed economy, forest management planning, etc.)
- Specially protected natural territories of the Kyrgyz Republic and the organization of a new natural reserve and national natural parks.
- Establishing parks in cities and settlements, creating of green space along roads and water ways and lakes, in schools, hospitals and other objects.

The implementation plan of the National Program "LES" for 1995 contains detailed and concrete actions. For example, 185 ha of poplar plantations are to be established, 61 ha of willow plantations, 200 ha of industrial plantations of walnut and 100 ha of industrial plantations of pistachio. Because during plan implementation the principles of central governance of the Soviet Union were still in place, the project received full funding from the State budget. An evaluation of the period 1995 – 2000 revealed satisfactory results.

The new national forest policy completed in 1998, takes into account the extremely important hydrological, soil-protective, water-security functions that also regulate the climate, improve sanitary and hygienic conditions and improve the role and value of forests for the people of Kyrgyzstan and its future generations. In this Decree, it is stipulated that new and more specific national forest policy guidelines be developed, providing the basis for preservation, dynamical augmentation, rational use of forests and steady development of the forestry sector. This concerns also the improvement of the ecological conditions of the environment and protection of the unique natural heritage of Kyrgyzstan for the period 2000-2005. The forest policy includes the following components:

- The Concept which determines the main strategic directions;
- The Forest Code and the environmental legislation which defines the legal frameworks of the forest policy (1999);
- The National Forest Program which defines a complex of activities and measures on implementation of the Concept (2005-2015); and
- The Five-Year Action Plan which provides concrete activities for implementation of the National Forest Program (2006-2010).

Overall, the forest policy is directed towards the sustainable management of forests, improvement of the organization of forestry, involvement of people and local communities in the development of forestry, development of cooperation among private businesses in forestry, and the definition of the role of the State in the forest sector.

Thus, the contemporary national forest policy is aimed at the systematic consideration of the forest problems and ensuring of transition from the use of forest resources to efficient management of forests with the purpose of conservation and augmentation of the national forest wealth.

## *2.7 Forest Administration and Management*

### *2.7.1 Forest administration*

The State Agency of Environmental Protection and Forestry under the Government of the Kyrgyz Republic is in-charge of the management of forests. The agency implements the country's forest policy through the following activities:

,

- Management and protection of all lands under the forest fund;
- Reproduction of trees and other flora for regenerating various natural ecosystems;
- Development of hunting farm facilities and their use;
- Development of the special protected natural territories and conservation of biodiversity; and
- Protection, reproduction, control of the use of wild animals and their habitat.

The State Agency of Environmental Protection and Forestry includes the Department of Hunting Control, Department of Forest Ecosystem Development which includes the territorial department of development of walnut fruit forest ecosystems in Jalal-Abad regions, 42 territorial leshozes (i.e. forest farms, forest hunting farms, forest ranges, forest nurseries, forest protection station), 9 State reserves, 8 national parks, the Biosphere Territory "Issyk-Kul", Department for Forest and Hunting Inventory, the Fund of Nature Protection and Forest Sector Development.

*The Department of Hunting Control* is a Division of the State Agency of Environmental Protection and Forestry exercising State control in the sphere of hunting management, conservation, hunting resources utilization and reproduction, wild animal habitat conservation, as well as favoring comprehensive development of sportive-amateur hunting and hunting tourism in the Kyrgyz Republic.

*The Department of Forest Ecosystem Development* is also a division of the State Agency of Environmental Protection and Forestry. The department controls and guides the work in the field of conservation and development of forest ecosystems and the sustainable management of forests in the Territory of the Kyrgyz Republic.

*The Department for Forest and Hunting Inventory* is a division of the State Agency of Environmental Protection and Forestry and is in-charge of monitoring of forest resources (e.g. forest cover, age class distribution, stocking, density of plantings, etc.), and hunting resources on the lands of the hunting fund. It also provides directives on forest management such as type of plantings for forest plantation establishment, felling operations and implementation of biotechnical control methods, etc.

*The Fund of Nature Protection and Forest Sector Development* operates under the State Agency of Environmental Protection and Forestry and receives its financial resources from State budgets, local funds for nature protection and the forest development fund. The agency provides funding for nature protection activities including improvement of the condition and facilities for environmental protection, securing of ecological safety, development of new systems for environmental protection and forestry, as well as environmental education and public awareness.

*The Territorial Department of Development of Walnut-Fruit Forest Ecosystems in the Jalal-Abad Region* is a division of the Department of Forest Ecosystem Development and carries out management functions and coordination of forest sector activities in the area of Jalal-Abad.

*The Territorial Forestry Enterprises (leshozes)* are the main component of the regional forest service and exercise territorial State control within the forest sector. Forestry enterprises are legal bodies with full economic and financial independence.

*State Reserves* have been created with the purpose of protection and study of genetic resources of animals and plants, typical and unique ecological systems and landscapes, creation of conditions for undisturbed flow of natural processes, working out of scientific grounds of protection of nature and represent the nature-preservative and scientific research institutions. State reserves are structural divisions of the State Agency of Environmental Protection and Forestry and have juridical power with full economic and financial independence.

*The State Nature National Parks* have been created for the protection of nature complexes which have special ecological, historical-cultural and aesthetic importance. They are nature conservation and recreational institutions also with educational and scientific purposes. The national nature parks operate under the State Agency of Environmental Protection and Forestry and have juridical power with full economic and financial independence,

*Biosphere Territories* are model regions of sustainable land-use in which - together with the inhabitants living and working there – the concepts of conservation, maintenance and development works are being tested and put into action. They can be distinguished from other protected areas by the fact that the people living in the cultural landscapes and their use practices are explicitly part of the biosphere reserve concept. The Issyk-Kul Region is recognized by UNESCO as main biosphere territory in the country as already mentioned in Chapter 1.8.4

### *2.7.2 Forest management*

Forest management in Kyrgyzstan is largely based on the Soviet approach, as many concepts and practices that had evolved prior to independence are still followed. The concept of the “State Forest Fund” (Goslesfund – the land managed by State forest authorities) developed under the Soviet Union has not changed (FAO, 2007).

Forests of the Kyrgyz Republic are basically located in the vicinity of rural settlements where more than 60% of the population lives. After disintegration of the USSR, the life of the population has considerably worsened in the countryside. The recession of the economy and its unstable development had largely negative effects at all levels of society, particularly for the poorest population. As a result, more than half of the rural population lives under the poverty line. In order to address this, the State Agency of Environmental Protection and Forestry has developed a number of legal tools directed towards reorganization of forestry and attracting rural people living on the State forest fund territory to forest management. An important component in these efforts is the delegation of forest management to local government, providing more employment in the countryside, better income and food security as well as strengthening weak social groups such as women and very poor people.

Since the 1930s, field-level management of forests has been undertaken by State forest farms (leshozes), with some forests allocated to collective farms (kolhozes) and State farms (sovhozes). In 1943, a forest classification system grouped forests of the former Soviet Union into three categories:

- Group I forests: State forest nurseries, protective forests, (e.g. shelterbelts, and green zones), steppe forests, national parks, State reserves, etc. Location: predominant in the central and southern regions of the Soviet Union. Logging restriction: clear cutting prohibited, restricted felling (e.g. regeneration felling, silvicultural thinning, selective cutting of over-mature trees).
- Group II forests: Forests of sparely forested areas (forest steppes), forests belonging to collective farms, forests in populated areas, etc. Location: central region of the Soviet Union. Logging restrictions: principally clear cutting, without exceeding the annual growth.
- Group III forests: All other exploitable forests. Location: northern regions of the European part, Taiga zone, Siberia, Far East.

Group I forests were primarily designated for environmental protection and most of forests in Central Asia were placed under this category, especially the forests of the Kyrgyz Republic. This classification resulted in improved protection and increased investments in afforestation. Kyrgyzstan is in the forefront of adopting participatory approaches and introduced Collaborative Forest Management (CFM) in 1998. CFM in the Kyrgyz Republic has its origin in an international seminar on walnut-fruit forests held in Arstanbap-Ata forest farm amidst the walnut-fruit forest in September 1995 (Blaser *et al*., 1998). However, the area with community involvement remains very limited (FAO, 2007). The need to establish new forest resources management approaches is justified by the real ecological situation and dynamics of socio-economic developments in the country. According to Carter (2003), the basic concept behind Collaborative Forest Management is “a working partnership between the key stakeholders in the management of a given forest, in particular the immediate, local users and the relevant forest authorities.” In CFM, local individuals take responsibility for the management of a forest plot, performing certain forest activities in return for permitted forest harvests (mainly of walnuts and other fruits) as well as dead wood for fuel (as felling trees for timber is not allowed).

The Forest Code of the Kyrgyz Republic does not completely take into consideration the aspects of the new national forest policy, and thus the existing legislation does not fully meet the requirements of changing national conditions. A State program, entitled "Forest" sets out necessary tasks and activities for the implementation of the concept of forest development but does not take into account possible changes to forest conditions because top-down planning procedures have not allowed for sufficiently flexible regulations. The peculiarities of the forest sector are not always considered by the main normative and legislative documents.

In Kyrgyzstan, the impact of local populations on forests has increased due to economic instability. Moreover, relations between the State Agency of Environmental Protection and forestry staff, local populations, and local authorities are not particularly strong, which sometimes leads to conflicts. Furthermore, coordination between the State Agency and other ministries and organizations needs improvement. Despite the fact that the area of cultivated forest is currently expanding, the safekeeping, tending and monitoring of forests must be also improved.

Today, the centralized forest governance system is not able to assure full sustainability of forest ecosystem development. That is why involvement of local communities in sustainable forest management is the only managerial alternative which will allow conserving forests. However, besides this approach, State forest farms (leshozes) use several other management approaches to involve local population into the forest sector through leasing forest plots for use (KIRFOR, 2009).

Poverty alleviation and environmental sustainability are important development goals for the countries (UNDP, 2003). These goals are found in one of the main strategies of the Kyrgyz Forestry Sector Development as well as in the Collaborative Forest Management Programme (Goslesfond, 2004; Intercooperation (IC), 2007). Even though, these strategies are clearly mentioned at a decision-making level, a contribution of them among different stakeholders and institutions is insufficiently recognized. Due to this reason, the progress of development towards sustainable forest management is limited and will only improve if the contribution of stakeholders to sustain forest resources is recognized.

The recently developed concept of Joint Forest Management (JFM) is defining frames for forest collaboration to introduce integrated management. Regional differences in forests and needs of the local population are considered by providing for flexibility in the participation of local communities in forest management.

## 3. Forest Degradation

The socio-economic transition processes are intimately connected with changing land-use systems and often forest degradation.

Forest degradation in the Kyrgyz Republic is defined as follows:" Gradual loss of viability and dying off of the forests as a result of deterioration of the ecological condition of the forest environment under influence of anthropogenic or natural factors" (Terminological Glossary, 2002). The creation of a centralized control system resulted in the disempowerment of rural populations - thereby loosing valuable knowledge about local forest ecological conditions and applied technologies with exclusion of stakeholders for ensuring sustainability - and in a fundamental change in their style of livelihoods and forest resource use (e.g. the sedentarisation of nomads and expropriation of farmers).

Today, forestry has to accommodate a changing administrative and economic environment. The recent changes have withdrawn the previous centralized institutional support and control without yet developing an alternative system and approach to replace it. Unlike agricultural land, State forest land has not been distributed to private individuals, and officially remains the property and responsibility of the State. Forests in the Kyrgyz Republic form a unified State Forest Fund, which comprises both forested areas and lands which are not covered with forests but intended for forestry purposes. Besides certain specified areas of production, Kyrgyzstan's function in the command economy of the Soviet Union was mainly characterized by the production of meat while utilizing abundantly available natural resources in the form of grazing grounds (Schmidt, 2001).

Obviously, the transition to an independent State was accompanied by several so far inexperienced side-effects:

- The State has to rely mainly on its own resources and expertise in running the State economy and managing the available natural resources.
- Despite a decrease of livestock numbers, the pressure on natural resources intensified. This on first sight paradox observation can only be explained by a growing pressure on natural resources due to an increase of subsistence-oriented survival strategies.
- Lack of experience of farmer-led resource management after 70 years of Soviet rule created a socio-political environment in which control mechanisms, power relations and access rights are not yet defined in a manner which seems to find a consensual balance and to become sustainable.

### *3.1 Causes of Forest Degradation*

The main negative factors affecting on ecological and resource potential of forests in the Kyrgyz Republic are fires, illegal felling, pests and diseases. It is necessary to elaborate the program of international cooperation on forest fires and the foundation of the regional network for Central Asian countries, since all these countries relate to sparsely wooded territories and international technical assistance in infrastructure development and improvement of the material base for fire protection is necessary. The elaboration of the system of control on illegal felling and creation of the system of forest disease monitoring is also needed.

Since 1994, the forest sector of the country has undergone four transformations. As for the Kyrgyz Republic with a low forested territory, such constant reformations negatively affect the sustainable development of the sector. Therefore, close cooperation with interested structures in the country, expansion of international cooperation and further international technical assistance is required for the preservation of an independent status of the forest sector. The First Regional Forest Congress (Bishkek, 2004) positively evaluated forest policy development in Kyrgyzstan and noted that international technical assistance in this further development might be a model for Central Asian countries (State Forest Service, Bishkek, 2004).

Overexploitations in the first half of the century coupled with overharvesting, overgrazing and insufficient silvicultural treatment have shaped the present-day appearance of forests (cf. Scheuber *et al*., 2000a; Müller & Sorg, 2001). Suffering great damage from human activities in the area, the maintenance of the manifold functions of the forests is seriously threatened and even their existence is at risk, despite decades of efforts into their conservation (Ministry of Environmental Protection, 1998). Problems presently exerting heavy pressure on these forests can be summarized as follows:

Grazing with cattle, sheep and goat is taking place almost everywhere in the walnut-fruit forests, obviously nearly completely destroying young growth of trees and most shrub vegetation, including walnut, apple, cherry, plum, and other valuable species. According to Musuraliev (1998), forest grazing has already caused extensive degradation in large areas. Although livestock numbers decreased significantly in recent years (Yunusova *et al*., 2000; Schmidt, 2001), grazing still seems to be the prime cause preventing natural regeneration. Seedlings and saplings are only to be found in places inaccessible to livestock.

Grazing pressure is extraordinarily high in areas close to human settlements and in spring and autumn, when alpine pastures are snow-covered, but the forests can be grazed. As a result, most of the forests have become secondary vegetation, consisting mainly of unpalatable shrub species, with a high percentage of inedible herbs (Sherbinina, 1998).

Hay-making is conducted nearly everywhere by enterprises, peasant farms, local people and even foresters themselves. Since animal husbandry is an important constituent of the newly revived subsistence economy, local people depend on a sufficient hay supply. Hay-making, mainly carried out in the forests, obviously results in the destruction of the natural regeneration of nearly all tree and shrub vegetation (Blaser *et al*., 1998).

Since collecting of nuts and fruit has an immense and growing economic importance for the households in the region and a harvest is to be expected only every third year, virtually 100% harvesting of nuts takes place, rendering natural regeneration impossible (Blaser *et al*., 1998; Musuraliev, 1998; Hemery, 1998).

The mountain forests have been exploited for timber, fuel wood, and, in particular, charcoal since ancient times. Whereas coniferous forests were predominantly utilized for construction timber, pistachio wood was the main raw material for charcoal production. Walnut stands were exploited for their valuable burrs, and also for firewood. In recent years, illegal cutting of firewood and illegal felling of trees has increased due to the energy crisis and high fuel prices. Also, uncoordinated commercial timber harvesting increased due to growing demand (Musuraliev, 1998).

After the collapse of the Soviet Union many changes occurred in the forests with impact on local populations and landscapes. Changes in employment resulted in more people becoming dependent on agriculture and harvesting natural resources for their daily needs as well as for providing income. The reduced ability to protect the forests from pests and diseases and overuse due to lack of financial resources has caused considerable negative impact on the local economy. As a particular result of the transition process, a currently unsustainable use of forest resources, widespread forest degradation and biodiversity erosion are to be lamented.

Forest fires occur as unguided (spontaneous) events (burning) in territories of the State Forest Fund, including forest and non forest lands. For the last 10 years, the number of fires changed from 1 up to 42 cases, and the general burnt area from 48 ha to 7,799 ha of forest areas. Illegal felling is defined as cutting of trees without the corresponding sanction or with infringement of its conditions (felling of a greater number of trees, other species, in other places, etc.).
In fact, forest protection is a major priority in the Forestry Development Program in the Kyrgyz Republic. During recent years, there have been many changes in walnut-fruit forests due to anthropogenic disturbances, resulting in significant impacts to this vital resource. Moreover, in recent years, the population has become more dependent on the natural

resources for dietary needs and income, causing an increase in the harvesting of walnut-fruit forests.

In addition, there has been a decrease in the ability to protect these walnut-fruit forests from pests and diseases due to a lack of financial resources. Due to the uniqueness and regional importance of the walnut-fruit forests, there is a need to develop a comprehensive pest management strategy and control of forest pests in the Kyrgyz Republic.

The implementation of policies relating to forest health and protection requires improvement of the forest sector activities in the Kyrgyz Republic. A new central unit should be established to deal with monitoring methodology. Given the information above, the fruit-nut forests of Kyrgyzstan are a unique biological community but are threatened in many ways. Adding to the problems facing these walnut and fruit forests, there has been a sustained outbreak of the gypsy moth (*Lymantria dispar* L.) (Orozumbekov *et al*., 2003, Orozumbekov *et al*., 2009) and other alien invasive species in the forests (*Sphaerolecanium prunastri, Diaspidiotus perniciosus, Pseudococcus Comstocki, Hyphantria cunea* and new quarantine species on pine plantations - *Monochamus galloprovincialis*). They are the main focus of forest protection in Kyrgyz Republic.

Defoliation of the walnut-fruit forests has significantly decreased the harvest of cash crops such as pistachio, walnut and apple resulting in major economic losses. Since these forests are also important for watershed protection, such damage also presents significant environmental problems. The species of moth can occur at low population levels in forests for many years without causing significant damage. However, at times, there are significant outbreaks that cause severe defoliation of trees, which can cause massive tree mortality. Frequently, outbreaks coincide with periods when the trees are under stress.

### *3.2 Gypsy Moth in the Walnut-Fruit Forests (Lymantria dispar L.)*

The gypsy moth is widely distributed throughout Asia. Across the region, populations utilize a slightly broader range of tree species, and outbreaks are common in many areas. In contrast, relatively little information exists about populations in Central Asia. Therefore, only an introductory description is given here about the occurrence of the moth in a variety of landscapes of Central Asian countries, mostly focusing on damages inflicted on the unique walnut-fruit forests in the Kyrgyz Republic (Orozumbekov *et al.,* 2003). While the biology of the gypsy moth resembles that in many other areas, there are certain aspects that differ in fundamental ways from other regions.

The gypsy moth population is isolated from other Euroasian gypsy moth populations by deserts to the north, spruce forests in Tien-Shan to the northeast and east, and the Caspian Sea to the west. There may be significant reproductive isolation among populations that are geographically separated by high mountains. Little is known about the distribution of the gypsy moth to the south of Central Asia in Pakistan, but it is likely that the population continues its distribution in high mountain valleys ultimately integrating with Lymantria obfuscata in India, Pakistan and Afghanistan (Pogue *et al*., 2007). Through most of the gypsy moth range in Europe, Asia and North America, its primary hosts are Quercus, Populus and Larix. In Central Asia, none of these hosts grow naturally but it is common in other hosts like Pistacia, Malus and Juglans.

In naturally regenerating forests of the Kyrgyz Republic, the gypsy moth attacks pistachio, walnut, apple and hawthorn trees and in planted forests it is known to infest walnut, apple and hawthorn trees. The larvae of this moth are defoliating large areas of the walnut-fruit forest stands, annually. Since the early 1980s the annual area affected by moth outbreaks has ranged from 10,000 to 52,000 ha (Ashimov, 1989; Orozumbekov, 2003).

In the forests of Kazakhstan gypsy moth outbreaks occur in intervals of 8-10 years, but this does not seem to be the case with gypsy moth outbreaks in walnut-fruit forests of Kyrgyzstan where there has been an epidemic outbreak for over 30-35 years (Gninenko, 1986; Orozumbekov *et al*., 2003). Thus, this complicated situation requires more study of the ecology of the gypsy moth and characteristics of outbreaks in the walnut-fruit forests of Central Asia.

### *3.3 Impacts of Forest Degradation and Loss*

Forests are exposed to internal and external factors which lead to degradation and loss. The exact loss of forests is unknown as statistics are not available. The remaining forests are typically used for collecting firewood and grazing of livestock in spring and autumn, before going to and after returning from the summer pastures (Fisher *et al*., 2004).

Scientific studies on changes in the forest sector have shown that the main negative factors affecting forests and the forest sector are forest fires, illegal felling, pests and diseases. The main external factors which can lead to significant changes in forest conditions are as follows:

- Demographic changes;
- Social changes;
- Economic changes;
- Environmental factors; and
- Political and institutional changes.

In some areas of the flood-plain forests where human settlements are located close to the forest (such as in the Talas Region), the forests are under high pressure because of illegal cutting of firewood. Where the forests contain dense bushes, firewood is the main product. Other products collected in the riverside forests, both for self-consumption and for sale, include berries, mushrooms and medicinal plants (Roth and Murzakmatova, 2003). In more open areas the land is intensively used for both legal and illegal grazing.

The juniper forests are located on the higher mountain slopes, and far away from permanent settlements. These forests play a role in the household economy of rural people only a few months per year, when people temporarily reside in the jailoos (high summer pastures). The use of trees and timber is strictly prohibited, but people collect dry branches for firewood and graze cattle in the open juniper stands. Medicinal herbs, various berries and mushrooms are collected mainly for local use (Roth and Murzakmatova, 2003), although marketing prospects are developing in some areas. In the longer term, the local population who will participate in the elaboration of the new Integrated Management Plans (IMP), together with other local stakeholders, are intended to benefit from improved management of these forests and their increased involvement in forest management will be promoted by this project (Chorfi, 2004, EU Project on Integrated Management Plan in the Juniper Forests 2004-2006).

Spruce forests are in an intermediate position between the walnut-fruit forests and the juniper forests in terms of playing a role in people's livelihoods. The forests are at intermediate distance from villages, and people can relatively easily collect firewood. The most important source of income from the spruce forests is the timber. However, so far, this has never been accessible to the local people. Harvesting and selling of round timber has been exclusively in the hands of the forest farms (leshozes) (Fisher *et al*., 2003).

Cattle grazing and hay making in walnut forests are major obstacles to the regeneration of walnut stands. Seedlings and young shoots of saplings are preferentially browsed. Moreover, grazing leads to the compaction of loess soils and is harmful to the uppermost root layers, particularly in spring, when soil water content is high. Soil compaction results in increased surface runoff. Under drier conditions during summer, forest soils are less susceptible to compaction by grazing animals. Forested areas that are used for hay making have increased in recent years. An extension of hay meadows is equivalent to a reduction of stand densities and forest areas.

### *3.4 Forest Utilization*

A long term continuation of the presently high utilization intensity would seriously threaten the maintenance of the manifold functions of the unique and global important walnut-fruit forests and would even put their existence at risk. On the other hand, the local rural population depends on the use of the forests for their livelihood. A pressing problem in recent years in the walnut-fruit forests has been the increasing use of firewood by local people. It presently concentrates on deadwood as well as on the shrub layer and on small trees. From year to year, longer distances to collect firewood have to be covered. Wood of Prunus, Crataegus, Acer, and Malus is primarily used as firewood.

At present, timber harvesting in walnut stands is not carried out on a large scale. However, there is a growing international demand for valuable burls (in Russian “kap”) and for root wood. After having removed the root wood and burls, the production of coppice shoots is no longer possible. Cutting of walnut trees often contradicts the interests of local people who depend on nut harvesting (Kyrgyz-German VW Project 2003-2005; Schmidt, 2005).

## 4. Forest Rehabilitation

### *4.1 Targets of Forest Rehabilitation*

The Ministry of Forestry (later transformed into the State Agency of Environmental Protection and Forestry) was created in 1947. One of its central tasks has been to enact measures that would restore forest areas that were depleted in the 1930s and 1940s, during which time almost 7 million $m^3$ of timber and firewood were harvested.

Unsustainable and destructive logging during this period gave rise to severe soil erosion, destruction of natural reforestation processes, impairing the protective function of forests and the watershed balance. During this time, natural reforestation processes were also disrupted by constant grazing of livestock in fresh clear-cuts. However, since 1948, more than 200,000 ha of forests have been planted throughout the Kyrgyz Republic in a concentrated effort to conserve, reforest, and expand the nation’s forested areas. From 1930 to 1966, the forest area decreased to 2.9% or 574,200 ha mainly because continuous logging led to forest degradation. In contrast, from 1966 to 2000, the forest area increased by 1.2% or 245,100 ha as a result of stopping regular logging, natural regeneration of forests and tree planting.

The Forestry Code of the Kyrgyz Republic of 1999 provides the forests with an exceptional protection status assigning them mainly soil-protecting, water-protecting, ecological, health, sanitary, and other similar functions. Industrial logging is prohibited. The forests of the Kyrgyz Republic are State property and form a unified State Forestry Fund (SFF) which includes forests and lands that are not covered with forest but earmarked for future forestry activities.

In 2003, the total area of the State Forest Fund lands was reported to be 3.3 million ha. Forests cover 4.3% or 865,000 ha of the territory of the Kyrgyz Republic. Nevertheless, the Government's efforts to develop forests in Kyrgyzstan are insufficient. Availability of sufficient financial resources is a major impediment to reforestation and restoration. Preliminary estimations which take into account the situation of mountainous forests in Kyrgyzstan and interests of various economic sectors of the country (i.e. agricultural sector) show that the area should be raised up to 6.0% (1194.0 thousand ha) in 2025 from a level of 4.3% (864.9 thousand ha)(National Forest Program for 2005 - 2015., Bishkek, 2004).

### *4.2 National Policy Program on Forest Rehabilitation*

One of the most important priorities of the State Policy Program is the profound reorganization and improvement of forest management for the purpose of pursuing an efficient policy of sustainable economic development of the State.

The process of a new national forest policy working partnership based on the participation of all stakeholders (forest governance, bodies, research, local communities, private sector and civil society) was the main approach in sector policy development. The National Action Plan provides for the annual potential possibilities of forest farms (leshozes) with regards to rehabilitation of field protection through shelterbelts, forest stands protecting against soil erosion, and afforestation activities outside the State Forest Fund. Forest farms (lezhozes) will carry out the rehabilitation work based on projects and agreements submitted by land owners.

The Action Plan also calls for the development of a new National Forest Policy ensuring the establishment of the necessary conditions for conservation, reproduction, rehabilitation, sustainable use and development of the forest sector in the period 2000-2005. The contemporary forest policy is aimed at the transition from the use of forest resources to efficient management of forests. For that, it is necessary to reconsider the system of forest management as a whole, in terms of its various ecological, social and economic functions.

With regard to forest rehabilitation, the Forest Code (1999) contains a separate section which is dedicated to forest rehabilitation and afforestation called "Reproduction of Forests".

Article 91 on forest rehabilitation includes the following main aspects:

As stipulated in Article 91 of the Forest Code, forest rehabilitation is to be carried out on land of the forest fund observance with the following requirements:

1. Compulsory reforestation of land after felling; reforestation should concentrate on valuable tree species
2. Lands not covered by trees and bushes need to be rehabilitated
3. Improvement of the composition of tree species and increase of forest productivity, protection and environmental functions
4. Conservation of genetic resources and forest biodiversity

Article 92. Afforestation:

Afforestation should be carried out on non-forest lands of the forest fund and other lands for the purpose of increasing the forest cover of the Kyrgyz Republic and as a means to prevent soil erosion and improve the overall ecological conditions of the land. Afforestation works will be carried out by special programs and projects established by the authorized forest department.

### *4.3 Methods of Forest Rehabilitation*

Forest rehabilitation methods mainly involve silvicultural practices. Silviculture is a complex discipline and requires sound ecological and technical knowledge. The main objective of silviculture is to timely and properly harvest and restore economically valuable forest stands after felling, or on areas damaged by fire or where no trees have grown for many decades.

Forest rehabilitation is guided by the following main criteria:

1. Forestry aspects: management objectives of forests, range of available forest species and their site requirements and the forest fund category;
2. Economy aspects: available manpower and expertise, financial possibilities of forest farms (leshozes) and cost of work; and
3. Social aspects: local population needs and reduction of impact on the forest, etc.

Forest rehabilitation techniques are dealing with appropriate methods of forest re-establishment, either by natural or artificial means, depending on forest type and site-specific ecological conditions. Such work is guided by the following aspects:

- Soil properties must be maintained;
- Negative impacts on the soil must be eliminated;
- Under-storey vegetation should be retained;
- Forest areas of more than one hectare with valuable advance growth must be selected;
- Forest plots requiring supplementary regeneration materials must be identified; and
- Young trees must be retained in the mountain forests in connection with all kinds of cutting regardless of their volume and location:

Artificial regeneration is a work intensive process involving the following basic stages:

- Seed production including maintaining seed orchards, collection, storage, tree nurseries with seedlings (1 to 2-year-old plants) and saplings (3-5 years old), growing in greenhouses or outdoor, in containers or seedling beds. It also involves soil preparation and treatment, mechanization, watering and fertilization.
- Transplanting of saplings to the site in desired spacings, spatial mixture and species composition, and
- Future stand treatment including fire prevention, thinning, pest and disease control.

### *4.4 Walnut-Fruit Forest Rehabilitation*

Walnut-fruit forest rehabilitation and expansion of its area is a priority in the Kyrgyz forestry sector. The reason for this priority is the walnut-fruit forests' significance for local people in terms of their timber and non-timber products.

Having experienced long periods of human exploitation, the historical natural cover of these forests in Southern Kyrgyzstan is hard to reconstruct (Lavrenko and Sokolov, 1949; Gan, 1970). The original cover may be in the order of up to 630,000 ha, while at present, the area of dense walnut-fruit forest stands is estimated to be as low as 40,000 ha (Musuraliev, 2004) (Table 4). When the Russian administration first introduced forest protection measures, the forests seemed to have been already massively degraded. This was mainly due to fire set by Kyrgyz nomads to extend their grazing areas and cutting of trees for charcoal production (Lisnewsky, 1884).

From 1938 to 1944, the USSR industrial enterprises of “Narkomles” and the “Narkompischeprom” conducted tree felling operations under special assignments in order to produce high quality walnut timber. Before the walnut-fruit forests were declared as protected areas in 1945, many trees had been felled for timber production. According to the numbers recorded by the Academy of Sciences of the USSR, 140,000 $m^3$ of timber, mainly walnut, were felled between 1938 and 1944 (Musuraliev, 1998). The timber harvesting was very wasteful: sometimes, clear cutting had even been practiced with the intention of later rehabilitating the land as forest plantation.

Systematic and large scale reforestation works started in 1948, after the forests had been transferred to the forest farms (leshozes) for management. Within 20 years, from 1948 to 1967, 60,200 ha had been treated. In 1955, revised instructions on walnut-fruit forests were issued by the Ministry of Forest Farming and the Forest Research Institute of the Academy of Sciences of USSR entitled: “Measures for the rehabilitation, conservation, development and improvement of soil protective properties of the walnut-fruit forests of Kyrgyz SSR”. These guidelines also specified the boundaries of walnut-fruit forest reserves and prescribed a system for their sustainable use.

Based on the above, the main method of regeneration should be plantations of different types, both of forest and fruit bearing species. It should be noted that, in the past, no special attention has been paid to the creation of walnut plantations in Kyrgyzstan.

For forest rehabilitation two different approaches were employed: (a) reafforestation of open space and (b) enrichment planting of seedlings under mature parent trees after the felling of overmature trees of the upper canopy layer. However, in addition to sanitary and maintenance felling, complex and extensive felling was also conducted on a commercial scale, with the aim of transforming overmature walnut stands into more productive forests to increase nut yield.

*Juglans regia* is a light and heat demanding, but hygrophilous tree species. At the same time, walnut is sensitive to cold and frost. Flowers and buds are heavily damaged by late frost. Although new buds might be produced, late frost causes lowering of the vitality of trees, and sprouting of new buds does not result in fruiting.

As walnut is a light demanding species and suitable felling methods have not been developed, no felling in the parent cover was made. The greater part of young growth established from the parent cover, therefore perished due to lack of light. In addition, plantations were established from ordinary seeds, which of course influenced their productivity.

The analysis of existing research materials on the ecology and biology of walnut-fruit forests as well as practical experience of silviculture, methods of rehabilitation and regeneration, increasing of forest productivity and also forest area covered by most valuable cash crops and varieties (primarily walnut, pistachio, almond and apple) suggest the need for changes of forest management and policy in the walnut-fruit forest areas (Venglovsky, 1998; Kolov, 1998).

Unfortunately, the consequences of the presently unsustainable forest use include the reduction in forested areas and the decrease of stand densities, decline of the regeneration capacity, loss of genetic diversity, and the loss of protective functions such as soil conservation and regulation of water supplies. Thus, the conservation and sustainable management of these unique walnut-fruit forests are currently uncertain. Therefore, new visions and approaches to forest management with the participation of the local population assuring the conservation of the walnut-fruit forest, its biodiversity and rehabilitation are urgently needed.

**Table 4:** ***Dynamics of walnut area changes from 1930 to 2003***

| No. | Years | Area, thousand / ha |
|---|---|---|
| **1** | 1932 – 1935 | 44 |
| **2** | 1966 | 25,7 |
| **3** | 1990 | 28,2 |
| **4** | 1993 | 31,3 |
| **5** | 1998 | 33,3 |
| **6** | 2003 | 40,5 |

## *4.5 Rehabilitation of Juniper Forests*

Among the forests of the Kyrgyz Republic, treelike juniper and elfin wood forests are of special importance occupying 277,000 ha or 33.1% of the total forest area (Musuraliev, 2004). There are five species of juniper on the territory of the Kyrgyz Republic, with the most common treelike forms represented by *J. seravschanica*, *J. semiglobosa*, and *J. turkestanica*. Juniper species grow in evergreen, light coniferous woods and under a wide range of soil and climatic conditions. Juniper species such as juniper (Archa) are very long-lived and some specimens reach the age of more than 1,000 years. The natural appearance of these trees creates a high aesthetic value in mountain landscapes which is particularly important for recreation.

According to inventory data of the forest fund, juniper forests occupied 479,200 ha in 1930, 319,300 ha in 1955, 253,300 ha in 1970, and 277,000 ha in 2003. Thus, degradation of juniper forests is being slowly stopped, and their area increased as a result of silvicultural operations and afforestation.

Main juniper forests are located in the southern regions of the Kyrgyz Republic (Osh and Batken occupy 145,000 ha or 54% of juniper forests). Forest cover in the Batken Region is 27.8%, and in the Osh Region 22,7%. The total stock of juniper wood in these areas is 3,913,000 $m^3$ or 91% of all stocks of juniper woodlands (Musuraliev, 2000).
Changes in high-altitude borders of the various forest zones on the northern slopes of the Turkestan and Alai mountain ranges are related to the latitudinal distribution of forests. Archa forests, by the proposal of K.D. Muhamedshin (1977), are divided into four sub-zones:

- Low mountain zone, covering the territory from 1,800 to 2,000 m asl represented by *J. seravschanica*;

- Middle mountain zone – 2,000 up to 2,500-2,700 m, occupied by *J. semiglobosa*;
- High mountain zone - from 2,500 to 3,000 m occupied by *J. turkestanica*;  and
- Subalpine zone - over 3,000 m where elfin wood species of *J. turkestanica* grow.

The juniper wood was widely used in pencil manufacturing, construction, and during the Second World War. It was one of the main sources of fuel supply for the country. Such excessive use of juniper wood led to significant depletion of the juniper forests, both in terms of area and timber stocks.

Irrational economic activities and reduction of the forest area gave rise to the so-called "juniper problem" in terms of conservation and restoration of these forests.  Realizing high the aesthetic value of juniper forests, the State National Nature Park "Kyrgyz-Ata" covering an area of 11,172 ha was established in the southern part of the Kyrgyz Republic.

The rehabilitation of juniper forests is a difficult undertaking. Growing seedlings in nurseries lasts 3-4 years, and subsequent care in the area of silviculture requires at least another 10-15 years. The allocation of forest reserves is also uneven. The lowest area is occupied by *J. seravschanica* (84,000 ha) with an average growing stock of 30.4 $m^3$/ha. *J. semiglobosa* takes the second place (72,000 ha) with an average stocking of 28.9 $m^3$/ha.  A smaller area is occupied by *J. turkestanica* (55,000 ha), with an average stocking of 27 $m^3$/ha, and elfin woodland has the smallest area (9,500 ha) and the lowest stocking of 7 $m^3$/ha.

As early as in the last century, first researchers of juniper forests paid attention to their protective properties and noticed that occurrence of landslides, mudslides and floods depends on the state of the forests. At the same time, first attempts of reforestation were made by planting juniper seedlings. However, these attempts failed because of the absence of sufficient knowledge of the biology of juniper species and their characteristics.

In the Kyrgyz Republic, various scientists intensively dealt with  juniper forests, their ecology and restoration. Among them were V.M. Dzhanaeva, Y. Nikitinskiy, K.D. Muhamedshin, A.V. Chub, K.A. Azhibekov, R.D. Golovina, V.G. Shevchenko, S. Sartbaev, L.A. Krylyshkina, Toktoraliev, Kosmynin, Kenjebaev, Shamshiev, Amatov and others. They developed not only theoretical, but primarily practical approaches and techniques for afforestation and reforestation.

During the reforestation works, gradually more knowledge was generated about the juniper forests and their establishment. A new technology of growing seedlings in nurseries with the subsequent establishment of forest crops on the slopes was developed. Juniper is practically the only forest forming species on the slopes of the Alai and Turkestan ranges. Based on the results of site mapping by Mukhamedshin (1967), sites that are favourable for juniper growth could be identified.

Although the technology of growing seedlings of juniper under the conditions found in the Kyrgyz Republic was developed by Chub as early as 1962 and immediately applied on forest farms (leshozes), the major difficulty of growing seedlings of juniper significantly constrained the cultivation of this tree species. On the basis of work experience, own studies and research works of A.V. Chub (1986-2003), guidelines for cultivation of juniper in nurseries were drafted.  As a result, more than 5,000 ha of forest plantations in the juniper zone, including about 4,500 ha of juniper, have been created since the late 1960s.

### *4.6 Rehabilitation of Spruce Forests*

The main areas of spruce forests in Kyrgyzstan (44%) are concentrated in the eastern part of the Issyk-Kul basin. In the south-west of the Issyk-Kul Lake spruce forests are found again in the basin of the Naryn River, where they also occupy a large area (up to 35%). In the north-west direction spruce forests are found in the Talas and Chatkal mountain ranges. In the south - in Osh and Jalal-Abad oblasts - spruce forests occupy only 13,200 ha (Kolov, Musuraliev, Zamoschnikov 2001). In 1925-1931, the area covered by spruce forests in Kyrgyzstan was about 160,000 ha.

As a result of selective logging in the 70s, the area of spruce plantations declined by almost 50% (down to 77,700 ha). At the same time, the stocking density of the remaining stands decreased significantly. This situation ultimately led to a complete lack of natural regeneration, and this raised the need to restore the spruce forests exclusively by artificial means.

As a result of excessive exploitation of the forest fund area in Northern Kyrgyzstan, in 1947, an area of about 35 ha was clear-felled and required rehabilitation. Rehabilitation measures in spruce forest commenced in 1947, when the Government decided to rehabilitate forest ecosystems for commercial purposes based on best silvicultural practices.

The first crops were not successful, because almost all planted seedlings died. However, by 1959, considerable experience had been gained in the production of forest plantations of spruce.

It should be noted that since 1931 attempts had been repeatedly made to establish forest plantations in the spruce forest zone. Thus, for the period from 1931 to 1943, 3,387 ha of forest plantations were established (Chebotarev 1960), of which only 33% survived by 1943 (mainly pine plantings). It should also be emphasized that the establishment of Tien Shan spruce trees failed completely. For this period, no spruce planting was carried out, and the attempts of growing Tien Shan spruce in nurseries also failed. Thus, the whole previous experience of creating crops in the zone of spruce forests shows the complexity and difficulty of solving this problem.

In 1948, the Kyrgyz Forestry Experimental Station began to develop and test methods of artificial afforestation in the zone of spruce forests of the Tien Shan. This research work included:

- To develop methods for the artificial afforestation of the Tien Shan spruce on the area previously occupied by this species.
- To find a range of fast-growing and technically valuable species for afforestation in the zone of spruce forests of Tien-Shan to enhance protective properties and productivity of crops, and increase forest cover through the involvement of forest land previously not occupied by spruce.

Solving these problems required long-term studies using field observations on permanent plots. The problem of choosing a site for the establishment of spruce forests arose because of their sparse and scattered distribution. It was decided to conduct basic research in the area around the Issyk- Kul Region because the most valuable spruce forests representing half of the stock of all fir forests of Kyrgyzstan are located in this region. Also, for a long time, these forests were subjected to heavy exploitation.

In order to increase the forest cover in any region, it is necessary to introduce new species to fill niches where local breeds can not grow. To this end, the work in the Tien Shan spruce forests focused on fast-growing and technically valuable species of trees and shrubs from other regions, so as to significantly improve the overall productivity of the forest area.

The purpose of the introduction of forest woody plants is to improve the quality of forests: the improvement of their environmental functions, productivity, sustainability, and aesthetic values. Such species introduction can only be successful if there are clear and very specific action programs based on sound research and closest to the theory of creating optimal forest phytocoenosis under specific site conditions.

Significant fluctuations in climate from the lower to the upper border zone of spruce forests allowed to split these zones into the following three climatic sub-zones Ghan (1990):

Subzone I - the lower one, extends from the lower border of the forest (1900-2000 m above sea level) until 2,100-2,200 m asl. Here, spruce forests do not exceed 5.2% of the total area.
Subzone II - middle, is located at altitudes ranging from 2,100-2,200 to 2,400-2,500 m asl. The area of spruce forests is 37.2%.
Subzone III - the top one which is located at altitudes ranging from 2,400-2,500 m to 3,100 m asl. Here, there was the maximum development of spruce forests, and they occupy 57.5% of the total area of spruce forests.

Overall efforts to rehabilitate spruce forests led to an increase in its area, which was down to 77,700 ha in the 1970s and reached a level of around 125,000 ha in 2003 (Musuraliev, 2004) (Table 5). This recovery was also facilitated by the fact that many spruce areas following reforestation had officially been transferred to forested area. Thus, their protection and sustainable use has improved.

**Table 5:** ***Dynamics of spruce area changes from 1896 to 2003***

| No. | Years | Area, thousand / ha |
|---|---|---|
| **1** | 1896-1929 | 218,5 |
| **2** | 1925-1931 | 160,0 |
| **3** | 1940 | 140,2 |
| **4** | 1956 | 105,3 |
| **6** | 1993 | 116,5 |
| **7** | 1998 | 115,1 |
| **8** | 2003 | 124,1 |

## *4.7 Forest Rehabilitation Outputs and Future Directions*

The national forest policy has been established by the Government in order to ensure the conservation and use of the forest resources according to common principles of sustainable development adapted to the socio-economic situation in the country. As most of the forests of Kyrgyz Republic are mountain forests, special attention needs to be given to their protective functions and to the conservation of forest biodiversity. In order to achieve this, complex forest inventories and management planning processes are applied on the whole territory of the forest fund. The forest inventory results allow for more effective planning and developing realistic forest management plans containing prescriptions of the necessary forestry activities. An example of systematic planning and implementation is the National

Program “Les” (Forest) for the period 1995-2000. Under this plan, a total area of 18,000 ha of degraded and treeless areas had successfully been rehabilitated.

Due to the fact that the majority of the forests of Kyrgyz Republic are over mature, new strategies in silviculture need to be introduced, promoting forest rehabilitation and restoration, improving the forests’ protective functions through appropriate timber harvesting and grazing regulations.

At the moment, the State Agency of Environmental Protection and Forestry is implementing the national forest action plan for the period 2006-2010. The plan prescribes reforestation activities within the territory of the forest fund up to a total of 10,000 ha, outside the forest fund up to 5,000 ha, regenerating areas by natural means on an area of 40,000 ha, and the production of planting stock of 25 million seedlings per year. The plan also pursues a step-wise introduction of the concept of multiple use forest management with emphasis on multi-stakeholder participation, thus linking forestry activities with societal needs.

One of the priorities of the Government policy on forests is to raise awareness among society about the importance of forest conservation and restoration. Therefore, it is necessary to carry on with forest rehabilitation in the future, particularly afforestation on non-forest areas. In this way, the intention is to increase the forest area from today’s 4.3% to 6.0% in 2025.

Despite the problems associated with the economic transition of the country, forest rehabilitation remains a priority of the State with main focus on the improvement of environmental conditions, securing long-term water supply and overall improvement of livelihoods in Central Asia.

## 5. Capacities in Forest Rehabilitation

### *5.1 Institutional Capacities*

The present main task within the forest sector of Kyrgyzstan is the re-definition of the role and responsibility of the State in implementing forest policy, and controlling and monitoring of forests and forestry operations at the national level. In addition, the forest sector of the Kyrgyz Republic is in the process of institutional transformation towards a market-based economy, affecting forest management on the ground and the ways economic returns are derived from forest products and services. The ongoing reforms focus on an institutional separation of the State control and management functions as well as re-directing forest uses to be in line with national forest policy. The current national forest program process for the period 2005-2015 is an important activity in order to ensure consistent implementation of forest policy in the country.

Evaluations on the progress made in forest development implementation conducted in 1999 and 2004 pursued the following objectives:

- Provision of sustainable forestry development;
- Bringing civil society and local communities into joint forest management; and
- Re-definition of the role of the State in forestry

According to the concept of forestry sector development in the Kyrgyz Republic, approved by the Decision of Government, one of the basic strategic directions of the concept is to enhance the knowledge and awareness of the population about forests and the forestry sector. In this context, comprehensive public relation campaigns are being implemented in order to inform the public about the useful role of the forest sector in promoting nature conservation and local development. In addition, integrated forest management requires contemporary forest managers not only to be knowledgeable in technical aspects such as silviculture, but they also need to be familiar with socio-economic aspects and social development. In this way, forest management decisions can be optimized.

### *5.2 Civil Society Involvement*

Civil society has great interest in the use of forest resources. Responsibility of conservation of forest resources, their rehabilitation and management should be vested with society in general and various forest stakeholders, in particular.

The current national forest policy provides for the necessary conditions for conservation, dynamic revision of aspects of sustainable use of forests and steady development of the forestry sector as well as improvement of the overall ecological conditions and functioning of the environment and protection of the unique natural heritage of the Kyrgyz Republic. To this end, specific goals and strategic directions have been formulated in a new edition of the Concept for Development of the Forestry Sector for the period until 2025.

It is important to note that the Forestry Concept takes into consideration the necessity of fostering "wide attraction of civil society to forest management to support socio-economic development of the regions and forest conservation through sustainable multipurpose (multifunctional) utilization." Civil society participation in natural resource management with different stakeholders such as village governments, and non-governmental organizations (e.g. Oikos, Regional Ecological Centre (REC), Development of Juniper Forests, Centre of Beekeeping, Biom, Taza, Bioresources) is a very significant component of the whole system of sustainable use of forest. As mentioned above, without civil society involvement forest reforms on rehabilitation and restoration will not be successful. Therefore, local people are involved in the creation of forest plantations, restoration activities, protection and conservation of forests as partners with the territorial forest service. This contributes to spreading information about the importance of forests. Local authorities will also be in-charge of disseminating information about the forests and forestry activities.

