Selected papers from the conference on

FORESTRY SERVING URBANISED SOCIETIES

Copenhagen,
Denmark,
27 to 30 August 2002

Jointly organized by:
IUFRO
European Forest Institute
Danish Centre for Forest, Landscape and Planning - KVL

Editors:
Cecil C. Konijnendijk,
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Preface

This volume in the IUFRO (International Union of Forest Research Organizations) World Series presents selected papers from the conference 'Forestry Serving Urbanised Societies', held in Copenhagen, Denmark, during August 27th-30th, 2002. This event was jointly organised by IUFRO (as the first European Regional Conference), EFI (European Forest Institute), and the Danish Centre for Forest, Landscape and Planning (*Forest & Landscape Denmark*) as local host. We would like to thank all three organisations for their contributions to the success of the conference. Our particular gratitude goes to *Forest & Landscape Denmark's* Director General Dr Niels Elers Koch, tireless and inspiring conference chairman, and to the IUFRO Secretariat in Vienna for assisting with this publication.

This publication could not have been realised without the professionalism in type-setting of Jette Alsing Larsen and Nelli Leth at *Forest & Landscape Denmark*, nor without the financial support of the Danish Ministry of Science, Technology and Innovation, the Andreas-Stihl-Stiftung and the Carlsen-Langes Legatstiftelse. But first and foremost we are indebted to the authors of the papers included in this volume, as well as to all conference participants.

The editors
Copenhagen, November 2003

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'Forestry Serving Urbanised Societies'

‘Forestry Serving Urbanised Societies’

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1 Urbanisation and forests

Continuing urbanisation is one of the main factors influencing use and management of urban and to a certain extent rural landscapes today. Presently, more than half of the world’s dwellers live in urban areas. As a result of urbanisation, attention towards the role of forests, parks, trees and other greenspace in contributing to sustainable and liveable cities and towns has increased. The expanding body of scientific literature on urban green resources, their current and potential functions, their appreciation by urban dwellers, and how to plan, design, establish, conserve and manage them, testifies of this growing awareness.

But urbanisation does not only concern the inner-city or peri-urban green spaces, as forests and natural resources at large are also affected by it. The dominance of urban values, norms, preferences and use has led to an emphasis on a wide range of forest and nature goods and services. In the case of forestry, in many Western countries timber production is regarded of equal importance as social and environmental services, as acknowledged in new forest and nature policies. Recreational use of forest and nature is higher than ever before, and increasing attention is given to the impacts of green areas on human health and well being. Environmental services that are prioritised include water regulation and protection, carbon sequestration, protecting against erosion and land degradation, and biodiversity. Urbanites demand these and other services, and are doing so more and more vocally, demanding to be actively involved in natural resource decision making. The traditional legitimacy of foresters and other natural resource professions is being challenged.

Urbanisation has also led to a blurring between urban and rural areas, and a need to go beyond traditional land-use and planning boundaries. The urban-rural divide, policy-makers are stressing, today is not more than an artificial and counterproductive distinction. In order to develop sustainable natural resource management for urbanising societies, more integrative approaches are needed that recognise the influence of urbanisation on forests and other green areas at large.

2 Conference ‘Forestry Serving Urbanised Societies’

The issues outlined above were addressed at the international conference ‘Forestry Serving Urbanised Societies’, held in Copenhagen, Denmark during 27-30 August 2002. The event was held as European Regional Conference of the International Union of Forest Research Organizations (IUFRO), in collaboration with the European Forest Institute (EFI) and the *Danish Centre for Forest, Landscape* and

Planning, host of the European Urban Forestry Research and Information Centre (EUFORIC). It discussed the need for structural changes in forestry and related professions in order to adapt to current demands. Many of the approximately 200 scientists and policy-makers from 40 countries stressed the need to develop natural resource management from its traditional rural roots to further embrace the urban dimension. Traditional forestry expertise has to be combined with new knowledge and skills, including conflict management, public relations, public participation, policy sciences, marketing, and landscape architecture and ecology. Not in the least, forestry has to encompass a partnership approach and alliances have to be formed with those other professions, as well as laymen with a vested interest in forests. The development of urban forestry, a multidisciplinary approach to all forest and tree resources in and near our cities and towns, may act as an example in this respect.

The conference had the following objectives:

- To define the role of forestry and forest research within an increasingly urban society.
- To identify and explore promising scientific and technological findings with regard to the urban aspects of forestry and the prevailing role of urban decision makers.
- To identify new directions and strategies in forest research in the context of extended networking within forest research and with other disciplines to meet urban demands.

Invited as well as voluntary papers were presented during 8 plenary and 17 parallel sessions. The papers included in this volume provide a good cross-section of the material presented at the conference. Additional conference papers were published earlier in the journal *Urban Forestry & Urban Greening* (Vol. 1, issues 2 and 3)[1].

3 Roles of forests and trees in urban areas

Forests, trees and other greenspace have been highly appreciated parts of cities and towns for ages, as the Estonian example presented by *Läänelaid & Sander* shows. Different roles of greenspace in cities, ranging from providing an important contribution to subsistence to aesthetic values, have been recognised.

The aesthetic and especially recreational benefits of forests, parks and trees in urban areas have often been in focus, also from a research perspective. Today, research is stressing the need to distinguish between different users of urban greenspace; the example from Denmark shows that children have their very own ways of perceiving their urban environment (*Guldager & Carstensen*). Recent years have also brought about increasing attention for other social services provided by urban green, and most notably health benefits. An expanding body of research, with important contributions from medicine and (environmental) psychology, has

[1] Reference to some of the latter papers is made through 'UFUG 1(2)' and 'UFUG 1(3)', respectively.

demonstrated that urban greenspace can help improve physical and mental health, as described in the papers by *Rachel Kaplan, Stephen Kaplan*, as well as *De Vries*. Greenspace provides an attractive and inviting setting for active forms of recreation, important for example in combating obesity and hearth diseases. Its presence can help reduce stress and mental fatigue.

The multiple environmental services provided by forests and trees in urban environments have also become recognised. Well-known research work in the United States presented at the conference (see *McPherson* in UFUG 1(2)) has come a long way in assessing and quantifying the environmental benefits of trees in urban forestry, for example in terms of air pollution reduction, carbon requestration, stormwater regulation, and cooling effects. Forests and trees also have a large potential in restoring degraded and polluted lands, creating more attractive settings for living, working and recreating, as shown by the examples from Germany (*Hüttl & Gerwin*) and the United Kingdom (*Jones*).

Environmental aspects are not only important on the 'benefit' side of the equation. One of the main tasks of urban greenspace managers is to deal with the often very difficult biotic and abiotic site conditions in and near cities and towns. While trees can help reduce air pollution, they are of course first and foremost negatively affected by it (*Paoletti et al.*). Urban tree health and vitality is also closely related to urban soils, as shown by *Makarova & Koolen* for the case of Moscow. Applying bio-waste compost may be one way to improve soil conditions, as studied in Vienna, Austria (*Stockinger & Sieghardt*). Every year the mass media report on forest fires at the urban-rural interface, e.g. in the European Mediterranean and in parts of the USA. Fires are especially devastating at the urban-rural interface, where the potential loss of property and lives is high (*Rego & Martins*). Therefore, integrated fire management strategies in close cooperation with citizens are called for (*Smith et al.*). Stresses are also biotic; many greenspace managers are preoccupied with combating pests and diseases on urban trees. Having nature in and close to town can result in conflicts with people, as demonstrated by *Montag et al.* (UFUG 1(3)) who describe wildlife conflicts at the urban-rural interface.

Competition for land and issues is very high in urban settings, as described by *Krott*. Therefore, the development, management and conservation of forests and trees in urban areas needs to be based on sound arguments, not in the least in an economic sense. Cost-benefit assessments that try to quantify and incorporate the various socio-cultural, environmental, and economic aspects are called for. *Price* (UFUG 3(1)) for social and aesthetic benefits and *McPherson* (UFUG 2(1)) for environmental benefits outline the state of art in greenspace benefit quantification. Sound inventories and monitoring of forest and tree resources are crucial to these assessments, as well as to planning and management at large. Examples presented at the conference show that a wide variety of approaches and tools is in use across the world (*Hernandez; Panahi et al.; Pourhashemi et al.*), and that Geographical Information Systems (GIS) are increasingly used as powerful tool to compile, present and analyse information.

4 Urban forestry as innovative approach

Emerging problems such as infestations of pests and diseases led to the call for more integrative approaches within urban greenspace planning and management. Especially when looking at forests and trees in urban areas, the need was felt for interdisciplinary approaches to manage greenspace resources for multiple benefits. Urban forestry, in brief defined as the planning and management of forest and tree resources in and near urban areas in order to provide multiple benefits to urban communities, emerged in North America during the 1960s (*Miller*). In line with recent developments and innovations in urban ecology and urban planning (*Tjallingii*), it embraces partnership approach between multiple professions, and takes an integrative perspective on all forest, tree and associated vegetation in and near cities and towns.

Urban forestry has gradually gained the attention of scientists, policy-makers and greenspace managers in other parts of the world as well. In Europe, research networks have been set up and urban forestry is considered in an increasing number of tertiary education programmes. *Palijon* provides a brief status of urban forests and urban forestry in different parts of Asia, noting for example significant research needs for the further development of the field. In many Asian countries, aesthetics and recreation are not the principal concerns, and urban forests are primarily seen in terms of their environmental services and livelihood contributions. Some of the challenges faced in Latin-American cities are described for the case of Curitiba, Brazil by *Spathelf & Nutto*.

Participation and inclusiveness are key characteristics of the urban forestry approach. The need to involve stakeholders in decision-making is illustrated by *Ackermann & Talbot*. They describe efforts to replace exotic forest stands at Table Mountain near Cape Town, and the objections of local residents to tree cutting.

Another important challenge for urban forestry is how to integrate different aspects and functions in design, planning and management. *Tyrväinen et al.* present Finnish research aimed at finding ways to combine ecological and aesthetic values in urban forest management. The incorporation of aesthetics in new ways of looking at and describing forest stands is touched upon by *Tronde*. As adapted and new types of forest management are developed, there is a need to test and demonstrate these, for example in special demonstration forests (*Von Gadow* in UFUG 1(2)).

Although recognising the innovative character of the urban forestry approach, both *Krott* and *Simson* raise words of caution. Urban forestry may soon run out of steam, they argue, if it is left to stand on its own without the needed integration with other urban policies and issues. Much needed funding, for example, could be generated through linking up with urban development schemes (*Krott*).

5 Impacts of urbanisation on forestry at large

While forests and trees in and close to urban agglomerations may be most heavily affected by urbanisation, forests and forestry at large also experience its effects.

Urban values and norms are often directing decision-making also for more rural forests (*Elands et al.*). The current paradigm of sustainable forest management, which has become broadly accepted across large parts of the world, has strong roots in urbanisation (*Paschalis*), as urban societies have called for multiple, sustainably-produced goods and services. This poses major challenges to the forestry profession.

Juslin describes how providing forest products to urbanised societies required adaptations in terms of marketing. Forest ownership is also affected by urbanisation, as for example demonstrated by *Schraml* (UFUG 1(3)) who mentions how many forest owners in Germany today are urban dwellers. Forest ownership also diversifies in terms of the role of female forest owners, who bring in their own values and preferences (*Boon & Anthon, Nilsson, Oldrup*). Gender issues have become acknowledged as a key topic within modern forestry, for example in follow up to Local Agenda 21 (*Späth*) and they require inclusion e.g. in forestry curricula. *Lewark* and *Schmaltz* describe the role of gender issues in forestry education at the global level, as well as for a specific German case.

The need for partnerships and cooperation across borders and disciplines requires common 'language' and terminology. Efforts to achieve this for forestry include the multi-stakeholder development of an international forestry thessaurus (*Petrokofsky et al.*) and the establishment of the Global Forest Information Service by IUFRO and others.

By involving experts from different disciplines, the conference contributed to the dialogue between foresters and other professionals taking care of forests and trees in urbanised societies. The need for these professionals to fully engage with urbanising societies was stressed, and although important steps in this direction have been taken much remains to be done in the years to come. Institutions such as IUFRO and EFI, for example through EUFORIC as its Project Centre on urban forestry have an important role to play in this further 'urbanisation' of forestry.

Plenary Session I

The development of urban forestry - a people-based approach

Urban forestry: History and introduction

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Abstract

Trees have been a part of human settlements since our first permanent communities. However, the concept of including trees, parks and forests as an integral part of urban design is of more recent origin, with many of its roots in Europe and North America. Urban forestry as a distinct discipline emerged in the late 20th century, drawing from horticulture, arboriculture, silviculture, forest management, planning and ecology. As a discipline urban forestry covers a continuum from the individual tree through urban woodlands and ultimately connects with the management of rural forests. Just as forest management touched the lives of urban residents so must urban residents connect with the rural forest.

Key words: urban forestry, history, urban forest management.

1 Introduction

There are three main elements to the history and evolution of urban forestry; the early use of trees by humans, the development of European cities and landscapes, and the synthesis of urban forestry as a discipline in North America. A fourth element is the current situation where urban forestry has now taken on a global mission.

2 Early use of trees

Early humans, existing as hunters and gatherers, are now being recognised as a major force in the development of pre-agricultural landscapes. Hunters and gatherers used fire for cooking and warmth, but they also burned native vegetation to create better hunting conditions and to create habitats more suited to their needs. There is now good evidence that even the forests of the Amazon basin have been greatly influenced by slash and burn agriculture, and the propensity of the native population to plant trees of their liking as they abandoned their plots.

Early Europeans hunted and gathered in the vast forests of Europe, and these forests and individual trees became parts of sacred pre-Christian religions and rituals. There were tree cults among peoples who worshipped in sacred groves with holy trees, and the Celtic alphabet had letters named for specific trees. Forests in Europe have also had a long history of providing refuge for the oppressed and for outlaws. Consider the story of Robin Hood and his merry men lurking in Sherwood Forest waiting to plunder the rich. Unfortunately holy groves and sacred trees were regarded symbols of paganism to the early Christian church, often leading to their destruction in the name of Christianity (Coder 1999).

The Agricultural Revolution brought new values for trees, wood for buildings and tools, wood for fuel, and trees cultivated for their fruits. Egyptian hieroglyphs depict the planting of balled trees over 4,000 BC (Chadwick 1971). Trees also were valued for shade and aesthetics, and were included in gardens around temples and palaces for the priests and rulers. Even with this use it is likely most trees were selected for their utilitarian value (fruit) as well as their beauty. By 2600 BP Babylon was a large, walled city with monumental architecture, a temple, rectangular street system, and dwellings for a variety of social classes. The famous hanging gardens of Babylon are described in a number of ancient texts.

In pre-Colombian America there was a large population of Native Americans, with many tribes developing extensive agricultural communities. Civilisations of the Maya, Inca and Aztecs built large cities with monumental architecture, and supported these cities with agriculture and agroforestry systems. Many lesser-known Native American tribes built large communities that relied on agriculture. Drawings and descriptions of these communities depict extensive gardens with planted trees.

In 13th century China Kublia Kahn had gained control of extensive land areas. Kahn required tree planting along all public roads in and around Beijing to provide shade and to mark the roadway in winter snows (Profous 1992).

3 European landscapes

Prior to the Renaissance, most urban trees were confined to private gardens of the elites, primarily for their fruit value. With the Renaissance it became fashionable for the well to do to have villas outside their cities, complete with walled gardens for their relaxation and amusement. It became common practice to plant allées of trees within these gardens for their aesthetic value. By the 17th century the allée moved from the countryside to the city. Allées were planted along city walls and moats, and were common in Baroque gardens. The earthen work fortification of Paris known as the Grand Boulevart was planted with allées eventually being called the "Grands Boulevards" and giving name to the present city tree lined boulevard. Town residents in the Netherlands planted trees along their canals (Lawrence 1991).

A popular pass time of the aristocrats was carriage riding through the allées. The English lawn game Pall Mall was played under allées, somehow leading to the name of a cigarette and giving name the modern shopping centers. In Italy allies were planted along avenues leading into Rome. Developers in London began constructing blocks of homes surrounding enclosed private tree filled squares, a feature they found made real estate much more marketable. As cities expanded rural allées were often included as part of the new street scheme (Lawrence 1991).

By the 18th century the merchant and professional classes were demanding the amenities common to the aristocracy. Builders of new upper class housing in London found they needed to include private squares complete with trees, shrubs and lawns. New larger-scale developments included carriage ways and avenues lined with trees. Recreation became a more passive pastime, with parks being used for relaxation and to contemplate nature. Private gardens were popular and were considered important fashion statements. Although most parks and gardens were private, some public plazas and large public parks were being constructed on the Continent. Commercial "pleasure gardens" were also popular, with a fee for their use (Lawrence 1991).

In the 19th century, city walls were removed; made obsolete by long-range artillery. Parks and promenades often replaced these walls. Resort towns grew popular, and were extensively landscaped as part of their marketing. Napoleon built promenades and boulevards in the cities he conquered, while the English introduced the naturalistic landscape into parks, in contrast to the formal Baroque garden. British engineers greatly improved the engineering of city streets and sanitation, with Parisians adopting this engineering and adding trees to streetscapes. Many parks in Britain were gated to exclude the lower classes, having a dress code or fee for admission. The British House of Commons addressed the need for parks being available to the lower classes, stating they were "…convinced that some Open Places reserved for the humbler classes, would assist to wean them from low and debasing pleasures" (Lawrence 1991).

The renewal of Paris in the 1850s and 60s by Napoleon III and Haussman transformed that city and served as a model for future urban construction and renewal. A radial pattern of tree-lined boulevards was superimposed on the old city street pattern. New public parks and squares were added, and old gardens, promenades and parks included in a comprehensive open space plan (Lawrence 1991).

Nineteenth century Great Britain gave rise to the "Romantic Landscape" and the detached suburban house for the newly emerging wealthy of the Industrial Revolution. As cities industrialised and became squalid and polluted, the wealthy classes moved out to the new suburban communities. Large parks, garden squares and tree lined residential streets of individual homes became commonplace in the new communities. Trees had arrived as an element in real estate value (Zube 1971).

4 Urban forestry in North America

Trees and forests in North America are a deeply embedded part of our culture as pioneers and immigrants. Europeans encountered a vast landscape dominated by forests on our East Coast. We both romanticised and destroyed the forest as we moved inland clearing land for agriculture and using the best wood the forest had to offer. Nature has been long regarded as a source of moral virtue in America. We also brought the urban values of Europe and applied these values as we built our cities. In 1646 the road from Boston to Roxbury in the Massachusetts colony was lined with trees to shade travellers. William Penn, first governor of the Pennsylvania colony, designed the layout of Philadelphia to include five parks. These parks are still there today. The popularity of shade trees forced insurance companies to insure homes with trees near them in 1784, something they were loath to do (Zube 1971).

The founders of Detroit planted double rows of trees on their new avenues in 1807. In 1921 the founders of the state capital of Jackson, Mississippi decreed that every other block be a park, partly for aesthetics and partly due to the fact that our wooden cities frequently burned down. It was hoped that alternate blocks without buildings would make fire control more effective. The State of Nebraska initiated the first day of tree planting, Arbor Day, in 1872 at the urging of Nebraska Department of Agriculture Commissioner J. Sterling Morton. It is worth noting that Nebraska being in the Great Plaines was largely without trees. Today, every state in the Union celebrates Arbor Day in the spring, typically the last Friday in April (Zube 1971).

Nineteenth century America saw three landscape movements that strongly influenced the appearance our cities today, and our concept of urban forestry. These were the City Parks Movement, the Romantic Landscape Movement, and the City Beautiful Movement. Frederick Law Olmsted is credited with being the founder of the City Park Movement, and is best known for Central Park in New York City. By the mid-nineteenth century New York was filling with new European emigrants largely living in squalor and cut off from nature. Olmsted saw the need to bring nature into the city as a "…simple, broad, open space with sufficient plan of surface and sufficient number of trees…" (Gardescu 1971). The park he envisioned and created was a natural landscape that resembled rural America, and that vision spread to influence urban park systems throughout the country, with Olmsted leading way.

The Romantic Landscape was brought to America along with industrialisation. This concept is to blend the best of nature and the city in new suburban communities. Olmsted can be credited for the design of a number of new American communities that were faithful to that vision. However, the Romantic Landscape also gave rise to urban sprawl as the original vision was scaled down in the 20^{th} century to suite the pocket book of the middle class and to serve the automobile commuter (Zube 1971).

The end of the 19^{th} century in America saw the Columbian Exposition of 1892 in Chicago, celebrating 400 years since Christopher Columbus landed in the New World. The fair grounds featured tree-lined parkways for carriages and walking, landscaped parks and boulevards, and monumental architecture in both Greek and Roman design. An intercontinental system of railroads brought visitors from all of North America to the fair giving them the opportunity to experience urban life unlike anything they had ever experienced at home. By the end of the 19^{th} century our cities had fully industrialised, and had become unpleasant, squalid places. Those who could afford to attend the fair were often industrial and civic leaders from their home communities, and many went home with a mission to transform their communities along the lines of their experience in Chicago; to create the City Beautiful.

A visit to an American city today will provide ample evidence of the three landscape movements of the 19^{th} century. The detached suburban house of the

Romantic Landscape is the driving force behind our problems of sprawl, but also provides opportunities for the urban forester in the suburbs. Olmsted's vision of the urban park dominants the park system of most of our cities, and we still trying to integrate pieces of the natural landscape in our cities. The street trees and parkways, of the City Beautiful Movement create an urban forest across our landscapes, while Greek and Roman architecture are often the theme of our older museums, civic centres and concert halls.

The emergence of the 20th century found the development of urban park systems and tree planting programs across North America. Larger cities often had their own nurseries to produce trees for city streets and parks. Municipal governments hired foresters, landscape architects, horticulturists, arborists and other professionals to design, plant and care for vegetation in our communities. Home shading was important, as was the front porch on warm summer evenings. In the 1920s and 30s the US Department of Agriculture published numerous bulletins dealing with selecting, growing, transplanting and caring for urban trees. During the Great Depression government agencies such as the Works Progress Administration and the Civilian Conservation Corps were created to hire the unemployed, constructed parks and planted trees in communities throughout America. Although the term "urban forestry" was not yet widely used, urban forestry as we know it was flourishing.

The end of World War II brought a decline of the urban forest and urban forestry. Suburban sprawl moved the middle class, and the tax base, out of the urban core leading to budget cuts for forestry. Suburban lots were large enough for private trees, so new communities saw little need for public trees planted along their streets. The availability of home air conditioning also made shading homes for comfort much less important. Dutch Elm Disease (Ceratocystis ulmi) added the final blow to the urban forest as mile upon mile of streets lost their tree cover of American Elms (Ulmus americana). However, as is so often the case, the loss of elms also brought with it the seeds of renewal for urban forestry as the disease denuded community after community. Even in the most economically depressed cities the loss of tree cover brought with it the desire to reforest our streets.

5 Emergence of urban forestry as a discipline

Several events of the 1960s brought urban forestry into its own as a profession and as an academic discipline. The activism that accompanied the war in Vietnam and racial desegregation spread to the environment. Among a variety of environmental issues the public was becoming increasingly critical of forest management, especially as practised on public lands. Removal of old growth forests, clear cutting, and general aesthetic degradation of the rural landscape led to widespread dissatisfaction with the forestry profession. Professional foresters responded to that criticism in a variety of ways, one of which was the promotion of urban forestry in cities, which is where most Americans live (Miller 1997).

The US Forest Service embraced urban forestry by both providing research funding and by providing funds to state forestry agencies to assist communities with urban forestry. The political power base had shifted from rural to urban

America, and state and federal forestry agencies recognised to need to cater to their interests. The first published paper to use the term "urban forestry" was by Jorgensen (1970), followed by a number of scientific conferences addressing urban forestry in the United States in Canada. Urban forestry emerged as an academic discipline in the early 1970s in several universities.

The New Federalism of Ronald Reagan in the 1980s brought with it a near suspension of urban forestry efforts at the federal level. However, the momentum of the 1970s was carried on through the 1980s both by citizen groups and by American Forests, a national conservation association. The 1988 election of George Bush (the elder) as president brought with it renewed effort at the federal level, as President Bush strongly supported tree planting and urban forestry. The US Forest Service re-emerged in urban forestry as Congress made funds available to States to support urban and community forestry, and to fund urban forestry research.

In North America urban forestry evolved not only from forestry, but also from the discipline of arboriculture. Our definition includes individual tree management on private and public land, management of populations of trees such as street trees, management of park vegetation, and management of peripheral forests. We are concerned with all urban forestry on both public and private land. Unlike Europe, we have few "urban forests" in the sense of public forests adjacent to or surrounding cities (Konijnendijk 1997), thus we include all vegetation in and around our communities.

Urban forestry includes elements of horticulture, arboriculture, silviculture, forest management, land use planning and ecology. The urban forest includes public street trees, private trees, parks, woodlands, forest remnants, watershed lands, peripheral forests, and urban influences on all forestland. The management of urban forest by the public sector includes city foresters, park managers, and county and state government forestry personnel. The private sector manages the urban forest through commercial arborists, consulting arborists and foresters, landscape contractors, ornamental nurseries, and utility foresters.

6 Global nature of urban forestry

With over half of the global population living in cities it is imperative that urban forestry address the emerging issues associated with global urbanisation. Urban populations will only continue to rise in the foreseeable future. As has happened in the developed countries, more and more residents of the world will find themselves cut off from nature and living in a world dominated by the work of humans. The role of urban forestry is to provide and to manage the vegetation where over half of the global population lives and to connect that population back to nature. Certainly as urban values increasingly dominate the world these will increasingly dominate the management of rural forests and other landscapes. Urban forestry needs to better understand the complexities of urban ecosystems and the complexities of people who live in those systems. We need to better understand what nature means to people and to shape our education of people based on that understanding. Moreover, we need to understand and educate urban residents, and we need to let them understand and educate us.

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Urban forestry in Asia: State of the art

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Abstract

Urban forestry is the science and art of planning and managing urban and peri-urban green spaces aimed, at environmental enhancement and sustainability for the benefit of the urban society. It plays a critical role not only in Asia but also across the world. Asia, the largest and most populous of all the continents, is continually experiencing rapid urbanisation. Megacities or cities with a population of more than 10 million will likely emerge in several urban centres of developing Asian countries. Huge demands for residential, recreational, commercial, industrial and transportation purposes will continue to develop. This will significantly contribute to the reduction of green cover both in urban and peri-urban areas, which will further strain the already deteriorating environment. The need to balance built-up areas with green structures in order to maintain desirable environmental quality in the region is high. Although urban forestry as a science and art has only been recently recognised in Asia, it is not a new phenomenon. This paper presents the status of urban forestry particularly in South, East and Southeast Asian countries. Specifically, it discusses current urban forestry management initiatives and practices, and highlights environmental, social, economic, political/legal, institutional and research/technological dimensions. Moreover, it provides some recommendations for future action to promote urban forestry as a science and a field of practice in the region.

Key words: urban forestry, Asia, environmental quality, urbanisation.

1 Introduction

Urban forestry, the science and art of planning and managing urban and peri-urban green spaces, plays a critical role not only in Asia but in all parts of the world if environmental enhancement and sustainability for the benefit of urban society are to be pursued.

The growth of the world's urban population is three times faster than that of the rural population. Thus, very soon, more of the world's population will live in urban than in rural areas (Nilsson et al. 2001). The majority of the megacities (urban areas with a population of more than 10 million) that are developing are expected to origin from urban centres in the developing countries of Asia (Table 1) (Hall 2001).

Table 1. Population of megacities of Asia (cited in Hall 2001)

Urban Agglomeration	Population (thousands)		Annual Growth Rate (%)	
	1995	*2015*	*1985-1995*	*2005-2015*
Tokyo	28,836	28,701	1.40	0.10
Bombay	15,093	27,373	4.22	2.55
Shanghai	15,082	23,382	1.96	1.85
Jakarta	11,500	21,170	4.35	2.34
Karachi	9,863	20,616	4.43	3.42
Beijing	12,362	19,423	2.33	1.89
Dacca	7,832	18,964	5.74	3.81
Calcutta	11,673	17,621	1.67	2.33
Delhi	9, 882	17, 621	1.67	2.58
Tianjin	10,687	16,998	2.73	1.91
Metro Manila	9,280	14,771	2.98	1.75
Seoul	11,641	13,139	1.98	0.32
Istanbul	9,316	12,345	3.68	1.45
Lahore	5.085	10,767	3.84	3.55
Hyderabad	5,343	10,663	5.17	2.83
Osaka	10,601	10,601	0.24	-
Bangkok	6,566	10,557	2.19	2.51
Teheran	6,830	10,211	1.62	2.30

In most developing countries, the rate of population growth is outpacing the planning capacity of municipal/city governments (Kuchelmeister & Braatz 1993). It is forecasted that within the next two decades more than a quarter of the current green spaces in most Asian countries will be lost due to continuing urbanisation and sub-urbanisation. A classic example is the projection of future land-use in relation to loss of green areas in Metro Manilla (MM), Philippines as presented by Doi (2001).

Aside from the very rapid conversion of existing green spaces into other land uses, another cause of greenery loss is the inability to provide housing for the ever-increasing urban population, resulting in the creation of slum and squatter areas. Moreover, if the housing pattern of one-storied or partly two-storied structures will continue to prevail rather than high-rise flats, condominiums and the like, then most transformable land consisting of agriculture and forestry will be become built up areas. As a consequence, many urban areas in Asian countries will experience more serious environmental problems, such as deterioration of air quality, higher temperatures, increased noise level, greater psychological stress and a decreased sense of community. Specifically, the social cost due to loss of greenery in Metropolitan Manilla is estimated at 237 billion pesos (Doi 2001), i.e. approximately 4.7 billion Euro as of July 2002 (ed.). While urban development has to proceed, there is an urgent need to have balanced green structures and built up areas in both urban and peri-urban zones.

This paper presents the status of urban forestry particularly in South and East Asia, and the Southeast Asian countries. Specifically, it discusses current urban forestry management initiatives and practices and highlights the environmental, social, economic, political/legal, institutional and research/technological dimensions. Moreover, it provides some recommendations for future action to promote urban forestry as a science and a field of practice in the region.

2 History of urban forestry in Asia

Greening or planting of trees in populated areas as an integral part of the landscape is not new, having its roots in ancient Chinese, western Asian and Greek civilisations. More than 3,000 years ago, many ancient cities had highly developed parks, gardens and other green spaces. The most notable example of this was Babylon, which was considered "the mother city of gardens" (Jellicoe 1985).

Early cultures complemented buildings and other structures with trees, shrubs and other plants purposely to create beautiful landscape. From then on, plants became important components of the urban landscape in most developed countries. Urban gardens and parks for visual amenities, relaxation, enjoyment, religious and spiritual values became popular not only in Europe and the United States, but also in Africa and Asia (Grey & Deneke 1986; Kuchelmeister & Braatz 1993; Miller 1997). Spanish colonisation introduced the concepts of interior patios in houses and public plazas to urban centres (Kuchelmeister & Braatz 1993), particularly in the Philippines. In many cities in Asia, the design of green spaces was influenced remarkably by the respective colonisers.

The planting and management of trees and forests in Asia have been traditionally based more on amenity, aesthetic and spiritual values rather than on utilitarian benefits. Currently, the image of urban forestry is changing from these traditional purposes to that of an approach providing multiple goods (food, medicine, fibre, wood and others) and services for the benefit of urban society regardless of social and economic status. Thus, urban forestry is no longer being considered as an "amenity service" but rather included among the "essential services" along with other health and welfare functions. As Kuchelmeister & Braatz (1993) have pointed out, "urban forestry is an opportunity to bring principles of forest ecology into the city. It is more than just being about tree planting. It is about managing the urban forest as an ecological entity."

3 Urban forests and green space resources in Asia

Information on the extent and distribution of urban and peri-urban forests and green spaces in Asia is very limited, despite their recognised importance in urban planning and development. So far, no comprehensive urban forests/green space assessment has been carried out in the region.

Asian urban forests and green spaces come in different forms. The most notable public green spaces include street/highway corridor trees, parks, plazas and gardens, and landscaped premises of institutions mainly for amenity and environmental amelioration (Braatz 1993; Kuchelmeister 1998). Aside from these traditional urban forestry systems, some innovative urban forestry practices have evolved. These include the development of public greenways and greenbelts, establishment and conservation of watersheds and wetlands, protected areas and establishment and management of urban and peri-urban tree farms, orchards, agroforestry and multi-purpose tree plantations (Kuchelmeister 1998).

In most major cities of Asia, private green spaces such as golf courses, memorial parks, resort and recreational areas, and parks and gardens in residential, commercial and industrial areas are part of the total urban forests. The development and management of these areas are the responsibilities of their owners. In some countries these private green spaces are regulated by existing policies, rules and regulations (Palijon 2001).

Information compiled by Kuchelmeister (1998) from several sources suggests that the poor cities in the region have green spaces below the minimum standard of 9 m^2 of green open space per city dweller set by the World Health Organization (WHO). Most cities in very poor developing countries in Asia lack urban green spaces. Table 2 shows the extent of green cover in some rich cities. However, the information mostly includes parks, gardens and recreational areas/reserves.

A study in 1991 of 439 cities in the People's Republic of China (PROC) showed that the total area of urban green spaces was 380,000 ha. It was claimed that 40 per cent of the cities in PROC had more than 30 per cent green cover. According to the report, there was an average per capita share of vegetation-covered space in cities of 4.1 m^2, amounting to an overall mean coverage of 20.1 per cent in the country. Beijing, for instance, has a 26 per cent green cover ratio, accounting for 6 m^2 per person (Yu cited by Dembner 1993). Table 2 also shows that in 1994, per capita green space and green cover percentage increased to 5.7 m^2 and 23 per cent respectively for all cities in China, and to 6.3 m^2 and 28 per cent for Beijing. According to Li (1997 cited by Kuchelmeister 1998), the per capita green space and the green cover percentage of all cities (i.e. referring to public parks and other green space) should have increased to 8 m^2/inhabitant and 40 per cent. The trend was reversed especially in major PROC like Beijing due to investor pressure for more economically profitable land use (Profous sa).

Table 2. Green space/urban forest resources in Asia (source Kuchelmeister (1998); for full references refer to this publication)

Country/City	Green space (% of total city)	Green space in m^2 per capita	Remarks
China			Public parks and other green space to increase to 40% by year 2000 or 8 m^2
- Average all cities	23.8	5.7	
- Beijing	28.0 ('94)	6.3	
- Hong Kong	39.2 ('97)	66.0	
- Hong Kong excl. of country parks	1.5 ('97)	2.5	
India			Unclear if it refers to public green space
- Mean		0.003	
- Bombay		0.120	
Indonesia			
- Jakarta		0.22	Parks per capita
Japan			
- Takatsuki City			5,000 ha refers to parks
- Urban forests	84.0 ('90)		Planned to increase to 6 m^2
- Tokyo		4.52	
South Korea			
- Seoul	25.2 ('96)	14.57	Public green space
Malaysia			
- Kuala Lumpur		2.2 ('97)	Public green space
Singapore	17.8 ('97)	7.5	Public parks and open space. To increase to 8 m^2 by year 2000 and finally to 18 m^2 per capita
Sri Lanka			Green space: 2.4 % private (golf courses, etc.) and 2.0% public (municipal parks, etc.)
- Colombo	4.4		
Thailand			
- Bangkok Metropolitan area		1.0	Planned to increase to 4-5 m^2 by the year 2000

Singapore, a very small island of only 650 km^2 located in the centre of Southeast Asia of but with a population of 3.2 million, is serving as one of the models in the region. It is, just like Kuala Lumpur, a garden city. Its Park and Recreation Department, being responsible for implementing an extensive greening program, was able to plant more than 5 million plants including one million trees along roadside since the mid-1960s. Evidenced of the "garden" concept is visible throughout the 50 per cent urbanised areas of the island (Yuen 1997). In response to the Agenda 21 Programme on *Sustainable Development and Environmental Protection,* Singapore's National Parks Board published a proposal for an island-wide park connector network aimed at conserving nature and at the same time meet the growing needs of the human population for various alternative recreational facilities. The Singapore Green Plan-Action Programmes of 1993 expanded the objectives of the park connector network to include habitat or corridor for the movement of bird life.

Tokyo, Japan has a large forest of 21,630 ha reserved for water conservation. The city administration started planting trees in treeless areas more than one hundred years ago. Now, its forest management systems have changed from promoting single-storied to multi-storied forest structures in order to improve water conservation. Hannou City, one hour drive from Tokyo, includes many artificial forests that covered 84 per cent of the city in 1990 (Yuji 1995).

In 1994, the Japanese Government adopted the Tokyo Metropolitan Plan for doubling the city's greenery. This plan aims to promote comprehensive, systematic policies with regard to urban green areas and bodies of water in Tokyo. Long range goals outlined in the plan include doubling the amount of green space in Tokyo, improving the quality of green space, and promoting activities to achieve these goals. Some primary activities to be achieved by the early 21st century include: 200 million trees planted in Tokyo's urban districts; 6 m^2 of parkland for every Tokyo resident; and conservation of forests and waterside areas in their natural states. The plan consists of four components: increasing nearby green space, preserving existing green space; organising a system to increase green areas; and creating a water and green area network (Tokyo Metropolitan Government 1998 cited by Kuchelmeister 1998).

Chandigarh, a model and planned city of India, is characterised by a rich and well-developed urban forestry component. Besides having clusters of trees on the outskirts, trees have been planted along roadsides, roundabouts, parks and gardens and within the premises of institutions and religious places. At present, 66 types of trees planted along road sides have been listed along with their common names, taxonomic family, flowering time and uses (Singh et al. sa cited by Kuchelmeister 1998).

4 Legal dimensions of urban forestry in Asia

Land use zoning

The fate of urban forestry in any city or municipality depends on how well the urban development plan is implemented based on land use zoning. Most local governments in Asia have the power to exercise land use planning decisions and to control land uses by zoning regulations. Zoning regulates land use by delineating boundaries between areas that are set aside for certain uses (e.g. agriculture, forestry, commercial, industrial, residential use). Within residential, commercial and industrial zones, certain restrictions will apply for buildings in terms of their size, height and occupancy, distance from property lines or roads, and minimum parcel size that can be developed. In each zoned area, attempts to preserve agricultural, green space or open space by permitting certain densities of buildings are considered (Westphal 2001).

Land use or zoning policies are supported by strict regulation of land conversion. In the Philippines, for instance, it is prohibited to convert prime agricultural land (considered green space) to other use specifically if the area is within the agricultural zone.

Tree planting policy

Over the past decades, legislation and regulations related to urban forestry have proliferated in Asia. A notable example is the policy of former Chairman of the People's Republic of China, Mao Zedong, who gave high priority to urban afforestation as early as during the 1950s. In 1979 a national tree planting day was designated and in 1981 it had become the policy of the state to launch a nationwide tree planting campaign. Every able-bodied citizen between ages 11 and 60 should plant 3 to 5 trees per year or do the equivalent amount of work in seeding, cultivation, tree tending or other services (Dembner 1993).

This policy penalised those who failed to do their duty either to make up planting requirements, provide funds equivalent to the value of labour required, or pay heavy fines. This penal provision made the tree planting campaign compulsory, or at least obligatory. Due to this, it is claimed that at least 1 billion trees were planted in China every year since 1982.