### *5.3 Research and Education in Forest Rehabilitation*

Research and education related to forestry in Kyrgyzstan is carried out by various research institutions including the Institute of Forest, Institute of Nut Farming and Fruit Cultures, and the Institute of Biology and Soil of the National Academy of Sciences as well as universities with the Department of Silviculture, the Department of Biology and the Centre of Innovation Technology in Agriculture of Kyrgyz National Agrarian University, the Department of Ecology and Forestry of the Jalal-Abad State University, the Department of Ecology, the JUMP Centre of Forests of the Osh Technological University and the Department of Ecology of the Issyk-Kul State University under the Ministry of Education and Sciences of the Kyrgyz Republic.

The Kyrgyz-Swiss Support Program on Forestry (KIRFOR Program, 1995-2009) operating within the bilateral agreement between the Governments of Switzerland and the Kyrgyz Republic is currently making its input in the development of the national forest sector, in particular, in the transfer of advanced technologies.

The forest research has been defined as one of the main KIRFOR project components from the very beginning, since everywhere forestry is based on scientifically defined technical norms and recommendations. KIRFOR is paying a lot of attention to the links between science and application with identification of applied research as one priority for support. The major activities of the programme include:

- support to research studies;
- strengthening of the links between research and field application;
- support of publications;
- provision of infrastructure and equipment; and
- support to scientific staff in developing future education and training programmes.

Within the framework of the Project “Orech Les” the Kyrgyz-Swiss Program on Forestry Support, in cooperation with the Swiss Technical Institute, carried out research on the improvement of existing forest typology (Sorg *et al*., 2003). A new methodology of forest typology (2009) was developed and, for separate types of forest stands, includes a rather complex set of questions ranging from soils and vegetation to social aspects and the use of non wood products. The research made use of some early studies conducted on the southern slopes of the Chatkal and Fergana ridges representing the starting point for further comparative research on the history of landscape development(e.g. Kashkarov, 1927; Saprjagejeva, 1938). In 1934, the Ak-Terek Research Field Station was established for permanent research into walnut-fruit forests. After World War II, the station was integrated into the Arstanbap-Ata Fruit Forest Experimental Station under the Forest Institute of the Academy of Sciences of the USSR.

It is worthwhile to note that a first comprehensive scientific expedition of the walnut-fruit forests of the southern part of the Kyrgyz Republic was conducted by one of the highly qualified specialists under the supervision of the well-known academician Sukachev V.N. from the USSR Academy of Sciences. As a result of the research conducted, several monographs on walnut-fruit forests were published as “The fruit forests of Southern Kyrgyzstan and their utilization” (Sukachev *et al*., 1949).

From the 1955s until now, Kyrgyz forest scientists made good progress reflected in a set of published monographs, textbooks, manuals, regulative and technical documents. During this period, various publishing houses printed a number of fundamental works on forests as shown in Table 6.

In order to increase the effectiveness and efficiency of reforestation activities, the Forest Institute has elaborated and published guidelines entitled “Recommendations on Spruce Forest Plantation Establishment and Tending”. Another technical instruction (“Guidelines on Growing Planting Material with Close Root System”) dealing with probation and testing of new effective and less expensive methods of the production of planting material under the conditions reigning in the Kyrgyz Republic, has been prepared and published by the Forest Institute. Several recommendations on forest plantations, nurseries, and best practices to maintain the hydrological and protective functions of forests, regeneration, economic assessments and forest biodiversity have been prepared.

One of the leading institutions in forestry education is the Department of Silviculture of the Kyrgyz National Agrarian University established in 1999 with the support of the Kyrgyz-Swiss Program. A special education standard for forest engineering as well as a curriculum were developed by specialists and approved by the Ministry of Education and Sciences in 2000 involving a studies program of five years.

**Table 6:** ***Publication material related to the forest from 1955-2009***

| Date | Author | Title |
|---|---|---|
| 1955 | Gan P.A. | Practice of mountain afforestation, introduction and acclimatization of trees and bushes in spruce forest belts |
| 1962 | Kamchibekov N.K | Natural regeneration features of Tien Shan spruce |
| 1968 | Prutenskaya M.D | Diseases of the walnut-fruit forests |
| 1967/ 1977 | Muhamedshin K.D | Juniper forests of the South Kyrgyz Republic |
| 1967 | Karavaeva R.P. | Biological control with *Yponomeuta malinella* L., Yponomeuta padellus L. in Kyrgyzstan |
| 1969 | Ozolin V.E | The pistachio forests of the South Kyrgyz Republic |
| 1970 | Gan P.A | Forests of the USSR in five volumes. Vol. 5: Forests of Kyrgyzstan, the Central Asian Republics and the Southeast of the European part of the USSR |
| 1971 | Cheshev L.S | Types of spruce forests of the North Kyrgyz Republic |
| 1972 | Bulychev A.S. *et al.* | Recommendations on Growing Walnuts in Kyrgyzstan. |
| 1976 | Shevchenko V.S | The form diversity and walnut selection in the South of the Kyrgyz Republic |
| 1981 | Venglovsky B.I | Creation of protective plantations types from walnut |
| 1984/ 2008 | Bikirov Sh.B | The Abies plantations of the Kyrgyz Republic |
| 1984 | Uzolin A.I | Taxation for the walnut-fruit forests |
| 1984 | Romanenko K.E | Pest of pistachio in Kyrgyzstan and methods of their control |
| 1984 | Kolov O.V. | Ecological and physiological explanation of increasing of walnut productivity |
| 1992/ 1997 | Gan P.A et al. | The walnut-fruit forests of South Kyrgyzstan |
| 1992 | Matveev P.N. | Hydrological and protective functions of walnut-fruit forests |
| 1993 | Toktoraliev B.A | Xylophages insects of forests of the South Kyrgyz Republic |
| 1998 | Sherbinina E.N. | The problem of conserving the biological diversity of walnut-fruit forests in Kyrgyzstan |
| 1998 | Chotbaeva E.A. | Water regime of walnut phytocoenosis dominants in the context of natural and anthropogenic dynamics |
| 1998 | Venglovsky B.I. and *et al.* | Biodiversity and sustainable use of Kyrgyzstan's walnut-fruit forests |
| 2000 | Chotonov A. | Particularities of quality estimation of forests in the Issuk-Kul Region |
| 2004 | Musuraliev T.S. | New forest policy of the Kyrgyz Republic |
| 2004 | Shamshiev B.N | Rehabilitation of Juniper forests in protected natural territories of the Kyrgyz Republic |
| 2005 | Ashimov K.S. | Dendrophyl insects of West Tian Shan |
| 2007 | Orozumbekov A.A. | Overview of forest pests of the Kyrgyz Republic |
| 2008 | Kosmunin A.V. | Juniper forests of the Kyrgyz Republic |
| 2008 | Gabrid N.V. | Pest insects in North Kyrgyzstan |
| 2008 | Bolotov S, Kenjebaev S. | Pistachio forests of the Kyrgyz Republic |
| 2008 | Orozumbekov A. *et. al* | Gypsy moth in South Kyrgyzstan |
| 2009 | Venglovsky B.I. | Forest typology |
| 2009 | Orozumbekov A.A, Musuraliev, T.S. *et al.* | Forest Rehabilitation in the Kyrgyz Republic |

The curriculum of the 5-year forestry study program at the Kyrgyz National Agrarian University consists of several subjects as follows:

- In the first and second year, students are trained in basic disciplines: mathematics, physics, chemistry, basics of forestry, geodesy, machinery, logging and transportation, ecology, forest botany, wildlife biology, hunting, forest soil, tree physiology, computer science, biometry, informatics, history, philosophy, and culture.
- In the third and fourth year, students are trained in special forestry disciplines: forest ecology, silviculture, forest inventory, forest management and planning, forest protection, forest legislation, remote sensing in forestry, forest genetics, forest tree breeding, forest economics, forest guarding, forest conservation, and training in pre diploma practices on forest farms (leshozes).
- In the fifth year, students need to prepare several projects in the main disciplines: silviculture, forest management and planning, forest protection, forest regeneration and afforestation, forest economics and others. Students prepare and publicly defend their graduation diploma project before the State Examination Commission for obtaining the degree of a forest engineer at the Kyrgyz National Agrarian University.

After graduation, students find employment in forest farms (lezhoses) and forest territorial services based on their specialisations. Later, some students will continue their education and enroll into M.S. and Ph.D. programmes at the Kyrgyz Agrarian University or other universities. Post graduated courses for training of academic staff in ecology and natural resources management are organized at the Kyrgyz Agrarian University, Jalal-Abad State University and Osh Technological University.

### *5.4 International and Regional Cooperation in the Forestry Sector*

International cooperation projects in research and development of the forest sector in Kyrgyzstan mainly focus on the conservation of flora and fauna and sustainable natural resources management. Technical assistance on a grant basis has been/is provided by:

- Kyrgyz-Swiss Forestry Sector Support Program (KIRFOR)
- The GEF and World Bank Central Asian transboundary project “Biodiversity Conservation of the Western Tien Shan”
- The Europe-aid Project for Biodiversity Conservation of the Western Tien-Shan Region
- The GTZ project (Issyk-Kul Biosphere Territory)
- The FAO project (Legal Frameworks for Forestry and Hunting)
- The FAO project (Harmonization of Legislation of the Protected Areas)
- The EU project (JUMP) on the sustainable multi-purpose management of the juniper forests in the south of the Kyrgyz Republic
- The EU Central Asian transboundary project in the Pamir - Alai Region
- The Kyrgyz-Norwegian Forest and Environment Program
- The Volkswagen Research Foundation (Volkswagen-Stiftung) project “The Impact of the Transformation Process on Human-Environmental Interactions in Southern Kyrgyzstan” (includes a component on walnut-fruit forests)
- The Turkish International Co-operation Agency (TICA) project on “Chemical Pest Control in Walnut-Fruit Forests”
- The Fauna and Flora International (FFI) Project “Forest Management Planning and Biodiversity Conservation in the Walnut-Fruit Forests of the Kyrgyz Republic”
- The FAO project “Capacity Building for National Forest and Tree Resource Assessment and Monitoring” in the Kyrgyz Republic

- The GEF and World Bank Central Asian Transboundary Project “Tien Shan Ecosystem Development” on Reforestation and Carbon Trading in the Kyrgyz Republic
- The Japan International Co-operation Agency (JICA) Project “Support for Joint Forest Management in the Kyrgyz Republic ”
- The Fauna and Flora International (FFI) Project “Community Conservation of Globally Important Fruit and Nut Forests in Kyrgyzstan”
- The Darwin Initiative Project “Conserving Eden: Participatory Forest Management in the Tien Shan Region”

## 6. Future Steps

The national forest policy of the Kyrgyz Republic is based on socio-economic and environmental objectives of the country within the framework of the Program for Sustainable Human Development and Poverty Alleviation, and Social Mobilization. The concept provides the foundation for the development of a new type of planning in forestry, decentralization and public action in the country to be fully operational after the year 2025. A National Forestry Program elaborating a concrete strategic framework derived from the concept of sustainable forestry is being elaborated as a basis for 5-Year Action Plans. Towards this end, the following comprehensive measures for forestry development need to be undertaken:

- Development of land rehabilitation plans for activities aimed at promoting natural regeneration, and restoration of protective and soil conservation plantations;
- Organization of efficient seed production and production of planting stocks in forest nurseries;
- Establishment of industrial plantations of fast growing tree species;
- Reforestation on degraded lands, which are appropriate for afforestation purposes, irrespective of the ownership forms;
- Organization of regular courses for forest users with the purpose of raising the level of knowledge and practical skills for proper implementation of silvicultural and forest management activities;
- Preparation of plans for the co-ordination of activities in the field of development and forest biodiversity conservation including the establishment of a network of specially protected natural territories and territories with unique natural resources; and
- Development of integrated management for all types of forests in the country.

## 7. References

____________ 2004. Forest Policy: problems and solutions. Regional Forest Congress. Bishkek. 217p.

____________ 2007. Problems of mountainous countries (by the example of Kyrgyzstan). Threats and challenges of modern times. Kyrgyz National Academy of Sciences of Kyrgyz Republic. Bishkek. 219 p.

____________ Kyrgyz-German research project: the impact of the transformation process on human-environmental interactions in southern Kyrgyzstan supported by VWStiftung (2003-2005). Germany.

____________ Kyrgyz-Swiss Forestry Support Program. KIRFOR 1995-2009. Bishkek. Kyrgyzstan.

____________ National Forest Program for 2005 - 2015. Action Plan on Implementation of the National Forest Program. Adopted by the Act of the Government of the Kyrgyz Republic as of November 25, 2004, # 858 (in Russian).

____________ Second National Communication of the Kyrgyz Republic to the UN Framework Convention on Climate Change (2009) – UNDP, Bishkek. p.206.

Abdymomunov, R. A., Ed. 2001a. Conclusions of the First National Census conducted in 1999. Oblast Jalal-Abad, Book III, Series R. Bishkek, National Statistical Committee of the Kyrgyz Republic (in Russian).

Ashimov, K.S. 1989. Biology, ecology and dynamics quantified of gypsy moth in the walnut-fruit forests of southern Kyrgyzstan. Ph.D. Thesis. Voronezh State Agricultural University. Voronezh, USSR (in Russian).

Blaser, J., J. Carter, and D. A. Gilmour. Gland, Cambridge and Bern, IUCN and Intercooperation: 55-58.

Blaser, J., J. Carter, and D.A. Gilmour. Eds. 1998. Biodiversity and sustainable use of Kyrgyzstan's walnut-fruit forests. Gland, Cambridge and Bern, IUCN and Intercooperation.

Brylski, P., T. S. Veen, and P. Eliste. 2001. Kyrgyz Republic Mountain Rangeland and Forest Sector Note. ECSSD Environmentally and Socially Sustainable Development Working Paper No 33. September 10, 2001. Washington, D.C., World Bank, Environmentally and Socially Sustainable Development sector of Europe and Central Asia (ECSSD).

Carter, J., B. Steenhof, E. Haldimann, and N. Akenshaev. 2003. Collaborative forest management in Kyrgyzstan: Moving from top-down to bottom-up decision-making. London, IIED Gatekeeper Series No. 108.

Chebotarev, I.N. 1960. Modern condition and perspective collaborative management in spruce forests of Kyrgyzstan. National Academy of Sciences Publisher. Frunze, Kyrgyzstan (in Russian).

ChorfI, K. 2004. The social and economic context for sustainable management in juniper forests of South Kyrgyzstan: Strategy making issues at leshoze level. Ecole Nationale du Génie Rural, des Eaux et des Forêts. Commission of the European Communities Artcha JUMP project. Nancy.

Davis, S.D., V.H. Heywood, and A.C. Hamilton. 1995. Centres of Plant Diversity: A Guide and Strategy for their Conservation. Vol. 2: Asia, Australia and the Pacific. WWF and IUCN, Gland, Switzerland.

Deakin, R. 2008. Wildwood: A journey through trees. Penguin Group publisher. New York, USA.

Eastwood, A., G. Lazkov, and A. Newton. 2009. The Red List of Trees of Central Asia. Fauna and Flora International, Cambridge, UK.

FAO. 2005. Global Forest Resources Assessment 2005 – Country Report – Kyrgyzstan. Country Report 181, Rome.

FAO. 2006. Global Forest Resources Assessment 2005 – progress towards sustainable forest management. Forestry Paper No. 147. Rome, Italy.

FAO. 2007. People, forests and trees in West and Central Asia outlook for 2020. Forestry Paper No. 152. Rome, Italy.

Fedorov, A. and B. Fedorov.1949. The apples of southern Kyrgyz SSR. *In*: Sukachev, V. N. (ed.): Fruit Forests of Southern Kyrgyz SSR and their Utilization, pp. 218 – 253. Moscow-Leningrad (in Russian).

Fisher, R.J. 2003. CFM Report 9/03 Collaborative Forest Management in Kyrgyzstan: Consolidating a new approach. Report on a mission to Kyrgyzstan 11-26 March 2003, submitted to the Natural Resources and Environment Sector of the SDC. INTERCOOPERATION and State Forest Service, Government of Kyrgyzstan.

Fisher, R.J., K. Schmidt, and B. u. N. AKenshaev Steenhof. 2004. Poverty and forestry: a case study of Kyrgyzstan with reference to other countries in West and Central Asia. LSP Working Paper, FAO.

Forsline, P. L., H. S. Aldwinckle, E. E. Dickson, J. J. Luby, and S. Hokanson. 2003. Collection, Maintenance, Characterization and utilization of wild apples of Central Asia. Hort. Rev. 29: 1–61.

Gan, P.A. 1970. Forests of the USSR in five volumes. Vol. 5: Forests of Kazakhstan, the Central Asian republics and the Southeast of the European part of the USSR. pp. 78-146. Moscow (in Russian).

Gan, P.A. and B.I. Vienglovsky. 1997. The principal forest-forming species. *In*: Kolov, O.V. (ed.): Walnut-fruit Forests of Southern Kyrgyzstan, Vol. 2, pp. 62-95. Bishkek (in Russian).

Gan, P.A. and M.K. Sartbaeva. 1990. Microclimat in forest plantations and temperature regime of trees in northern part of Tian-Shan. Frunze (in Russian).

Gninenko, Y.I. 1986. Elements of monitoring of the gypsy moth populations in Kazakhstan. Journal of Forestry 4:45-49 (in Russian).

Hawkes, J.G. 1998. Back to Vavilov: Why were plants domesticated in some areas and not in others? *In*: The origins of agriculture and crop domestication (eds. Damania, A.B., Valkoun, J., Willcox, G., Qualset, C.O.) ICARDA, Aleppo, Syria.

Heinen, J.T., E. Shukurov, and Ch. Sadykova. 2001. Legislative and policy initiatives in Biodiversity Conservation in Kyrgyzstan. Post-Soviet Geography and Economics 42(7): 519-543.

Heleniak, T. 1997. The Changing Nationality Composition of the Central Asian and Transcaucasian States. Post-Soviet Geography and Economics 38(6): 357-378.

Hemery, G.E. and S.I. Popov. 1998. The walnut (*Juglans regia* L.) forests of Kyrgyzstan and their importance as a genetic resource. Commonwealth Forestry Review, 77: 272-276.

IUCN. 1994. Guidelines for Protected Area Management Categories. Gland, Switzerland: World Conservation Union.

Juniper, B. E. 2007. The mysterious origin of the sweet apple. Amer. Sci. 29: 44–51.

Kashkarov, D. N. 1927. Results of the expedition of the Main Museum of Middle Asia to the area of lake Sary-Chelek, Tashkent.

Kolov, O. V. 1998. Ecological characteristics of the walnut-fruit forests of southern Kyrgyzstan. *In*: Blaser, J.,Carter,J. & D. Gilmour (eds.): Biodiversity and Sustainable Use of Kyrgyzstan's Walnut-Fruit Forests, pp. 59-61. Gland-Cambridge-Berne.

Kolov, O.V., T.S. Musuraliev, Sh.B. Bikirov, V.D. Zamoshnikov, and T.M. Koblizkaya. 2001. Forest and forest use in mountains. Kyrgyz Mountains. Technology publisher. Bishkek. pp.103-120. (in Russian).

Kyrgyz Republic Government. 1999. National Forest Policy of Kyrgyzstan. Kyrgyz State Forest Service, Bishkek, Kyrgyzstan (in Russian).

Kyrgyz Republic Government. 2004. Concept of forestry sector development in Kyrgyz Republic. Intercooperation-Kyrgyz State Forest Service, Bishkek, Kyrgyzstan (in Russian).

Lavrenko, E.M. and S.Y. Sokolov.1949. The vegetation of the fruit forests and adjacent regions of southern Kyrgyzstan. *In*: Sukachev, V.N. (ed.): pp. 102-145. Moscow-Leningrad (in Russian).

LES-IC. 2004. Vision of the forestry sector development in Kyrgyzstan: Concept. Kyrgyz-Swiss Forestry Support Program, LES-IC, Bishkek.

LES-IC. 2006. Implementation of the development concept: National Action Plan. Kyrgyz-Swiss Forestry Support Program, LES-IC, Bishkek.

LES-IC.1999. The Kyrgyz Forestry Concept. Kyrgyz-Swiss Forestry Support Program, LES-IC, Bishkek.

Lisnewsky, W.J. 1884. Mountain forests of Fergana Oblast). Nowyj Margelan (in Russian).

McGranahan, G. (1998) The importance of genetic diversity to the world's walnut nut crop industry. *In*: Blaser, J., Carter, J. and D. Gilmour (eds.) (1998): Biodiversity and Sustainable Use of Kyrgyzstan's Walnut-Fruit Forests, pp. 105-106. Gland-Cambridge-Berne.

Miller, D. 2006. Wild and domesticated apples in the Kyrgyz Republic. Newsletter, Midwest Apple Improvement Association 8: 2–6.

Ministry of Environmental Protection of Kyrgyz Republic.1998. Biodiversity Strategy and Action Plan. National Report. Bishkek (in Russian).

Muhamedshin, K.D. 1967. The Juniper forests of southern part of Kyrgyzstan. Kyrgyz Forest Research Station. Vol. 5. Frunze (in Russian).

Muhamedshin, K.D. 1977. The Juniper trees of Tian-Shan and their importance. Frunze. Ilim (in Russian).

Müller, U. and J.P. Sorg. 2001. Gestion multifonctionelle des forêts de noyer du sud du Kyrgyzstan: tradition, problèmes actuels, perspectives. Schweiz. Zeitschrift Forstwesen 152(3): 138-144.

Musuraliev, T.M. 1998. Forest management and policy for the walnut-fruit forests of the Kyrgyz Republic. *In*: Blaser, J. *et al.* (Eds.): Biodiversity and sustainable use of Kyrgyzstan´s walnut-fruit forests. - Proceedings of the Seminar Arslanbob, Dzalal-abad Oblast, Kyrgyzstan, 4-8 September 1995. Cambridge, pp. 3-17.

Musuraliev, T.M. 2004. Forest Policy: problems and solutions. Regional Forest Congress. Bishkek (in Russian).

Orozumbekov, A. A. 2008. Insect – Plant Interactions in the walnut-fruit forests. Thereport to Rufford – Nature protection, London, UK.

Orozumbekov, A.A., M.A. Liebhol, V.I. Ponomarev, and P.Tobin. 2009. The Gypsy moth in Central Asia. Journal of American Entomology, USA (in print).

Orozumbekov, A.A., V.I. Ponomarev, A. Mamytov, E.M. Andreeva, and M.A. Liebhold. 2003. Population ecology of gypsy moth in Kyrgyzstan. XIV USDA Interagency research forum on the gypsy moth and other invasive species, Annapolis, Maryland, USA, pp. 49-50.

Pogue, G.M. and W.P. Schaefer. 2007. A review of selected species of Lymantria Hubner (1819) (Lepidoptera: Noctuidae: Lymantriinae) from subtropical and temperate regions of Asia, some potentially invasive to North America. US. Department of Agriculture. Forest Service. FHTET. Morgantown, WV. pp. 1-223.

Pryde, P.R. (ed.). 1995. Environmental resources and constraints in the former Soviet Union. Boulder, CO.

Roth, L. and R. Murzakmatova. 2003. Development of a social aspect assessment in the frame of national forest typology in Kyrgyzstan. Technical report 2003. Bishkek, KIRFOR Kyrgyz-Swiss Forestry Support Program.

Saprjagejeva, V.J. 1938. The walnut - *Juglans regia* L. - in the watershed of river Kondara. *In*: Tr. Tadzhik. department, Academy of Sciences, 8: 293-305.

Scheuber, M., U. Müller, and M. Köhl. 2000. Wald und Forstwirtshaft Kirgistans. Schweizerische Zeitschrift für Forstwesen 151(3): 69-74.

Schmidt, M. 2005. Utilization and Management Changes in South Kyrgyzstan's Mountain Forests. *In*: Journal of Mountain Sciences 2, 2, S. 91-104.

Schmidt, P. 2001. The scientific world and the farmer's reality: Agricultural research and extension in Kyrgyzstan. *In*: Mountain Research and Development 21 (2): 109-112.

Sherbinina E.N. 1998. The problem of conserving the biological diversity of walnut-fruit forests in Kyrgyzstan. Biodiversity and sustainable use of Kyrgyzstan's walnut-fruit forests (in Russian).

Sorg, J.P., B.I. Venglovsky, and K. Schmidt. 2003. Orech-Les: Biodiversity and sustainable management of Kyrgyzstan's walnut-fruit forests: development of new silvicultural approaches. *In*: European Tropical Forest Research Network News 38: 65-67.

Stadelbauer, J. 1996. Die Nachfolgestaaten der Sowjetunion. Großraum zwischen Dauer und Wandel. Darmstadt.

Stadelbauer, J. 1998. Umweltprobleme in der Gemeinschaft Unabhängiger Staaten (GUS) und ihre globale Dimension. Geographische Rundschau 50: 306-313.

Sukacev, V. N. (ed.). 1949. The fruit forests of southern Kyrgyzstan and their utilization. Moscow-Leningrad (in Russian).

UN. 2003a. Common Country Assessment. Bishkek, the UN System in the Kyrgyz Republic.

UN. 2003b. The Kyrgyz Republic Millennium Development Goal Progress Report. Bishkek, United Nations, UNDP.

UNDP. 2003. First National Communication of the Kyrgyz Republic under the UN Framework Convention on Climate Change.Bishkek.

UNDP. 2005.Third National Report of Biological Diversity of Kyrgyz Republic. Bishkek.

UNDP. 2008. Fourth National Report of Biological Diversity of Kyrgyz Republic. Bishkek.

Venglovsky, B. I. 1998. Potential and constraints for the development of the walnut- fruit forests of Kyrgyzstan. Biodiversity and sustainable use of Kyrgyzstan's walnut-fruit forests. J. Blaser, J. Carter and D. A. Gilmour. Gland, Cambridge and Bern, IUCN and Intercooperation: 73-76.

Von Maydell, H.J. 1983. Forst- und Holzwirtschaft der Sowjetunion: Teil 4: Kasachstan und die mittelasiatischen Sowjetrepubliken Usbekistan, Kirgisien, Tadshikistan, Turkmenien. Mitteilungen der Bundesforschungsanstalt für Forst- und Holzwirtschaft Nr. 140. Hamburg, Bundesforschungsanstalt für Forst- und Holzwirtschaft.

World Bank and International Moneroty Fund. 2000 Kyrgyz Republic Poverty Reduction and Growth Facility Policy Framework Paper, 2000–2002.

World Bank. 1995. The Kyrgyz Republic. Agricultural Sector Review. Report No. 12989-KG, Washington.

World Bank. 2003a. Country Brief Kyrgyzstan, http://www.worldbank.org.kg/ECA/Kyrgyz.nsf/ECADocByUnid/5D1C02A085120E6BC6256DC1001063F0?Opendocument (01.02.2004).

World Bank. 2005. Ensuring sustainability of forests and livelihoods through improved governance and control of illegal logging for economies in transition. Working document for Kyrgyz Republic for World Bank. Savkor Indufor Oy.

Wyse Jackson, P.S. and L.A. Sutherland. 2000. International Agenda for Botanic Gardens in Conservation, Botanic Gardens Conservation International, Kew, Richmond, UK.

Yunusova, I., Chyngojoev, A. and G. Buttoud. 2000. The Kyrgyz forestry concept: policy changes for a multipurpose management of mountain forests in Central Asia. *In*: Price, M.F. & N. Butt (eds.): Forests in Sustainable Mountain Development: A State of Knowledge Report for 2000, Wallingford-New York, pp. 411-413.

***Forest and grazing in Kyrgyzstan (Photo taken by Almaz Orozumbekov)***

***Juniper forest in Kyrgyzstan (Photo taken by Almaz Orozumbekov)***

***Walnut forest in Kyrgyzstan (Photo taken by Almaz Orozumbekov)***

***Spruce forest in Kyrgyzstan (Anonymous)***

# Restoration, Rehabilitation and Management of Deforested and Degraded Forest Landscapes in Turkey

Alper H. Colak[19], Simay Kirca[19] and Ian D. Rotherham[20]

## Summary

Turkey contains ancient cultural landscapes with a rich biodiversity and distinctive vegetation. They are strongly influenced by human activity reaching back far into history. This is very obvious in Anatolia, a region where Eastern and Western civilizations meet, and which is one of the oldest continually inhabited regions in the world. It has repeatedly been a battleground for foreign powers, being noted as a melting pot of cultures. Their cumulative impacts caused the destruction of forest vegetation. Historical records and contemporary research indicate that 4,000 years ago the Anatolian landscape was 60%-70% forest (approximately 50 million ha) and 10%-15% steppe. However, overgrazing, overcutting, fires, clearance for agriculture, wars and general misuse of the land have caused a decrease in forest area to 26% (approximately 21 million ha), and an increase in steppe area to 24%, thus locating forest landscape rehabilitation and restoration as considerably important issues in Turkey. Additionally, Turkey, consisting of European Turkey and Anatolia, is the meeting place of three phytogeographical regions. Hence, composed of different phytogeographical regions with a high biodiversity, Turkey requires highly differentiating forest landscape rehabilitation and restoration studies, which are hard to implement and need great attention.

In the years following World War II, intensive and deliberate rehabilitation and restoration practices began in Turkey. At the same time, many infrastructure works (high capacity regional nurseries, development of country-wide afforestation master plans, etc.) were developed for future rehabilitation and restoration practices. Systems were set in place for a yearly afforestation program to cover 300,000 ha. Preliminary forest rehabilitation and restoration studies mainly started with the afforestation of bare areas which were viewed as potential forests, and with erosion control works of formerly wooded areas. Therefore, between the years 1935-1960 a total area of 75,382 ha was subject to rehabilitation and restoration by afforestation, while between the years 1960-1982, (22 years) a further 823,323 ha land was afforested. In the following years there was a significant increase in afforestation activities with over 100,000 ha of land per year (105,127 ha in 1984). Even in 1987, 150,000 ha of land was afforested. These numbers indicate the rise of awareness and interest in land rehabilitation and restoration of forests in Turkey. The overall total was 1.95 million ha of afforestation and 693,062 ha of erosion control work. The rehabilitation and restoration works mostly began with the afforestation of bare lands and erosion control practices. They later concentrated on watershed rehabilitation. Subsequently, the rehabilitation framework was expanded to include different techniques and more extensive areas. Furthermore, a total of 741,854 ha of forest land was rehabilitated. Within the framework of the 2008-2012 National Rehabilitation Action Plan, afforestation, rehabilitation, erosion control and rangeland rehabilitation works are to be implemented on 2.3 million ha. This reflects the current enthusiasm and trust of the Turkish authorities for major rehabilitation and restoration. However, the obvious decrease in afforestation in recent years is troubling when large-scale planned massive rehabilitation is yet to be implemented in practice.

[19] Istanbul University, Faculty of Forestry, Turkey
[20] Sheffield Hallam University, Tourism and Environmental Change Research Unit, England

The enthusiasm for speedy afforestation of degraded areas led to almost complete afforestation with monoculture conifers and exotic tree species. However, later works used more trees of local origin. Later on, monocultures were then converted into coniferous mixed forests, and broad-leaved tree species were also included. Today, the planning projects are matched more according to the local character, and afforestation is carried out with broad-leaved tree species in broad-leaved forest zones.

As explained above, although important progress and great efforts were made in rehabilitation and restoration activities in Turkey, it is considered that 10.2 million ha of forest are still degraded or highly degraded. These areas can only be transformed into productive or a more natural state with implementation of rehabilitation and restoration works. Around 18 million ha of bare land need to be converted into a productive state through afforestation activities. Calculations show that 80% of the country's land suffers from moderate to severe and very severe erosion. Therefore, forest rehabilitation and restoration concepts play an important role applying various methodologies for specific problems. In the case of Turkey, rehabilitation and restoration concepts also present a possible vehicle for promoting the values that forests can provide to society, including hydrological regulation and watershed protection, soil stabilization, and a repository of biological diversity of local and national value.

Forest landscape rehabilitation and restoration approaches in Turkey show a tendency to combine adaptive management and participatory techniques. Actually, there is no lack of knowledge to implement sustainable restoration and rehabilitation strategies. A wide range of experience has already been built up since the 1950s on how to restore even very difficult sites. In this context, more often there is a lack of understanding of the overall landscape and the factors that determine whether different land-uses are mutually reinforcing or in conflict (Maginnis and Jackson, 2005). However, the transformation of coppices into high forests, the end of clear-cutting, the extension of nature protection areas, the conservation of deadwood, etc. have gained prominence as positive phenomena. Indeed, in Turkey, as indicated in Maginnis *et al*. (2005) landscape restoration and rehabilitation concepts still tend to need refining and redefining. They need to accommodate new perspectives and ideas to put trees back into the forest landscape. In Turkey, the experience gained indicates that successful forest rehabilitation and restoration require supportive local and national policy frameworks and a strong constituency of local-level support for rehabilitation and restoration activities.

## 1. General Information

### *1.1 Geographic Information*

Turkey is located in the Northern hemisphere between the 36º-42º northern parallel and the 26º-45º eastern meridian on an area of 783,562 km$^2$. The country is situated in a landscape where Europe meets Asia, creating a link between these two continents. The European part is called Thrace, while the Asian part is known as Anatolia (or Asia Minor). According to the 2008 population census results, the population of Turkey is 71.5 million, with an average population density of 93 persons per km$^2$ (www.turkstat.gov.tr). In the 2008 Population Census it is indicated that Turkey is a country with a young population, with 26.3% of its population under 15 and 6.8% above 65. According to the census results, the literacy rate is around 88%. The lowest incomes were in agriculture, forestry, fishing and hunting. The population is not evenly distributed across the country. Therefore, density is greater in areas suitable for agriculture, in industrialized regions and in some coastal provinces with easy access. It is lower in the inner parts of the country and in mountainous areas. The levels of education and income show features similar to the distribution of population.

Most of the region consists of a plateau, rising steadily towards the east and bounded to the north and south by steep mountain ranges. In the west, this plateau falls gradually to sea level, terminating in a series of promontories. Half of the land is above 1,000 m and 10% is over 2,000 m. The northern Anatolian mountains are the continuation of the Carpathian-Balkan mountain chains while the Taurus Mountains in the south are eastern extensions of the Alps. The geology of Turkey is very varied and a fascinating mosaic, containing a great range of igneous, sedimentary and metamorphic rocks, including extensive areas of recent volcanic rock and numerous extinct volcanoes. The mountainous topography results in pronounced vertical and horizontal climatic differences from semi-arid, steppe conditions, to humid, broad-leaved forest (Bozkurt and Mittwede, 2001; Mayer and Aksoy, 1986; Colak and Pitterle, 1999). While the coastal areas enjoy milder climates, the inland Anatolian plateau experiences extremes of hot summers and cold winters with limited rainfall (Sensoy *et al.*, 2003).

Turkey is a country with considerable water resources in a region where generally water has always been in short supply. Most of the country's water potential lies in the southeast (28%) and the Black Sea region (8%). Turkey's water resources include 26 river basins. Turkey has a great diversity of mineral resources which serve to provide the raw materials required for the industrial development, while they become at the same time an increasingly important component for foreign trade (www.mta.gov.tr). As a commercial centre of the ancient world, diverse agricultural activities continue to take place in Anatolia. Vegetable farming is practiced on an area of around 1 million ha in Turkey, which meets 3% of the global vegetable production. Through greenhouse growing, one of the most important agricultural sectors in recent years, farmers obtain higher yields per unit area.

Turkey has 21.18 million ha of forest, covering 26% of the land surface of the country. In Turkey, forests occur in every altitudinal zone, from sea level to alpine level, but most of these forests grow in the high mountains. According to Sag (2002), there are 3.15 million ha of forest found in the subalpine zones (1,500-2,500 m). As a result of a variety of phytogeographical regions, Turkish landscape is divided into distinctive forest communities, which consist of more than 450 native species of trees and shrubs. Today, the annual wood raw material production of forests is approximately 13-14 million $m^3$. Total growing stock is 1.3 billion $m^3$, of which the majority is high forest and the rest coppice forest. In addition to wood raw material, there is an important amount of production of non-wood forest products. Furthermore, 10,376 villages are found in forests and 77,983 near to forests.

### *1.2 Land-use*

Turkey's 26.3 million ha of its 77.9 million ha soil resource is used for agriculture and this compares with 14.8 million ha in 1940. While on 17% of the cultivated land irrigated farming is practiced, the rest is used for 'dry' farming. As a traditional system, nearly half of the agricultural land is managed by field farming systems (Yavuz, 2005). Throughout the Five-Year Plan periods applied since 1963, "industry based growth" was the prime target in Turkey. After 1980, with the introduction of export-oriented industrialization, significant progress was made in Turkey towards establishing the principles and fundamentals of an economy open to competition, liberalizing the foreign trade, substituting market forces to a great extent for administrative decisions in determination of prices, and restructuring the role of public institutions and of the government. Turkish industry depends mainly on the private sector (DPT, 2000).

Even if the urbanization rates were quite low in Turkey before 1950's, urbanization processes gained momentum due to migrations from rural to urban regions from 1950 onwards (Isik, 2005). Tourism has been one of the fastest growing industries in Turkey in the last 20 years.

In addition to the coastal tourism in the western and southern parts of the country, it has unique potential for different types of tourism activities, relating to its geographical and environmental diversity.

Despite centuries of human activity, much of the forests in Anatolia are still relatively natural. In particular, until very recently they have escaped many of the impacts of modern forestry management methods that have impacted negatively on forests. However, Turkish forests are typically mosaics, and include clear-felled or highly altered areas. These forests may be classified as near-natural, semi-natural and partly altered or as oligohemerobic, mesohemerobic and partly euhemerobic. There are still some residual virgin forest areas, but much has degraded from near natural to semi-natural and altered. Where natural forests have been completely cleared they are classified as artificial/polyhemerob with some afforestation (Colak *et al*., 2003). Turkish forests represent a high concentration and a productive character, particularly in the Black Sea and Mediterranean Region, as a result of geographic and climatic conditions, while they are mostly degraded and low in amount in inner and eastern parts of Turkey. High forest covers approximately 15.4 million ha, coppices approx. 5.7 million ha, productive high forest approx. 8.9 million ha, degraded high forest approx. 6.5 million ha, while productive coppices cover approx. 1.6 ha and degraded coppices approx. 4.06 million ha. About 99% of the country's forests are owned by the state. The above ground timber volume of conifers, broad-leaved, mixed high forest and coppice forest land is given in Table 1, with 1.3 billion $m^3$ the average asset (planted tree volume) in a unit area is quite low. Despite the annual current volume increase of the forests running at 35.4 million $m^3$, the annual allowable cut given in management plans is 17.2 million $m^3$ (Anonymous, 2008a).

**Table 1: *Distribution of conifers, broad-leaved, mixed high forest and coppice forest land (Anonymous, 2009)***

| Forest form | Total forest land (ha) | High forest | | | | Coppice forest (ha) |
|---|---|---|---|---|---|---|
| | | Total high forest (ha) | Coniferous forest (ha) | Broadleaved forest (ha) | Mixed coniferous and broadleaved forest (ha) | |
| **Total** | **21 188 747** | **15 439 595** | **11 403 791** | **1 831 536** | **2 204 268** | **5 749 152** |
| **Productive** | **10 621 221** | **8 940 215** | 6 280 245 | 1 298 806 | 1 361 164 | 1 681 006 |
| **Degraded** | **10 567 526** | **6 499 380** | 5 123 546 | 532 730 | 843 104 | 4 068 146 |

*In-situ* programs and conservation or land management designations such as National Parks, Nature Parks, Natural Monuments, Nature Protection Areas, Wildlife Conservation Areas, Recreation Areas, Gene Conservation Forests, Seed Stands and Seed Orchards have been applied in Turkey since the 1950s. In the last decade, the proportion of protected areas under various status to the country’s total surface area increased from 1% to about 3%. However, the area that is strictly protected is still low.

### *1.3 Land-use Pattern*

When examining the Turkish land-use mosaic, the prominent weight of agricultural land (35%) is easily noticed, while 27% is covered by meadows and pastures, 27% by forests, 11% consist of settlement areas and 1.5% of water bodies (Konukcu, 2001). The main components of land-use pattern have been explained below according to Anonymous (2008d):

- The field crops are the main production elements of Turkey's farming. Turkey is a home to the wild relatives of many field crops and therefore makes significant contribution to biological diversity with local field crops varieties.
- In Turkey, grazing areas can be roughly classified as coastal and steppe meadows. Coastal meadows include grazing land in the Black Sea, Marmara, Aegean, Mediterranean and Thrace regions. Coastal meadows constitute approximately 25% to 30% of the country's meadow resource. Steppe meadows are divided into two categories, namely mountain meadow and plain meadow in terms of altitude and topography. Meadows in the high plateaus and the alpine meadows above the timberline are very important for animal breeding. In addition, in some parts of the forest ecosystem where trees do not grow or are destroyed, in-forest-meadows have grown which are partly or completely covered by forest.
- In forest areas, land-use patterns are strongly influenced by production and 63% of the country's forests are managed as production forests with 62% being age-class forests. Coppices cover 19% of the forest area and protection forests 15%. The remaining forest area is distinguished as Protection Forests, including National Parks, Nature Protection Areas, etc. Under the framework of government-managed forestry tradition in Turkey, private forests occupy only 18,482 ha (T.R. Prime Ministry State Planning Organization; www.dpt.gov.tr).
- In Turkey, settlements and industrial areas are mainly concentrated in the western parts of the country as a result of geographical, climatic and socio-economic dynamics. The distribution of settlements and industrial areas also has a correlative relationship with the road network mosaic in Turkey.
- Turkey has important inland water ecosystems in terms of biological diversity with its rivers covering an area of around 10,000 km2 (1.6% of the country's total surface area) and lakes. In the country, there are seven drainage basins including twenty-six river basins, with an estimated groundwater volume of 94 billion km3. Lakes, marshes, deltas, reeds and mud plains are very important for birds, in particular, for other wildlife too, as well as for recreational purposes. More than half of Turkey's birds are migratory species.

## 2. State of Forests

### *2.1 Forest Cover*

Turkey, which consists of European Turkey and Anatolia, is the meeting place of three phytogeographical regions: (1) Euro-Siberian, (2) Mediterranean and (3) Irano-Turanian (Figure 1). Their distinctive vegetation reflects differences in climate, geology, topography, soils and floristic diversity, including endemism (Davis, 1965). Ninety percent of the forest in Turkey is 'natural' in origin and contains over 450 species of trees and shrubs.

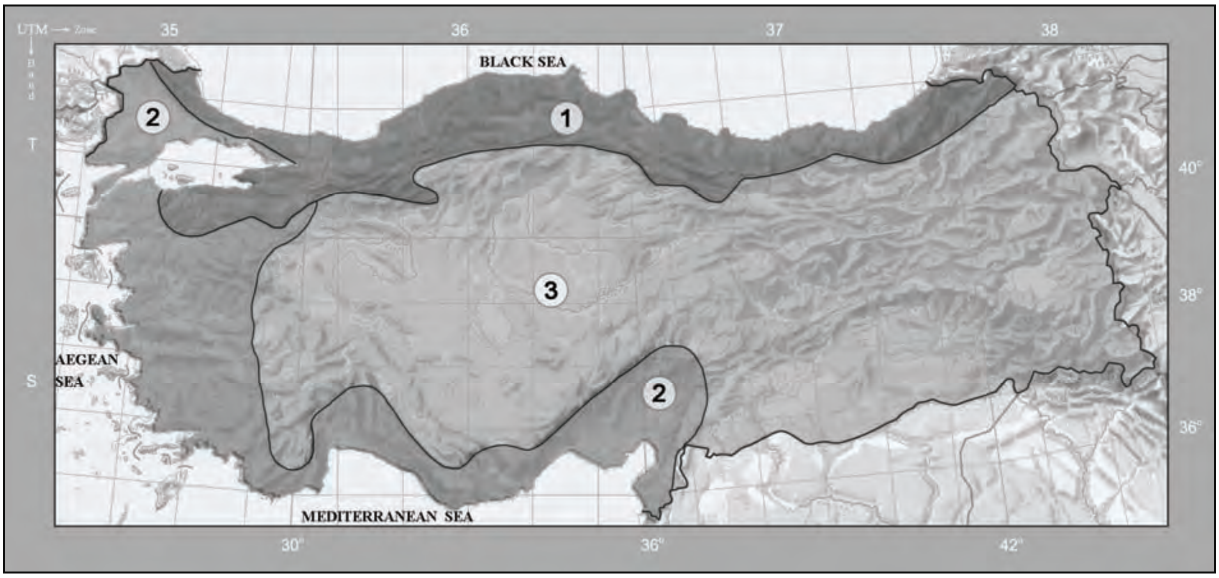



**Figure 1:** ***The phytogeographical regions of Turkey: 1) Euro-Siberian Region; 2) Mediterranean Region and, 3) Irano-Turanian Region (modified from Davis, 1965)***

## *2.2 History*

### *2.2.1 Forest history*

Turkey and other Mediterranean countries comprise ancient cultural landscapes with a rich biodiversity and distinctive vegetation. They are strongly influenced by human activity reaching back far into history and often resulting in degradation (Kehl, 1995; Rackham and Moody, 1996). This is very obvious in Anatolia, a region where Eastern and Western civilizations meet and which is one of the oldest continually inhabited regions in the world. It has been repeatedly a battleground for foreign powers, being noted as a melting pot of cultures. From the first known urban city (Catalhoyuk *c*. 7500 BC) to the historically famous Troy, and from the Ionians to the great empires of the world (e.g. Roman, Byzantine, and Ottoman), many cultures (e.g. Sumers, Cimmerians, Hurries, Cilicans, Phoenicians, Lydian, Carians, Persians, Hellenes, etc.) were established in this geographic region. Palaeoecological studies have greatly increased our knowledge of Late Quaternary environmental changes in Turkey and the Eastern Mediterranean arising from both climate change and human impact (e.g. Bottema *et al*., 1993a, 1993b; Eastwood *et al*., 1998; 1999). However, in Turkey many palynological studies are spatially very limited (e.g. Aytug, 1970; Aytug and Gorcelioglu, 1993; 1994; Bottema *et al*., 1993a, 1993b) and correlation of sediment profiles from different regions is often impossible because of the very distinct local differences in deposition rates. Furthermore, there are chronological problems, particularly for the mid-Holocene onwards, in relation to vegetation development in different regions of the Near East. Pollen diagrams show that, following the end of the Ice Age, a wetter and warmer climate led to the spread of forest into the steppes of Central Anatolia and other large landmasses. Over the last 2,000 years, anthropogenic impacts have significantly reduced forest areas, most markedly in the last five centuries. All these civilizations and especially their cities required wood, timber and grazing land. Their cumulative impacts caused the destruction of forest vegetation. Mayer and Aksoy (1986) drew attention to periods of deforestation and degradation during the Prehistoric Period (*c*. 1850-1180 BC) and again during the rise and fall of the Ottoman Empire (1299-1922 AD). Anatolia was a centre for the production of both big timber and secondary forest products for the great Mediterranean and Near-East civilizations, e.g. Egyptians, Mesopotamians, Phoenicians and Romans. High quality logs were transported to construct temples, houses, and ships (Senitza, 1989).

The importance of anthropogenic impacts, however, is still debated. According to Hempel (1981, 1983) people played a far less important role in the origins of present-day vegetation and the current eroded landscapes than was previously assumed. Human activities certainly reduced forest areas and caused soil erosion (Tavsanoglu, 1978; Ekizoglu and Sengönül, 2007), although significant soil erosion is also shown to have occurred in the Sub-boreal (4680-2890 BC) to early Atlantic Periods (2890-1690 BC). Historical records and contemporary research suggest that Anatolia had 60-70% forest cover and 10-15% steppe around 2,000 BC (Walter, 1956). The forest area has declined to 26% as a result of over-grazing, over-cutting, fires, spread of agricultural lands, wars, etc., and steppe has increased to 24% in the intervening 4,000 years (Louis, 1939; Walter, 1956).

### *2.2.2 Restoration and rehabilitation history*

Considering the periods before the establishment of the Turkish Republic, not many forest rehabilitation and restoration measures were implemented. However, it is known that some measures were taken to prevent the filling of Golden Horn (Istanbul) by afforestation on the ridges of Golden Horn in the second of the fifteenth century, and, the edicts dating years 1717 and 1739 represent some limited plantations in Istanbul in the Tulip Period. In the following years, only some moderate afforestation was done. Therefore, afforestation work done before the Republic Period should be accepted as discrete practices, while regular applications could only start after World War II (Ürgenc, 2004).

As it is understood from the brief forest history of Turkey above, forest land experienced a distinct decline while steppe area increased. Consequently, Turkey came into a position where every type of erosion could be seen and floods became very prominent. As a result, the General Directorate of Afforestation and Erosion Control was established and became involved in afforestation by the Forest Law No. 3116 dated 1937. Following the years after World War II, first steps for the planned period were taken with the decisions made at the Turkey Afforestation Technique Congress which was held in 1955. The process was accelerated with Forest Law No. 6831 dated 1956, so that intensive and deliberate rehabilitation and restoration practices (especially afforestation) based on the plans and projects were initiated. Yet in these years, many planned infrastructure works (foundation of high capacity regional nurseries, development of country-wide afforestation master plans, etc.*)* were realized for future rehabilitation and restoration practices, while the basic facility has been prepared for a yearly 300,000 ha afforestation. Preliminary forest rehabilitation and restoration studies began with a focus on the afforestation of bare areas that are potentially forest and the erosion control works for priority lands.

From 1935 to 1960 totally 75,352 ha area was afforested, while the rehabilitation and restoration framework was broadened in different application fields in the following years. Between the years 1960-1966, there were 278 reported floods, and from 1955 to 1965, 409 people lost their lives because of floods. Furthermore, soil erosion and siltation in dam basins caused the rapid infilling of dams (Urgenc, 2004). As a result of such negative experiences between the years 1960-1982, in only 22 years, a total of 823,323 ha afforestation was undertaken. In subsequent years, an important increase in afforestation was experienced with over 100,000 ha afforestation per year (105,127 ha in 1984). In 1987, a further 150,000 ha land was afforested. These numbers indicate the rise of awareness of rehabilitation and restoration practices in Turkey in the form of afforestation and erosion control. As a matter of fact, in total 1,953,707 ha of afforestation and 693,062 ha of erosion control work were put into practice. The rehabilitation and restoration started mostly with the afforestation of bare lands and erosion control practices. Later on they concentrated particularly on watershed rehabilitation and restoration. Subsequently, the rehabilitation and restoration framework was expanded to be practiced with different techniques and across extensive areas: greenbelt afforestation (140,634 ha), artificial regeneration (737,052 ha), energy forest generation (623,000 ha), rangeland rehabilitation (113,954 ha), and private afforestation (72,197 ha). Furthermore, a total of 741,854 ha degraded natural forest land was rehabilitated.

Therefore, 3,610 projects have been prepared until 2007. In Turkey, the first mass seedling production was initiated in 1925 and by the end of 2007, 11.4 billion forest trees were produced. Afforestation, erosion control, rehabilitation, private afforestation and forest rangeland rehabilitation implementation addressed nearly 5 million ha land (Anonymous, 2008a). While these initiatives were undertaken, afforestation was also done with fast growing exotic species to produce wood-based raw materials as well as for soil stabilization. As a result of these projects, it seems that effective measures to combat erosion were begun, many unproductive areas were transformed into productive forests, and unproductive agricultural areas were diverted into other uses in many parts of the country. Active sand dunes were stabilized with 'greening and afforestation' practices initiated in the 1960s. Today, these areas are regarded as outstanding tourism centres.

At the same time, nature protection areas have spread to various parts of the country. There has been a growing need for models of rehabilitation and restoration approaches and nature conservation implementation. With this aim of strengthening the institutional framework for natural resource management, the General Directorate of Nature Conservation and National Parks was established in 1958. This was followed by the foundation of the General Directorate of Forest-Village Relations (ORKOY) in 1970 to prevent negative impacts (over-grazing, over exploitation of forest resources, cutting, agricultural land expansion, etc.) of approx. 7 million people living in the forest or dependent on forest resources, to contribute to the improvement of their socio-economic status and to the sustainability of forestry activities, and consequently to strengthen the relationships between the community and the forests (Anonymous, 2009).

So as discussed, great efforts were made in rehabilitation and restoration activities and important progress was achieved but serious flaws in the methods led to problems. Therefore, it is considered that 10.2 million ha of forest is still 'degraded' or 'highly degraded'. These areas can only be transformed into productive or natural state forests with carefully implemented programs of rehabilitation and restoration. There is also around 18 million ha of eroded bare land which needs to be converted into productive forest. It is estimated that 80% of the country's land suffers from 'moderate to severe' and 'very severe' erosion. Therefore, forest rehabilitation and restoration concepts play an important role in Turkey. According to Anonymous (2008d), 14% of the country's soil is to a slight degree threatened by erosion, 20% to a medium degree, and 63% to a high or very high degree.

The enthusiasm for prompt afforestation of degraded areas led to almost complete afforestation with monoculture coniferous and exotic tree species. However, in more recent works locally-native species have been used. Later on, monocultures were organized as coniferous mixed forests, while broad-leaved tree species were included in the polyculture plantations afterwards. Today, in broad-leaved forest zones afforestation work is implemented with broad-leaved tree species.

In recent years, there has been an improvement in texture and structure of natural forests. There has been a transformation of coppices into high forests, an end of clear-cutting, and the introduction of close-to-nature forest management even in small areas. The application of particular techniques dovetailed to mountain forests has become more common. There may be issues about resolving tensions between the rehabilitation and restoration to 'natural' forest types and the retention or conservation of important cultural forest systems such as coppice.

### *2.3 Forest Biodiversity*

Forty two percent (42%) of the forests in Turkey are composed of coniferous species (30% *Pinus* sp., 4.6% *Juniperus* sp., 0.9% *Abies* sp, 0.7% *Picea orientalis*, 0.5% *Cedrus libani*, and 5.5% mixed coniferous forests), 53.3% of broad-leaved species (22.7% *Quercus* sp., 3.3% *Fagus orientalis*, 0.2% *Alnus* sp., 0.1% *Castanea sativa*, 0.1% other broad-leaved species, 18.5% mixed broad-leaved forests and 8.4% maquis) and 4.5% mixed coniferous and broad-leaved forests (Mayer and Aksoy, 1986). However, these basic forest types are divided into distinctive forest communities adapted to the different climatic conditions (Table 2). These forest communities have more than 450 native species of trees and shrubs, the most important are listed in Table 3.

**Table 2:** ***The forest regions of Turkey (after Mayer and Aksoy (1986) from Colak and Odabasi (2004))***

| | |
|---|---|
| **Euxin-Subeuxin Forest Regions of North Anatolia** (cool winters, humid, sub-humid summer) | |
| a | Northwest Euxin |
| b | Middle Euxin |
| c | East Euxin<br>, |
| **Steppe Forest Region** (cold winters, dry summers) | |
| a | East Thrace Lowland Steppe Forests |
| b | Central Anatolia Sub-Mediterranean Steppe Forests between Lowland and Highland |
| c | East Anatolia Highland Steppe Forests |
| d | Southeast Anatolia Mountain Steppe Forest |
| e | Mesopotamia Steppe Forests |
| **South and East Anatolia Mediterranean / Sub-Mediterranean Forest Regions** (very hot summers, mild winters) | |
| a | South Anatolia Mediterranean Forest Regions |
| b | Mediterranean West Aegean Forest Regions |
| c | Sub-Mediterranean East Aegean Forest Regions |

**Table 3:** ***The forest tree species found in the different forest regions (Colak and Rotherham, 2006)***

| | | |
|---|---|---|
| **Euxin-Subeuxin Forest Regions of North Anatolia** | | |
| *Abies bornmülleriana* | *Picea orientalis* | *Ulmus glabra* |
| *A. nordmanniana* | *Pinus nigra* | *U. minor* |
| *Acer trautvetteri* | *P. sylvestris* | *Tilia platyphyllos* |
| *Alnus glutinosa* subsp. *barbata* | *Platanus orientalis* | *T. argentea* |
| *Betula pendula* | *Prunus spinosa* | *Zelkova carpinifolia* |
| *Buxus sempervirens* | *Pterocarya fraxinifolia,* | Relict: |
| *Carpinus betulus* | *Quercus cerris* | *Arbutus andrachne* |
| *Castanea sativa* | *Q. hartwissiana* | *Juniperus excels* |
| *Corylus avellana* | *Q. iberica* | *J. foetidissima* |
| *Crataegus orientalis* | *Q. macranthera* subsp. *syspirensis* | *J. oxycedrus* |
| *Fagus orientalis* | *Q. petraea* subsp. *iberica* | *Laurus nobilis* |
| *Fraxinus angustifolia* subsp. *oxycarpa* | *Q. petraea* subsp. *petraea* | *Myrtus communis* |
| *F. excelsior* | *Q. robur* subsp. *robur* | *Olea europea* |
| *Ilex colchica* | *Q. pubescens* | *Phillyrea latifolia* |
| *Juglans regia* | *Rhododendron ponticum* | *Pinus brutia* |
| *Juniperus comminus* subsp. *nana* | *Sophora jaubertii* | *P. pinea* |
| *J. communis* subsp. *communis* | *Sorbus aucuparia* | *Pistacia terebinthus* |
| *Laurocerasus officinalis* | *S. torminalis* | *Punica granatum* |
| *Ostrya carpinifolia* | *Taxus baccata* | *Quercus coccifera*) |
| **Steppe Forest Region** | | |
| *Betula pendula* | *P. sylvestris* | *Q. libani* |
| *Juniperus excels* | *Populus tremula* | *Q petraea* subsp. *pinnatiloba* |
| *J. oxycedrus* | *Q. brantii* | *Q. pubescens* |
| *J. foetidissima* | *Q. cerris* | *Q. robur* subsp *pedunculiflora* |
| *Paliurus spina-christi* | *Q. coccifera* | *Q. robur* subsp. *robur* |
| *Pinus nigra* | *Q. frainetto* | *Q. vulcanica* |
| **South and East Anatolia Mediterranean/Submediterranean Forest Regions** | | |
| *Abies cilicica* | *J. foetidissima* | *Prunus divaricata* |
| *Acer hyrcanum* | *J. oxycedrus* subsp. *oxycedrus* | *Quercus aucheri* |
| *A. sempervirens* | *J. phoenicea* | *Q. calliprinos* |
| *Alnus orientalis* | *J. sabina* | *Q. cerris* |
| *Arbutus andrachne* | *Laurus nabilis* | *Q. coccifera* |
| *Arceutos drupacea* | *Liquidambar orientalis* | *Q. frainetto* |
| *Carpinus betulus* | *Olea europaea* | *Q. ilex* |
| *C. orientalis* | *Ostrya carpinifolia* | *Q .infectoria* subsp. *infectoria* |
| *Castenea sativa* | *Phillyrea latifolia* | *Q. ithaburensis* subsp.*macrolepis* |
| *Cedrus libani* | *Pinus brutia* | *Q. pubescens* |
| *Celtis australis* | *P. halepensis* | *Q. trojana* |
| *Cercis siliquastrum* | *P. nigra* | *Sorbus umbellate* |
| *Ceretonia siliqua* | *P. pinea* | *Styrax officinalis* |
| *Cupressus sempervirens* | *Pistacia terebinthus* subsp. *palaestina* | *Tamarix smyrnensis* |
| *Fraxinus ornus* | *Platanus orientalis* | |
| *Juniperus excelsa* | *Populus tremula* | |

## *2.4 Forest Tenure, Legislation and Policy*

In terms of forest tenure, legislation and policy-making, Turkey has a government-centralized system. The general framework of forest management consists of: (1) Protection of forest areas; (2) Sustainable provision of industrial use; (3) Fuelwood to meet the domestic demand; (4) Provision of non-wood products; (5) Afforestation, rehabilitation and restoration of degraded forest areas; (6) Range improvement; (7) Erosion control; (8) Establishing green-belts; (9) Expanding national parks and protected areas; (10) Protecting wildlife; (11) Providing socially important services such as recreation, hunting, ecotourism, etc.; (12) Contributing to the rural economy; and (13) To decrease pressure on forests. These basic principles are reflected by the forest management requirements in Forest Law No. 6831. Although important progress has been made in forestry since the foundation of the Turkish Republic, the aforesaid principles could not be implemented ideally in practice. In order to address deficiencies of outmoded approaches and to meet the requirements of global environmental understanding protocol, and to implement ecosystem approaches to forest administration and management, changes have been necessary. The associated research, conservation, sustainable use, management and monitoring of forest ecosystems are highlighted in recent development plans and regulations.

### *2.4.1 Forest tenure system*

In Turkey, three types of forest tenureship are applied: government, public and private forest ownership and administration. Today, nearly the whole forest asset belongs to the government (99.99%), while just 15,864 ha is owned by private and local entities. Although there had been a private forestry tradition carried out since 1870s with both domestic and foreign managers, the dramatic scale of issues like land degradation, especially between the years 1928-1938, led to a view that private forestry was mostly disastrous. This lent urgency to the conversion of private forests into state forests under the framework of the Forest Law in 1937. As a result, the assignment of private forests to the state was completed in 10 years time and Legislation No. 4785 was introduced in 1945 to facilitate privately owned forest land being converted into state forests. The main underlying principle was the view of the state as the best manager of forests to balance community benefits and natural resources. Today's private forests are the lands, which were excluded from conversion or later returned to their former owners on appeal. For approximately 20 years, it has been possible to rent restricted areas of state forests for a limited time period for purposes such as recreation, tourism, industrial activities, mining, etc. This is under the framework of privatization procedures (Günay, 2003).

According to Turkish Constitutional Law, ownership of state forests cannot be assigned and these areas are to be managed and executed by the state. State forests cannot be owned by prescription and subjected to easement right except common interest. Correspondingly, easement right is dependent on the permission of the Ministry of Finance, Ministry of Environment and Forestry and Ministry of Agriculture and Rural Affairs due to the current Forest Law. Again, according to the same law, the production in state forests is made directly by the state or commitment way within the framework of determined principles and management plans of the Ministry of Environment and Forestry. Public Forests are also managed and executed according to the management plans prepared by the State Forest Administration and controlled by the same institution. However, the ownership belongs to local administrations (villages, municipalities, and special provincial administrations) and public institutions. The management of these forests can be applied directly by the owners or the management right can be assigned to others. However, partition and ownership transfer of these lands are strictly forbidden. Although the domination of the state interest is clear across most forest areas in Turkey, it is even effective within the small areas of private forests. The management plans prepared by the owners, and the protection and administration of these lands are controlled by the state. In Turkey, these forests are owned by persons, foundations, companies, associations, etc. Again, according to the Forest Law, private forests cannot be divided into pieces smaller than 500 ha, except plantation forests. As with public forests for building and facility construction, the approval of the Ministry of Environment and Forestry would be necessary. Projects with common interest and community benefits would be favored. The most important characteristic of the forest tenure system in Turkey is the protection of natural forests with a high degree of naturalness. The natural forests in Turkey are especially important since most of them have not been converted into the plantation forests of the majority of Europe. Consequently, the tenure system eases the rehabilitation and restoration of degraded areas and natural forests provide ideal models for such project implementation. These unique resources reflect the natural mechanisms of the forest ecosystems.

### *2.4.2 National Forest Legislation and Policy*

The roots of Turkish forestry legislation and policy reach back to the Forest Directory prepared in 1870 in the Ottoman Period. The only expected benefit from forests was to draw income from forest resources in favor of the government. Therefore, some measures were taken to ensure the sustainable use of these resources. However, the major benefits of forests, like climate regulation, water production, soil protection, community health, and recreation were not taken into consideration under the framework of national policy. After half a century, in 1920, Coppice Legislation was introduced for the unlimited utilization of forest resources in favor of national defense as a necessity due to the politics of the time. Following the foundation of the Turkish Republic, extensive studies were made on Turkish forests and as a symbol of technical and scientific forestry Forest Law No. 3116 was introduced in 1937. This had the following aims: 1) Extension and protection of forests to sustain the development of welfare, social and agricultural benefits in favor of the public and the country, 2) To provide forest management by the government and the sale of the forest products to the nearest costumers, 3) Increase of production to promote industrial efficiency and to meet the wood and timber demand of the public, and 4) Export of surplus produce after meeting the demands of the country. Today, Forest Law No. 6831 dated 1956 is in force, describing three types of forests as production forests, protection forests and national parks, respectively. In addition to the aims of the previous law, scientific use, nature protection, enhancement of the country's beauty, recreation and tourism were underlined as further benefits of forests (Ozdönmez *et al*., 1996).

In accordance with the major forest law and legislations, the VIII and the draft of the IX Five Year Development Plan highlights the ecosystem approach as the basic element of forestry policy and today's forestry applications. Some of the main aims related to forestry under the framework of the plan are (www.dpt.gov.tr):

- Protection of forest areas and their integrity against forest fires, disturbing effects and negative factors.
- Multiple use and effective management of forests in respect to biodiversity, wildlife, gene resources, forest welfare, non-wood products and services and the development of eco-tourism.
- Promotion of industrial and soil stabilization afforestation on watershed areas restoration and rehabilitation implementations, effective use of land by urban forestry and agroforestry, development of private afforestation and the education of the public on these issues.

Consequently, the research, conservation, sustainable use, management and monitoring of forest ecosystems are achieved under the scope of the Forest Management Regulation redrafted in 2006 (Anonymous, 2008d).

### *2.4.3 Forest policy enforcement*

Turkish forest policy enforcement may be summarized under five institutional bodies as legislative, consulting, executive, technical and scientific bodies. Under this framework, the only legislative body responsible for the introduction, change and cancellation of laws related to forest policy is the Grand National Assembly of Turkey. The Council of State provides a service for consultation by examining laws and legislations. The first institutional bodies in charge of the execution of forest policy are the President and the cabinet. However, the Ministry of Environment and Forestry and its departments enforce the forestry policy on behalf of the government. On the other hand, the Prime Ministry State Planning Organization supports the preparation, application and the assessment of plans. The Ministry of Agriculture and Rural Affairs, Ministry of Finance, Ministry of Industry and Trade, Ministry of the Interior, Ministry of Transport and Communication and Ministry of National Defence are the other major ministries providing support for the implementation of forest policy. In addition to governmental institutions, the Chambers of Industry and Trade, the Chambers of Agriculture, the Union of Chambers and Commodity Exchanges, the Foundation of Turkish Foresters and many other civil society organizations constitute the technical bodies together with the higher education institutions, which serve as the scientific research and advisory bodies (Ozdönmez *et al*., 1996).

## 2.5 Forest Administration and Management

### 2.5.1 The institutional framework of forest management

It is the responsibility of the Ministry of Environment and Forestry as the highest authority and its affiliated organizations to formulate the policies concerning the conservation and sustainable use of the environment and biological diversity. This includes designation and management of protected areas under various statutes, development and implementation of plans and programs, carrying out of activities and ensuring coordination among the different relevant institutions. Main service units and dependent institutions of the central organization of the Ministry are as follows; General Directorate of Environmental Management; General Directorate of Environmental Impact Assessment and Planning; General Directorate of Afforestation and Erosion Control; General Directorate of Forest-Village Relations; General Directorate of Nature Conservation and National Parks; Department of Research and Development; Department of Foreign and EU Affairs; Department of Training and Publication; General Directorate of State Hydraulic Works; Turkish State Meteorological Service; General Directorate of Forestry; Environmental Protection Agency for Special Areas. There are also provincial organizations under the Ministry of Environment and Forestry, which are the Forestry District Directorate, Provincial Directorate of Environment and Forest, and the Directorate for Forestry Research, respectively.

The institutional structure of forestry has been subject to frequent changes over the years and naturally this instability and fragmentation caused a lot of criticism in the forestry community. Although the government's attempts to improve the organizational structure are not yet ideal, progress has quickened in order to comply with EU requirements.

### 2.5.2 Sustainability and Ecosystem Management Approaches

The importance of sustainable forestry is increasingly recognized in Turkey. Despite this recognition, in countries such as Turkey there has been little awareness of the sometimes subtle but important ecosystem differences between different forest areas. This has led to often drastic and damaging impacts of inappropriate forest management being often not environmentally or even economically sustainable. Ecologically distinct forests and their ecosystems have been simplified and both landscape quality and conservation value reduced. In these areas the local economies are in decline and this has been exacerbated by deterioration of forest 'quality' and associated ecosystem services. A rejuvenated forest is seen as a positive contributor to social and economic recovery in these areas. Approaches to forest management have changed dramatically in recent decades with the emergence of ideas of 'sustainable forestry'. This has had increasing influence in Turkey. Though, these ideas are not everywhere applied. There are many approaches and a diversity of terms and quality indicators. These include forest stewardship, sustainable forestry, continuous cover forestry, natural regeneration, and close-to-nature forestry. A complication is that how these concepts are interpreted varies across the country. The basic idea of sustained forestry is not new in Turkey, but that of environmentally sustainable forestry is. A parallel development has been the gradual understanding of the critical roles of particular features of wooded landscapes such as dead wood, and their importance in maintaining biodiversity. This is both a dramatic shift in emphasis of contemporary practical work and a critical point in the evolution of forestry and woodland management in Turkey (Colak *et al.,* 2008ab). Effective recognition and sustainable management of the cultural forest landscape remains problematic in Turkey. There are many approaches and a diversity of terms and quality indicators such as forest stewardship, sustainable forestry, continuous cover forestry, natural regeneration, etc. These are acknowledged but not considered in detail. In many parts of Turkey, the changes from traditional and largely sustainable woodland management to intensive high forestry can be seen over a period from the eighteenth to the mid 20$^{th}$ century. During the late 20$^{th}$ century there was a fierce debate over the future of forestry and forest landscapes, with an awareness of the huge environmental damage done in countries such as Turkey. The long-term impacts of both forest loss and woodland clearance and the intensive management of the remaining forest lands in Turkish mountains caused massive ecosystem disruption with social and economic deterioration. Other landscapes such as some wetlands can provide some of these effects but woodlands and trees appear to be the most important.

The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Application of ecosystem approaches will help to balance the three objectives of the Convention. An ecosystem approach is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompasses the essential structures, processes, functions and interactions among organisms and their environment. It recognizes, that humans with their cultural diversity are an integral component of many ecosystems (Sayer, 2005). In Turkey, as indicated in Sayer (2005), in many situations the best way to ensure that ecological services are maintained, may be to retain natural ecosystems but this will not always be so. It will often not be consistent with the principles of societal choice and decentralization. In Turkey, it is preferred to interpret the ecosystem principles in the sense of seeking to modify ecosystems in ways that will favor the best combination of social and ecological outcomes. The ecosystem approach can thus be applied to highly degraded systems and may involve engineering works to restore ecological functions.

One of the ideas which a group of Turkish foresters is now actively promoting is that of close-to-nature forestry. The general principles of close-to-nature forestry or silviculture are known to both woodland and forest managers. Indeed, uneven-aged silviculture has alternated between periods of popularity and rejection over the last 10-20 years. Successful future management will require practices that recognize the disturbance and stand dynamics of individual forest types and use these to guide management. Over much of the Turkish forest the present regime of management is counter to the principles of close-to-nature silviculture and an immediate objective is the maintenance or improvement of environmental stability. There is an urgent need to decrease erosion and hydrological disruption (Colak *et al.*, 2008ab).

### *2.5.3 Multiple uses*

When examining Turkish forestry and management history, it can be seen that earlier plans were concentrated on wood production. Other forest functions were minor components or not recognized. This means that multiple use was not adopted as a principle in the real sense. Furthermore, between the years 1940-1965, clear-cutting and harvesting were the basic methods applied across extensive areas. But for two decades, a forestry concept suitable for multiple-use began to emerge and in recent years many forests have been planned to provide more than one resource objectives simultaneously. These include fish and wildlife, wood products, recreation, aesthetics, grazing, watershed protection, and historic or scientific values. As the extensive benefits of this new management understanding have been recognized, clear-cutting was abandoned and new works were undertaken in small areas. Briefly, the trend in Turkish Forestry can be described as “Changing from Timber Production to Mixed Outputs“. In particular, the concept of multi-functional forest management with the landscape producing sustainable tourism and leisure (with essential income to the regions), forest products of wood and timber, wildlife and heritage, and forest culture including local food and drink, begins to provide a potential framework for long-term remediation. A vital element is local difference and distinctiveness of landscape, of forest produce, and advocated here, of management. However, the first key step is to halt the continuing decline, and to set in place the necessary forest management to sustain the resource. Beyond this there will be opportunities to grow the support of the local communities, to encourage economic drivers such as tourism, and to reverse the demographic drift to the cities. This is generally incorporated into development plans that help sustain local communities through jobs and economic regeneration; the forest seen as a key to success (Colak *et al*., 2008ab).

#### ***2.5.4 Interactions among competing uses***

Today, many land-use types are in close interaction with forests as a result of changing socio-economic, technological and natural dynamics. However, some uses are particularly prominent like agriculture, livestock production, industry, trade, transportation, tourism, and nature conservation, respectively.

Forests provide many benefits to the aforesaid land-use types by enhancing the formation of underground and spring water, decreasing of surface runoff, improving the quality and quantity of spring water, preventing soil removal, protecting agricultural products against drought and frost, providing grazing areas for animals, providing raw materials for industry, constituting important resources for national and international trade, the same for transportation infrastructure, providing space for tourism facilities, and making important contributions to nature conservation. However, the structure of the interaction between these land-use types has always been imbalanced. This manifests itself mainly in agriculture and livestock production. The increase of rural population and the over-use of forest resources by forest villagers and the local people living nearby forests brought about the overexploitation of these valuable resources and opening forest land for agriculture and settlements. Furthermore, considering that Turkey is not a suitable country for extensive livestock production pastures have become progressively infertile as a result of overgrazing and increasing animal numbers. This leads to grazing on fertile forest land although it is strictly forbidden by law. A parallel situation is encountered by industry and trade practices in Turkey, since the sustainable and effective use of wood and non-wood forest products could not yet be managed effectively by the government and the private sector. Tourism has also been a growing industry in Turkey especially in the last twenty years and, as a natural result, forests became a potential 'battleground' for tourist facilities. This is especially so for coastal forests and is putting unquestionable pressure on natural dynamics. Although the concepts of eco-tourism, farm recreation and rural tourism have begun to make important contributions to the socio-economic situation of the rural livelihoods bringing new perspectives to the outmoded intensive tourist land-use patterns, the problems still remain. There is over-use of forest resources, fragmentation of valuable forest habitats by road networks, landscape alteration by settlement and infrastructure construction, and so environmental pollution remains a high risk for these highly sensitive areas. Therefore, landscape conservation practices will play a vital role in recreation, natural resource and wildlife management implementations for the regulation of interactions among competing uses in Turkey (Ozdönmez *et al*., 1996).

# 3. Forest Degradation

## *3.1 Understanding Forest Degradation in Turkey*

As forestry changes worldwide, the nature and timing varies across Europe and around the globe. The drivers of this change are both the recognition of the need for multi-functional forest landscapes, delivering ecosystem benefits beyond traditional social and economic ones, and increased awareness of long-term impacts of economically-intensive forestry. In many parts of Turkey, the changes from traditional and largely sustainable woodland management to intensive and almost industrial high forestry occurred over a period from the 18$^{th}$ to the mid 20$^{th}$ century. During the late 20$^{th}$ century, there was a fierce debate over the future of forestry and forest landscapes. This was followed by awareness of the huge environmental damage done in countries such as Turkey by the imposition of large-scale industrial agro-forestry onto other wildlife habitats such as peat bogs, and the demise of traditional woodland management in other areas. The long-term impacts of both forest loss and woodland clearance, and the intensive management of the remaining forest lands caused massive ecosystem disruption with social and economic deterioration. Furthermore, stand structure, type and diversity were greatly affected by human intervention. These impacts are seen across the continent, from Northern Sweden to Poland and the Ukraine, in England, Wales, and Scotland, and throughout afforested areas of Italy and Turkey, for example. Typical scenarios were lowered biodiversity, reduced landscape values, declining socio-economic benefits, and problems with both invasive species, and with water management. In marginal areas such as the Turkish high mountains and even some Alpine regions, these impacts become acute (Colak *et al.*, 2008ab).

A history of distinct change in Turkish forests (Colak *et al.*, 2008ab):

(1) Ottoman Empire Period prior to 1900: There was no national forest management but irregular utilization in many regions. Remarkably, there was regulation of a number of aspects of use by the edicts and orders of the sultans. Some of these even come close to today's multi-functional forest management and sustainable forestry. So during the Period of Süleyman the Magnificent the usage of forests and the need to supply the water demands of Istanbul was regulated. The cutting of trees from these forests was prohibited. Similarly, there were edicts about the regulation of hunting, provision of public fuelwood for heating, etc.

(2) The end of the Ottoman Empire: For the first time there was planning of forestry with the first forest management plan developed in collaboration with Austrian experts.

(3) The period 1963-1972: Forest Management Plans were developed for the whole country leading to forest management practices based on age classes, resulting in a loss of diversity and moving to single aged stands.

(4) The 1990s onwards: There has been a gradual improvement from even-aged forest management to the implementation of concepts of close-to-nature silviculture, uneven-aged forest management and multi-functional forest management. This has been influenced by the development of environmentally-based forest management and nature protection around the world, but especially in Central Europe.

This is very obvious in Anatolia, where Eastern and Western civilizations meet and which is one of the oldest continually inhabited regions in the world. Repeatedly a battleground for foreign powers, it has been a melting pot of cultures. The importance of anthropogenic impacts on the landscape and especially the forest are still debated. It is likely that people had given less importance to present-day vegetation and eroded landscapes than previously assumed. Human activities certainly reduced forest areas and caused soil erosion. If you go to Turkey you will see these problems. The issues that drove and determined the changes are as relevant today as they were in the past, but we now describe our response as a move towards ‘sustainable forestry’. A paradox running through all civilizations is that while they utilize natural resources they also destroy the living systems on which they depend. This poses the question of whether the natural system and the cultural landscape can adapt to changes. When they cannot, then often disaster strikes (Colak *et al.*, 2008ab).

From a comparison of primary remote sensing data used in the process of preparation of nation-wide management plans and today’s detailed air photographs, alteration and degradation in forest structures becomes obvious. The following features can be clearly observed, i.e. conversion of mixed stands into pure stands, increase in number of erosion affected areas, extension of agricultural lands against forests, invasion of settlements through forests, the descend of timberline level, the decrease of canopy closure degrees in dense stands, and the degradation and loss of forests (Erdin *et al*., 1985; Hizal, 1984; Koc *et al*., 1997). Such temporary data suggest that degradation is still continuing and effective counter measures are not yet in place. Whilst high-cost rehabilitation implementations are carried out in deforested land, such an approach reflects simply a “wait and see” principle.

## *3.2 Causes of Forest Degradation*

### *3.2.1 Human-induced phenomena*

- **Forest management**: Excessive harvesting and unplanned exploitation in the past and present have destroyed, and still are destroying, the structure of highly specialized forest systems in Turkey. The potential timberline has descended by between 50 m and 400 m due to human impacts. This varies with different impacts affecting high mountain forestry at the timberline. Over the last 200 years, timber production, clear cutting for pasture and direct impacts of grazing stock have destroyed many areas and the forest has retreated. Afforestation with monocultures and a tendency towards the planting of barren areas within the forest zone has compounded the damage. This has changed species composition and structure away from natural forests, resulting in a characteristic mosaic of degraded maquis around many rural settlements. The maquis is species-rich with fringe forbs, heliophilous plants, species of extensive pastures and clearings and ruderal and segetal species close to settlements. There are often intimate mosaics of shrub complexes but such land-use does not necessarily lead to an increase in biomass suitable for grazing. The migration of species more ecologically resistant to extreme habitats into extensive pastures has been accompanied by a process of negative selection (Colak and Rotherham, 2007).

- **Urbanization and industrialization**: There has been an expansion of industrial and urban areas into the mountain zone. Fires and air pollution have massive, if very localized, impacts (e.g. at Murgul, Karabuk and Yatagan) (Colak and Rotherham, 2007). Natural ecosystems degrade and decline rapidly as human populations increase. Due to the rapid population increase in Turkey within the last few decades many natural habitats have been fragmented, reduced in size, degraded or destroyed. Natural habitats have also been degraded due to urbanization and industrialization. Forests have been polluted especially because of the surrounding industrial plants and this fact is perceived particularly in the forests near urban areas (e.g. Istanbul Belgrade Forest) (Kaya *et al.,* 2001).

- **Tourism**: There is an increasing threat from uncontrolled and unsustainable tourism development. This is presently associated with dense housing and countless luxurious hotel construction along the coastal zones. The consequence of these pressures is damage to high quality forests and ecosystems in mountain areas and declining local economies. In all forest zones, from sea level to the timberline, even-aged stands have become standard over large areas and in some regions there has been extensive clear-felling. Natural regeneration has been used at high altitudes and to a limited extent for some tree species at all altitudes because of high visitor pressure (Colak and Rotherham, 2007). In other words, increasing construction due to tourism incentives, upland tourism, the high number of visitors in the archaeological sites, and other tourism activities exceed the site carrying capacity (Anonymous, 2008d).

- **Fire**: Approximately 25% of the Turkish population lives either within the forest, on the edge of the forest, or at a distance of less than 10 km from the forest. The socio-economic level of the people living in or near the forest is below the average living standard. This is why people would like to use the forest without any limitation for their survival, regardless of laws and regulations being violated. Therefore, setting fires for various reasons like acquiring new grazing land, clearing for new farmland, etc., has become an important method among some rural livelihoods. Between 1937, the year in which the first Forestry Law entered into force, and the end of 1994, 55,485 forest fires occurred, and about 1,432,585 ha of forest land were burned. From 1994 until today, annually a minimum of 1,339 and a maximum of 3,239 forest fires occurred, while annually, a minimum of 2,821 ha (2005) and a maximum of 30,828 ha (1994) of forest land was burned. The dramatic point is that the ratio of naturally caused forest fires is very low compared with anthropogenic-origin fires. The latest survey in 2007 shows that the foremost cause of forest fires is negligence (58%), followed by unknown reasons (17.3%), natural-caused (14.4%) and intentional (10.3%), respectively (Anonymous, 2009). According to the research carried out in the various forest fires regions, fire did much damage especially in the Mediterranean and Aegean regions over the centuries (Serez, 1995; Kücükosmanoglu, 1989, 2006).

- **Economic overexploitation of forests**: By the first years of modern forestry, the knowledge and experiences of Central Europe were imposed, rather than local experiences. In many forests, including mixed forests, clear-cutting was applied in huge areas, especially in mountainous lands. This was to gain wood-based raw material with an economy oriented point-of-view rather than an ecological perspective. This led to the destruction of valuable forests. Accordingly, because of the poor road network, over-harvesting happened in the accessible parts of the forests, while the rest was left to nature. In this way, economical and easy production was assured. In periods of economic crisis, forests were cut more than their increment rates to raise the income. Furthermore, the forests were exposed to great degradation when they were utilized by domestic and international companies. The situation today is that there is still an over-exploitation of forests rented for different land-use activities (mining, recreation, and industry, etc.) while non-wood forest product collection is uncontrolled. Some economically important tree species in forest ecosystems have been harvested, irrespective of sustainable management principles. Therefore, many mixed forests were converted into pure forests or their structure was destroyed. Over-exploitation has led either to decline or loss of populations and genetic diversity of many organisms of forest ecosystems.

- **Overgrazing**: Today, there are nearly 7.5 million forest villagers living, either in or around forests, in 20,293 villages. In these areas, 14.5 million sheep, 10.4 million goats and 0.7 million cattle (totally 25.6 million animals) are fed which results in the overgrazing of forests and forest rangelands. Approximately seventy years ago, the total rangeland was nearly 45 million ha, while today this number has declined halfway to 21.7 million ha. In other words, there are grazing levels three or four times above what is reasonable according to normal rangeland grazing capacity. In terms of grazing capacity, in 1935 one animal grazed 2.2 ha, while today the amount of grazed land by one animal is 0.76 ha. Forest meadows are widespread, especially in the oak forests found in the south-eastern and southern parts of Anatolia. The branches of the oaks are cut in order to supply both fuel requirement and to feed the animals during the winter period. Maquis vegetation is also the native meadow for the grazing of especially goats in the Mediterranean region. Maquis vegetation in Turkey is a secondary regressive plant succession in the places where red pine (*Pinus brutia*) forests have been destroyed, degenerated and cleared (Atalay *et al.*, 2001).

- **Rural pressure**: Rural pressure is among the most severe factors causing forest decrease in an “insidious” way. Indeed, in Turkey, settlements and forests are mostly intertwined, while in numerous examples villages were directly located in or near forests. As a result, their poor socio-economic level and low income is illegal extension of agricultural land, theft of wood, and millions of animals grazed in the forests. Consequently, the structure and amount of forest land has typically decreased or forests cannot regenerate. This problem still remains as an important issue.

- **Infrastructure**: An adequate road network is inevitable for a developed forest management. Although there is no comprehensive forest road network in Turkey, it is hard to say that road damage is at a low level. Particularly, roads constructed first were planned just to transport wood raw material without regarding their ecological consequences. Therefore, in many regions roads were built by using huge construction machines and dynamite which resulted in the fragmentation of natural patterns (Hasdemir *et al.*, 2007; Demir *et al*., 2008; Colak *et al.*, 2009ab). Furthermore, by the planning process of other infrastructure like regular roads (highways, regional roads, local roads and power lines, etc.) the least-cost route was taken. This was the basic principle which has over-ridden consideration of natural cycles. This has caused the disappearance of endemics and rare species, fragmentation of metapopulations, and a loss of wildlife corridors. Furthermore, the fact that roads were not constructed in an environmentally-friendly manner caused soil erosion later on.

### *3.2.2 Natural phenomena*

- **Diseases and pests**: If the recent history of forests is examined, the situation has become less drastic in terms of pests and diseases. Those which occur are a regular component of the ecosystem. However, a typical increase has been examined in recent years with the growing anthropogenic pressure on forests. Particularly, by using inappropriate techniques, mixed stands were converted into pure stands or composition ratios were distinctly changed, which caused an increase in diseases and pests. For example, many stands, where fir is the minor tree species, were converted into fir-dominant stands and critical pest and disease damage could increasingly be observed. Poor management activities favored the occurrence of diseases and pests. In general, the Forest Mapping and Photogrammetry Directorate (FMPD) and Forest Protection and Fire Fighting Department (FPFFD) are commissioned for the monitoring of pests and diseases.

- **Storms**: In Turkey forests are found from the lower altitudinal zones (sea level) to the alpine zone (approx. 2,700 m). Therefore, many forests are prone to wind and storm damages. Nevertheless, these are accepted as natural phenomena of the ecosystem and do not result in forest loss. The locations where such damage is seen easily regenerate by themselves. However, wind damage has increased in the last two decades, and strong thinning applied in forests threatened by wind has caused stability loss in stands.

- **Drought and other climatic stresses**: In recent years, as seen in many places worldwide, drought and other climatic stresses have been negatively affecting forest vitality in some Turkish forests. Specifically, plantations made with exotic species and partly in structurally-degenerate forests have been affected.

- **Fire**: See human induced phenomena above.

## *3.3 Impacts of Forest Degradation and Loss*

### *3.3.1 Impacts on the environmental functions*

Turkey is listed among the countries that will be most affected by negative effects of global climate change (Anonymous, 2008a). Reducing emissions from deforestation and forest degradation in Turkey has emerged as potential to complement ongoing climate policies. The geographical position, climate, topography and soil conditions led to degradation of the country's land/soil and increase sensitivity against drought. Through aridity in farmlands, degradation of diversity types and natural structure, erosion due to misuse of lands; soil loss has reached a significant level. Sedimentation in dam reservoirs deriving from erosion causes a decrease in dam water collection capacity and prevents optimal utilization of dams. Due to the fact that floods wash out the farmlands, productivity rate of the lands decreases. Moreover, the productivity is lost in the long term and there are losses of life and property (Anonymous, 2008a). The water cycle is also affected by forest degradation and loss in Turkey. Deforestation in Turkey reduces the content of water in the soil and groundwater as well as atmospheric moisture. The most striking issue in Turkey is the increase of soil erosion rates parallel to deforestation, while flooding and landslides ensue. Most particularly, degradation and loss on steep slopes thus increases the risk of landslides, which threatens people living nearby. As a result, the presence or absence of forest cover in Turkey can change the quantity of water on the surface, in the soil or groundwater, or in the atmosphere. This in turn changes erosion rates and the availability of water for either ecosystem functions or human services. Loss of original forest cover to other land-uses, increased degradation of remaining forests, and decreasing areas of authentic forest habitats have had a deep impact on biodiversity in many forest vegetation zones in Turkey.

### *3.3.2 Impacts on people*

In Turkey, an important part of the population (*c*. 7.5 million) subsists in and close to forests. They have mostly worked in the area of forest management activities, utilized secondary forest products, or grazed their animals in the forest (Ekizoglu and Geray, 1997; Colak and Rotherham, 2006). As a result of these activities in the regions where forests have become highly degraded, sufficient work opportunities could not be found, the amount of secondary forest products has dramatically declined, and more extensive areas were required for grazing. These negative developments have decreased the living standards of many rural inhabitants, resulting in the immigration from rural to urban areas. Furthermore, many protection forests could not fulfil their functions which resulted in frequent floods and landslides. Even more important: the quality and quantity of potable water decreased in time resulting in the use of plastic bottled water in many regions. Many forests have been moved away from naturalness with their brand new "park" structure and recreation values have decreased markedly. Since Turkey is a mountainous country, an important part of agricultural land is located on the lower slopes of the mountains and plains. Therefore, highland forests are accepted as the assurance of lowlands. However, with the degradation and loss of these forests, fertility capacity of lowland agricultural areas has continued to decline as a result of massive erosion. Regarding this fact, prominent decrease in local settler's income could not be avoided, and resulted in some regions in rural exodus. Briefly, damage to forests and other aspects of nature could halve living standards for many inhabitants of Turkey. Many people stay poor because they have insufficient rights to manage their natural resources; the result is the degradation of forests and trees outside forests and increase in vulnerability. In many parts of the country, the destruction of forest lands has increased the number and the size of natural disasters affecting the nearby human populations.

At this point the question must be how these impacts affect different social classes in Turkish society. By constituting the poorest part of the society, forest villagers are the prime group to be affected from changes in forests. Well-being of these villagers is a concept that has mostly been disregarded in management policies. Due to levels of education and health, their degree of access to resource consumption, their vulnerability and exposure to risks, and the limited opportunities to take part in decision-making processes related directly or indirectly with their own lives. These communities are significantly disadvantaged. Consequently, these poor people are the most dependent on the resources of forest habitats, which brings about the need for a multi-stakeholder planning concept, which is a newly developing understanding in Turkey.

In accordance with the introduction of modern concepts forest management practices are planned and carried out in a manner to prevent or minimize adverse effects on cultural heritage values. Although there may be a monetary cost to the state forest industry in doing this, benefits are derived for all the participating parties. However, the actual situation in Turkey shows that cultural heritage sites are poorly conserved. Four classes of cultural heritage values can be defined in Turkey. These are: (a) archaeological sites, (b) cultural heritage landscapes (Okan and Ok, 2006), (c) historical traditional values, and (d) cemeteries.

In relation with the accelerating increase of population and expectancy of better life standards the need for forest products has increased. In spite of this fact, wood-based raw material supply from forests has decreased as a result of forest loss and degradation. The tragic fact is that Turkey is now a foreign resource-dependent country, which satisfies its 50% wood-based raw material need from foreign countries, particularly from Russia. This situation has partly increased the pressure on forests, while the forests products demand of private sector keeps this problem on the agenda.

### *3.4 Desertification*

Although there are not any actual deserts in Turkey, there is a significant erosion risk over much of the area with associated potential desertification risk as indicated on the National Erosion Map. According to Anonymous (2006), the diverse topography along with deforestation, unsuitable tillage, and irrigation management, has exacerbated the rate of erosion for centuries. The majority of the country's soils are prone to erosion risk due to the dominant steep slopes, and 72% of the soils are more or less affected by water and wind erosion. This is a most severe rural environmental problem affecting 81% of the total land surface to varying degrees. About 73% of the cultivated land and 68% of the prime agricultural land are prone to erosion. Stream bank erosion affects 57.1 million ha and wind erosion degrades another 466,000 ha. As a result, about one billion tons of soil are transported to the sea each year. The share of severe erosion is also relatively more in areas where agriculture is practiced without soil conservation measures. Alongside the difficult conditions, accelerating anthropogenic pressure has created today's dramatic scenery in

Turkey. This suggests that if fundamental measures are not taken to combat the decline, then many areas will be prone to desertification in the very near future. The degradation of the natural vegetation on the sand dunes of the Eastern Mediterranean in the 1960s caused the extinction of several endemic plant species. Moreover, agricultural lands and villages were threatened by the movement of mobile sand dunes. The Ipsala-Edirne flood plain and the Sanliurfa-Harran plain are the best examples for salinity build-up due to excess irrigation and poor drainage. Successful attempts were implemented by related institutions to deal with the threat of burial by moving sand. This was in the wind erosion prevention area in Konya-Karapinar (Tavsanoglu, 1976) in Central Anatolia, in the “Eastern Anatolia Watershed Rehabilitation Project” area, and in the “Sand Dune Rehabilitation Area in Akyatan-Adana”. Although these efforts have been successful and prevented erosion to some extent, they employed an artificial forestry ecosystem. This was established using inappropriate plants and exotic tree species instead of indigenous ones, and so contributed further to ecological decline. The causes of land degradation and erosion risks in Turkey can be summarized as follows (Anonymous, 2006):

1. The natural causes: a) Soil degradation by water and wind erosion, and the movements of the sand dunes, b) Decline of soil productivity/soil quality due to leaching plant nutrients from the surface and subsurface horizons and, c) Climate change.
2. Technical causes: a) Deforestation, b) Over-grazing of rangelands, especially rangelands on hillsides, c) The human-induced destruction of the hydro-geological cycle, d) Stubble burning, e) Mismanagement of agricultural lands, and inappropriate/excess irrigation, f) The lack of ground water management, g) Inappropriate use of agricultural and forest lands (e.g. soil sealing), h) Salinity build up in agricultural lands and increase of aridity, i) Soil pollution, and j) Physical degradation of land.
3. Socio-economic, administrative and legal causes: a) Problems arising from the lack of legislation (The authority for land-use and land management for different purposes belongs to a number of institutions and lack of coordination between them causes confusion about sensible management of natural resources. To ensure sustainability means making rational decisions without political and populist concerns. This requires legislation to protect and use natural resources more effectively as well as addressing the inappropriate distribution of land ownership and its legal implications). b) Migration and rural poverty (Loss of natural resources in a region leads to income reduction and migration to areas with better job prospects). c) Lack of awareness of land management (It is crucial to train farmers about contemporary methods of cultivation practices and demonstrate to them the importance of living sustainably within natural ecosystems. However, in order to facilitate this development it will also be necessary to foster an economic system which allows the farmers to follow this approach).

## 4. Forest Rehabilitation and Restoration

### *4.1 Targets of Forest Rehabilitation and Restoration*

Forest rehabilitation and restoration has always been a sophisticated issue in Turkey. Many ecological, socio-economic and political factors have to be taken into consideration by setting targets and implementing them as in the plans. It is understood that with many failed projects the vital point is to build understanding and gain acceptance of key stakeholders. As indicated by Sayer (2005), one person’s “restoration” is often another one’s “degradation”.