This policy has become the model for some countries in the Asian region. The Philippines adopted it by designating and celebrating an Arbor Day or Week during which the major activity is tree planting. Presidential Decree 1153, known as the tree planting decree, with almost similar provisions or stipulations with those of the China policy, was issued and acted as vehicle for promoting the greening of urban areas and the countryside. This decree was later revoked by Executive Order because that tree planting should not be compulsory but rather voluntary in the real sense. These tree planting or greening efforts in the Philippines were pursued by succeeding programs like "Luntiang Kamaynilaan" (Metro Manilla greening), Clean and Green, and currently the "Luntiang Pilipinas" (Greening the Philippines). In 1990, the Philippine Master Plan for Forestry Development included urban forestry as a response to the degrading urban environment. The plan particularly aimed to establish tree strips and forest parks to attain a tree to person ratio of 1:4, help arrest some environmental problems, and provide liveable, wholesome and pleasant environments.

In Singapore, an annual clean and green week launched and implemented by the Ministry of Environment with participation by the Nature City, Singapore (a non-governmental organisation) is used as a venue to educate the public about the status and beauty of nature in Singapore. Use/reintroduction of native species of plants for urban greening in Singapore is promoted (Briffet & Bellamy 2001).

In 1992, the Tokyo Metropolitan Government adopted its Ordinance for Conservation and Restoration of Nature, which provides for the designation of conservation areas, the regulation of development and the designation of green areas. Conservation zones include green areas that incorporate forests, waterside locations or historical landmarks, and where activities like development and logging are restricted. Development regulation provides that "any change in land-use which affects 1000 m^2 or more of natural land or farm land must be approved by the government of Tokyo. In addition, the approval of the Tokyo Metropolitan Nature Conservation Council must be sought before any development involving 30,000 m^2 or more can be undertaken." To promote expansion of the green area, highly urbanised districts where the proportion of green area is low are designated "greenery promotion areas." In these areas, the Tokyo Metropolitan Government - working in conjunction with municipal authorities - implements a variety of greening projects. In various areas of Japan, a total of 7,821 parks with an aggregate area of 5,352 ha and an estimated 4.52 m^2 per capita park areas were designated for development in 1992 (Kuchelmeister 1998).

In some Asian countries, such as India, Sri Lanka, Nepal, and China, laws exist that require minimum reservations for tree lawns or planting verges along roads, pathways, waterways and others. In the Philippines, there is a national policy that requires residential, commercial and industrial estates to allocate at least 30 % of the gross area as open space for parks, playgrounds and recreational use (Palijon 2000). Similarly in Malaysia, a new law requires real estate developers to allocate 20 % of the land to green space use (Philip 1997 cited by Kuchelmeister 1998).

Tree conservation and preservation

In many countries of Asia, the protection, conservation and preservation of historic, rare and century old large trees have also become part of national policy. The legal basis for the protection and use of trees varies considerably across countries. In some countries, legislation related to protection of urban trees is quite comprehensive, while in many others it is still weak (Braatz 1993). In China, for instance, these types of trees have been declared state property and therefore should be preserved. Furthermore, the law states that all urban trees are protected and new trees are planted in order to maintain an ecological balance, improve the environment, and beautify the city. Removal of trees requires permission of the appropriate local government authority (Dembner 1993).

In Beijing, informal regulations have long prohibited the removal or cutting of any tree that has grown taller than a building or is more than 100 years old without approval from the Beijing Forestry Bureau. Diseased or damaged trees that cause hazards may be cut. Notification from the Beijing Institute of Landscape and Gardening is necessary if fewer than ten trees are to be removed. If more than ten trees are to be removed, notification should come from the Municipal Gardening and Landscape Administration.

If permission is granted, a resident may remove the tree or pay the institute to do the removal. Wood has to be turned over to the institute, thereby discouraging deliberate damaging of the trees. Heavy fines are imposed for cutting trees without permission; the penalty is higher than the average monthly basic salary. Unauthorised cutting of a tree that is 10 cm in diameter is fined 300 to 500 yuan while the salary is only 150 Yuan (Dembner 1993). Each city in China has a planting bureau in charge of tree maintenance. It has to obtain permission from the city's central planting office to remove, cut or prune trees.

In the Philippines, Presidential Decree 953 prohibits cutting, damaging or destroying trees and other plants in public places and stipulates corresponding fines and penalties to violators.

5 Institutional dimensions - management of urban forests and green spaces in Asia

The diversity of ownership and stakeholders of urban forests complicates management. Public green spaces like parks, highway corridors, street/roadside trees and others are mainly the responsibility of the government, while private ones such as those in residential, commercial, industrial areas and on institutional premises are the responsibility of individual owners. In some cases, concerned government authorities have control over the development and management of private green spaces.

Some countries like Singapore and Malaysia have rather well organised institutions responsible for the management of all public green spaces/urban forests. The success of the greening in these countries is attributed to the strong commitment of municipal leaders to urban forestry, allocation of sufficient funds, strong urban planning capabilities, and a high level of technical expertise (Braatz 1993).

In China, the management of urban forests is assigned to various levels. Small streets and lanes are the responsibilities of the local bureaux while the larger thoroughfares fall under the City Parks bureau. Species selection and decision making concerning choosing a species for planting is done by the City Planting Office in consultation with district bureaux and the Institute of Landscape and Gardening (Dembner 1993). In Hong Kong, multiple authorities used to exist responsible for trees in all urban areas with overlapping and ambiguously defined realms of responsibility. As early as 1990, it was suggested that the authority would be centralised in one government department with the necessary experience and expertise (Jim 1990).

In the Philippines, the Metro Manilla Development Authority (MMDA) is responsible for the greening, landscaping and beautification of the major thoroughfares, while the Parks Department or Environmental Services or Clean and Green Office (whichever is existing in each city/municipal government) is responsible for the municipal, barangay roads, watercourses, city parks, gardens and plazas in its own jurisdiction. Other parks are managed by the Department of Tourism through its attached agencies; the Protected Areas and Wildlife Bureau (PAWB); and, by NGOs such as the Parks Development Foundation Incorporated in Quezon City. Other agencies including the Department of Environment and Natural Resources (DENR), Department of Public Works and Highways

(DPWH), and Department of Education, Culture and Sports (DECS) are members of the inter-agency committee responsible for planning and implementing greening programs.

From the above discussion, it can be derived that a number of Asian cities are already incorporating urban forestry into city planning or are starting to take a comprehensive approach to the management of urban forest resources.

There is only a need to sustain interest, commitment, and political will of the national as well as city/municipal governments in order to cope with demand for the proper management of public and even private green spaces. The commitment to urban forestry must be matched with the means of providing other basic social services on a sustainable basis (Braatz 1993).

6 Social dimensions of urban forestry

Each urban area may differ by the kind of people (both residents and visitors) in terms of number, attitude, socio-cultural values and characteristics, and economic status. All these factors have been identified to influence the management of green space or urban forest (Grey & Deneke 1986; Profous & Rowntree 1993; Miller 1997).

As emphasised in the Philippine Master Plan for Forestry Development (1990), urban forestry is a greening movement, a people-oriented endeavour designed to raise the quality of life for people in urban centres. Hence its success will depend on their collective efforts. The needs, desires, cooperation and participation of local people make the urban forest situation unique.

Historically, in many countries in Asia, local communities, groups and individuals, students and professionals, have been involved in tree planting particularly during the observance of Arbor Week, World Environment Week, World Earth Day, World Food Day and others (Miller 1997; Kuchelmeister 1998) or in politician-sponsored cleaning and greening campaign. Their participation in most of these tree-planting activities normally starts and ends right there. Sometimes nurturing is done by agencies or sponsors involved but often the fate of the planted seedlings is left to nature.

Harnessing community rights in planning, decision-making, implementation and management, and assuring them of the benefits from urban forestry is a key to success. In Dacca, Bangladesh, for example, communities plant trees in public green spaces and manage them as part of a social forestry programme with the arrangement that the products and other benefits will accrue to them. Similarly, in China the people are allowed to obtain direct benefits from the trees such as fruits for food, flowers and leaves for oil, bark for fibre and medicine and wood for fuelwood and timber construction (Kuchelmeister 1998).

In choosing the species to use for planting, it is important that the community is consulted. The species preferred by the community have very high chances of survival. In India and other countries, those trees that are worshipped and considered economically and environmentally useful are cared for and protected by the community.

Even though vandalism on trees, other plants and facilities, theft, and illegal occupancy of public and even private green spaces due to poverty are still widespread in most developing countries of Asia, the situation is changing. Nowadays, more and more people, groups and stakeholders are recognising the importance of urban forestry as a form of resource management due to diminishing natural resources, increasing pressures for more economically profitable land uses and the need for better quality of urban life.

Remarkably, in some cities of Asia, NGOs are involved in tree planting, nurturing and protection in particular and in green space management in general. In the Philippines, for instance, environmental groups like the HARIBON, World Wildlife Fund (WWF), Parks Development Foundation Inc., Foundation for Philippine Environment; civic groups like the Rotary Club and Jaycees; and religious organisations are among the common groups involved in urban forestry and related activities. They either adopt a space like street corridors or parks to develop and manage (Palijon 2001).

The ABS-CBN Foundation, through its "Bantay Kalikasan" (Environment Watch) program, is currently involved in the rehabilitation of the La Mesa Dam. This dam which is more than 3,000 ha, is not only serving as watershed but also as processing area for water coming from the Anggat, Ipo and Umiray dams for domestic use in Metro Manilla. The foundation operates largely on the basis of contributions from individuals and institutions.

The Bantay Puerto Program is another environment watch program launched by Puerto Princesa City, Philippines. It aims to protect, conserve, and rehabilitate the city's forest and marine resources so as to improve the quality of life of the people. Moreover, it sets out to increase the city's economic contribution to the country by utilising its resources in a manner that is ecologically sustainable, socially equitable and economically viable. One of its activities is the "*pista y ang kageban*"- *a* massive reforestation project. This is implemented with the help of the local people. It has mobilised about 80,000 people from all walks of life who participated in planting approximately 700,000 trees. Encouraged by the success in managing and preserving the natural resources, the DENR turned over management of the world-renowned St. Paul Subterranean River National Park and the Iriwan Watershed to the city government (Puerto Princesa City's Bantay Puerto Programme 1998).

In Yokohama, Japan, the city's Board of Parks together with several citizens' associations operates an ecological park. Responsibilities of each association in so far as park maintenance is concerned are well-defined (Kaneko & Nanbu 1997).

Concerned stakeholders do not only assist in the development and management of green spaces. They lobby to save green spaces from development and conversion into other land uses. A classic example is Delhi, India where the efforts of citizens and volunteer groups caused the Delhi Ridge Forest to be proclaimed nature reserve. Another example can be found in Metro Manilla where the conversion of the historical Mehan Garden, Nayong Pilipino and other green spaces was halted because of the persistent lobbying and protests of various stakeholders.

In Singapore, unfortunately, the greening plan incorporated in the Agenda 21 activities is not so well known. As a consequence there is not much support from the public. One of the reasons is the top-down, government-financed and -led activities of the past. The public has become used to government authorities to lead, provide finance and implement. It does not attach any urgent need to develop public participation. Recently, however, the situations have gradually changed specially with the increasing activities and interest of the Town Councils in greening and nature conservation (Briffet & Bellamy 2000).

7 Physical and ecological dimensions

Green spaces and/or urban forests exist in a unique urban ecological system. As Jim (1997) pointed out, the urban physical environment is characteristically stressful or hostile to plant growth and development. In addition, most Asian countries are under threat by natural calamities like typhoons and earthquakes (Philippines and neighbouring countries), tornadoes (Bangladesh) and even fires (Indonesia). Most urbanised cities in Asia are suffering from excessive pollution either in the form of suspended particulate matter or gaseous pollutants. Pollution can either be in the soil, water or atmosphere and is highly detrimental to the growth and development of plants. Transportation, electricity generation, improper garbage collection and disposal and industries are the major sources of pollutants.

Palijon (2001) identified the following characteristics of the environment for urban trees in Metro Manilla, Philippines (which could be seen as typical for Asian cities):
- limited open spaces for planting;
- narrow street corridors;
- too many above and below ground utilities that are often wrongly mapped;
- polluted air and soil;
- harsh temperature;
- very thin top soil, characteristically lying on hard pan; high soil pH in low lying areas; and
- prevalent vandalism.

Similarly, Kuchelmeister (1998) characterised urban growing conditions as:
- soils are compacted, contaminated and poorly drained;
- sunlight is blocked by tall buildings;
- air is polluted;
- above-ground space is reduced by buildings and utility lines;
- below-ground space has underground wires, building foundations, drainage and water supply systems; and
- damage by humans through vandalism and accidents is high.

8 Technical dimensions

Availability of technical information on which management decisions for urban and peri-urban forestry can be based has improved quite remarkably the last few years, although it is still not sufficient. In some Asian countries, arboriculture and urban forestry have been or are being included not only in urban planning and development but also in their research activities.

Urban forestry research is a top priority program of the Forest Research Institute Malaysia (Adnan Mohammad 1997). In South Korea, the Forest Research Institute is actively involved in the reclamation of urban forest ecosystems; ecological-landscape management of urban forests; and investigation of Seoul's urban forest ecosystem. Planned activities include assessment and functional classification of urban forests and optimal arrangement of urban forests (Park 1997).

In China, urban forestry research has been institutionalised in the early 1990s through the Chinese Academy of Forestry. There are also urban forestry units in some provincial forestry research institutions. Some leading universities in key Chinese cities such as Beijing Agriculture College have urban forestry department engaged in formal and informal education and research (Li 1997).

In the Philippines, the Department of Environment and Natural Resources has created an urban forestry division at the national capital region purposely to provide technical and material (seedlings) assistance to cities in Metro Manilla. Aside from this, its research branch, the Ecosystems Research and Development Bureau and the Environmental Management Bureau are actively engaged in arboriculture and urban forestry researches and in producing technical bulletins to support the cleaning and greening programs of the government. The College of Forestry and Natural Resources, University of the Philippines Los Baños (CFNR-UPLB) and other universities in Metro Manilla are also engaged in green space management and urban forestry research. The CFNR-UPLB has developed technical guidelines, manuals and extension aids, conducted studies on the management and socio-economic aspects of urban forestry, and provided training on various levels. The Japan Society for the Promotion of Science (JSPS) Manilla Project entitled "Impact Analysis of Metropolitan Policies for Environmental Conservation and Development" includes, among others, studies on green spaces.

Although wide research gaps still exist, the volume of urban forestry research results produced by the various Asian institutions, if compiled, packaged and transferred and/or shared properly, could provide the basis for improving development and management of green spaces/urban forests. In the annotated bibliography of urban forestry published by FAO (1995) and other sources, a significant number of research and technology publications concerning urban forestry in Asia were listed. Presumably, additional findings have been published in national and international journals, proceedings, and the like.

What is needed currently is the networking of these urban forestry research and development institutions within each country and among Asian countries. In this way, access to information and collaboration through the implementation of more comprehensive joint urban forestry research and training can be improved.

9 Recommendations for future actions

The growing interest in alleviating urban environmental problems will considerably increase efforts to develop, expand, preserve, conserve and manage urban forests and green spaces in Asia. During the coming years, the challenge in the region will be how to ensure that urban forestry or planning and managing of green space will be implemented within the framework of sustainability. From the above discussion, it can easily be derived that the integrity and sustainability of urban forests/green spaces are very much influenced by its legal/policy, social, economic, institutional, physical/ecological and technological/research dimensions. It is therefore important that specific plans, programmes, and projects aimed at providing holistic, systematised approaches toward sustainable urban forestry and green space management in each of the countries in Asia be developed. Figure 2 presents the proposed sustainable management framework. In line with this, the following future needs can be defined:

- A long term, holistic sustainable urban forestry/green space management programme with a well defined vision, mission, plans and activities that is very much focused on sustainability should be crafted based on specific situations in each country.
- A look at the best organisational structure of institutions primarily responsible for urban forestry is important. Singapore and Malaysia having permanent, independent, single institutional bodies with sufficient technical, material and financial resources can serve as models in the region.
- A systematised institutional network or linkage within country and among countries in the region for a more coordinated exchange of information and collaboration toward sustainable development and management of urban forests and green spaces should be promoted and cultivated.
- It is imperative that the expertise of management people and the skills of the urban forestry field operation personnel be developed and/or further improved by providing formal and informal training, enriching and modernizing facilities, equipment and tools.
- There should be a high level of political will to make urban forestry equally important, if not more so, as the other social, economic and political concerns of the local and national governments.
- Since the social dimension of urban forestry is one of the major factors influencing its success, there should be socially acceptable, culturally consistent participatory programs that can optimally harness this sector as partner in development and management. Among others, there should be systematised and aggressive information and education programs that will not only increase awareness and enhance and sustain a positive attitude and high regard to environment, but also promote favourable responses to greening and environmental policies and improve the level of respect to authorities.
- Finally, there should be a comprehensive bio-physical, social, economic, institutional, policy and technological research programme not only to improve urban forestry or green space management, but also to generate information and knowledge necessary for the development of urban forestry as a *Science* and an *Art*.

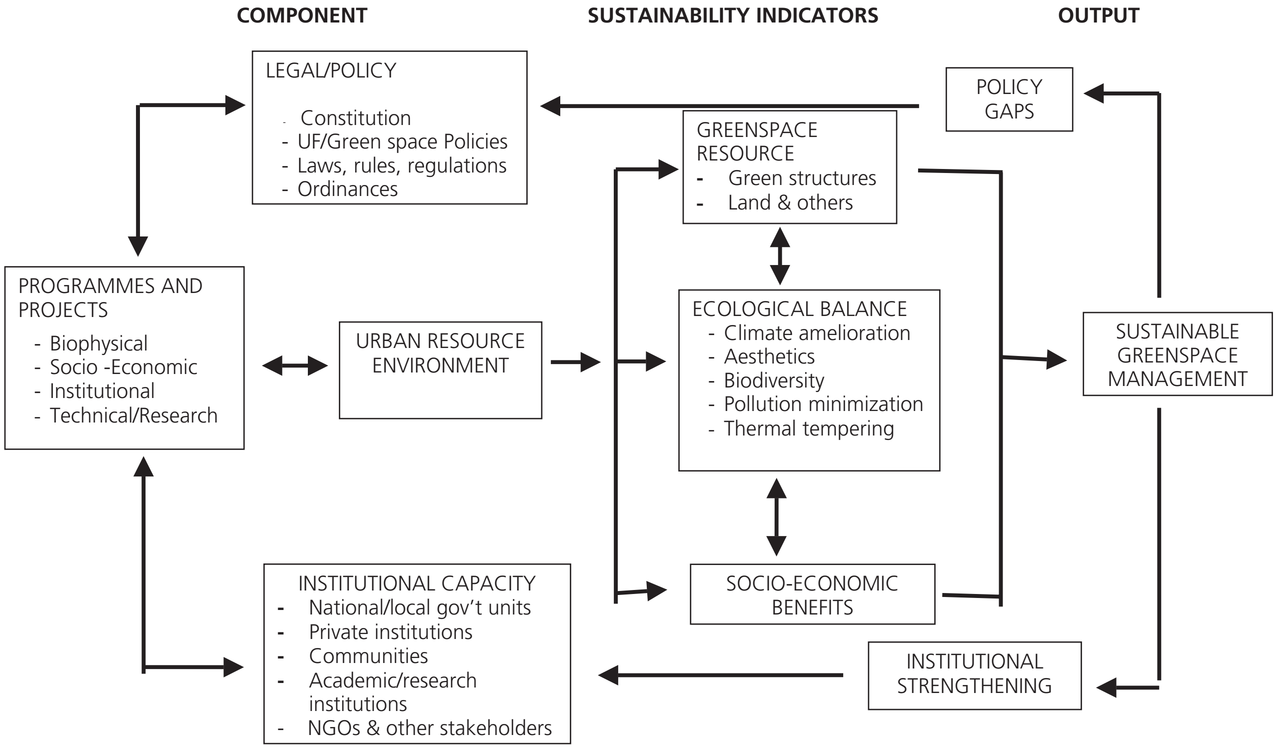

Figure 1. Sustainable urban greenspace management framework (adopted from Palijon et al. (2001)).

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Plenary Session II

The environmental functions and benefits of forests and trees in urban societies

Sustainable and green: ECOPOLIS and urban planning

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Abstract

Is urban development essentially a threat to environmental qualities and to urban forests and other green areas? Or is it possible to make urban development more 'green' and to integrate green qualities in urban planning and design? The latter option is the point of departure of ECOPOLIS, a conceptual tool for integrated urban planning first published in 1992. The aim of the present paper is to re-examine the core ideas of ECOPOLIS in the light of current debates on these issues and against the background of the experiences of the users of ECOPOLIS in urban practice over the last decade. The paper first describes the main features of ECOPOLIS: the general frame, the priorities for flows, areas and actors and three of its guiding models. Among these guiding models is the Strategy of the Two Networks that takes water and traffic networks as a point of departure for planning tasks in both built-up and green areas. In the second section the paper discusses two concrete planning cases in Dutch cities that took ECOPOLIS as a strategic planning tool. The Nijmegen-Waalsprong case is the making of a structure plan for a new development. The Haarlem-Schalkwijk case is the making of a strategic plan for the process of restructuring an existing residential district. The final section assesses the experiences and discusses the position of ECOPOLIS compared to other approaches.

Key words: green areas, urban planning, management and design, sustainable development

1 Introduction

Is urban development essentially a threat to the qualities of the urban environment, urban forests and other green areas? Or may urban development contribute to the quality of green areas? In the first case green area planners have to stage defensive strategies. The second option calls for offensive strategies that aim at making urban development more green by integrating green qualities in urban planning and design. The two options may not be mutually exclusive and the complexity of urban development may urge us not to look at the choice in an either-or but in a both-and perspective. However, even then it seems to make a difference where to start: with the defensive limiting conditions or with the offensive carrying conditions.

The Ecopolis strategy (Tjallingii 1995) is an integrated urban planning concept that starts with carrying conditions for the role of green areas and environmental quality in urban development. ECOPOLIS, as the strategy will be called in this paper, originated in the early 1990s as an attempt to create a conceptual frame for sustainable urban development, a frame that was felt necessary for the formulation of coherent policy and action programmes addressing the role of green issues in urban development. The aim of the present paper is to re-examine the core ideas of ECOPOLIS in the light of current debates on these issues and against the background of the experiences of the users of ECOPOLIS in urban practice over the last decade.

The outline of the paper is as follows: first it describes the main features of ECOPOLIS in three layers. At first, there is the basic frame: a triangle with flows, areas and actors as its corners and the plan in the middle. Planners, experts and stakeholders are invited to develop expertise in their own corner and, simultaneously, keep an eye on the whole plan. The second layer of ECOPOLIS formulates strategic priorities for sustainable development of flows, areas and actors. The third layer adds guiding models: integrated concepts for planning options that may guide planners to develop planning alternatives for concrete situations. Among these guiding models is the strategy of the two networks that takes water and traffic networks as a point of departure for planning tasks in both built-up and green areas.

In the second section the paper discusses two concrete planning cases in Dutch cities that took ECOPOLIS as a strategic planning tool. The urban planners of Nijmegen-Waalsprong used the strategy during the preparation of a master plan for a new urban development that will provide housing for 20,000 new residents. The planning issue is the transformation of an agricultural landscape with some woodland into an urban landscape with a different role for green areas. The Haarlem-Schalkwijk project used ECOPOLIS as a planning frame for the process of restructuring an existing residential district with 30,000 residents. Here, too, the transformation process involves both building and new roles for green areas. In both cases, the networks of water and traffic define conditions for the network of green areas: the urban green-structure.

The final section assesses the experiences and discusses the potential use of ECOPOLIS in future planning processes. In general terms, the case studies and other experiences demonstrate the advantages of ECOPOLIS if compared with greenbelt containment and layer approaches. Complementary roles are conceivable with the Brundtland Committee's social-environmental-economic triangle that is sometimes formulated as people, planet, profit (PPP). Concerning the position of green areas experiences demonstrate the influential role of green structure-plans as area-oriented strategies. Moreover, the position of the urban green-structure will be enhanced if traffic and water networks act as carrying conditions that support its use and management. In this perspective, the best defence is embedding green areas in urban development.

In this context the paper will focus on the following questions:

1. In which way is ECOPOLIS used as a tool to structure sustainable urban development projects?

2. How does the tool perform in generating creative proposals that enhance the synergism of urban activities and environmental processes?
3. More specifically: how does the strategy influence the policy concerning the role of green areas in urban development?
4. Is ECOPOLIS competing with other tools or is it complementary?

2 ECOPOLIS, a strategy for sustainable urban development

Natural process and sustainable urban development

According to some, nature starts where the city ends. This romantic view, however, is at odds with the urbanising world around us. The city provides habitats for wildlife, sometimes even more than the intensively cultivated countryside. Moreover, the workings of rainwater, climate and soils, the growth of trees are just some examples of processes are at work in cities. If we look at nature in this way, both culture and cultivation, building cities and land use in rural areas, is working with nature (Tjallingii 2000a). Classic sourcebooks for this process-oriented approach are Ian Mc Harg's 'Design with Nature' (1969) and Michael Hough's 'Cities and Natural Process' (1995). Whether we like it or not, the city is also an ecosystem. This approach, of course, is not incompatible with seeing the city as an economic, an institutional or a socio-cultural system. Different viewpoints throw different lights on the city.

The ecological approach is indispensable if we look at the way cities can contribute to sustainable development. In this context a number of issues emerge, ranging from health and safety to the quality of urban life, including the care for natural and cultural heritage. Central, however, to the discussion about sustainable urban development is the idea of minimising the ecological footprint: the transfer of environmental costs to the ecosystems surrounding the city and to the global ecosystem that will be the resource base for the next generation (Rees 1995; Satterthwaite 1997). A more prominent role of ecology in planning and design may have become self-evident; the meaning of ecology is far from clear. To some, the presence of green areas is the central topic, to others managing flows and recycling is the essence and yet others think the lifestyle of actors is the real issue.

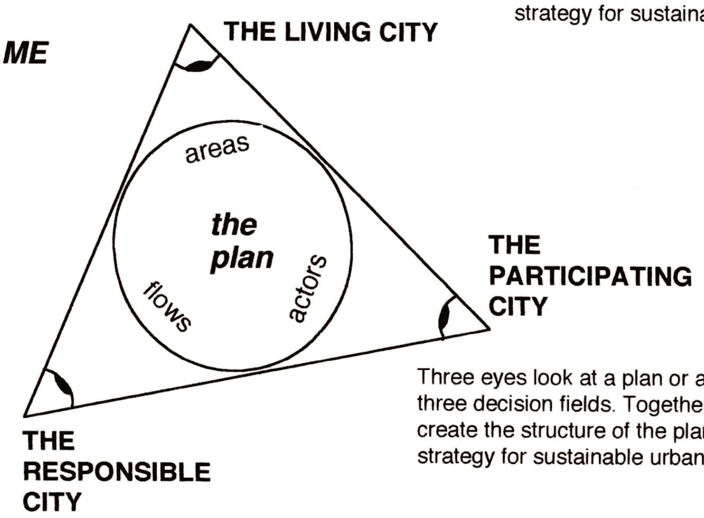
Against this background ECOPOLIS (Tjallingii 1995; Zonneveld & Dubbeling 1996) approaches cities as dynamic and complex ecosystems. The strategy emerged from a number of design and planning projects aiming at sustainable urban development. Discussion and reflection on these projects led to the formulation of guiding principles for urban planning that, together, form ECOPOLIS.

This paper first discusses the conceptual frame (the first layer), then planning priorities for flows, areas and actors (the second layer) and finally three of the guiding models. There are many more guiding models, that offer basic schematic design solutions for certain categories of planning tasks. Together the three layers represent the guiding principles. The scheme in Figure 1 summarises the three layers.

ECÓPOLIS STRATEGY

strategy for sustainable urban development

FRAME



Three eyes look at a plan or an existing system. They look at three decision fields. Together, decisions in these fields create the structure of the plan. From each point of view a strategy for sustainable urban development is formulated.

PRIORITIES

for flows, areas and actors as aspects of *one* plan

flows	*areas*	*actors*
1. prevent unnecessary use	1. use natural and cultural heritage and landscape potentialities	1. in the planning process: • create consensus about the frame for sustainable development • create conditions for inter-active detailed planning
2. use sustainable and durable resources; reuse and recycling	2. create conditions for safety, health and quality of life	2. in the stage of use and maintenance: • interactive management
3. take responsibility for supply and discharge flows	3. create conditions for wildlife	3. create a learning organisation

GUIDING MODELS

for creating conditions for spatial form and social process by planning for flows, areas and actors

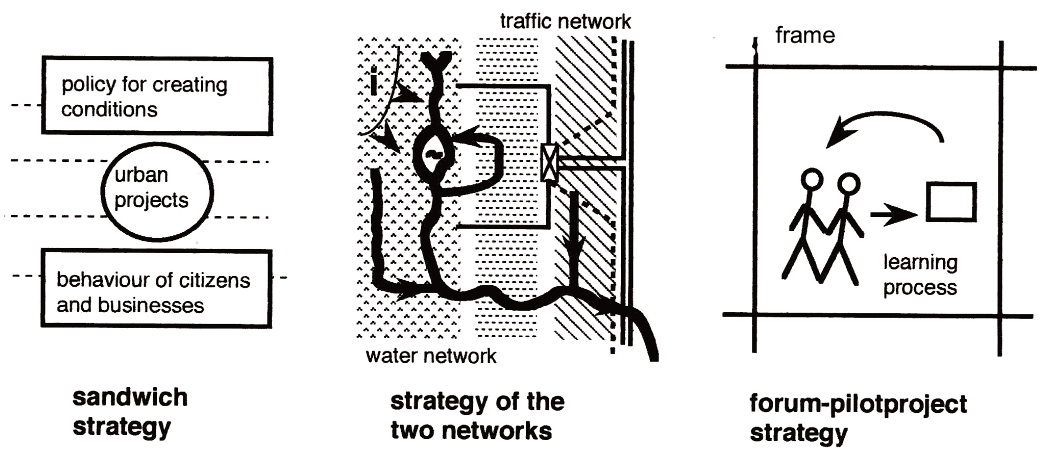


Figure 1. ECOPOLIS guiding principles for sustainable development.

The ECOPOLIS frame

The frame is drawn as a triangle with the three eyes looking at the plan in the middle. Instead of wedges of the cake or layers, the different aspects are represented as viewpoints. This symbolises the need for scientific disciplines and municipal sector departments to look at the whole instead of defending their own territory. Expertise should be developed at different points, but from these points the experts are invited to think about the whole plan. The three points chosen here focus on flows, areas and actors. Why these three?

In urban and regional planning, good plans create conditions for interrelated activities and inter-relatedness takes place when activities affect the same area, the same flow or the same network of actors. Most environmental policies are concerned with decisions about flow issues like resources and pollution. Decisions about building, urban planning and nature protection are directed to areas and actors are the focal point in discussions about the process of decision-making and about attitude and behaviour of citizens and businesses. In practice, categories of performance criteria are related to flows, areas and actors. The approaches may be different; a good integrated plan contains them all.

One may consider flows, areas and actors in an economic or social perspective. ECOPOLIS, however, takes ecological processes as the starting point of planning. Linking planning strategies for sustainable urban development to flows, areas and actors leads to the three mottos:

- The responsible city is the strategy to create and restructure urban systems to make them responsible for the incoming and outgoing flows that connect the city to its regional and global surroundings.
- The living city is the strategy to design with nature and to use the life support systems to create urban areas that contribute to the quality of life of urban residents and wildlife in the city.
- The participating city is the strategy to create commitment of citizens, businesses and other stakeholders in the urban environment by stimulating their participation in decision making and management of the urban ecosystems.

Priorities for flows, areas and actors

ECOPOLIS does not provide precise targets to be met in a certain period. That is left to operational planning and should fit to local circumstances and the actual planning situations. Instead, ECOPOLIS provides guiding principles to be used in the making of plans for urban systems aiming at steps towards sustainable urban development. The second layer presents priorities: options that are recommended to consider in the given sequence in the process of design. Designing is a cyclic process but it makes sense to take explicit decisions and discuss them.

A first priority in the making of plans for flows is prevention of unnecessary use of building materials, nutrients, energy and water, or unnecessary transport. Both reduced consumption and more efficient technology may contribute to prevention. The second step in the elaboration of the plan is to consider the options for durable and sustainable resources and the feasibility of reuse and recycling. Lifecycle Analysis (LCA) is a useful tool to assess the alternatives. The third step is to look at the supply and discharge flows generated or sustained by the planned system. Sometimes co-operation with actors responsible for neighbouring systems may be a better option that avoidance of ecological footprints at all costs. The three steps presented here are close to those developed by Duijvestein (1990).

A first priority in the making of plans for areas is to look at the options for using natural and cultural resources in creating the identity of the new plan. The next step is to elaborate the functional programme of the area keeping a close eye on health, safety and quality of life issues. Last but not least, creating conditions for wildlife is on the agenda, preferably in combination with other items of the programme.

A first actor-oriented priority in the making of plans is creating consensus among the most important stakeholders about a planning concept that may act as a sustainable frame for diversity and flexibility at the stage of detailed planning. Then, in the stage of use and maintenance, the focus must be on direct interaction with users and residents. In some cases this may imply a producer-consumer interaction, in other cases there is a need for direct interaction between municipal officials and citizens and businesses. The last step is to combine a plan for an urban system with the institutional basis for a learning organisation. In this way evaluation and improvement may become normal parts of the planning process.

Guiding models

In case of agreement about goals and means it is relatively easy to use technical models for optimising planning solutions. In many cases, however conflicts may emerge in the process of defining the priorities and criteria for flows, areas and actors. Because we need all three groups, the one is not categorically less or more important that the other. The interactive process of decision-making should therefore focus on integrated options. The prototypical solution schemes for these options are called guiding models. We need them for the making of good plans. The three general guiding models discussed here may serve as frames for the discussions in situations of conflict. Other guiding models address more specific planning situations. One of them is the circulation model, made for the design of water systems in a polder situation and used in the two cases that will be discussed in this paper. A more elaborate discussion of the guiding principle approach is presented in Tjallingii (2000b).

The sandwich strategy addresses the conflicts between centralists and decentralists. From a one-sided, flow-management efficiency perspective it may seem attractive to solve problems in big treatment plants outside the city. This represents the centralist's position. Proponents of a one-sided personal actor-commitment perspective prefer to solve everything in their own house. This is the ultimate decentralist's position. Integrating the flow, area and actor perspectives, the sandwich strategy stresses the effective role of central policy in creating incentives for citizens' and business' behaviour. Moreover, the strategy emphasises the important role of urban projects like recycling shops, cycle tracks and rainwater retention ponds. The projects visualise the urban ecosystem and in doing so they unite the flow, area and actor perspectives.

The strategy of the two networks addresses the situation of conflicting spatial claims. Starting with carrying conditions for all spatial claims, the strategy takes water and traffic networks as a spatial frame for sustainable regional development.

In the planning process the participating actors are invited to think first about the common frame. The second step is to make spatial claims fit the carrying frame of the sustainable water and traffic systems. One aspect of the two-networks approach is that it creates conditions for clean water and tranquillity, being the most vulnerable elements in urban planning that are essential for the quality of human life and for wildlife.

The forum-pilot-project strategy addresses conflicts about change. If parties do not agree about proposed changes towards sustainable development, the pilot-project might be an option to find out how new ideas work, how the new situation will look like, how much it costs and what needs to be done to get it started. In case different actors may be persuaded to form a forum for joint assessment of pilot projects, the approach may contribute to increased consensus about the concrete steps towards sustainable urban development. The city is also a laboratory.

3 The use of ECOPOLIS as a conceptual tool

3.1 The Nijmegen-Waalsprong case

The Waalsprong case

The city of Nijmegen, in the east of The Netherlands, has engaged in a new urban expansion of approximately 12,500 dwellings to be built in an area of 2000 ha, during a period of more than 20 years. For the first time in the city's history it will expand its boundaries north of the river Waal, the river Rhine's main channel. This is why the new residential area, occupying an area of approximately 5 km^2, is called Waalsprong ('Jump over the Waal').

The 1995 draft structure plan for the Waalsprong development accounts for the slow process of change and the need to have good conditions at any stage of development (Gemeente Nijmegen 1995). This implies the functioning of residential areas (including existing villages), fruit farming and glasshouse horticulture, areas for wildlife, new industrial and commercial areas and traffic and water infrastructure. In the mean time, the public private consortium in charge has realised the first stages of the new development.

The case concerns the strategic stage of the planning process, leading to the Waalsprong Structure Plan that, after extensive public consultation, was adopted by the Municipal Council in 1996. The structure plan set the frame for subsequent operational stages of the planning process that are now going on.

The role of ECOPOLIS in the Waalsprong project

In an early stage of the planning process the municipal planners commissioned a special analysis to explore the design options for water and green structures in the new urban area (Claringbould & Tjallingii 1993). The planners thus opted for a guiding role of the 'soft' water and green structures in the planning process that used to be dominated by 'hard' structures like roads and existing buildings.

Later, in 1994 and 1995, the municipal team that worked on the Waalsprong structure plan decided to take ECOPOLIS as a guiding strategy of the planning process. A special panel of experts outside the municipal organisation followed and guided the making of the plan and in regular meetings with the planners discussed with them how the ECOPOLIS guiding models could be used in generating concrete proposals. The members of the panel were recruited from other municipalities, from the Nijmegen and Wageningen universities and research institutes and from the National spatial planning agency. They represented expertise in the fields of the natural and social sciences as well as in local governance.

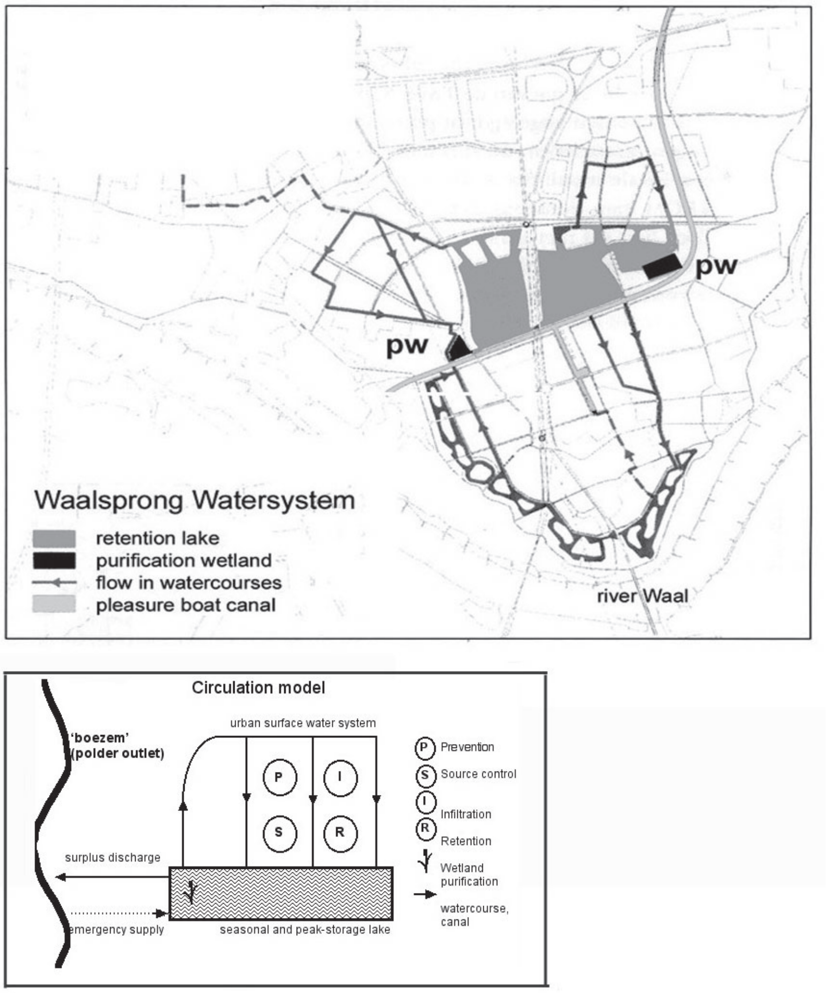


Figure 2. The Waalsprong - Planned water system and the guiding model.