This is a main reason for the failing projects in rural Turkey, since by setting targets governmental bodies do not listen to the needs and expectations of public institutions and rural organizations. Yet these are often the voices of the local community and their common sense. On the other hand, various interest groups mostly have different visions of an area to be rehabilitated or restored. For example, as emphasized by Sayer (2005), foresters consider land degraded if it does not support a crop of commercially valuable trees. This resulted in the conversion of wide areas to monoculture plantations in Turkey. However, ecologists, silviculturists and landscape planners, consider a forest degraded if it does not have multiple layers of vegetation and a reasonable number of dead or decaying trees as habitat for birds and invertebrate. However, amenity groups do not like dense forests but want mosaics of woodland and open land with extensive views. Furthermore, the last two opinions were adopted only after a long time in Turkey. Yet even so it is often a concept that is not put into practice. The basic lesson is that there can never be a single vision of an "end point" for restoration that will automatically meet with the approval of all interested parties. Yet the following concepts and approaches can be used as a new vision in Turkey after Sayer (2005). This provides the tools to guide forest landscape rehabilitation and restoration projects in the right direction and to find the middle point by the process of determination of the targets:

1. Answer the questions: Restoring what, for whom and why? These questions should be answered by real stakeholders-local people, conservation organizations, etc.- those who will do the work or incur the costs and benefits.
2. Work with scenarios, visions, and stakeholder processes: Care has to be taken to ensure that the interests of less powerful groups are addressed. Achieving genuine public participation is not just common sense. It requires professional skills. Neutral professional facilitation is almost always necessary.
3. Understand development trajectories: What would happen if there were no intervention? What is the underlying development trajectory? What are the principal drivers of change? It is vital to get the correct answers to these questions. Modelling can help. Normally, only a small number of drivers of change are significant at any one time. It has to be known which ones they are and how they can be influenced. The underlying processes of ecological succession also have to be understood. The factors that influence rehabilitation and restoration at a single location are not necessarily confined to that place. A variety of extra-sectoral influences such as economic and trade policies and levels of public understanding of issues will have a continuing and variable influence on rehabilitation and restoration processes.
4. Use monitoring and evaluation as a management tool: Monitoring and evaluation have to be linked to the desired outcomes of interventions. Indicators of the desired outcomes have to be agreed to or negotiated at the beginning, and they then become the tools for adaptive management.
5. Find and protect reference landscapes: Whether or not the objective of forest landscape rehabilitation and restoration is to restore the "original" vegetation cover, it will always be useful to have reference areas that are as near as possible to the natural conditions of the area. These are useful as benchmarks, for understanding ecological processes, for education, and as sources of plants and animals to be used in assisted rehabilitation and restoration. It is also important to avoid falling into the trap of assuming that natural systems reach a climax condition and are then constant. This is rarely the case. Natural landscapes are highly dynamic, and decisions to restore to "natural" conditions will always be arbitrary and open to multiple interpretations. Reference landscapes, or plots, with minimal intervention remain valuable in helping to understand landscape processes and can be useful components of any large-scale rehabilitation and restoration program. They can be valuable as examples to look at during negotiation processes.

6. Be realistic about “designer landscapes”: Once a comprehensive stakeholder participation process is engaged, it will gradually become possible to begin to talk about desirable outcomes. Eventually, a vision of a “designer landscape” may begin to emerge. Different approaches and tools are useful to explore what the landscape should look like in order to respond to the needs and wishes of different interest groups.

In Turkey, the following main forest rehabilitation and restoration targets have been determined as outputs: (a) operation of ecosystem processes, (b) accelerating productivity, (c) stimulating services, and (d) sustaining cultural mosaics. These targets are elaborated as the official and national targets of the government as follows; to increase the forest assets, rehabilitate degraded forest lands, decrease erosion, preserve the soil and manage it in a sustainable way, preserve water bodies, prevent sedimentation in dams, lakes and ponds and guarantee water and electricity generation, minimize floods and overflows, especially, ensure sustainable operation of farmlands, minimize the negative effects of climate change and desertification so as to re-establish the spoiled balance of nature and to prevent air pollution, meet the community’s need for recreation and conserve water bodies by surrounding the cities with greenbelts and city forests (Anonymous, 2009).

Planned tools by government to reach the aforesaid targets are (Anonymous, 2008a):

- Increasing seedling species of forest tree species and endemic and wild fruit species to sustain biologic diversity
- Raising awareness of the community on natural cycles with tree and forest sympathy,
- Making sapling plantings a common tradition
- Promoting private nursery initiatives to become a country that exports seedlings
- Ensuring participation and contribution of the community in afforestation works
- Spreading private afforestation and social forestry
- Supporting private afforestation and private forest nursery works
- Decrease the production stress on natural forests by meeting the demand for forest products through plantations
- Improving livestock by rehabilitation and restoration of rangelands within forests
- Promoting quality of life standards of the community

Along these targets, the concept of restoring forest landscapes for traditional cultural values arouses interest among decision makers, since Turkey is a mosaic of many different traditional cultural values. In this context, the following framework represented by Joseph and Mansourian (2005) is very effective for the situation in Turkey:

- Some values provided by forests can be essential to a culture. The rehabilitation and restoration of these cultural values can be a major objective of rehabilitation and restoration in a landscape.
- Cultural values need to be considered along with economic and ecological values to make forest landscape rehabilitation and restoration effective.
- Often the rehabilitation and restoration of traditional knowledge must go hand in hand with the rehabilitation and restoration of certain species in order to sustain its continued protection and use.
- Restoring for diverse cultural values encompasses a wide range of land holdings and tenure systems, and therefore needs to be culturally and geographically specific.

People rely on forest products for their basic subsistence but also for a range of other values. Traditional cultural values that have coevolved with local ecosystem goods and services are integral to a community’s health, food, livelihood, art, and spiritual needs. Degradation of ecosystems impacts on the entire cultural lifestyles of these communities, generally leading to continued erosion of traditional knowledge systems. Indeed many typical examples of this traditional cultural value loss can be found in different parts of the country. Cultural traditions and values are as heterogeneous as ecosystems and their life forms. However, these values and traditions are under threat by external factors associated with global change such as globalization, population growth, inequity in distribution of wealth and livelihood options, and climate change. These macro-drivers have cascading and complex impacts at the local levels on biodiversity and the traditional knowledge associated with it. Cultural values provided by forests are both impacted by and impact on rehabilitation and restoration. However, a basic understanding of the close interaction between forests and cultural values cannot be perceived in most of the applied projects until today. As forests are lost, so are the numerous values they provide. Thus the loss in forests could lead to the decline in local cultural values that have protected the land and its resources for centuries. Although being a melting pot of cultures, the historical documents indicate the disappearance of many values. It has been proved with many successful applications worldwide that specific cultural values can be used as triggers for rehabilitation and restoration. However, this is not yet the case in Turkey (Joseph and Mansourian, 2005). If cultural values are to be used as an objective of forest rehabilitation and restoration in a landscape in Turkey, a participatory process will be necessary. This may include the following steps after Joseph and Mansourian (2005):

- Document the traditional knowledge with local people to identify cultural drivers for the rehabilitation and restoration of forest functions in a landscape.
- Together with local people, identify the current status of those cultural values.
- Through focus groups, discussions, and other locally applicable participatory tools, identify the links between those cultural values and other forest functions that may need to be protected and restored.
- In conjunction with stakeholders, set objectives for the protection and rehabilitation and restoration of the identified cultural values.
- Develop locally adapted approaches, such as biodiversity-rich agroforestry, to restore cultural and other forest values in the landscape.
- Promote traditional knowledge pertinent to the local area through local schools and other local civic and user forums.

## *4.2 National Policy on Forest Rehabilitation and Restoration*

### *4.2.1 The framework of rehabilitation and restoration planning in Turkey*

Changing policy toward rehabilitation and restoration or land-use is often the most effective way of stimulating large-scale rehabilitation and restoration. Such policy changes can be addressed, in different ways, at a local scale (e.g. changing grazing patterns), at a national scale (e.g. modifying forestry laws), or at a global scale (e.g. ensuring that international conventions favor high-quality rehabilitation and restoration). Key tools in policy interventions include good analysis, especially economic analysis, case studies, and advocacy (Mansourian and Dudley, 2005). When examining Turkish forestry history, the emphasis on restoring degraded lands is quickly apparent. However, as explained above, policy changes have been in favor of short–term political benefits rather than the increase of rehabilitation and restoration quality. Localized and site-based interventions to restore habitat can be very useful, and much of what has been learned about ecological rehabilitation and restoration comes from small-scale initiatives, primarily carried out by governmental departments and some few nongovernmental organizations (NGOs). The reflection of rehabilitation and restoration into national policies is mostly localized and site-based, instead of generalized and schematic.

Additionally, small-scale initiatives are inevitably limited in what they can achieve on their own and are usually expensive, stretching the resources of the organizations or communities that carry them out (Dudley, 2005a). Therefore, after such experiences, large-scale implementation was seen as a key to the rehabilitation and restoration policies. As indicated by Dudley (2005a), in Turkey, the more recent tendency has moved to spending effort to change policies at local, provincial, national, regional, or even global levels to encourage rehabilitation and restoration at a broader scale. Many NGOs undertake rehabilitation and restoration initiatives to use them as a lever to change policies, by for example, showing that different approaches can be more effective or cost less money. But although working examples can be powerful tools in stimulating change, they usually need to be accompanied by effective advocacy and a thorough understanding of the policy climate.

There are also increasingly opportunities to change policies that transcend national borders, thus potentially having an impact on a global or a regional scale. However, many policies couldn't be implemented into practice, although Turkey has signed various international agreements related to the subject. Consequently, the Turkish point of view of rehabilitation and restoration policy still remains in its infancy. As indicated in Dudley (2005a) far better understanding of the economic and other benefits of environmental goods and services from rehabilitation and restoration are still required. More generally, major changes are still needed in domestic and global trade policy to remove the perverse incentives that currently act against rehabilitation and restoration in many areas.

### *4.2.2 Policies for encouraging forest rehabilitation and restoration*

In Turkey many supporting measures have been thought and put into practice to encourage forest rehabilitation and restoration. Indeed these applications do also find wide place in international landscape rehabilitation and restoration concepts (Dudley, 2005a). The results of these policies are criticized with just some examples below:

- Agreed changes in grazing regimes to allow natural regeneration, agreeing to protect different zones at different times: Although it is an old policy in Turkey, still some deficiencies are experienced by the implementation.
- Governmental controls on collection of non-timber forest products to ensure that these are not degraded: The illegal collection of wood and non-wood forest products is still ongoing, although there are many strict laws on this issue.
- Collective investment in private and state tree planting (poplar, chestnut, etc.) for instance to establish fuelwood and round wood plantations: In Turkey large-scale poplar afforestations have been put into practice and 10% of the world's total poplar production is done in Turkey, thus on this issue an important success has been gained.
- Allow old-growth forest to remain, facilitate retention of deadwood, and remove perverse incentives that discourage rehabilitation and restoration: The continuous forest concept has been introduced in Turkey, while the need for leaving 3-5 units old dead wood per hectare has been accepted and partly started to be implemented.
- Changing national forest restoration and afforestation programs to increase the range of goods and services that they provide: The enthusiasm for speedy afforestation of degraded areas led to almost complete afforestation with monoculture coniferous and exotic tree species. However, in late projects, afforestation used trees of local origin. Later on, monocultures were converted into coniferous-mixed forests, and broad-leaved tree species were included in the polyculture plantations. Today, afforestations are implemented with broad-leaved tree species in broad-leaved forest zones. In this context particularly, there has been a reduction in the proportion of intensive plantations and an increase in assisted natural regeneration. These have been accepted as basic principles.

### *4.3 Methods (Examplars) of Forest Rehabilitation and Restoration*

In Turkey, forest rehabilitation and restoration practices have been applied to large areas and three different phytogeographical regions (Euro-Siberian, Mediterranean and Irano-Turanian) for a long time (*c*. 85 years) (Ürgenc and Boydak, 1982, 1985, 1992; Ürgenc *et al.*, 1988, 1993; Saatcioglu, 1961, 1952; Saatcioglu and Atay, 1978). Some modern projects came onto the agenda in the last 10-15 years. Today, from a conservation perspective, the most pressing rehabilitation need is to increase quality in existing forests rather than to establish new forest areas. In Turkey, restoring ecological quality requires a proper understanding of the components of a natural forest (composition, pattern, functioning, process of renewal, resilience, and continuity in time and space). Approaches to restoring quality include (Dudley, 2005b) active management to restore missing microhabitats and steps to influence both processes and the way in which the forest renews itself. In this context, rehabilitation and restoration of deforested and degraded forest landscapes and forest rehabilitation and restoration implementations are brought together under major- and suntopics in Table 4. It is easily remarkable that the constitution of new forest land, erosion prevention, and recruitment of watershed areas and conservation of human habitats have been given priority, while ecosystem improvement, forest rehabilitation and close-to-nature applications are newly-developing issues. Accordingly, Turkey succeeded in developing unique methods on basic applications due to its local and national settings, while failed to improve modern concepts bound to lack of experience. As the general structure of rehabilitation and restoration implementations in Turkey is examined, the following basic principles are seen:

- Locality characteristics of Turkey vary within short distances. Therefore, survey and project activities are important. Implementation projects are analyzed in detail for location, climate, vegetation cover, topography of site, physical and chemical characteristics of the soil, land property status, existence of any social conflicts and the demands of the local community (Anonymous, 2008a).
- Adaptation of available participatory approaches and tools for rehabilitation and restoration projects with different management objectives, socioeconomic and ecological conditions, and stakeholder groups.
- Determination of simple technical guidelines on how to design, implement, and monitor efforts, incorporate participatory approaches and tools for different objectives and site conditions.
- Evaluating prospects for forest products and environmental service payments to communities. This includes the feasibility of producing high-value timber for industries; timber, fuel wood, and other forest products for local needs and markets; and payments for biodiversity and watershed at the local to national levels.
- Framework for assessing potential contribution and impact of different rehabilitation approaches to communities, in comparison with other local income-earning opportunities and alternative land-uses.
- Boosting policy, donor, and implementation support for genuine local participation and consideration of local needs in projects. Integrated rehabilitation and restoration activities with regional development strategies and community development activities based on local conditions and needs.

**Table 4:** ***Primary and secondary implementations on rehabilitation and restoration of deforested and degraded forest landscapes in Turkey***

| Forest rehabilitation and restoration | | |
|---|---|---|
| Long-term continuing | | Current |
| **Primary implementations** | • Restoration and rehabilitation of watershed areas (especially water quality and quantity)<br>• Afforestation of deforested areas (especially in arid regions).<br>• Erosion control with greening and afforestations<br>• Greenbelt afforestation<br>• Dune afforestation<br>• Rehabilitation and restoration of floods, overflows and avalanche areas | • Rehabilitation of burned forests.<br>• Transformation from coppice forests to high forests<br>• Rehabilitation and restoration of degraded Oaks forests<br>• Active restoration and rehabilitation of hotspot forest habitats for target species.<br>• Rehabilitation and restoration of deadwood as a critical microhabitat in forest landscapes<br>• Promotion of rare tree species in mixed natural forests |
| **Secondary implementations** | • Rehabilitation and restoration quality in existing native forest landscapes.<br>• Restoration and rehabilitation of degraded and eroded macchia forests.<br>• Rehabilitation and restoration of protection forests.<br>• Biological combat against ductile and wheat stink | • Replacing exotic tree plantations with native tree species<br>• Restoring soil and ecosystem processes<br>• Mountain forest rehabilitation and restoration<br>• Rehabilitation and restoration of protection forests<br>• Restoration and rehabilitation of urban forests<br>• Wetland rehabilitation and restoration<br>• Cultural practices for restoring and maintaining ecosystem function<br>• Rehabilitation and restoration of Olea/Corylius forests |

The technical features of differing rehabilitation and restoration implementations realized due to the above mentioned principles are explained briefly below.

### *4.3.1 Primary implementations (Long-term continuing)*

#### *4.3.1.1 Afforestation of deforested and degraded forest areas (especially in arid regions)*

The entire afforestation practices of deforested and degraded forest areas are applied as indicated in the flow chart below (Table 5). Particularly by the studies implemented in Inner Anatolia, Aegean and Mediterranean Regions various techniques, that are convenient for local conditions, have been developed and used in afforestations. Thus, Turkey succeeded in finding or developing appropriate afforestation techniques for its highly differing habitats.

**Table 5:** ***The considered stages by the afforestations in Turkey (Colak and Odabasi, 2004)***

| | | |
|---|---|---|
| **Preliminary work for afforestations** | • Selection of the area to be afforested<br>• Inventory studies in afforestation area (Preparation of habitat maps, biotope map, native tree and shrub species map, slope class map, etc.)<br>• Determination of afforestation targets | **Box 1** |
| | • Assessment of local and regional experiences<br>• Determination of the opportunities for the formation of close-to-nature forest structure near-native (potential) vegetation (uneven stand, mixed stand, etc.).<br>• Classification of afforestation area and allocating afforestation units<br>• Aerial setting, time scheduling and section planning (main service roads, fire roads, etc.)<br>• Determination of the measures for the conservation and regeneration of biological diversity | |
| **Afforestation planning** | • Selection of tree species and suitable origin<br>• Seed procurement (Seed harvest, harvest stand selection, harvest method, seed storage, seed stands, etc.)<br>• The organization and planning of essential seed and sapling yield<br>• Sapling production and transportation<br>• The assessment of needs in technical tools, machines, labor and related issues (accommodation, storage, etc.) | |
| **Land preparation** | • Need for weeding control and handling felling material<br>• Soil processing (Challenges, targets, methods, etc.)<br>• Planning of protection measures | **Box 2**<br>**Box 3** |
| **General method selection** | • Sowing (Soil processing, sowing, seed requirement, sowing period, sowing technique)<br>• Planting (Sapling yield facilities, sapling quality, planting period, planting-distance, planting density, planting method, etc.) | **Box 4** |
| **Maintenance planning** | • Maintenance planning of afforestations<br>• Determination of control method for success in afforestations | |
| **Planning of expenses** | • Planning of afforestation expenses | |

**Box 1 (**Anonymous, 2007):

Afforestation targets:

Afforestation targets need to be introduced in relation to the method used and the reason for undertaking the work. The main targets of afforestations implemented in Turkey can be summarized in three categories, which are: (a) Wood-based raw material production; (b) Conservation, hydrological and ecological purposes; (c) Increasing aesthetic beauty, recreational and social purposes (Figure 2).

**Figure 2:** ***An example of a greenbelt afforestation implemented on the edge of an urban area (Source: AGM)***

The areas below are preferable for successful and unchallenging afforestation:

- Areas with most favorable site conditions and suitable for intensive plantation methods.
- Areas without ownership problems and land parcelling completed.
- Areas without any social pressure or possible to be improved with social development services for forest villages.
- Burnt areas.
- Areas where worksites can be easily built.
- Areas where there is an afforestation demand from local people,
- Areas close to settlements and suitable for recreation.
- Areas near or next to former afforestation sites and areas with potential continuity.
- Small and fragmented areas are not preferred.

Mainly considered issues as not to face with social conflicts after the afforestation are:

- The borders and ownership of afforestation area should be determined accurately and prevention of entering private lands
- The cooperation with ORKOY (Directorate of Forest and Village Relations) plays a critical role by the afforestation of socio-economically conflicting areas
- Buffer zones should be constituted by the borders of the afforestation area near the residential zones
- By the afforestations as from buffer zones, broad-leaved and coniferous species (Chestnut, Linden, Walnut, Stone pine, Acacia, *etc.)* should be preferred as to promote the non-wood forest products production and motivate local inhabitants with economic benefits of afforestation
- Rangelands and water ways should be considered by the implementation.
- The social and economic outputs should be clearly explained to local people by building close and constant contact between governmental bodies and stakeholders.

**Box 2 (**Anonymous, 2007):

The basic principles of weeding control are as follows:

- The protection of broad-leaved and fruit trees should be provided considering their growth features, fire resistance and stand structure. If necessary, refreshing cut should be applied to broad-leaved trees. The constitution of broad-leaved mixtures by sowing and planting should be determined based on natural systems and local provenance. For broad-leaved mixtures with native vegetation, groups and strips should be marked first, since they will not subjected to weeding control. This enhances protection for native flora and fauna.
- Endemic species, aromatic plants and some valuable species like Linden, Chestnut, Juniper, Wild cherry, Common hawthorn, Mountain ash, Yew, Box tree, etc. should be protected in suitable groups.
- Species within 100 m of lakes, ponds and dam reservoirs should be protected and amendment measures should be taken, while conservation measures should also be taken for the native species in high-sloped areas without considering their genus and other features.
- Stream vegetations should be protected as a whole. Dried and diseased species should be disposed, while drained individuals should be rehabilitated.
- Suitable areas for wildlife development should be avoided by the afforestation work.
- Present cover like *Rhododendron* should be protected in areas, where there is a high risk of land slide, erosion, flood and overflow (e.g. Black Sea Region).

Weeding control is applied with man power and/or machines (Figure 3) due to the site conditions of the afforested area. In the areas, where ground cover is degraded high forests, degraded coppice or maquis, the strips are located vertical to the land slope in constant intervals to stack the slash. Therefore, bush rake functions vertical to the land slope from top to bottom (0-20% slope: 36-42 m; 21-40% slope: 30-36 m; 41-60% slope: 21-30 m) (Figure 4). Special equipment is required


**Figure 3:** ***Bush rake for land clearing (Source: AGM)***

**Figure 4:** ***Land clearing and land cover stracks (Source: AGM)***

**Box 3 (**Anonymous, 2007):

Soil procession:

Man power or machines (slopes under 40%) are used for soil procession. Subsoiling is done with ripper or plow in areas smaller than 10 ha /Figure 5). Soil is processed 60-80 cm deep and parallel to the contour lines with this equipment, while topsoiling is practiced with disc harrow in slopes under twenty-five percent. Human power is used mainly in areas, where slope is over forty percent and machine use is not applicable. Here soil procession is practised with terracing parallel to the contour lines. In wet climates, slope length is shortened to decrease surface


**Figure 5:** ***Subsoiling with ripper(Source:AGM)***

flow and change its direction by constructing "diversion" or "inclined" terraces, while, in addition to these functions, in arid and semi arid climates "horizontal" or "absorbing terraces" are built for water storage and seepage. Terraces are constructed as continuous (Figure 6) and disconnected terraces (Figure 7).
The soil procession steps are represented in Figure 8.

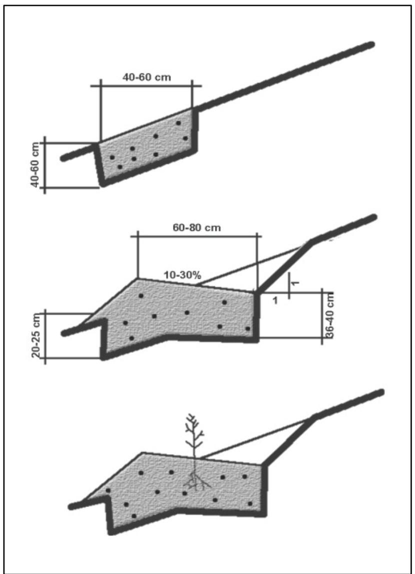



**Figure 8*****: Terrace construction steps (Source: AGM)***

**Figure 6:** ***Continuous terrace (60-80 cm wide, 35-40 cm deep, slope: 10-30%) (Source: AGM).***

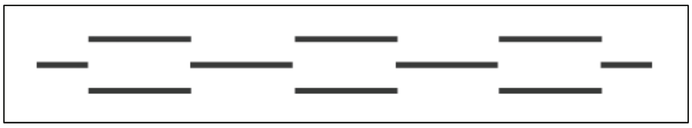


**Figure 7:** ***Discontinuous terrace (Source:AGM)***

**Box 4** (Anonymous, 2007):

Planting methods:

Planting is implemented mainly with three different methods: (a) Bar planting (Figure 9); (b) Side-hole planting (Figure 10); and (c) Hole planting (Figure 11).

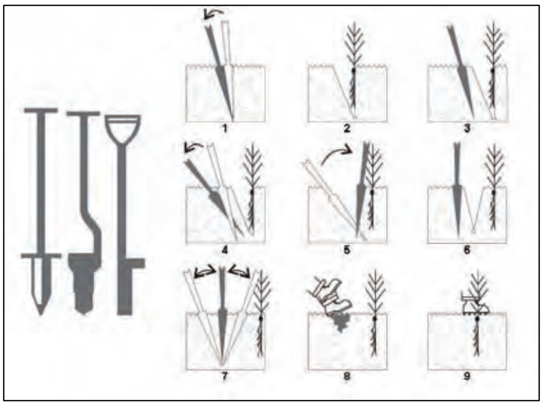


**Figure 9:** ***Bar planting (Source:AGM)***

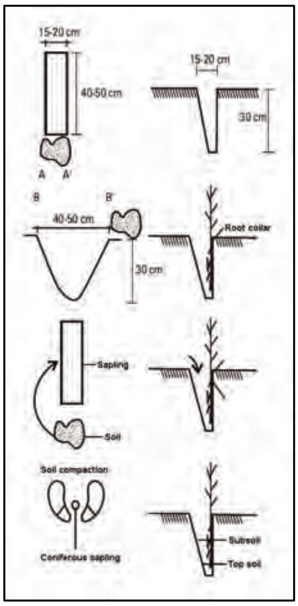



**Figure10:** ***Side-hole planting (Source: AGM)***

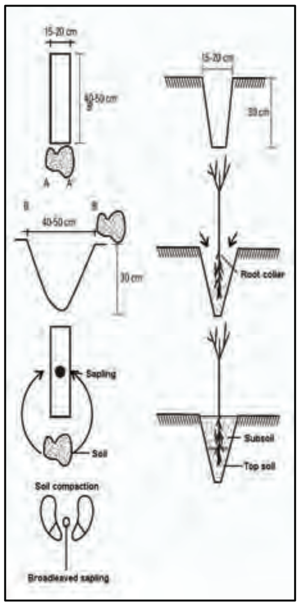



**Figure 11:** ***Hole planting (Source: AGM)***

Sowing methods:

It is applied with broadcast sowing method and partial sowing methods (strip sowing, spot sowing) (Figures 12 and 13).

Basic afforestation principles with sowing are as follows:

- Providing genetically favorable, easy to access and cheap seeds in suitable origin.
- Seed recruitment, transfer to the field, preparation for sowing, storage under suitable conditions, distribution in sufficient amount and density for the field.
- Selection of deep rooted species in new growth period.
- Determination of sowing methods suitable for the stand structure and species, preparation of seed bed, detection of sowing period and depth.
- Taking measures against pests.

The areas to be afforested by sowing:

- Arid and semi-arid areas.
- Areas and aspects exposed to high temperatures and drying winds.
- Highly inclined bare slopes.
- Areas, where physiological depth is insufficient, horizontal stratified, and bedrock is uncracked
- Weedy, wet and dense-stacked soils.

The areas where ground cover is intensive are not suitable for sowing.

**Figure 12:** ***An afforested area constituted with planting method (Source: OGM)***

**Figure 13:** ***2005-2011 Rehabilitation Action Plan of Cedar Forests. Sowing the 30, 000 tons seed with carpel (Source: OGM)***

The major experiences gained from afforestations are as follows:

- About 10-15 m are left from both sides of primary and secondary streams for the native vegetation and this amount has been increased in recent implementations, while riperean vegetations were not considered in early projects.
- Bare rooted and seedling plantations have generally succeeded except extreme habitats. Later, pot plants with peat were used for cultivation but did not increase the afforestation in parallel to increased costs.
- Early implementations were mostly site-based, thus soil processing and weeding control were regular applications. However, with the introduction of biological conservation concept vegetation has started to be protected in strips, klumps and groups. This approach has been applied to various current projects.
- Many important and rare biotopes were lost, since they were not appropriately considered in the afforestations. Therefore, a new tendency has begun for the conservation of biotopes, besides biotope mapping has aroused interest among practitioners and experts.
- The gaps in natural forests are started to be imitated by the afforestations.
- Early afforestations were implemented with monocultures, while polycultures are widely used in later practices. Today, the main method is using native species of the habitat in the afforestations.
- Regular planting was the basic method used alongside afforestation areas. However today, even they might be monocultures, forest edges are formed by irregular planting distances and mixtures of particularly native broad-leaved species are used.
- Local species and origins have been considered since the early implementations, which increased the stability and vitality of the afforestation.
- After experiencing dramatic failure in afforestations made with exotic species, native species are preferred almost in each implementation.
- Dense planting method has been left, while widely spaced planting suitable for species' biological features has been applied in recent years.
- Economically valuable coniferous species were used by the early applications, while today a wide-range of broadleved trees and shrubs are preferred in afforestations.
- Terrace afforestations succeeded and different terrace models have been developed considering differing habitats.
- Use of the same technique in upland and lowland has resulted in failure mostly in areas near timberline. Therefore, cluster-shaped afforestation models are not used.

#### *4.3.1.2. Restoration and rehabilitation of watershed areas*

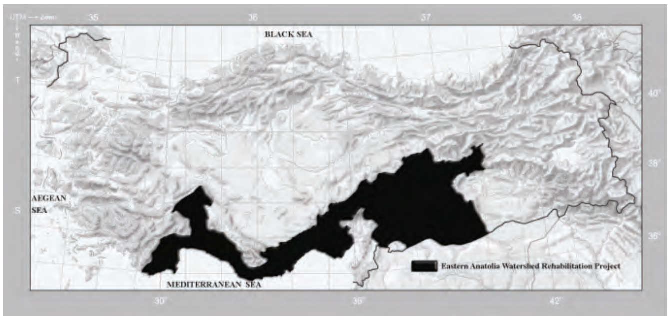
The loss of forests has been blamed for everything from flooding to aridity. This is due to many natural disasters experienced by Turkey. Although forests certainly play a critical role in regulating hydrology, this is complex and variable. There appears to be a clear link between forests and the quality of water from a catchment, a more sporadic link between forests and the quantity of water, and a variable link between forests and the constancy of flow. However, in contrast to popular understanding, many studies suggest that in both very wet and very dry forests, evaporation is likely to be more intensive from forests than from other vegetation, as is the case in Inner Anatolia, leading to a decrease in water from forested catchments as compared with grassland or crops. In addition, some very old forests such as mountain forests of 150 years or more, apparently increase stored water.. The precise interactions between different tree species and ages, and different soil types and management regimes are still often poorly understood, making predictions difficult. Forested catchments have important local impacts in regulating water flow. Undisturbed forest is also the best watershed land cover for minimizing erosion by water and hence also sedimentation (Dudley and Stolton, 2005).

First watershed based works in Turkey were introduced with the aim of decreasing the damages of floods and overflows and thereby providing safety for current dams through erosion and afforestation projects. These primary implementations at the upper watersheds were realised as decreasing soil erosion, facilities regulating the water regime and afforestations. In the meantime, various supports were provided to local communities in the watersheds by preserving natural vegetation and regulating grazing of rangelands. The method for prioritizing public participation in the decisions related to local implementation is the main theme in the first generation of watershed rehabilitation in Turkey. By the second generation of watershed rehabilitation in Turkey, the overall watershed was taken into consideration and in selected micro-catchments the aim is the integration of preservation and rehabilitation of natural resources alongside income-raising activities. Training of local people and capacity building of related agencies are further objectives. In sustainable watershed management, decreasing surface pollution and contamination of underground waters by animal-related activities, manure and agricultural pesticides are further targets. The intention is to decrease drainage of nutrients and pollution into low-lying basins and ultimately into the sea. Monitoring water pollution, supporting organic farming activities, spreading these activities around the country, and providing support in the implementation of the EU Nitrate Directive are additional aims. In the third generation of Watershed Rehabilitation Projects that are still ongoing, integrated water management is included within the projects since the need for water resources increases along with conservation and improvement of natural resources. The following subjects are featured: prevention of pollution deriving from industrial and domestic wastes, water production and management and operation of upper watershed forests in line with water production (Anonymous, 2008b).

As indicated with the above rehabilitation projects, in Turkey there is a clear link between forests and catchment water quality. There are more sporadic links between forests and the quantity of water, and also between forests and the constancy of flow. The potential role of restoration with respect to water supply needs to be considered on a case-by-case basis and on a long time-scale. More basically, there is need for greater understanding of the links between forests and water, perhaps initially through better diffusion of existing research and case studies. There is also a need to beter understand the linkages between water supplies and forest cover to help use these links as arguments for restoration. However, the Turkish government has made decisions about forests and water based on flimsy data and poor methodologies, leading to disputes over most of the applied projects. In general, watershed values are an additional argument for restoration rather than being associated with specific restoration techniques. Information for policy makers about the value of different forested watersheds remains scarce, and models for predicting responses in individual catchments are at best approximate. Restoration for water-related purposes within individual catchments will vary according to circumstances and will be able to draw on many of the tools outlined elsewhere (Dudley and Stolton, 2005).

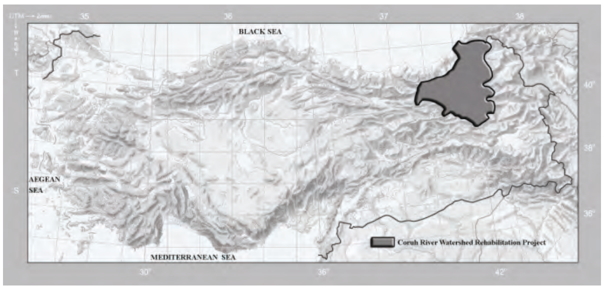
Although important progress has been made with rehabilitation projects in the three generations of Watershed Rehabilitation Projects in Turkey, the essential globally accepted techniques are still lacking. As a particular example, using forest cover to maintain water supplies at a watershed scale often requires a mosaic approach, where protected areas, other protective forests, and various forms of management are combined depending on existing needs and land ownership patterns. Rehabilitation and restoration then becomes a management option that can be used in any of the above. Agreeing on the mosaic and balancing different social, economic, and environmental needs on a landscape scale requires careful planning and negotiation. Suspended soil in water supplies can render irrigation water unfit for use, or greatly increase the costs to make it useful. The potential role of rehabilitation and restoration needs to be considered on a case-by-case basis and probably also on a long time-scale. Establishing fast-growing plantations (Boydak and Dirik, 1998) is unlikely to do much to help either the quantity or the quality of water, while carefully located and managed secondary forests can do much to regulate sediment load, other pollution, and erosion, and may in some situations affect the flow regime. Restoration for water supplies should also look at options for reducing impacts from managed forests through, for instance, removing unnecessary roads or changing their location, camber, and drainage facilities (Dudley and Stolton, 2005).

### Case Study: 1



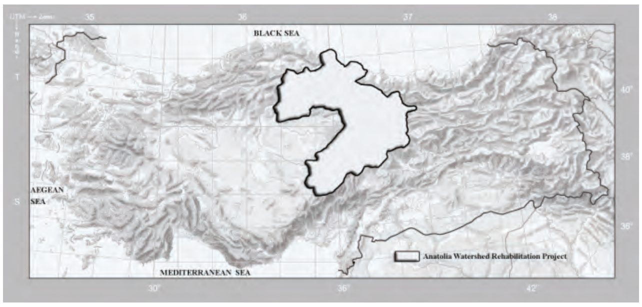

**Eastern Anatolia Watershed Rehabilitation Project** was a first generation watershed rehabilitation financed by the World Bank. The integrated participatory approach was embraced and a project approach was implemented in which all related government agencies cooperated with the local people. All the activities within the project were aimed at upper parts of the catchment. Natural resource conservation and rehabilitation were targeted and in order to reach this target, income raising activities to increase the living standard of local community as well as training the local people for natural resource preservation and sustainable management activities were realized. Local people were trained while the capacity building activities for the agencies were also continued. AGM, by the end of 2001 within 85 project micro-catchments accomplished the program for 73,156 ha. Soil Conservation Afforestation, 19,882 ha. Rangeland Rehabilitation, 81 ha. Gallery Plantation, 2,240 ha. Oak Rehabilitation and 1,687 ha. Cedar Rehabilitation establishment. For all these works, from the beginning until the end of 2001, in total USD 43,027,000 was spent; USD 27,039,000 was external loan and USD 15,998,000 was internal disbursement. Within the Project TUGEM completed 7,888 ha Agronomic Package Implementation, 9,813 ha Fallow Reduction, 1,588 ha Demonstration Works, 1,224,000 Unit Pistachio Vaccination, 238,049 Unit Field Boundary Plantation, 1,903 ha Irrigated fodder production, 8,864 ha Fruit Garden Establishment, 34,560 Unit Beehive distribution. KHGM completed 1,069,498 m irrigation channel, 1.260 unit Irrigation pond, 2,643 ha Agricultural Terraces and 12,368 ha land was opened to irrigation. In total, USD 29,258,000 was spent for these activities. During nine years of implementation, all institutions spent USD 78,333 in total (Anonymous, 2008b).

**Case Study: 2**




**Çoruh River Rehabilitation Project** is similar to the previous projects in a different part of the country with different characteristics. Apart from the above activities, the work included extending and supporting the solar energy system, which is a renewable energy source, was targeted in order to reduce consumption of fossil fuel (Anonymous, 2008b).

**Case Study: 3**




**Anatolia Watershed Rehabilitation Project:** The project was initiated in 2005 for five provinces located in Kizilirmak and Yeşilirmak watersheds and will be concluded in 2012. Its difference from Eastern Anatolia Watershed Rehabilitation Project are that the Project covers reduction and monitoring of agricultural pollution, animal and water pollution in the lower catchments as well as natural resource rehabilitation and decreasing rural poverty. In 2005, the Project was initiated in Amasya, Corum, Samsun, Tokat, Sivas, and Kayseri provinces Kizirmak and Yeslilirmak watersheds that are discharged into Black Sea. In this ongoing project the Ministry of Environment and Forestry will cooperate with the Ministry of Agriculture and Rural Affairs in an integrated work in the same watershed in order to prevent natural resource degradation (prevention of erosion, rehabilitation of rangelands, prevention of nitrogen and phosphate pollution, etc.*)* and decreasing rural poverty. Rehabilitation of watershed is achieved within the scope of micro-catchment plans that are prepared by the agencies with a participatory approach (Anonymous, 2008b).



#### 4.3.1.3 Greenbelt afforestation

In the recent years, there has been significant migration in Turkey from rural to urban areas. With the growing urban population the need for community recreational spaces has also increased. In parallel, the Greenbelt Afforestation works were initiated around the cities. The aim of greenbelt afforestation works is to meet people's need for recreation and at the same time to address the imbalance of urban developments, decrease environmental and air pollution, and to protect city centres from floods and overflows. The first greenbelt afforestation works in Turkey were started in 1960 and 140,000 ha of land was afforested for this purpose (Anonymous, 2008a).

#### 4.3.1.4 Flood-overflow-avalanche control

The reason that floods and overflows experienced in Turkey's river catchments cause extensive life and property loss is that irregular and uncontrolled urbanization has taken place on sites within the floodplains. This has included sites with ongoing flood risk together with disrupted ecological and environmental systems. The Ministry of Environment and Forestry, and the General Directorate of Afforestation and Erosion Control have undertaken erosion control projects, as well as afforestation and erosion control works to prevent floods. Thereby, they have accomplished many successful projects over the years and have combated erosion in many regions. This has helped control floods and overflows. The following key points are considered in rehabilitation and restoration activities (Anonymous, 2008a):

- In order to make economical works in water collection catchments effective against preventing damages of floods and overflows, all factors should be studied well and what to be done where should be pre-decided correctly.
- Measures should be taken particularly against surface runoff from precipitation on the catchment which may flow across the surface and cause floods and overflows. The most important measures are the ones for erosion control to be taken in upper flood catchments i.e. water collection sites.
- Thus, floods and overflows will be prevented at the beginning stage and there will be assurance for the expensive facilities to be built on flood stream.

#### 4.3.1.5 Erosion control with greening and afforestations

The first erosion control works in Turkey were initiated in 1955. In 1969 the General Directorate of Afforestation and Erosion Control was established and planned and programmed afforestation and erosion control works have been carried out since then with an accelerating tempo. Mostly surface erosion prevention techniques were used with many other techniques to combat erosion. Some of these techniques were terracing, wattle fence, fascine fence, non-irrigated wall sill, mixed sill, biological structures, afforestation and plantation. The General Directorate of Afforestation and Erosion Control accomplished 692,508 ha of land erosion control works by the end of 2007. The annual working area was doubled after 2003, and underlines the importance attached to erosion in Turkey (Anonymous, 2008a).

### 4.3.2 Secondary implementations

#### 4.3.2.1 Rehabilitation and restoration quality in existing native forest landscapes and replacing exotic tree plantations with native tree species

In Turkey, many native forest landscapes are intensively managed or logged. However, the dramatic consequences of a production-based approach are noted particularly in the last decade. The primary focus of rehabilitation and restoration activities is now on restoring forest quality in existing stands of trees rather than extending the area under tree cover.

There is a new tendency in Turkey through withdrawing management or other pressures, allowing natural ecological functioning to reassert itself gradually (for example in the Mediterranean Region *Cedrus libani* forest). However, in other cases, where, for instance, species have been lost from a locality, or where remaining pressures are undermining natural disturbance patterns, more active rehabilitation and restoration efforts may be needed (Dudley, 2005b). Some future works to improve quality in existing native forests are as follows:  restoring a native forest composition by removing invasive species, re-creating dead wood microhabitats in managed forest, restoring natural fire disturbance patterns by prescribed burning (e.g. *Cedrus libani* and *Pinus brutia*), reconnecting forest fragments, building capacity for better forest management and restoration. However, methods for control of invasive species (e.g. *Rhododendron ponticum* in Northern Turkey) are in most cases still poorly developed as is management of artificial disturbance. Codes of practice and perhaps principles for artificial disturbance remain to be developed (Dudley, 2005b).

#### *4.3.2.2 Rehabilitation and restoration of protection forests*

Rehabilitation is required even within many protected areas in Turkey, either because they have previously been degraded or because of over-exploitation since protection. This is often the case through illegal use. However, as a general administrative rule in Turkey, forest rehabilitation and restoration activities are strictly forbidden. For a short period in past years, the afforestation of burned areas and removal of pests and diseases were achieved in these forests, however, today such measures are forbidden again. In recent years, many problem protection forests were taken out of nature protection designations, while others have been newly included. However, these new protected areas are already threatened or are actually losing habitat and biodiversity. As a basic method, zoning is often used in protection forests, permitting some level of use, including strictly off-limit areas to allow natural dynamics. However, rather than regulating the competing uses, this approach mostly opened way to over-exploitation of resources because of inaccurate zoning. Current threats to forest protected areas include illegal logging, over collection of non timber forest products, and encroachment. Many other protected areas in Turkey have been set up in areas where forests have previously been managed and otherwise altered, degraded, or destroyed. Many forest protected areas have become isolated from other forest habitat, creating long-term problems of viability. The tendency towards rehabilitation in protected areas is as defined by IUCN (Regato and Berahmouni, 2005): (a) Restoration may be required to re-establish natural habitat or to re-create or improve corridors between forest protected areas and thus build a strong protected area network; (b) Restoration in protected areas often a time-limited process to restore specific areas of forest or forest types that have been degraded or destroyed; (c) In some parts of Turkey, virtually all protected areas have been altered and could thus be candidates for restoration. However, there is also a growing movement for re-creation of “wilderness,” and this creates tension with restoration activities and sometimes a backlash against management interventions within protected areas; (d) Key needs for the future include more systematic integration of restoration into protected area networks (for example, through buffer zones, corridors, etc.) and greater investment for restoration in protected areas, which is still generally approached as a minor part of protected area management.

#### *4.3.2.3 Biological combat against ductile and wheat stink*

In accordance with the five-year protocol made by the Ministry of Agriculture and Rural Affairs each year, nearly 1 million seedlings are produced from species such as mahaleb, almond, walnut, acacia, oak, oleaster, cedar, black pine, stone pine, etc. These seedlings are planted by the Ministry of Agriculture and Rural Affairs on farmland borders to be used for biological combat against ductile and wheat stink (Anonymous, 2008a).

#### *4.3.2.4 Restoring soil and ecosystem processes*

It is necessary to link human restoration efforts with the re-establishment of ecosystem processes in order to maximize biodiversity and ecosystem services (e.g. clean water, stable soils) while minimizing additional human inputs. Simply planting local vegetation and adding agricultural levels of fertilizer is not necessarily sufficient. Restoration activities focused solely on maximizing substrate stability or primary productivity frequently result in arrested succession and require further effort to encourage successional change. Without them, restoration is incomplete (Walker, 2005). Although the aforementioned principles are accepted to be implemented in restoring soil and ecosystem processes, practice did not achieve consent results.

#### *4.3.2.5 Mountain forest rehabilitation and restoration*

In Turkey, there is a diverse differentiation within the lowland and upland mountain forests. This distinguishes upland life zones with a variety of site conditions (Mayer and Ott, 1991). With a more sophisticated zonation and recognition of distinct communities, it is clear that management requirements to achieve sustainability, and nature conservation objectives, also vary. It is argued that along with sound economic silvicultural reasons, and for forest health and nature conservation needs, appropriately tailored forest management regimes are needed (Colak and Rotherham, 2007).

#### *4.3.2.6 Rehabilitation and restoration of deadwood as a critical microhabitat in forest landscapes*

As a result of severe “clean management” systems in Turkish forests, many species have been lost or reduced to the point of being endangered. This is a broad term which refers to the pursuit of a tidy system of intensively productive forest in which dead and dying wood, standing and fallen, is rigorously removed or cleaned from the system. This is because foresters believed that such wood harboured diseases and pests. The consequence of such policies applied over decades or in some cases centuries has been a massive depletion of the resource and serious declines of removal of biodiversity (Atici *et al*., 2008; Colak, 2002). In recent years, the leaving of five standing deadwood units (snags) per ha was adopted as a basic target in many management plans. However, knowledge about the role of deadwood in Turkish forests is far less complete, and further research is needed on its role and conservation.

#### *4.3.2.7 Rehabilitation and restoration of burnt forests*

According to the Turkish Constitutional Law, the burnt areas should be afforested in the same year. However, past implementations were mostly undertaken with monoculture plantations. Recent practice is more ecologically focused. It is clear that in the absence of an understanding of the causes of fire and its role in the ecosystem, rehabilitation and restoration works will fail.

Furthermore, the community/local understanding of fire and its role as well as techniques for using fire in these ways, should be the basis for improving fire management. Expanding the recognition of community-based fire management and the core role people play through using fire in the landscape is essential in Turkey where government structure and approaches are developing and resources and support are limiting. It is critical to obtain, maintain, or initiate records of unwanted fires, fire use, and fire behavior to enable analysis to support the refinement of techniques of deliberate fire use and targeting of information and inputs to reduce unwanted impacts of fires (Moore, 2005). There may be much to learn from research and practice in other Mediterranean countries.

#### *4.3.2.8 Conversion from coppice forests to high forests*

Coppices make up 5.74 million ha of Turkish forests, while 19% is degraded. Within the framework of the Action Plan concerning the period 2006-2015, there is an annual target of 100,000 ha of degraded land and 1 million ha coppice planned to be converted into high forest in ten years. The basic method is direct conversion with native species rather than non-native or exotics. Previous works converted broad-leaved forests into coniferous forests.

## *4.4 Research Projects in Forest Rehabilitation and Restoration*

### *4.4.1 Interest groups in research projects*

Forestry research in Turkey is mostly carried out by three interest groups based in governmental institutions, universities and NGO's. As a natural consequence of state-based forestry tradition in Turkey, wide range of research activities are implemented by various research institutions offering services under the Ministry of Environment and Forestry. In this context, the Department of Research and Development and 11 local directorates have the biggest share in research activities. Beyond this, there is an accelerating interest in forest restoration and rehabilitation among 10 forestry faculties across Turkey. Academics from other related disciplines like ecologists, biologists, landscape planners, agriculturists, sociologists, etc. are also entering the field. NGOs do also play an important role in research both by undertaking small-scale forestry related research and by supporting through knowledge and direct implementation.

### *4.4.2 University-government-private sector cooperation*

In accordance with global trends in nature protection over the last decade there have been attempts to increase the capacity of forest research in Turkey. In this context, the importance of university-government-private sector cooperation was emphasized in recent action plans and in national policies related to the EU adaptation process and other international agreements. There are some good examples of progress in the areas of information gathering, analysis, consultations, group discussions, and workshops. Although good progress has been achieved in the broad area of forestry research, the structural fragmentation within state institutions still affects the viability of research projects. The impacts of this discontinuity are seen in communications between research stakeholders.

### *4.4.3 Funding opportunities*

Funding opportunities for restoration and rehabilitation research have also been accelerated by national and international interest in environmental issues. There is an increased share of funded research activities on forestry issues in the national budget, a sponsorship system for the private sector, and international support for research and education (EU-Funds, UN-Programmes, World Bank Support, etc.). This has allowed state institutes and universities to establish long-term experimental stations, engineering centers and key laboratories. In this context, The Scientific and Technological Research Council of Turkey offers academics, universities, research/education communities, local institutions and private sector increased opportunities to improve knowledge on forest rehabilitation and restoration.

### *4.5 Analysis of Past and Current Rehabilitation and Restoration Activities: Lessons Learned, Challenges Remaining*

Key facts on past and present forest rehabilitation and restoration activities in Turkey are presented in Table 6. Until the 1960s, afforestation was the only practice used for restoration of forest land. Although, small amounts were afforested in the early years, there has since been an increased impact with improved experience, better basic facilities (nursery techniques, high seedling production, etc.*)* and at the same time exacerbated disasters (floods, landslides, etc.*)*. Even though there was success with afforestation as a rehabilitation and restoration activity, the effective rehabilitation and restoration of degraded natural forest was neglected. On the contrary, forests were managed mostly for wood-based raw material production and this was particularly with clear-cutting management systems. This generated many rehabilitation and restoration-dependent areas in the forested parts of Turkey until 1960. Since then, the scope of rehabilitation and restoration was widened and began to be applied in different fields. Erosion control works became more frequent and this tendency continues today. Other approaches were also introduced: rangeland rehabilitation, dune stabilization, energy forests, and private forest management and rehabilitation. Under these diverse activities the share of simple afforestation decreased, and forest rehabilitation and restoration works gradually increased. As a result, experience was gained from long-term rehabilitation and restoration projects. There were 3,610 projects on 3,700,000 ha land; including afforestation; 1,953,707 ha forest rehabilitation; 741,854 ha erosion control; 693,062 ha greenbelt afforestation; 140,634 ha artificial regeneration; 737,052 ha energy forest generation; 623,000 ha rangeland rehabilitation; 113,954 ha private afforestation; 72,197 ha, and the production of 11 billion seedlings, which were projected by afforestation, erosion control, degraded forest land rehabilitation and rangeland rehabilitation activities. The main impacts of these efforts emerged from the application of different techniques on various land characteristics. These are given below:

- Site oriented local projects should be evaluated at a locally specific level rather than just applying general rules. Otherwise failure is inevitable.
- Consideration of native tree species and local origins is important.
- Different methods should be applied in different regions although the general character of the study is same.
- Continuous maintenance and monitoring of the site lead restorations to success.
- Implementations are prone to fail if the socio-economic situation and community needs are not taken into consideration.

As indicated earlier, forestry and rehabilitation and restoration works in Turkey are conducted by the government. However, considering the need for the prevention of massive forest degradation and the establishment and protection of community forests, private afforestations have been encouraged since 1986. Today, the Turkish Government pays high importance to private afforestation. Such projects are promoted by grants and low interest long-term credits. Furthermore, clearings and unused Treasury lands are assigned to be afforested, while all types of necessary technical assistance are provided. Nevertheless, this opportunity was not welcomed with great interest and did not spark excitement among neither the public nor the private sector as hoped for. Accordingly, as indicated by Erdönmez and Ok (2009), socio-economic factors also play an important role. In some cases there was misuse of credits.

Even though the professional Turkish forestry tradition has gained a lot of experience, massive investments and successful works (wood production from plantations, erosion and flood prevention, etc.*)*, erosion, one of the most important threats to the country, has occasionally been overlooked. The annual 300,000 ha afforestation target were decreased to

15-20,000 ha and state nurseries, which were established with considerable investment, have started to close down. The main underlying fact is that there cannot be a sustainable restoration and rehabilitation programme in Turkey, while policies and approaches are changed by each new administration. Unfortunately, except for degraded forest lands and rehabilitation dependent areas, a potential 18 million ha area still needs to be restored (mainly afforested). The situation today is even more difficult since the annual afforestation of 150,000 ha land in the poorest parts of the country must be taken into consideration. However, while accepting these difficulties the recent progress towards multi-functional and close-to-nature forestry (end of clear-cutting, conversion of coppices into high forests, etc.) are accepted as generally encouraging developments.

Indeed, Turkey has succeeded in developing techniques appropriate for its climatic, topographic and local conditions with an admirable enthusiasm. However, the application of such generally high-cost techniques seems pointless alongside the annual removal of 500 million tones of soil through erosion to seas, lakes, dams and closed watersheds. Unfortunately, the actions which seem to trigger a practical response are usually a major environmental disaster such as a flood. It would be better and more cost-effective to predict future problems and to take action to avoid their occurrence or at least to minimize their impacts.

In this context, the general challenges in restoration and rehabilitation implications in Turkey can be summarized as follows:

- Since afforestation investments are labor-intensive, expensive and their yields cannot be seen in a short while, it is important to analyze and project the sites in terms of social conflicts and availability for technical practices (Anonymous, 2008a).
- Afforestation and erosion control works continuing since the 1950s were mostly realized in areas where the habitat conditions are suitable for forest establishment and abroad from social conflicts. Therefore, today the rehabilitation and restoration dependent areas mostly comprise socio-economic problems, emphasizing the importance of stakeholder-government cooperation in future projects.
- The reasons for failure of private afforestations should be carefully examined and criticized with the technical support provided by the government.
- The neglected maintenance of many restored areas should be undertaken.
- Wide range of restoration implementations succeeded; however, the underlying reasons of these achievements were not determined in detail, so model development could not be implemented for different cases by using effective monitoring systems.
- While restoring degraded forest land, accidental damage to nature (valuable biotopes, drainage of marshes, etc.) should be prevented.
- Lack of effective nature protection gives way to conversion of restored land into inappropriate land-uses in favor of short-term political benefits. For example after succeeding in the high-cost stabilization of dunes and afforestation of these areas in the Mediterranean zone, due to political pressure, these lands were converted into golf areas (e.g. Antalya-Belek). Considering this particular case, there is an urgent need for determining long-term targets and policies.
- Many close-to-nature alternative forest use types appeared in Turkey as a new tendency in the last years. However, measures should be taken for the unplanned and uncontrolled uses of resources (ecotourism, collection of non-wood products, etc.). Otherwise, the rehabilitation and restoration dependent area will be extended in the very near future.
- The regulation of over- and irregular grazing at the rangelands and the high amount of nomadic animal husbandry should be resolved as one of the major problems in Turkish forests.

- Turkey has no specific law aimed directly at land restoration and rehabilitation matters. However, these matters are included in various laws, in a piecemeal manner. Among these, laws are: Forestry Law No. 6831; Law on Mobilization for National Re-forestation and Fighting Erosion No. 4122; Environmental Law No. 2872; Agricultural Reform Law on Rearrangement of Land- Plots in Irrigation Areas No. 3083; Law on Meadows No. 4342; Regulation on using Agricultural land for purposes out of Agriculture; decree of Land Combination; TRGM Implementation Regulation; and Regulation on Meadows.

Furthermore, other challenges affecting the success of restoration and rehabilitation implementations can be expressed in keywords as: incomplete land cadastre, dispersed settlement; decrease in human resources (insufficient manpower due to migration); decrease in animal productivity, misuse of farmlands, insufficient water bodies, lack of modern agriculture techniques, insufficient organic substance at farmlands, rural poverty; lack of training for correct use of natural resources, destruction due to industry and polluted natural resources (Anonymous, 2008b). These give an effective flavor of the key issues and challenges.

**Table 6:** ***Forest establishment activities and distribution of their above-ground components between 1946-2007 (Anonymous, 2009)***

| Years | Total | Afforestation | | | Rehabilitation | Erosion control | Range rehabilitation | Private afforestation | Artificial regenartion | Energy forest |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | In-forest | Out-forest | | | | | | |
| **1946** | **3 083** | 3 083 | 3 083 | - | - | - | - | - | - | - |
| **1947** | **3 441** | 3 441 | 3 441 | - | - | - | - | - | - | - |
| **1948** | **4 203** | 4 203 | 4 203 | - | - | - | - | - | - | - |
| **1949** | **3 268** | 3 268 | 2 007 | 1 261 | - | - | - | - | - | - |
| **1950** | **3 610** | 3 610 | 3 299 | 311 | - | - | - | - | - | - |
| **1951** | **13 401** | 13 401 | 13 105 | 296 | - | - | - | - | - | - |
| **1952** | **1 598** | 1 598 | 1 303 | 295 | - | - | - | - | - | - |
| **1953** | **478** | 478 | 86 | 392 | - | - | - | - | - | - |
| **1954** | **1 719** | 1 719 | 1 336 | 383 | - | - | - | - | - | - |
| **1955** | **3 206** | 3 206 | 2 639 | 567 | - | - | - | - | - | - |
| **1956** | **4 657** | 4 657 | 4 423 | 234 | - | - | - | - | - | - |
| **1957** | **6 535** | 6 535 | 5 785 | 750 | - | - | - | - | - | - |
| **1958** | **9 150** | 9 150 | 8 503 | 647 | - | - | - | - | - | - |
| **1959** | **15 911** | 15 911 | 15 018 | 893 | - | - | - | - | - | - |
| **1960** | **11 796** | 11 796 | 10 521 | 1 275 | - | - | - | - | - | - |
| **1961** | **10 107** | 10 107 | 8 941 | 1 166 | - | - | - | - | - | - |
| **1962** | **30 133** | 14 366 | 11 602 | 2 764 | - | 14 806 | 961 | - | - | - |
| **1963** | **46 841** | 39 920 | 38 970 | 950 | - | 6 362 | 559 | - | - | - |
| **1964** | **34 114** | 25 687 | 25 052 | 635 | - | 7 629 | 798 | - | - | - |
| **1965** | **45 483** | 33 324 | 32 701 | 623 | - | 10 631 | 1 528 | - | - | - |
| **1966** | **37 443** | 25 635 | 25 037 | 598 | - | 9 951 | 1 857 | - | - | - |
| **1967** | **31 534** | 23 963 | 23 311 | 652 | - | 5 313 | 2 258 | - | - | - |
| **1968** | **27 503** | 20 991 | 20 282 | 709 | - | 4 454 | 2 058 | - | - | - |
| **1969** | **24 586** | 19 048 | 18 622 | 426 | - | 4 155 | 1 383 | - | - | - |
| **1970** | **25 962** | 20 171 | 19 730 | 441 | - | 4 642 | 1 149 | - | - | - |
| **1971** | **21 717** | 17 540 | 17 438 | 102 | - | 3 626 | 551 | - | - | - |
| **1972** | **20 321** | 16 507 | 16 356 | 151 | - | 3 273 | 541 | - | - | - |
| **1973** | **41 502** | 18 187 | 17 996 | 191 | - | 4 253 | 403 | - | 18 659 | - |
| **1974** | **47 468** | 15 926 | 15 659 | 267 | - | 4 257 | 313 | - | 26 972 | - |
| **1975** | **63 467** | 29 413 | 28 457 | 956 | - | 6 255 | 2 044 | - | 25 755 | - |
| **1976** | **68 169** | 33 344 | 32 448 | 896 | - | 6 275 | 3 365 | - | 25 185 | - |
| **1977** | **73 475** | 37 985 | 36 361 | 1 624 | - | 8 595 | 7 800 | - | 19 095 | - |
| **1978** | **76 684** | 34 050 | 32 943 | 1 107 | - | 5 368 | 3 332 | - | 28 904 | 5 030 |
| **1979** | **69 578** | 27 867 | 27 408 | 459 | - | 3 560 | 2 588 | - | 31 575 | 3 988 |
| **1980** | **52 543** | 20 969 | 20 744 | 225 | - | 2 217 | 2 174 | - | 23 670 | 3 513 |
| **1981** | **88 624** | 45 943 | 43 118 | 2 825 | - | 4 984 | 3 164 | - | 29735 | 4 798 |
| **1982** | **97 835** | 53 680 | 52 341 | 1 339 | - | 4 826 | 2 017 | - | 26 437 | 10 875 |
| **1983** | **124 761** | 66 210 | 63 785 | 2 425 | - | 13 635 | 3 915 | - | 21 449 | 19 552 |
| **1984** | **153 451** | 87 627 | 85 471 | 2 156 | - | 12 608 | 1 838 | - | 17 776 | 33 602 |
| **1985** | **182 191** | 100 400 | 98 189 | 2 211 | - | 15 907 | 3 395 | - | 17 342 | 45 147 |
| **1986** | **198 582** | 108 354 | 106 540 | 1 814 | - | 12 520 | 2 189 | 264 | 19 840 | 55 415 |
| **1987** | **215 632** | 114 132 | 111 167 | 2 965 | - | 14 264 | 2 460 | 719 | 23 705 | 60 352 |
| **1988** | **233 173** | 119 369 | 114 698 | 4 671 | | 23 806 | 3 640 | 512 | 24 246 | 61 600 |
| **1989** | **226 920** | 113 639 | 110 890 | 2 749 | - | 25 555 | 3 530 | 311 | 26 217 | 57 668 |
| **1990** | **148 734** | 78 884 | 76 673 | 2 211 | - | 9 912 | 1 772 | 647 | 22 864 | 34 655 |
| **1991** | **107 937** | 56 752 | 54 317 | 2 435 | - | 2 801 | 982 | 925 | 19 832 | 26 645 |
| **1992** | **69 708** | 24 519 | 24 519 | - | - | 3 660 | | 490 | 18 508 | 22 531 |
| **1993** | **86 262** | 27 058 | 27 058 | - | - | 7 458 | 880 | 263 | 23 614 | 26 989 |
| **1994** | **91 854** | 39 652 | 39 652 | - | - | 10 280 | 2 408 | 835 | 25 533 | 13 146 |
| **1995** | **70 821** | 24 257 | 24 257 | - | - | 6 114 | 3 455 | 1 317 | 22 870 | 12 808 |
| **1996** | **104 501** | 37 927 | 37 927 | - | - | 26 329 | 3 834 | 1 744 | 23 079 | 11 588 |
| **1997** | **103 330** | 32 031 | 32 031 | - | - | 26 124 | 3 120 | 2 282 | 34 200 | 5 573 |
| **1998** | **92 430** | 25 959 | 25 959 | - | 3 135 | 29 430 | 2 885 | 7 245 | 13 502 | 10 274 |
| **1999** | **81 740** | 11 529 | 11 529 | - | 8 739 | 22 571 | 4 096 | 2 494 | 21 263 | 11 048 |
| **2000** | **97 080** | 24 494 | 24 494 | - | 6 502 | 30 449 | 4 995 | 4 189 | 13 824 | 12 627 |
| **2001** | **96 692** | 25 672 | 25 672 | - | 4 089 | 32 780 | 3 800 | 2 499 | 14 658 | 13 194 |
| **2002** | **79 121** | 28 647 | 28 647 | - | 2 093 | 18 608 | 440 | 2 199 | 14 034 | 13 100 |
| **2003** | **116 929** | 36 914 | 36 914 | - | 5 187 | 42 042 | 2 500 | 4 943 | 10 531 | 14 812 |
| **2004** | **165 343** | 34 016 | 34 016 | - | 48 013 | 42 136 | 3 240 | 8 624 | 15 737 | 13 577 |
| **2005** | **177 705** | 21 439 | 21 439 | - | 65 260 | 47 493 | 4 259 | 10 503 | 9 980 | 18 771 |
| **2006** | **401 168** | 25 319 | 25 319 | - | 285 177 | 60 776 | 5 315 | 11 002 | 13 579 | - |
| **2007** | **400 196** | 18 228 | 18 228 | - | 313 659 | 42 984 | 4 163 | 8 190 | 12 972 | - |

### *4.6 Forest Rehabilitation and Restoration Outputs and Future Directions*

Great efforts were made in rehabilitation and restoration activities and important progress was achieved but serious flaws in the methods led to problems. Therefore, it is considered that 10.2 million ha of forest is still 'degraded' or 'highly degraded'. Afforestation and erosion control practices do not simply cover the areas into forest regime, but many public bare lands expect maintenance in this sense. There are also around 18 million ha of eroded bare land which needs to be converted into productive forest. It is estimated that 80% of the country's land suffers from 'moderate to severe' and 'very severe' erosion and Anatolia is yet to be described as a typical "erosion museum". In this sense afforestation and erosion control efforts are the reparation of degraded natural cycles with biological and technical measures. If implemented in an accurate way it may result in the "rehabilitation and restoration of nature", which requires an important amount of investments.

Outputs achieved by rehabilitation and restoration of natural resources and increasing rural poverty activities (Anonymous, 2008b):

- Conservation of current forests and rangelands,
- Rehabilitation and development of degraded forests and rangelands,
- Prevention of erosion, flood and overflows,
- Strengthening and diversifying agricultural systems,
- Creating additional employment opportunities and decreasing poverty,and
- Strengthening organizational capacity.

Outputs achieved by decreasing and monitoring agricultural and livestock production related water pollution (Anonymous, 2008b):

- Increase in the quality of surface and underground waters,
- Decrease in nutrient discharge to major rivers and the Black Sea,
- Compliance with environmental regulations with regard to water discharges,
- Compliance with EU regulations and good agricultural practices with regard to nitrate monitoring,
- Creation of additional employment opportunities and poverty alleviation, and
- Strengthening organizational capacity.

Although restoration and rehabilitation implementations cover extensive areas and was successful in most cases, cultural values could not be applied to most projects. In this context, identified needs for the future should include the following (Joseph and Mansourian, 2005):

- Document and exchange information about successful models of restoration for cultural values, and also where cultural values have driven restoration.
- Increase understanding of potential cultural indicators and drivers of restoration which require more collaborative work among anthropologists, sociologists, and ecologists.
- Integrate socio-ecological landscape-level approaches to culturally driven land-use systems such as home gardens and sacred groves to understand the process at a larger spatial scale.
- Develop appropriate extension methods to enhance diffusion of culturally driven restorative land-use systems.
- Build capacity in adaptive and participatory research methods in restoration.
- Develop/refine and use a holistic-systems approach to natural resource management. In most cases, planning and management for conservation, sustainable-use, and restoration have to be developed together rather than as separate components.

### *4.6.1 Application of ecosystem-based management techniques*

Some of ongoing intensive forestry caused serious damage to the landscape and the nature conservation heritage of vast areas of forest in the Black Sea Mountains, for instance. Now this is changing and work in Turkey is leading a quiet revolution in approaches to forest management. There are moves away from intensive approaches and some of these began decades ago. However, change takes time and in countries like Turkey it is not easy to move beyond established practices which have been in place for decades. This applies to both the rehabilitation and restoration of degraded landscapes and the rehabilitation of degraded natural forests. There are other important issues. So for example, the protection and conservation of locally distinctive traditional management is now being recognized. Important for cultural heritage, this is of high importance in a context of rapidly changing forest management practices. For example, charcoal production still continues in many regions, especially in the western part of Turkey. This is a traditional process going back several centuries but has been lost in large parts of Europe. There are important opportunities to safeguard these processes and the cultural knowledge that is attached to them (Colak *et al.*, 2008ab). The steps to be taken in this context would play a vital role for the future direction of intensive rehabilitation and restoration implementations.

Outputs in recent Turkish forestry practices in the field of forest rehabilitation and restoration (Colak *et al.*, 2008ab):

- Prohibition of clear-cutting management;
- Conversion of coppices to high forests: coppice in Turkey is simple coppice with no over-storey and most of this was considered to be degraded. A shortfall in Turkish domestic timber supply was predicted, and a vigorous program of rehabilitation and conversion of ‘degraded’ forest to more productive species was strongly advocated. (This may now raise issues of the European-wide loss of coppice as an important wildlife habitat and a cultural landscape feature);
- Establishment of regeneration areas in numerous small areas rather than single large ones;
- Dead wood has been removed through “clean management” systems in many forests, but this is changing. So in recent years, 3-5 trees per ha are being left. However, the changes take time and in countries like Turkey, it is not easy to change these habits;
- Stand rotation periods have been extended;
- There has been a gradual move away from the age class method;
- Multi-functional management planning has gradually been introduced; and
- There is a gradual move away from monoculture afforestation.

The impacts of intensive forestry with blanket treatment of vast areas of wooded landscape are the simplification of forest structure and diversity, and bring with it the demise of associated distinctive biodiversity. With such intense impacts it is clear that in many situations contemporary tree distribution is significantly affected by forest management history. Furthermore, stand structure, type and diversity are also greatly affected by human intervention. These impacts are seen across the continent from Northern Sweden, to Poland and the Ukraine, in England, Wales, and Scotland, and throughout afforested areas of Italy and Turkey, for example. Typical scenarios are lowered biodiversity, reduced landscape values, declining socio-economic benefits, and problems with both invasive species, and with water management. In marginal areas such as the Turkish high mountains and even some Alpine regions, these impacts become acute. Critical issues observed in this study are the loss of ancient trees, and associated dead wood habitat, and the simplification of the ecosystems involved. Differences in distinctive forest character related to topography, geology, and microclimate are ignored and a blanket approach to planting and management adopted. Clearly in many areas, there are moves away from these approaches, and some of these began decades ago.

With the effect of close-to-nature forestry concept rehabilitation and restoration works, particularly degraded forestlands, in Turkey were approached with a new vision. The main approach in the afforestation work is "conservation of existing species, realization of regeneration preferentially with the seeds and seedlings of local existing species, and if not, then the selection of species of appropriate provenance for plantation" (Anonymous, 2008a).

#### *4.6.2 Maintaining biodiversity*

When examining the Turkish rehabilitation and restoration history, it can be seen that only superficial attention was generally given to maintaining ecological biodiversity. For instance, a striking example is that the maquis in the Mediterranean ecosystems was converted into coniferous plantations. Additionally, rare biotopes, endemic and rare species and ecosystem diversity were hardly taken into consideration by restoration and rehabilitation activities which caused negative consequences for associated biodiversity. However, some measures have now started to be taken after such unfavorable experiences and new approaches were incorporated into national programs. In this context, the reflections of this approach are seen in the 2004 National Forestry Program (Anonymous, 2008d):

- To address forestry issues from a broad viewpoint within the framework of sustainable development;
- To plan and carry out forestry activities paying the required attention to changes both in society and in multi-faceted expectations of forests and to developments;
- To build appropriate capacities and mechanisms to enable the preparation, implementation, monitoring, evaluation and development in a participatory manner of development policies and strategies for the forestry sector;
- To establish a positive relationship between forests and people raising awareness about the role of the forest;
- To promote harmony and relations between the forestry and other sectors;
- To raise awareness and strengthen interest, involvement, contribution and support of both the community and the interest groups to achieve a forest management, conservation as well as sustainable development of forests with a view to the country’s balanced and sustainable development;
- To improve and strengthen the living conditions of the actually poor and forest dependent forest villagers living either in or around forests and therefore achieve a multi-sided benefit from forests by way of enhancing a multi-functional and participatory forest resources management; and
- To achieve maximum use of both local and foreign financing sources for the forestry activities.

#### *4.6.3 Marketing and promotion opportunities*

Restoring landscapes is expensive, but can and should yield economic benefits. The valuation of environmental goods and services is still an imprecise science. It is a developing issue in Turkey. All large-scale rehabilitation and restoration initiatives have to be rooted in economic realism. For instance, massive restorations have such a character in Turkey (e.g. plantation for wood production in deforested areas). The cost-benefit ratios are essential in determining what is possible and desirable. There are countless examples of forest restoration programs that have cost a lot of money and have yielded few real benefits. It is especially important to remember that investments in restoration carry opportunity costs. The same money could be invested in employment creation, and establishing protected areas, etc. This evidence puts forward the importance of risk analysis by selection of the areas that are subject to restoration. Even though complete economic valuation will only rarely be possible or necessary, it is always important to thoroughly examine options from an economic perspective (Sayer, 2005). In accordance with this point of view, promotion and marketing play a vital role to reach the targets under the framework of the evaluated program. Forest landscape restoration needs to be clearly communicated and different target audiences will require different channels and media. Communicating the issue can be planned to respond quickly and strategically to news items that emerge and where restoration can create a positive message. Marketing complex restoration programs is equally important and it is essential to clearly understand the key triggers that might make the chosen audience engage in a forest landscape restoration program (Sayer, 2005). This approach would be useful to focus the scarce resources for restoration and rehabilitation works in Turkey. Furthermore, it is vital to convince politicians of the necessity and long-term benefits of such works.

Communication is about moving people from awareness to action. If done well, it can help achieve conservation goals. Communicating about forest landscape restoration can be done either proactively/strategically or opportunistically. Marketing or "selling" projects to potential funders or donors requires good communication and research. Just the target audience needs to be understood when communicating; the same applies to marketing. One need to know what makes funders "tick," what are their pet interests, goals, history of giving, etc. Such information is useful in helping to draw up approaches that are appropriate to the donor, and also in developing good funding proposals (Sayer, 2005). Although such an optimum method should be used in Turkey, rehabilitation and restoration works in practice are often only put into action until after natural disasters (floods and landslides, etc.) and associated loss of life.

#### *4.6.4 Carbon sequestration through rehabilitation and restoration*

In Turkey, over 2.5 million ha new forest land has been gained through rehabilitation and restoration, particularly with bare land afforestation, which is greater than the surface area of many countries. Besides, the contribution of industrial afforestation is unquestionable (e.g. 150,000 ha poplar afforestation). Thus, forest area gained by rehabilitation and restoration implementations plays an important role in carbon sequestration. It has been claimed that Turkey has the potential to make important contributions to carbon sequestration with afforestation projects planned in the near future. Furthermore, the increase of the total area of natural forests rather than its decline (natural regeneration of abandoned rural areas and antropogenically disturbed lands back into forests), reflects the strength and sustainability of this approach.

## 5. Capacities in Forest Rehabilitation and Restoration

### *5.1 Institutional Capacities*

#### *5.1.1 Governmental support*

In the early years of the newly-founded Republic after the Ottoman Empire, the highly degraded nature of much of the country was apparent. Key professionals were invited to develop a better knowledge base of the phenomena. As a matter of fact, various institutions were established under the framework of the Ministry of Forestry. These cooperative units were aimed at direct rehabilitation and restoration activities. For instance, the Directorate

General of Forests was responsible for the conservation, management and administration, rehabilitation of forests. On the other hand, the Directorate General of Erosion Control and Afforestation conducted studies on bare land rehabilitation and restoration. Thus, according to FAO's 2005 World Forestry Report, Turkey was listed among the top ten countries that have achieved large-scale afforestation works. Although important technical success has been achieved, the social aspect of these projects remained weak. Therefore, the Directorate General of Forest and Villages Relations was founded to analyze and regulate the social pressure on rehabilitated and restored lands and *vice versa*. The general overview shows the strong institutional capacity in Turkey but also highlights the lack of common and consistent targets that fragments and weakens the effectiveness of these governmental bodies.

The National Afforestation Campaign was started to increase the forest assets immediately, to rehabilitate degraded forests, and to save the soil from being carried to lakes, dams and seas by combating erosion. With this purpose, the "Afforestation and Erosion Control Campaign Action Plan" was prepared and put into practice as "Afforestation Campaign". Many public organizations and bodies as well as non-governmental organizations are given undertakings in the Action Plan. This Action Plan covers 2008-2012. Within the plan, in five years it is planned that afforestation, rehabilitation, erosion control and rangeland rehabilitation works will be achieved on 2.3 million ha of land and 2.3 billion seedlings will be planted. The Ministry of Environment and Forestry will carry out the work on 2.16 million ha and other bodies and institutions address another 136,000 ha (Anonymous, 2008a).

The important advantages of supportive public campaigns have been understood in recent years, while many have been carried out with the assistance of Turkish Government. The most typical ones are as follows (Anonymous, 2008a):

- "15 Million Seedlings to 15 Million Students": The "15 million seedlings to 15 million students" campaign was started with the protocol made by the Ministry of Education in 2003. In accordance with this campaign plantations were established in all provinces.
- "15 Million Seedlings to 15 Million Families": In 2005, fall and spring seedling plantation period, with a campaign held in all provinces, 15 million seedlings were given to 15 million families.
- "Let them grow up together": A seedling shall be planted for each child to be born each year by the figures received from the General Directorate of Population and Citizenship Affairs. The location of the seedling and their names will be published on a website.
- Sympathy for nature, particularly forests, is tried to be embraced among students.
- Publications are made in written and visual media.
- Costless Seedling Distribution Campaigns are organized.
- Memorial forests are established.
- Government bodies and institutions, military groups, education institutions, and civil corporations are encouraged to get involved in afforestation.
- Planting with voluntary support from the public (e.g. in 2005-2006 planting season, 35,000,000 seedlings were distributed and 40,000,000 seedlings were distributed in 2006-2007 planting season to encourage afforestation and improve awareness of forest and environment).

#### *5.1.2 Participation of public institutions*

Turkey is a relative large country with diverse topographical features. Therefore, there is often a lack of coordination between the central and local governmental units. This is evident in the preparation and implementation of rehabilitation projects. Public institutions play a critical role to build communication between public and governmental institutions to satisfy the expectations and needs of local people and *vice versa*. However, such efforts remain mostly local and transitory while many public institutions do not pay any interest to rehabilitation activities. Despite this, there are many examples of successful positive participation of local institutions in terms of public education, and technical support achieved with the cooperation of governmental bodies, the private sector and NGOs.

#### *5.1.3 Role of private sector*

In Turkey, forest restoration and rehabilitation implementation are carried out mostly by the government. However, in recent years, with the support of the government and civil society institutions, the private sector started to play a major role. Thus, private afforestation began with 264 ha in 1986, reaching up to 72,196 ha in total. Average annual afforestation rates exceeded 5,000 ha. Furthermore, there has been 150,000 of poplar plantations developed reflecting the potentially important capacity of the private sector in Turkey. If supportive measures are taken, the quality and quantity of such implications would increase by extending to larger areas. In addition to afforestation, the private sector established twenty-nine private nurseries during 2004-2007 with credit promotions (Anonymous, 2008a):

### *5.2 Civil Society Involvement*

#### *5.2.1 Role of civil society institutions*

Although rehabilitation and restoration activities were carried out by the government since the 1940s, and their benefits are recognized and used across different parts of society, future threats and the need for further works were introduced to the public by civil society institutions. These included TEMA -The Turkish Foundation for Combating Soil Erosion, for Reforestation and the Protection of Natural Habitat and the particularly successful use of mass media. In the context of forest protection, rehabilitation and restoration, civil society has played a triggering role for the introduction of some laws and the generation of political pressure (e.g. Rangeland Law). Chambers also take part effectively in decision-making processes acting as a regulating and supervising mechanism on state policies.

Furthermore, civil society institutions have conducted some large-scale restoration and rehabilitation projects in cooperation with the government. A typical example might be the 10 Billion Oak Plantation Project. The Ministry signed a protocol with TEMA foundation on 1998 for a five-year period. In accordance with the protocol, oak trees were planted on 11,367 ha land. The project was funded by TEMA foundation (Anonymous, 2008a).

A further objective of civil society institutions in Turkey is to build a community of interest groups that can experiment and learn together. In this context, CEKUL (The Foundation for the Promotion and Protection of the Environment and Cultural Heritage) conducts a project named “7 Regions 7 Cities” that achieved great success in terms of public capacity building. This greatly enriches the ongoing stakeholder negotiations that continue throughout the program. A sense of community or “social capital” can really enhance efforts to restore landscapes. Voluntary groups have accomplished some remarkable restoration achievements. People can work together and develop a shared passion for restoring the habitat of a rare animal or the beauty of a disfigured landscape. Such communities will fine-tune their objectives and adapt their programs as they advance. They provide an excellent mechanism for setting and updating goals and end points (Sayer, 2005).

### 5.2.2 On-the-job training, education with sharing experiences

Forest restoration is a difficult, energy-consuming, and expensive undertaking. It is almost always a long-term, complex, and multidisciplinary process. On the one hand, forest restoration requires recreation of a treed landscape within just a few years (usually less than 10 to 15 years); an embryo ecosystem that will only be fully developed after several decades. On the other hand, forest restoration requires inputs and expertise from fields like ecology, economics, public policy, and social sciences, further complicating monitoring and assessment (Vallauri *et al*., 2005). Therefore, the contributions of people from related disciplines play an important role in a large country like Turkey. Thus, past experiences indicate that, beside experts related to the issue, there is a growing interest in public on forest landscape restoration and rehabilitation. In this context, on-the-job training and education activities concerning the whole public have started with the cooperation of government and civil societies. The personnel are provided with on-the-job training each year in order to increase efficiency, improve capacity and obtain harmony in practice. Under this program many activities were realized, while one of them is the training courses on "Integrated Participatory Watershed Rehabilitation Techniques in the Degraded Lands" to be held in August and October 2009.

## 5.3 Education on Forest Rehabilitation and Restoration

### 5.3.1 Graduate, Master and PhD Programs

In Turkey, technical training and education in forestry began in November 1857 with the establishment of the Forestry School under the guidance of French specialists in Istanbul. The elevation of the technical forestry training and education to the level of faculty is accepted as a turning point in the historical development of higher education in forestry. After this point, not only technical staff was trained for the forest service, but also research projects were held in country forests with the contribution of experts from Central Europe. In this sense, there are many programs related directly or indirectly with forest restoration (e.g. afforestation techniques, watershed management, etc.). In total, there are ten forestry faculties. However, forest rehabilitation and restoration issues feature mainly in Graduate and Post-graduate Programs rather than in Research Master's or Ph.D. Programs. Although there are no forest rehabilitation and restoration programs, different postgraduate routes can be combined if particularly forest rehabilitation and restoration education is desired. As indicated below, there are numerous programs to build up the substructure of a specific forest rehabilitation and restoration program. There is now a growing need for such a program.

### 5.3.2 Contribution of related discipline

The increasing contribution of related disciplines in recent years plays an important role in research activities. A qualified network system is at the stage of development with contributions from specialists and experts ranging from agriculture to social sciences to the preparation and implementation of a new generation of rehabilitation and restoration projects. Watershed rehabilitation and restoration projects are the typical examples of this approach.

### 5.3.3 International education programs

Although there is no international education program on forest rehabilitation and restoration, seminars, occasional courses, workshops, etc. are being held by governmental institutions, universities and NGOs.

## *5.4 R&D Needs in Forest Rehabilitation and Restoration*

### *5.4.1 Research in forest rehabilitation and restoration*

The basic knowledge of forest rehabilitation and restoration based on fundamental research has been acquired through long-term experience and study. In this context, forest research institutes were established in different regions of the country to understand and analyze the extensive ecological processes in Turkey. However, the contribution of other disciplines and the use of modern technology were not sufficiently applied in rehabilitation and restoration projects. They still continue with classical and basic methods and approaches in their research. Although there is much research in universities, these studies are not reflected in practical work on the ground. Therefore, it would be beneficial if the research concepts of state institutions and universities were re-evaluated to direct capacity and potential to increase the quality and quantity of rehabilitation and restoration activities.

### *5.4.2 Use of modern technologies (monitoring)*

Monitoring is a process of periodically collecting and using data to inform management decisions. It is best done not as a separate activity at the end of a project, but as an integral part of an adaptive management cycle. A complete monitoring plan outlines information needs, specifies the least number of indicators to meet these needs, the methods for collecting the indicator data and who is responsible, and when the data are collected. The amount of resources spent on monitoring should vary inversely to the degree of certainty that project activities will be effective. There are tools and guidance available for doing monitoring in the context of adaptive management, but not enough has been done specifically for long term multiparty forest restoration projects (O'Connor *et al*., 2005). However, such an approach in monitoring for the management success of rehabilitation and restoration works was not adopted in Turkey. The studies have not gone beyond a simple success inventory. However, in recent years, there has been a tendency to use modern technologies more effectively. This should help increase the success rate of restorations. Thus, monitoring is important for projects of all sizes and for all areas of conservation, including forest restoration, to demonstrate impact and to help improve project effectiveness. Monitoring becomes particularly vital when projects become complex and include many different types of goals and a variety of stakeholders, as is often the case with forest restoration projects (O'Connor *et al*., 2005).

A national monitoring unit has been established to perform monitoring at both the species and ecosystem levels, and it is currently gaining influence. The Ministry of Environment and Forestry conducts controls and investigations at the local level under the Regulation on the Environmental Impact Assessment and monitors any activities that may have adverse impacts on the environment. It takes measures to reduce and mitigate adverse impacts to the greatest extent possible. Climate change is monitored by means of meteorological data and air quality parameters. Pollution and eutrophication are monitored by means of regular controls by local authorities. Land changes and degradation throughout the country are monitored via a Central Remote Monitoring System (GIS). The Turkey Plant Data Service of TÜBITAK (www.tubitak.gov.tr/tubives) has established coordination in part in data collection and management concerning plants. The Turkey Biological Diversity Information System Project, TUBIOS, was initiated in 2003 to improve the system in such a way as to fully cover biological diversity with all aspects (Anonymus, 2008d).

In this context, a monitoring method considering the steps indicated by O'Connor *et al.* (2005) will be essential for the success of past, current and future restoration and rehabilitation projects in Turkey. The first step in any type of restoration project is to carefully define the site and issues, and to identify what elements of biodiversity and other values are to be focused on. This should be followed by a thorough situation analysis that establishes the causal chains that link the restoration targets (features) to the threats (pressures) and root causes that affect these targets. The third step is to identify where along these causal chains it may intervene with the actions (responses) and to develop specific objectives for how it is needed to change the system to improve the chances of success. Once this basic work has been done, it should be readily apparent which key indicators are needed to track how the targets are doing and whether the restoration actions are having their intended results. A complete monitoring plan clearly outlines the information needs, specifies the least number of indicators needed to meet these needs, details methods for collecting the indicator data, and describes who has this responsibility and when these data are collected. In addition, the monitoring plan identifies what analysis is undertaken by whom, and to whom information is circulated and when. The amount of project resources that are invested in monitoring will vary depending on the particular situation (O'Connor *et al.*, 2005).

### *5.5 International and Regional Cooperation on Forest Rehabilitation and Restoration*

As a UN member country, Turkey is a member of many organizations affiliated to the UN, such as UNEP and FAO in particular, and of the bodies created within those organizations such as the International Commission of Plant Genetic Resources. In addition, it also participates in other international organizations such as the International Plant Genetic Resources Institute (IPGRI, Italy), the International Centre for Agricultural Research on Dry Areas (ICARDA) and the International Union of Forest Research Organizations (IUFRO) and in regional bodies such as the European Forest Genetic Resources Programme (EUFORGEN) and the European Cooperation Programme in Plant Genetic Resources (ECP/GR). These memberships are an indication of the importance attached by Turkey to the conservation of biological diversity (Anonymous, 2008d). As well, there are many projects conducted in Turkey comprising forest rehabilitation and restoration implementations with the support of World Bank, European Union, United Nations, international partnerships and some regional initiatives such as; Anatolia Watershed Rehabilitation Project, Biodiversity and Natural Resource Management GEF Project, Turkey *In-situ* Gene Conservation Project, Eastern Anatolia Development Programme, etc.

## 6. Future Steps

If forestry is to have a central role in the battle to combat climate change and environmental deterioration, then we must be more international and less parochial in our outlooks (Colak *et al.*, 2008ab). This is important in Turkey both for forestry and the success of rehabilitation and restoration. In Turkey, the long-term rehabilitation and restoration activities demonstrate the difficulty and great costs of these works. Therefore, the effective protection and management of present forest areas is of vital importance so as not to increase the amount of future restoration and rehabilitation which may be required. Therefore, effective conservation management of Turkish forests is an urgent necessity, with new approaches and practical applications. Steps are being taken to organize forestry activities such as silvicultural conversion, restoration and 'close-to-nature' silvicultural operations by 'naturalness zone maps'. With these naturalness maps it is possible to predict human impacts on forest ecosystems and so influence the degree to which 'close-to-nature' forestry practices can meet forest management and conservation targets. Furthermore, the use of naturalness maps with biotope maps can assist in the prediction of any likely variations, deviations or conservation risks at a landscape scale. In preparing naturalness maps, natural forest conditions and relevant natural life-stages and processes are taken into account.

Zones in which management ceases and for which only natural successional development is allowed are to be carefully monitored. New technology such as Geographic Information Systems, Geographic Location Systems, and portable computers, will assist site management and monitoring. This approach should help to provide a useful and unifying framework for management and the setting of realistic targets and ensure effective monitoring and evaluation of progress (Colak *et al.*, 2003, 2008ab).

However, despite this recognition, like many countries, in Turkey in particular there has been little awareness of sometimes subtle but important ecosystem differences. As a consequence, management practices are often not environmentally or even economically sustainable. Ecologically distinct forests and their ecosystems have been simplified, landscape and conservation quality reduced. Local economies are in decline and have been affected by deterioration of forest 'quality' and associated ecosystem services. The latter include protection of soils, watersheds, biodiversity, and the actually recognized benefits of carbon sequestration. If effective management to maintain and restore Turkish mountain forests and the deforested areas is not undertaken, the consequences will be serious (Colak and Rotherham, 2007): (a) Disruption to groundwater re-charge and discharge leading to flood risk; (b) Deterioration of groundwater and spring-water quality; (c) Downwash and erosion of soil with accumulation of sediments in the valleys; and (d) Increased landslide and avalanche activities. There are additional problems and socio-economic impacts, including serious loss of potential for heritage-, wildlife-, and eco-tourism and their consequent economic benefits to the areas. If harnessed, such benefits can be long-term and sustainable (Colak *et al*., 2003; Colak and Rotherham, 2006).

In particular, the concept of multi-functional forest management with the landscape producing sustainable tourism and leisure (generating income to the regions), forest products of wood and timber, wildlife and heritage, and forest culture including local food and drink, begins to provide a potential framework for long-term remediation. A vital element is local difference and distinctiveness of landscape, of forest produce, and advocated here, of management. However, the first key step is to halt the continuing decline, and to set in place the necessary forest management to sustain the resource. Beyond that, there will be opportunities to increase the support of the local communities, to encourage economic drivers such as tourism, and to reverse the demographic drift to the cities (Colak and Rotherham, 2007).

Regarding the success of past rehabilitation and restoration implementations, Turkey is to make promising progress in future applications. With the aim of increasing forest assets, rehabilitating degraded forestlands, preventing erosion, minimizing the possible effects of global warming and climate change on our country and establishing a liveable environment, the Ministry of Environment and Forestry prepared the "Afforestation and Erosion Control Campaign Action Plan" covering the years 2008-2012 and activities have been initiated accordingly. Within the scope of the Action Plan, afforestation, erosion control and forest rehabilitation works shall be performed during five years on 2,300,000 ha of land (Anonymous, 2009).

The following steps are determined as the near-future campaign objectives in Turkey: (Anonymous, 2008a):

- Degraded forests and 10% canopy closures shall be rehabilitated and made productive again with a minimum effort and minimum cost through a close-to-nature forestry approach.
- By restoring the imbalance of nature, a liveable environment shall be established; potential effects of global warming, climate change and desertification shall be minimized.

- Floods and overflows observed frequently in the river catchments and which lead to loss of lives and goods shall be prevented. Water run-off in the catchments shall be regular and water quality shall be better.
- The current pressures for wood production on the forests shall be reduced by establishing forests in order to meet our country's need of wood as raw material.
- Caring for saplings, trees and forests shall be more important for the community by the afforestation mobilization to be initiated. Planting saplings shall be a common tradition and the public shall practice this tradition every year.
- Soil shall not be carried by erosion to the lakes, dams or seas. The fellow citizens shall live in a greener nature and a cleaner environment.
- The resources and their assets should be sustained and accelerated. This can be achieved by mobilizing everyone to plant saplings and to re-establish the forests.
- Potential afforestation areas cannot be established by the financial and physical capability of the Ministry of Environment and Forestry's only. One of the biggest services that can be provided is to say "Stop erosion" by planting saplings. Therefore, agencies and institutions, troops, local authorities, and non-governmental organizations of our country should provide financial and physical support to this afforestation mobilization.

Regarding the past, present and future directions in Turkey, the following issues should be considered for a successful rehabilitation and restoration approach (modified from Anonymous 2008abcd; Colak and Rotherham, 2007; Colak *et al.*, 2008ab; Maginnis *et al.,* 2005; Maginnis and Jackson, 2005; Lamb, 2005; Ürgenc and Boydak, 1982, 1985, 1992; Ürgenc *et al*., 1988, 1993; Saatcioglu, 1952, 1961):

- A landscape-level view should be adopted, since site-level rehabilitation and restoration decisions should accommodate landscape-level objectives and take into account likely landscape-level impacts. The practitioners should be encouraged to take site-based decisions within a landscape context, ensuring, at the very least, that such decisions do not reduce the quality or quantity of forest-related functions at a landscape level and, ideally, that the decisions contribute towards improving landscape-level functionality. Particularly, site-level specialization strongly discourages actions that would result in human well-being being traded off against ecological integrity at the landscape level, or vice versa. Such trade-offs are unsustainable and tend to be counterproductive in the medium to long-term;
- It should focus rehabilitation and restoration decisions on how best to restore forest functionality (that is, the goods, services and processes that forests deliver), rather than on simply maximizing new forest cover. It should be understood that rehabilitation and restoration are more than just tree-planting. In this context, understanding and analisis of the dynamics operating within a forest landscape play a vital role;
- The main target should not be to recreate the past but rather to keep future options open, both in terms of human well-being and ecosystem functionality;
- It should be a collaborative process, involving a wide range of stakeholders to decide collectively on the best options for rehabilitation and restoration. The crucial point is to prove to stakeholders that the investments (not only financial) in the rehabilitation and restoration program are worthwhile and that political support will be constant;
- It requires that local needs are addressed and balanced alongside national-level priorities and requirements for reforestation, thus making local stakeholder involvement in planning and management decisions an essential component;
- It should be recognized that neither the solutions to complex land-use problems nor the outcomes of a particular course of action can be predicted accurately, especially as ecosystems and land-use patterns change over time. Therefore, the use of an

adaptive management approach in planning and implementing is essential and it requires that necessary provision is made for comprehensive monitoring and learning;

- Technical options available should be evaluated at the site level and the biophysical and socioeconomic factors that will influence the success of the implementation should be taken into account;
- Building a scenario model would be helpful to make choices explicit and trade-offs inherent in restoration and rehabilitation planning and to facilitate collaborative learning with stakeholder groups which technical options to pursue. Delivering meaningful results at the landscape scale will require more than just technically competent interventions. It will also require a good understanding of how land-use policies and people's livelihood needs influence the overall quality and availability of forest goods and services in the landscape; and
- Field testing and learning from years of experience are highly essential for Turkey to build up a knowledge repository which gives direction for future developments.

## 7. References

Anonymous. 2006. Turkey's National Action Program on Combating Desertification. United Nations Convention to Combat Desertification (UNCCD). Ministry of Environment and Forestry Publication No: 250, Ankara.