How ECOPOLIS influenced the plan and the process

The analysis of planning options for green and blue structures indeed influenced the final draft of the plan that was basically adopted after elaborate public consultation. As suggested by the analysis, following ECOPOLIS, the plan's green-structure is 'carried' by water. The river Waal and its floodplain is the main open space that confronts the old city and the new development. Following the river, there is a greenway that can be used by plants and animals but is also very attractive for pedestrians and cyclists, who can move freely, undisturbed by car traffic. Other green areas follow the watercourses and lakes that are part of the internal water system in the new district.

The Waalsprong area is below the higher levels of the river and protected against flooding by a dike. The new urban district plan should therefore have an internal water system that is not directly connected to the river. Figure 2 shows how the plan for this internal water system is based on the circulation model proposed by the analysis of green an blue planning options. This circulation model articulates the ECOPOLIS guiding principles and was, in fact, one of the practical conceptual tools that eventually led to the more general formulation of the strategy as a family of guiding principles.

Essential to the circulation model is the seasonal storage of unpolluted rainwater. In this flat polder area in a climate of water-surplus in winter and shortage in summer, it is important to store as much of the surplus as is necessary to make summer supply redundant. This prevents the influx of polluted water from other areas. In the Waalsprong plan the seasonal storage takes place in the three lakes shown in Figure 2. The difference between the guiding model and the plan demonstrates how designing involves a process of tuning general ideas to the details of the local situation.

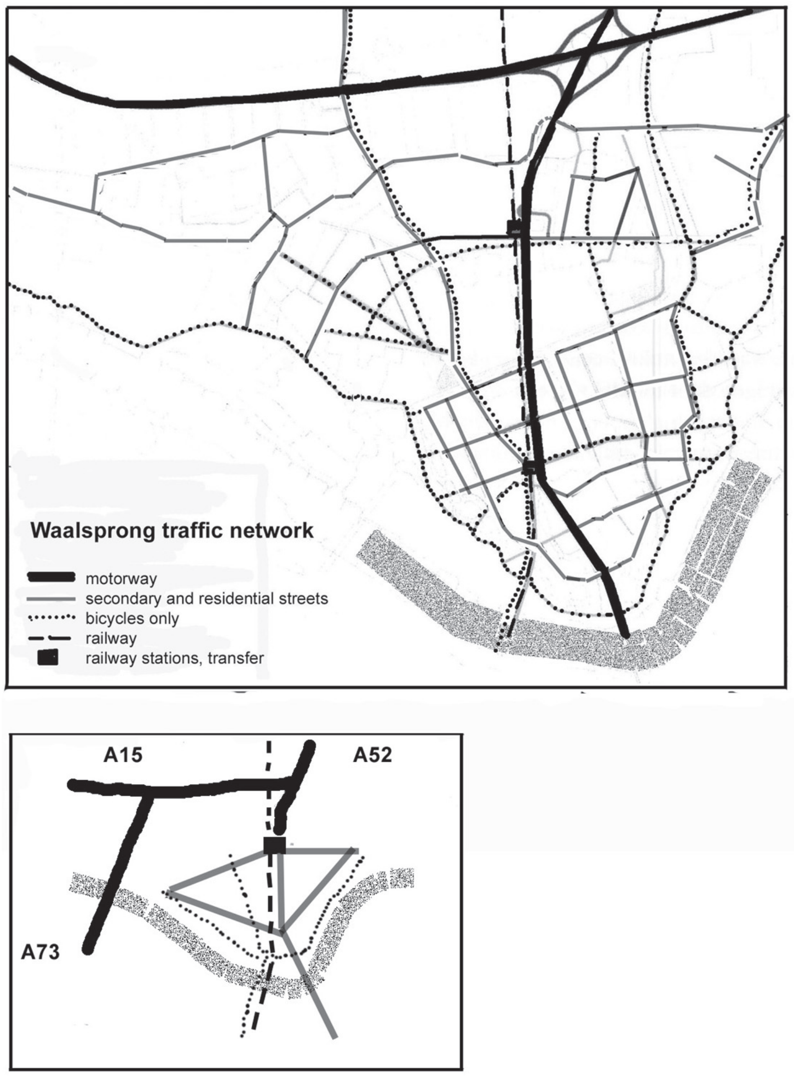


Figure 3. The Waalsprong – planned traffic system and the guiding concept.

Figure 3 demonstrates a traffic planning concept proposed for the Waalsprong area on the basis of the guiding model of the Strategy of the Two Networks. As shown in the figure, this proposal was not followed by the planning team, because it would involve politically unacceptable serious limitations to thoroughfare car traffic. This would impair the accessibility of the inner city. Planning is negotiating! Thus, the central North-South car traffic axis had to be kept in the plan. At a lower lever, however, from that axis to the river, the plan followed the guiding model in the design for the gradient between the dynamic car traffic zone and quiet pedestrian areas to the east and the west.

The discussions about the traffic plan took part in the meetings of the Waalsprong structure planning team with the expert panel. Apart from the plenary meetings individual panel members also took part in special working groups for issues like water, traffic, waste collection and recycling and energy.

An independent inquiry among municipal officials assessing the role of the expert panel (Rentjes 1996) revealed a general positive feeling about the critical and confronting discussions that took place. Theoretical ideas became concrete, dilemmas became clear. To some, the results in the structure plan were disappointing. Others felt the plan had gained quality and had become more sustainable. There was a general concern about the small group that had actively participated in the making of the plan. It was felt that more political support and commitment of developers was vital to keep the aims of sustainable urban development alive through the operational stages of planning and the realisation of the new development.

During these later stages ECOPOLIS only indirectly, through the structure plan's frame, influenced the planning process.

3.2 The Haarlem-Schalkwijk case

The Schalkwijk-case

In 1993, the city of Haarlem decided to start a planning process for restructuring the Schalkwijk district, a predominantly residential area of 14,000 dwellings with 33,000 inhabitants that covers an area of 730 ha in the southern part of the city. Built in the 1960s, Schalkwijk faces a number of problems that ask for renewal of the urban area. Big high rise buildings with apartments built for a low-income population dominate the area. Today, most people have middle-class incomes and the quality of the apartments and open spaces does no longer meet their wishes. The housing corporations and the municipality want to improve the quality of buildings and public open space to keep the district attractive for a diversity of people. In doing so they hope to prevent a downward spiral for Schalkwijk and to enhance the quality of life for the present residents. These economic and social motives merge with the need to adjust the physical conditions in the district to modern needs and technology in a sustainable perspective (Gemeente Haarlem 1999: 1-2).

The case concerns the strategic stage of the planning process that led to the Action Plan Schalkwijk 2000+ (Gemeente Haarlem 1998). In 1999, the Municipal Council adopted this plan after extensive consultation, a standard procedure for strategic plans that offers the public an opportunity to react to the planning proposal. This procedure implies a rather passive role for the public and the initiators of the process of change in Schalkwijk explored ways for a more active role of those directly concerned from the beginning. Therefore, even at the strategic stage, the making of planning proposals was organised as an 'open' process.

The role of ECOPOLIS in the Schalkwijk restructuring programme

In an early stage the planners chose ECOPOLIS as a leading strategy (Gemeente Haarlem 1998: 6). Planning started with public meetings that led to three working groups in which residents and other stakeholders participated, together with officials. The working groups addressed three themes closely related to the flows', areas' and actors' perspectives of ECOPOLIS: (1) environmental quality, (2) spatial/physical quality and (3) social quality The working groups produced quality reference documents that had to guide the further design process.

The working group environmental quality, for example, discussed and formulated environmental ambitions in the fields of water, traffic, green, waste materials, recycling and building materials. The working group used Duijvestein's three-step approach that is also presented in the priority part of ECOPOLIS in Figure 1.

In 1997 and 1998, an interdisciplinary professional design team developed a draft structure plan during two series of workshops (10 in total) using the documents from the working groups and the results of a residents' festival. In both series, the Strategy of the Two Networks was the leading strategy for the spatial organisation of Schalkwijk.

How ECOPOLIS influenced the plan and the process

An external assessment of the role of water in the planning process (Groen & van der Graaf 2001) revealed that most participants appreciated the role of external experts, who brought in innovative ideas like the ECOPOLIS frame and the Strategy of the Two Networks.

The Schalkwijk project also clearly illustrates the participating city idea. The bottom-up process with active involvement of local residents was considered essential. Frequent questions like "will the water be safe for our children?" were addressed seriously from the beginning and residents could discuss the proposals for 'safe banks'. It is the combination of innovation and participation that created a sense of shared learning among the actors. One of the key problems brought to surface by the assessment is the slowness of the process, which together with a frequent change of personnel in the departments made it hard to maintain the spirit of a joint process (Groen & van der Graaf 2001: 17-19).

Van Eijk et al. (2001: 50-53) discuss the experiences of a number of workshops in which residents and other stakeholders in the Schalkwijk programme participated. A general commitment becomes clear from the number of 2,500 people that participated in the residents' festival and the 1,500 written reactions with comments and suggestions. The workshops, however, reveal that many residents find it difficult to relate the rather abstract proposals to the impacts on their daily life. To a certain extent this is the inevitable drawback of the strategic stage in planning. Later, in the operational stage, things will become more concrete at the detailed evel.

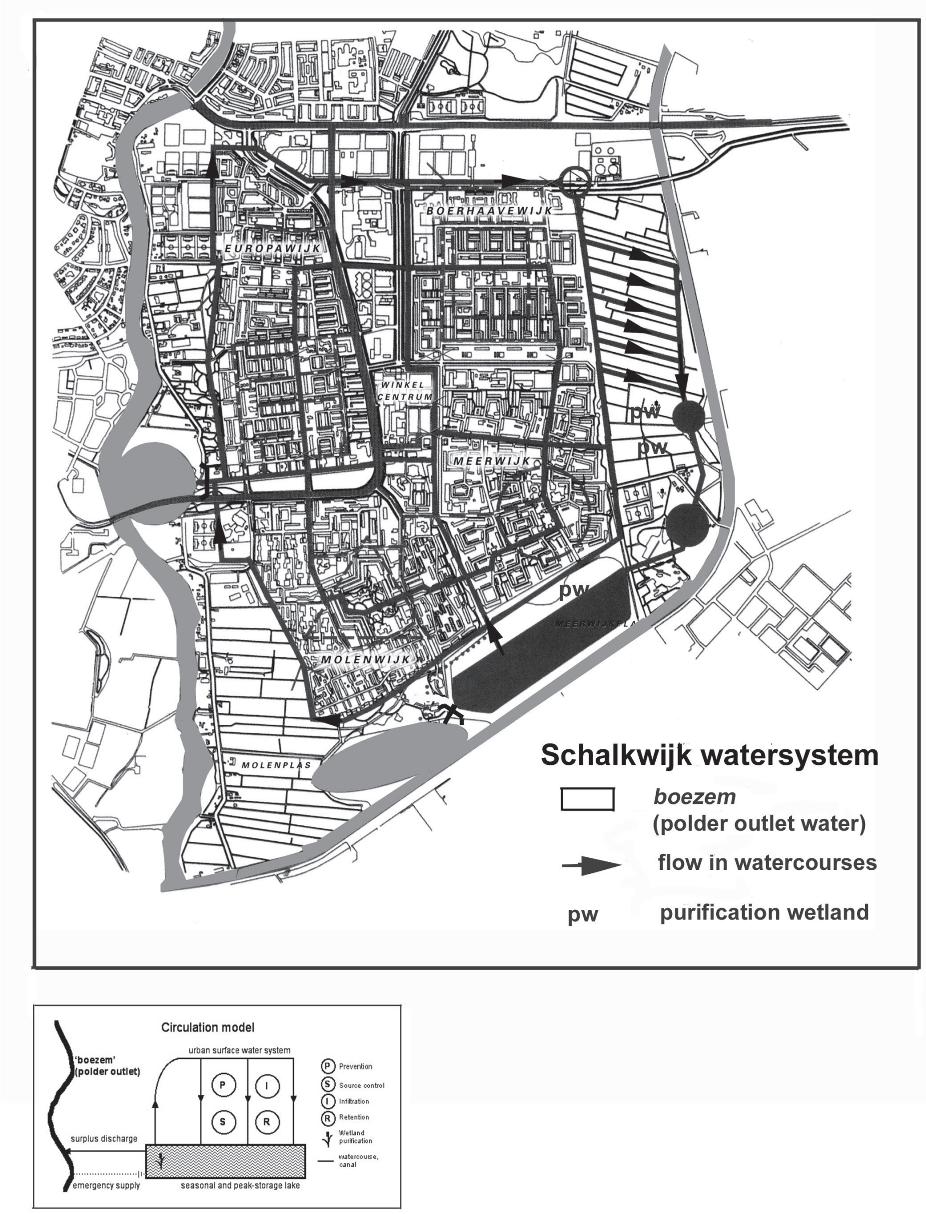


Figure 4. Schalkwijk – the planned water system and the guiding model.

It is difficult to assess the role of ECOPOLIS in detail but a comparison of recent urban renewal projects in The Netherlands showed that the Schalkwijk process is the most integrated and has the highest ambitions concerning sustainable development (van Hal & Sylvester 1998).

The influence of the circulation model, the guiding model for water plans in such situations is demonstrated by Figure 4. More water storage cannot easily be found in the existing built-up area but the urban fringe offers a good opportunity. The use of the strategy of the two networks is illustrated by Figure 5. The new structure plan concentrates traffic in a central axis with connections to all parts. Thus, there will be no ring road on the edge of the city as occurs in many in similar situations. Instead, water carries an attractive green area that marks the permanent edge (van Eijk 2001).

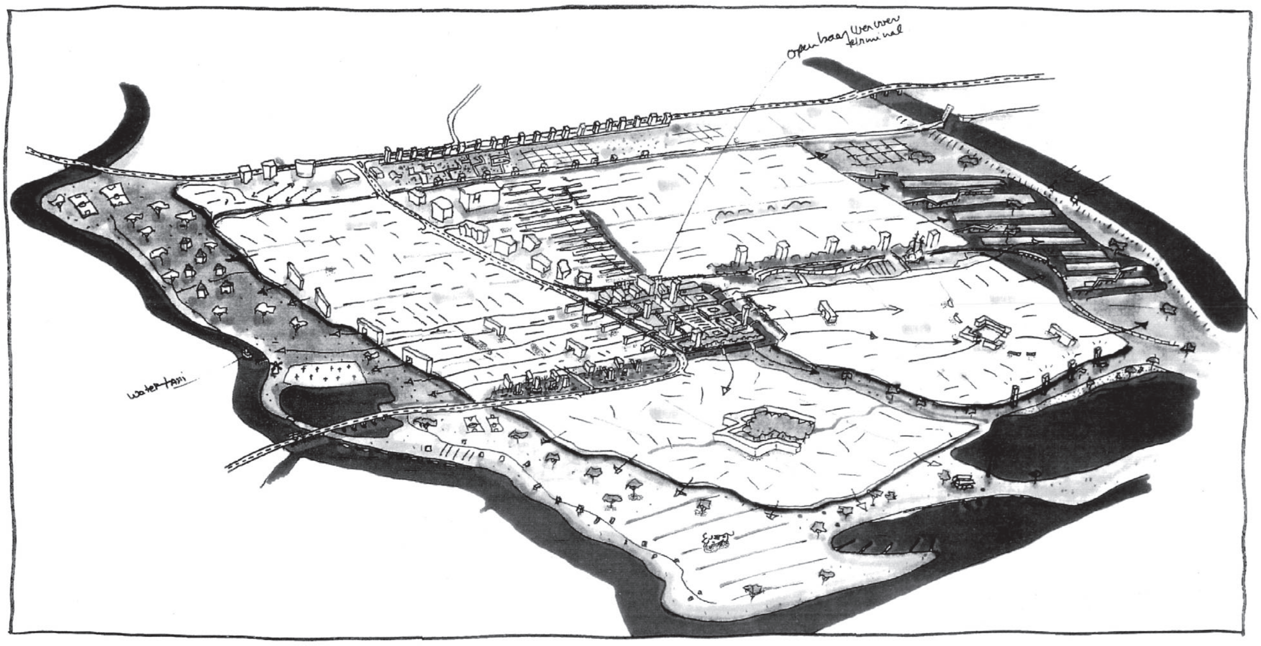


Figure 5. A bird's eye view of Schalkwijk.

Traffic proposals, especially plans to concentrate car traffic in some zones and to reduce it in others, met with a resistance that was not easily resolved by workshops. Besides the 'not in my backyard' (NIMBY) syndrome of residents, there were objections from the municipal traffic department and the housing corporation. In the end, however, there was support for the general scheme to concentrate traffic in the central axis. This consensus reached in the strategic stage of planning, of course, does not prevent the issue from turning up again in later operational stages of planning.

4 Discussion

The four questions raised in the introduction will be discussed here from two perspectives: the planning process and the substantive planning themes.

The use of ECOPOLIS in planning processes
How is ECOPOLIS used to structure complex planning processes? The two cases described in this paper represent new urban developments and restructuring projects in the existing city. In other cases ECOPOLIS, or guiding principles belonging to it, were used in planning projects for neighbourhoods and regions. One of the four scenario studies for The Netherlands in 2030 took the Strategy of the Two Networks as its point of departure (Ministerie van VROM 1997: 92). Other projects include policy guiding documents and a local Agenda 21 programme for the municipality of Wageningen.

How does ECOPOLIS perform? The evaluation studies of the Waalsprong and Schalkwijk cases demonstrate that creating order on the path towards sustainable urban development and stimulating awareness and creativity among the participants in the planning process are considered the strengths of the approach.

A weakness, according to some of the users, is the lack of concrete objectives in ECOPOLIS. One way to overcome this is to sharpen flows to environmental quality, areas to spatial quality and actors to social quality as was done in the Schalkwijk case. This case is not the only one that felt ECOPOLIS was too abstract. So, why should ECOPOLIS not develop more concrete targets for flows, areas and actors?

There seems to be no objection to this modification if it serves the users and makes the conceptual tools more useful in their particular case. It would not improve the general ECOPOLIS strategy, however, to change a guiding perspective for a measurable quality. Doing so would imply to give up a dynamic criterion for a static figure. The gain of having a concrete short-term target would mean a loss of a structural perspective with long-term benefits. Building walls to meet a maximum noise nuisance standard, for example, may frustrate more structural solutions to prevent noise. According to the priority sequence, that would be the first option to consider. Other experiences with ECOPOLIS may throw more light on this discussion.

Although conceived for guiding the making of plans, ECOPOLIS can also be used for the assessment of plans. This is what van Bueren et al. (2000: 9-11) did in their evaluation of the National Packages for sustainable building in The Netherlands. The issue of short term and long term, again, turned up in their analysis and they decided to add to the ECOPOLIS criteria the distinction between static quality and dynamic quality. Earlier, I proposed to use these criteria in this context (Tjallingii 1996: 140; 1999: 53), drawing on Pirsig's reflections (Pirsig 1991: 133). In a planning context static quality refers to the immediate quality and the standards to be met, whereas dynamic quality describes the capacity of the planned system to react to change and yet keep its basic quality. In hindsight, one may conclude that both the Waalsprong and the Schalkwijk plans do have dynamic quality through their two networks structure that can carry changes in the use of built-up and green areas.

Thus, it seems better to stay with the general guiding principles for ECOPOLIS, as it is conceived as a tool for the orienting and consensus seeking strategic planning, and leave the concrete targets for the result seeking operational stages of planning.

Are there other approaches that might serve as an alternative and compete with ECOPOLIS? An analysis and comparison of recent urban water plans in The Netherlands (van Eijk & Rijsberman 2001), reveals three alternative approaches: a guiding principle strategy like ECOPOLIS, a concrete target image or blueprint approach, or, as a third alternative, an open planning process approach. The comparison throws light on the strengths and weaknesses of the three alternatives.

The blueprint strategy is attractive because it is concrete. Those involved in decision making have a detailed image of the planning result and this enables the planners to make precise calculations and effect studies. Many people think of this approach as identical with planning as such. Yet, urban planners themselves have experienced the drawbacks of this architect or engineer's view of planning: (1) blueprints do no right to the complexity and uncertainty of most urban situations and (2) the target images tend to frustrate the interaction process, they polarise conflicts rather than creating the broad support that is essential for the plan to work. As a result, urban planners and planning theorists, like policy and organisation scientists have turned from blueprint planning to process approach (Faludi 1987: 53; de Bruijn et al. 1998: 9). More recently, this movement evolved to what is called the communicative turn in planning. Healy (1993: 241) summarises the core idea: "A communicative approach to knowledge production - knowledge of conditions, cause and effect, moral values and aesthetic worlds - maintains that knowledge is not merely a preformulated store of systemised understandings but is specifically created anew in our communications...". In Dutch urban water planning the experiences with an open process approach demonstrate that the participation of many actors may produce active interaction and broad support for the result. However, there may be frustration too. Different interests and motivations do not necessarily produce acceptable compromises. The participants expectance to have real influence is not always fulfilled (van Eijk & Rijsberman 2001: 31-33).

The ECOPOLIS guiding principle approach combines guiding substantive ideas with a process orientation. The hope is to be able to get support for general ideas in a joint process of learning and planning for the local situation. The substantive guiding models result from a process of learning in many cities and, thus, may act as a basis of innovation. The guiding models are abstract schemes and do not prescribe the image or the details of the plan. The creative process of exploring local solutions with a possible input from all actors is visible in the two completely different designs of the Waalsprong and Schalkwijk cases, resulting from the use of the same set of guiding models.

The ECOPOLIS frame is helpful in the first selection of key actors and the Schalkwijk case illustrates a process that is 'opened up' further through workshops and a festival. The guiding principle approach, however, also combines the weaknesses of the other strategies. Firstly, the views and values incorporated in the guiding models are not a priori accepted by all participants and even a growing consensus in the strategic stage of planning is fragile and in both cases there is concern about the continuity through the operational stages. Secondly, conflicts of interests bout building in green areas or about roads may be persistent, regardless of the planning approach.

The two cases presented here have, so far, successfully managed to develop consensus about the strategic plan. Creating a sense of urgency and a process of learning around the issues of sustainable urban development has been crucial is this context. The presence of pilot projects in The Netherlands and elsewhere had greatly contributed to this learning process. Through excursions to pilot projects with the actors concerned the Waalsprong and Schalkwijk initiators have generated shared understanding and a process of building a collective memory that is the key factor (van Eijk 2002: 9). The ECOPOLIS model of the forum - pilot - project strategy seems to function at two levels: at the national and international level the pilot projects are generated and at the local level lessons are drawn and next steps in the learning process result.

ECOPOLIS and sustainable development

How is ECOPOLIS used to structure the complex issues of sustainable urban development? The description of Waalstroom and Schalkwijk illustrates the way these cases worked with ECOPOLIS. Special working groups for the central themes had their impact on the planning proposals.

In recent years I used ECOPOLIS as a frame of assessment criteria for the evaluation of recent water plans with my students at the Larenstein MSc Training Course on Land and Water management. In this context of plan evaluation there are two basic questions. The first is: in which way is this an integrated plan? Here the focus of the analysis on flows, areas and actors produced an understanding of the way these three were addressed and combined in the plan. The second question asks: in which way this plan contributes to sustainable development? Here, the assessment criteria followed the normative statements of the responsible flows, the living areas and the participating actors, the ECOPOLIS mottoes extended to regional planning, as proposed in Tjallingii (1996: 194).

How does performance in these fields relate to the official objectives for sustainable development? Derived from the Brundtland report and officially adopted by institutions like the European Union is the common representation of sustainable development in three dimensions: the social, environmental and economic dimension. The EU Expert Group on the Urban Environment (1996: 238) links these general aspects to urban development by formulating four principles that sound familiar: (1) urban management, (2) policy integration (including spatial policy), (3) ecosystems thinking (including the Strategy of the Two Networks) and (4) cooperation and partnership. In other words: urban development does not primarily asks separate policy programmes for social, environmental and economic issues, but for integrated plans at the levels of politics, management and partnership in an ecosystem inspired frame. This is exactly what ECOPOLIS offers.

To bring the ideas of sustainable development to the city, one cannot simply fill in the goals and means of social, environmental and economic qualities, or, for that matter, the objectives and tools for People, Planet and Profit (PPP). It seems practical, as ECOPOLIS does, to distinguish between flow and area aspects of environmental issues and to start with an actor analysis. The next step, then, could be to explore the promising urban policy options that combine the economic, social and environmental interests of the actors with sustainable solutions for flows and areas. Thus, the ECOPOLIS approach is not competing with PPP, rather, it provides the conceptual tools to work at the practical urban planning level.

Are there alternative comparable approaches? In a recent interfaculty research project at Delft University of Technology we discussed other options like the 'Factor 20 approach', a strategy to reduce the over all resource use by a factor 20 in 50 years or by a factor 4 in 10 years (Weiszäcker et al. 1997). The approach was inspired by the UN Rio Conference in 1992 and combines creative and concrete proposals for flow management with a truly global orientation. It does not make sense, however, to force 'area objectives' under this umbrella. Arguments concerning the quality of the local urban landscape should be combined with flow arguments in a global perspective but cannot be measured in global terms. Thus, the Factor 20 approach should be regarded as a valuable strategy that is complementary to ECOPOLIS, elaborating strategic concepts for a number of flows.

ECOPOLIS and the role of green areas
How is ECOPOLIS used in relation to the role of green areas in urban development? As becomes clear from the two cases, the more or less urbanised landscape is analysed as a basis for the making of plans. This implies seeing urban design as a Language of Landscape (Spirn 1998) rather than protecting green areas as isolated claims. Nature, in this context, is seen as natural process (Tjallingii 2000).

How does ECOPOLIS perform in the context of the role of green areas? In the Waalsprong there is a prominent role of the river floodplain that will also be an area for wildlife habitat creation. Moreover there will be new green areas connected to the central rainwater storage lakes. In the Schalkwijk case the fringes of the existing built-up area will be developed as green areas, whereas the new building programme is directed inward. In the Schalkwijk densification process some of the scattered green areas will thus be used to build houses. This proposal is justifiable in the light of the low quality of some green areas. The functionalist designers attributed to these areas only a weak role as 'articulating the urban layout'. In the new plans, both in Waalsprong and Schalkwijk, there will be a strong greenstructure carried by water and bicycle networks. Thus the multifunctional meaning of green areas contributes to their empowerment. This is quite different from the idea of functional segregation held by the functionalist designers of the district in the 1960s. Thus the discussions and the solutions generated in Schalkwijk will be useful for a great number of these districts that are all in a process of renewal.

The question about alternative strategies is a hot topic in The Netherlands and in other countries that cope with a strong movement of disperse sub-urbanisation. Suburbs grow and villages near the cities grow even faster. This development blurs the contrast between urban and rural, between built-up and green. As a result, the beloved Green Heart of the Randstad Holland is becoming a chaotically built-up area of big villages and villa parks. The official reaction of Dutch planners is a defensive strategy. The draft Fifth National Memorandum on Spatial Planning (Ministerie van VROM 2001) stages a policy of contour lines reminiscent of London's Greenbelt policy. The Flowlands scenario, based on the Strategy of the Two Networks (Ministerie van VROM 1997: 92) argues for a lobe city and, beyond that, for a compact satellites along a transport network like beads on a string. This idea corresponding with a recent scheme of Breheny and Rookwood presented by Hall (1996: 414) is not new either. It reminds of the English garden cities, Copenhagen's green fingers, the Stockholm General Plan of 1952. What is new is the idea of the carriers and the role of water. Hall (1996: 413) comments: "Planners, it seemed, had reinvented the wheel. One could say that it was a good wheel, worth reinventing." Local practice, however, is hard to steer and the two strategies might not be mutually exclusive and thus may both contribute to local solutions.

The European Spatial Development Plan (ESDP) introduces the layer approach:

1. groundlayer(land and water, with ecological sustainability as a guiding principle);
2. the layer of networks (infrastructure, with economic functionality as a guiding principle); and

3. The layer of land use (urban and rural, with social justice in the struggle for space as a guiding principle) (EC 1999; Ministerie van VROM 1999: 4).

Introduced as an analytical approach, the use of guiding principles suggests strategic planning ambitions. The level of abstraction seems to be somewhere in between Brundtland and ECOPOLIS and this creates a perspective of fruitful complementary roles.

The layer approach, as such, raises questions: Does the metaphor of the layers not lead to a static approach? Will it not be more appropriate to consider water as a network? The ECOPOLIS experiences suggest a meaningful and useful role for the concept of carrying structures. Water is certainly one of these carriers and we may need them to organise durable backbones that can carry sustainable development of dynamic urban processes. Further elaboration of the layer approach will have to address these questions.

ECOPOLIS, one may conclude, is a fruitful conceptual tool for strategic planning that emerged from practical experiences in urban planning. Over the last ten years the concept has been used in a number of different projects. This paper described how the experiences of the users contributed to a process of learning and enrichment of the original guiding principles and this process of learning will continue.

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Plenary Session III

Socio-economic aspects of forests and trees in urban societies

Marketing of forest products serving urbanised societies

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Abstract

This paper offers enlightened marketing thinking as a tool for the forest sector to serve the urbanised society. Concepts of marketing and corporate social responsibility are analysed. Research results and case studies are presented to show how forest industry companies have responded to recent market demands concerning social responsibility. In free market economies, marketing is a tool for satisfying the needs of people. It provides the link between production and consumption in society. The basic function of marketing is to analyse customer needs and transform them into business opportunities. In urbanised societies the relationship between people and forests has changed and the needs satisfied by forests have diversified and are different than historically. The challenge of marketing is to respond to the new environment and diversified needs. Changes in both marketing philosophy and practices are necessary to meet the challenge. Modern marketing must do the right thing, do things the right way and utilise the best available technologies. In future society, profitability of the forest sector and forest industry companies is not enough; they must maintain a good reputation based on responsible behaviour. Responsibility is a comprehensive marketing philosophy. A major challenge is to take the needs of various stakeholders into account and to recognise how culture and other local characteristics influence those needs. Responsibility is extremely important for forest industries, because forests are vital for the future of mankind. The forest sector, including forest industry companies, has to balance economic profits, people's diversified needs, community interests, and global and local environmental needs.

Key words: marketing philosophy, marketing thinking, responsible marketing, forest-based need satisfaction.

1 Introduction

When starting forest products marketing classes I ask my students - what is society for? In this Conference we could ask what are urbanised societies for? The simple answer to my students is: people have formed societies because with cooperative efforts they can better satisfy their needs. Urbanised society, following industrialisation, is an appropriate context and form of cooperation for modern people to satisfy their versatile needs. What is the forest sector for? It is society's servant, its tool for the production and distribution of forest based products and services, used by the members of society in their need satisfaction. Forest sector legitimacy then means that forestry and forest industries exist and act with society's permission, and within society's expectations defined by people through markets or through public policy processes.

What is marketing for? In developed market economies, society needs marketing to be able to effectively satisfy the needs of its members. On a societal level, marketing builds a bridge between the production system and the consumption system in the society. On an organisational level, marketing integrates the various functions of a company, connecting the company to its customers and other stakeholders. Marketing mediates information about markets and customers to the whole company, enabling the company to adapt to environmental changes. As concerns the forest sector, the marketing mechanism should mediate changing societal and consumer demands to forestry and the forest industry; and these should change accordingly. What are the present expectations of people towards the forest sector?

At the most general level, the societal demands for the forest sector can be defined by saying that the activities of the forest sector have to be economically, ecologically and socially sustainable. The concept of sustainability is old in forestry, but earlier it has been defined by the forest sector itself, and not by society and markets. Sustainability has been connected to wood production. Ecological sustainability emphasises biodiversity. Endangered species and conservation of old growth forest have become topics of marketing interest. The environmental impacts of forest industries have traditionally been connected to emissions to waterways and air. Justified claims for clean air and clear waters have resulted in remarkable reductions of emissions in forest industries. However, it is very difficult for the forest industries to rid themselves of the reputation of polluters of air and water. Nowadays, the worldwide climate change issue forms an umbrella, which covers environmental problems both in forestry and the forest industry. The more conscious consumers become of global warming the more this will be a marketing issue.

In the forest sector, environmental issues have received serious attention since the 1960s. However, at that time these did not become a marketing issue. Forest legislation and forest management instruction regulated forestry. Forest industry followed the emission restrictions prescribed by authorities. The forest sector acted on laws, statutes and regulations. This was enough and marketing had no need to bother about environmental issues.

Figure 1 describes how forest products marketing has become environmentally conscious.

Phase 1: As the figure implies; marketing of forest products has been, and still is, business to business marketing. The figure shows how the forest industry is linked directly or through intermediaries to its industrial customers. The relationship is characterized by mutual trust; and explicit product and delivery characteristics are themes of business discussions. External pressures don't disturb long-term relationships.

Phase 2: Customer-orientation in marketing ("customer is king") emerged already in the 1960's, but still the topics of mutual interest were in product and delivery

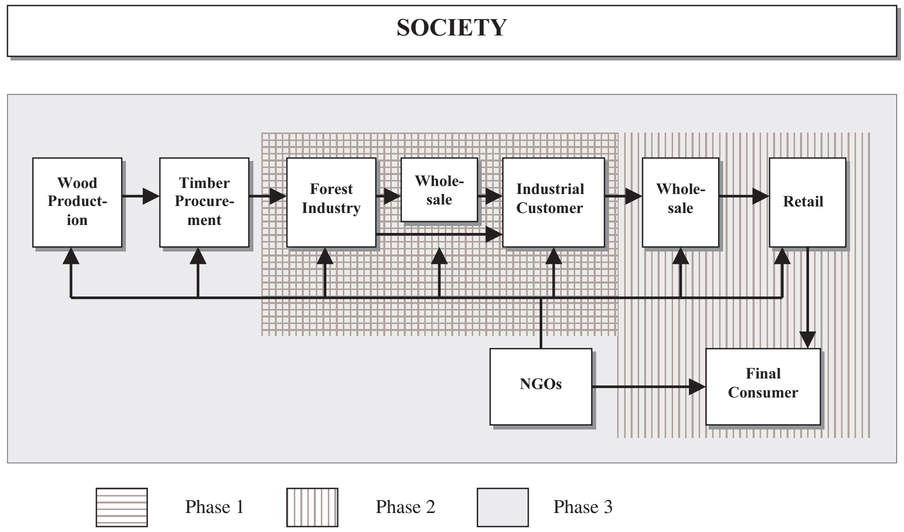

Figure 1. Environmental consciousness and the domain of marketing.

characteristics. Business was a matter only between buyers and sellers with no external disturbance.

Phase 3: Decisive change took place in the 1980's. The continuous deterioration of the environment made customers worried, especially in developed markets. The most active environmentalists worked through environmental organizations and exploited the environmental consciousness and concerns of the silent majority. Environmental activists considered that influencing environmental issues through political processes was too ineffective, slow and inflexible. Markets and companies were chosen as targets.

The logic behind the actions of NGOs was as follows: considering that company operations have heavy impacts on the state of the environment, it is appropriate to push or persuade companies to act in a more environmentally friendly way. The most effective way to push or persuade is through markets. These actions, through the companies, aim at more environmentally friendly processes, products and market demand. Environmental (E)NGOs have followed this kind of logic particularly since the mid 1980s. Boycotts and demonstrations have been extreme actions aimed at damaging the image of a target company. As a result of the actions of consumers, but especially ENGO's, the operating environment of companies has changed, especially in developed and prosperous markets. As the figure implies, environmental friendliness is required at each stage of the supply chain. For the first time in the history of forest products marketing, sales people were genuinely interested in what happened in the mills, wood procurement and forest management!

As a result of environmental consciousness in the 1990s, all actors in the forest sector, but especially marketers, needed a reputation of environmental responsibility. It was important that customers had the possibility to buy environmentally friendly products from an environmentally responsible industry. In environmentally conscious markets it was appropriate for the industry to aim for a competitive advantage based on a good environmental reputation. Industry also believed that a good environmental reputation was an insurance or protection against hostile attacks by the ENGOs.

Environmental issues dominated the relationship between the forest sector and the markets during the 1990s and green marketing, forest certification and environmental labels were indicators of this. What are the societal challenges to the forest sector in the future, and how might marketing contribute when responding to those challenges?

2 Purpose and approach

Based on Juslin & Hansen (2002) and Kärnä et al. (2003), this contribution offers enlightened marketing thinking as a tool for the forest sector to serve the urbanised society. The starting point is the role of marketing in bridging and adapting the forest sector and the changing societal environment. The concepts of responsible marketing and corporate social responsibility are defined. Research results and case studies are presented to show how forest industry companies have responded to recent market demands concerning social responsibility.

Marketing must continue to evolve in order for the forest sector to successfully adapt to the fast paced changes in today's societal environment. The idea of this paper is the concept that, success through marketing is based on the ability of the company to do the right thing, do things the right way, and utilize the best available technologies.

3 Role and nature of forest products marketing

What marketing is all about?

Urbanised societies and marketing share the same origin, as industrialisation gave birth to both. Industrialisation conclusively separated production and consumption. Something was needed to connect them again. In modern industrialised societies, marketing acts as the connector between production and consumption. At the company level, marketing connects the company to its customers and its other stakeholders. Figure 2 describes marketing as a connector and relationship builder. Modern marketing serves to build and maintain relationships among the

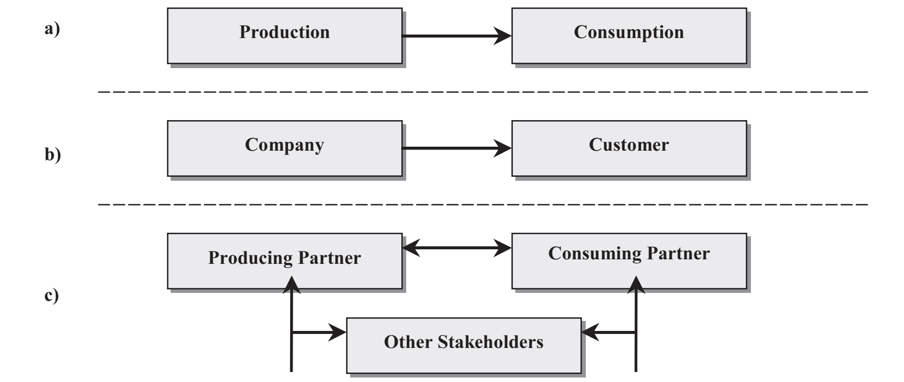

Figure 2. Marketing as a connector and relationship builder.

company, its customers and other stakeholders. "Relationship marketing" is a popular term from the early 1990's suggesting the importance of positive relationships with a range of stakeholders.

When emphasising the company level we can summarise the role of marketing as follows:

Marketing can serve to connect the company to its environment, allowing it to develop a better understanding of markets and customer needs, and transfer this understanding into business opportunities. Marketing integrates company functions and divisions into a customer serving entity, ensuring the fluid transfer of products and services to end-users.

When stressing the societal role of industries the mission of marketing can be defined as:

… a means of satisfying customer needs in a societal context. In developed societies, marketing is necessary to satisfy the needs of the members of society. Industry is society's tool for producing products that satisfy these needs.

The last-mentioned definition contains the idea that business and society are interwoven and society has certain expectations for appropriate business behaviour and outcomes. Marketing is the interpreter and fulfiller of these expectations. However, neoclassical economists have stressed the efficiency of the division of labour, and the hazard of tinkering with it, by requiring business to have social responsibilities (to fulfil societal expectations). The position on social responsibilities is one of the core issues as to the future of forestry, forest industries and forest products marketing. Before analysing that position, the evolution of marketing is examined.