Anonymous. 2007. Agaclandirma Tamimi (18 Nolu Tamim). Republic of Turkey, Ministry of Environment and Forestry General Directorate of Afforestation and Erosion Control, Ankara.

Anonymous. 2008a. AGM Activities. Republıc of Turkey, Ministry of Environment and Forestry General Directorate of Afforestation and Erosıon Control, Ankara.

Anonymous. 2008b. Watershed Rehabilitation Projects. Republic of Turkey, Ministry of Environment and Forestry General Directorate of Afforestation and Erosion Control, Ankara.

Anonymous. 2008c. Forest Atlas. Republic of Turkey, Ministry of Environment and Forestry General Directorate of Forestry, Ankara.

Anonymous. 2008d. The National Biological Diversity Strategy and Action Plan. Republic of Turkey, Ministry of Environment and Forestry, General Directorate of Nature Conservation and National Parks. Ankara.

Anonymous. 2009. Forestry Statistics, 2007. Republic of Turkey, Ministry of Environment and Forestry, Ankara.

Atalay, I., A. Semenderoglu, H. Cukur,and N. Gumus. 2001. Driving Forces of Rangeland Degradation in Turkey. Workshop on Land-use Changes & Cover and Water Resources in The Mediterranean Region, (RECAMARE) Research In Global Change in The Mediterranean: A Region Network, Institut des Regions Arides (IRA), Medenine, Tunisia 20-21 April.

Atici, E., A.H. Colak, and I.D. Rotherham. 2008. Coarse Dead Wood Volume of Managed Oriental Beech (Fagus orientalis Lipsky) Stands in Turkey. Investigación Agraria: Sistemas y Recursos Forestales 17(3): 216-227.

Aytug, B. 1970. Arkeolojik arastirrmalar isiginda Anadolu stebi. Review of Faculty of Forestry, Istanbul University, Series A, 20 (1):127-143.

Aytug, B. and E. Gorcelioglu. 1993. Anadolu bitki örtüsünün Gec Kuvaterner'deki degisimi. I.U. Review of Faculty of Forestry, Istanbul University, Series B, 20:27-46.

Aytug, B. and E. Gorcelioglu. 1994. Archaebotany in Anatolia. Archaeometry 94: The Proceedings of the 29th International Symposium on Archaeometry, Ankara, p. 393-400. Ankara, Turkey. TUBITAK.

Bottema, S., H. Woldring, and B. Aytug. 1993a. Late Quaternary vegetation history and climate in northern Turkey. Palaeohistoria 35/36:13-72.

Bottema, S., H. Woldring, and B. Aytug. 1993b. Palynological investigations on the relation between prehistoric man and vegetation in Turkey. Proceedings of the 5th Optima Congress, September 1986, Istanbul. 315-328.

Boydak, M. and H. Dirik. 1998. Achievements in the Fast Growing Tree species Works in Turkey and Applicable Strategies and Policies. "Hizli Gelisen Türlerde Yapilan Calismalarin Degerlendirilmesi ve Yapilacak Calismalar" Konulu Workshop. Orman Bakanligi: 188-193.

Boydak, M. and S. Ozhan. 1996. Assessment of Burned Areas in Terms of Watershed Management and Reforestation. I. U. Orman Fakültesi Dergisi Seri: A. 46(2):37-57.

Bozkurt, E. and S. Mittwede. 2001. Introduction to the Geology of Turkey-A Synthesis. International Geology Review, 43 (7): 578-594.

Colak, A. H. 2002. Dead wood and its role in nature conservation and forestry – a Turkish perspective. The Journal of Practical Ecology and Conservation (The Journal for Professional Ecologist and Conservation Managers), Wildtrack Publishing, Sheffield, 5(1): 37-49.

Colak, A. H. and I. D. Rotherham. 2006. A review of the Forest Vegetation of Turkey: its status past and present and its future conservation. Royal Irish Academy, Journal of Biology and the Environment, 106(3): 343-355.

Colak, A. H. and I. D. Rotherham. 2007. Classification of Turkish forests by altitudinal zones to improve silvicultural practice: a case-study of Turkish high mountain forests. International Forestry Review, 9(2): 641-652.

Colak, A.H. and T. Odabasi. 2004. Silvikültürel Planlama. I.U. Fen Bilimleri Enstitüsü Yayinlari, 4514/14. Istanbul. Dilek Ofset.

Colak, A.H. and A. Pitterle. 1999. Mountain sylviculture (Band I Middle Europe). Forest Ministerial OGEM-VAK., Ankara, Lazer Ofset.

Colak, A.H., I.D. Rotherham, and M. Calikoglu. 2003. Combining ''Naturalness Concepts'' with close-to-nature silviculture. Forstwissenschaftliches Centralblatt 122 (421-431).

Colak, A. H., I.D. Rotherham, and S. Kirca. 2008a. Learning together: the implications of close-to-nature silviculture for Turkish forest management. World of Trees, 16:44-46.

Colak, A.H., I.D. Rotherham, and S. Kirca. 2008b. Turkish Forestry Changing From Timber Production to Mixed Outputs. World of Trees, 17: 42-44.

Davis, P.H. 1965. Flora of Turkey and the East Aegean Islands . Edinburgh. Edinburgh Uni. Press.

Demir, M., E. Yilmaz, E. Makineci, and A. Kücükosmanoglu. 2008. Forest Road and Firebreak Standards and Statistical Analysis of Forest Fire Causes in Turkey Between 1994-2006. 31st Annual Council on Forest Engineering Meeting (COFE-2008).

DPT. 2000. Industry in Turkey. December 2000.

Dudley, N. 2005a. Policy Interventions for Forest Landscape Restoration. *In*: Mansourian S.,Vallauri D., Dudley N., eds. (in cooperation with WWF International) 2005. Forest Restoration in Landscapes: Beyond Planting Trees, Springer, New York.121-125.

Dudley, N. 2005b. Impact of Forest Loss and Degradation on Biodiversity. *In*: Mansourian S.,Vallauri D., Dudley N., eds. (in cooperation with WWF International) 2005. Forest Restoration in Landscapes: Beyond Planting Trees, Springer, New York.17-21.

Dudley, N. 2005c. Policy Interventions for Forest Landscape Restoration. *In*: Mansourian S.,Vallauri D., Dudley N., eds. (in cooperation with WWF International) 2005. Forest Restoration in Landscapes: Beyond Planting Trees, Springer, New York.121-125.

Dudley, N. and S. Stolton. 2005. Restoring Water Quality and Quantity. *In*: Mansourian S.,Vallauri D., Dudley N., eds. (in cooperation with WWF International) 2005. Forest Restoration in Landscapes: Beyond Planting Trees, Springer, New York.228-232.

Ekizoglu, A., and A.U. Geray. 1997. Waldörfer in der Turkei-Ein Forstpolitisch dringendens Problem. Algemeine Forst Zeitschrift.

Ekizoglu, A. and K. Sengönül. 1992. Orman Alanlarinin Daraltilmasi, Bu Olgunun Icme Suyu Havzalarinda Dogurdugu Sorunlar. Istanbul'daki Su Havzalarinin Cevre Sorunlari ve Korunmalari Simpozyumu.

Erdin, K., A. Hizal, and M. Sümer. 1985. Türkiye'de Ormancilik Calismalarinda Uzaktan Algilama Verileri. Istanbul Universitesi Orman Fakültesi Dergisi A. 35(2):122-141.

Erdonmez, C., and K. Ok. 2009. Ozel Agaclandirmalari Etkileyen Sosyo-ekonomik Etkenler. II. Ormancilikta Sosyo-Ekonomik Sorunlar Kongresi:74-80.

Günay, T. 2003. Ormancılığımızın Tarihçesine Kısa Bir Bakış. TARIM ORKAM-SEN, Ankara.

Hasdemir, M., T. Ozturk, M. Demir, and E. Yilmaz. 2007. Problems and Suggestions of Timber Harvesting and Transportation in Turkish Forestry. International Symposium on Bottlenecks, Solutions, and Priorities in the Context of Functions of Forest Resources: 341-352.

Hempel, L. 1981. Mensch und/oder Klima. Neue physiogeographische Beobachtungen Über das Lebens- und Landwirtschaftsbild Griechenlands seit der Eiszeit . Hellenika, Jahrbuch 1981, 61-67. Vereinigung der Deutsch- Griechischen Gesellschaften.

Hempel, L. 1983. Klimaveraenderungen im Mittelmeerraum Ansatze und Ergebnisse geowissenschaftlicher Forschungen. Universitas, Jahrgang 38, 873-885.

Hizal, A. 1984. Hava Fotograflari Yorumlamasinin Havza Amenajmani (Ova Deresi Havzasi, Kocaeli ) Calismalarinda Uygulanma Olanaklarinin Arastirilmasi. :190.

Isik, S. 2005. Urbanization and Urbanization Models in Turkey, Aegean Geographical J., 14 (57-71).

Jackson, W. and S. Maginnis. 2005. Building support for FLR. *In*: Restoring Forest Landscapes. An introduction to the art and science of forest landscape restoration. IUCN & ITTO (International Tropical Timber Organization) Technical Series No 23.

Joseph, G. and S. Mansourian. 2005. Restoring Landscapes for Traditional Cultural Values. In: Mansourian S.,Vallauri D., Dudley N., eds. (in cooperation with WWF International) 2005. Forest Restoration in Landscapes: Beyond Planting Trees, Springer, New York.233-240.

Kehl, H. 1995. Vegetation dynamics ofmaquis and their derivatives under the influence of a small settlement near Antalya (SW-Turkey). *In* H. Sukopp, M. Numata, and A. Huber (eds), Urban ecology as the basis of urban planning, 85-150. Amsterdam, The Netherlands. SPB Academic Publishing bv.

Koc, A., O.Y. Yilmaz, H. Yener, and K. Erdin. 1997. Tools Offered by GIS For Determining, Planning, and Monitoring Forest Resources. Proceedings of the XI. World Forestry Congress :52.

Konukcu, M. 2001. Forests And Turkish Forestry “Benefits, Statistical Facts and Forestry in The Constitution, Development Plans Government Programs and Annual Programs”. DPT: 2630. Ankara. 238pp. http://kutuphane.tbmm.gov.tr:8088/2001/200108147.pdf

Kücükosmanoglu, A. 1989. Türkiye'de Cikan Büyük Orman Yanginlari ve Bunlari Etkileyen Ana Faktörler. Orman Genel Müdürlügü, Orman Koruma ve Yanginla Mücadele Dairesi Baskanligi. 28(671):93-101.

Kücükosmanoglu, A. 2006. Orman Yanginlarinin Ulkemizdeki Seyri. (151): 35-39.

Lamb, D. 2005. Identifying site-level options. *In*: Restoring Forest Landscapes. An introduction to the art and science of forest landscape restoration. IUCN & ITTO (International Tropical Timber Organization) Technical Series No 23.

Louis, H. 1939. Das naturliche Pflanzenkleid Anatoliens. Geographische Abhandlungen no. 12. Stuttgart.

Maginnis, S. and W. Jackson. 2005. What is FLR and how does it differ from current approaches? *In*: Restoring Forest Landscapes. An introduction to the art and science of forest landscape restoration. IUCN & ITTO (International Tropical Timber Organization) Technical Series No 23.

Maginnis, S., J. Rietbergen-McCracken, and W. Jackson. 2005. Introduction. *In*: Restoring Forest Landscapes. An introduction to the art and science of forest landscape restoration. IUCN & ITTO (International Tropical Timber Organization) Technical Series No 23.

Mansourian, S. and N. Dudley. 2005. Challenges for Forest Landscape Restoration Based on WWF's Experience to Date. In: Mansourian S., Vallauri D., Dudley N., eds. (in cooperation with WWF International). Forest Restoration in Landscapes: Beyond Planting Trees, Springer, New York. 94-100.

Mayer, H. and H. Aksoy. 1986. Waelder der Tuerkei. Stuttgart. Gustav F.V.

Mayer, H. and E. Ott. 1991. Gebirgswaldbau- Schutzwaldpflege. Eine waldbaulicher Beitrag zur Landschaftsoekologie und zum Umweltschutz no. 2. Auflage, Stuttgart, New York. Gustav F., V.

Moore, P. 2005. Forest Landscape Restoration After Fires. *In*: Mansourian S.,Vallauri D., Dudley N., eds. (in cooperation with WWF International) 2005. Forest Restoration in Landscapes: Beyond Planting Trees, Springer, New York. 331-338.

O'Connor, S., N. Salafsky, and Salzer D. 2005. Monitoring Forest Restoration Projects in the Context of an Adaptive Management Cycle. *In*: Mansourian S.,Vallauri D., Dudley N., eds. (in cooperation with WWF International) 2005. Forest Restoration in Landscapes: Beyond Planting Trees, Springer, New York.145-149.

Okan, T., and K. Ok. 2006. Opportunities in Turkish Cultural Heritage for Conservation of Natural Values. International Conference Cultural Heritage and Sustainable Forest Management: The Role Of Traditional Knowledge: 424-431.

Ozdönmez, M., T. Istanbullu, A. Akesen, and A. Ekizoglu. 1996. Ormancilik Politikasi. I.U. Orman Fakültesi Yayinlari. Istanbul. 417pp.

Rackham, O. and J. Moody. 1996. The making of the Cretan landscape. Manchester. Manchester University Press.

Regato, P. and N. Berrahmouni. 2005. Using Nontimber Forest Products for Restoring Environmental, Social, and Economic Functions. In: Mansourian S.,Vallauri D., Dudley N., eds. (in cooperation with WWF International) 2005. Forest Restoration in Landscapes: Beyond Planting Trees, Springer, New York. 384-391.

Saatcioglu, F. 1952. Türkiyede agaclandirmanin önemine ve problemlerine toplu bakis. Istanbul Universitesi Orman Fakültesi Dergisi A. 2(1): 60-82.

Saatcioglu, F. 1961. Türkiyede orman davasi ve bazi memleketlerin agaclandirma calismalari. Istanbul Universitesi Orman Fakültesi Dergisi A. 11(2):1-11.

Saatcioglu, F. and I. Atay. 1978. Terkos Gölü'nu Tehdit Eden Buyuk Kumulun Tesbit ve Islahina Matuf Agaclandirmalarin Emniyeti ve Gelistirilmesi Uzerine Arastirmalar: 52.

Sag, B.M. 2002. Türkiye'deki Yüksek Dağ Ormanlarının planlama ilkeleri. Yüksek Lisans Tezi, I.U. Istanbul, Istanbul. Fen Bilimleri Enstitüsü.

Sayer, J. 2005. Goals and Targets of Forest Landscape Restoration. In: Mansourian S.,Vallauri D., Dudley N., eds. (in cooperation with WWF International) 2005. Forest Restoration in Landscapes: Beyond Planting Trees, Springer, New York.101-108.

Senitza, E. 1989. Waldbauliche Grundlagen der Libanonzeder (Cedrus libani A. Rich) im Westtaurus/Tuerkei. Dissertation 34, Wien, Universitaet fuer Bodenkultur.

Sensoy, S., M. Demircan, Y. Ulupinar, and I. Balta. 2008. Climate of Turkey, http://www.meteor. gov.tr/files/en-US/climateofturkey.pdf.

Serez, M. 1995. Status of Forest Fires and Fire Management in Turkey. IFFN No. 12- January 1995, p. 13-16.

Tavsanoglu, F. 1976. Türkiye'de Rüzgar Erozyonunun Kapsami, Rüzgar Erozyonuna Karsi Mücadele (Ornek: Ic Anadolu Konya Karapinar'da Rüzgar Erozyonü ile Mücadele). Istanbul Universitesi Orman Fakültesi Dergisi A. 26 (2): 65-95.

Tavsanoglu, F. 1978. Türkiye'de Toprak Tasinmasi ve Seller, Tarim ve Endüstrinin Kalkinmasi Sorunu. İstanbul Universitesi Orman Fakültesi Dergisi A. 28(1): 20-27.

Thirgood, J.V. 1987. Cyprus: a chronicle of its forest, land and people. Vancouver. University of British Columbia Press.

Urgenc, S. 2004. Agaclandirma. I.U. Orman Fakültesi Yayini, Bahceköy, Istanbul.

Urgenc, S. and M. Boydak. 1982. Some Recommendations for Applicability of Turkey's Reforestation Plannings. T.M.M.O.B. Orman Muhendisleri Odasi VII. Teknik Kongresi: 7 s.

Urgenc, S. and M. Boydak. 1985. Current Situation of Reforestation and Afforestation Activities in Turkey and Their Objectives I. U. Orman Fakültesi Dergisi Seri: A. 35(2): 8-18.

Urgenc, S. and M. Boydak. 1992. Characteristics of the Plantations in the Mediterranean Region; Problems and Recommendations. I.U. Orman Fakültesi, Ormancilik Arastirma ve Uygulama Merkezi Müdürlügü. (1): 45-57.

Urgenc, S., M. Boydak, and C.U. Alptekin. 1988. Achievements, Problems and Recommendations Related to Plantations, Nurseries and Tree Breeding Activities in Turkey. Türkiye'de Orman Isletmeciliginin Gelisimi Sempozyumu :187-202.

Urgenc, S., M. Boydak, and H. Dirik. 1993. Importance and Objectives of Plantations in Turkish Forestry and Planning Principles of Plantation Investments. "1. Ormancilik Surasi" :646-653.

Vallauri, D., J. Aronson, N. Dudley, and R. Vallejo. 2005. Monitoring and Evaluating Forest Restoration Success. *In*: Mansourian S.,Vallauri D., Dudley N., eds. (in cooperation with WWF International) 2005. Forest Restoration in Landscapes: Beyond Planting Trees, Springer, New York.150-160.

Walker, L.R. 2005. Restoring Soil and Ecosystem Processes. *In*: Mansourian S.,Vallauri D., Dudley N., eds. (in cooperation with WWF International) 2005. Forest Restoration in Landscapes: Beyond Planting Trees, Springer, New York.192-196.

Walter, H. 1956. Das Problem der zentralanatolischen Steppe. Flora 143.

Walter, H. 1968. Die Vegetation der Erde (Band 2) . Jena, VEB. Gustav Fischer Verlag.

Yavuz, F. 2005. Turkiye'de Tarım, Tarım ve Koyisleri Bakanligi, Ankara. pp.252.

**Figure 14:** ***Some implemented forest rehabilitation and restoration projects in Turkey (Source: AGM)***

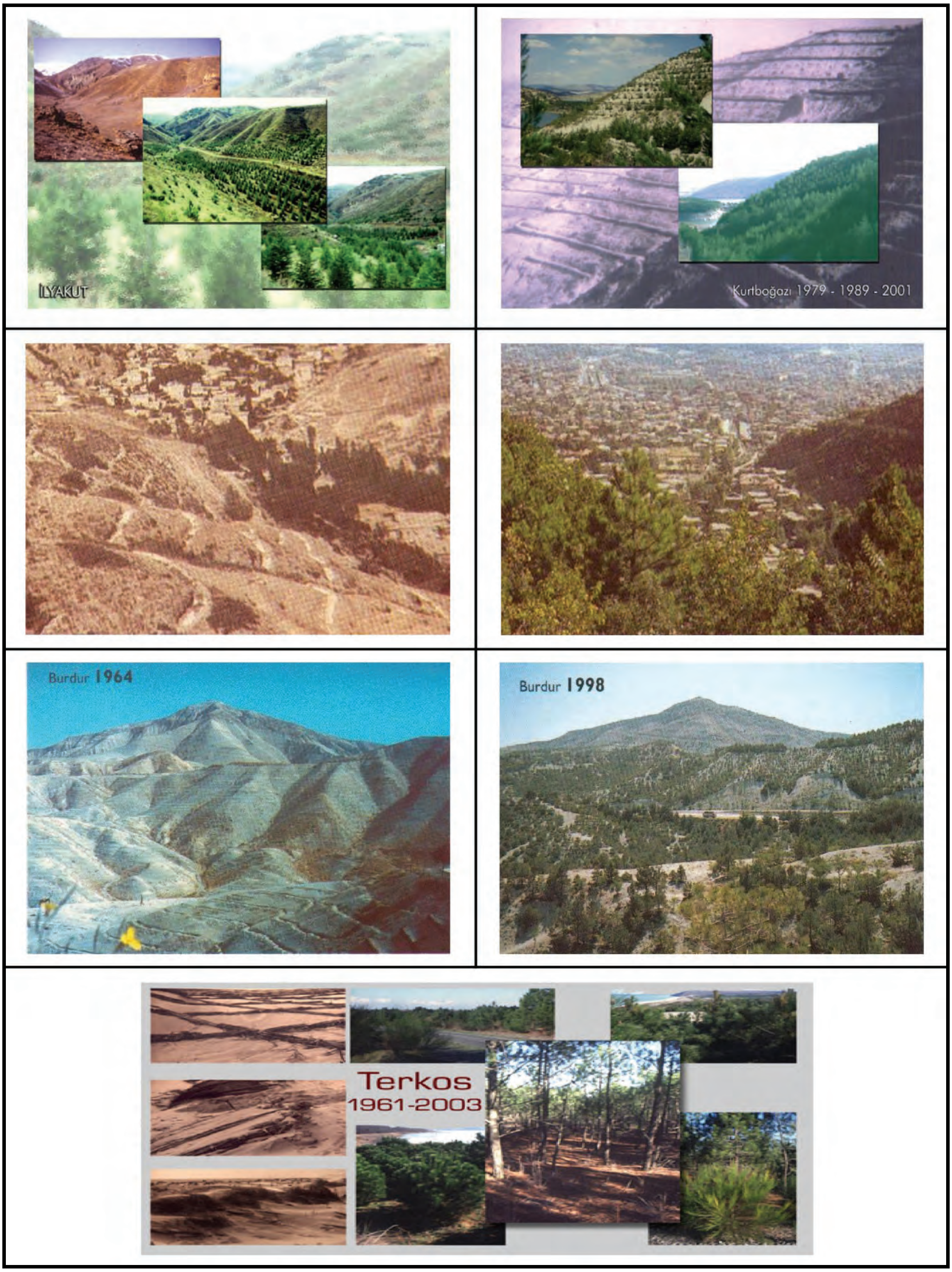



**Figure 15:** ***Some implemented forest rehabilitation and restoration projects in Turkey (Source: AGM)***

***Natural broadleaved-coniferous mixed forest (Abies bormülleriana, Pinus sylvestris, Fagus orientalis, etc.) in North-western Turkey (Photo taken by A. INCE)***

***Restoration of a rural landscape with Pinus brutia in South-western Anatolia (Photo taken by A. INCE)***

***Erosion control with terracing in order to stabilize high slopes with coniferous species in North-western Turkey (Photo taken by A. INCE)***

***Greenbelt afforestation around a settlement in Southern Anatolia (Photo taken by A. INCE).***

***Erosion control with terracing by using coniferous species in South-eastern Turkey (Photo taken by A. INCE)***

***Restoration activities applied in an eroded landscape in the Aegean Region (Photo taken by A. INCE)***

***Afforestation with Pinus pinea for multifunctional purposes, particularly pine nut production, in Western Turkey (Photo taken by A. INCE)***

***Typical example of a degraded Pinus sylvestris forest in Eastern Anatolia (Photo taken by A. INCE)***

***Different phases of sand dune stabilization work in the Mediterranean Region (Photo taken by A. INCE)***

# Forest Rehabilitation in the Republic of Uzbekistan

Evgeniy Botman[21]

## Summary

The Republic of Uzbekistan is a Central Asian country that borders Kazakhstan, Kyrgyzstan, Tajikistan, Afghanistan and Turkmenistan. The total area is 447,400 km$^2$. Approximately, four-fifth of the territory of Uzbekistan is occupied by desert plains; eastern and south-eastern areas of the country include mountains and foothills of the Tien Shan and Pamir-Alai mountains. The climate is characterized by continental and subtropical conditions. The population of the Republic of Uzbekistan amounts to around 28 million people (data of end of 2009) with an annual increase of 483,100 people or 1.8%.

As of January 1, 2008, the State Forest Fund of the Republic of Uzbekistan has comprised 8.66 million ha of which 3.24 million ha are covered by forests including 594,883 ha of artificial forest plantations. The percentage of forest land, i.e. ratio of the area covered by forests to the total territory, is 7.3%.

Based on soil climatic conditions, the forests of Uzbekistan are divided into the following categories: desert, valley-tugai (floodplain) and mountain. The current appearance of the country's forests is very different from the original forests in terms of composition of forest species, density and area distribution primarily due to changing of climatic conditions towards aridity. The decrease in forest areas and deterioration of their condition over the last 200 - 300 years is also connected with anthropogenic pressure such as tree felling, uncontrolled livestock grazing and fires.

All forests in Uzbekistan, both existing and newly established ones, have protective and land reclamation values. This means that the better forests fulfil or will fulfil their forest reclamation functions, according to their value orientation. Therefore, the objectives of reforestation and afforestation for different climatic zones of the country have their own characteristics, though all are aimed at strengthening the reclamation functions.

Artificial afforestation has been initiated on the territory of Uzbekistan as a government policy priority since the late 19$^{th}$ century. Forest science has developed a large number of recommendations on afforestation under various edaphic conditions such as in the sand-desert zone and on the dried bottom of the Aral Sea, the valley-tugai, and in the mountain zones. The country's forestry profession has accumulated a large and sometimes unique experience on afforestation under the most extreme arid conditions.

After independence the role of forestry has become more important. In the social sphere, the need of the local population for use of forest resources has increased significantly as has the necessity in meeting recreational needs within the country.

In the field of ecology, the country now has international commitments relating to the conservation of biological diversity, the mountains of Central Asia beiing one of the 32 global biodiversity hot spots. One of the major challenges is to address the problems associated

[21] Senior Researcher, Republican Scientific Production Centre for Decorative Gardening and Forestry, Tashkent, Uzbekistan

with combating desertification including afforestation of the dried bottom of the Aral Sea and stabilization of irrigated agricultural landscapes. The growing water shortage pays higher importance to the water conservation role of forests in the mountains, i.e. watershed management in headwater rivers.

As stipulated in the national forest programme, Uzbekistan's forestry is now on the eve of significant reforms. These necessary reforms have taken shape, but their implementation depends on many conditions ranging from professional training of branch' specialists to financial provisions. The implementation of the NFP will inevitably lead to necessary institutional changes in the management of the industry and the involvement in forest management not only of professionals but also of other stakeholders.

## 1. General Information

The Republic of Uzbekistan is located in Central Asia. It borders Kyrgyzstan (in the northeast and east), Kazakhstan (in the north and northwest), Turkmenistan (in the southwest), Afghanistan (in the south), and Tajikistan (in the southeast). The territory of Uzbekistan stretches from southeast to northwest. The northernmost point is located at the northeast side of the country at the Ustyurt Plateau (45°36' northern latitude) whereas the southernmost point is located at Termez City (37°11' northern longitude), and the westernmost point at the Ustyurt Plateau (56 northern longitude), and the easternmost point, southeast of Fergana Valley (37°10' northern longitude). The distance between extreme northern and southern points is 925 km, and 1,400 km - between western and eastern points (Anonymous, 1).

The territory of the Republic has a general inclination from southeast to northwest leading to an inland lake, the Aral Sea. The main part of the country is located between the largest rivers of Central Asia, Amudarya and Syrdarya. Nearly four fifth are plains, mainly the Turan lowlands and only in the far east there are mountains belonging to the systems of the Tien Shan and Gissar-Alay mountain ranges.

In ancient times, the Great Silk Road passed through the territory of the country linking eastern (Asian) and western (European) countries.

### *1.1 Geographic Information (Anonymous, 2)*

***Relief:*** Based on the topography, the territory of the country is divided into plains, sub-mountain and mountain areas.

The plains cover the Ustyurt Plateau, the alluvial-deltoid plain of Amudarya and Kyzylkum.

- Ustyurt is a wavy plateau with prevailing hills of 200 – 250 m asl; it is delimited by ledges from adjoining plains
- The alluvial-deltoid plain of Amudarya sits at lower elevations. The relief is flat (height up to 100 m asl) with not many hills
- Kyzylkum is an upland plain with hills ranging from 100 m in the northwest to 200 – 300 m in the southeast. There are several mountain formations with elevations of up to 1,000 m. They have rocky slopes sharply cut by dry erosive valleys. Mountains are separated from each other by sandy massifs with distinct forms of aeolian relief. There are closed caves and hollows, some of them below sea level (up to 12 m).

The sub-mountain and mountain part includes mountain ridges of the Tien Shan and Gissar-Alay mountains, and intermountain depressions separating them. The elevation of ridges is up to 4,000 m and higher (reaching 4,643 m at Gissar mountain ridge). There are ridges of the Western Tien Shan located in the extreme northeast: Karjantau, Ugam, Pskem, Chatkal and Kuramin. The Fergana Valley and Tashkent-Mirzachul sub-mountain plains separate the Turkestan ridge (Gissar-Alay) and its western branch (Malguzar and Nuratau) from this group of ridges. Towards the south, there is the Sanzar-Nuratau Valley while in the extreme south of the country there are the Kashkadarya and Surkhandarya Valleys separated by the Gissar mountain ridge.

***Climate*:** The climate of Uzbekistan is continental subtropical with a long and dry hot summer, a cool damp autumn and a mild winter with little snow. The winter period in the plains and lower foothill areas lasts from one and a half months up to two months in the extreme south and up to five months in the extreme north (at Ustyurt). The average temperature in January is about -8°C (at Ustyurt), in the extreme south in Sherabad it is 3.6°C. An absolute minimum in the country is -37°C. The average temperature in July in the northern areas is up to 26°C, and over 30°C in the south. At an elevation of 3,000 m, the temperature is about 10°C. The absolute maximum temperature measured in the lowlands and foothill areas is about 42°C. In summer time, during the afternoon, the temperature on the land surface can reach 60°C, and even 70°C in sandy deserts.

The minimum precipitation in the lowlands amounts to 80 – 90 mm annually. In the east and south, rainfall increases slowly with the increase of elevation. Further up as mountain ridges are approached, precipitation rapidly increases and in some places it can reach and even exceed 890 – 1,000 mm per year. Over 70% of precipitation falls during winter and spring time. Snow cover is formed almost annually, but it is often unstable in the lowlands and foothills, and remains for several days only. Now snow heights vary from several centimeters in the west up to 60 - 80 cm in the east (i.e. in foothills and mountains), and sometimes exceed 100 cm in the mountains.

***Inland waters*:** An extremely non-even distribution of rivers throughout the territory is typical for the country. Rivers are especially underrepresented in the lowlands. When reaching the plains, a large proportion of their water is used for irrigation and they often get dried out. There is a branched river network in the mountains. All rivers belong to the Amudarya Basin and the Syrdarya Basin. Most of the rivers are fed by glaciers with a maximal charge in June. Annual water discharge of the Amudarya is about 79 km$^3$ on average representing half of all runoff formed within the mountain ranges of Central Asia. Out of them around 6 km$^3$ are supplied by the mountain areas of Uzbekistan. The runoff of Syrdarya is around 38 km$^3$, of which 4 km$^3$ lies within Uzbekistan. Most of the tributaries of the Syrdarya are being fully withdrawn for irrigation purposes and do not reach the river.

Lakes are mainly located in valleys and in deltas of large rivers and at the periphery of irrigated oases. The largest lake is the Aral Sea the size of which has substantially decreased due to withdrawal of water from the Amudarya River and the Syrdarya River for irrigation purposes. There are also artificial lakes that have been created as water reservoirs such as Kattakurgan, Chardarya, Charvak, and others.

***Soils*:** Sandy soils prevail in the upland plains of Kyzylkum, grey-brownish soils in the interior mountains and ancient detrital cones, takyr and takyr-type soils in depressions. In the foothill belt and low mountains sierozem soils of three types namely light (from 250 up to 400 m), typical (400 – 700 m), dark (700 – 1,200 m) are commonly found. At the medium elevation belt (1,200 – 2,800 m) brown and brownish mountain-forest soils are dominant and in the highlands (over 2,800 m) light-brown grass-steppe soils prevail. Hydromorphic soils (alkaline lands, meadow, meadow-marsh and marsh) can be found on low-runoff foothill plains and river valleys. Irrigated soils are classified according to a special typology.

The soils of Uzbekistan, and especially those of desert ecosystems like gray-brownish, takyr, and sandy soils, have a low level of humus (around 1% in upper soil layer). Grey soils, i.e. sierozem, also have low level of humus that is explained by insignificant organic residual and their rapid rate of mineralization.

### *1.2 Demography*

As of January 1, 2008, the population of the Republic of Uzbekistan has been 27.55 million (Anonymous, 3) people and has grown annually by 483,100 people or 1.8%. The natural growth of the population is 508,900, out of them 331,800 (65.2%) live in rural areas. The urban population makes up 37%, while 63% of the total population live in rural areas.

Uzbekistan is a multinational country, with representatives of more than 100 nationalities living there. The main part of the population are Uzbeks, representing almost 80% of the total population. Russians are less than 5.5%, Tadjiks 5%, Kazakhs 3%, Karakalpak 2.5%, Tatars 1.5%, Kyrgyz 1%. Uzbeks, as well as other Central Asian people profess Islam, while Russians and other representatives of Caucasians are Christians.

The Republic of Uzbekistan, as well as other states of Central Asia, is characterized by a relatively “young” population and large proportion of people in an able-bodied age. The relative population density of younger than able-bodied age in the total number of population comprises 39%, of able-bodied age 54%, and older than able-bodied age 7% (Anonymous, 4). The ratio between males and females comprises 1:1.003. According to Goskomstat’s [State Committee for Statistics] data, 249,000 marriages and 16,100 divorces were registered during 2008.

The official language is Uzbek with more than 74% of the population speaking Uzbek. The Russian language is widely used in the cities and over 14% of the population is speaking it regularly. The largest city of Uzbekistan is Tashkent, the capital city of the country, with a population of 2.3 million people (Anonymous, 5). From the administrative point of view, the territory of Uzbekistan is divided into 12 regions, one autonomous Republic, and one capital city.

### *1.3 Natural Resources*

The Republic of Uzbekistan has great mineral and raw material potentials, unique agricultural raw material, significant volumes of semi-finished goods, and a well developed infrastructure. A wide range of minerals (around 100 types), of which 60 are already used in the national economy, can be found on the territory.

The main energy resources of the country are natural gas (confirmed reserves of up to 2.0 trillion $m^3$, including large deposits at Shurtan (0.5 trillion $m^3$) and Alan with an estimated 0.2 trillion $m^3$, coal deposits (at Angren with reserves of up to 1.9 billion t of brown coal), reserves of uranium ores (up to 230,000 t of uranium, including the largest deposit in Uchkuduk), and hydraulic power mainly from large rivers such as Chirchik, Akhangaran, Surkhandarya, and many other smaller streams (Anonymous, 6).

Being ranked 55th in terms of territory and 39th in terms of population, Uzbekistan is among the world leaders as regards:

- Reserves of silver, tungsten and phosphorites, potassium, rare-earth metals and other valuable minerals. In terms of gold reserves Uzbekistan ranks 4th in the world, uranium 7th , molybdenum 8th, natural gas 14th; and in terms of confirmed reserves of copper 10th;
- Area of artificially irrigated lands ranks 11th in the world;
- Production of astrakhan fur [karakul] ranks 2nd , cotton 5th , raw silk 6th in the world;
- Extraction of cadmium ranks 3rd , uranium 6th, gold and natural gas 8th, it is also among the 15 largest countries of the planet concerning extraction of molybdenum, feldspar and a number of other types of industrial raw material;
- Uzbekistan is in the second top ten of countries which produce sulfuric acid, nitrogen fertilizers, mineral lubricant oils and paraffin, cotton yarn and fabrics, tomato paste, dried fruits, harvesting of cucurbitaceous and grapes, shearing wool, rail freight turnover; and
- In terms of exporting: cotton fibers ranks 2nd and uranium ranks 3rd in the world.

### *1.4. Socio-Economic Situation (Anonymous, 7)*

In 2008, Uzbekistan's GDP was UZS 36,839.4 billion (109% compared to 2007) that makes UZS 1,316,000 per capita. In the structure of GDP the production of goods accounted for 45.4%, services 45.3%, taxes on goods and export-import transactions 9.3%. While 79.4% to GDP falls in the non-government sector of the economy and 20.6% in the government sector. The volume of industrial output has made UZS 23,679 billion (112.7% to 2007), consumer goods UZS 7,436.5 billion (117.7% to 2007), and agricultural products UZS 10,479.6 billion (104.5% to 2007).

The share of non-state enterprises in the total number of registered enterprises accounted for 93%, of which 56.0% farm and dehkan entities, 20.8% private enterprises, 0.9% enterprises with participation of foreign capital, 0.4% joint-stock companies, and 21.9% other enterprises. The share of the non-state sector accounted for 79.4%.

UZS 2,193.7 billion of foreign investments were brought into the country in 2008, including UZS 601.9 billion in the form of loans. Foreign trade turnover has reached USD 1.9 billion (121.4% to 2007), including export USD 1.16 billion (60% to the total trade turnover), import USD 0.75 billion (39.3% to the total amount). Exports mainly include energy resources and oil products (25.2%), whereas imports mainly include machines and equipment (53.3%).

The number of people employed in the economic sector in 2008 was around 11 million, representing an increase by 2.8% in comparison with 2007. The total number of people employed including government employees amounts to 15.6 million. The increase in workforce resulted from the higher number of employed people in the non-production sector by 3.2% and in the production sector by 2.6%. About 44% of able-bodied people are employed in the agricultural sector, 20% in the industrial sector, and 36% in the services sector.

In 2008, approximately 623,300 unemployed people registered with the government for assistance in job-seeking. Out of the total number of citizens seeking employment, 72.1% are from rural areas. Due to state programs on development of the services industry, cattle breeding and in-house jobs, 660,900 new workplaces were created during 2008.

In order to support the local economy, various measures provided for in the anti-crisis program (approved in November 2008) have been carried out during 2009. A number of privileges and benefits, including credit and budgetary assistance, have been provided to domestic enterprises. For the purpose of increasing competitiveness of domestic production and stimulating of domestic demand a number of activities on reduction of production costs are currently being carried out. The implementation of a localization program had an import-substituting effect amounting to USD 296.9 million which is 1.7 times higher than the results achieved in the same period in 2008. In addition, various projects are being planned which will be implemented in "Navoi", a newly created free industrial economic zone. Currently, the necessary facilities and external communications in the zone itself are established.

### *1.5. Land-use (Anonymous, 8)*

***Agriculture:*** The gross output of the agricultural sector in 2008 reached UZS 10,479.6 billion, or 104.5% compared to 2007, including crop production (UZS 5,605.5 billion) and cattle breeding (UZS 4874.1 billion). The largest contributions to the agricultural production was made by the Samarkand Region (13.4%) and Tashkent Region (12.1%), followed by the Andijan Region (9.2%), Bukhara Region (9.2%), and Kashkadarya Region (9.1%).

***Crop production:*** The basis of agricultural production of Uzbekistan is irrigation farming at flat oasis locations with well developed irrigation infrastructure. However, irrigation is carried out as a rule by furrows resulting in significant losses of water. In addition, using this technique of irrigation under flat conditions leads to an increase of the water table resulting in a source of secondary salinization of the soil. Up to one third of irrigated arable land of the country is subject to soil salinization of different degrees. During previous years greater attention has been paid to land reclamation of irrigated arable land and significant funds for improvement of the drainage network have been invested. Pilot projects on the use of drop irrigation are being implemented.

The total area of planted agricultural crops expands over 3.6 million ha. After gaining independence from the Soviet Union, one of the priorities has been to achieve self-sufficiency in grain production. During the Soviet regime, the area of irrigated arable land had been allocated primarily to cotton. After independence the distribution of arable irrigated land for agricultural crops shifted mainly towards grain crops reaching 1.56 million ha in 2008. The share crops included cotton plantations (1.43 million ha), vegetables (162,300 ha), potatoes (59,900 ha), gourd plantations (42,200 ha), fruits and berries crops (214,400 ha), and grapes (125,400 ha). In total, 6.73 million tons of grain was threshed, including 6.15 million tons of wheat. The average crop yield per hectare reached 4.28 metric tons. The other harvested crops included 3.4 million tons of raw cotton, 1.4 million tons of potatoes (yield 19.53 metric tons/ha), 5.22 million tons of vegetables, 981,200 tons of gourds, 1.4 million tons of fruits and berries, and 791,000 tons of grapes.

***Cattle breeding*:** The share of cattle breeding in total agricultural production is about 46.5% and has been developed in specific zones on the basis of natural conditions. Astrakhan sheep breeding is based on semi-arid and arid pastures. In foothill and mountain dry zones, there is breeding of meat-fatty sheep and goats; in irrigated zones mostly meat-and-milk cattle breeding as well as meat-fatty sheep breeding and poultry farming. There is also breeding of horses and camels. Silkworm breeding is one of the oldest sectors of agriculture practiced in irrigated zones.

The number of livestock is estimated at about 8 million heads of cattle. Annual production of meat in live weight amounts to 1.29 million tons. Also, 5.43 million tons of milk, 2.43 billion eggs, 23,800 tons of wool, 896,800 fells of astrakhan sheep, and 23,500 tons of silkworm cocoons are produced.

***Industry:*** The main energy resource of the Republic is natural gas, the extraction of which is concentrated mainly in the Ghazli and Karshi areas. Oil is primarily extracted in the Fergana Valley and Bukhara Region. A new oil field was discovered in the western part of the Fergana Valley. Coal is being extracted near Tashkent, Denau and in the Fergana Valley.

Industrial processing of deposits of nonferrous metals, including zinc, copper, lead, tungsten, and nonmetallic minerals (feldspar, quartz, limestone, calaite) is being carried out. Gold is exploited in the Basin of the Zerafshan River and the Kyzyl-Kum Desert. Extraction of uranium is reported from the Fergana Valley.

In 2008, the industrial sector has produced goods of a total value of UZS 23,679.0 billion representing 112.7% of the value achieved in 2007. The basic sub-sectors of industrial production are fuel and energy, the share of which amounted to 29% of the total volume of industrial production. The contributions of mechanical engineering and metal processing (16.2%), nonferrous metallurgy (12.6%), light (12.9%) and food (9%) industries are significant.

Power generation accounts for 50.1 billion kw/h. The extractive industry also produced 4.8 million tons of crude oil and gas condensate, 685,700 tons of steel and 643,000 tons of rolled iron, about 1.0 million tons of mineral fertilizers, 195,000 cars, 6.65 million tons of cement, 1.17 million tons of cotton fibre and a range of other goods.

The most significant production of industrial output and consumer goods has been reported from Tashkent and the Tashkent Region, the Andijan Region, the Kashkadarya Region, the Navoi and Fergana Regions.

***Urbanization:*** *(Anonymous, 9)*: More than 42% of the country’s population lives in cities. The largest city of Uzbekistan is Tashkent, the capital city with a population of 2.3 million people. More than half of the Russian population of Uzbekistan lives in Tashkent City. In 1966, there was a destructive earthquake, but the city was quickly re-built. Major parts of the industry of the Republic are concentrated in Tashkent City with main roads passing through it. The city is the center of the country’s economy, education and culture. The second largest city is Samarkand (404,000 people). Samarkand City, famous for its architectural monuments, used to be the capital of the Uzbek Soviet Socialistic Republic until 1930. A number of large cities are located in Fergana Valley and include Namangan (300,000 people); Andijan (310,000); Fergana (200,000); and Kokand (176,000). The ancient City of Bukhara (255,000 people) has been the largest cultural and political center of the Uzbek people for a long time, and is famous for its ancient architectural heritage. Nukus City (189,000 people) is the capital of the Karakalpak Autonomous Republic.

***Tourism:*** *(Anonymous, 10)*: Uzbekistan offers great potential for tourism development, particularly in the fields of health and wellness, sightseeing and education, as well as nature tourism. Favorable climatic conditions, the beauty and variety of the landscape and natural features, availability of different mineral sources with healing properties, and a diversity of the natural and historical heritage makes Uzbekistan a suitable tourist destination.

Cultural tradition of the people living in the territory of modern Uzbekistan goes back many thousands of years. The ancient and medieval civilizations of Khorezm, Sogd and Maveraunnahr have been founded, and flourished in the country, whose majestic ruins or magnificent architectural complexes in Samarkand, Kitab, Khiva and Bukhara, as well as rich literature in many languages have been preserved. Since the 8$^{th}$ Century Islam has contributed greatly to the formation of cultural traditions. The mosques, madrasahs and mausoleums of Samarkand and Bukhara are considered to be a model for the world's Muslim architecture.

During Soviet time, numerous museums and libraries have been created in Uzbekistan. Large art, ethnographic and historical collections are located in Tashkent, Bukhara, Samarkand, Khiva, Kokand, Nukus and other cities. Practically every city of Uzbekistan has its own local history museum. There are extensive collections of books and ancient manuscripts stored in the libraries of Tashkent, Samarkand and Bukhara. The museum dedicated to the life and activity of Tamerlane, the greatest conqueror of the $14^{th}$ Century, was opened in Tashkent in 1996. In ancient Samarkand City the international ethnographic musical festivals are held on a regular basis.

More than 60 sources of mineral water of various chemical compositions can be found in the mountains of Uzbekistan, on the basis of which spa and clinics have been established. There are natural monuments with interesting botanical, geological and hydro-geological features. Also, waterfalls and groundwater wells can be found in the Tashkent, Surkhandarya, Samarkand, and Kashkadarya regions. Many interesting monuments of ancient history have been conserved and include rock paintings and barrows, fortresses, footprints of sites of ancient people, relics of mines and melting furnaces, antiquities, traces of dinosaurs, and others.

Important tourist destinations are located in the mountains of the Tashkent Region while Western Tien Shan represents the largest health resort treatment and health improving area of the Republic of Uzbekistan. There are sanatoria, numerous recreational zones, wellness camps, hotels, as well as tourist and sports complexes with the most modern tourist complex found on the coast of the Charvak water reservoir.

The rich heritage of Uzbek people attracts numerous foreign tourists. More than 1 million foreign tourists have visited the country in 2009 (Anonymous, 11). Tourism has become an important industry in the country with a huge potential for development. After independence, modern hotels as well as small guest houses (on the basis of family businesses) have been constructed in Tashkent and other large cities and tourist centers. The development of tourism for both locals and foreigners, creates the foundation for the development of local handicrafts, production of souvenirs, establishment of new restaurants, cafes, family cafeterias offering national food, and other facilities of tourist infrastructure.

***Protected areas:*** At present, there are nine reserves in Uzbekistan, three of which refer to valley-tugai reserves (Badai-Tugai, Kyzylkum, Zerafshan), four reserves refer to mountain-juniper reserves (Chatkal, Gyssar, Zamin and Surkhan), one reserve refers to a geological reserve (Kitab), and the last one refers to a mountain-nut-bearing reserve (Nurata).The total area of Uzbekistan's reserves amounts to 2,274 $km^2$ or a little more than 0.5% of the country's territory. In most countries of the world the area of reserves varies between 3% and 7% or more. In addition, two national parks have been opened for ecotourism, with an area of 5,987 $km^2$ or about 1.4% of the country's total area (i.e. Zamin National Park and Ugam-Chatkal State national Natural Park). Reserves and national nature parks are administratively under the jurisdiction of various authorities such as the regional Khokimiyat, the State Committee for Nature Protection, the State Committee for Geology, and the Main Department for Forestry. Unfortunately, such distribution of responsibilities between establishments does not promote the implementation of a uniform nature protection policy in these protected territories.

A brief characteristic of protected territories is presented in the table below.

**Table 1***: Brief characteristic of protected territories of the Republic of Uzbekistan*

| Name of protected territory | Prevailing landscape | Year of creation | Area, km² |
|---|---|---|---|
| **Zamin State Reserve** | Mountain forest | 1926/ 1959 | 268.4 |
| **Chatkal State Biosphere Reserve** | Mountain forest | 1947 | 356.8 |
| **Kyzylkum State Reserve** | Tugai-sandy | 1971 | 101.4 |
| **Nurata State Reserve** | Mountain nut-bearing | 1973 | 177.5 |
| **Kitab Geological Reserve** | Mountain forest | 1979 | 53.7 |
| **Zerafshan State Reserve** | Valley-tugai | 1975 | 23,5 |
| **Badai-Tugai Reserve** | Plain-tugai | 1971 | 64.6 |
| **Gissar State Reserve** | Mountain-juniper | 1973 | 814.3 |
| **Surkhan State Reserve** | Mountain forest | 1986 | 276.7 |
| **Zamin National Park** | Mountain- juniper | 1976 | 241.1 |
| **Ugam-Chatkal National Natural Park** | Mountain forest | 1990 | 5,745.9 |

The existing reserves and natural parks do not cover essential components of biodiversity of Uzbekistan. These under-represented vegetation types include populations of pistachio growing in the territory of Babatag forestry enterprise and in Sangardak forestry area of Uzun forestry enterprise, subtropical natural populations of fig, persimmon, pomegranate, sumach, grapes in the Tupolang river basin, and nut-bearing cenosises in most favorable places for their growth in Burchmulla forestry enterprise. For this reason, the network of protected territories of Uzbekistan requires significant expansion.

### *1.6 Land-use Pattern*

In Uzbekistan, physical-geographic features of the territory significantly influence the type of land-use in different parts of the country. Flat lands (i.e. Ustyurt plateau, alluvial-deltoid plain of Amudarya and Kyzylkum) are used as natural low-productive pastures due to their extreme aridity. Distant cattle breeding is being developed here, including astrakhan sheep breeding, i.e. herds of animals constantly migrate in search of acceptable pastures. A significant proportion of this territory belongs to the State Forest Fund. Here, forestry enterprises manage and conserve existing forest plantings as well as establish new plantations both in deserts and in tugai forests along the Amudarya River. Some parts of the deltoid plain of the Amudarya have been used for farming based on artificial irrigation since old times in the ancient Khorezm oasis or during the Soviet rule in Karakalpakstan. More recently, some of the areas have been gradually opened up for extraction of minerals, such as gas, gold, and oil in Ustyurt plateau and on the dried bottom of the Aral Sea.

When discussing land-use pattern in Uzkekistan, it is necessary to also address the issue of the retreat of the Aral Sea in more detail. The problem of drying-out of the Aral Sea is connected to large-scale projects on agricultural utilization of lands of Central Asian Republics during the Soviet time. Diversion of significant parts of the runoff of Amudarya and Syrdarya rivers has distorted the natural water balance of the Aral Sea, resulting in a catastrophic reduction of the water volume in the sea and its surrounding area. Thus, the basin has changed from fresh-water to a strong-mineralized water body. At the same time, the area of the drained bottom of the Aral Sea has been constantly increasing and presently covers more than 4 million ha. Significant parts of this area are saline lands. The intensive wind activity that is being observed in this region results in the shifting of salt and dust, thus considerably worsening the ecological situation in extensive adjoining spaces. The only realistic means of preventing this negative process is forest reclamation of the drained bottom area. Therefore, significant areas of the drained bottom were placed under the authority of the State Forest Fund for planting purposes.

In this part of the country population density is very low, except for Khorezm oasis and a narrow belt along the Amudarya River in Karakalpakstan. The eastern part of the country is located in submountain and mountain terrain with broad valleys and plateau plains. Here, the bulk of the country's population, the industrial enterprises and agricultural lands are concentrated.

One of such intermountain plains is called the Fergana Valley, where the highest density of population in the country (exceeding 350 persons per $km^2$) can be observed. This is a region of intensive irrigated farming producing the main agricultural crops (cotton, grain). Significant areas are also covered with gardens and vineyards. The rural population mostly grows poplar trees in their farmlands. Industrial production is concentrated in the cities with e.g. a car assembly plant in Asaka City.

Because of the general aridity of the climate, most of the people of Uzbekistan live at the foothills of mountain ranges along the river valleys. Examples for this distribution are the capital city (Tashkent) and many other smaller industrial centers located in the Chirchik-Angren Valley, as well as other cities such as Samarkand, Bukhara and Navoi located in the Valley of the Zerafshan River. Agricultural production, both irrigated farming, and cattle breeding, is dominant in this part of the country. Practically all rural people keep animals and poultry, grow vegetables and fruits on plots of land attached to their houses. Part of the land at the foothills, where precipitation exceeds 350 mm a year, is used for dry, non-irrigated farming (i.e. grain, vineyards, gourds, and oil crops).

In the mountain ranges of the country the population density is smaller. Here, on moderate mountain slopes and on plateaus, local people pursue rain-fed agriculture (i.e. grains, vineyards and gardens) sometimes supplemented by irregular artificial irrigation. Each household maintains animals and overgrazing can be observed practically everywhere. This affects biodiversity negatively, in particular through limited natural regeneration. It is especially disturbing because in the mountains of Uzbekistan a high level of biodiversity can be observed, including many wild relatives of cultivated plants.

## 2. State of Forests

### *2.1. Forest Cover of Uzbekistan (Phytogeographical Information)*

Based on soil-climatic conditions, the forests of Uzbekistan are divided into the following categories: desert-like plains, valley-tugai (floodplains) and mountain areas.

Forests are very irregularly distributed over the territory of the Republic. The largest forest areas in the desert-like plains are located in the Karakalpakstan, Bukhara and Navoi regions. Small areas of mountain forests can be found on slopes of Western Tien Shan, a western branch of the Turkestan and Gissar ridges. Tugai forests extend by narrow belts along the main water courses of the the Amudarya and Syrdarya rivers.

As of January 1, 2008 the State Forest Fund of the Republic of Uzbekistan extended over 8.66 million ha, with a proportion of forest area of 3.24 million ha. The percentage of forest land, i.e. the ratio of area covered with forests of the country's territory, amounts to 7.3%. On average, there are 0.07 ha of forests per capita. In comparison, the average figure for CIS countries is 3.3 ha.

**Table 2:** ***Forests of Uzbekistan (according to the system of the Main Department for Forestry, as of January 1, 2009)***

| Forest category | Total area | Including forest covered areas | % of forest lands in the country |
|---|---|---|---|
| **Mountain** | 877,000 | 296,000 | |
| **Desert-like plains** | 6,967200 | 2,502,300 | |
| **Floodplain** | 103,300 | 8,500 | 6.4 |
| **Valley** | 197,900 | 39,100 | |
| **In total** | 8,145,400 | 2,845,900 | |

The main forest fund holder is the Main Department for Forestry (MDF), the share of which extends over 8.15 million ha or 94.0% of the total forest fund area. The forest area is equal to 2.85 million ha or 87.7% of the total area in the Republic covered with forests.

For a better understanding of forest statistics, adopted during the Soviet period and followed until today, the following definitions are required:

- The area of the State Forest Fund is termed forest land and includes land for afforestation, and non-forest land, where afforestation requires additional reclamational activities for site preparation.
- Forest lands include such categories of lands as forest covered area, non-closed-up artificial (young) plantings, sparse crops, sparse forests, fire-sites, perished stands, cut sites, and glade abandoned sites.
- Non-forest lands include arable land, hayfields, pastures, marshes, sands and other lands.

**Table 3:** ***Distribution of State Forest Fund (under the responsibility of MDF) by land categories (01.01.2008)***

(Area, thousand ha)

| Total area of forest fund lands, thousand ha | **Forest lands** | | | | | | | | | Total forest lands |
|---|---|---|---|---|---|---|---|---|---|---|
| | Covered by forest | | Not closed up artificial (young) plantings | Forest nursery and plantation | Non Covered by forest | | | | | |
| | Altogether | Including artificial plantings | | | Sparse forests | Fire-sites, perished stands | Cut sites | Glade, abando-ned sites | Total Not Covered by forest | |
| 8,178.9 | 2,827.5 | 594.9 | 155.9 | 0.7 | 711.9 | 20.6 | 5.2 | 217.9 | 955.6 | 3,939.7 |

| Non forest lands | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Arable lands | Hay-making | Pasture | Waters | Gardens, Vineyards, mulberry grove and others | Roads, cuttings | Farmstead and others | Swamp | Sands | Glaciers | Other lands | All non-forest lands |
| 9.0 | 3.8 | 1,598.9 | 62.9 | 1.7 | 5.4 | 3.0 | 0.8 | 96.1 | 0.7 | 2,456.8 | 4,239.1 |

The basic forest forming species of forest stands in desert like plains is saxaul (*Holoxilon persicum Bge*. and *H. aphillum Hjin*.). Large areas are also occupied by saltwort (*Salsola Richterii Kar*., *S. paletzkiana Litv*.), kandyms (*Calligonum*), and tamarisks (*Tamarix*). Most of the forest stands under desert conditions are of low-density (i.e. 0.3 – 0.4) reaching rather low growing stocks of wood: for saxaul stands up to 60 $m^3$ /ha, saltwort stands up to 30 $m^3$ /ha, and tamarisk stands up to only 3-4 $m^3$ /ha.

Vegetation of mountain territories has zonal character and distinctions are made between desert-like and dry steppes, meadow steppes, bushes, deciduous and coniferous (juniper) forests, and subalpine and alpine meadows. Although relatively small in terms of area, the mountain forests of Uzbekistan are diverse by species composition. More than 100 tree and shrub species can be found here. Based on the composition, the mountain forests can be divided into various types such as juniper, pistachio, almond, nut-tree, apple-tree, hawthorn, mixed forests, and shrubbery.

Juniper forests occupy a special vegetation belt at higher elevation, and extend over an area of 193,100 ha represented basically by thinned plantings. They can be found as open stands with densities of 0.2 – 0.5 along the slopes of the Alay, Turkestan, Zerafshan, Fergana, Chatkal, Kuramin ridges and along the southwestern branch of the Gissar and Babatag ridges.

Pistachios in the mountain forests rank second by area and they basically concentrate on the ridges of the Babatag Mountains. Their total area in the Republic of Uzbekistan amounts to 39,322 ha. As such they are long-living with trees reaching an age of 300 years and more, very drought-resistant, but form very open stands with an average growing stock of only 2.54 $m^3$/ha. Natural regeneration of pistachio is very poor, partly because of intensive fruit harvesting and use as cattle pasture.

Walnut-tree forests are presented both as pure and mixed stands and are confined to the slopes of northern aspects and lower watersheds. Pure walnut stands most typically grow at the valley bottom and at the gentle northern slopes of the Fergana and Chatkal ridges.

Mixed maple-walnut and apple-walnut forests develop under poor site conditions on southern slopes with shallow soils. They form open stands (i.e. density 0.3-0.4) with stunted trees. An average stock of mature walnut trees reaches up to 60 $m^3$/ha.

In the flood-plain and valleys of the rivers one can find woody-shrub and grassy plant communities – so called tugai, mainly located on islands and in strips along the rivers. The basic forest forming species of tugai are Asiatic poplar (*Populus diversifolia*, *P. pruinosa*), Russian olive (*Elaeagnus angustifolia L*.), willow (*Salix songarica Anderss*.), and tamarisk. Their total area in the country is estimated at 103,300 ha. The largest concentrations of tugai forests can be found in the delta of the Amudarya River in the Republic of Karakalpakstan, as well as along the Syrdarya River, in the Fergana Valley, in the lower reach of the Chirchik River, near to Samarkand, and along the Zerafshan River. For their existence, tugai vegetation requires peculiar ecological conditions such as high water table, periodic floods combined with dry hot climate, low air humidity and absence of precipitation during the summer period. Present-day Tugai forests are of low productive stands with a density of 46-64 $m^3$/ha. However, there are exceptions like in Khorezm and Karakalpakstan where tugai stands have been producing up to 200 $m^3$/ha of wood , including 40 $m^3$/ha for industrial purposes.

## *2.2. History*

For an objective assessment of the current status of forests it is necessary to know the history of their formation (Griza *et al.*, 2008). This will allow an evaluation of recent changes, which have affected the development of forest resources, and planning for their sustainable management and conservation. In this context, mountain forests such as juniper and nut-fruit forest types are discussed in more detail.

Most authors (Ovchinnikov, 1958; Korovin, 1962; Konnov, 1966) associate the origin of juniper forests with the Quaternary period, basically with the Holocene (20,000 to 25,000 years ago). Most researchers of juniper forests indicate that the current appearance of these forests differs sharply from the original appearance in the composition of forest species, density and area of distribution. The main reason for this is the change of environmental conditions towards a more arid climate. Insufficient moisture supply has created conditions for a reduction of mesophilous deciduous species in the composition of the vegetation cover, expansion of steppe vegetation, and formation of pure open juniper forests. Latest research (Beer *et al*., 2006) conducted in the juniper forest zone shows that juniper had occupied large areas in this zone (about 4,000 –6,000 years ago) and probably even has prevailed in the area until today covered with nut-fruit forests. Besides the fact that in the past the juniper forests area was much larger in comparison with the present area, the forests also showed a much denser stocking level. The reduction in the juniper forest area over the last 200–300 years is associated with anthropogenic pressures such as felling, unregulated grazing and fire.

Different scientific opinions can be found in the literature about the origin of walnut forests, though most of the researchers believe in the Tertiary nature of their origin (Popov, 1938; Arnoldi, 1946; Sadovskaya, 1954; Rubtsov, 1955; Samsonov, 1966). They found evidence that walnut forests are a relict of mesophilic forests of the Tertiary period, because walnut associated species such as apple, pear, maple, and pearlbush are also relicts of the same period. Based on the paleontologic analysis, Sadovskaya (1978) believes that in the Fergana Valley during most of the Middle-Miocene epoch there was a warm and humid climate favoring mixed forests made up of tugai deciduous broadleaf species with a greater admixture of subtropical plants. At the end of the Middle-Miocene epoch, tectonic processes led to a rise of landscape in Central Asia resulting in a vertical zoning with clearer climate differentiation between a warm and humid zone, which is typical for plains and foothills, and a much colder zone in the mountains (Utkina, 1968, 1992). As a consequence, species composition in the forests changed leading to a reduction in the share of subtropical species and an increase in the number of boreal species. In addition, the significant rise of the mountain terrain around the Fergana Valley resulted in overall lower temperatures and drier climate. This has caused the extinction of representatives of thermophilic vegetation, migration of species from one vegetation zone to another, xerophytization of flora of plains and foothills, reduction of forest lands, and depletion of their composition. Thus, areas of open forests and forest-steppes have emerged replacing ancient woodlands.

All in all, today's forest landscape in Uzbekistan was shaped after formation of the mountain ranges had been completed. These forests sharply differ from the initial appearance due to changes in forest growing conditions that have taken place over a long period of time. This has caused changes in species composition, distribution of forest areas and other parameters. Over the last decades, human activities have been greatly influencing forest coverage and conditions

## *2.3. Forest Biodiversity*

Biological diversity of Uzbekistan includes more than 27,000 species, with more than 15,000 breeds of animals and a total number of plant species, mushrooms and algae of approximately 11,000 species. The flora of Uzbekistan includes 4,800 species of vascular plants, which relate to 650 genera and 167 families. The number of endemic species is relatively low, in the range of 8% (or about 400 species) of the total species richness. Relict endemic species include 10-12% of all endemics. 305 flora representatives are included in the Red Book of the Republic of Uzbekistan.

According to the International Red Book (IUCN Red List Categories and Criteria, 2001), the following tree and shrub species in Uzbekistan are included in the various categories:

- Critically endangered: *Calligonum calcareu, Lonicera paradoxa, Malus niedzwetzkyana, Pyrus korshinskyi, Ribes malvifolium, Zygophyllum bucharicum*;
- Endangered: *Armeniaca vulgaris, Betula tianschanica, Calligonum molle* (endemic of Uzbekistan), *Calligonum elegans* (endemic of Uzbekistan), *Calligonum matteianum* (endemic of Uzbekistan);
- Vulnerable: *Amygdalus bucharica* (Central Asian endemic), *Calligonum paletzkianum*, *Malus sieversii*, *Rhus coriaria*; and
- Close to endangered - *Amygdalus petunnikovii, Restella albertii, Juglans regia, Juniperus seravshanica, Populus pruinosa, Pistacia vera,* and *Fraxinus sogdiana*.
- There is lack of information on a few other tree and shrub species with regard to the identification of their vulnerability.

The total fauna of the Republic of Uzbekistan includes 97 species of mammals, 424 species of birds, 59 species of reptiles and 83 species of fish. Out of them, 24 species of mammals, 48 species of birds, 16 species of reptiles, 18 species of fish, 78 species of invertebrates (Anonymous, 12&13) are included in the Red Book of the Republic of Uzbekistan.

The lands of the State Forest Fund provide the basic habitat and concentration of biological diversity in Uzbekistan.

Desert-like ecosystems are the main habitat of rare and endangered animal species, such as Indian honey badger, caracal, Persian gazelle, marble teal, serpent eagle, imperial eagle, griffon vulture, balaban, houbara bustard, and pin-tailed sand grouse. About 50 species of birds are adapted for living under conditions of sandy deserts with saxaul tangles and shrubs serve them as a place for nesting. In the sandy deserts of the country, there are about 320 species of flowering plants related to 31 families and 134 genera.

Floristic composition of the tugai type of vegetation is represented by 285 species of vascular plants relating to 35 families and 105 genera. There are about 40 species of typical tugai plants. Abundance of moisture allows amphibians to settle in tugai ecosystems. Reptiles, such as lidless skink and grass snake can be found here, while racerunners can be found in drier places. Pallas' coluber and water snake as well as lebetina vipers can frequently been spotted here.

The most typical representative of birds is a pheasant species. Carrion crows, magpies, small sparrows can be seen frequently. There are also colonies of herons, glossy ibises, cormorants, kites, tyuviks and others. Mammals are presented by predators (e.g. jungle cat, jackal, fox, wolf, badger), rodents (e.g. tamarisk gerbil, pest rat, trans-Caspian vole), and ungulate (boar, Bukhara deer).

Flora diversity of mountain forests includes 47 species of trees and 96 species of bushes. Typical inhabitants of mountain forests are birds (e.g. white-winged woodpecker, magpie, starling, Bukhara titmouse, turtle-dove, wood pigeon, paradise and spotted flycatcher, whitethroat, oriole, birds of prey and others), mammals (e.g. badger, boar, ibex, argali, Siberian brown bear, snow leopard, fox, wolf, stone marten, Menzbir marmot) and others.

Degradation of habitats and direct extermination has affected, first of all, large carnivorous and hoofed animals. The turan tiger and cheetah have disappeared; striped hyena, caracal, front-Asian leopard are endangered. The habitats of many species have changed in terms of area and quality and their numbers have sharply decreased.

Aquatic and semi-aquatic ecosystems have seriously changed because of increase in salinity and pollution with significant alterations of overall hydrological regimes.

Agricultural biodiversity has also suffered seriously. Uzbekistan, being the homeland of many wild ancestors of cultural plants, and possessing a huge potential of traditional forms of cultural plants and animals, has lost wealth in many respects. Underestimation in the past of the importance of traditional forms of agricultural biodiversity has resulted in their large-scale replacement by exotic species reducing and endangering traditional species (Anonymous, 12).

### *2.4. Forest Tenure, Legislation and Policy*

The following laws have directly or indirectly influenced the forestry of Uzbekistan: the Constitution of the Republic of Uzbekistan (1992); Laws and Regulations on “Nature Protection” (1992), “State Committee of the Republic of Uzbekistan on Nature Protection” (1996), “Protection and Use of Flora” (1997), the Land Code of the Republic of Uzbekistan (1998), The Law on Protected Natural Territories” (2004). The Forest Act of 1999 regulating all matters concerning the management and protection of forests is most important in the context of forest rehabilitation.

According to Article 4 of the Law “On Forest” (1999), forests are state property and national wealth, subject to rational use and protection by the state. Key issues addressed in this law are presented below.

(a) All forests are an integral part of the State Forest Fund and include:

- forests of state importance, i.e. forests under the authority of state forestry bodies; and
- forests being used by other establishments and legal entities.

The State Forest Fund does not include:

- trees and groups of trees, field-protecting forest belts, as well as other wood and bush vegetation on agricultural lands;

- protective plantings on the strips along railways, highways, channels and other water bodies;
- trees and groups of trees, as well as green plantings in cities and other habitations; and
- trees and groups of trees on farmlands and gardens.

(b) The establishment, maintenance, protection and use of wood and bush plantings, not included in the State Forest Fund, is regulated in accordance with the Law on Protection and Use of Flora.

(c) Lands of the State Forest Fund can be given for use to legal and private entities.
(d) Forest use can be of permanent and temporary nature.
(e) Permanent forest users are forestry enterprises, establishments and organizations, which are provided with lands of the State Forest Fund under a permanent tenure agreement.
(f) Temporary forest use can be of short-term (i.e. up to 3 years), and of long-term (i.e. up to 10 years).

Long-term planning in the forest sector has in many respects maintained the features of the Soviet style of planning system. These are economic plans, where the quantity indicators of various specific types of works are planned including sowing, planting, supporting measures for natural regeneration and afforestation. Forestry management, its monitoring and activity evaluation are still carried out by out-of-date methods using inefficient approaches developed during Soviet times.

As Uzbekistan is located in an arid zone with sharply continental climate, the activities on forestation and creation of new forest plantations require significant financial and manpower resources. Limited financial resources, allocated from the state budget, do not allow to enhance the volume of activities on reafforestation and forestation as well as its quality, and therefore there is a need for development of more sustainable and effective strategies of forestry management by involving the local population. Despite the low percentage of forest land, the forest fund lands nevertheless provide different opportunities and benefits for local people. Unfortunately, these opportunities are not fully used as yet. Strengthening of the role of local communities through ensuring better access to natural resources and effective participation in the process of planning and management of forestry will help to gradually restore degraded forests. Participation of local communities will enable reafforestation and forestation to be much more sustainable and less expensive. However, presently, participation of local stakeholders in the processes of planning and management develops at very slow rates.

Weak institutional capacity for carrying out inventory, monitoring and evaluation of forest resources is the reason for the lack of accurate information about the lands of the State Forest Fund. This in turn is a barrier for planning and carrying out all types of activities in the forestry sector. In addition, participation in international conventions has raised obligations of Uzbekistan to adhere to international standards and agreements.

These and some other circumstances provide the basis for reforming the forestry sector. Adaptation of forestry to market-oriented conditions requires integrated consideration of its problems and ensuring transition from the simple use of forest resources to their efficient management for conservation and sustainable development of forestry in Uzbekistan. For this purpose, the Main Department for Forestry with technical and consulting assistance of the Food and Agricultural Organization of the United Nations (FAO) has developed the National Forestry Policy of Uzbekistan, which will be submitted this year for review and approval by the national government.

The National Forestry Policy contains a development concept, forest policy for a 10-year period and a short-term action plan for a five-year period. The Action Plan will be developed after approval of the forest policy. The section on forest policy includes objectives (long-term task), primary tasks, and basic directions of development and necessary conditions for its implementation. The section, devoted to the implementation strategy, includes the main targets and concrete actions which should be undertaken in order to achieve assigned objectives. The basic conditions for successful implementation of the National Forestry Program include improving forest legislation, improved dialogue and partnership between forestry organizations and other stakeholders, enhancement of institutional potential and organization of an effective system of monitoring and evaluation.

### *2.5. Forest Administration and Management*

The state management in the field of conservation, protection, use and reproduction of forests is carried out by the Cabinet of Ministers of the Republic of Uzbekistan, local state bodies, the Main Department for Forestry under the Ministry of Agriculture and Water Resources of the Republic of Uzbekistan and the State Committee of the Republic of Uzbekistan on Nature Protection (Resolution of the Cabinet of Ministers. No. 98, 2000).

In the field of forest relations, the Cabinet of Ministers of the Republic of Uzbekistan is in charge of the:

- Implementation of a uniform state policy on protection and rational use of forests;
- Control of the State Forest Fund;
- Establishment of legal orders on determining categories of forest protection;
- Establishment of the order of collecting fees and their rates for forest use;
- Organization and implementation of state control over preservation, protection, use and reproduction of forests; and
- Establishment of the order of conducting state inventory of forests and maintaining a state forest cadastre and some other issues.

In the field of forest policy implementation, the local state bodies are in charge of the:

- Provision of State Forest Fund sites to legal and private entities upon approval of the state forestry bodies, except for forests of state reserves and forest reserve zones of the state national nature parks;
- Conducting state inventory of forests and maintaining a state forest cadastre;
- Exercising state control over preservation, protection, use and reproduction of forests;
- Making decisions on restrictions, suspension and termination of the activity of enterprises, establishments and organizations in cases of causing harm to the state of forests;
- Establishment and regulation of the norms of cattle grazing in the forests and other types of use of forest resources in collaboration with the state forestry bodies; and
- Organization of environmental education for the public in the field of preservation, protection, use and reproduction of forests.

The Main Department for Forestry (MDF) under the Ministry of Agriculture and Water Resources of the Republic of Uzbekistan and its regional bodies function as the state forestry bodies. Presently, the main tasks and functions of the MDF are as follows:

- Monitoring and control over forestry legislation, application of technical specifications related documentation on the implementation of forestry and hunting operations;
- Forest management including forest operations, reproduction, conservation and protection of forests, state reserves, natural parks and other protected natural territories within the forestry fund area;
- Implementing a uniform technical policy and standard aimed at overall expansion and rational use of the forestry fund area;
- National forest inventory and studying of forest land, fauna and flora;
- Promotion of scientific innovation and best practices in forestry;
- Development and implementation of measures on reforestation and protective forestation, organization of erosion control planting operations on hillsides, in ravines and wastelands;
- Implementation of measures on combating desertification on agriculture land;
- Protection of forests from fires, unauthorized cuttings and other forestry violations, protection of forests against pests and diseases including improvement of the systems of forest protection;
- Conducting conservation activity and maintaining hunting facilities in subordinated territories;
- Departmental management and supervision of hunting facilities, ensuring observance of rules, norms, terms of hunting on forest fund territory;
- Organizing development and implementation of an uniform strategy for decorative gardening on the basis of an assessment of needs of local and foreign markets;
- Implementation of measures for the preparation and production of medicinal and food plants, products of subsidiary farming, gardening, and creation of a specialized divisions for these purposes;
- Increasing the level of economic independence of forestry enterprises, and specialized forestry enterprises on production of medicinal herbs, adapting them to a market economy for the purpose improving their financial situation;
- Attraction of foreign investments, creation of joint ventures, development of private entrepreneurship, and small businesses in the sphere of forestry; and
- Capacity development of personnel for forestry enterprises and organizations.

The administrative structure of the Main Department of Forestry consists of various departments and organizations including an inventory and survey section, the Scientific-Production Center of Decorative Gardening and Forestry, the Training Center; the Forestry Seed Production Center; the Department of Reserves, National Nature Parks and Hunting Facilities; and the Scientific and Production Center for Herbs.

There are also 67 forestry offices in the Republic of Karakalpakstan and all regions of the country, which are responsible for forest protection (i.e. against fires, pests and diseases), registration, inventory, reproduction of forests, regulation of forest use and organization of conducting of other forest-related activities. In addition, there are eight specialized forestry offices dealing with non-wood forest products (mainly cultivation and processing of medicinal and food herbs), six reserves, six forest hunting facilities, Zaamin National Nature Park, seven forest experimental stations, two specialized enterprises, 10 production sites, and one specialized forestry and state enterprise for the development of forestry technologies and operations.

## 3. Forest Degradation

### *3.1. Understanding Forest Degradation in Uzbekistan*

So far, there is no generally accepted definition, glossary or standard for the term "forest degradation" in the country. However, it does not mean that there is no phenomenon itself, which is expressed in different degrees of both loss of quality of forest plantings, and reduction in forest area.

The loss of forest quality includes the following aspects:

- Reduction of productivity of plantations due to various reasons;
- Impoverishment of species composition of forest biomass;
- Unbalanced age structure of plantations, especially under-representation of young growth; and
- Absence or insufficient regeneration of basic forest forming species.

The reduction in forest area is defined as follows:

- Fragmentation of forest area, and, as an initial stage, gradual reduction of stand density over time;
- Formation of degraded forests, fire-sites, destroyed stands, non-regenerated timber cuttings sites; and
- Reduction in the size of forest area.

### *3.2. Causes of Forests Degradation, Impacts of Forest Degradation and Loss*

Both natural and anthropogenic factors can be considered to be the causes of forests degradation.

**Natural factors:**

Among the natural factors that influence the forests condition, the following are most important in Uzbekistan:

- Transformation of the earth surface's relief and periodic climatic changes influence vegetative cover in the long-run;
- Influence of pests, diseases; and
- Droughts, floods, landslides, volcanic eruptions, fires from lightning, falling of a celestial body on the earth's surface.

These factors are so significant that they can cause a complete change of vegetative formations. In terms of history, such changes caused by any of these events may take long time intervals and mostly will be imperceptible for any specific human generation.

**Anthropogenic factors:**

Anthropogenic factors have quite different effects. With the development of human civilization its influence on the environment has been growing steadily having negative effects on the natural environment in general and on forests in particular. Population growth can be named as the primary factor. In 1913, the population of Uzbekistan was estimated at about 4.33 million people (Anonymous, 11). At the end of 2009, this figure has reached almost 28 million. This means that the population has grown almost 6.5 times during less than one century. Most of the population of Uzbekistan still resides in rural areas resulting in growing pressure on forest resources. Growing populations require larger resources to satisfy vital needs, including forest resources. With the acceleration of scientific and technical progress these human needs become more and more diverse and extended, and the impact of human civilization on the natural environment has reached global scale. Major types of human activities causing forest degradation are summarized below:

- Expansion of agriculture land: While in 1913 cultivation areas extended over 2.2 million ha, in 2008 3.6 million ha were under irrigation alone. It should be noted that lands along rivers are cultivated in the first place as there are no significant efforts required for construction of irrigation systems. However, since tugai forests in Uzbekistan are located right on the riverside, the agriculture area has been primarily encroached into tugai forests. However, plowing up is not limited to tugais, it is also actively performed on dry foothills, plateaus and mountain slopes.
- Growth in livestock: In 1916, the number of livestock in Uzbekistan is estimated at approximately 1.4 million heads of cattle and 4.3 million heads of sheep and goats. In 2008, these numbers had increased to 8 million cattle and 13.6 million sheep and goats. Though, during the former Soviet Union most cattle were kept stalled, today almost the entire livestock is dispersed on rural localities and pastures in surrounding territories. Extensive overgrazing is alarming and involves loss of grass cover, regrowth and undergrowth. The soil suffers from condensation, destruction of surface layer and soil structure causing wind erosion, increase in surface runoff and reduction of interflow. And this, in turn, causes mud streams, reduction of river discharge, and loss of soil fertility, particularly in mountain areas. Deterioration of soil-hydrological conditions inevitably affects productivity of forest plantings in these territories.
- Harvesting of non-wood forest resources: Grass production in the territory of the State Forest Fund, especially on forest lands, results in complete destruction of natural vegetation of forest species, undergrowth and even re-growth. The collection of medicinal plants, food and other non wood products for local use contributes to the loss of diversity in plant composition. Full harvesting (for example, of walnut, pistachio, hips) not only leads to unavailability or very small natural regeneration, but also represents a real threat to the forest fauna.
- Demand for commercial timber and fuel wood: The total annual wood harvest in the country is less than 50,000 $m^3$. Such a quantity cannot satisfy the current demand for commercial timber and fuel wood. After the collapse of the Soviet Union commercial wood is basically imported to Uzbekistan from Russia, though poplar woods grown on farms and dehkan facilities are available on the local markets. However, current prices are not affordable for the majority of the local population and this pushes people to fell forests, basically poplars and juniper species suitable for construction purposes. Not all of the rural population has access to natural gas for everyday life and heating purposes. Therefore, people often cut wood in nearby forest plantations;
- Large-scale industrial development causes environmental pollution (air, soil, and water), negatively affecting forest condition. For example, massive deterioration and even destruction of forest plantations and gardens can be observed within the range of harmful emissions of the Tadjik Aluminium Plant in the upper reach of the Surkhandarya.
- Withdrawal of water from the rivers for artificial irrigation, and power generation through the construction of huge dams and operation of water storage reservoirs (i.e. water discharge during winter time in order to cover power shortage) completely change natural water regimes of rivers. Regeneration of tugai forests, in particular poplars, fully depends on the availability of summer water floods. These water floods may not always occur in the lower reaches of the Amudarya, where the largest

remaining areas of Uzbekistan's poplar forests are located. Therefore, the future of the tugais, especially those with poplar species is of greatest concern.

- Industrial development: The construction and operation of industrial facilities such as mines, factories, highways, railways, gas and oil pipelines, etc., not only negatively affect the area where such facilities are located, but also the surrounding environment. Adjacent forest areas have either been completely removed or their growing conditions considerably reduced.
- Change in land tenure: Transfer of land-use rights to the farmers has complicated development of the field-protecting reforestation in the country. Thus, agroforestry on irrigated arable lands in the desert zone has emerged as a powerful stabilizing factor of these fragile anthropogenic ecosystems subject to water and wind erosion, secondary salinization, high mineralized water table and others. In the mid 1980's, there were about 40,000 ha of such plantings in Uzbekistan, and by 2006 only about 25,000 ha were left. New protective plantings have not been established on arable lands, whereas existing plantations become mature and are cut down.
- Global warming: Climate change in the territory of Uzbekistan is expected in terms of an increase in average annual air temperature of 1.3 – 1.9$^{o}$C by 2030 and of 3.3–4.4$^{o}$C by 2080 and an increase in annual precipitation of 5–18% (Spektorman *et al*., 2007). Besides other consequences, these climatic changes will likely cause alterations also in the natural forest cover. The climate in the deserts zone will become more arid (especially by 2080), that is warmer and dryer. Such conditions may result in a reduction of the productivity and deterioration of the health conditions of tree species. The influence of climate change on the flood-plain forests and plantings in the valleys will also be felt more strongly due to deterioration of water-supply on irrigated lands, reduction of river runoff and its artificial regulation.

Vulnerability assessments of forests in the territory of Uzbekistan have shown that due to climate change the forest formations in mountains will be exposed to great risk. In mountain regions, the increase in temperature will result in an upward shift of the distribution of all tree and shrub species accompanied by all ensuing consequences, including changes in species composition and loss of biodiversity (Botman, 2007).

### *3.3. Desertification*

The UN Program on Environment (United Nations, 1992) and the UN Convention on Combating Desertification define the term "desertification" as "land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities". Desertification results in degradation of vegetative cover; degradation of soil cover, change of relief, occurrence of changes caused by anthropogenic impact and change of hydrological regimes.

The condition of vegetative cover is a primary indicator of desertification. The long-term sustainable decrease of productivity of natural vegetative cover over large territories is one of the most widespread and visually determined processes of desertification. Degradation of lands is aggravated by overgrazing (35%), forest clearing (30%), agriculture (27%) and industrial activities (1%). It is also necessary to mention here the consequences of natural disasters such as droughts, floods and landslides.

The impacts of the Aral crisis, as well as other anthropogenic factors, have led to gradual desertification in Uzbekistan and, as a consequence, to soil degradation, and decrease in fertility of irrigated lands. Occupying only 10% of all agricultural lands, the irrigated fields contribute over 95% to the gross agricultural products. Over the last 15-20 years, the area of saline lands has grown by 0.8 million ha and presently covers over 2 million ha, including 0.85 million ha of medium-saline and severe-saline lands. Humus content in the soil has decreased by 30-50%. Presently, the soils with low and very low humus content occupy nearly 40% of the area of irrigated lands, and the total area of low-productive arable lands comprises more than 0.5 million ha.

In this context, the issue of combating desertification is presently of high priority in the Republic of Uzbekistan. About 10 million ha of pastures require radical improvement. Overgrazing and felling of forests for different purposes have caused significant reduction of tree-shrub vegetation in the desert zone. Desertification is greatly spreading in foothill areas of the mountain ranges (Shivaldova, 2009).

Shoaling of the Aral Sea is one of the most striking examples of environmental degradation caused by human activities. The reason for this problem was a decision by the USSR Government to expand the size of irrigation areas in Central Asia in order to achieve self-sufficiency in the cotton industry. Intensive development of irrigation since the 1950s in the Central Asian Republics has resulted in a substantial reduction of water inflow to the sea from its main tributaries such as the Amudarya and Syrdarya. In 1960, the Aral Sea was the fourth largest lake in the world, but since then it has lost two thirds of its volume and twice as much of its surface. The water level has decreased by 16 m, and its salinity has become close to that of sea water. The fishing industry has discontinued its operations as the majority of the fish stocks of the Aral Sea basin have died out, and the deltas of the Amudarya and Syrdarya have changed due to shortage of water. The withdrawal of river water has led to extensive decrease of the level of underground waters, and the retreating sea has also affected the climate locally. The exposed bottom of the sea has become a strong source of aerosols causing pollution of agricultural lands and negative influences on human health. Irrigated lands suffer from salinization and flooding due to insufficient management resulting in a decrease in crop harvests. In addition, the drainage waters have a high level of salinity and are also polluted due to a high concentration of fertilizers and pesticides significantly influencing the health of people in the region.

## 4. Forest Rehabilitation

As already noted, there is no officially accepted glossary or standard on forest terms in the country. Presently, forest terms which have been accepted during the Soviet time are used. There are differences in the understanding of equally sounding terms in Russian language [forestry related] literature and in internationally accepted interpretation. Moreover, there are terms and concepts, which have not been previously used in forestry of Uzbekistan. Therefore, in this section, the terms will be used in their international interpretation (FAO, 2002).

Forest rehabilitation is the process of restoring the capacity of a forest to provide goods and services again, where the state of the rehabilitated forest is not identical to its state before degradation. In Uzbekistan, it means reforestation and afforestation. However, afforestation refers not only to forest plantings within the forest lands of the State Forest Fund, but also outside the Fund area, e.g. on irrigated agricultural lands, called field-protective afforestations. As a rule, afforestation is carried out on non-forest land, e.g. on the dried bottom of the Aral Sea while reforestation is carried out on forest lands not covered with forests.

Forest restoration is the process of restoring a forest to its original state before degradation (i.e. same functions, structure and composition). Practically all forests of the country are exposed to degradation to a different degree. Due to significant variability of habitat conditions, a number of forest types close to natural composition have been delineated, though there are no reference sites where the original state of each type of forest could be preserved. Therefore, it is practically impossible to carry out forest restoration under the conditions reigning in Uzbekistan.

### *4.1. Targets of Reforestation and Afforestation in Uzbekistan*

In Uzbekistan, all forests, both the existing ones and those newly created, have a protective function. This means that the better forests perform or will perform their forest reclamation and protection functions, the higher the value they have. Therefore, the objectives of reforestation [reproduction of forests] and afforestation are different in the various climatic zones of the country, though all are aimed at strengthening reclamation and protection functions. The objectives are as follows:

- In the desert zone, the main focus is on afforestation of the dried bottom of the Aral Sea for preventing or reducing salt and dust erosion from the soil surface as well as stabilization of shifting sand. In addition, new forests are planted for the enrichment of forage areas, creation of protective forest stands along the borders of oases located in the Bukhara, Navoi, Samarkand, Jizzakh, and Syrdarya regions to prevent the impact of dust storms, dry winds and other negative natural phenomena. Protective forest belts are also created around industrial sites (e.g. Bukhara refinery plant, Shurtan gas and chemical plant, Kungrad soda plant), along railways, roads and pipelines.
- The conservation of tugai forests aims at embankment stabilization, purification of waters flowing into the river, including those originating from irrigated arable lands.
- The creation of forest plantations in the valley zone is intended to improve timber production, recreation, and sanitary-hygienic purposes. The most important objective for irrigated lands in the arid zone is the creation of field-protective forest plantations which stabilize this fragile and vulnerable anthropogenic landscape through improvement of microclimate, soil erosion control, biodrainage, as well as recreational, aesthetic and other functions. Forest plantations on irrigated lands have higher productivity and thus also high carbon sequestration ability.
- In the mountain zone, the establishment of forest plantations primarily aims at reducing surface water run-off and mudflows. Afforestations of small watersheds have water protective and water regulative roles with positive effects on river flow rates and seasonal distribution. The creation or improvement of nut-bearing forests aims at increasing their yields. For all the natural zones of the country, the conservation of biodiversity is a priority objective, including the conservation of wild crop relatives.

### *4.2. National Policy on Reforestation and Afforestation*

In 2006, the Main Department of Forestry developed and approved a Forestry Development Program for the period of 2006 - 2010. The program in particular includes the sections devoted to reforestation [reproduction of forests] and afforestation, enhancement of the environmental and protective functions of forests, and expanding the forest covered lands of the Republic.

The program contains specific average annual figures on the creation of protective plantations in the Aral region, on volumes of planting in the second stage of the Bukhara green barrier, on the creation of industrial plantations of nut-bearing and fast-growing forest species and so on. The program has a technocratic nature and is intended primarily for the use by foresters.

As mentioned earlier, the national forest policy was developed under the technical assistance of FAO in 2009. The objective of the country's forest policy was defined as conservation and sustainable management of forests to provide environmental and socio-economic benefits and contribution to sustainable development for the whole country. The national forestry policy consists of three sections: development concept, problem solving strategy for a 10-year period and short-term action plan (for a 5-year period). The latter will be developed after approval by the Government of the development concept and the problem solving strategy.

For achieving the goals, the following three broad issues will be addressed: (a) rational use of State Forest Fund resources, (b) conservation, protection and development of existing forests, and (c) expanding forest covered lands through afforestation.

For the first time in the history of forestry in Uzbekistan, the national forestry policy was not only widely discussed by many stakeholders, but also the program has envisaged the development and introduction of a joint forest management system, and the creation of a mechanism for the participation of the local population in forest planning.

Further, the national policy on reforestation and afforestation calls for "Improving the effectiveness of reforestation and afforestation" through the following activities:

Restoration and afforestation of lands, located in the desert zone for combating desertification:

- Development of the national program and action plan on combating desertification and expanding protective afforestation on the dried bottom of the Aral Sea and Priaralie and subsequent approval of the developed documents by the Main Department of Forestry in collaboration with corresponding government and international organizations and the local population; and
- Improving the condition of existing degraded desert forest ecosystems. Expansion of the forest area on forest lands through afforestation by means of natural regeneration, and improved agricultural techniques for the establishment of artificial plantings as well as through the reduction of existing anthropogenic impacts on the forests.

Restoration and creation of forests in mountainous terrain:

- Restoration and improvement of the conditions of existing sparse forests in mountainous areas through planting, seeding, conducting of measures to promote natural regeneration and forest reclamation works;
- Monitoring of soil erosion processes and creation of the system of protective forest plantations through terracing of steep slopes in watershed areas with risks of mudflows; and
- Restoration and improvement of the condition of natural forests in the mountain zone. The emphasis in the sub-mountain zone is on the establishment of industrial plantations of nut-bearing trees and other species, and regulation of cattle pasturing with involvement of the local population.

Restoration and creation of tugai forests:

- Restoration of degraded tugai forests located along the rivers and on river islands, through enhancement of protection and conservation, as well as through measures to promote natural regeneration and seed reproduction in suitable areas.

Restoration and creation of forests in the valley zone:

- Expanding the areas of planted fast-growing and nut-bearing species in order to create plantations for harvesting timber and nut products.

Another direction of solving the problems of forestry development in Uzbekistan anticipates the “Enhancement of protection of forests and conservation of their biological diversity” through the following activities:

- Raising public awareness about the forest. Involving state, non-governmental organizations (NGOs), local population, and mass media;
- Ensure participation of local communities and other stakeholders in the conservation, protection and guarding of forests through creation of economic and moral incentives (e.g., guaranteed rights for using corresponding lands of the State Forest Fund and forest resources, etc.);
- Enhancement of legal framework of forestry enterprises on protecting forests from damage and threats of anthropogenic nature (e.g., illegal felling, grazing, fire, unauthorized collection of plants, fruits and nuts, etc.);
- Strengthening the protection of forests against forest pests and diseases through the application of preventive measures, improvement of equipment and rising capacity of human resources;
- In order to fulfill commitments under the UN Convention on Biological Diversity it is required to expand protected natural territories (reserves, national parks, sanctuaries, and others up to 10% of the total country area), taking into account the needs of people residing in these areas;
- Development of an action plan in accordance with the international program on the improvement of forest legislation and forest management (FLEG program, special attention is paid to combat illegal timber felling); and
- Ensuring safety and protection of forests located on lands of other holders of the Forest Fund with their own means.

## *4.3. Methods of Reforestation and Afforestation*

The methods applied in reforestation [reproduction of forests] and afforestation depend on the specific natural-climatic zone of the country and intended functions of forest plantations. Therefore, these methods are described separately for each natural-climatic zone as follows.

### *4.3.1 Sand-desert zone and drained bottom of the Aral Sea*

**Fixation of shifting sands:** In Uzbekistan they occupy over 1 million ha. When protecting oases from shifting sands, it is necessary to fix the first row of dunes on the entire windward slope length, and subsequent rows on 2/3, 1/2 and 1/3 of the windward slope height through planting of saxaul crops and creating pastures on 1/4 of windward slopes height.

The operation begins by removing lose sand from the dune and leveling of the top. The width of fixed zone ranges from 50 to 250 m, when protecting linear objects up to 400 m (250 m from the windward side and 150 m from the leeward). In the rear sands, where lowlands occupy less than 50% of the area, the sands are not fixed, but in the lowlands the saxaul crops need to be created, which block dunes and gradually overgrow them.

In order to create forest crops on shifting sands, it is required to fix them preliminary using mechanical shields, or with chemical binding materials. Mechanical shields can be standing and semi-standing, row-type and cellular, lying belted and solid. Solid or narrow-banded covers can be made from the chemical binding materials.

Forest crops on shifting sands along mechanical shields are created through planting of seedlings of sandy species. After completion of the sand fixing by chemical binding materials, tree plantations are created applying a planting scheme of 1 m x 4 m (2,500 plants/ha) at a distance of 10 - 25 cm from the leeward side of covers.

**Desert and semi-desert areas of Uzbekistan**

For these areas, it is most common to create pasture protective plantings made up of shrubs and semi-shrubs. Such plantations can be created in sandy deserts, gypsum deserts and foothill semi-deserts. Each of these desert and semi-desert belts have their own specific methods of plantation establishment, taking into account their specific soil and climatic features.

As an example, an agro-technical approach for creating plantations in the gypsum desert is briefly described. Gypsum desert is the most common type of desert in Uzbekistan, occupying an area of 13 million ha in Kyzylkum and Ustyurt. Here, the most extreme aridity of the climate is combined with site conditions dominated by loamy gypsiferous soils.

For the creation of protective plantings (shrub-semi-shrub and pasture) the following species are used: black saxaul (*Holoxylon aphillum*), salsola rigida (*Salsola orientalis*), aellenia (*Aellenia subaphilla*), Kochia prostrate and different types of wormwood and glasswort. Pasture-protective plantings are planted in belts with a width of 3 - 5 m each with spacing between rows equal to 5 - 10 times of belt width. In the gypsum desert, the following methods of processing and reclamation of gypsiferous gray-brown soils are recommended:

- ordinary moldboard plowing to a depth of 20-22 cm;
- deep plowing to a depth of 32-35 cm;
- creation of moisture accumulative trenches; and
- creation of sand accumulative trenches.

The method of soil treatment is selected depending on the specific site conditions of the location of planting. For example, creation of moisture accumulative trenches is used on strongly compacted soils (takyrs, gray-brown).