Marketing philosophies

How marketing is executed and the role it plays in an organisation and society depends on the marketing philosophy of the company.

FROM:		TO:
Production Orientation	→	Marketing Orientation
Product Orientation	→	Customer Orientation
Volume Orientation	→	Value Orientation
Capital Investments	→	Know-how Investments
Mechanistic Modes	→	Innovative Modes
Shareholder Value	→	Stakeholder Value
Sole Economic Responsibility	→	Broader Social Responsibility

Figure 3. The development of marketing philosophies.

Marketing philosophies can be summarised through a list of three orientations. The illustrations of various philosophies are taken from the forest sector.

- *Production and Sales Orientation*
  We are interested only in how to produce as much as possible and how to sell roducts as effectively as possible.
- *Customer and Marketing Orientation*
  We are interested in what kind of needs customers have to be satisfied by our products, and how to communicate with customers as effectively as possible.
- *Responsible Forest Industry – Responsible Marketing*
  We are not only interested in the need satisfaction of our own customers but we also ask what could the forest sector contribute to constructing "a good society".

Although in the forest sector there are still companies and organisations representing a production and sales orientation, for the analysis of future development only the third orientation "Responsible Forest Industry – Responsible Marketing" is considered.

From a neoclassical economics point of view, the responsibility of the firm is to maximize profits for the owners, while operating within the laws of society. The opposing view is that companies have many responsibilities to a wide range of stakeholders (e.g. owners, employees, customers, business partners, non-governmental organizations (NGO's) and communities). Despite the debate, it is clear that business is a subsystem of society, and business has both a social and economic role. Society dictates what companies must be responsible for. Society ultimately grants a company "a social license to operate", but if the company does not operate within the society's values, it risks losing this license and ceasing to be competitive.

4 Making the future of marketing

According to the line of thought of this paper we assume that marketing reflects the values of the operating environment (society and markets) to the companies. The future of marketing in the forest sector clearly depends on the development of markets. Although long-term predictions are inherently inaccurate it can be expected that markets will have the following features in the foreseeable future:

- Local markets will grow global.
- More diverse customer needs will be met by bigger and more global companies.
- The information environment will be transparent, global, and rapidly changing.
- Stakeholders will increasingly demand social and environmental responsibility.

As to the theme of this publication, special attention is paid to the fact that urbanisation of society has led to greater environmental and social demands on the whole forest sector. The response of forestry to these demands has been the adoption of broad principles of sustainability, which contain ecological, economical and social dimensions. Whereas forestry emphasises sustainability the response of the forest industry is corporate social responsibility and responsible marketing.

The basic idea here is that, in this changing environment, the success through marketing is based on the ability of the companies and other organisations to do the right thing, do things right, and utilise the best available technologies.

The ability to do the right thing
As the responsibility discussion above shows, companies will increasingly be judged not only on their profitability but also on their ability to do the right things. The evolution of the concept of corporate social responsibility (CSR) is an indication of this. It generally refers to business decision-making linked to ethical values, compliance with legal requirements, and respect for people, communities and the environment. Corporate social responsibility is a term describing a company's obligation to be accountable to all of its stakeholders in all its operations and activities. The World Business Council for Sustainable Development defines corporate social responsibility as "*the commitment of business to contribute to sustainable economic development, working with employees, their families, the local community and society at large to improve quality of life*". A key idea is that social responsibility means going beyond legal, technical, and economic requirements of the company. There are six, key, generally accepted dimensions of corporate social responsibility. In Western Europe, Japan, and North America, an increasing number of companies are finding that it makes good business sense to fully integrate the interests and needs of customers, employees, suppliers, communities, and our planet (environment) - as well as those of shareholders - into corporate strategies. It is argued that over the long term, this approach can generate more growth and profits. There can be no social responsibility without profits.

A major challenge in doing the right thing is taking into account the needs of various stakeholders and recognising how culture and other local characteristics influence those needs. Social responsibility is especially important because the forest industries are using a globally important natural resource, i.e. forests. The living conditions of people are heavily dependent upon forests at both the local and global levels. Responsible use of forests is vital for the future of mankind, and the challenge for the forest industry is to balance company profits, customer need satisfaction, community interests, and local and global environmental needs. In the future, those companies that can properly identify key responsibility issues and efficiently implement strategies to deal with those issues will reap competitive advantage (Juslin & Hansen 2002; Kärnä et al. 2003).

The following research results and case studies show how forest industry companies have responded to the recent societal demands for broader responsibility.

Research results: social responsibility in environmental marketing planning
Kärnä et al. (2003) surveyed forest industries and their industrial customers (454 companies in total) from four European countries, in order to examine social responsibility in values, and environmental emphasis in their marketing planning. Most of the Finnish, Swedish, German and British companies surveyed emphasise environmental issues in their values, marketing strategies, structures and functions. The companies were classified into three groups according to their respon-

sibility values based on the concepts of redirection towards sustainability and the role of government. An interesting result is that "proactive green marketers" (companies emphasising sustainability but believing in a free market system) clearly stress environmental issues more in their marketing planning than "consumption marketers" (companies that do not emphasise sustainability and are neutral regarding the free market system and governmental balancing), as well as than "reactive green marketers" (companies emphasising sustainability and governmental balancing). The authors interpret that proactive marketers are the most genuine group in implementing environmental marketing voluntarily and seeking competitive advantage through environmental friendliness. Thus, the example of these progressive companies should be the direction towards sustainable development in business and society.

According to the study some managers may doubt, saying that the competitive strengths of business will be weakened by taking on social tasks. However, being socially responsible does not mean that a company must abandon its primary economic task. Nor does it mean that socially responsible companies could not be as profitable as other less responsible companies. Social responsibility or environmental friendliness can be a competitive advantage for proactive companies.

The results also provide evidence that green values, environmental marketing strategies, structures and functions are logically connected to each other according to the model of environmental marketing used to guide this study. Because environmental marketing functions (e.g. green advertising or examining environmental information) seem to logically reflect environmental values and strategic and structural level decisions, the industry should not be risking accusations of "greenwashing".

Case 1: MacMillan Bloedel Ltd. and the social license to operate

MacMillan Bloedel Limited (MB) (now a part of Weyerhaeuser Company) was a large western British Columbia company. It had significant operations on Vancouver Island, a place where environmental groups (ENGOs) took an international stand against clear cutting and the harvest of old-growth timber. ENGOs targeted a number of British Columbia companies by not only protesting at harvest sites, but aggressively attempting to eliminate the markets of those companies. This was done through on-site protests targeting customers of the forest industry companies.

Partially because of the "war" with ENGOs, by 1997 MB was in poor shape and had nearly lost its license to operate. The company had a terrible in-woods safety record, was losing money each time it harvested, and its markets were being constrained because of the protests by ENGOs. In 1997 the company undertook a study with the following objectives:

- No compromise of employee safety.
- Achieve 'outrageous' financial success.
- Make MB the most respected forest company in North America.

Basically the company chose to meet some of the demands of the ENGOs and change in order to maintain its license to operate. This meant rather than always fighting with ENGOs, the company began to use them as advisors and to bring them into decision making. In 1998 the company announced three main commitments:

- Replace clearcutting with variable retention.
- Increase old growth conservation above status quo rate.
- Certify forest operations to meet market demand.

According to MB the challenge in doing this was two-fold:

- To move from simplistic, adversarial relationships into more complex relationships capable of simultaneously involving cooperation and competition.
- To pursue environmental enterprise with the same level of creativity and passion previously devoted to battle, and frequently still devoted to competition.

Case 2: Varied views of responsibility
In February 1999, the Forest Products Marketing unit at the University of Helsinki organised a seminar titled “Responsibilities of the Forest Cluster”. The directors of a powerful environmental organisation, a global forest industry company, the world’s largest mail order company and the central union of forest owners reflected on the question how they see social responsibility in their own companies/organisations.

Although each speaker mentioned the three components of responsibility (economic, social, environmental), there were clear differences in their responsibility statements:

- The ENGO director clearly stressed their responsibility for nature. ENGO’s defend nature!
- The global forest industry company director listed all the ingredients of social responsibility but emphasised the forest industry’s responsibility to shareholders and customers. The general message of the talk was: “the business of business is business”!
- The director of the central union of the forest owners emphasised the duty of big forest industry companies to be socially responsible. According to him the main responsibility of forest owners is the sustainable production of raw wood for forest industry and energy production, for a fair price. The message here was that industry should take care of social responsibility!
- The director of the mail order company balanced all three components of societal responsibility. The company carries out environmental marketing and management, which means balanced economical, ecological and social responsibility.

From these various perspectives it can be concluded that companies nearer to final consumers and environmentally conscious consumers adapt the idea of social responsibility first.

Case 3: The Home Depot and social responsibility
The Home Depot (HD) is the largest do-it-yourself retailer in the world. The company has over 1,000 stores in North America, Chile and Argentina and expects to have around 1900 stores by 2003. By 2003 it could employ as many as 700,000

people. Social responsibility is a key part of the company's business philosophy. Every year HD publishes a Social Responsibility Report. According to the report, HD has a vision of leading the marketplace to a better world. The President of HD points out that because of the company's size it can have, "an enormous ability to effect change by doing the right thing". During 1999, HD made two major commitments to do what it felt was the right thing:

- An environmental policy giving preference to certified wood and the phasing out of wood products from environmentally sensitive areas.
- A pledge that diversity in its personnel (minorities well represented) will be a company-wide standard.

The Social Responsibility Report also documents:

- Charitable giving and grant making.
- A renewed commitment to environmental management.
- A renewed commitment to reduce and reuse both within the company and by providing products that allow customers to do the same.
- Documentation of women and minorities as a proportion of total employees.

The cases above show what social license to operate and social responsibility mean in practice and how companies have taken those issues into account in their operations. The case companies are big, innovative and successful. They are examples of early adopters and opinion leaders mentioned in the theory of diffusion of innovations. This may be a positive indication of the future of the responsibility issue in the forest sector.

The ability to do things right

For a successful industry or company it is not enough to do the right thing. It is also important to do things right. Doing things right means having the right approach to the problem, knowing the right tools to use, and being able to efficiently implement plans. Experience has shown that a marketing philosophy and a marketing orientation (consumer demand guides production) produce the most efficient production system at both the societal and company levels. Consequently, marketing thinking should direct all the activities of a company, and being customer and marketing oriented results in strong customer relationships.

Although it is only a tool, IT requires and enables closer relationships and the integration of systems between business partners. Current activities used by companies to improve the efficiency of the production system include supply chain management, customer relationship management and e-business. Knowledge management and information sharing are clearly the core issues of marketing development. In order to do things right, companies must have knowledge of the operating environment for marketing planning, provide value-oriented information to customers with regard to products and services, and maintain a high-level of information connected to business processes (e.g., transparency of the supply chain).

The ability to identify and use the best available tools

Information technology (IT) is altering the role of marketing within firms as well as the nature of communication with customers. Essentially, IT is allowing marketers to develop better marketing information systems and better marketing planning systems, thereby increasing the sophistication of marketing.

IT one example of a tool that successful marketers must integrate into their companies. In the future, information will become ever more crucial as a basis for improved decision making and more advanced marketing systems. Marketing planning and implementation must evolve as the company's ability to manage and use information improves.

An essential question is whether applying IT in forest products marketing promises to create stronger, closer relationships. Independent e-marketplaces are examples of a move toward weaker, more distant relationships. This does not follow the general evolution of marketing and may speak to the future success of such marketplaces. As to the future of marketing, the real gains of IT come from deeper customer relationships and the sharing of information.

5 Conclusions

This contribution has offered enlightened marketing thinking as a tool for the forest sector to serve the urbanised society. Marketing has a historical ballast of negative connotations, like creating materialism and artificial needs, and being built on the idea of constant growth (as opposed to sustainable development). However, in developed societies based on the market economy, production and consumption are definitely separated and something is needed to bridge those two - that is marketing. Experience has shown that marketing philosophy and customer orientation have produced the most effective production systems both on a societal and organisational level. The core of marketing thinking is that the needs of customers direct the production, and free competition forces companies to develop the most effective production methods. Although the best features of marketing thinking are widely applicable, the products and services of the forest sector are that versatile that societal interference is also needed. Also in those cases the core of marketing philosophy should be remembered: human need based production and competition based efficiency.

Wide introduction of marketing thinking presupposes changes in marketing philosophy. This can already be seen in the operations of progressive and innovative companies. Those companies are moving from the era of environmental responsiveness to the era of social responsiveness. This means balancing the interests of economy, ecology and people in the company operations. Companies decide voluntarily to promote the development of a better society and cleaner environment. This sounds idealistic when knowing that during recent years, forest industry companies have also emphasised shareholder value. However, according to the principles of social responsibility the interests of various stakeholders converge in the long term. Shareholder value is retained when customer relationships are in good condition, employees are treated well, the environment is taken care of and other societal responsibilities are borne.

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Task-oriented comprehensive urban forestry - A strategy for forestry institutions

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Abstract

For maintenance of urban trees and forests research and experts recommend a comprehensive concept for management. In contrast to this strategy the analysis of urban areas shows that the dynamics of urban policy cause a permanent crisis for each attempt to formulate and implement a comprehensively planned green management. But urban forestry must not give up. Three trends are identified which could support urban forestry. Firstly the development of towns is driven by huge market-oriented projects. Such projects need to integrate green elements in an innovative way defining the use and the aesthetics of trees and buildings anew. Secondly urban forests are full of symbols evoking emotions. By utilising professional public relations, forests could become part of the strong symbolic communication necessary to ensure harmony between highly diverse citizens. Thirdly urban forests offer important areas for fringe groups and urban forestry could become an esteemed partner for social policy. Through the three tasks of developing projects, symbolic communication and social policy urban forestry would meet strong demands from the town and therefore achieve reasonable political support and resources. In order not to neglect the goals of comprehensive maintenance of urban forests it is recommended to combine the dynamics and resources of successfully handling the specific tasks under comprehensive management. Such spill-over effects will work best if there is a single institution solely responsible for all multiple uses of urban forests.

Key words: urban communication, urban development, urban planning, urban social policy.

1 Green policy within urban dynamics

Urban trees and green islands 'floating' within an ocean of housing and traffic lines are a realistic picture of the situation of urban forestry. The urban socio-economic framework determines the options for green areas. Multiple demands and threats are expressed towards the green areas. In the last decade the comprehensive analysis done by urban foresters and scientists shows an increasing number of specific uses of urban green, as well as of sophisticated requirements for the management of the sustainable use (Konijnendijk 1999).

The question discussed in this paper is how policy can cope with the growing demands for sustainable urban forestry. As a starting point, the present concept of urban forestry is deduced from literature. Then the requirements of the concept are compared with the options the policy process in urban areas offers. The chances to realise a comprehensive urban forestry concept should be judged. Further alternatives can be elaborated which make use of the urban dynamics to promote urban forestry. The analysis is based on recent results of research in urban policy discussed in the literature.

2 The concept of urban forestry

Trees and forests are important parts of urban green. They contribute to the high ecological and aesthetical significance of green elements for the quality of life in densely inhabited areas. The impact of trees and forests comprises benefits in the field of atmosphere, hydrology, noise reduction, wildlife and biodiversity (Nowak & Dwyer 2000). Furthermore trees provide aesthetic surroundings and significant emotional and spiritual experiences that are important in people's lives and can foster a strong attachment to urban areas. But there also exist great pressures on urban space resources (Nilsson & Randrup 1997). New buildings and traffic lines are devouring green areas. Harsh air and soil conditions are threatening the health of plants. Users not respecting ecological limits cause heavy damages to trees and soil. The competitiveness of potential green area-users of different recreational types as well as competition with other users cause additional conflicts and stresses.

Due to the high density of population maintenance of trees and forests in urban areas has to cope with specific problems. From this need the concept of urban forestry was developed. By definition urban forestry addresses "the land in and around areas of intensive humane influence, ranging from small communities to dense urban centres, that is occupied or potentially occupied by trees and associated natural resources" (Strom 2000). Following this broad definition the urban forest is an ecosystem that does not only include vegetation but also soil, water, animals, utilities, buildings, transportation systems and people. Elements are, among others, community gardens, street corridors, green visual linkages, vacant land and productive land in urban areas.

Managing such a complex resource as urban forests is by no means a simple task. Inventory, techniques of treatment, planning, implementation, funding and responsibilities are very demanding. Facing these problems and looking for solutions created the concept of urban forestry and innovative solutions have been found (Grey 1992; Konijnendijk 1999; Kuser 2000). The inventory has to be 'tree-sharp' because each single tree counts much more in urban areas than in rural forestry stands. Additionally, information has to cover green areas affiliated with the trees and forests. The importance of forests and trees can be appropriately judged only as part of the whole sources of green. The demands of users are even more complex to investigate. Wood production, the traditional main branch of forestry, is of minor importance. The multiple uses with regard to ecological functions, nature values and recreation are dominant. The user groups are dispersed and the noon-wood products they demand are difficult to describe and even more difficult to measure. Yet the non-wood products and services are essential for the value and management of urban forests.

Treatment seems to be as difficult as the inventory. Techniques must be oriented toward the specific products and needs. Handling conflicts in recreation does not only require appropriate ecological and recreation facilities but also psychological skills in convincing and guiding people. Planning is aimed at coordinating management in order to meet the objectives the community requires. These objectives are as diverse as the user groups in communities. The complex process of making decisions benefits from many stakeholders and the citizens should participate. Even the best plan is only half the solution. Implementation within urban areas needs strong legal instruments, financial support and a high ability to solve conflicts. In urban areas even the most basic forestry activities like planting or especially cutting down a tree are not a self-evident, unquestioned measure but can cause disturbances. They need administrative permissions and public relations for ultimately being carried out.

Thus it is not surprising that the concept of urban forestry insists on strong organisation and on a stable budget. Key funding for this public task has to be provided by the community. In addition other public and private funds are necessary. The responsible organisation and funding have to be reliable to maintain sustainable urban forestry for the benefit of the whole community.

3 The crisis of urban forestry

Summing up, urban forestry wants much more than sustainable, profitable wood production. Urban forestry is aimed at optimising the protection and use of trees and forests within urban areas. This goal is in principle a public good, because every inhabitant can benefit from advantages of healthy green areas. The demand for free public goods is very often higher than the supply. Due to this simple economic fact the demand for healthy trees and forests within densely populated areas is usually higher than the supply. Urban forest and green cannot be other than scarce, causing pressure on those managers devoted to serving urban needs with urban green.

Urban forestry shares the fate of falling behind its own goals with all other public programmes aimed at public achievements. The exceptional situation here is that the shortcomings will increase beyond the usual due to specific factors typical of urban forestry and urban areas:

(1) The guiding concept of sustainable urban forestry is unclear
Concerning urban forestry it becomes most evident that sustainability of the forest makes sense within a sustainable urban community only. If the town is not sustainable itself survival of trees makes no sense at all. It is even more likely that a town growing unlimitedly will destroy its green first. Therefore the concept of urban forestry has to be integrated into the concept of the sustainability of a city region. These concepts are contradictory. The first version is through restriction of land use for housing within and traffic both towards and within existing centres. Greenbelts, mostly consisting of forests, around city areas should be strictly protected; the city should not grow into the green surrounding. The strong tendency of area-wide sprawl of housing, shopping centres and industry is seen as the major threat to sustainable cities due to the huge consumption of land and

traffic increase causing pollution of water and air (Hesse & Schmitz 1998). If the pressure of growth is overwhelming it should be concentrated within new centres. The first scenario designs the concentration on and restriction to urban centres as a solution for sustainability and is therefore named 'reurbanisation'. The second scenario questions the sustainability of big centres and wants to guide the sprawl of housing, offices, industries and traffic lines into a new structure consisting of de-central networks of housing, working, consumption and cultural facilities, with the main traffic inside the network. The version of 'de-centralised networks' would save green land and traffic lines compared with the sprawl caused by centres just growing into their surroundings. Whether the restriction to different centres or the reorganisation in de-central networks is the more promising option for sustainability remains unclear.

Both versions have completely different requirements for urban green. The concentration into different centres needs strict protection of all green areas including forests. Only when creating new centres green land will be converted into buildings and traffic infrastructure. To keep people inside the centres adequate urban green should be provided. This means that trees which are able to grow in areas with a high housing density are needed. Back yards and roofs should become greener and forest greenbelts should be strictly protected but accessible for people.

De-centralised networks are much more dynamic in terms of land use. New buildings and traffic lines are established in the surrounding areas, forming de-centralised networks of housing, working, shopping and recreation. Such networks interrupt the homogenous green land around city areas but within the networks space is given to forests and other green land. Additionally vast building blocks in the centres are broken down partially to make room for new green elements. Even small forests may grow where for instance an old factory has moved somewhere else. Forest will have to be moved but simultaneously new areas for urban forestry will be built up.

The contradiction of the two sustainable city concepts means that the concept of urban forestry that wants to support sustainable cities cannot follow a clear guideline. Having no clear line for the central issue of sustainability is weakening the concept whenever the necessity of justification of specific needs of urban forestry arises. One could say that - in a way - the concept is still unable to clarify its most important goal!

(2) Implementation of well-planned urban forestry is very limited

Let us assume that somehow in the future the integrated urban planning will be able to provide clear direction for sustainability in town. In this case comprehensive planning for urban forestry could show the way for management of sustainable urban forests. But here the story of success will end. Each step of implementation of the green plan will have to overcome overwhelming economic and political forces. In this respect urban planning as a whole is a very weak partner for urban forestry.

The development of towns is driven by strong economic enterprises competing on markets. They promise tax revenues and employment to the town. But they also know their value and importance. So they demand inexpensive areas for building, a reasonable infrastructure of traffic and information lines, energy and waste disposal. Whenever investors offer a large project the town administration is eager to supply it with the right infrastructure. The town prefers to do this within the different development plans. But whenever the plans get in conflict with the options of major business projects, towns have a strong tendency to follow the ideas of the investors by flexible implementation or even by reformulation of the legally binding plans. The strength of the enterprises can empirically be seen by the growing sprawl of shopping centres, industry and office complexes in the surroundings of urban areas which contradicts the different concepts of urban planning (Hesse & Schmitz 1998). Planning does not change much of the market-driven development in which urban green is just a residual factor that has to adapt to new projects and traffic lines. The formal procedure requires coordination of economic development with all other sectors and plans but in the implementation nearly no freedom is left for implementing a green plan demanding respect for green needs (Roth 1994).

(3) The ecological risks of urban forests are hidden and unseen by the public and the politicians

Forests and trees are changing all the time but change is slow in a good as well as in a bad direction. Worsening conditions of air, climate and soil in cities increase the stress of each tree, but these do not immediately stop growing. Losses of green areas to buildings or traffic may be small in the individual case but they add up step by step to a huge damage to the green potential. Loss of biodiversity within green structures is even more difficult to detect (Schulte et al. 1997). When trees become older, their vitality goes down and diseases increase. Renewing and planting new trees is inevitable but again new trees grow slowly and the expected positive effects will only be observed decades later. The slow development of urban forests means that “the reduction of maintenance activities is not readily apparent to city residents in the short run, but may have a tremendous long-term impact on the urban tree resource” (Tate 2000). Major costs of not doing enough today will occur in the future only. Long term damages and costs are weak arguments compared with public budgets. Sectors that can immediately show negative feedback to relevant groups from budget cuts gain stronger support for their needs than urban forestry, which is forced to spend money to prevent long-term negative effects.

(4) Funds for urban forestry are shrinking

Due to urban forestry’s emphasis on producing public goods, public funds are of key importance. Municipalities all across Europe are in a very difficult economic situation. The municipal revenues do not match the growing costs for infrastructure and administration. Making debts has given municipalities sources for active policy but the amount of obligations has reached its limits in many of these. They are forced to cut back and to focus on the most essential services. Reforming the municipal or community administration is to a high degree aimed at prohibiting the growth of the public budget. In most towns urban forestry is fighting - with little or no success - to save itself from budget reductions. Prospects to cover the growing costs by public funds are gloomy.

Many costs and benefits of urban forestry are related to private users. The activities of residents and visitors benefit from green areas and at the same time do damage by pollution or even by converting green land into land for building. Such negative and positive externalities are well known as an important problem of multiple use of forestry. In densely populated areas with intensive human influence on the forest the problems of externalities become much more significant than in rural forestry. Economists recommend that the private user who has the benefit or who causes the damage should pay personally (Wicke 1994). Unfortunately users do not appreciate such a concept. They are accustomed to free use of the public goods provided by urban green and not willing to pay for general damages their activities like housing or car driving are doing to the environment. Science has developed a variety of models of how to establish economic instruments to collect money from users causing externalities and progress can be made in practice (Mantau et al. 2001). Nevertheless, as long as externalities exist which cannot be overcome by economic instruments, urban forestry will suffer from an indisputable lack of income from private users compared with forests that are mainly producing wood for markets.

The four trends discussed will also cause severe problems to urban forestry in the future. It will not be easy even with intensive research to clarify the concept of sustainability of urban areas and its meaning for urban green. The implementation of green plans within urban dynamics will in practice be nothing better than an exhausting fight against interests mostly stronger than forestry. Selling a preventive strategy against long-term threats for green areas to citizens and politicians will remain an extremely difficult task and funding will be short in terms of public, and even shorter of private sources. It depends on the policy standard chosen for comparison whether the conclusion thus is that an urban forestry following a comprehensive concept is one of the most difficult tasks, or rather that a crisis of urban forestry is evident.

4 Green for making money

For a weak urban forestry it makes sense to look for strong allies. An interesting target group could be smaller and bigger projects in town driven by profits to be earned on markets. Examples of such projects are new urban entertainment centres, new urban districts for housing on the urban fringe, renovation of housing districts in the town, new shopping and office centres on the fringe, or follow-up use of abandoned industrial areas in town.

The forces behind such projects are strong. Investors seek new opportunities to make money. Marketing and management of the projects are professional according to the way industry handles its projects. The projects offer tax revenues and employment to gain the support of the politicians. Administration reforms encourage private-public partnerships to use the dynamics of private investors and management. They simultaneously guarantee the influence of the administration to secure public goals.

The economic and political rationale of such projects cannot be discussed here and it is beyond the task and influence of urban forestry. The challenge for urban forestry is to find out how trees and maybe forests can serve the needs of such projects and develop new opportunities. By looking at the programmes and practice of urban planning new chances can be found.

New urban districts have been built on the urban fringe (Wiegandt 1998). For example, Berlin and Freiburg, Germany designed and implemented projects building housing facilities on areas of 60 ha and 80 ha for 5,000 and 10,000 residents, respectively. Public and small-scale private investors are involved. The whole area is designed via a comprehensive concept giving active green planning chances to participate. In Freiburg, 25 % of the entire green area of 320 ha was used for housing and the remaining area is envisaged for natural preservation. The architectural variety and the creation of public spaces including green areas provide significantly higher urban development qualities than the sprawl of individual housing fighting their way into the urban fringe.

Another type of project concerns new shopping malls, sometimes in combination with new recreational centres or new office centres at the urban fringe. The projects destroy green land but at the same time need an excellent design and high amenity value. Trees and forests could play an important role if the aesthetic of integrating trees and buildings are developed further. Offices in the shadow of trees might be quite prestigious. The traditional preference for closed forest separated from buildings does not offer innovative options for the needs of such new projects.

Even in the centres of cities trees are necessary. On the one hand large abandoned buildings of former factories or hospitals, which have been shifted to the fringe, are looking for follow-up uses of which recreational facilities with trees could have their share. On the other hand the dense housing in the city needs green elements to become an attractive housing area again which combines garden elements with excellent access to downtown facilities (Kühn 1998). There is a need for innovative models bringing green and trees back into existing built-up structures.

The discussion among planners and architects teaches urban foresters that within new projects there is need for green elements for which trees and forests could prove innovative models. Compared with comprehensive green planning the advantages of such projects are their strong financial basis and the professional management that can be expected to turn the plans into reality.

5 Forest for peace in town

In urban areas human activities reach their highest intensity. People meet, cooperate, but also get into intense conflicts. This poses a perpetual challenge for keeping up the community. Therefore maintaining the social community and accordance is an important task for urban policy-making.

A stable base of peace is a sufficient and just supply of basic facilities such as housing, employment, health care, recreation, and cultural and green sources for every inhabitant. Urban policy is devoted to such public goals but a shortage of resources and a distribution of wealth, which is determined by the economic system, leads to a result that is far away from the goals (United Nations Centre for Human Settlement 1996). Policy needs additional instruments to foster the community and keep it in peace.

If the situation is bad, people must have hope. They need a feeling of trust in the town and future development. Community politicians play a key role in bringing hope to citizens motivating them to participate in the development of the town or at least to accept the given opportunities. Political communication cannot do this difficult job by technical explanations only. The task of urban development is too complex to be discussed on a pure factual basis in public. Communication with the public relies to a large extent on symbolism. This does not explain things technically, but condenses "into one symbolic event, sign, or act patriotic pride, anxieties, remembrances of past glories, of humiliations, promises of future greatness: some one of these or all of them" (Edelman 1985). Evoking emotions is as important as explaining facts. Symbolic communication has a great impact on the public perception of urban policy and on the peaceful life together in town.

Foresters love forests, but they should know that the public perception of forest in Europe is also full of condensation symbols. The media are sensible for the symbolic aspects of forest. A survey of the press coverage of the '1. Deutscher Waldgipfel', the most important public forest event in 2001 in Germany, indicates that 50 % of all messages about forests use symbols evoking emotions. Most prominent associations are 'Sustainability', 'German', 'Recreation', 'Forest-Die-Back' and 'Home' (Krott et al. 2002). 'Forest' is a suitable symbol for positive feelings like home or sustainability, but 'forest' can also signal major threats like forest-die-back.

Combining the highly symbolic content of forest with the urban policy's need for symbolic communication urban forestry offers the chance to serve a key need of urban policy. Even today specific urban forests are a significant part of the identity of many towns, e.g. the 'Wienerwald' in Vienna. Political communication has to continuously renew the symbols of identity in order to keep the community together. The message needed is not mainly what happened in the forest, the benefits from the forest and the activities for maintenance. It rather should stress the forest's emotional role in providing an image of the town to be the best and a unique home to be proud of, with a challenging future full of hope for everybody.

The public discourse, of course, is already full of issues; the media are oversupplied with news. Active public relations are needed to catch the attention of the media and the public. In addition to communicating events in urban forestry professionally, specific 'produced media events' form a promising technique to take part in the symbolic media discourse (Krumland 2000). A single tree planted by a visiting president is a big step for the forest to become part of the identity of the town and for strengthening this identity, even if the tree is a completely insignificant contribution to the forest in an ecological sense. Producing media events by using the forest to shape symbolic messages is a product of urban forestry, which meets the strong demand of urban symbolic communication.

Due to the hard competition of sectors and stakeholders to become part of the symbolic message and image of the town only a few produced forestry media events will get through. But whenever a media forestry event occurs a window of opportunities opens for a short while. In this very moment urban forestry has the attention of the public and politicians. Such support is one of the few chances for urban forestry to get the desired decisions. In the long run being frequently part of the symbolic communication of the town strengthens the position of urban forestry significantly.

6 Integration of fringe groups into urban society

Green areas and especially forests are open public areas in town. Most of the time the access is free of charge and although many things are forbidden, the freedom for different uses is larger than in most other public areas of the town. Therefore it is not surprising that the forest attracts fringe groups. Due to their incomplete assimilation they prefer activities for which the town does not offer sufficient or affordable facilities. There are, for example, immigrants who are accustomed to open air meetings and activities, but live in small flats without gardens, backpackers, homeless people, drug-addicts or prostitutes. The variety and number of fringe groups are huge in modern towns.

Taking care of fringe groups is a big issue for urban social policy. Supporting the integration into urban life is a complex issue that cannot be discussed here. Scientific analysis has shown that the role of urban forest in this process is not well known and management concepts have not yet been developed (Seeland 2002).

The task of urban forest policy could be a mixture of two basic strategies. Firstly, green facilities can contribute to solving problems of fringe groups. If people need a place for a barbecue and have no private garden, forests and parks do offer such a places. The management problem is to maintain the security and amenity of the place and to handle the conflicts among the users for barbecuing and other activities. This is not a question of discipline only, but a challenge to understand the users' needs and the habits of foreigners that differ from the traditional domestic ones. Difficult problems have to be solved with regard to scarce resources and activities on the borderline to illegal behaviour. It is important to understand and solve these problems not as specific forestry problems but as part of the social and security policy of the community.

Secondly, fringe groups are not clients for social welfare only. They are citizens who have the desire and the right to participate in political decisions in the community. Due to their lack of integration their ability to participate in policy is very low. Participation in the planning process is a chance which fringe groups are able to use very seldom. The lack of sources, organisation and power prevent them from being a genuine partner in these procedures. As they are not much different from other interest groups they would need some sources of political pressure for successfully promoting their interests. Therefore dealing with fringe groups includes the challenge to support them in finding their own way, building up political pressure and withstanding the guidance of public agencies. Helping the urban minorities who meet in green areas is such a difficult task because it includes giving them a voice to fight for their own interests, which might cause additional conflicts for public agencies.

7 Task-oriented comprehensive urban forestry

When combining the political deficiencies of urban forestry with the chances mentioned above, a strategy of a 'task-oriented comprehensive urban forestry' seems promising. In spite of stating a contradiction this strategy might work better within the given dynamics of urban areas than the perfection of a comprehensive urban forestry concept or the concentration on a few issues only.

The concept of urban forestry definitely has shown the multiple benefits and the significant need for maintenance of urban trees and forests. But the forces of urban policy do not guarantee sufficient support for the comprehensive concept, which could optimise the use and protection of urban forestry. The basic concept of the sustainable urban town itself is unclear, the impact of planning on town development is very limited, the political pressure of long-term ecological risks is weak and public and private funds for green issues are shrinking. These political shortcomings signify that urban forestry is under strong pressure and will not have sufficient political support to implement a comprehensive concept, however desirable such a concept might be.

Nonetheless does the dynamic of urban areas offer three main basic trends in which urban forestry could play a major role. Firstly, the development of towns is driven by large-scale market-oriented projects for new shopping, recreation, offices or housing facilities with major buildings and traffic lines. Such projects cause severe damage to green or agricultural belts around cities, but they need to integrate green elements in an innovative way defining the aesthetics of integration of trees and buildings anew. Strong financial sources and political support make it even more important to carry these projects through. Secondly, strong symbolic communication, which is full of emotion-evoking symbols, is necessary to maintain peace among the highly diverse and conflicting town population. It offers urban forests the chance to frequently become part of this discourse in the media and in public. Any time this happens, a window of support for urban forestry opens. Thirdly, urban forests are important for fringe groups. Within this task urban forestry could be recognised as an important partner for social policy and could even help the voice of fringe groups to be heard.

The three chances can be met by active and professional urban forestry institutions only. Participation in development projects needs high technical skills and efforts. Professional PR has to become part of the central discourse in town. To contribute to the social policy requires new professional abilities of foresters. Resources and efforts of institutions have to be focused on these tasks in order to achieve the critical majority.

At the same time there is the permanent need of comprehensive maintenance of urban trees and forest. The idea is that successful action according to the new main tasks will spill over and strengthen the urban forest institution in also fulfilling its ordinary tasks. Experiences and manpower financed by participating in projects will be available; the good image in public discourse will help in the competition for funding. Social policy is a mighty new partner.

The spill-over effect will work best if there is one single institution responsible for urban forests. This institution can combine the success in specific tasks with the need to maintain the urban forests in a comprehensive manner. If other institutions focus on one specific forest task only they can easily be successful but nothing will be left to cater for many other needs of urban forests. The innovation and professionalism of existing institutions managing urban forestry, jointly with the strength of the competing institutions trying to be successful in the few growing forestry tasks, will decide whether the concept of task-oriented comprehensive urban forestry will be implemented in practice.

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Plenary Session IV

Degraded land areas in urban societies and the need for innovative forest management

Ecology of disturbed landscapes – A case study from Germany

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Abstract

Restoration of sustainable ecosystems resembling the situation before mining or rehabilitation towards designed systems with predefined goal functions requires complex knowledge, particularly if semi-natural systems shall be recreated, e.g. by directed succession. Areas designed for agricultural or forestry use must be rehabilitated considering the future perspectives of the users. This means that interactions with socio-economical questions have to be considered also if successful recultivation is to be achieved. Knowledge can be extracted from mined land rehabilitated during the 20th century, e.g. by means of chronosequence studies. Natural succession processes on post-mining sites starting from "point zero" are not only unique events in cultivated landscapes; they help understand natural ecosystem dynamics - far beyond the actual post-mining landscape. Results from a number of research projects will highlight the various aspects and the scope of development of the ecology of post-mining landscapes using as an example the lignite mining district of Lower Lusatia in Eastern Germany.

Key words: recultivation, post-mining landscapes, chronosequence studies, succession.

1 Introduction

Worldwide, Germany is the most important producer of lignite (DEBRIV 2001). Particularly in eastern Germany opencast lignite mining has disturbed vast landscape areas. Although large-scale surface mining represents an ecological disaster at the landscape level, the restoration of post-mining areas offers a unique opportunity to examine the development of ecosystems and even of entire landscapes on "terra nova" starting at "point zero".

As a case study the Brandenburg University of Technology in Cottbus investigates the restoration of mining landscapes in the Lusatian lignite district, a region about 100 km south-east of Berlin (Figure 1). In Lusatia over the last 150 years lignite was produced in 22 opencast mines. With the German reunification in 1990 many of the former mines were discontinued.

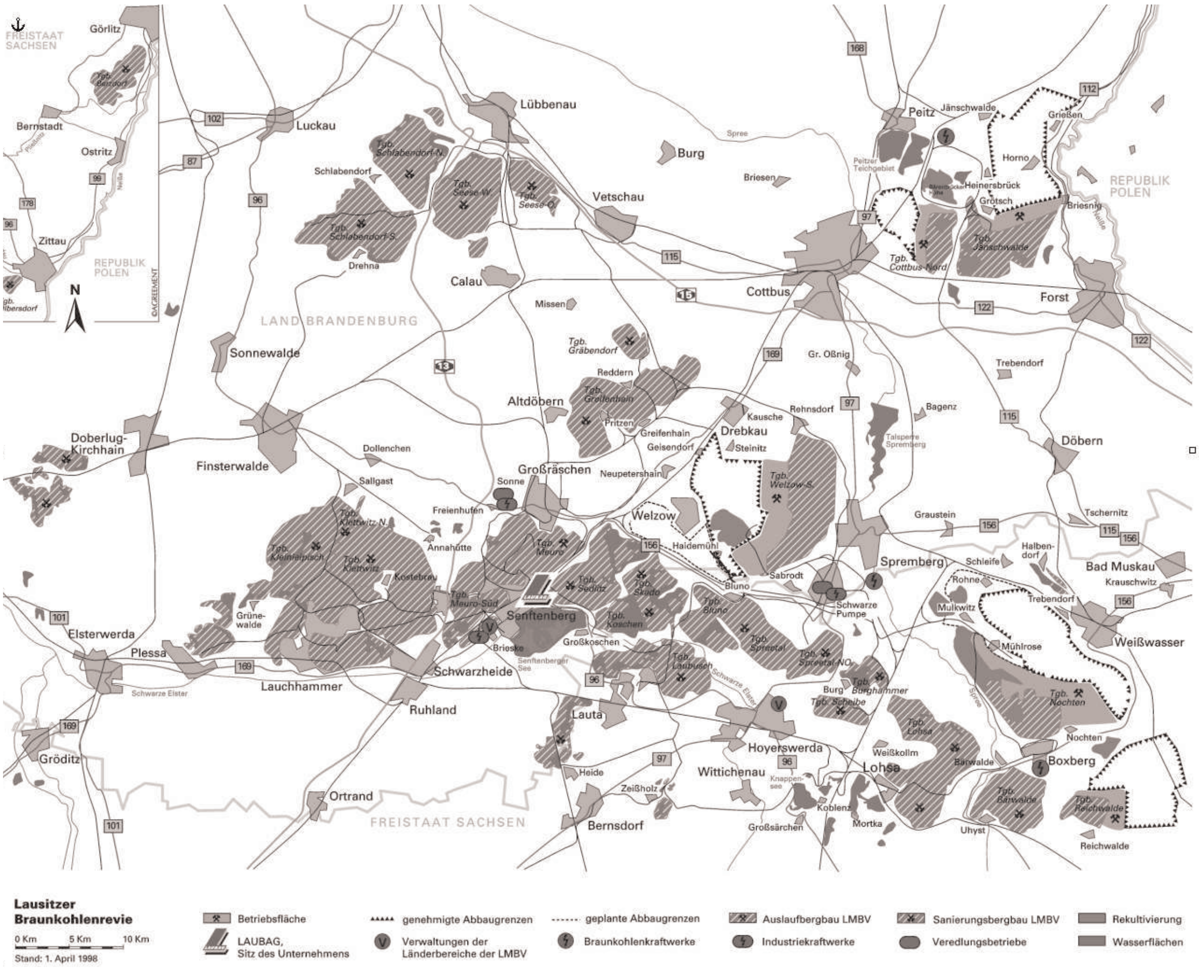

Figure 1. The Lusatian lignite mining district (LAUBAG 2002).