Due to a weak permeability, the rain water does not penetrate deep into such soils, but flows down the slope. Precipitation of 4-5 mm form a runoff on a wet surface of such soil, which can be used for keeping the soil wet and leaching it from the salt. This is the only way of reclamation of such soil for phytoreclamation, as plowing does not improve its original state. Moisture accumulative trenches are created using single-moldboard trenching plows. They are established perpendicularly to the slope gradient so that the water flowing down the slope surface can freely slide into the trench. Trenching plows cut the trenches with a depth of 35 - 40 cm and a width at the soil surface of 60 - 70 cm.

Trenches are made in the autumn for the accumulation of snow or in early spring on moist soil. The trenches are established at least 10 - 15 m apart from one another so that the runoff water collected from the surface in between the trenches provides sufficient moisture loading for each trench. Due to runoff of spring rains the soil in the trenches is moistened to a depth of 100 -120 cm. The best sowing period is November - January. Seeding is carried out mechanically or manually to a depth of 0.5 – 1.5 cm (Instructive Guidance, 1987)

**Afforestation on the dried bottom of the Aral Sea**

The drained bottom is composed of light and heavy soils. Afforestation is currently possible on light types of soils. There is a variety of bottom sediments that can be described with the help of two groups corresponding to different methods of forest reclamation. The first group includes sandy and sandy-loam plains, as well as loamy sediments. The second group includes all types of shifting sands. The principle difference in the methods of establishing protective plantations in these two groups of sediments is that the first group includes sowing and planting without fixation of the relief surface, but with processing of soils, whereas the second group requires obligatory fixation of the sandy relief surface.

Three types of protective plantations are created on desert and sub-desert plains, namely pasture-protective, reclamation-forage, and soil-protective as described below.

- Pasture-protective strip plantings improve the microclimate and reduce erosion processes in spaces between the strips. Best results in the creation of such plantations were obtained when preparing the soil by chisel and disc harrow. The strips are created in tree rows with a row width of 3 m (coverage width of chisel) with a distance of 5 m between them. The distance between the strips is around 90 m. In the spring, along the rows of chisel plowing, it is required to sow seeds with burying using a spike-tooth harrow or plant seedlings at 1 m in a row. The main species is a black saxaul and Richter saltwort.
- Meliorative-forage strip plantations for growing forage shrubs and semi-shrubs are created between the pasture-protective belts. Preparation of soil for such plantations also consists of autumn strip chisel-plowing. Meliorative-forage strips are placed at intervals of 18 - 20 m. The following seeds of forage shrubs and semi-shrubs are sown along the tilled strips: aellenia (*Aellenia subaphilla*), kuyreuk (*Salsola orientalis*), and teresken (*Ceratoides eversmaniana*). The seeds of these species are sown in autumn, winter and spring; they are buried in the soil by means of a spike-tooth harrow.
- Large shrubs are used to create soil-protective plantings. Their main purpose is to reduce wind erosion of soil, stabilize the surface, and increase forage productivity in the area. Preparation of the soil is also carried out by chisel. However, placing the strips differs from the first two types. The strips are placed uniformly over the area at intervals of 10 m. Soil-protective plantations are created by sowing seeds or planting seedlings. Plantations are established as pure saxaul stands or from saxaul and saltwort by clean rows. This is necessary as mixing the two species within the same row will lead to high competition and saxsaul will overgrow the saltwort.

The same types of plantations and the same technology of creation are used in alluvial deposits of the coastal zone, i.e. in the delta of the Amudarya (Recommendations, 1979).

The procedure of creation of soil-protective plantations on mobile sands of drained bottom of the Aral Sea is the same as on mobile sands of the desert zone.

### *4.3.2 Mountain zone*

Forest rehabilitation in mountain areas includes the following activities:

- Terracing of mountain slopes with creation of forest, nut-bearing and fruit plantations, orchards and vineyards;
- Creation of erosion-preventive plantations along ravines, riversides, water storage reservoirs and mudflow reservoirs; and
- Afforestation in the riverbeds of permanent and temporary streams.

There is a wide assortment of species suitable for rehabilitation in the mountain zone. When choosing the species, the area's altitude, drought resistance and demand towards soil fertility need to be taken into account. Species are divided into fruit and nut-bearing trees, timber trees, and shrubs. On mountain slopes, the following types of soil treatment are recommended whereby it is mandatory that all operations be performed along the contour lines only:

- On slopes with a steepness below 8° - continuous plowing of the soil;
- On slopes with a steepness of 9° to 12° - strip tillage or tilled terraces;
- On slopes with a steepness of over 12° (up to 40°) – terracing; and
- Special sites (1 m x 1 m and others) are also constructed on the slopes.

Terraces serve both as method of soil preparing and hydrotechnical structures that serve to intercept runoff from the surface between terraces. Based on the method of construction they are classified into tillage, bulldozer, terracing and terracing with explosives.

Terraces are positioned obligatorily along the contour lines at distances at which the flowing water would not wash away the slopes. Terraces must intercept all the emerging runoff water and at the same time meet the requirements for growing main wood species. On the slopes of 15-20° at the most effective width of 2-3 m they are best positioned at a distance of 6 m from one another along the slope, on the slope with a steepness of 21-27° 7 m and over 27° 8 m. The width of terraces and the distance between the terraces can be different and depends on several factors; there are specific formulas for their determination.

Planting sites are mostly constructed in the areas of slopes, unsuitable for terracing, with different steepnesses and availability of a large number of stones, outcrops of rocks, as well as channels with deep gullies. Sites of a triangular cross-section with the length of 2 m and a width of 1 m are constructed manually on such slopes. They are positioned in the staggered order, the elevation between the site rows along the slope is 3 m, and the distance in the row is 6 m. The number of sites at such locations is 900-1,000 sites per one ha.

Mixed species planting is encouraged for protective plantations, because they are most productive, sustainable and have best protective properties. When mixing species, it is important to consider inter-species interactions in terms of growth behavior in order to avoid unnecessary competition. Forest crops on slopes can be created both by sowing and planting into suitable planting sites. For those species with large seeds such as walnut and black walnut, almond, apricot, oak, chestnut it is also possible to establish a stand by sowing.

Willow, poplar, sometimes Russian olive and sea-buckthorn are planted as seedlings from rooted cuttings. Willow can be planted as stake in wet sites. For the rest of forest species, it is recommended to plant one-year (fast-growing species) or two-year (slow-growing species) standard seedlings with well-developed root systems. Birch and pine is better to plant as 2 to 3-year-old seedlings, and spruce and juniper of 3 to 5-year-old seedlings. Forest crops of juniper are better planted by planting material with a closed root system that increases the survival rate of crops up to 90%.

The Republican Scientific Production Center of Decorative Gardening and Forestry (the former Central Asian Scientific Research Institute of Forestry) has also developed a large number of other recommendations on reforestation [reproduction of forests] and afforestation, such as, for example, field-protective afforestation, conducting activities in the flood-plains (tugai forests) in Central Asia, on the cultivation of industrial plantations of poplar, walnut, pistachio, and others.

### 4.4. Research Projects on Reforestation and Afforestation

The assignment and all the activities of the Republican Scientific and Production Center of Decorative Gardening and Forestry (RSPC DG&F) are related to research projects on reforestation and afforestation. Due to the nature of applied research activities and features of the forest sector of Uzbekistan, the entire scientific research focus of the Center is aimed at both conservation and improvement of existing forests and creation of forest reclamation plantations in various natural zones of the country.

For the desert-sand zone of the country and the dried bottom of the Aral Sea applied research is carried out in the following categories of protective plantations:

- Soil-protective, fixation of shifting sands;
- Pasture-protective belts;
- Pasture reclamation-forage belts;
- Protective plantations around oases, villages, and industrial sites;
- Protective plantations along channels and roads;
- Protective plantations along pipeline routes; and
- Creation of various forms of plantings on light sediments of the dried bottom of the Aral Sea.

In the valley zone of the country, research on protective afforestation on irrigated and dry lands has focused on the following aspects:

- Creation of the systems of field-protective forest plantations;
- Garden-protective belts;
- Plantings along channels and roads, and around water storage reservoirs;
- Large-scale forest plantations, including plantations of fast-growing species;
- Species selection and technology of establishing plantations on salt affected soils;
- Detailed growth and yield research on cultivation of forest plantations using irrigation by mineralized waters;
- Afforestation on pebbles; and
- Establishment of industrial plantations of walnut, pistachio, poplars and willows.

For the mountainous zone of the country research on protective afforestation has been conducted on the following types of plantations:

- Riparian water-regulating plantations;
- Plantations along permanent and temporary watercourses, on slopes and bottom of the ravines;
- Large-scale plantations on the slopes with steepness of over 15°;
- Plantations on mountain slopes of over 20° enabling the capture of additional precipitations in the catchment area; and
- Plantations on steep, eroded slopes with poor site conditions, especially in the upper catchments.

For all these types of protective plantations, guidelines were developed prescribing the following aspects: range of suitable species for appropriate zones based on growth and site conditions; methods of mixing species in plantations and planting density; principles of spatial distribution of protective plantings; methods of soil preparations, methods of plantation establishment such as sowing, planting, use of vegetative reproduction, as well as planting techniques; effective constructions and width of field-protective forest belts; and agrotechnology for the maintenance of plantations. In addition to the forest plantation guidelines, a set of torrent control facilities for the mountain zone and rules of final harvest and sanitary felling were developed. Furthermore, various measures on facilitating natural regeneration were identified and a pest and disease control systems developed.

Research on forest seed orchards and nursery techniques have been conducted and include:

- Technology of collection, storage, and preparation of seeds for sowing;
- Principles of creating permanent forest seed stands and seed orchards;
- Studies of crop rotations in nurseries;
- Reclamation and rehabilitation of soils;
- Irrigation regimes;
- Use of mineral and organic fertilizers;
- Site preparation for sowing and planting;
- Nursery techniques of various sown species;
- Nursery techniques for seedlings and cuttings in seed and transplanting beds; and
- Development of rules of temporary storage, transportation and planting of seedlings and saplings.

Research on breeding, hybridization, improvement by grafting was carried out using walnut, pistachio, sea-buckthorn and other species. The Zhondor form of black saxaul, which is resistant to pests and diseases, was selected in nature for improvement purposes while several fast-growing hybrid poplars of Uzbek selection were breed.

Other areas of scientific research and experimental development works were pursued on mechanization of forest operations as well as on the protection of forest from pests and diseases by using chemical agents and biological control methods.

### *4.5. Analysis of Past and On-going Activities of Reforestation and Afforestation*

As it was mentioned earlier, the activities on reforestation and afforestation in different natural zones of Uzbekistan have their own specific patterns. Below some examples of these activities in the valley zone and mountains are described in more detail.

In the valley zone, as evidenced by archival materials, the rights of way from both sides of the canals equal to their width were legitimated in 1894. It was recommended to plant willows on these rights of way in order to stabilize the banks and reduce evaporation. In 1898, during land development near Tashkent, foresters recommended to create forest belts with a width of 200 m at a distance of 2 - 4 km from one another. Belts had to be placed perpendicularly to prevailing winds. In 1915 – 1916, after completion of the construction of the canal in the Mirzachul Steppe and at the beginning of land development, it was planned to create plantation of trees on the entire irrigated area in the form of belts along irrigation canals, roads and streets of the villages, and around the fields to protect them from dry and cold winds.

In order to stop sand shifting to and destroying irrigated lands in Fergana Valley, protective afforestation began already in 1919. Sand holding protections in the form of belts with a width of 100 m have been created here. In the same year, protective afforestation began in the Syrdarya Region. The Mirzachul forestry enterprise established plantations in the rights of way of canals on an area of 550 ha. The works on fixing the most dangerous shifting sands, threatening irrigated lands of Tashkent, Samarkand and Fergana regions started in 1924.

In 1937, the planting of forest shelter belts was scheduled for an area of 1,000 ha. The first system of field-protective forest plantations was created in agricultural farms (sovkhoz) “Pakhtaaral” in the Mirzachul Steppe. Protective plantations were created here along the permanent canals in the form of 1 - 2 rows, mostly of poplar and willow. Especially large-scale planting works began in the Mirzachul Steppe after 1956, when development of virgin lands commenced. Plantings were carried out on 6,000 ha of perennial stands, including 3,000 ha of field-protective forest belts, a green zone around the city of Yangier on an area of 300 ha, as well as other plantings.

Large-scale works on forest rehabilitation and afforestation in Uzbekistan began in the 1960’s.

In the Bukhara Region which is surrounded by deserts, afforestation activities were projected to be carried out by zones. The first zone with a width of 3 km has covered desert territory adjacent to irrigated lands. Activities on the creation of a green barrier to stop shifting sand dunes and to break dry winds were projected to be carried out within this zone. The second zone with a width of 10 km covered irrigated cotton fields bordering the first zone, i.e. desert. In this zone, four row field protective forest belts with placement of 300 - 400 m from one another have been created. The third zone with a width of 5 km covered cotton fields located far from the desert. Here, three row forest belts, placed from one another at a distance of 300 - 500 m, have been created. By 1979, about 1,000 ha of forest belts have been established here.

Extensive activities on afforestation were also carried out in the Ferghana Valley. From 1960 onwards, such activities were expanded to the Kokand’s group of districts where the wind activity was particularly strong. In addition to the field-protective forest belts, 4 state forest belts were created on 250 ha, located at a distance of 20 - 30 km from one another. Considerable works were also performed in Central Fergana, where plantings for fixing shifting sands, in addition to the field-protective forest belts, had to be established. In total, more than 3,000 ha of forest plantations were established here.

Field-protective afforestation on large scales has been carried out in the South of the country, particularly in the Karshi Steppe and Surkhan-Sherabad Valley (Molchanova, 1979). In total, about 40,000 ha of field-protective forest plantations, including on non-irrigated sub-mountain lands, were established.

In Central Asia, there is a famous saying that “water is life”. Mountain forests directly influence the water regimes of rivers and, therefore, special attention has been paid to mountain afforestation and reforestation. At the first congress of Turkestan forest rangers (1898) it was stated that “mountain forests should be recognized for their protective functions in preventing soil erosion and rapid snow melting, formation of mudflows and protecting springs and upper reaches feeding the entire river system of the country”.

Deforestation along mountainous rivers has caused formation of mudflows and destruction of irrigation systems. Because of these events, afforestation activities along the river basins that feed irrigation canals were carried out. The first works on afforestation of mountain slopes have been initiated in the basin of the Aman Kutan River, near Samarkand (1871). Unsuccessful experience of plantation establishment, along the entire tilled areas, has resulted in the need for terracing the slopes. Afforestation in mountain areas began in the Ferghana Valley in 1884 particularly in the tract of the Peshkaut of the Shakhimardan river basin. At the same time, planting trees in Fergana City has been a common practice.

The operations on terracing of the Aktash tract, which is near to Tashkent City, began in 1896. Plantations of walnut, American ash and poplar extending over 55 ha were created in

1898. These plantings had erosion-preventive objectives, as often mudflows have been destroying irrigation canals downstream. It took up to two weeks for the local population to repair canals, while there was no water for irrigation.

During these works, the following operational aspects were tested empirically: different profiles of terraces, their ability to receive rain water of up to 100 mm per day without being destroyed, width of extension, distance between terraces, place of planting of trees on the terrace, range of suitable species, and many others. Terracing was conducted manually by trench-terraces, which have trapezoid shape in transverse profile, the so-called Aktash type terraces.

The capacity of terraces, depending on the steepness of the slope, was different from 0.49 to 0.89 $m^3$ per running meter. The basis for calculating the capacity assumed a daily maximum of precipitation of 100 mm. The steeper the slope the closer the distance between the terraces, less capacity to absorb runoff was required. On the contrary, the terraces with bigger capacities were constructed on gentle slopes with large distances between the terraces. In order to avoid water runoff at the bottom of a terrace, bulkheads at a distance of 21 m were constructed.

Afforestation works continued until 1960 by planting trees within the areas between the terraces. Soil preparation was carried out by creation of holes with the size of 40 cm x 40 cm x 50 cm, and later on, this was increased to a size of 1.5 m x1 m.

Since 1960's, the works on creation of terraces have been mechanized (Botman, 1968).

In the desert zone, fixation of sands by methods of forest reclamation was initiated in the late 1920's in the Bukhara region by the Bukhara Sand-Fixation Party, founded in 1924 by the Forest Department under the National Commission of Agriculture of the USSR. Forest crops of saxaul and saltwort have been created using mechanical ground cover shields from bulrush and other local materials. Most of the forest-crop works in the desert were performed during the postwar years by aerial sowing, solid seeds scattering from camels, cars and tractor trailers and by planting of seedlings using tree-planting machines on plowed belts.

Thus, afforestation in Uzbekistan looks back to more than a hundred years of history and has strongly focused on ameliorative activities, which is associated with local soil and climatic conditions and lifestyle. Currently, there are 2.83 million ha of forest covered lands in SFF, including 5.95 million ha of artificially created plantations or 21% of all forests. In addition, there are 1.56 million ha of so-called forest crops without crown closure (young plantation), which can replenish the area of artificial plantations in case of sufficient survival rate at a certain age (generally at an age of four years).

As it was mentioned earlier, in 2006, the Main Department of Forestry developed and approved a Forestry Development Program for 2006-2010. This program is aimed primarily at strengthening the measures on conservation and accelerated reproduction of forest resources, enhancement of ecological and protective functions of forests, rational use of forest fund lands, and expanding the forest lands of the Republic.

The works on sowing, planting and performing measures on promoting natural regeneration on the area of 42,000 ha of the State Forest Fund are carried out every year. These include 13,100 ha of new forests created through sowing of seeds of forest species, 17,900 ha through planting of seedlings and saplings of different wood and shrub species, and 11,000 ha where enhancement of natural regeneration is carried out.

Out of the total volume of seeding and planting operations, more than 80% are undertaken in the desert zone of Priaralie and on the dried bottom of the Aral Sea (Republic of Karakalpakstan, Bukhara, Navoi and Khorezm regions). In these territories, every year reforestation and afforestation operations are carried out on an area of over 34,000 ha using the main sand-tolerant species such as saxaul, saltwort and kandym. In the mountain zone, the main species planted belong to three genera of archa, walnut, almond, and pistachio. In the valley zone poplar, maple, plane, elm, gleditschia, and fruit species were used while in the tugai zone the mostly poplar, willow and oleaster were planted.

Natural regeneration all over the territory of the forest fund, in general, shows unsatisfactory progress due to various reasons explained earlier in this paper. Because the establishment of forest plantations through sowing and planting is labor-intensive and expensive, more and more attention is paid to expand the forest area through activities promoting natural regeneration. The main activities on promoting natural regeneration of forests include:

- Conservation and protection of undergrowth;
- Retaining seed-bearers during timber harvesting;
- Cleaning cluttered areas and liberating natural regeneration;
- Preparation of the soil for promoting natural regeneration;
- Fencing of felling and cutting areas; and
- Maintenance of undergrowth.

At present, activities on natural regeneration are carried out on an area of 11,000 to 13,000 ha each year. In the coming years (2007-2011) reforestation works are scheduled to be carried out in an area of 211,000 ha.

Despite the significant volumes of planned and ongoing works on reforestation and afforestation, their final effectiveness is relatively small. It is connected to the rather difficult and complex forest growing conditions of the country, quality of performed work, weak conservation and protection of new plantations, and lack of qualified personnel.

Growing of planting stock for artificial reforestation and afforestation, and improving of green spaces and beautification have been implemented in more than 50 specialized subdivisions of the forestry enterprises. Presently, the area of forest nurseries comprises over 700 ha. Out of these, 200 ha are considered to be permanent (organized in 25 forest enterprises) and 500 ha are temporary. More than 80% of the forest nurseries are located in irrigated, while others are situated in desert and sandy zones. Of these, 46% are used for germination, 44% for transplanting, and 10% for supporting activities of forest nursery operations.

The annual production of planting stock is over 50 million seedlings and saplings and fully meets the needs for forest plantings. In addition, part of the planting stock is sold for planting of trees in cities and other localities of the republic. The variety exceeds 60 species of trees and shrubs. This includes 18.5 million sand-tolerant species, 18.1 million fast-growing species, 12.8 million nut-bearing species, 0.4 million coniferous species and 0.6 million decorative species.

### *4.6. Forest Rehabilitation Outputs and Future Directions*

Due to the nature of forestry in Uzbekistan, the efficiency of activities on reforestation and afforestation in general benefits the country's economy. The economic, social and environmental aspects of forestry can be highlighted as follows:
Economic role of forests

The natural conditions and the nature of the forest vegetation in Uzbekistan are responsible for the relatively minor economic role of the forestry sector. Commercial felling in natural forests of the country is prohibited (only sanitary cuttings are allowed). Moreover, the species composition of forests does not favor timber harvesting for commercial purposes. The income from the forests of Uzbekistan consists of commercial and fire woods, medicinal and aromatic plants, hunting and fishing on lands of the State Forest Fund. In 2002, the total amount of income from these types of products and activities was USD 314.090 (FAO, 2005). In addition, the planting stock of forest, fruit and decorative species of trees and shrubs are also cultivated for sale. Also, 40 tons of honey and 1,300 tons of vegetables are being produced. Annually, the forestry enterprises, on average, harvest 130-150 tons of nuciferous products, including 90 tons of walnut, 15 tons of almond, and 35 tons of pistachios. Fruits and berries are harvested and processed at about 2,500 tons. There are also some dozens of small wood processing plants producing windows, doors, furniture, and products made from canes for the local market.

**Social role of forests**

The social role of forests is mainly determined by the fact that there are local people living in the territory of the State forest fund, including in areas close to the forests. For local communities forests represent their natural environment and serve as a source to meet vital daily needs. Due to recent significant socio-political and economic changes, the needs of the local population for forest resources (i.e. grazing, firewood, non-wood forest products), partly satisfied illegally, have highly increased. This is connected to a lack of dialogue between the local people and authorized forest bodies or this dialogue has been one-sided in the form of law enforcement. Therefore, cooperation of the forestry sector with local communities becomes more and more urgent, though only very few steps have been made in this direction.

Gaining independence and breaking relations with other former Soviet Republics have created a demand for satisfying recreational needs inside the country. Opportunities exist but have not been used fully until now. It is quite natural that for a country with an arid climate, the recreational potential is associated with forests and water. However, the number of tourist routes and rest houses located in the forest or nearby is very limited. Although the cases of renting out to tourist residences in mountain forest areas by the local population are rapidly increasing.

Growing urbanization also increases the need for enhancing the urban environment in the desert zone, thus resulting in the creation of urban and suburban forest plantations. Forestry provides jobs, though their number is quite insignificant (less than 8,000).
Ecological role of forests

The ecological functions of forests are recognized at state level and their importance grows with the worsening of the ecological situation in the country. It includes conservation of biological diversity and combating against desertification (including on the dried bottom of the Aral Sea, and stabilization of irrigated agricultural landscapes). The increasing water shortage attaches growing importance to the water conservation role of forests in the mountains, i.e. watershed management in places of formation of river runoff. In all natural zones of the country the soil protective function of forests becomes more and more important. Afforestation on the territory of the State Forest Fund, and more importantly on irrigated agricultural lands, has high carbon sequestrating potential, but has not been used thus far. This potential contains not only an ecological aspect related to the mitigation of climate change, but has also an economic value that can be realized in cash income. Despite the fact that it is difficult to evaluate these forest functions in monetary terms, in Uzbekistan it has higher priority compared to all other forest uses.

It has been noted already that a National Forest Policy has been developed in the country. Based on a thorough analysis of the current situation of the country's forestry sector in general, and efforts towards reforestation and afforestation in particular, the policy outlines systemic directions and the necessary changes for implementation suitable to raise the forestry sector of the country to a higher level. Therefore, the main task today is to adopt the new forest policy and ensure its gradual implementation.

## 5. Capacities in Forest Rehabilitation

### *5.1. Institutional Capacities*

In order to improve the activities in reforestation and afforestation, general measures to strengthen the capacity of the authorized bodies for forestry will be required.

The structure of forest administration in Uzbekistan has been discussed in subsection 2.5. During the years after independence, forestry has been developing inertially and has not undergone any deep and systemic reform. The status of the authorized body for forestry has been reduced (it was changed from the State Committee for Forestry [1991] to the Main Department under the Ministry of Agriculture and Water Resources [2000]), as well as its ability to perform its tasks. This is due to the fact that forestry was not a priority direction in the country's development.

However, since gaining independence, the value of the forest sector has objectively grown and now this situation is further changing with the Government's proposal for assistance to FAO in the development of a national forest policy. Currently, the draft of the medium-term document "Strategies for solving forestry development problems", which is a part of the NFP, is ready and in case of its approval and implementation, the forest sector will be reformed. It should also result in institutional changes in the authorized body for forestry [MDF].

According to the new policy, the Main Department of Forestry should be the authority in charge of formulating and implementing the country's forest policy, which requires in particular:

- Involvement of stakeholders in forest management;
- Establishment of cross-sectoral cooperation and coordination with local authorities;
- Evaluation of its activities in accordance with corresponding international treaties; and
- Establishment of regional cooperation and communication with communities.

Addressing these new challenges will require creation of new structures, such as:

- Subdivision on cross-sectoral cooperation and coordination with local authorities (or the National Coordinating Council of Forestry, or to assign a person for such cooperation);
- Subdivision on community based forestry and joint forest management;
- Subdivision on international cooperation; and
- Subdivision on public relations.

Effective implementation of these tasks will require other structures to perform regulatory, supervisory and managerial functions. Currently, all these functions are assigned to MDF.

In addition, in order to enhance the institutional capacity of MDF, it will be helpful to restructure MDF as an independent subdivision under the Cabinet of Ministers of the Republic of Uzbekistan. It is advised to delegate to the Main Department of Forestry the main responsibilities for the management of all protected natural territories, forestry fund and forest lands outside the forestry fund area.

It is required to increase the capacity of forestry departments of universities by a revision of curricula in accordance with the forestry development strategy, close cooperation of MDF with scientific research institutions for identifying research topics and using results of their research and available scientific knowledge.

### *5.2. Civil Society Involvement*

There is only one NGO in Uzbekistan specializing on problems of the forestry sector: “Ecoles”. This organization has implemented several projects on afforestation and landscape gardening. However, conservation and improvement of forest conditions of Uzbekistan can be reviewed in a broader context, namely as part of the problem of environmental protection.
In the mid-1990’s, environmental issues have attracted wide public attention. Thus, non-governmental organizations working in this field, not only in regional, but also in district centers, were created in Uzbekistan. Specialization of these NGOs was very diverse: environmental education, biodiversity conservation, desertification, drying of the Aral Sea. At this time, the following ecological NGOs were founded and became operational: Zoological Society of Uzbekistan, “Ecology”, Association “For ecologically clean Fergana”, “Union of protection of Aral Sea and Amudarya”, Center of Ecological Law “Armon”, Scientific Advisory Center “Ecoservice”, Youth Ecological Network of Uzbekistan, Republican Community Center “Atrof-muhit va soglom hayot” [“Environment and healthy lifestyles”], Ecological Resource Center “Ecomaktab”. For example, at present about 70 NGOs are operating and dealing with environmental protection issues in Uzbekistan (Turabekova Sh.).

In order to join the efforts of NGOs on increasing the effectiveness of public participation in environment protection and implementation of joint activities in addressing environmental issues, the Republican Association Ecoforum of NGOs of Uzbekistan was established in 2007. Several coalitions of ecoNGO have successfully implemented various projects within the framework of EcoForum including water-related subjects, environmental education and education for sustainable development, biodiversity conservation, development of ecojournalism, and others. In the dissemination program, the Ecoforum offers a web site (www.ecoforum.sk.uz), electronic newsletters, and exchange of information via the electronic network of EcoForum members.

Working with young people is an important arm of EcoForum’s activities. There are environmental NGOs working with schoolchildren and students; school eco-clubs successfully operate in different cities of the country; ecological summer camps and trips are organized; youth is involved in nature protection activities initiated by NGO coalitions. The cooperation with the youth ecological network of Central Asia is developing.

During 18 years of development, considerable work has been performed in the field of environmental protection, significant experience in addressing ecological problems and overcoming their negative impacts has been gained. However, the seriousness and the magnitude of the existing problems have required combined efforts of state bodies, public associations, civil society institutions and citizens to improve the ecological situation in the country and in the region. As a logical and timely consequence in this regard the Ecological Movement of Uzbekistan was established. One of the most important tasks of the Movement is to increase active participation of communities in environmental protection and improvement of the ecological situation, fulfilling systematically existing laws and other government regulations on environmental issues and promoting further improvement and development of legislation in this area.

One of the priorities is promoting unconditional fulfillment of legislative acts aimed at addressing existing ecological problems, ensuring rational use of resources allocated for this purpose. The Ecological Movement actively engaged in the improvement of ecological awareness of the population, the development of a system of ecological education and training. It also deals with international cooperation in the field of environmental protection, consolidation of efforts, coordination of the activity of non-governmental organizations operating in the field of environmental protection. Since its establishment, the Ecological Movement has conducted a large-scale informational campaign in the mass media through various meetings, promotions, contests and other activities. The Ecological Movement of Uzbekistan is represented in the Lower Chamber of Parliament (15 seats). Representation in the Legislative Chamber of Oliy Majlis of the Republic of Uzbekistan will enable the Ecological Movement to have a direct impact on the effective improvement of environmental legislation, ensuring its unconditional fulfillment.

### *5.3. Education on Reforestation and Afforestation*

Until 2003, there was a Tashkent Forest Training College located in the Tashkent Region, which trained 45-60 forestry technicians annually. Due to lack of qualified teachers, material and technical difficulties this institution was restructured. There is a Sariassiya Professional College operating in the Surkhandarya Region, which trains 15 forestry technicians annually. Currently, the college experiences the need for qualified teaching staff, new educational programs, and material (e.g. textbooks).

There are 3 institutes of higher education:

The Tashkent State Agrarian University (TSAU) has educated 117 - 216 bachelors and 8 - 11 masters annually during 2004 - 2008.

Preparation of forestry specialists has begun in TSAU since 1944. To date, the number of graduates of the University exceeds 2,000 people, including 15 doctors and 50 candidates of science (PhD). Until 1990, TSAU was considered to be the main educational institution for Central Asian countries. At that time education was conducted at the Forestry Faculty. Presently, it is conducted in the Department of Forestry of the Agronomy Faculty. Students are taught in the following subjects: dendrology, forestry, tree breeding, forest fires and fire control measures, scientific research methods in forestry, landscape gardening, mechanization of agricultural production, hydrology and hydrometry, geodesy and topography, forest management and forest use, forest valuation, economics and management of forestry, accounting and statistics in forestry.

In 2004, the students had the choice of two specializations: 1) Agroforestry reclamation, protective afforestation and 2) Forestry management. In 2005-2006, they could choose between 1) Agroforestry reclamation and protective afforestation, 2) Forestry management, 3) Tree planting and landscape construction. Since 2007, only one specialization, namely Forestry Management, is offered.

Presently, there are 3 professors, 4 associate professors and 3 assistants working in the Department. Currently, there is a forest seed laboratory operating in the department; the students receive practical training in different forestry enterprises of the Republic.

Faculty of Forestry in the Nukus Branch of the Agrarian University. In 2008, the first graduates were 15 bachelors who received diplomas in forestry engineering.

Department of Forestry of the Samarkand Agricultural Institute (2005). Presently, there are 17 students at bachelor level being taught in this department. Resource base and pedagogical capacity are inadequate.

The Production Center on Training of Forestry Specialists conducts 24-hour training courses, where the trainees are familiarized with existing and newly adopted legislative documents, economics and forestry management. Classes are held in the form of lectures, with practical sessions using videos and computers.

Every year, 20-25 heads of forest enterprises, 30-50 chief foresters, 35-40 chief accountants and economists of farms undergo short-term trainings in the Production Center on Training of Forestry Specialists.

The Republican Scientific and Production Center of Decorative Gardening and Forestry, as well as the Tashkent State Agrarian University train postgraduate and Ph.D. students in forestry subjects (Anonymous, 14).

There are various difficulties encountered in forestry education, including problems with specialized educational literature in Uzbek language, translation of forest terms and their application under specific conditions of the country, insufficient knowledge of students, and not all of the graduates are working in the specialized area they have studied.

### *5.4. R&D Needs in Forest Rehabilitation*

During Soviet times, the Central Asian Scientific Research Institute of Forestry was the main regional institution in forestry, with branches in Turkmenistan and Tajikistan. Since independence, it has become the Uzbek Scientific and Research Institute of Forestry (USRIF), and its responsibility has been limited within the borders of the country. The organizational structure of the Institute included the following divisions: field-protective afforestation, breeding and seed production, mountain forest reclamation, desert forest reclamation, radiobiology, forest crops, mechanization, agrichemical laboratory, and forest operations and machinery.

Almost until the end of 1990’s, the Institute has been working on scientific research areas, inherited from the Soviet times, within five-year research periods. At this time, there was an active outflow of qualified personnel, especially young persons. At the end of 1980, the institute employed about 50 people with academic degrees and by the end of 1990, this number decreased to 20.

In 2005, the USRIF was changed to the Republican Scientific and Production Center of Decorative Gardening and Forestry (RSPC DG&F). Its tasks now include a new area, in which it has not been engaged previously, related to the development and implementation of a unified strategy for development of decorative gardening. The scientific part of the Centre consists of scientific research projects which have been acquired on a competitive basis. Scientists form temporary creative teams which are not employed by the Center. Presently, there are about 10 professionals with academic degrees at the age of over 55 employed by the Center.

The main needs of forest science of Uzbekistan in general and research on reforestation and afforestation in particular can be summarized as follows:

- Ensuring continuity of the Uzbek School of Foresters, at least, its main directions, as almost all qualified scientific personnel is near retirement age and its number is decreasing rapidly, while there is lack of young scientists;
- Working out in coordination with MDF of priority research programs on the most important areas of practical forestry (forestry reclamation of deserts and dried bottom of the Aral Sea, mountains and farming lands, creation of industrial plantations to obtain timber and nuts of different nut-bearing species, conservation of genetic resources and forest biodiversity);
- Breakdown of these programs into stages, joint monitoring and adjustment of their implementation;
- Increase of funding of scientific research through various sources and their concentration, including the state grant funds, for research outlined in the priority programs;
- Conducting training for scientists, e.g. foreign language (mostly English) learning program, computer classes (Word, Excel, PowerPoint, Internet, statistical processing of field data, etc.);
- Access to new scientific publications and participation in scientific conferences, familiarization with the new directions of forest research and new methods of its implementation;
- Improvement of material and technical conditions of the research work; and
- Effective use of accumulated knowledge, critical analysis of available scientific recommendations, their adaptation to modern conditions and further development as well as broad use in forestry production.

### *5.5. International and Regional Cooperation on Forest Rehabilitation*

Specialists of the Main Department of Forestry actively participate in international events such as workshops, conferences and symposia organized by international organizations.

The Main Department of Forestry has appointed national correspondents to collect data on the forestry sector and conduct an international assessment of forest resources of the country for FAO. In the frame of FAO/EEC UN in Central and Eastern Europe, Uzbekistan has delegated its representative to the Group of Experts of Eastern Europe countries, which is assigned to assist FAO and EEC UN in their activity in the region and to provide feedback. The objective of the Group of Experts is to increase the effectiveness of international activity (FAO/EEC UN), aimed at promoting contribution to multi-functional forest management and sustainable development of the countries of Eastern Europe through enhancement of the private forest sector, as well as forest policy and institutional framework, promoting discussions, dialogue and exchange of information among the countries.

Below are the international projects which have been implemented on the lands of the State Forest Fund under the jurisdiction of the Main Department of Forestry:

- Afforestation of the dried bottom of the Aral Sea by local salt resistant plants. The project was implemented on the basis of a contract between the Main Department of Forestry of the Republic of Karakalpakstan and the Aral Sea Salvation Fund during 2003-2008. The total area of planted trees amounts to 10,000 ha.
- Afforestation of the dried bottom of the Aral Sea and agrotechnology of cultivation of poplars in the Fergana Region, which was implemented by the NGO KOFUTIS (France) during 2002-2005. The project consisted of two components: one of them

included the cultivation of saxaul in the Aral Region, and the second one established plantations of fast-growing hybrid poplars of French breed;
- Creation of forest crops on the dried bottom of the Aral Sea under the Program Section 416 (b) (USA). Funds in the amount of UZS 800 million were used for planting forest crops on the dried bottom of the Aral Sea during 2004-2006;
- For the purpose of improving the ecological situation in the Aral Sea Region and reclamation of the dried bottom of the Aral Sea a GTZ-supported project (since 2000) has been implemented, involving the establishment of forest plantations on the dried bottom of the Aral Sea;
- For the purpose of developing the National Forest Program and improving the forest legislation in Uzbekistan the Main Department of Forestry with the support of FAO has implemented the project "Development of the National forest policy and improvement of forest legislation" TCP/UZB/3101 (A). Within the framework of the project, the draft of the National Forest Policy and the draft of the Forest Code have been worked out with participation of international experts, local communities, agencies, ministries and other stakeholders. These documents were discussed on May 5-8, 2009, in Samarkand at the sub-regional FAO workshop on exchange of experiences and opinions with representatives of the forestry sector of Azerbaijan, Kyrgyzstan, Kazakhstan, Tajikistan and Turkey.

Current international projects:

- Project of the Government of the Republic of Uzbekistan, the Global Ecological Fund (GEF) and the United Nations Development Program (UNDP) "Achieving ecosystem stability on degraded lands in Karakalpakstan and Kyzylkum desert". The project has been implemented since 2008. The prerequisites for the start of the project were the phenomena of degradation and desertification of lands in the Karakalpakstan and Kyzylkum deserts. The project is being implemented within the framework of the International Convention to Combat Desertification and the International Convention on Biological Diversity;
- Project of the Government of the Republic of Uzbekistan, the Global Ecological Fund (GEF) and the United Nations Development Program (UNDP) "Enhancement of sustainability of the national system of protected natural territories by focusing on the reserves". The project has been implemented since August 2008. Prerequisite for the start of the project was inefficiency of biodiversity protection from various threats. The project intends to demonstrate the new approaches to management with the purpose of expanding the system of protected natural territories in Uzbekistan;
- Project of the Government of the Republic of Uzbekistan, the Global Ecological Fund (GEF) and the United Nations Development Program (UNDP) "*In-situ* conservation of wild crop relatives by strengthening information management and its practical application"; and
- Project of the Government of the Republic of Uzbekistan, the Global Ecological Fund (GEF) and the United Nations Development Program (UNDP) "*In-situ*/on farm conservation and use of agro-biodiversity (fruit crops and their wild relatives) in Central Asia".

## 6. Future Steps

There is no reason to discuss development perspectives of reforestation and afforestation outside the context of the general state of the forestry sector. Currently, the forestry sector is under pressure to implement the necessary changes. Therefore, the most important issue for forestry of Uzbekistan is the approval and implementation of the developed National Forest

Policy. This will be an important step in the transition of the forestry sector from simply forecasting the scope of forestry activities to the elaboration of the development strategy of the sector.

It is assumed that NFP will be implemented on a step-by-step basis. Currently, the drafts for the elaboration of a national concept and strategy for forestry development have been prepared. Following approval of these documents, an Action Plan, i.e. a short-term document for the next five years with detailed elaboration of activities, terms, volumes and sources of funding, responsible persons and other activities, will be developed.

In addition, prior to implementation of the Action Plan, or in parallel with its implementation it is required to meet the following main conditions:

- Development and adoption of the Forest Code and relevant regulations, making additions and changes to other normative documents;
- Strengthening institutional capacity of forestry organizations, namely restructuring of MDF as a separate subdivision; transfer to MDF of main authorities on the management of all protected natural territories, as well as forest covered lands to the Main Forestry Department; improvement of working conditions of forestry employees, provision of necessary requirements for vehicles, technical equipment and other equipment; increasing budgetary financing of the Republican Training Center under the Main Department of Forestry; improving training programs; improvement of dialogue and cooperation of MDF and its subdivisions with interested organizations, including government agencies, NGOs, local population, private sector, schools, mass-media; enhancement of the capacity of forestry training institutions through revision of their programs in accordance with the forestry development strategy, establishing closer cooperation of MDF with RSPC DG&F in selection of subject areas, use of research results and existing scientific knowledge;
- Allocation of funds and introduction of mechanisms for the implementation of the National Forestry Program: using available limited budgetary resources for priority programs and priority types of activity; increasing the revenues of forestry enterprises through development of collection and processing of forest products, land lease, sale of seedlings, recreational activities, ecotourism and hunting, as well as exempting the forestry activities from taxes. In order to increase funding for the forest industry from the state budget, it is required to raise awareness of the members of Oliy Majlis, heads of public organizations, Ministry of Economy and Ministry of Finance, and the whole society about economic, social and environmental importance of forests; increasing the investment by local authorities to forestry through joint projects; creation of conditions for attracting private investments to the forestry sector; and
- Broadening the knowledge base on forestry: in order to make necessary well-grounded decisions on forest management, it is required to conduct an inventory of forests and to create a corresponding database and monitoring system. For this reason the necessary technical infrastructure and qualified personnel need to be created in the MDF.

This preliminary work will enable the implementation of the main directions of forestry development in the country.

## *7. References*

_____________ 1987. Instructive guidance on design and cultivation of protective forest plantations and agro-technical erosion-preventive activities in the Uzbek SSR. Tashkent.

_____________ 1991. Recommendations on creation of protective plantations on soils of light mechanical compounds of the dried bottom of Aral Sea. Tashkent.

_____________ 1999. Law of the Republic of Uzbekistan, 15.04.1999, No.770-I "On forest".

_____________ 2000. Resolution of the Cabinet of Ministers of the Republic of Uzbekistan. No. 98 "On organization of the activity of the Main Department of Forestry under the Ministry of Agriculture and Water Resources".

_____________ 2001. IUCN Red List Categories and Criteria.

Anonymous, 1. http://ru.wikipedia.org/wiki/география_Узбекистана.

Anonymous, 2. 1977. Great Soviet Encyclopedia. Moscow: Soviet Encyclopedia.

Anonymous, 3. Main indicators of socio-economic development of the Republic of Uzbekistan in 2008 http://www.stat.uz/STAT/index.php?lng=2&event=1630

Anonymous, 4. http://www.gov.uz/ru/helpinfo/population_labour/206

Anonymous, 5. http://www.uz.spinform.ru/people.html

Anonymous, 6. http://www.uz.spinform.ru/ekonomics.html

Anonymous, 7. Main indicators of socio-economic development of the Republic of Uzbekistan in 2008 ttp://spint/stat/index.php?lng=2&article=27

Anonymous, 8. Main economic and social indicators. Statistical Review of Uzbekistan. http://www.stat.uz/STAT/index.php?lng=2&publication=0

Anonymous, 9. http://www.krugosvet.ru/enc/Earth_sciences/geografiya/l_20/sl_2/

Anonymous, 10. http://ru.wikipedia.org/wiki/ Category: Turizm_v_Uzbekistane

Anonymous, 11. http://100dorog.ru/guide/news/3292841/

Anonymous, 12. 2005. National report on the state of surrounding environment and use of natural resources of the Republic of Uzbekistan. State Committee of the Republic of Uzbekistan for Nature Protection, Tashkent, 2006. p 132.

Anonymous,13. 1998. Conservation of biological diversity. National Strategy and Action Plan. Republic of Uzbekistan. Tashkent, p.135.

Anonymous, 14. The modern condition of forestry in Uzbekistan. http://forestry.uz/index.php?option=com_content&task=view&id=22&Itemid=32

Arnoldi, K.V. 1946. About insects of walnut-fruit forests of southern Kyrgyzstan and the importance of entomological data for general biological characteristics and problems of the genesis of these forests. Tr. AS USSR, Vol. 53, ed.9.

Beer, R., F. Kaiser, and W. Tinner. 2006. History of vegetation of Kyrgyzstan of postglacial period (Holocene). Report of expedition. University of Bern, Institute of Plant Sciences, Section of Paleoecology, Bern, 41 pp.

Botman, E.K. 2007. Vulnerability of archa formations to climate change in the territory of Uzbekistan. Consequences of climate change in Uzbekistan, issues of adaptation. Bulletin No. 7 - Tashkent: SISMI, p. 68-75.

Botman, K.S. 1968. Experience of mountain afforestation works to combat against soil erosion and mudflows in the river basin Aktash. Thesis for the degree of candidate of agricultural sciences. Tashkent, 236 pp.

FAO. 2002. Second Expert Meeting on Harmonizing Forest-related Definitions for Use by Various Stakeholders, Rome, September 11-13, 2002.

FAO. 2005. [1]Global Forest Resource Assessment 2005, Uzbekistan Country Report, Rome, Italy.

Griza, E. 2008. Venglovsky B., Sarymsakov Z., Carraro G. Typology of forests of the Kyrgyz Republic. Bishkek, 263 pp.

Konnov, A.A. 1966. Archas of northern slope of Turkistan Ridge. Dushanbe: publ. Donish, 183 pp.

Korovin, E.P. 1962. Vegetation of Central Asia and Southern Kazakhstan. Book 2, Tashkent, publ. Uzbekistan SSR.

Molchanova, A.I. To the history of field-protective afforestation on irrigated and dry lands of the republics of the Central Asia. Protective afforestation on irrigated and irrigated lands. Proceedings of SredAzNIILH, ed.18. Tashkent, 1979. p.10-29.

Ovchinnikov, P.N. 1958. About some botanical and geographical features of archas of Tajikistan. Archas of forest-central part of Turkistan Ridge. Proceedings of the Botanical Institute under the Academy of Science of Tadjik SSR, Volume. XX111.

Popov, M.G. 1938. Main periods of formation and migration in the flora of Central Asia in the age antofitov and relict types of flora. The problem of relics in the flora of the USSR. M.-L. publ. AS USSR, edition 1, pp. 10-26.

Rubtsov, N.I. 1955. To the history of vegetation cover of the Tien Shan. Materials on the history of fauna and flora of Kazakhstan. Alma-Ata: publ. AS Kaz. SSR, ed.1.

Sadovskaya, N.A. 1954. Distribution and stratigraphic significance of pollen and spores in the Cenozoic sediments of north-west Fergana. – Ph.D. Thesis. Tashkent.

Sadovskaya, N.A. 1978. The stratigraphic division of the Cenozoic deposits of Fergana on the basis of palynological studies. Uzb., Geol.zhurnal, ed.1, p.28-41.

Samsonov, S.K. 1966. New data on upper-calciphyte flora of north-eastern Central Asia. M.: Nauka, 115 pp.

Shivaldova, N. 2009. Protection of soil and water - a guarantee of our future. http://uznature.uz/rus/prirodauzbekistana.html

Spektorman, T.Y. and E.V. Petrova. 2007. Climate scenarios for the territory of Uzbekistan. Climate scenarios, assessment of climate change impacts. Bulletin No. 6 - Tashkent: SISMI,. p.14-21.

Turabekova, Sh. http://www.uzembassy.ru/5841.htm

Utkina, N.G. 1968. History of geological development in the late Cenozoic of South-Eastern Fergana and Alai. Izv. AS Kirg.SSR, ed.4, p.37-46.

Utkina, N.G. 1992. Geomorphology and paleography in the latest stage. Nut-fruit forests of the Southern Kyrgyzstan. Bishkek: Ilim, p.9-52.

***Desert forest ecosystem in Uzbekistan (Photo taken by Nikolai Lyutsian)***

***Former bottom of the Aral Sea (Photo taken by Nikolai Lyutsian)***

***Pistachio forest in Uzbekistan (Photo taken by Nikolai Lyutsian)***

***Tugai forest in Uzbekistan (Photo taken by Nikolai Lyutsian)***

***Walnut forest in Uzbekistan (Photo taken by Nikolai Lyutsian)***

***Juniper forest in Uzbekistan (Photo taken by Nikolai Lyutsian)***