Thus, in the Lusatian mining district only 5 surface mines are still operating. As a result of these past and still ongoing mining activities an area of about 800 km² has been devastated by mining activities. Mining related lowering of the groundwater table has affected more than 2,100 km² of land.

In the Lusatian mining district the conveyor bridge technology is prevailing. Utilising this technology, overburden sediments of up to 60 m in depth can be excavated in one step. Due to this technological process, the different overburden sediments, i.e. Quaternary and Tertiary mainly sandy materials are mixed and exposed to atmospheric oxygen. Oxidation of pyrite contained in different quantities in the Tertiary substrates, and after dumping also in the mixed substrates, causes the release of large amounts of sulphate as well as iron ions and is the reason for extreme acidification of dump soil, seepage and groundwater.

For reclamation of mining soil in the Lusatian lignite district, specific amelioration techniques have been developed and tested for more than 5 decades (Pflug 1998). For example, different amounts of lime or alkaline ashes - the latter stemming from lignite fired power plants - have been used to neutralise soil acidity resulting from pyrite oxidation. In addition, fertilisers have been applied to provide nutrient elements for revegetation.

In general, four types of mine site reclamation can be differentiated in the Lusatian post-mining landscape (Pflug 1998). Due to the prevailing edaphic conditions, i.e. continentally influenced climate, low annual precipitation, nutrient and carbon-poor sandy soils, forests are the dominant natural vegetation type and hence the re-establishment of forest ecosystems is the most important recultivation approach (Figure 2). Agricultural recultivation is of importance for mining areas with more fertile soil substrates. Alternatively, some of the former mining areas are left to natural regeneration as succession sites with a major focus on nature protection. Mining lakes for recreation or nature conservation are another common re-construction aim after mining activities have been discontinued.

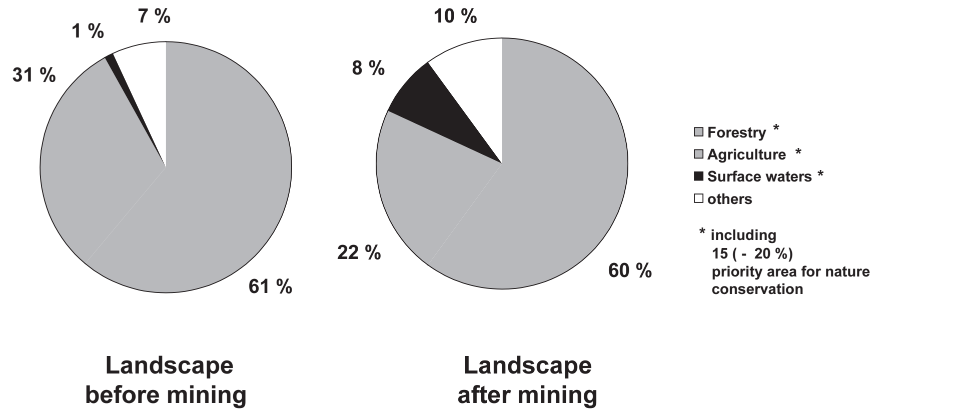

Figure 2. Land-use sectors in the Lusatian lignite mining district before and after mining (Pflug 1998, modified).

With regard to the different land use sectors, only minor changes in the relevant proportions can be seen after mining when compared to the pre-mining situation (Figure 2). But with regard to aquatic ecosystems, the area of lakes is growing immensely when, after brown coal extraction has been ceased and groundwater pumping is stopped, pits remaining in the landscapes are filled by rising ground-water tables. However, due to the acid substrate conditions these lakes generally contain extremely acidic and nutrient poor waters (Grünewald & Nixdorf 1995). As forests represent the prevailing natural vegetation type in Lusatia, as is true for the whole of north-eastern Germany where Pinus sylvestris stands make up almost 80 % of all forest stands, following the development of forest ecosystems on these extreme sites will be presented in some more detail.

Pinus sylvestris also plays the dominating role in forest recultivation practises in the Lusatian post-mining areas. However, recently in forest recultivation a more ecologically oriented silviculture is practised, leading to the establishment of mixed stands of e.g. oak and pine and even pure deciduous stands. Another practice in this context is the transformation of already existing coniferous stands into mixed stands, particularly oak-pine ecosystems.

At the Brandenburg University of Technology in Cottbus, comprehensive research into restoration ecology was initiated by the establishment of the Centre of Excellence “Ecological development of post-mining landscapes in the Lusatian lignite mining district”, funded by the German National Science Foundation (DFG) between 1994 and 1999 (Hüttl et al. 2000). In 2001 the Collaborative Research Centre (SFB 565) "Disturbed Landscapes" was established as a large-scale follow-up research programme. Also this project, with a potential time frame of 10 to 12 years, is funded by the German National Science Foundation for further investigation into the development of post-mining landscapes. Parallel to these basic research projects several applied studies were and are carried out in this research area. In this context, innovative approaches for landscape utilisation are studied as well. For example, the Lusatian region receives particularly attention for recreational purposes of people from the large cities of Berlin, Dresden and Cottbus (Figure 3). This onset allows an interesting insight into the development of new interactions between urban areas and surrounding landscapes.

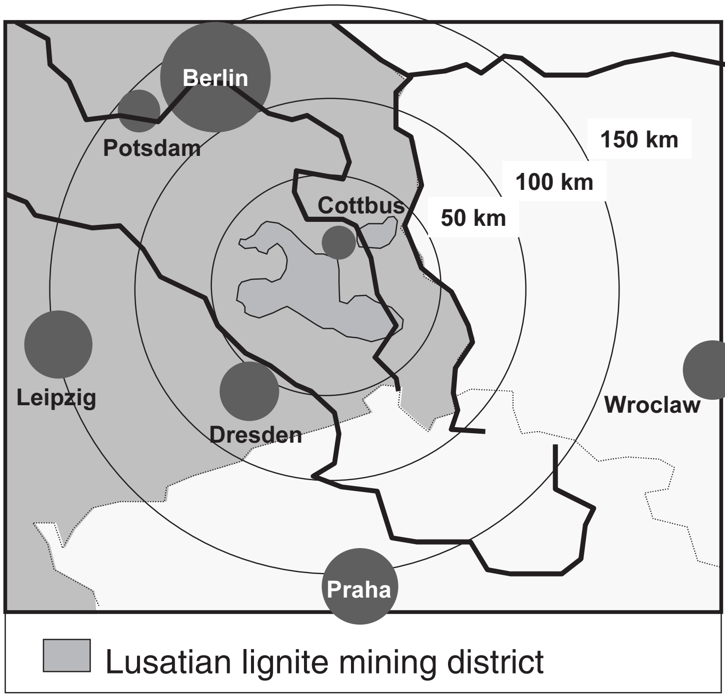

Figure 3. Large cities around the Lusatian lignite mining district.

Particularly with regard to the intensive construction activities in the metropolitan area of the new German capital Berlin these "new" landscapes south-east of Berlin may not only serve for multiple recreational purposes but also as natural compensation sites for the destruction of natural land in the process of constructing new buildings and infrastructure elsewhere, such as in Berlin.

2 Results

The development of young forest ecosystems on mine sites, i.e. on *terra nova* can be investigated by means of the chronosequence approach (Hüttl 2000; Hüttl & Weber 2001). This methodological technique allows for substitution of time by space. However, due to the heterogeneity of the prevailing site factors the results obtained with the help of this method need to be interpreted with care in order to avoid misleading conclusions.

In the Lusatian post-mining landscape chronosequence studies were established on sites with sandy substrates containing pyrite and lignite, which prior to afforestation were ameliorated with fly ash. The amount of fly ash needed to continuously compensate for acidity resulting from pyrite oxidation was calculated by way of the so called acid-base-balance (Illner & Katzur 1964). Amelioration depth was usually 40 to 60 cm into the soil substrate. Furthermore, chronosequence studies were also initiated on pyrite- and lignite-free substrates from Quaternary strata.

"Prima vista" *Pinus sylvestris* forests on post-mining re-cultivation sites do not differ from stands on non-mined sites in the Lusatian region. Interestingly enough, biomass production of Pinus stands on these mine sites seems even to be higher than in comparable stands on sites in this region that were not disturbed by mining activities (Böcker et al. 1999). A closer look, however, reveals significant differences in forest ecosystems on the mine sites when compared to those on natural sites. This is e.g. the case with regards to soil properties. As indicated above the oxidation of pyrite is the dominant process in young mine soils on substrates consisting, at least in part, of tertiary sediments. This oxidation process results in high amounts of soluble salts (sulphates) and also in the production of large amounts iron ions and protons:

(1) $FeS_2 + 3{,}5\ O_2 + H_2O \rightarrow Fe^{2+} + 2\ SO_4^{2-} + 2\ H^+$
(2) $Fe^{2+} + 0{,}25\ O_2 + 2{,}5\ H_2O \rightarrow Fe(OH)_3 + 2\ H^+$

Hence electrical conductivity, SO_4^{2-} as well as Fe concentrations reach very high values, particularly in younger mine soils (Hüttl 2000). In the subsoil of those profiles, extremely high values can be found even 10 to 15 years after re-cultivation (Table 1).

Table 1. Chemical characteristics (median) of a mine soil chronoqequence on Tertiary substrate and of a non-mined forest site (from Hüttl & Weber 2001).

Site	**Weissagker Berg**			**Bärenbrücker Höhe**			**Domsdorf**			**Taura**		
Substrate	**Tertiary spoil**			**Tertiary spoil**			**Tertiary spoil**			**Non-mined, forest soil**		
Age	Just planted			14 years			32 years			48 years		
Depth (cm)	0-30	30-60	>60	0-30	30-60	>60	0-10	30-60	>70	0-5	45-60	75-94
pH (H_2O)	3,9	3,8	3,1	5,5	5,4	3,1	5,1	4,5	3,3	3,8	4,3	4,9
EC (mS cm^{-1})	2,3	2,2	2,5	0,1	1,4	2,2	0,1	0,6	1,1	n.d.	n.d.	n.d.
C_t (%)	2,3	2,4	2,3	4,0	5,0	4,5	8,9	7,3	5,8	1,6	0,1	<0,1
S_t (%)	0,4	0,4	0,5	0,2	0,7	0,7	0,2	0,2	0,2	0,01	0,01	<0,01

However, the rate of pyrite oxidation decreases with time and about 20 years after re-cultivation practically no pyrite is present in the substrate down to a depth of about 100 cm (Heinkele et al. 1999). As would be expected, also extremely high amounts of soluble salts were measured in soil water of these ecosystems. Depending on the buffering effect of the alkaline materials amended in the process of soil amelioration, pH values are generally much higher in the topsoil as compared to the non-ameliorated subsoil. However, percolation of seepage water containing buffering substances into the subsoil gradually improves the chemical conditions also in the lower soil profile. As a consequence, pH values are slightly elevated at least in parts also in the soil matrix of the subsoil (Schaaf et al. 2000).

Preferential flow along cracks and other physical structures into the subsoil allows a rather rapid drainage of seepage water. Tracer experiments revealed that the spatial distribution of draining structures is, as would be expected, extremely heterogeneous (Figure 4). Obviously seepage water is limited to some specific areas of the subsoil. In addition, preliminary results of investigations into the three dimensional structure of a typical ameliorated dump spoil down to a depth of 2 m illustrate the extremely heterogeneous physical and chemical conditions of subsoils of these post-mining sites (chaaf, personal communication).

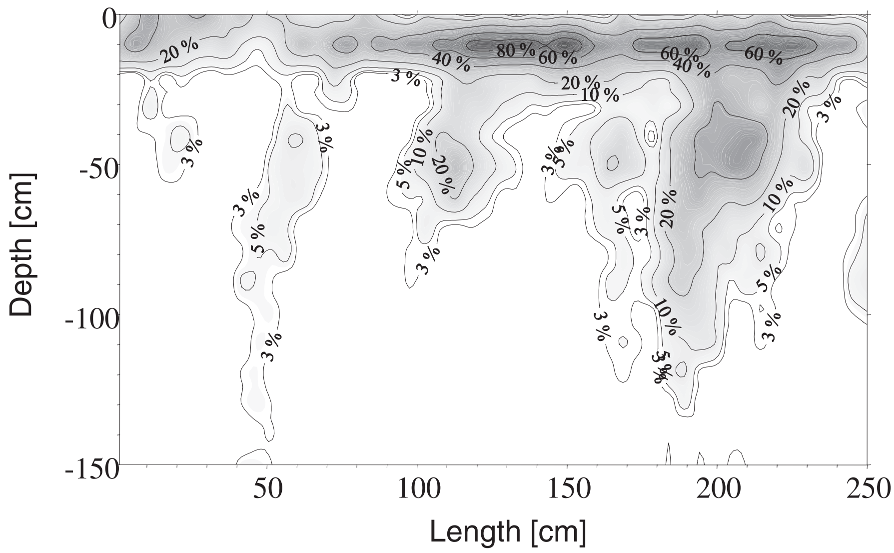

Figure 4. Heterogeneity of spoil substrates: spatial distribution of a jodid tracer, Bärenbrück (Gerke et al. 2000).

Extreme soil acidification also results in very intensive mineral weathering, particularly weathering of silicates. Accordingly, high concentrations of aluminium but also of calcium, a weathering product of calcareous components present in marine sediments of the Tertiary strata, were analysed in the soil solution. As a consequence, secondary minerals such as gypsum are formed under these conditions (Schaaf et al. 2000).

The nutrient pools of the post-mining soils are very small. As mentioned above fertilisers must be added to these sites to allow forest trees to grow. However, N flow rates under *Pinus* stands on reclaimed sites differ significantly from non-mined sites of the general region (Figure 5). Large amounts of N in form of NH_4-N are leached from the subsoil of Tertiary substrates. These output rates exceed the atmospheric input rates by far. It is hypothesised that N is mobilised from lignite particles contained in these sediments and leached by way of seepage water from the rooted solum (Hüttl & Weber 2001).

With regard to the results of soil and soil water analyses, P - even despite P-fertilisation - would be considered hardly available for plant uptake under these site conditions. Nevertheless, P nutrition of the trees is adequate. To explain this phenomenon it must be noticed that fine root tips of *Pinus* sylvestris on these sites are almost to 100 % associated with ectomycorrhizal fungi (Golldack et al. 2000). These mycorrhizae are extremely vigorous and the observed mycorrhizal fungi show a much larger diversity than would be expected from Pinus stands on non-mined sites. The tree - ectomycorrhizal fungi - symbiosis is known to improve

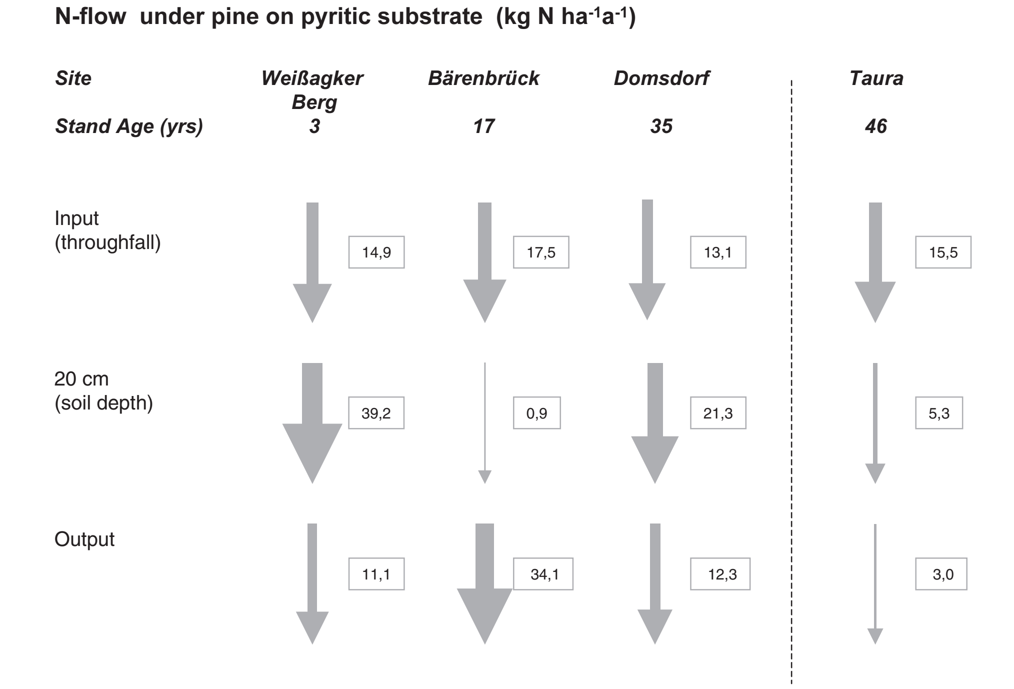

Figure 5. Nitrogen-flow under pine on pyritic, i.e. Tertiary substrate (kg N ha^{-1} a^{-1}) (from Hüttl & Weber 2001).

nutrition particularly when P-availability for tree roots seems limited. Therefore, mycorrhization might play a crucial role as a successful establishment strategy for forest ecosystem development under these site conditions.

On the other hand, root systems of pine stands on these recultivation sites are characterised by a significant disturbance when compared to pine ecosystems on natural sites; pine stands on former mine sites cannot establish a deep rooting system with a taproot due to the adverse chemical subsoil conditions (Hüttl 2000). On natural sites in the region, the taproot strategy is believed to guarantee survival of pine trees on sandy sites with prolonged summer drought periods. This significant difference in forest ecosystem development must certainly be the focus of further research, as it will be an essential indicator for the sustainability of forest stands on mined sites. Presently, it is our hypothesis that intensive and vigorous mycorrhization might also help to improve water availability for the Pinus trees that are not able to produce a "normal" taproot system due to the prevailing conditions on mine sites.

Another important difference of mine soils versus non-mined soils is soil organic carbon. Carbon in mine soils can be divided into pedogenic and geogenic carbon. Geogenic carbon is derived from lignite particles in dump spoils of Tertiary or mixed Tertiary sediments. Other sources of soil carbon are atmospheric input particularly of fly ashes as well as input from amelioration ashes being alkaline residue from combustion processes in brown coal fired power plants (Hüttl 2000). These lignite derived carbon fractions are not an inert soil component. Lignite derived carbon was found to be subject to microbial decomposition. However, so far it is unclear whether or to what extent geogenic organic matter plays a role in the nutrient pool for the developing forests stands (Waschkies & Hüttl 1999). Furthermore, geogenic carbon fractions may increase the water-holding capacity of mine soils (Embacher 2000). Particularly in a dry area such as the continentally influenced Lusatian region, the improvement of soil water availability might be an important factor for the development of forests stands. Comparable to „normal" forest stands on non-mined sites pedogenic organic matter is accumulated on the forest floor as well as in the upper-most mineral topsoil of the mine site forest chronosequences. In mine-site forest stands that have already developed an organic topsoil layer, high amounts of the nutrients added by fertilisers are stored in this layer (Heinsdorf 1992).

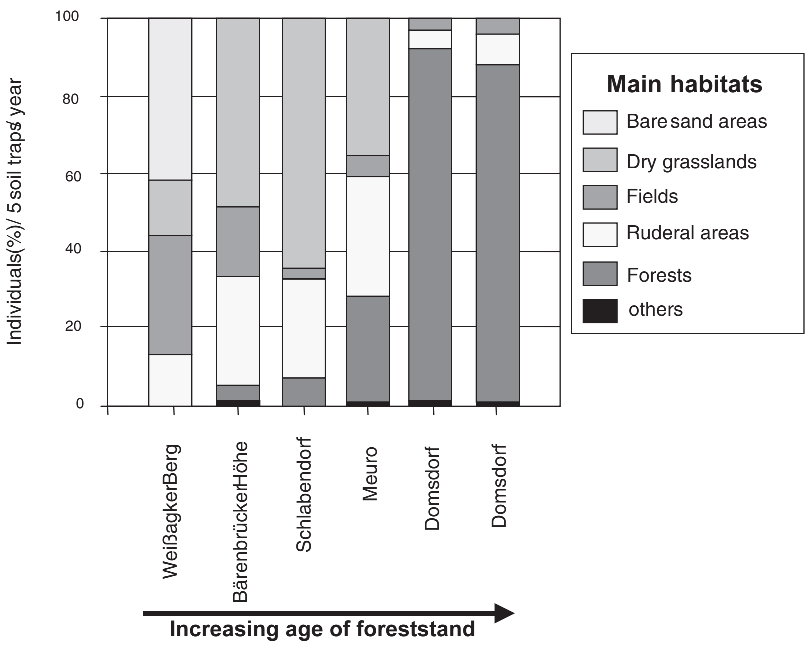

Figure 6. Distribution of carabidae according to their main habitats with increasing age of recultivation sites (from Kielhorn & Keplin 1999).

The decomposition of soil-organic-matter-pools by soil fauna and microorganisms is crucial for the further development of forests on the experimental mine sites. The colonisation of mine sites by soil fauna happens quickly, i.e. within the first year after recultivation. In the early stage of this succession, species typical of open habitats are dominating. In the older *Pinus* stands a clear trend towards species typical for forest habitats was observed (Figure 6; Keplin et al. 2000).

3 Conclusions

"Prima vista" forest ecosystems on recultivated mine sites in the Lusatian lignite district do not differ completely from those on non-mined sites. However, at a closer look there exist a number of substantial differences. For example, root system development of pine trees on mine sites is quite different from that on non-mined sites due to the adverse chemical and physical condition of the mine soils. This is particularly relevant for soil sediments that consist of or are influenced by Tertiary sediments. These substrates generally contain large amounts of pyrite as well as lignite and thus substrate development is driven by pyrite oxidation. This process results in strong acidification of especially younger dump soils. Along with this process the prevailing specific recultivation techniques are responsible for intensive small-scale soil heterogeneity. Afforestation, i.e. the establishment of forest ecosystems on mining sites, is only possible after site-specific amelioration of the prevailing soil substrates. However, *summa summarum* the development of investigated forest chronosequences would in fact point towards development of comparable forest stands on non-mined sites in the experimental region; with the exception of a much shallower rooting system (Böcker et al 1999).

The results of our process studies will eventually be integrated into a forest ecosystem model. This model will serve as a module in a suitable model for the landscape level. GIS supported models for disturbed landscapes will then be used to estimate the ecological consequences of the impacts of ecosystem disturbance on the level of landscapes as well as to eventually predict the rehabilitation potential of disturbed ecosystems or even of entire disturbed landscapes. Finally, these predictive models will be part of a decision support system for the management of disturbed landscapes.

Despite the negative effects of landscape disturbance, rehabilitation of disturbed landscapes offers a unique chance to eventually create new landscapes with an own sustainable development that may serve societal needs more adequate than the previous landscape or the remaining landscapes of the area in general. For example, it offers the chance to design an innovative landscape, dominated by new forests and a large number of lakes providing a potential for activities such as hunting, fishing and a large number of sport activities, thus meeting the strong request for recreation facilities by today's urban societies. This is possible as Lusatia is a rural area that can easily be reached by the citizens of e.g. the metropolitan area of Berlin. But parts of these "new" landscapes also offer the potential for nature protection in the context of biodiversity (natural succession) in both aquatic and terrestrial ecosystems and at the same time could be used as natural compensation areas for intensive construction measures in urban areas that result in the destruction of natural habitats.

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Urban forestry for land regeneration – The UK example

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Abstract

The regeneration of wasteland has been a major driving force for the development of urban forestry in the UK. This paper reviews land reclamation in that context from as early as the 19th century, but draws particularly on more recent experience. In the mid 1960s, national concern for public safety led to the urgent reclamation of unstable coal waste tips. Since then, techniques have developed considerably. From the late 1980s onwards there has been particular interest in promoting urban forestry as a way of dealing with the extensive dereliction which has resulted from the collapse of much of the UK's heavy industry, and in the past 15 years a number of local and regional urban forestry initiatives have been established. There is an increasing focus on the role which woodland can play in stabilising land and in the reclamation of contaminated sites, through the process of phyto-remediation. Urban forestry for land regeneration is now widely practised across the UK by local authorities, government agencies, non-governmental organisations and private developers as a cost effective contribution to sustainable development.

Key words: trees, urban, derelict land, forestry, regeneration, naturalistic.

1 Introduction

This paper reviews the history and changing practice in the use of urban forestry for land regeneration within the UK. It examines technical trends and the developing social, environmental and economic context for urban forestry.

2 Historical approaches

The Industrial Revolution began in the UK in the 1780s. The explosive growth of towns and cities and the rapid increase in transportation networks was accompanied by greatly increased mineral extraction, metal smelting and manufacturing, to serve the worldwide market of a huge and expanding British Empire. Throughout the following 200 years or so a great deal of land despoilation resulted from these activities.

Early greening programmes
From the early 1800s onwards there was occasional interest in greening the scars caused by industrial dereliction. For example, almost two hundred years ago, the Earl of Dudley planted trees in the urban West Midlands region to reclaim worked-out limestone quarries and the resulting woodland still survives today.

Between 1903 and 1924 the Midlands Reafforesting Association, a community-based voluntary organisation, planted new woodland on industrial spoil heaps in and around Birmingham - a region which, at the time, was particularly badly disfigured by mining operations.

Because of the atmospheric pollution from heavy industry, there was a widely held view that nothing green could be grown successfully. However, the Association raised money by public subscription and bought land. It also planted on local authority and privately owned land (Bastin 1914). In 1911 there were 5,700 ha of pit mounds (coal and other waste) - representing about 16 % of the area to the immediate north and west of Birmingham, known as the Black Country. By 1924, the Association had established over 40 ha of new woodland on a variety of different sites, planting one and two-year-old seedlings into spoil, with minimal site preparation. The species which were found to grow best were *Alnus incana, Alnus glutinosa, Betula pendula, Populus x euramericana "Serotina", Ulmus glabra,* and *Acer pseudoplatanus* as these were able to withstand the very harsh ground and atmospheric conditions.

The Association's pamphlets and lectures emphasised a number of key issues:

"An enormous area lies wholly waste
Pit-tips and spoil banks are ugly, and should be concealed if possible
The greater part of this waste land can be planted with no great trouble, and will readily support trees of appropriate kinds
Plantations so made will be commercially profitable: directly as producing timber, indirectly as increasing the value of building land in their neighbourhood
The presence of trees, besides being pleasant to the eye, and refreshing to tired workers, will improve the general health of the district"

Although the organisation was disbanded as long ago as 1926, its philosophy of tree planting by the community for the environmental and economic benefits it bestows is as relevant today as it ever was.

3 The technical challenge

By the 1950s, forestry was beginning to be recognised as a cost-effective way of dealing with the growing problem of dereliction. A number of local authorities in coal producing areas experimented with different techniques.

In 1964 there were estimated to be around 67,000 ha of despoiled land in England and Wales and this area was increasing at the rate of over 1,500 ha per year. From the 1960s onwards, the technical challenge of restoring land was thought to be the primary issue. Advances in the machinery for moving waste and in the science of soil-making led to more ambitious attempts to reduce the impact of urban dereliction. The Civic Trust brought together the research findings of the Forestry Commission with the results of a number of practical forestry initiatives and summarised current best practice in its publication *"Derelict Land"* (Civic Trust 1964).

In 1966, a disaster occurred in Aberfan, South Wales, which proved to be a turning point in political and technical attitudes to land restoration. Following a period of exceptionally heavy rain, a neglected colliery spoil tip slipped from the mountainside into the village below, destroying a school and killing 144 people, most of whom were children. The lack of geophysical testing and the siting, construction and monitoring of tips was called into question. The resulting report of the Aberfan disaster led to changed legislation regarding the disposal of colliery waste (Her Majesty's Inspectorate of Mines and Quarries, 1971). Quarry owners were now charged with securing the safety of solid and liquid waste and providing for design, supervision, inspection, notification and record keeping with regard to tips. The 1971 Regulations also placed duties on local authorities in respect of disused tips.

Experience showed that trees could be established on steep spoil heaps or on the „hill and dale" formation created by the extraction of certain minerals and this could provide a useful economic basis for reclamation, whereas restoration to agriculture did not succeed unless the ground was levelled, heavily fertilised and covered with a deep layer of topsoil. Nevertheless, for trees, it was recognised that physical exposure (related to the planting aspect), soil compaction, atmospheric pollution and biotic factors such as vandalism, were still significant barriers to tree establishment (Civic Trust 1964).

Coal waste

Mid-twentieth century approaches to the use of trees for stabilising coal waste involved a very simple technique of planting directly into the colliery spoil, with little site preparation. This gave very mixed results, with trees often growing quite well for the first 10 years, but then failing because of the self compacting nature of the material, poor drainage and particularly because of the extreme acidity of the substrate, due to the presence of iron pyrites.

Liming the soil did not necessarily solve the problem, with the quantities required for success often severely underestimated. The compaction of tips which had been reshaped using large machinery made the problems for tree growth even more severe. However, once this was realised, success could be achieved.

More recent approaches to coal waste reclamation have involved ripping to a depth of around 1m, followed by a more minimalist treatment which leads to a more naturalistic result. A number of the sites in the Groundwork *Changing Places* programme have successfully used this ecologically informed approach, which aims to work with the grain of nature (National Urban Forestry Unit 1999a).

Metal contamination

For many years, sites contaminated by heavy metals were either ignored altogether or reclamation work concentrated on establishment of grassland rather than woodland, requiring inert soil cover to reduce plant metal uptake. Anxiety over the consequences of disturbing such sites by planting them with trees may have been largely misplaced. Some species of trees can grow in substrates which contain levels of metal contamination which are a factor of 10 to 100 times higher than current toxicological guidance values. These statutory limits are based on human toxicity, rather than on the trees' ability to withstand levels of heavy metal contamination. More recent work in the 1990s (Dickinson et al. 2000) has focussed on the phytoremediation potential of metal tolerant genotypes of pioneer tree species on highly polluted sites. Trees may deal with the contamination through a process of *phytostabilisation* (immobilising metals in either the soil or the roots) or by *phytoextraction* (removing metals from the soil). Trees therefore have the potential to provide a safe and cost-effective solution to the treatment of contaminated land.

Landfill sites

Landfill sites (household refuse) were originally restored to agriculture by covering them with considerable depths of topsoil so that grassland could be established. This proved both expensive and relatively unsuccessful. As a consequence, trees came to be regarded as a good low cost alternative, although there was often a high rate of localised tree failure due to leakage of methane gas.

Much more stringent regulations concerning the construction of landfill sites led them to be sealed with a layer of clay, to prevent the escape of gas and liquid leachate. This in turn led to government guidance (Department of the Environment 1986) advising against the planting of woodland on landfill sites, for fear of penetrating the cap which sealed in the refuse.

More recently, Forestry Commission research (Dobson & Moffatt 1993; Moffatt & McNeill 1995) has shown that loose-tipping of a layer of 1.5m of material on top of the clay seal provides a perfectly good rooting medium for tree and shrubs. Moreover, the roots will not penetrate the densely compacted clay cap. Root growth is restricted to the better aerated and moisture-retentive loose material on top. This work has led to a change in the most recent government guidelines, which now accept woodland planting (Department of the Environment 1995).

Beyond engineering

By the end of the 1970s, there had been a recognition that the techniques of land reclamation could not depend on engineering alone:

"If we are to restore the land we must understand that it functions physically, chemically and biologically. This is essentially a task for the biologist and agricultural scientist"
(Bradshaw & Chadwick 1980)

4 Social and ecological dimensions to reclamation

Urban ecology

The relevance of the ecological and social value of urban wildspace had already been identified (Mabey 1973) and in the late 1970s, the Government nature conservation agency, the Nature Conservancy Council, commissioned an ecological survey of Birmingham and the Black Country (Teagle 1978). This seminal work revealed extensive areas of urban wildspace and also recognised the potential for natural recovery of damaged land.

By the mid 1980s, an urban nature conservation movement had become established in many of the UK's towns and cities. These organisations began to build popular and political recognition of the value of naturally regenerated derelict land (Baines 1986).

Strategic greening

The potential for a more strategic approach to urban wasteland was recognised over 30 years ago (Fairbrother 1970). In her book, *"New Lives, New Landscapes"*, she advocated that all the wasteland in and around towns should be identified and infilled with trees:

„…if we can transform our present disturbed areas to good green-urban landscape, it will be more effective than any other single reform in upgrading our general outdoor environment… …….in many places, this alone would frame our towns in green……..By planting areas of otherwise unused land we could travel into our cities through wooded landscape and unless there are definite reasons against it, tree planting could be the accepted and universal practice on all such land..."

A more strategic approach to large scale urban greening began to emerge through the derelict land programmes of local authorities in the West Midlands, South Yorkshire and other industrial areas. Policy makers in these conurbations were concerned with greening for:

- derelict land reclamation;
- image enhancement; and
- economic regeneration

However it was not until the late 1980s that urban woodland began to play a major role in strategic land reclamation, through such initiatives as the Black Country Urban Forest (ASH 1986).

This initiative involves a partnership of public, private and voluntary sector organisations. Its original aim was to use urban forestry to improve the image of the region, and also to improve the quality of life for those already living and working there. Over a ten-year period 800 ha of new woodland were planted and 400 ha of existing woodland were brought under active management. Strategic transport corridors, in particular, were targeted to maximise the impact for those travelling through the region and thousands of local people were actively involved in caring for the Black Country Urban Forest. This initiative has proved to be a very significant model for large scale urban greening programmes elsewhere across the UK (Johnston 1999).

Importance of natural colonisation

Broadleaved woodland is the natural form of vegetation in much of lowland Britain and trees tend to recolonise vacant open spaces quite naturally. A comparative survey of land cover in the industrial West Midlands, using aerial photographs, showed that 49 % of that region's tree cover was made up of young emergent woodland, formed through natural colonisation. In one part of the area, the borough of Sandwell, a comparative study was made of the change in woodland cover over the 12 year period 1977 and 1989. This showed an overall increase in woodland of 74 %, with natural regeneration being the most significant element (National Urban Forestry Unit 1995a). The potential for natural recovery had been recognised as long ago as the 1940s, as the survey of Birmingham and the Black Country by the West Midland Group noted in its publication, "*Conurbation*":

"Land cannot be rendered permanently derelict: in the course of time a natural covering of soil and herbage will return. This process can be speeded up and used to advantage in the rehabilitation of the Black Country landscape."
(West Midland Group 1948)

The benefit of this approach has been recognised by a number of researchers (University of Liverpool Environmental Advisory Unit 1984). It is also argued that natural succession is preferable to planting new woodland because the trees will be better adapted to site conditions and genetic distinctiveness will be preserved (Rodwell & Patterson 1994).

This has helped to inform the more ecological approach to urban woodland design adopted under the Black Country urban forestry initiative: bold, simple designs, using only two or three species, leading to the creation of robust, pioneer woodland (National Urban Forestry Unit 2001) - a strong echo of the approach taken by the Midland Reafforesting Association almost a century earlier.

A similar approach was taken in Merseyside, in the north-west of England, where the *Wasteland to Woodland* initiative (1990-1998) resulted in 124 ha of pioneer-style woodland being planted on derelict land such as coal spoil, brick pits and former land fill sites (Groundwork St Helens et al. 1998).

Social emphasis

In heavily populated urban areas, the relationship between local people and the urban forest is one which can lead to significant failure unless skilfully managed. In the 1970s the Lower Swansea Valley project in South Wales attempted to tackle problems such as burning and vandalism through actively involving local communities in tree planting and other activities (Lavender 1981). This approach of working closely with local people began to be more widely acknowledged (Brown 1982) and this philosophy underpinned the establishment of the government sponsored national regeneration charity Groundwork (Perry & Handley 2000).

The more successful woodland establishment projects in the mid 1980s began to combine effective community involvement with forestry techniques (use of small planting stock and good site preparation) as opposed to use of larger trees for a more dramatic instant impact. Nevertheless, this latter approach was, and regrettably, in many cases still is, favoured by many landscape designers. The frequent failure of larger trees is often blamed on vandalism, but this cause is generally exaggerated. Tree loss is much more likely to be due to poor planting and aftercare and the inherent loss of root systems occurring when large stock is transplanted (Bradshaw et al. 1995).

The success of Groundwork's *Changing Places* programme (1995-2001) in transforming large tracts of neglected industrial land into parkland and conservation areas depended as much on their community-led approach to regeneration as it did to the physical techniques employed (Barton 2000; Groundwork UK 2001). Throughout the 1990s, a number of urban forestry initiatives were established in a wide range of locations across the UK and there are now over 40 programmes at a city-wide or sub-regional scale, including the Community Forests programme and the National Forest (See Figure 1). Many of these initiatives have transformed substantial areas of derelict, despoiled and underused land into woodland, e.g. nearly 450 ha in the Central Scotland Forest between 1994 and 2001, but they are essentially long-term projects (The Countryside Agency 1999). Since derelict and despoiled land is usually closely associated with areas of high population density, its reclamation and the benefits that this can bring for local people generally form a major component of urban forestry initiatives. Clearly this greening of dereliction close to where people live and work is likely to be popular.

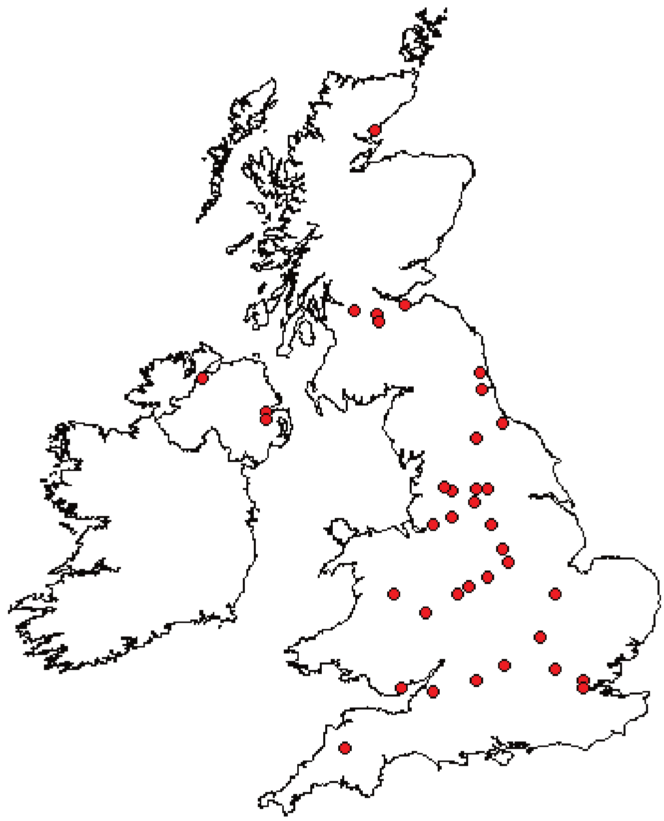

Figure 1. Distribution of urban forestry initiatives in the UK (NUFU 2002).

Sustainable development context

Towards the end of the 1990s, a very considerable and sustained fall in timber prices, combined with increased recognition of the non-timber value of woodland, led to a change in government policy, which in turn resulted in the publication of the England Forestry Strategy (Forestry Commission 1998). This has redefined the purpose of forestry in England so that the wider needs of society are given far higher priority. The strategy identifies four themes:

1. Forestry for rural development
2. Forestry for urban regeneration
3. Forestry for recreation, access and tourism
4. Forestry for the environment and conservation

This represents a major shift in policy and, despite the fact that the UK imports over 85 % of its timber requirements (Forestry Commission 2000), the emphasis is now moving away from timber production, and towards greater promotion of the non-timber benefits which come from woodland.

This change has been embraced by the state forestry agency, the Forestry Commission, in its work within the former coalfields and the Community Forests Programme and a special Land Regeneration Unit has been set up to promote the use of urban forestry for reclamation. Between 1997 and 2003, over 1,000 ha of derelict land is expected to be reclaimed as community woodland. The technical specification for this work has also begun to change significantly. In areas where new woodland is planned, the emphasis is now on ripping the land, loose tipping of "root-friendly" material to a depth of around 1.2m and use of a range of species appropriate to the site. Formerly, at least 60 % of the planting would have been non-native coniferous species, but now that timber production is no longer the first priority, this proportion has been reduced to around 25 % or less, with the conifers being used primarily for diversity and landscape enhancement reasons. On some sites, no conifers at all are used. In some cases, new planting may cover as little as 30-50 % of the site area and this is a clear indication that the importance of other habitats is now being acknowledged as a valuable part of forested landscapes.

A similar shift has taken place in Wales, where greater attention is now being paid to nature conservation in land reclamation projects. The Welsh Development Agency has produced its own guidance "*Working with Nature*", which describes a variety of low cost reclamation techniques (Welsh Development Agency 1994) and the Agency's current practice of encouraging natural regeneration is strongly influenced by the EU Habitats Directive (European Community 1994).

Despite the considerable extent of reclamation programmes, these have barely kept pace with the constant stream of new derelict land over the past two decades (Handley 1995). Derelict land is strictly defined as "*land that has been so damaged as to be incapable of beneficial use without further treatment*". The total amount of truly derelict land has remained remarkably stable, as Figure 2 below shows. However, wasteland is a much wider category, and includes operational, vacant and contaminated land. It is probable that there is a similar pattern of turnover of land in these other categories. In total, there are currently 175,000 ha of derelict and despoiled land in England. The extensive potential for woodland on urban and industrial land in the UK has been recently quantified (Perry & Handley 2000). The majority of this open space offers scope for restoration to woodland.

The full potential for afforestation of wasteland in urban areas is very far from being realised (National Urban Forestry Unit 1995b). The reasons for this slow take-up may be summarised as:

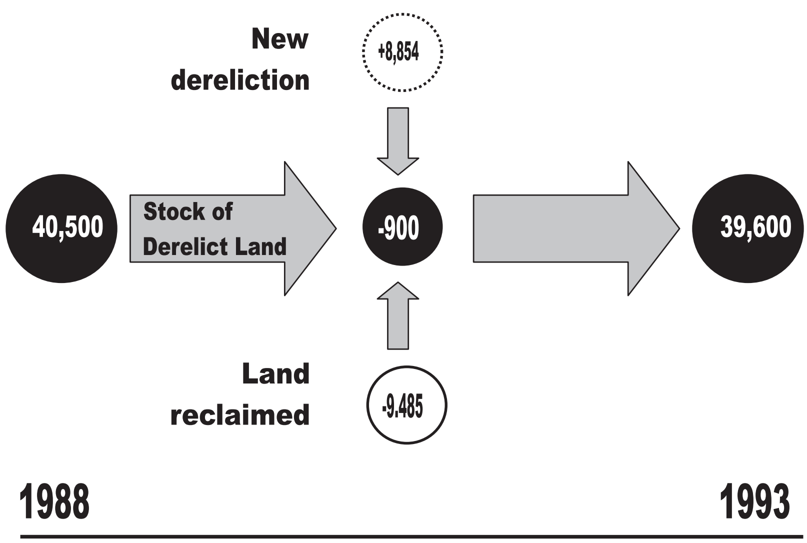

Figure 2. Stock of derelict land and components of change, 1988-93 (Source: Department of the Environment 1991; 1995b; reproduced by permission of John Handley).

- landowner attitudes to reduced development prospects;
- inappropriate client expectations;
- the public's fear of crime;
- difficulty in obtaining administrative and maintenance grants for low capital schemes;
- vested interests which militate against simple, low cost restoration solutions, and prefer much more expensive techniques, with their attendant higher professional fees and financial turnover;
- a lack of understanding of the relative costs of woodland and grassland establishment;
- a poor understanding of how to establish and care for woodland; and
- a lack of appreciation of the benefits of woodland.

It is not widely recognised that urban woodland can be a low cost / high benefit land use (Hodge 1995). A comparative study of the relative cost of managing different types of urban vegetation shows that informal woodlands (both naturally colonising and pioneer-style planted woodlands) that cater for casual public access are considerably cheaper to manage than most types of amenity grassland (National Urban Forestry Unit 1998).

New regional programmes

The National Urban Forestry Unit (NUFU) was established by Government in 1995 in order to promote and develop urban forestry across the country. One key contribution from NUFU has been its active promotion of the need to encourage urban greening on a strategic scale across whole conurbations (National Urban Forestry Unit 1999b). A strong emphasis on ecological continuity and the use of urban forestry as functional green infrastructure is now beginning to be adopted by some strategic planners.

One major new regional programme that promises to increase the amount of urban woodland substantially is the *Newlands* initiative, in the north-west of England. This programme is being jointly developed by the Forestry Commission, the North West Development Agency (one of nine regional government agencies) and the Red Rose and Mersey Forests. Urban woodland has been clearly identified as a means of delivering many of the North West Regional Development Agency's policies and the programme is regarded as making a significant contribution to economic regeneration, by enhancing the image of the north-west of England and by reinforcing its green environment. Sites will be assessed according to a *public benefits* scoring system – a methodology for prioritising sites using a range of economic, environmental and social measures. Over a four year period, over 500 ha of new urban woodland will be created and *Newlands* is intended to be the most extensive urban forestry programme for land reclamation in the UK.

The Thames Gateway, to the east of London, is another Government priority area for regeneration, where an enormous amount of new development is planned. There are proposals for up to tens of thousands of new homes to be built by the year 2020. Here, a new urban forestry initiative, the *Green Gateway,* forms an integral part of the regeneration plans and 30 different partner organisations have signed up to a strategy policy document (National Urban Forestry Unit 2002). The initiative promotes linked urban greenspace as a key element of the proposed economic, environmental and social regeneration.

Advocacy

There is a clear need for advocacy to promote the benefits of woodland as a means of regenerating urban land (Jones 1999). The justifications for this are, interestingly, much the same as those promoted by the Midland Reafforesting Association a century ago, as this extract from their literature shows:

Pollution amelioration	*"Trees absorb from the air large quantities of carbonic acid gas (choke damp)"*
Land value enhancement	*"The presence of each plantation adds enormously to the value of building land"*
Reducing storm water run-off	*"The destruction of forests leads to violent alternations of temperature and an increase of floods"*

It is essential that the role of trees and woods in towns as ***functional green infrastructure*** is clearly articulated, so that the full environmental, economic and social benefits of urban forestry and its contribution to sustainable development are understood and appreciated.

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Plenary Session V

Threats to forest and their sustainability in urban societies

Sustainable forest management in National Forest Programmes - A European perspective

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Abstract

In its recent regulations concerning forests, the European Union has assigned a high rank to National Forest Programmes (NFPs). From the point of view of the formulating and implementation of NFPs in a European context, the concept of sustainable forest management suffers from:

- lack of an operational European definition;
- differing interpretations of the individual elements of NFPs from country to country;
- a very strong tendency to attribute much greater weight to environmental and social aspects, with the role of forestry as a substantial element of economic development being played down.

As a further background to these considerations, Europe also bore witness to profound economic, political and social changes during the 1990s, above all in the countries on the list of application for European Union membership. The main question seems to be whether forestry management in Europe is commonplace and remains valid when implemented in accordance with the developed criteria and indicators for sustainable development, as well as introduced into in the European economy for good. While it is not the intention of this paper to evaluate the degree of compliance with sustainable forest management (SFM) principles shown by forestry management in a given country, an attempt is made to identify the problems, causes and concerns in relation to SFM in European NFPs.

Key words: national Forest Programmes, sustainable forest management.

1 Introduction

There is no doubt that the 1992 Earth Summit in Rio de Janeiro initiated a process of growing acceptance of many systemic solutions in the field of natural environment protection. Among these is sustainable forestry; a concept which has been known for a long time - both in practice and theory (Paschalis 1997), although the applied solutions that should align with Sustainable Forest Management (SFM) do not always meet the set of conditions in reality. This is due, amongst others, to the use of terms, definitions, principles, and assumptions in the language describing SFM, which promise more than can be executed in practice (Paschalis 2000).

The variation in cultural, economic, political and social conditions across Europe is sufficiently great to imply real threats to sustainable forest management under conditions of changing climate, environment and forests. The Europe of the 1990s also faced profound economic, political and social changes, above all among the countries applying for membership of the European Union. The insufficient control with industrial growth has evoked a growing feeling among the population that the environment is threatened and also stimulates social mistrust in SFM.

2 Materials

For almost 10 years now, an interesting discussion has been going on as regards the necessity for European countries to prepare National Forest Programmes. This was expressed very clearly when elaborating principles and assumptions to be included in the EU's Forestry Strategy (EC 1998) that in fact gives basic orientations of European activities in the area of forestry. This argumentation is further signified by the fact that the European Union (EU) has assigned a high rank to National Forest Programmes in its recent regulations concerning forests. Within the Union, national and sub-national Forest Programmes are perceived as instruments of the Strategy and are treated as a pre-introductory condition underpinning the implementation of EU policy in the development of rural areas.

The preparation of an NFP is a rational initiative over which each country must assume full leadership and responsibility. This follows from the *sovereign rights* of states to use their forests in line with their own environmental policies and developmental needs. NFPs refer to forests, forestry and the forestry sector in their broadest senses, which is to say that they are concerned with all forest or forest-related activities of human beings. They encompass everything related to the growing, harvesting and wise use of forest products, notably both wood and non-wood products, e.g. conservation of flora and fauna found in forests; protection of soils, landscape heritage sites and watersheds; forest-based tourism and national parks, and the main factors influencing them.

Most European countries have long conducted forest management on the basis of legislation concordant with principles of sustainable development (Neven 2002). However, only a few countries have elaborated National Forest Programmes, with the rest having National Forest Policies or Forest Statutes that define rules for forest resource management (NFP Germany 2001). Nevertheless, there is surely awareness that the basic goal of the management of a forest enterprise, in the past as well as at present, is preserving the forest's state of balance, identified as an optimal state of permanence of its various functions.

3 Problems

In the late 1990s, a growing conviction of a realistic opportunity for the Central and Eastern European Countries (CEECs) to join the European Union led to the adoption of new set of assumptions behind forest practice shaped by the definition of SFM functioning. This referred and still refers to several aspects of forestry, and first and foremost to:

- the existing gap between theoretical assumptions and the principles linking forest use with practical possibilities for the latter's implementation. This means that the different kinds of promise shown by SFM notions in terms of the multi-functionality of forestry cannot be taken advantage of simultaneously and immediately;

- many European countries' inability to date (in spite of an intensive development of research and education on forests and nature) to prepare their societies for full comprehension and approval of the regimes that must rule in forestry, with an attendant limitation on the use of some forest goods by the general public (Konijnendijk et al. 2000).

In many CEECs, the transformations that took place after 1989 restored the protection of property rights and increased the value of real estate, ensuring in turn a change in ownership structure, and a transformation of land use opportunities when advantage was to be taken of the new, dynamic reality of supply, demand and price relationships. For many countries, all this constitutes a serious barrier to sustainable development, whereby the superior interest of the community does not always coincide with that of the individual (Turaj 2001).

One of the problems of SFM is the concept of rural development being a common challenge not only to meet the principles of land use but also rural land use. A treatment of tourism and recreation as an element of non-urbanised, rural areas is worth supporting, but ultimately unacceptable to those countries with high forest cover and well-developed forest-timber industries. Furthermore it needs to be understood that the timber production function could remain dominant over the other forest functions across the given time span (Paschalis 2001).

New reasons, but at the same time additional difficulties connected with the new challenges, were ushered in by the resolutions of the Ministerial Conference on the Protection of Forest in Europe (e.g. MCPFE 1993). The catalogue of indicators thereto does not point to desired levels or even preferred trends to changes, as is the case with such economic categories as profit and costs. The result is an opportunity for conflicts of interests to arise, particularly when the desired increase in the level of a given indicator exerts a negative influence on the economic condition of the forest enterprise (Cubbage et al. 1993).

It seems that a lack of acceptance by the general public joins a lack of conviction as to "environmentally-safe" working technologies in forestry to constitute some of the most serious problems that broadly conceived forest use has to contend with. It is therefore necessary for NFPs to incorporate prescriptions documenting the fact that the technical and technological level of machines and devices now in use minimises environmentally negative effects. However, even environmentally-sound logging systems and the most sophisticated technology may cause devastation if the work is not properly planned and the machines not operated by trained and motivated personnel. The evaluation of the significance of wood harvesting and issues of minor forest uses in European NFPs is allowed to enhance the rationality of policies.

In the majority of the European countries, we can see an increasing interest in non-wood raw matters on the one hand, and considerable shortfalls in regulations concerning their use on the other. If the use of minor forest products is to be optimised, reliable information on the size and character of individual kinds of the resource is also required. However, the data available on this topic is very poor (UN/ECE 1997 etc.).

When it comes to the formulating and implementing of NFPs in a European context, the concept suffers in three regards:

- from the lack of an operational European definition of SFM;
- from differing interpretations of the individual elements of NFPs by countries;
- and from disappointing experiences with technocratic-oriented policy planning during the last few centuries.

The formulation of "principal elements" for NFPs is related first and foremost to the social and protective functions of forests, with the emphasis on partner relations assuming activity on the part of all actors in the environmental area.

Especially worthy of comment is a very strong tendency (in many European countries) for much greater weight to be attributed to environmental and social matters than to the role of forestry as a substantial element of economic development. Matters linked with the techniques and technologies of forest operations, and the construction of forest infrastructure, are often considered secondary, with the focus being put on environmental effects. This is related above all to the effects of introducing machines and devices into a forest area, with engineering access to forest space via the construction of roads being considered a nuisance factor disturbing, for example, the beauty of the landscape.

A lack of proper dialogue with society and public approval over intended actions can be a serious barrier. It should be mentioned that many European countries' lack of ability to solve conflicts and seek common areas of agreement between parties striving to obtain different kinds of benefits (including benefits from forests) is the cause of many conflicts. The reasons are numerous, yet the major one seems to involve the difficulties resulting from the necessity to determine the aim and scope of benefits deriving from forest goods and services. The lack of dialogue between those taking administrative and executive decisions in forestry and the rest of society generates an irrational approach on the part of the public to forest goods. This results from a lack of knowledge and consequent susceptibility to manipulation by the media.

4 Causes

The differences in approaches to forest management in Europe do not result merely from a lack of professional knowledge, but are very much dependent on the level of economic development and on possibilities for the basic social needs in a given country to be satisfied.

We can distinguish regions in Europe characterised by overproduction of timber with regard to current domestic market needs, as well as countries with under-production as regards the home timber market (FAO 1999). The reasons for the above countries to experience difficulties with the sustainable management of forests are variations in the demand level for other forest functions, such as the protective or the recreational functions. Furthermore, the demand dynamics for specified functions of forest resources can change rapidly over short periods of time, something, which can also be problematical where the implementation of SFM principles is concerned. Attempts to limit direct benefits from forest use which developments of wood substitutes may represent can leave some European countries with a substantial barrier to the further development of their forestry sector. At the same time, these attempts influence other countries which need to conserve their forests. Special account should here be taken of the cultural conditions prevailing in a given country, as one of the most important tools behind the practical implementation of the sustainable management principles into forestry.

One of the causes of threats to SFM is a growing awareness that many European countries - especially those on the list of candidates for European Union accession - have large forest complexes that cannot be made freely available to the general public, and so are unable to supply social and recreational functions.

5 Concerns

The above-mentioned problems and causes of a still-uncertain situation as regards the implementation of sustainable forest management in Europe are accompanied by concerns that complicate the situation even more.

It is suggested that the following elements should be taken into account:

- The growing feeling of threat to the environment that is evoked by uncontrolled industrial growth not always in line with general trends of development. This mistrust shared by new forest owners can be stimulated by a lack of professional knowledge and experience in managing forests (Matejicek 1996).
- The growing conviction that nearly 25-30 % of the arable land in the EU countries should not be utilised in agricultural production (Sinner 1996), with a simultaneous lack of cohesion between environmental and development programme's.
- The lack of sufficiently strong pressure on the non-productive functions of the forest economy, with a simultaneous unwillingness on the part of society to compensate for expenditures incurred in relation with social and recreational functions of forests (Klocek 2001). The competition between the characteristics of forest production functions and public goods is clearly a cause of this phenomenon.
- An insufficient interest shown by the wood industry in many of the main forest tree species of Europe, with a simultaneous preference for a few best-known, commonly occurring species.
- Awareness of the evident differences between forest management over 2-50 ha (landscape management), and that in areas exceeding 2000 ha (ecosystem ma-

nagement). The managing of larger forest areas is disproportionately more complex (Laacke & Schoeppach 1995).
- The adoption of the direction in forestry development, generally known as market-oriented management, also raises objections. This denotes the use of tools making possible the prediction of future demand for goods derived from forest or generated by forest resources.

To find a balance between the sustainable distribution of costs and benefits is difficult, and even more so as no proper economic tools are available for the correct valuation of both profits and losses.

6 Conclusion

The process of implementing principles of sustainable management into forestry was commenced many years ago and has been characterised by significant achievements, not just in single European countries but also on the scale of the continent as a whole. It is nevertheless far from being perfect, with identified weak points encompassing the following four main areas:

- There is a need to set appropriate criteria for the main stakeholders participating in both the benefits and losses occurring as forest resources are managed, which is to say the body taking administration decisions and the community. The advantage of participation lies in the possibility that a consensus may be reached in practice, as one of the ways of avoiding conflicts (Richardson & Counelly 2001). The current research results on the merging of forest management and communities are promising, having the kinds of chances for success indicated by Ishii et al. (1996).
- The need to promote the multiple-use, often irreplaceable benefits provided by forest resources fulfilling criteria as regards multifunctionality and public access. This implies the availability of forests as elements in the technical infrastructure of the country, their protection, and a reaping of benefit from the utilisation of functions that forests afford in the fields of cultural heritage, aesthetics and humanistic and spiritual experience. This is associated with the promotion of timber as a natural renewable and irreplaceable raw material, of which European forestry currently produces more than it can consume. Promotion and development of the role of timber processing as an integral process supporting SFM should therefore back up the above initiatives.
- There is a need to develop *long-term research projects* focusing first and foremost on mechanisms underpinning the functioning of forest ecosystems, as well as the effects of civilisation conditions on changes ongoing in ecosystems.
- The National Forestry Programmes in the European context are comprehensive policy frameworks for the achievement of sustainable forest management, based on a broad inter-sectoral approach and implemented in the context of each country's socio-economic, cultural and environmental situation.
- Relations between the NFPs and the problems of forest utilisation offer significant proof as to the reality, efficiency and economic potentials of their implementation and execution in forest practice.

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Urban trees and air pollution

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Abstract

Urban settings are highly artificial environments and - as suc - their climatic parameters differ considerably from non-urbanised environments. Among these parameters, air pollution is often elevated downwind of cities. Urban trees offer a range of positive benefits (climatic, psychological, recreational, didactic). In addition, they also play an important toxicological and hygienic role, in that they can chemically neutralise unstable pollutants (ozone, nitrogen and sulphur oxides). They are responsible for the first stage in the detoxification process, eliminating persistent substances and particulate matter from the air. As trees remove atmospheric pollutants from the environment, their functional status undergoes certain changes, be it visible or invisible. Thus, when we determine the health status of trees, we are also establishing an indirect indicator of the quality of the air. The presence of trees in urban environments also provides further benefits to the quality of urban air. Evapotranspiration reduces air temperature in summer. In turn, the lower temperature reduces the speed at which pollutants react and at which volatile organic compounds (such as those present in fuel or solvents) are released. Buildings surrounded by trees have lower energy needs for summer air conditioning and therefore less pollution is generated for energy production. The choice of forest species for urban design must bear in mind the fact that many trees release hydrocarbons involved in photo-smog production, the most abundant of which are isoprenoids. Forest trees can release as VOC's anywhere from 2 to 10 % of the carbon fixed in photosynthesis. In the presence of anthropogenic compounds (mainly nitrogen oxides), isoprenoids form ozone and indirectly cause greenhouse gas accumulation, since they react with anthropogenic compounds more slowly than isoprenoids. The reason why trees form and release these compounds is still unknown, but recent findings suggest that volatile isoprenoids are powerful antioxidants. After reviewing the main types of pollution affecting urban environments, we examine the role of urban trees as bio-monitors of air quality, pollutant sinks and source of pollutants. The paper further provides indications as to the most suitable forest species to use in order to clean urban air, and gives an overview of knowledge gaps and possible trends for future research, with emphasis on the species-specific relative effectiveness in particulate and ozone uptake.

Key words: air quality, bio-monitoring, carbon sequestration, urban forests, VOC.

1 Introduction

Trees in cities are confronted by a variety of adversities, including atmospheric pollution. An in-depth understanding of how urban trees interact with pollutants provides information that can be useful in planning their management, and allows us to fully exploit the potential benefits trees can offer in terms of community health and hygiene.

Although alteration of normal light and noise levels may be considered forms of pollution that can affect trees or be influenced by them, this review will concentrate on chemical air pollution, with special reference to ozone (O_3), sulphur (SO_2) and nitrogen oxides (NO_x), particulate, and carbon dioxide (CO_2). The latter is released by the same processes that produces pollutants, and can actually be considered a pollutant. If we define any foreign substance that negatively influences the function of plants as a "pollutant", then CO_2 cannot be included, since its effects on vegetation are never negative. But if among the various current definitions of pollutants we choose the one that considers them "substances found in the troposphere in quantities in excess of normal values", then CO_2 is to all intents and purposes a pollutant, since its atmospheric concentration has increased by some 25 % over the last 150 years (Brown et al. 1988).

After reviewing the main types of pollutants affecting urban environments, we examine the direct and indirect effects of urban trees on air pollution, and provide suggestions about the choice of the best tree species to plant in urban areas.

2 Major pollutants in urban air

Ozone

Ozone is the most widespread and harmful pollutant in Europe and North America; its presence is constantly increasing, especially in developing countries. Fowler et al. (1999) have estimated that by 1990 24 % of global forest was exposed to O_3 > 60 nmol/mol, a concentration likely to be phytotoxic to sensitive forest species, and this will increase to almost 50 % of global forest by 2100.

Ozone is a normal component of the upper layers of the atmosphere (stratosphere), where it absorbs harmful UV rays. Even in the lower atmosphere (troposphere), O_3 is normally formed in the presence of oxygen (O_2) and light, but it rapidly degrades back down to O_2. The presence of other atmospheric pollutants, especially NO_x and volatile organic compounds (VOC), shifts the balance of this reaction and favours the formation of O_3.

The new agreed Ozone Daughter Directive for Europe (2002/3/EC) defines information and alert thresholds as 1 h average values of 180 and 240 (formerly 360, Council Directive 92/72/EEC) mg/m^3, respectively. It sets a target value to protect human health of 120 mg/m^3 as a rolling 8 hour average, not to be exceeded on more than 25 days per calendar year, averaged over three years, from 2010 (Table 1). Last year's figures, still based on the less restrictive previous Directive, show that the exceedances of EC O_3 threshold values during the summer season April-August 2001 are widespread throughout Europe and especially in the Mediterranean area (De Leeuw & Bogman 2001).

Measurements performed in Pisa, Italy, for example, show that the critical level of O_3 for forests (10000 (nmol/mol)*hour AOT40 for the daylight hours from April through September) is reached in only eight weeks between June and July (Lorenzini 2002). By "critical level" we mean the concentration of O_3 above which direct negative effects can occur on the receptors (the plants), according to our current knowledge. The most significant negative effect is thought to be the reduction (by at least 10 %) of biomass accumulation. AOT40 is Accumulated hourly concentration Over a Threshold of 40 nmol/mol O_3, concentration below which no significant biological effect can be reasonably expected.

Yet it frequently occurs that O_3 concentrations recorded in rural areas are higher than those in the city. The main reasons for this are:

(a) O_3 is a secondary pollutant, the synthesis of which takes time: it is therefore probable that a considerable fraction is formed at a certain distance from the precursors;
(b) the increased pollution level in urban areas favours return reactions with NO_x which lead to O_3 depletion;
(c) in green areas, biogenic hydrocarbons may contribute to the formation of O_3, since they are more reactive than anthropogenic hydrocarbons.

The most common effects of plant exposure to O_3 are: alteration of stomatal behaviour; reduced photosynthesis and increased respiration; increased above ground/roots ratio; reduced biomass production; reduced reproductive capacity; reduced quantity of epicuticular wax and increase of its degradation; alteration of pathways related to secondary metabolism (polyammines, ethilene, pathogenesis proteins, phenilpropanoids).

Visible O_3 injury of foliage is being detected more and more frequently, even in open field conditions. The earliest reports related to *Pinus ponderosa* and *P. jeffrey*, followed by other tree species both in the United States and in Europe (reviewed in Matyssek & Innes 1999). Today we can also benefit from manuals and handbooks that make diagnosis easier (Brace et al. 1999; Flagler 1998; Innes et al. 2001; Skelly et al. 1987). Typical symptoms include red, brown, purple or black stipple on the upper sides of sun-exposed leaves of broad-leaved trees, and chlorotic mottling of older needles in conifers.

Sulphur and nitrogen oxides

Sulphur and nitrogen oxides are emitted during the burning of fossil fuels. SO_2 problems on trees - which have been recognised since the early 1900s - are usually localised around point sources such as power plants or ore smelters. The burning of lower sulphur level fuels, the construction of tall smoke stacks which widely disperse pollution, and the use of stack scrubbers have all served to decrease the number of SO_2 problems on trees within the past 10 years. In the European Union, a limit value of 125 mg/m^3 24h average, not to be exceeded more than three times in a calendar year, has been set for the protection of human health (1999/30/EC Table I). This limit value has to be met by January 2005.

In urban areas the number of days on which the EU limit for SO_2 was exceeded has decreased between 1990 and 1999 (Figure 1), thanks to several legislative measures. Economic recession and subsequent restructuring of the Central and Eastern European countries has also contributed to decreasing winter smog episodes. Concentrations are expected to continue to decline. Present peaks occur especially close to sources and in cities.

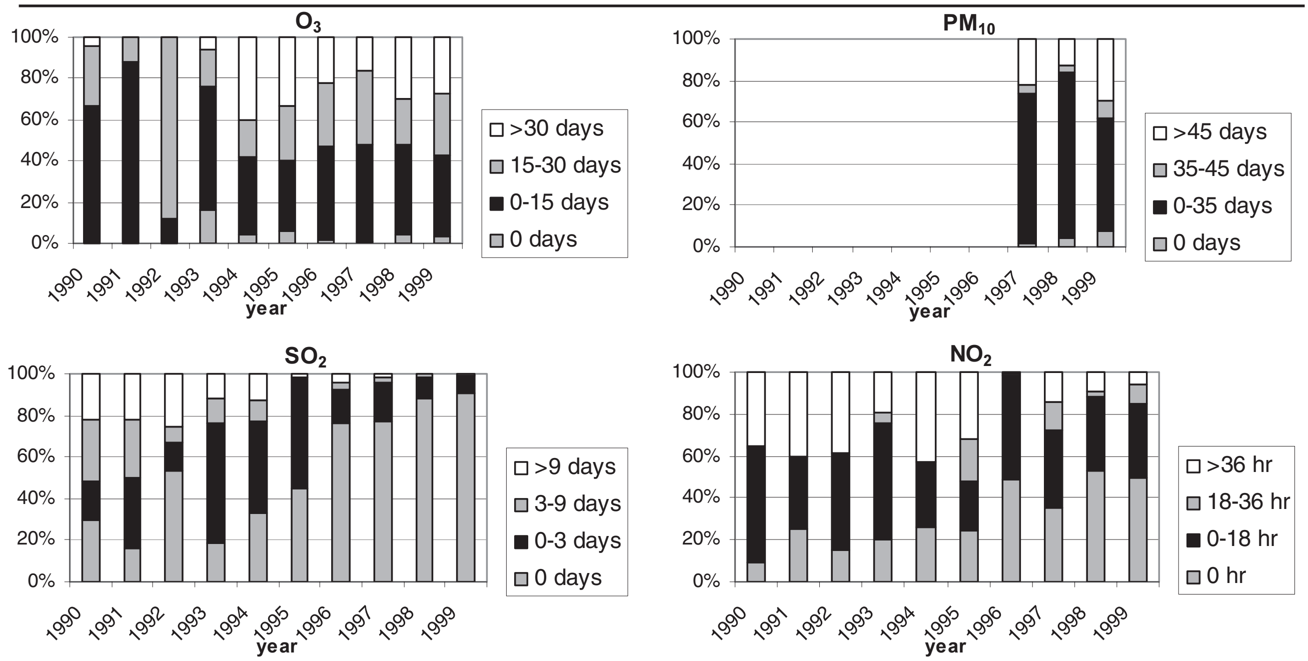

Figure 1. Exposure of urban population to ozone (O_3, 8-hr average concn. > 110 mg/m^3), fine particles (PM_{10}, 24-hr average concn. > 50 mg/m^3), sulphur dioxide (SO_2, 8-hr average concn. > 125 mg/m^3) and nitrogen dioxide (NO_2, 1-hr average concn. > 200 mg/m^3) in the 1990s in the European Union (EEA 2002).

Among the seven nitrogen oxides, only monoxide (NO) and dioxide (NO_2) are important pollutants. The latter is the more phytotoxic due to its higher water-solubility. For NO_2 a limit value of 200 mg/m^3 1h average, not to be exceeded more than 18 times a calendar year, has been set for the protection of human health (1999/30/EC), within January 2010. In addition, a 40 mg/m^3 limit has been set for annual mean concentration (Table 1). No clear trend in the exposure of urban population to the short-term limit has been recorded in the last decade (Figure 1). Peak concentrations occur in busy streets where road traffic is the main source. The introduction of catalysts in the car fleet has contributed to reducing urban emissions.

Table 1. Air quality limit values for the protection of human health in the European Union (EEA 2002).

Pollutant	Value (μg/m^3)	No. of exceedances should be	To be met (year)	Reference
Ozone	120 (8-h average)	< 26 days/year	2010	2002/3/EC
PM_{10}	50 (24-h average)	<36 times/year	2005	1999/30/EC
PM_{10}	40 (yearly average)	none	2005	1999/30/EC
Sulphur dioxide	350 (1-h average)	<25 times/year	2005	1999/30/EC
Sulphur dioxide	125 (24-h average)	<4 times/year	2005	1999/30/EC
Nitrogen dioxide	200 (1-h average)	<19 times/year	2010	1999/30/EC
Nitrogen dioxide	40 (yearly average)	none	2010	1999/30/EC

SO_2 and NO_x are toxic in the form of gases or of fine particles when are converted to sulphate and nitrate. Deposition onto the ground is an important cause of acidification. The main role of NO_x at present is in eutrophication and photochemical smog.

Phytotoxic gases damage cuticles and stomata; but, more importantly, they penetrate through the stomata and alter the tissues of the foliar mesophyll. SO_2 can cause both acute (cell plasmolysis) and chronic injury (reduced gas exchange, chlorophyll degradation, chloroplast swelling, alteration of cellular permeability). Yellowing and necrosis is interveinal in leaves and apical in needles. Levels of NO_x detectable in the environment are generally responsible for chronic type effects, due to the lowering of cellular pH, to deamination of aminoacids and nucleic acid bases, to the formation of nitrosammines. Visible symptoms (mild chlorosis and reduced development) are so aspecific as to make diagnosis practically impossible.

Particulates

Atmospheric pollutants that damage trees are mainly gaseous chemicals, although particulate substances are also involved. Negative impacts on human health are mainly associated with PM_{10}, i.e. particulate matter with a diameter less than 10 mm. PM_{10} in the air can result from direct emission or emissions of particulate precursors (NO_x, SO_2, ammonia and organic compounds). Particles thus result partly from the same emissions that cause acidification, eutrophications and ground-level O_3.

The Air Quality Daughter Directive (1999/30/EC) sets a limit of 50 mg/m^3 24-h average, not to be exceeded more than 35 times a calendar year from 2005 (Table 1). A significant proportion of the EU urban population is exposed to concentrations of fine particles in excess (Figure 1) and these are expected to remain well above the limit.

Dust that sediments on leaves can shield sunrays, affecting photosynthesis, respiration, transpiration, and allow the penetration of phytotoxic gaseous pollutants (Farmer 1993). Further, chemical substances contained in the dust can dissolve in the presence of moisture and damage the leaves, especially tender ones or those with hairs on their upper surface.

Apart from the nitrogen and sulphur compounds mentioned above, these substances also include heavy metals (HM), i.e. metals or metalloids that are stable and have a density greater than 4.5 g/cm^3, namely lead (Pb), copper (Cu), cadmium (Cd), nickel (Ni), platinum (Pt), zinc (Zn), mercury (Hg) and arsenic (As). The first three can be found both in particulate and in precipitation, while the other four return to the ground and to vegetation mainly with precipitation.

At environmental concentrations HM are never toxic for plants, but they can be toxic for man and animals, although Europe still lacks emission indicators for HM.

Carbon dioxide

Global change is becoming a decisive environmental issue in our time. It has been defined as "those changes that alter the well-mixed fluid envelopes of the Earth system (the atmosphere and the oceans) and those that occur in discrete sites but are so widespread as to constitute a global change" (Vitousek 1992). Those major efforts to elucidate its causes and effects have been devoted to the increase in the atmospheric CO_2 concentration. It showed a 25 % increase since the onset of the Industrial Revolution and is projected to double from the current concentration of 350 to 700 mmol/mol within the next 80 years.

In 2000, total European Community greenhouse gas emissions were 4,059 Tg (CO_2 equivalents), which was 0.3 % above 1999 and 3.5 % below 1990 levels (Gugele & Ritter 2002). In the Kyoto Protocol, the EC agreed to reduce its greenhouse gas emissions by 8 % by 2008-2012, from 1990 levels. Assuming a linear target path from 1990 to 2010, total EC greenhouse gas emissions were 0.5 index points above this target path in 2000. CO_2 is by far the most important greenhouse gas, accounting for 82 % of total EC emissions in 2000. In 2000, EC CO_2 emissions were 3,325 Tg, which was 0.5 % above 1999 but 0.5 % below 1990 levels.

The increase in atmospheric CO_2 concentration may affect biological processes at many levels of organisations, even if its direct effects on vegetation are never negative. Its indirect effects (i.e. climate changes) rise the greatest concern. Trees can contribute to mitigation of global changes because of their key role played in the energy and mass exchanges between the atmosphere and the geosphere.
Recent evidence from a long-term FACE experiment demonstrates the strong influence of O_3 at relatively low seasonal concentrations in offsetting predicted biomass gain due to enhanced CO_2, as well as its effect on insect performance (Percy et al. 2002).

3 Urban trees as bio-monitors of air quality

As trees remove atmospheric pollutants from the environment, their functional status undergoes changes. Thus, when we determine the health status of trees, we are also establishing an indirect indicator of the quality of the air. Bio-monitoring can be defined as using an organism to obtain information on the quality of the environment. It can be active, if it deliberately introduces into the study area selected and standardised plant material, or passive, if it uses plants that are naturally present in the environment. Urban trees are excellent passive monitors. Thanks to their long life span they are exposed to pollutants for very long periods, they are well adapted to the environment where they live, and they are usually well distributed throughout the urban area. But care must be taken in the interpretation of effects (macroscopic, physiological and biochemical), since many pollutants elicit similar responses and it is very rare that only one kind of pollutant is present in an environment. Furthermore, the injury is hardly ever acute, i.e. caused by a short exposure to high concentrations of the pollutant; damage is usually chronic, caused by prolonged exposures to relatively low levels of pollutants. Occasionally trees can also display reduced productivity and vitality in the absence of visible symptoms.

The effects of pollutants are very subtle, since they are often invisible and a-specific. Diagnosing air pollution injury to trees is not easy because the injury can occur in many different forms depending on the pollutant, the tree species, and the environmental conditions. The US Environmental Protection Agency's manual on diagnosing vegetation injury caused by air pollution (Applied Science Associates 1978) lists

Table 2. Typical symptoms from ozone and sulphur dioxide injury on hardwoods and conifers.

Pollutant	Hardwood symptoms	Conifer symptoms	Indicator plants
Ozone	Upper leaf surface stipple or fleck, often purple or black in color. Green veins. Premature leaf drop.	Current-year needle tip necrosis (tipburn), shortened needles (dwarf), mottling (chlorosis). Premature needle drop.	Bel W-3 Tobacco, NC-S White Clover, Green Ash, Milkweed, Black Cherry
Sulphur dioxide	Bifacial, interveinal tan or brown necrosis.	Current-year needle tip necrosis (extending towards base when severe). Yellowing of older needles.	Alfalfa, Blackberry, Birch

six questions to be answered in attempting to diagnose air pollution injury: (1) What plant species are injured? (2) What are the injury symptoms and what plant parts are affected? (3) Is there a pollution source nearby capable of causing injury? (4) What is the distribution of affected plants? (5) Are biological agents (insects, diseases, nematodes) present? (6) What is the recent history of the affected area?

Visual injury, like growth reduction, crown thinning, phenological alteration, and leaf injury (chlorosis and necrosis) may be caused by several factors and may be related to pollution only inside large monitoring investigations. However, there are types of visible symptoms that are associated with specific air pollutants (Table 2). The use of indicator plants (active monitoring) can help to address diagnosis.

In the 1990s, 3.5 % of the tree population died annually in Poland's largest and most polluted cities (Chmielewski et al. 1998). Dieback of street-side trees in Warsaw was a long-term process, due to unfavourable conditions, particularly air and soil pollution and water deficiency. The process was intensified by microclimatic changes leading to a xeric environment (lowering of air humidity and rising of air temperature). To study this problem *Tilia euchlora* trees were examined. This species represents more than 40 % of *Tilia* in Warsaw, and was used in the reconstruction of urban plantings after World War II at the beginning of 1950. Observation of phenological development of trees indicated a shortening of their vegetation period (up to 30 days) depending on the proximity to the city centre. The dendrometric examinations revealed a reduction of stem diameter of affected trees. These changes were accompanied by leaf dieback starting at the beginning of July. Significant correlations were found between leaf damage and chemical concentration of some pollutant elements.

Among visual injuries, attention today focuses on O_3. Except for very sensitive species, no injury to trees is usually seen until late season (Harkov et al. 1979). Some degree of expertise is required to recognise O_3-induced foliar symptoms. Symptoms variability may induce mistakes in diagnosis. For this reason, these symptoms are referred as "ozone-like" or those that may be caused by O_3. Some basic O_3 visible injury such as stipples and general pigmentation are now recognised as typical symptoms of chronic exposure to O_3 in broadleaf trees, despite some symptoms caused by biotic or abiotic agents may be confused with those caused by O_3. Some species show natural leaf coloration which may be enhanced under O_3 (ex. young leaves of *Corylus avellana* and *Rubus* spp., and mature leaves of *Cornus sanguinea* show a natural reddish coloration). Although O_3 visible injury is species-specific and can vary with environmental and/or physiological conditions, the most important distinctive symptom characteristics that can be observed and applied to distinguish from non-O_3 induced symptoms in broadleaves, are summarised in Innes et al. (2001):

(1) O_3-induced injury is usually expressed as a dark-coloured, upper leaf surface stipple (smaller than 1 mm) or as an upper surface general pigmentation (bronzing or reddening discoloration) with the lower leaf surface clear of symptoms. Only towards the late season, O_3-induced injury may also be visible on the lower surface.
(2) Symptoms are never present on the veinlets.
(3) Leaves towards the base of the twigs (older leaves) exhibit an increasing presence of stippling due to longer seasonal O_3 exposures (age effect).
(4) Additional typical features include the shading effect by an overlapping leaf (shaded leaf area is clear of symptoms) and premature leaf senescence followed by early leaf abscission. Ozone-like injury has been identified for many tree species (Brace et al. 1999; Flagler 1998; Innes et al. 2001; Skelly et al. 1987), even if further research may reveal more symptomatic plant species and a wider range of symptoms.

Nevertheless, correlations between foliar injury and ambient oxidant levels were sometimes weak or lacking, depending also on tree species (Harkov et al. 1979). For example, ascorbate-specific peroxidase activity in leaves of *Ailanthus altissima* growing in Berlin showed weak positive correlation with SO_2 and NO_x and negative correlation with O_3, and there was no correlation with pollution in *Betula pendula*, *Tilia platyphyllos* and *Platanus acerifolia* (Rank 1997). The quantum yield of PS2 and the amount of thiobarbiturate-reactive substances in the leaves were not influenced by the concentration of air pollutants.

Among microscopical injuries, most of the attention has been paid to cuticles. Waxy cuticles are the interface between higher plants and their aerial environment. The erosion of the surface structure is considered one of the most reliable indicator of pollution, even if ageing and artefacts may complicate data understanding (Percy et al. 1994). The total amount of diluted waxes is often inversely proportional to the amount of accumulated surface substances (dust) and decreases from rural to urban areas (Huttunen et al. 1985b). Leaf washing is the simplest method to allow quantification of dust.

The analysis of urban dust loadings on leaves of urban trees may give important information to investigate the spatial and temporal pattern of dusts. Matzka & Maher (1999) measured higher dust loadings for leaves collected adjacent to uphill road sections than for those next to downhill sections. This suggests that vehicle emissions, rather than friction wear or re-suspended road dust, were the major source of the roadside particles. The particle size fell dominantly in the range classified for airborne particulate matter as PM2.5 (<2.5 μm), a particle size hazardous to human health due to its capacity to be respired deeply into the lungs. Loadings fell significantly from high values proximal to the roadside to lower values at the distal side, confirming the ability of trees to reduce dust concentrations in the atmosphere. Analysis over days and weeks showed that rainfall produces a net decrease in leaf loadings.

Scanning electron microscope (SEM) is one of the most useful tools for investiga-

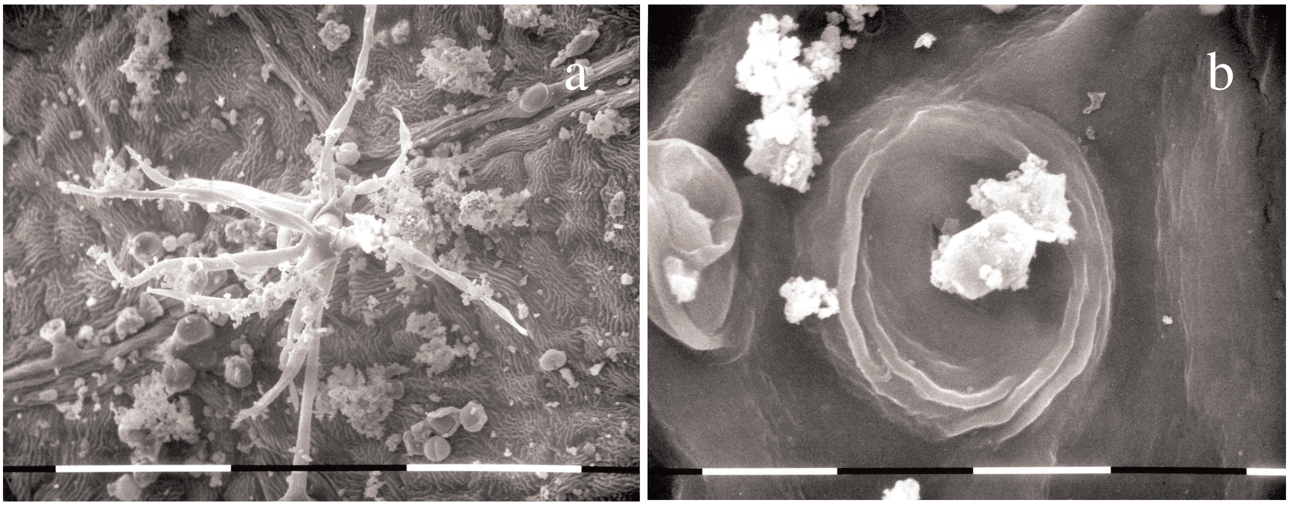

Figure 2. Cement dust trapped by a trichome on the adaxial surface of a Platanus acerifolia leaf (a, white bar = 100 mm), and interfering with a stomatal opening on the abaxial surface of the same leaf (b, white bar = 10 mm).

ting dust deposition onto leaves and to identify dust particles, coupled with electron probe microanalysis. Particles usually accumulate over time and then are more numerous later in the growing season. The spatial pattern of dust accumulation on leaves is species-specific, depending on leaf morphology (size, position, type and distribution of hairs). In *Platanus acerifolia*, particles are more abundant in the centre of the leaves near the petiole, and on the adaxial surface (Smith & Staskawicz 1977). They were variable in size (mostly 5-50 mm) and morphology, with carbonaceous and aggregate particles commonest. Fungal mycelia were in close association with particles. Stomatal blockage or contamination sometimes occurred on the leaf abaxial surface, and trichomes accumulated many particles (Figure 2).

Higher number of particles and levels of HM in leaf dusts are usually observed closer to roads (Freer-Smith et al. 1997; Sakagami et al. 1982). Metal accumulation in leaves is usually species-specific, possibly related to differences in leaf surface structure (Paribok et al. 1982). After uptake by leaves and roots, metals are stocked in the wood. Lead was the most investigated HM in urban and street tree wood, after its addition to petrol in the 1930s. The pattern of lead concentration in the wood corresponded to increasing ambient concentration as a result of increased vehicular traffic (Ragsdale & Berish 1988), but recent restrictions on leaded petrol have strongly limited the usefulness of investigating lead accumulation in plants.

Also winter sulphur content of foliage, frequently investigated as an index of air pollution (Cha & Lee 1991; Huttunen 1982; Huttunen et al. 1985a), today is less significant due to the decrease in sulphur emission.

4 Urban trees as pollutant sinks

Energy use is the main contributor to air pollution. In the US, of all electricity generated, about one-sixth (around 40$ billion/year) is used for air-conditioning of buildings. Of this one-sixth, about half is used in cities classified as "heat islands", where the air-conditioning demand has risen 10 % within the last 40 years (HIG 2001). Trees affect energy use in buildings through both direct and indirect processes:

(1) reducing solar heat gain and radiant heat gain from the surroundings by shading, even if shading can increase the heating use during the winter, so that deciduous trees are the most beneficial; moreover, trees block the heat flow from the building to the cooler sky at night;
(2) reducing outside air infiltration into buildings by lowering wind speed;
(3) reducing the heat gain by lowering ambient temperatures through evapotranspiration in summer – a tree can use up to 400 liters of water a day (Kramer & Kozlowski 1960);
(4) in some cases, increasing the latent air-conditioning load by adding moisture through evapotranspiration (Huang et al. 1987).

Energy savings attributable to urban forests are largely due to a reduction in the use of air conditioners or heaters in homes and offices when temperatures fall outside human comfort zone (Akbari et al. 1989; Huang et al. 1987; McPherson et al. 1994). The range of values reported in the literature reflects the different sources of energy (coal, hydrological, gas), tree habits, and climatic conditions. Overall, evergreen trees may reduce the need for heating by reducing the cooling effects of the winds although this effect may be balanced by their shading of the winter sun (Brack 2002). A reduction in energy consumption, as well as providing a cost saving may also result in the avoidance of producing pollutants, so that trees act as indirect pollutant sinks or pollutant avoiders.

Vegetation directly reduces the amount of air borne pollution by capturing particulate pollutants on its leaf surface, and either trapping them there or directing them into the ground during rain. Gaseous pollutants may be directly absorbed into the leaf through stomata, and indirectly adsorbed by physical reactions with their surfaces. The deposition of gaseous pollutants and particulates is greater in woodlands than in shorter vegetation (Fowler et al. 1989). In addition to having greater leaf areas than other types of vegetation, trees create more turbulent mixing of the air passing over land.

Thus, urban woodlands and the presence of trees in the urban environment contribute to removing considerable amounts of materials from the atmosphere, as reflected by the high ionic contents in throughfall and stemflow (Abas et al. 1992). For Chicago, Illinois, Nowak (1994a) concluded that through dry deposition trees on average remove about 0.8 % NO_2, 0.3 % SO_2, 0.3 % O_3, and 0.4 % PM_{10} from the air. In Fushun, China, average concentrations of SO_2, NO_x and particulates were reduced by 13.3, 16.0 and 43.2 %, respectively, inside the forest belt surrounding the city (Xie et al. 1998). The addition of 11 millions trees in Los Angeles, on a daily basis scavenged 1 % of the mass of O_3 by dry-deposition, plus 0.6 % by also scavenging NO_2, an O_3 precursor (Taha et al. 1997). Thus exceedance over the California standard of 90 nmol/mol was reduced by 6 %, resulting in an estimated savings of about US$180 million/year, i.e. much higher than the smog benefits from the 0.1 % reduction in PM_{10}, worth US$7 million (Rosenfeld et al. 1998). The tree-induced temperature reduction in summer also leads to reduction in O_3 concentration, even if in humid climates trees can be less effective than increasing the reflectivity of surfaces (Taha et al. 2000). Planting 500,000 trees in Tucson, Arizona, would reduce airborne particulates by 6500 t/year (McPherson 1991). Trees in Philadelphia, Pennsylvania, improved air quality by 0.72 % through removal of PM_{10} (Nowak et al. 1997).

Larger trees have a greater leaf area to trap air borne pollutants, and tend to extract and store more CO_2 from the atmosphere, so that Wee (1999) found correlations between projected crown area and dollar benefits in a number of US studies. Beckett et al. (2000a) found that younger, smaller trees of the same species were also highly effective at removing pollutant particles due to their greater foliage densities than those of much larger mature specimens.

Due to the increase of the atmospheric CO_2, the related climate changes and the Kyoto commitments, the mass of carbon (C) sequestered in urban trees is also of interest at present. Several studies have estimated the total C, usually by modelling bole volumes on the basis of statistical models and tree surveys, by converting volume to bole mass (multiplying by average basic density) and then to C (multiplying by average C content), and adding a below ground C mass estimated from root-shoot ratios.

Data for the rate of C sequestration by urban trees anyway are scarce; most data are given in units of tons per year of C per hectare of forested land, even in the cities (Mayhew 2000). However, Nowak (1994b) and Akbari (2002) have analysed C sequestration by individual trees as a function of tree diameter measured at breast height (dbh). The calculation yielded an average of about 4.6 kg/year over the life of a tree until its crown has grown to about 50 m^2. As trees grow, the rate of sequestration increases. The average sequestration rate for a 50-m^2 tree was estimated at about 11 kg/year. If planted in Los Angeles, the same trees avoid the combustion of 18 kg of C per tree per year, thanks to the indirect reduction in the cooling/heating energy use of buildings.

Despite CO_2 is evenly distributed in the atmosphere, the urban C cycle has its own driving forces. Vehicles are by far the largest contributors of CO_2 in urbanised area (Koerner & Klopatek 2002). A tree planted in close proximity to the pollutant source may be more effective in mitigating pollution. Planting efforts must focus on reducing early tree mortality and putting the right tree in the right location (Rowntree & Nowak 1991), e.g. parking lots (Scott et al. 1999). A consistent pool of C can be stored in forest soils. Very little data exists to assess how urbanisation affects the soil C. A preliminary analysis suggests that soil C storage in urban ecosystems is highly complex and variable (Pouyat et al. 2002). The direct measurement and modelling of surface-to-atmosphere exchanges of CO_2 in urban landscapes are still lacking to date, but should be characterised in the future with continuous eddy covariance measurements (Grimmond et al. 2002).

Annual, combined energy reduction, pollution mitigation and C sequestration account for considerable values, e.g. US$4-15 million by the about 400,000 trees in Canberra, Australia (Brack 2002), and US$2.81 million by the 90,000 trees in the city of Modesto, California (McPherson et al. 1999).

5 Urban trees as source of biogenic organics

Trees emit volatile organic compound (biogenic VOCs) that may contribute to air quality problems. The term VOCs includes organic atmospheric trace gases other than CO_2 and CO. Focusing on hydrocarbons but excluding methane, the term nonmethane hydrocarbons (NMHCs) is used, while VOCs without methane are termed nonmethane VOCs (NMVOCs). Biogenic VOCs include isoprenoids (isoprene and monoterpenes) as well as alkanes, alkenes, carbonyls, alcohols, esters, ethers, and acids. Isoprenoids are the most prominent compounds (around 500 Tg C/year), followed by alcohols and carbonyls. The release of compounds other than isoprenoids has been poorly investigated; gaps in knowledge still exist for stress such as air pollution (Kesselmeier & Staudt 1999). The high diversity of VOCs implies problems with sampling and analysis, understanding the atmospheric chemistry, the biological metabolism and the factors influencing the release from different biogenic sources. These sources can be highly variable owing to stress effects, e.g. O_3.

Atmospheric concentrations of biogenic NMVOCs range between a few pmol/mol and several nmol/mol. Many VOCs can be quite reactive under atmospheric conditions, with a chemical lifetime ranging from some minutes to hours. Concentrations reflect the diverse factors influencing VOCs, such as anthropogenic and biological sources or sinks, as well as meteorology, chemical reactivity, and deposition. Isoprene and monoterpenes, in particular, as well as their reaction products, are involved in tropospheric chemistry, fuelling (directly or indirectly) the production of air pollutants and greenhouse gases, such as O_3, carbon monoxide (CO), and methane, and increasing acidity as well as the production of aerosols (Kesselmeier & Staudt 1999). VOCs emitted at night (as many monoterpenes) are not implied in photochemical reactions, as they are degraded before dawn.

Monoterpenes constitute the main fraction of essential oils that are produced (and stored) in plant secretory organs like glandular trichomes and resin ducts. Isoprene is never stored in plants, but is rapidly lost by volatilisation.

Isoprenoids protect plant membranes against oxidative stress by O_3 (Loreto et al. 2001), drought (Sharkey & Loreto 1993) and elevated temperatures (Loreto & Sharkey 1990).

Trees can release as VOCs anywhere from 2 to 10 % of the C fixed in photosynthesis. Many plant species have been investigated as isoprenoids emitters, and emissions factors have been calculated in relation to leaf biomass and time, under standard environmental conditions (Kesselmeier & Staudt 1999). Anyway, emissions studied in laboratory on young potted plants may considerably differ from those in the field on mature plants. Table 3 summarises emission rates for the most common trees and shrubs in urban areas.

6 Choice of the best urban tree species

Taking into account air pollution only, the main parameters to analyse in choosing tree species for urban planting are: main sources of pollution; type and concentration of pollutants; meteorological parameters such as wind direction and precipitation; aims of the air-pollution reduction strategy; age, size, and characteristics of plants. This review focuses on the last parameter.

Table 3. Emission rates of isoprenoids (mg g LDW^{-1} h^{-1}) at 1000 mmol m^{-2} s^{-1} PAR and 30°C, from some urban trees and shrubs (from Kesselmeier & Staudt 1999).

Family Species	Isoprene	Monoterpenes	**Family** Species	Isoprene	Monoterpenes
Aceraceae			**Hamamelidaceae**		
Acer floridanum	+	2.0	*Hamamelis virginiana*	<1	<0.2
Acer rubrum	-	3.5	*Liquidambar styraciflua*	3.5-99	2.9-51.5
Acer platanoides	<0.04		**Hippocastanaceae**		
Acer saccharinum	-	2.2-3.5	*Aesculus flava*	<1	<0.2
Anacardiaceae			**Juglandaceae**		
Pistacia lentiscus		0.41	*Carya aquatica*	-	0.7
Pistacia vera	-	9.0	*Juglans regia*	-	1.8
Schinus molle	-	3.7	**Lauraceae**		
Schinus terebinthifolius	-/+	1.3-10.4	*Cinnamomum camphora*	-	0.03
Apocynaceae			*Persea americana*	+	+
Nerium oleander	-/+	-/+	*Persea borbonia*	-	1.2
Aquifoliaceae			**Lythraceae**		
Ilex cassine	-	-	*Lagerstroemia indica*	-	-
Arecaceae			**Magnoliaceae**		
Elaeis guineensis	172.9		*Liriodendron tulipifera*	4.1	
Phoenix dactylifera	15.8	+	*Magnolia grandiflora*	+	5.9
Sabal palmetto	4.7	0.4	**Mimosaceae**		
Serenoa repens	8.9	+	*Acacia farnesiana*	-	4.7
Washingtonia filifera	9.9	+	*Acacia nigrescens*	110	0.7
Xylosma congestum	6.8	+	*Acacia tortilis*	<0.5	8.8
Asteraceae			*Albizia julibrissin*	10-40	<0.2
Artemisia californica	-	9.6-47.0	**Moraceae**		
Artemisia tridentata	<1.0	<0.2	*Ficus fistulosa*	27	0.2
Berberidaceae			*Morus rubra*	-	1.6
Mahonia spp	10-40	<0.2	**Myrtaceae**		
Nandina domestica	25.1	+	*Eucalyptus globulus*	15-57	0.7-9.2
Betulaceae			*Eucalyptus viminalis*	8.0	+
Alnus rubra	0.02		*Eugenia grandis*	12.1	
Betula pendula	-	0.19-5.4	*Myrtica cerifera*	-	1.1
Carpinus betulus	-	0.04	*Myrtus communis*	25-137	0.3
Bignoniaceae			**Oleaceae**		
Catalpa spp	<1	<0.2	*Fraxinus caroliniana*	-	-
Jaracanda mimosifolia	-	-/+	*Fraxinus ihdei*	+	+
Caprifoliaceae			*Ligustrum lucidum*	+	+
Sambucus simponii	-	+	*Olea europaea*	+	0.1-0.5
Symphoricarpus occidentalis	<1	<0.2	*Phillyrea angustifolia*		0.47
Viburnum rufidulum	-	0.2	**Pinaceae**		
Caesalpiniaceae			*Abies lasiocarpa*	<0.1	3.0
Cercis canadensis	-	-	*Cedrus deodara*	-/+	0.3-0.9
Burkea africana	36	<0.5	*Picea abies*	0.34-1.8	0.6-12.0
Cupressaceae			*Picea engelmannii*	9.5-16.0	4.3
Cupressus forbesii	-	1.7	*Picea glauca*	7-15	1.4
Cupressus sempervirens	-	0.1	*Picea mariana*	15	+
Juniperus chinensis	-	0.6	*Picea pungens*	12	1.0
Juniperus oxicedrus	0.08	0.96	*Picea rubens*	1.1	+
Juniperus phoenicea		0.77	*Picea sitchensis*	1.8-4.0	1.1
Thuya plicata	0.02	0.07	*Picea canariensis*	-/+	1.7-2.6
Ericaceae			*Pinus clausa*	-	11.5
Arbutus unedo		0.12	*Pinus densiflora*		0.15
Arctostaphylos glandulosa	-	-	*Pinus ellottii*	-	3.2-6.2
Arctostaphylos glauca	+	+	*Pinus halepensis*	+	0.2-1.0
Erica multiflora	2.0	0.03	*Pinus palustris*	-	5.9
Erica arborea	6.4-20.3		*Pinus pinaster*		0.6-1.0
Kalmia latifolia	<1	<0.2	*Pinus pinea*	-/+	0.4-15.0

(Table 3 continue on next page)

Table 3. (continued from previous page)

Family Species	Isoprene	Monoterpenes	**Family** Species	Isoprene	Monoterpenes
Euphorbiaceae			*Pinus ponderosa*		2.5
Hevea brasiliensis	7.5	0.5	*Pinus radiata*	-/+	0.7-0.9
Fabaceae			*Pinus sabiniana*	-	0.6
Robinia pseudoacacia	10.1-13.5	0-4.7	*Pinus sylvestris*	-	0.8-12.1
Spartium junceum	6.4	0.53	*Pinus taeda*		5.1
Fagaceae			*Pseudotsuga macrocarpa*	-	1.1
Castanea dentata	<1	<0.2	*Pseudotsuga menziesii*	1.5	2.3
Fagus sylvatica	<0.01	0.25-0.5	*Tsuga mertensiana*	0.03	0.4
Quercus agrifolia	35	+	**Pittosporaceae**		
Quercus alba	7.8-120	1.5	*Pittosporum tobira*	+	+
Quercus borealis	19.7-40.4		*Pittosporum undulatum*	+	+
Quercus calliprinos	0.1	3.1	**Platanaceae**		
Quercus canariensis	11.3	1.0	*Platanus occidentalis*	27.5	-
Quercus cerris	0.1	3.1	*Platanus racemosa*	10.9	+
Quercus crysolepis	11.7	0.1	**Rosaceae**		
Quercus coccifera	0.1	18.7	*Amelanchier alnifolia*	<1	<0.2
Quercus coccinea	20-130		*Cercocarpus betuloides*	-	-
Quercus douglasii	8.7	-	*Cercocarpus montanus*	<1	<0.2
Quercus dumosa	5.0-54.4	+	*Cotoneaster pannosus*	+	+
Quercus faginea	111	0.5	*Crataegus spp*	<1	<0.2
Quercus frainetto	134	-	*Malus domestica*	<1	0.2-1
Quercus gambelii	151		*Prunus armeniaca*	-	0.1
Quercus garryana	59.2		*Prunus avium*	-	0.1
Quercus ithaburiensis	0.1	13.9	*Prunus domestica*	-	-
Quercus ilex	+	6-58	*Prunus dulcis*	-	-
Quercus incana	45.6	0.2	*Prunus persica*	-	0.1-0.3
Quercus laevis	24.3	0.8	*Pyrus kawakamii*	+	+
Quercus laurifolia	10.4	0.2	*Rhaphiolepis indica*	+	+
Quercus libani	3.2	0.1	*Sorbus scopulina*	<1	>3
Quercus lobata	3.4	-	**Rutaceae**		
Quercus macrolepis	0.2	0.7	*Citrus limon*	-	3.2
Quercus mexicana	14.4	0.1	*Citrus sinensis*	-	1.8
Quercus myrtifolia	15.2	0.2	**Salicaceae**		
Quercus nigra	24.6	+	*Populus deltoides*	37	-
Quercus petraea	0.61	0.12	*Populus balsamifera*	100	0.3
Quercus phellos	32.2	-	*Populus tremula*	51	4.6
Quercus prinus	6.5-90	1.5	*Populus tremuloides*	50-86	-
Quercus pubescens	45.3-90.7		*Salix babylonica*	115	-
Quercus pyrenaica	59	0.3	*Salix caroliniana*	12.5	+
Quercus robur	76.6		*Salix nigra*	25.2	-
Quercus rotundifolia	0.1	14.6	*Salix phylicifolia*	32	0.33
Quercus rubra	45-61		**Taxodiaceae**		
Quercus serrata	15-30		*Metasequoia* spp.	<1	
Quercus suber	<0.1	<0.1	*Taxodium* spp.	-	8.5
Quercus trojana	0.2	0.2	**Tiliaceae**		
Quercus velutina	18.9-100	1.0	*Tilia americana*	1-10	
Quercus virginiana	9.5-30.9	0.3	*Grewia flavescens*	<0.5	0.5
Quercus wislizenii	12.0-16.6	-	**Ulmaceae**		
Ginkgoaceae			*Ulmus americana*	-/+	-/+
Ginkgo biloba	<1	3.0	*Ulmus parvifolia*	+	+

No species is absolutely resistant to pollution. Resistance is always relative and depends on:

(1) the type of pollutant, its concentration and duration of exposure (dose);
(2) the plant's phase of development (age, season, general health condition) and leaf physiological age;
(3) growth conditions (soil, climate, nutrition);
(4) location (distance from the ground, shielding by buildings or protective plantings).

Lists are available ranking resistance of trees to pollutants (e.g. Bernatzky 1978; Flager 1998), even if most investigations have been carried out by chamber exposures, at high pollutant concentrations for short time periods and under nearly optimum conditions of nutrients, water, light, and temperature. The sensitivity lists from chamber observations should be re-examined on the basis of more realistic field experiments.

Moreover, different provenances, families, and even clones may respond differently to pollutants, as demonstrated for O_3 (Larsen et al. 1990; Nali et al. 1998; Pääkkönen et al. 1993; Taylor 1994). This would allow for selecting resistant clones to be used in areas at elevated O_3 concentrations, like cities. A few species have been tested in this respect (*Populus tremuloides*, *Fraxinus americana* and *F. pennsylvanica*; Berrang et al. (1986); Karnosky & Steiner (1981)) and the conclusion was that trees in the field are already facing a natural selection for O_3 tolerance in O_3 enriched environments.

Karnosky (1981) studied the relative O_3 and SO_2 tolerance of 32 urban-tree cultivars by both chamber fumigations and field exposures. Only oxidant-type injuries were observed in the field plots. Cultivars sensitive to O_3 and that may serve as bioindicators were *Gleditschia triacanthos inermis* 'Imperial' and *Platanus acerifolia* 'Bloodgood'.

In designing a planting program, low VOC-emitting trees should be considered. Biogenic VOCs, in fact, show a reactivity 2-3 times higher than that of a weighted average of hydrocarbons from gasoline combustion (Carter 1994), thus increasing the relative contribution of biogenic emissions to O_3 formation. Biogenic hydrocarbon emission rates are plant species-specific and vary by as much as four orders of magnitude (Benjamin et al. 1996), indicating that the selection of low-emitting trees and shrubs may be critical in polluted urban air sheds. Although emission rates have been experimentally determined for only a limited number of plant species, rates have been assigned to unmeasured species using a taxonomic method, allowing rankings of candidate trees to be developed on the basis of hourly emission rate (Benjamin et al. 1996). However, because of the strong dependence of biogenic emissions on environmental factors (e.g. temperature and light intensity) and differences in biomass and photochemical reactivity, hourly mass emission rates - which are commonly expressed in terms of grams of isoprene or monoterpenes per gram of green leaf biomass per hour - do not account for the actual ozone-forming potential (OFP) of individual tree species. By taking into account the effects of diurnal light and temperature fluctuations, interspecies biomass variability, and biogenic hydrocarbon reactivity factors, Benjamin & Winer (1998) ranked 308 tree and shrub species of the California South Coast Air Basin on the basis of their OFP (Equation 1). Table 4 reports only some of the species examined. Although their OFPs reflect environmental conditions representative of a summer day in Southern California and an assumption concerning VOC/NO_x ratios, the methodology can be used to select low-emitting trees and shrubs for urban planting programs. A serious limitation is that the parameters leaf-mass constant (g/m^3) and tree canopy volume (m^3/tree), necessary for calculating tree species-specific biomass factors, have been measured only for few species. Moreover they depend on pruning programs and are all the same very variable, e.g. 33 kg/tree in *Picea abies* and 1 kg/tree in *Robinia pseudoacacia*.

Equation 1: $OFP_{species} = B\,((E_{iso}\,R_{iso}) + (E_{mono}\,R_{mono}))$

Table 4. Tree grouping based on calculated ozone-forming potential (OFP) (from Benjamin & Winer 1998).

OFP <1 g O_3 plant^{-1} day^{-1}	OFP <10 g O_3 plant^{-1} day^{-1}	OFP >10 g O_3 plant^{-1} day^{-1}
Acer negundo	*Abies concolor*	*Eucalyptus globulus*
Arbutus unedo	*Ceratonia siliqua*	*Fagus spp.*
Cinnamon camphora	*Liriodendron tulipifera*	*Liquidambar styraciflua*
Cotoneaster pannosum	*Magnolia grandiflora*	*Phoenix canariensis*
Cupressus sempervirens	*Myrtus communis*	*Picea abies*
Ginkgo biloba	*Pinus pinaster*	*Populus tremuloides*
Ilex aquifolium	*Pinus sylvestris*	*Quercus ilex*
Jasminum spp.	*Platanus acerifolia*	*Quercus robur*
Juniperus occidentalis	*Pseudotsuga menziesii*	*Quercus suber*
Juglans nigra	*Quercus rubra*	*Salix babylonica*
Lagerstroemia indica	*Sequoia sempervirens*	*Washingtonia robusta*
Laurus nobilis	*Sequoiadendron giganteum*	
Ligustrum lucidum		
Nerium oleander		
Olea europaea		
Pinus pinea		
Pinus radiata		
Pittosporum tobira		
Pyracantha coccinea		
Rhododendron spp.		
Robinia pseudoacacia		
Rosa spp.		

where B is the biomass factor (kg green leaf/tree) for a given species; E_{iso} and E_{mono} are species-specific mass emission rates (mg VOC /(g dry leaf weight) d) for isoprene and monoterpene, respectively, calculated for a representative summer day in Southern California; and R_{iso} and R_{mono} are reactivity factors (g O_3/g VOC) for isoprene and monoterpene.

Species can also differ in their detoxification ability. *Ailanthus altissima*, introduced from China to Europe in 1751, is propagating very successfully in some urban areas despite increasing air pollution. Leaf samples were collected in Berlin, Germany, to examine whether this rapid spread might be supported by a high capacity of antioxidative protection (Rank 1997). In comparison with *Betula pendula*, *Tilia platyphyllos* and *Platanus acerifolia*, the leaves of *Ailanthus* had the lowest content of thiobarbiturate-reactive substances and the highest activity of ascorbate-specific peroxidase. This indicated a lower level of oxidative lipid breakdown and a higher capacity for detoxification of H_2O_2.

The effectiveness of tree species in capturing pollutant particles, as well as in sinking HM, is also variable. Maximum particle trapping efficiency values ranged from 2.8 % for *Pinus nigra*, to 0.12 % and 0.06 % for *Populus trichocarpa x deltoides* and *Acer campestre*, respectively (Beckett et al. 2000b). The finer, more complex structure of the foliage of the two conifers (*P. nigra* and *Cupressocyparis leylandii*) explained their much greater effectiveness at capturing particles. Beckett et al. (2000a) have shown that the rate of uptake of particles varies between species, with trees that display a more aerodynamically rough surface performing as the best air pollution filters. Particle loads on the foliage ranged between 70 and 490 mg/m^2 of PM_{10} depending on the plant species, site, and exposure conditions (Beckett et al. 2000c). *Cinnamomum* spp. were most effective at adsorbing Pb from the air, followed by *Agathis loranthifolia*, *Paraserianthes falcataria*, and then *Swietenia macrophylla* (Gusmailina 1996). The greatest uptake was by *A. loranthifolia*.

Tree species also differ in their ability to sequestrate C (Table 5), even if planting distances, and maintenance and pruning methods may strongly affect C sequestration by individual trees in the cities.

Table 5. Annual carbon sequestration by individual trees (Akbari 2002). Each tree is assumed to have a crown area 50 m^2.

Tree species	Average C sequestered (kg/year)	C sequestered at maturity (kg/year)
Acer platanoides	3.2	9.9
Acer rubrum	2.8	8.9
Acer saccharum	2.9	7.8
Celtis occidentalis	2.7	8.5
Fraxinus pennsylvanica	3.6	10.8
Gymnocladus dioica	2.1	3.6
Juglans nigra	3.0	8.0
Picea glauca	3.3	7.7
Picea pungens	6.7	12.8
Pinus lambertiana	4.2	15.2
Populus deltoides hybrids	14.9	29.6
Tilia spp.	5.3	13.8
Average	**4.6**	**11.4**

7 Conclusions

Air pollution is one of the many unnatural stress factors affecting the growth and survival of trees in urban areas. The problem's complexity is demonstrated by the fact that urban and rural areas alike commonly have high air pollution levels. Currently within the EU, the greatest air pollution threats to urban trees and population are O_3 and fine particles (Figure 3).

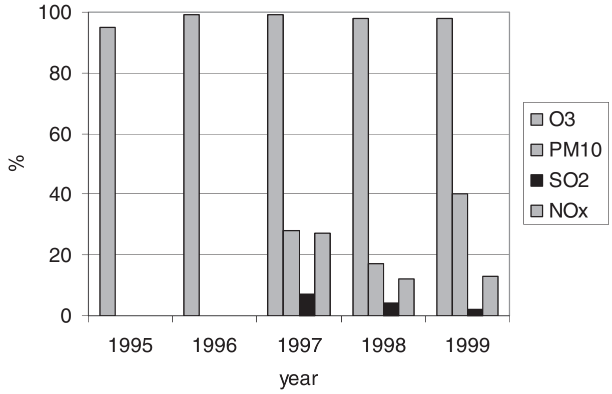

Figure 3. Population exposed to air pollution above limit values in the European Union (EEA 2002).

Trees in cities directly and indirectly affect urban air quality by impacting:

(1) meteorology (air temperature, radiation absorption and heat storage, wind speed, relative humidity, turbulence, surface albedo, surface roughness and consequently the evolution of the mixing-layer height);
(2) dry deposition of gases to the earth's surface (deposition velocity);
(3) emission of VOCs that contribute to the formation of O_3 and CO; and
(4) anthropogenic emissions through reduced energy use due to lower air temperature and shading of buildings.

While lower pollutant emissions generally improve air quality, lower NO_x emissions, particularly ground-level emissions, may lead to a local increase in O_3 concentrations under certain conditions due to reduced NO_x scavenging of O_3 (Rao & Sistla 1993). All these impacts of vegetation interact to affect O_3 concentrations.

Research integrating the cumulative effects of urban vegetation on air quality, particularly O_3, is very limited. Freer-Smith & Broadmeadow (1996) modelled pollution uptake by urban woodlands in the Greenwood Community Forest, Nottingham, and predicted that the current 10 % woodland cover may reduce air pollutant concentrations by 4-5 %. The proposed increase in woodland area to 22 % could result in pollutant reductions of 6-11 %, with attenuation greatest (23-31 %) when pollutant concentrations are highest. Pollutant uptake could be maximised by increasing the length of woodland edges, and planting trees with larger uptake capacities and higher leaf area index. Cardelino & Chameides (1990) modelled vegetation effects in the Atlanta region, Georgia, and found that a 20 % loss in forested area could lead to a 14 % increase in O_3 concentrations. Although there were fewer trees to emit VOCs, an increase in air temperature, concomitant with tree loss, increased VOC emissions from the remaining trees and anthropogenic sources. Taha (1996) revealed that the net effect of increased urban tree cover in the California's South Coast Air Basin was a decrease in O_3 concentrations if the additional trees are low VOC emitters. Nowak et al. (2000) reported that urban trees had a locally positive effect by reducing O_3 in urban areas from Washington, DC, to central Massachusetts, but slightly increased O_3 concentrations in surrounding areas. The physical effects of vegetation appeared to be more important than atmospheric chemical interactions with biogenic VOCs. Pollutant deposition of NO_x to trees tended to increase night time O_3 concentrations due to loss of NO_x scavenging. Trees reduced horizontal wind speed and pollutant dispersion in the atmosphere. Shifting to low VOC emitting tree species had little impact on O_3 concentration (< 1 nmol/mol).

The beneficial effect of trees on urban air quality through their uptake of particulates has been widely discussed in the literature and is often cited as one of the multiple benefits of amenity plantings (Beckett et al. 2000a; 2000b). However, uptake rates have not been measured for European amenity trees and thus only limited advice can be given on the design of urban planting to maximise removal of particulates. Data from the network of urban air quality monitoring sites suggests that modern particles may represent a greater threat to human health in urban areas than any other air pollutant. Clear understanding of both the value of urban trees in removal of particulates and the principle factors which determine capture efficiency are therefore required. The most important present limitation to quantify the relative effectiveness of tree species and develop generic model for particulate uptake, is the lack of species-specific velocity of particle deposition.

Over 100,000 chemicals – substances which have never been part of the terrestrial environment – are at present marketed in the EU. There is a serious lack of monitoring and information on these chemicals. For 75 % of the 2,000 - 3,000 large volume chemicals on the market there are insufficient toxicity and eco-toxicity data publicly available for "minimal" risk assessment (Gee 1998). "No evidence" does not necessarily mean "no effects". To reduce people's exposure to pollutants, chemical feed stocks such as plants, must be further developed.

Against direct and indirect benefits of trees on air quality, and the additional benefit of sequestering CO_2, biogenic VOC emission is a potential air quality liability associated with urban trees. The species-specific ozone-forming potential has been calculated for some urban trees, while the species-specific capacity to remove pollutants (gases and particles) has not.

In conclusion, knowledge gaps still limit the understanding of tree-pollutant interactions in urban areas, as well as planting programmes designed to improve air quality. Future research should concentrate on:

- selection for resistance to pollutants, both at inter and intra-specific level;
- species-specific ability to remove and detoxify air pollutants, particularly ozone and dusts, and including CO_2;
- carbon pool and flux in urban soils, and continuous eddy covariance measurements in urban landscapes.

Costs of a tree (planting, maintenance, removal) are elevated and should be justified by other amenities trees provide beyond air-conditioning and smog reduction (Akbari 2002). The net value of investment in planting and care of trees, e.g. in Chicago (McPherson et al. 1994), indicates that the overall long-term benefits of trees are more than twice their costs. The economic value of urban trees in limiting risks to human health should be carefully re-evaluated. More people are prematurely killed from the effects of vehicular emissions of particles in Europe than from car accidents (WHO 1999).

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Forest fires in urbanised societies: Status and management

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Abstract

In southern Europe fire is a very common threat to forests and urban forests are no exception. There are, however, some distinctive features of forest fires closer to larger cities and some Portuguese examples can document this. The number of human-caused ignitions tends to increase dramatically near urban areas where, at the same time, fires are small due to early detection and fragmentation of forests. In forests further away from the urban areas fire sizes and proportion of total area burned increase. These trends are documented in gradients starting from the centres of the two larger cities in Portugal, Lisbon and Porto. A general model of the relationships between fire characteristics and landscape composition is proposed based on statistical analysis of more than four thousand spatial units covering the entire Portuguese mainland. Some suggestions are made on how these considerations may be taken into account in the design and management of urban forests threatened by fire.

Key words: urban forests, fire, Mediterranean region, landuse.

1 Introduction

Southern European landscapes have been changing through the influence of man for a very long time and fire has always been associated with those changes. The decrease in original forest cover was also accentuated after the use of bronze instruments around 2,000 BX (Larrère & Nougarède 1993), and the Roman landscape was typically made up of agricultural areas (*ager*) and, beyond its limits, the *saltus*, with shrublands and forests (*silvae*).

The dynamic equilibrium between these major components of the traditional landscapes of southern Europe continued from medieval to recent times when urbanisation processes resulted in the rapid increase urban area size. Therefore, in modern times, the three major components of landscape dynamics can now be considered forests, agricultural and urban areas.

The importance of the urban areas is not only due to their size but also to the fact that rural-to-urban migration led to rapid population growth. This resulted in a situation in Europe where more than two thirds of the total population is already living in urban areas, sharing many concerns for the quality of their environment (EEA 1995).

One of such concerns in Mediterranean Europe is the fire problem at the interface between urban and forest or wildland areas. This problem is well documented in Greece where, as result of internal migrations of the last two decades, half of the population is now residing in only two cities, Athens and Thessaloniki (Dimitrakopoulos 2003).

The problem of forest fires was recently enhanced because of the decrease in profitability of traditional wood production during the last years. This has caused a decrease in management effort which, in turn, has led to an increased risk for forest fire in Mediterranean conditions (Dominguez-Torres et al. 2001).

The problem of forest fires is common to all European countries of the Mediterranean region, and of special concern in Portugal, Spain and Greece, where recent decades have shown sharp tendencies towards an overall increase in the number of forest fires (EC 2001). The status of the forest fire problem at the urban interface and the consequent management implications have been addressed by various authors from across the Mediterranean regions of the world.

The specific characteristics of these fires include the increased threat to human lives and property, their greater impact due to increased public awareness and media attention, and an increased complexity of planning suppression activities dealing with the many fires occurring in these interspersed urban landscapes.

This paper describes the changes of fire characteristics along a gradient from the centre to the surrounding area in the two largest cities of Portugal (Lisbon and Porto). Based on the results provided by those two examples, a general hypothesis is presented aimed at providing a general framework to characterise the fire problem at the urban interface. This hypothesis is tested through the development of a model based on the analysis and interpretation of patterns of number and sizes of fires which occurred during the past decade in all 4037 geographical units (parishes) of the Portuguese mainland.

2 Methodology

According to the United Nations Environment Programme (UNEP), in 1990 Portugal had an urban population of below 40 %, i.e. the smallest percentage of all European countries (EEA 1995). However, in a country of about 10 million inhabitants, about 2.5 million are concentrated in the metropolitan area of Lisbon and about half that number in the metropolitan area of Porto. Population growth in the two metropolitan areas resulted from internal migrations during the two decades (1960-1980) when the cities spread through their suburban areas. After 1980 there was a demographic decline in the two city centres, compensated by high birth rates in the suburban areas (Ferrão 1997). The growth of urban or artificial surfaces, however, often stabilises but very seldom declines (Machado et al. 1997).

The two gradients studied were therefore based on the metropolitan areas of Lisbon and Porto, extending from the city centres to the larger forested area in a 25 km radius. The statistical units used were the municipality sections (parishes), ranked by their distance to the centre of the respective metropolitan area.

Statistical data was provided for all units by the Direcção Geral das Florestas (DGF) and the Comissão Nacional Especializada de Fogos Florestais (CNEFF). These data included the number of fires and areas burned between 1990 and 2001, and the areas of the different land cover classes in 1990. The classes of land use considered were forests (including shrublands), agricultural land, and urban areas.

The average number of fire occurrences and burnt area were standardised in relation to the total area of each unit, and therefore they were used as the average annual number of fire occurrences per hectare and the annual proportion of burnt area. The qualitative relationship between land use and fire incidence was interpreted by visual comparison of the graphics of the sequence of fire characteristics with ternary graphs, using proportions of the three general land use classes (forest, agricultural and urban areas).

A related quantitative analysis was performed at the national level by the fitting of multiple polynomial equations represented as contour plots on ternary graphs produced with the STATISTICA 5.0 computer package. The spatial unit considered was the parish as well, and thus the previously mentioned statistics could be compiled for all 4036 sections of all municipalities of the Portuguese mainland. Outlier detection excluded from the analysis 7 units for the analysis of fire occurrences and 3 units for the analysis of area burnt. Statistical analysis concerning the significance of the various regression coefficients for each of the equations developed was also performed with the same package, using the Nonlinear module.

Finally, a rank correlation between proportions of land use classes and ignition causes was developed at the district level, as this was the only administrative unit for which the causes could be analysed. Using all districts on the Portuguese mainland (18), this correlation was established by the Spearman Correlation Coefficient (Daniel 1990), as calculated between the proportion of the three land classes considered within the district range and the proportion of fire occurrences falling into eight classes of causes. These classes were:

1) natural causes;
2) land management (fire applied to shrub control and pasture renovation);
3) agriculture practices (ignition caused by machinery);
4) fireworks;
5) waste sites;
6) picnics and smoking;
7) arson; and
8) others.

3 Results

The characteristics of land uses and fires within the parishes along the two selected transects are presented in Figures 1 and 2. The gradient from urban to forest areas was more evident in the west-east transect from Porto than in the east-west transect

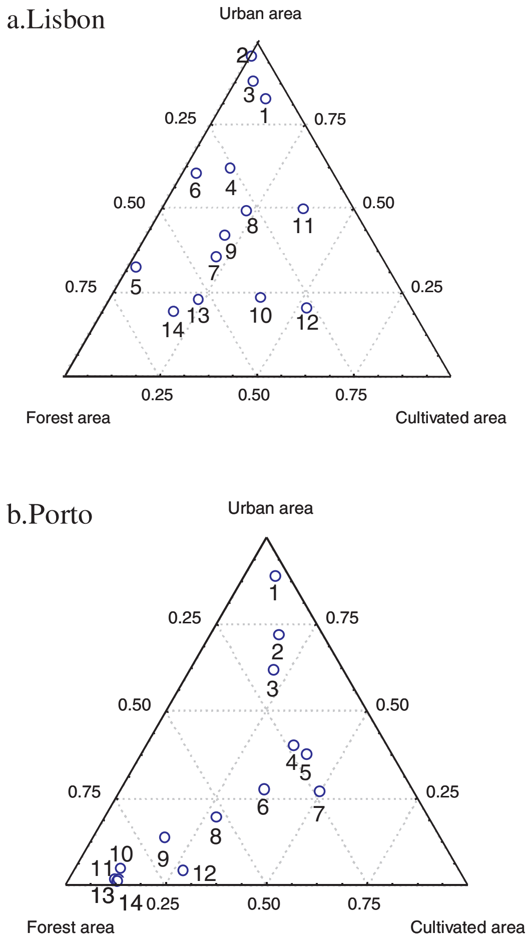

Figure 1. Ternary graphs representing land use changes along parishes from the center of the cities of Lisbon (a) and Porto (b) to the largest forest areas in a 25km radius. In both cases parishes 1, 2 and 3 correspond to truly urban areas in city centers and parishes 13 and 14 to the more distant and more forested areas.

from Lisbon, where agriculture was still important. In spite of these differences, both transects were successful in capturing a gradient of land use from urban to non-urban classes (Figures 1a and 1b).

As concerning the trend of fire characteristics, there was a tendency in both transects for increase of the number of fire occurrences within a certain distance from the city centre, followed by a clear decrease thereafter. The proportion of area burnt increased only for the more distant areas (Figures 2a and 2b), where the proportion of forests (and shrublands) became significant.

The relationship between land use and fire occurrence for all municipal sections of the Portuguese mainland is illustrated in Figure 3. The analysis of the regression equation shown in that figure indicates an highly significant ($p<0.001$) contribution of the second-order interaction Forests*Agriculture*Urban. This is in agreement with the fact that the number of fire occurrences was maximal when the landscape was made up by a combination of significant proportions of forest, agricultural and urban areas. The presence of urban areas ($p<0.001$) and, to a lesser extent, the combination of urban areas with forests ($p<0.01$) or urban with agricultural areas ($p<0.05$) also contributed to the increase in the number of fires. This is shown in Figure 3 by the area of higher fire numbers being somewhat shifted to the top (and to the left) sides of the ternary graph.

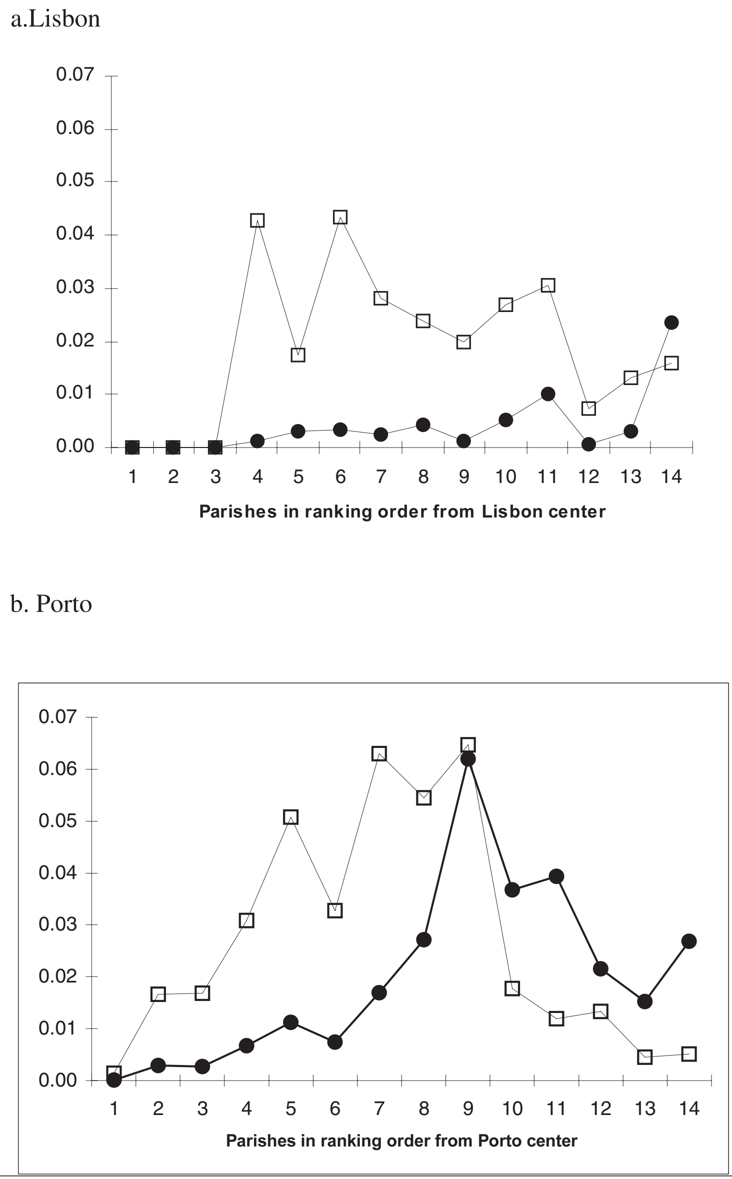

Figure 2. Variation of the average fire numbers per hectare (open squares) and proportion burnt areas (black circles) for the period between 1990 to 2001 along the transects from the Lisbon center (a) and from the Porto center (b).

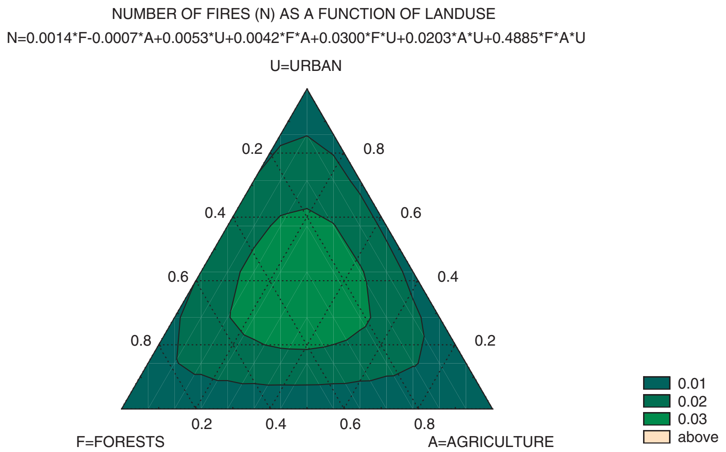

Figure 3. Ternary graph relating fire occurrences with landscape composition for all municipality sections of the portuguese mainland.

Regarding the area burnt annually, Figure 4 indicates that the higher proportion, reaching values above 3 %, occurs when the landscape is dominated by forests (above 70 to 80 %). This is confirmed by statistical analysis of the coefficients of the computed regression equation. The proportion of forests was shown to be highly significant ($p<0.001$) in explaining the increase in the proportion of area burned. The interaction between forests and urban areas seems to be significantly ($p<0.01$) contributing to a decrease in burnt areas.

Rank correlations between proportions of the different land uses and proportion of the different fire causes at the 18 districts also provided interesting results. Urban areas were positively correlated with arson fires ($rs=0.54$; $p<0.05$), results that confirm general knowledge. On the other hand, natural causes - which are mainly lightning strikes - were negatively correlated with proportion of urban areas ($rs=-0.51$; $p<0.05$). This is also in agreement with Velez (2000) who reports natural causes to be more common in the interior of the Iberian peninsula. Forest areas and fire occurrences due to fireworks were positively correlated ($rs=0.62$; $p<0.01$). Urban areas together with forest and shrubland areas were therefore positively correlated with arson and fireworks, but also with land-management related causes such shrub or pasture fires ($rs=0.53$; $p<0.05$).

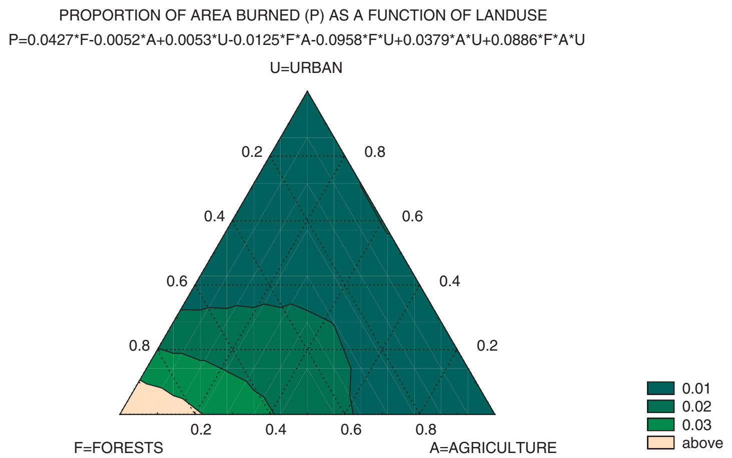

Figure 4. Ternary graph relating proportion of area burned with landscape composition for all municipality sections of the portuguese mainland.

4 Discussion and conclusions

Based on the results presented above it is possible to discuss some interpretations and tentative generalisations based on comparisons made with situations in Spain and Greece. First, it seems clear that the intermix of forests, agricultural and urban lands tends to accumulate the different fire causes specific for the various land uses, with others caused by their proximity. From the agricultural side, it is common that fires are started by farmers or shepherds, the main fire causes in the northwest of the Iberian peninsula (Velez 2000). In Greece it is in the rural/urban interface, moreover, that most fires are attributed to arson for the encroachment of urban settlements (Dimitrakopoulos 2003). In France and Spain this causal relationship has not been established. Instead, it was made clear that increased tourism and recreation or other human activities in accessible forests close to urban areas resulted in a sharp increase of fire risk. This is similar to our example of fireworks. All authors agree that waste sites created nearby forests to burn urban waste constitute another fire risk component.

Secondly, it is clear that the major impact of fires at the urban interface lies not in their size but rather in their threat to human lives and property, as well as in increased public and media interest. In fact, the areas that burn most frequently are those with a large proportion of forests and shrublands, and the proximity to urban areas seems to have an important effect on the reduction of area burnt. This can be due to early detection and rapid fire-fighting operations that generally start from the urban areas.

Finally, the implications of this study's findings relate to the possibility of explaining the fire characteristics of any spatial unit based on the knowledge of the composition of its landscape. This knowledge can be used to generate scenarios for the future and as a baseline for comparing and evaluating future data and trends.
It is clear, nevertheless, that it is not only composition but also configuration that affects fire characteristics which should be considered in subsequent analyses. This approach will hopefully enable the design of landscapes that are, both in composition and configuration, less susceptible to fire. In this respect, a useful guide for planners of the wildland-urban interface was written by Moore (1981).

Based only on compositional data it is apparent that areas with high proportions of continuous forests (and shrublands) will burn at a high rate. Also apparent is that fragmentation by 30 % of urban areas or, equivalently, 40 % of agricultural areas will reduce the annually burnt area from more than 3 % to less than 1 % of the total area.

It is also apparent that, from the point of view of reduction of the number of fire causes and the difficulty of dealing with complex fire management strategies, it is preferable to deal with only one type of urban interface (urban-forest or urban-agriculture) rather than a mixed interface (urban-forest-agriculture). Traditionally, in the Mediterranean region the model of small rural villages surrounded by agricultural areas resulted in just one type of interface. It is now proposed that, with the abandonment of agriculture, a suitable model for the urban interface would be the creation of Mediterranean "peri-urban forests" that should be of low flammability in order to protect human lives and structures from fire. Selection of appropriate tree species is extremely important. Deciduous broadleaf trees are generally very adequate, but a more extended list of "fire-resistant" species suitable for Mediterranean environments is given by Radtke (1983). These urban forests should also be managed for modern forest values such as landscape aesthetics, recreation, and environmental protection, together with the traditional wood production function. These urban forestry concepts and practices should ideally be implemented for city parks, private gardens or other vegetation areas in buffer zones protecting entire urban areas or isolated structures.

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Plenary Session VI

Forests and trees in urbanised societies - The social agenda

The social values of forests and trees in urbanised societies

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Abstract

People. The source of environmental degradation. The culprits of resource decline. The bane of management. People. Harassed, easily angered, irritable; reluctant to trust managers; ignorant about fundamental issues. People. Lovers of nature, eager volunteers, willing stewards. Essential for any solution that seeks to protect resources for the future of all living organisms. We humans are a difficult animal. Why are we so difficult? Can we be reasonable too? Yes, there are many relatively easy ways to bring out the best in people. Sadly, they are frequently ignored or violated. Urbanization has intensified the situation. There are more demands and fewer respites. For many city dwellers there is scant opportunity for nature contact. Yet there is substantial indication that the presence of trees and green places in the proximal environment is highly valued and beneficial. It has been shown to be related to greater reasonableness and civility and on the part of tenants in low income high rise buildings. Lack of natural places has significant costs to human health. At the same time, however, the presence of natural elements may not be sufficient to support reasonable behaviour. An understanding of some basic human needs can help bridge the gap. I will focus on three interrelated needs: the need to understand, to explore, and to be able to take meaningful actions. These needs can be met even with small-scale bits of nature as well as small-scale efforts. Unfortunately, even well-intended public decisions often block opportunities for meeting these basic needs. People are often left out of the equation. Perhaps thinking of people as uncomfortable when they fail to understand their world, frustrated when they have no opportunities to explore, and eager to be listened to and given a chance to be helpful could provide insight into ways to enhance the better side of this sometimes difficult animal.

Key words: human needs, landscape management, participation, urban forestry.

1 The social values of forests and trees in urbanised societies

As the title suggests, this contribution is about the natural environment. However, it is also about a difficult animal that has run wild, certainly in the United States, but in many other parts of the world as well. This animal is all too familiar to all of us. We humans have been self-confident in transforming our planet; we have been greedy and arrogant. We want things even though we may not use them. We want to be heard but do not want to listen. People have even been known to get angry when Good People (like forest managers) try to do the Right Thing.

But humans can also be cooperative, thoughtful, and reasonable. We have an enormous desire to be helpful and useful, to feel needed and to make a difference.

How does one bring out the best in this difficult animal? I will argue that it requires an understanding of a few basic human needs and that the environment - both physical and conceptual - is central to supporting these needs. I hope this framework will help you see the vital role played by trees and forests, as well as the vital role forestry practitioners can play.

The first section of this text focuses on the concept of "nearby nature" as a more inclusive way of thinking about urban forests and trees. I will then turn to the insights we gained from extensive research on environments that people prefer. These led to our focus on seeing preference as a reflection of basic needs. The next section, The Reasonable Person Model, expands on these basic needs. The final section suggests that meeting these needs need not entail major costs or efforts.

2 Nearby nature

Cities are described as vibrant, bustling, and exciting, as well as noisy, crowded, fast, and stressful. They are rarely characterised as tranquil or peaceful. Yet we all know that there can be tranquil places in the urban context. Where are such places likely to be? Perhaps beneath the canopy of a large tree, or in a park with many trees, or in a colourful garden, or possibly by a brook or a lake.

It is hardly surprising that studies repeatedly find that such natural places are preferred and play an important role in people's satisfaction with their surroundings. The role that trees and forests play, however, goes much beyond creating pleasant places and being enjoyable. Having nature nearby is not an amenity, but a potential response to many basic human needs (Kaplan et al. 1998).

There is a substantial research on the many ways that the natural environment "matters". I will not focus on this literature here. It is encouraging to see this work now being extended to include the pervasive health implications of having nature nearby. Frumkin (2001) provides an excellent review of this material.

I also want to highlight some of the work by Frances Kuo, William Sullivan, and their associates at the University of Illinois, which is set in the context of inner-city neighbourhoods in Chicago. Their results have been particularly important in showing just how pervasive the effects of some trees and grass can be. Within these poor neighbourhoods and housing projects, they have found that residents with even small amounts of contact with trees and green space:

- show lower levels of aggression and violent behaviour (e.g. Kuo & Sullivan 2001);
- are more civil with each other and know more of their neighbours (e.g. Kuo et al. 1998);
- can concentrate better and take greater control of their lives (e.g. Taylor et al. 2002).

Contact with nearby nature for these people is hardly an amenity or luxury. It has made a difference in their ability to cope with very difficult circumstances.

What do I mean by "nearby nature" and why not just talk about trees and forests? "Nearby nature" certainly includes trees and forests, but it also includes many other kinds of vegetation and other settings, such as roadside plantings, the nearby countryside, and even backyard gardens, and lawns. It encompasses much that is "green", even in seasons when it is not.

There is growing understanding that urban forestry includes a broad range of contexts possessing "tree resources" (Konijnendijk 2000a). "Nearby nature" probably goes even beyond such a holistic view. As Konijnendijk (2000b) mentions, the expanded view calls on a great range of expertise needed to deal with the many constituencies and stakeholders. From the perspective of many experts who deal with the management of tree resources my use of "nearby nature" may seem too broad. An important lesson from many years of research, however, is that people's perception and appreciation of the natural environment is not based on the experts' categories.

Understanding the public's perception, in turn, can provide essential input to the experts, leading ultimately to less contentious debate and more effective management.

What do people do in their nearby natural environment?

People engage with the natural environment for many reasons. The ones that are most obvious, and receive the most attention in the various recreation-related fields, are forms of active engagement. There are, however, many other important ways in which people engage with their nearby natural surrounding (Kaplan 1984). For purposes of the current discussion, only a few of these are mentioned.

Surveys often ask about people's "activities", and these usually focus on the active types of engagement, including such pastimes as walking, hiking, cycling, horseback riding, and canoeing, among many others.

In contrast to "active" involvement, some activities might be considered more passive. For example, the construction workers at the building where I work often go outside for their lunch break. They might just sit and eat beneath a tree, or two or three might sit on a stone bench and talk to each other, or to someone else on their cell phone. Why did they choose to be outside? Does it matter that they are in a natural setting?

For many other pastimes the nature setting is central to the activity. For example, nature photography, bird watching, or checking on the plants in the garden. In terms of physical exertion these are likely to be as passive as sitting outside during one's lunch break. However, it may be distorting to call these "passive". The mental activity could be quite intense. Such efforts to notice and observe the natural world are important aspects of experiencing nature.

One of the most pervasive interactions people have with nearby nature comes from looking out the window. It is hardly surprising that many of us find windowless environments to be problematic. There is substantial research to document the psychological benefits of having nature in the view from the window (Kaplan 2001). This has been shown many times over and in a variety of settings, including hospitals, prisons, dormitories, residential settings, and work places.

The striking results of these studies is not that people like to have windows, but that what you can see out the window makes a difference. In a prison study, for example, those with nature in the view used the health services significantly less often (Moore 1981). In work settings, having nature in the view was related to: fewer reported ailments, higher job satisfaction, greater patience, and less frustration (Kaplan 1993). The "nature" in the view for these people was not a snow-capped mountain, or a tranquil stream. It may have been no more than a tree, or even just some shrubs or other plants. Even these can make a substantial difference in well-being.

3 Environments that are preferred

Nearby nature includes a broad range of natural settings. Are these equivalent in terms of people's preferences and the values they provide?

When we began our research on environmental preference, more than 30 years ago, there was very little information we could find to substantiate what we all know intuitively - that people like trees.

Our first study was motivated by research in what was known as experimental aesthetics. Rather than restrict his work to the kinds of artificial stimuli that were characteristic in that area, Jack Wohlwill (1968) carried out a study that used scenes of 14 actual environments. Wohlwill reported that, just as with artificial stimuli, people liked most the scenes with a medium amount of complexity. When we looked at his reported findings, however, we had a different interpretation. There were two outliers: the scene that was clearly most preferred was of "Lake scene with partial view of shore" and the least preferred scene showed "Factory and downtown area of small city". Yet these two scenes were very similar in terms of their rated complexity.

While Wohlwill did not think the content mattered, we felt it was important to examine that issue. Our first study included 56 scenes selected to represent four categories: "nature" and "urban", as well as "nature with human influence" and "mostly human influence, with some nature". The results did not show a strong relationship between complexity and preference. They did show very strong differences based on content. The nature scenes were far preferred to the urban ones. (Kaplan et al. 1972).

The study also instructed us about people's *perception* of nature. Using statistical procedures that are based on similarities in ratings, we found that "nature" included not only the scenes selected to represent "nature", but also those in the "nature with human influence" category. It included an unpaved road, and even a car parked on it. It did not, however, include scenes where the trees are along a residential street.

That study led to many dozens more. These were done by many different researchers, in many places around the world, and have led to a much richer sense of what affects preference. One of the surprises from these studies was substantial consistency in preference, with two exceptions: The first is that teens are often different (Kaplan & Kaplan 2002), and the second is that expertise can make a difference. Resource managers, landscape architects, and architects, for example, have shown clearly different patterns in their preferences (Kaplan & Kaplan 1989).

The consistency helped us see that "preference" is not about making something pretty or beautiful - not about amenities - but about something much more basic. People's preferences reflect ways that the environment can help meet their needs.

Preference and informational needs

It may be easiest to present examples of the needs that the environment can support by using images from some of studies, as these were the way our own intuition was sharpened. (These images, however, are not included in this written form of the presentation. Many of the concepts mentioned here are explained more fully in Kaplan & Kaplan 1989) We found that people tend to prefer:

- Scenes where it would be easy to locomote, to move about.
- Whether or not one has physical access, people prefer scenes where there is visual access, where one's view is largely not obstructed.
- At the same time, however, a wide open scene may not be preferred. Though the view is not obstructed, there may be insufficient complexity.
- People like scenes that make it easy to figure out where they are. We have referred to this as „legibility", a dimension that Kevin Lynch (1960) first talked about in his *Image of the City*. Landmarks and distinctive places increase legibility.
- One of the most consistent findings in our research has been high preference for scenes that invite you to keep going "deeper into the scene" not only because there is a path, but because there is a sense you will learn more. This is what we have called "mystery". It often involves some partial obstruction - a screen, or deflection, or the bend in the path that permits one to see enough to wonder what is beyond.
- Finally, coherence has been another factor in preference. Coherence involves the ease of making sense of the elements comprising the scene or situation.

What do all these themes have in common? Are there some underlying needs that are satisfied by environments that permit visual access and locomotion, that provide legibility and offer mystery, that are coherent and not lacking in complexity?

The many studies suggested to us that the environment is a vital source of information. People prefer environments where that information fulfils two basic qualities: it is understandable and it permits exploration. In other words, people have strong needs to make sense of things, and at the same time, they want to venture beyond what they understand.

People are consumers as well as producers of information - not just information provided in written form or on television. The environment is a rich and important source of information. We are constantly and very rapidly processing that information and making assessments of how the environment will support our needs. Will I learn new things? Will I get lost? Will I get eaten?

There is good reason to believe that our evolution in the natural world has made a difference in human preferences. Being attracted to water and to trees may have such origins. The inclination to prefer settings that are understandable and permit exploration also makes sense from that perspective.

4 The reasonable person model

These concepts were developed in the context of our research on environmental preference. We have found, however, that they have much wider applicability. These same themes are important to human functioning in many other contexts.

One can readily appreciate the importance of the concepts of understanding and exploration by considering situations where they are blocked or made difficult. Think about the intense emotions that can accompany such situations: People strongly dislike being confused or disoriented. They avoid places where they have gotten lost in the past. They go to great lengths to seek out information. They feel helpless if they have no basis for predicting an important future state.

What happens when people find themselves in environments where their understanding and exploration are severely restricted? They may feel helpless and fearful, angry and distrustful. The same person who was kind and generous before may now appear to be substantially less reasonable.

Directed Attention Fatigue

Failures to achieve understanding and exploration are not the only impediments to reasonable behaviour. When people are tired they are often less reasonable. Closer analysis, however, shows that the tiredness is not physical, but mental. Here again, the environment can contribute to the human condition.

As presented more fully by Stephen Kaplan (2003), the environment makes many demands on our attentional capacity. The ability to pay attention, to focus on tasks and demands, is fragile. Even under the best circumstances we become mentally fatigued; we can only direct our attention for a limited amount of time before we need a break or a change in activities. Directing our attention is much more difficult when there are distractions, when we need to juggle a variety of demands at the same time. Urban life is rich with such distractions.

While the environment can be a source of increased demands on our directed attention, it can also play a role in recovery. A powerful way to restore one's mental fatigue is to be in the presence of fascination (Kaplan et al. 1998). Nearby nature offers many opportunities for fascination. Many of these entail little more than noticing or observing - raindrops on a leaf, a bird on a branch, signs of spring on the tree outside the window. As Kuo (2001) points out, trees and the green spaces in inner-city neighbourhoods offset the attentional demands of that environment and contribute to the residents' ability to cope with poverty.

Meaningful action

The core hypothesis of what we have called The Reasonable Person Model (Kaplan & Kaplan 1989; Kaplan 2000) is that people are more likely to be reasonable in the context of environments that support their information processing needs.

Understanding and Exploration are two of these needs. There is one more basic informational need to add to the story. It is the pervasive human requirement to be able to take meaningful action. People can feel restored, have an understanding of a situation, and a chance to explore, but even these may not be sufficient for reasonable behaviour. People also want to be heard and feel they can make a difference. That does not mean they want control of a situation, or that they always need to be part of the action. There are many circumstances, however, when the possibility of making a difference is a key human element.

Once again, it is perhaps easier to understand the concept by looking at the consequences of its absence. The opposite of making a difference is a sense of helplessness; it is a sense that one does not matter; that one's needs will not be considered; that one is blocked from being helpful. These can be deeply demoralising. Fortunately, it often takes only small steps to help people feel that they can make a difference.

Understanding, exploration, and meaningful action are presented here as three separate needs; in many contexts, however, they are strongly interrelated. Making a difference often requires exploration. Exploration often is an effort to extend one's understanding. Understanding can be critical for taking action. The difficult animal we talked about earlier, the one that can be uncontrolled and contentious, can be quite cooperative and helpful when we are sensitive to these few basic needs.

5 Small things that can make a big difference

Attending to these needs need not cost a great deal. It often does not require huge pieces of land. And it does not call for high tech tools. It does, however, challenge some of the ways most of us have learned to do our work and some of the things we take for granted.

What if we accepted the propositions I have offered? It would seem relatively straightforward to offset mental fatigue by having trees and "nature" nearby. This simple step could go a long way toward ameliorating personal and societal malaise. It could contribute to physical and mental health, make the workplace more satisfying, and offer greater sense of community in the residential context. If one is privileged to live and work in the midst of a lovely city with an abundance of green places it may be difficult to recognise that for many millions of urban people the contact with nature is minimal. They may rarely see trees or green places from their homes, at work or school, or even on their routine travels between these places. Despite its relative simplicity, however, even this solution is far from being realised.

Even if it were feasible to provide trees in front of all windows, it is worth considering the implications of the other basic needs that comprise the Reasonable Person Model. While having a tree planted outside the window would have great value, involving people in the process could make it even better. What are some of the added values?

People would feel included in some of the decisions that affect their lives. They might be asked about the kinds of trees they prefer. They might be included in efforts related to planning and maintaining the tree. People could be given a chance to learn about trees and their needs, about rationales for selecting particular trees.

Some of the added values may also accrue to the professionals who are working with these individuals and groups. These practitioners could learn about what is important to the citizens, how they value their neighbourhood, and how to engage them in future projects.

There are many other potential benefits though their impact may be difficult to document. For example, there could be ramifications at future times, such as increased interest in other stewardship projects or possibly even in careers related to these activities. Ramifications might also extend spatially and socially as people might become acquainted with neighbours and find things to share with them. They might have greater pride in where they live and work toward improving their community.

Examples

These are not crazy ideas that came to me in the middle of the night. Different aspects of these notions are being used in a great variety of contexts with exciting ramifications. They are clearly manifestations of urbanization, borne of needs and opportunities for creating and managing trees where the people are. Kennedy et al. (1998) provide an excellent analysis of how this transformation has necessitated a major paradigm shift in "values, beliefs, and management".

Here are just a few examples of programs and approaches that incorporate opportunities for individuals to participate in ways that enrich their own lives, improve their communities, and enhance the urban forest.

Engwicht's (1999) book, *Street Reclaiming: Creating Livable Streets and Vibrant Communities*, provides superb ideas for meaningful action that at the same time enhances exploration and understanding. Although the book's focus is not on the natural environment, the realisation of many of the suggestions for reducing traffic readily makes it possible to increase the availability of trees and green spaces.

Inerfeld & Blom (2002) describe community-level efforts to establish shared green spaces. The "community greens" provide the benefits of nearby trees and a park-like setting, adjacent to people's residences, as well as enhancing the sense of community. The focus here is not only on the green areas, but on the shared ownership and management. Managing shared areas can provide many opportunities for fulfilling the human informational needs mentioned earlier. It should also be said, however, that shared ownership can involve some frustrations (Austin & Kaplan in press).

Another form of shared "nature" comes in the context of neighbourhood tree-planting projects. These have sprung up in numerous cities and often generate considerable media coverage because of the festive atmosphere at planting time. Austin's (2002) study involved an examination of the efforts by the leaders of some of these projects and by those who looked after the trees and plots where they were planted in the months and years after the big day. The simple act of planting a tree can have far-reaching effects for the community.

Tree plantings and many other forms of environmental stewardship rely heavily on volunteers. It is not only the physical settings and the sponsoring environmental organizations that benefit from these efforts. For the volunteers these are ways to make a difference and to feel they are part of something larger. Our studies on the psychological benefits of such activities (e.g. Ryan et al. 2001) have shown important satisfactions participants derive from "helping the environment" and from learning about the flora and fauna. At the same time participation leads to further explorations and to activities that create and preserve additional natural areas.

The National Urban and Community Forestry Advisory Council (NUCFAC), was created by the US congress to promote and enhance sustainable urban forests for all communities. Funded by the US Forest Service, this agency's goals include "cultivating appreciation of the social, economic, environmental and aesthetic value of trees and community forests" (NUCFAC 2001). Their funded projects as well as promotional material (e.g. www.communitytrees.org) have increased awareness of the many ways in which trees enrich the lives of individuals and communities.

There are, of course, many other examples, varying widely in scale, sponsorship, and forms of involvement. A key ingredient in all of these is the opportunity for people to participate (Konijnendijk 2000a). At the same time, participation is a potential source of trepidation and frustration for forestry professionals whose backgrounds have ill-prepared them for the challenges (Kennedy et al. 1998). As many of you may have discovered, however, even a little bit of participation can go a long way toward having a reasonable animal to deal with. You may even have been surprised to find out that it makes your own job more interesting and fulfilling.

Permitting people to explore, to figure out what they need to know, to play a role in decisions that affect their lives - these are key ingredients in creating environments that support human needs. Add to these some trees and nature places, then perhaps we can look forward to improvements both in the urban environment and in the outlook of the people who live there.

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Health benefits of a more natural living environment

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Abstract

Research has shown that experiencing nature tends to have beneficial effects on one's health. Further research almost seems redundant, since most people are already convinced that nature and health are positively related, at least, as far as domesticated nature and people in urbanised societies are concerned. However, this is not always reflected in spatial planning practices. In the planning of residential areas, public green space is often looked upon as a luxury good rather than a necessity. Together with it being a public good, this makes it difficult to finance urban nature. At the same time, urban sprawl is frowned upon, because it is thought to spoil the countryside. One of the solutions is the densification of cities. As a result in the future more and more people have to go further and further away from home to spend time in (quiet) natural surroundings. It is argued that the nearness of green, natural spaces to residential areas positively affects their contribution to public health and empirical evidence supporting this argument is briefly presented. However, this evidence only shows that a positive relationship between the amount of green space within the living environment and health does exist. It does not prove conclusively that the relationship is causal in nature. Neither does it tell us which mechanism, or mechanisms, lie behind the observed relationship. Experiencing nature of course comes to mind. However, other mechanisms, e.g. dealing with air quality, may also contribute, or even contribute more strongly, to the observed relationship. Knowing which mechanisms are most responsible for the health benefits helps to go beyond the basic statement that more green space nearby is beneficial for one's health. It will provide indications on how to plan and design these local green spaces to maximise their health effects. An overview is provided of the possible mechanisms identified thus far. Special attention will be paid to mechanisms that presuppose that the living environment will influence the behaviour of the residents. This includes the amount of time spent in natural surroundings and the type of activity displayed during that time, recreational or otherwise. It is on these latter two aspects that present research of the author focuses at the moment. By means of secondary analyses of survey datasets enriched with GIS-data on the physical environment, the effects of the (green) environment on behaviour are investigated. Results of this ongoing research are presented.

Key words: health, nature experience, recreation, living environment, distance.

1 Introduction

In Western industrialised societies nature is strongly associated with health. For example, most people think of natural ingredients in their food as healthy. Also spending time in a natural environment is generally considered to be good for one's health. There is a growing body of studies that substantiates these beliefs. Viewing natural environments through a window, for example, has already been shown to have restorative qualities (Ulrich 1984; Kaplan 2001). However, these beliefs and facts are not reflected in current spatial planning policies regarding residential environments. The amount of green space in urban environments tends to be under strong pressure. In the Netherlands the most recent policy document of the Ministry of Spatial Planning, the Fifth National Spatial Planning policy document, propagates the concept of 'compact building': further urbanisation should mainly take place by making existing cities more compact (VROM 2001). One of the motives behind this compact building is actually to save the countryside from urban sprawl. By this urban sprawl the countryside is thought to loose its identity, and to become more uniform and 'messy'. Compact cities imply higher building densities. Although there are several ways to achieve this goal, the practice shows that the concept tends to threaten existing green spaces within or nearby cities (RIVM 2002). Consequently, in the future more and more people are likely to have less and less green space nearby.

The above observations raise the following question. Why is it that nature, while intuitively strongly associated with health - a primary value in life for most, if not all of us - often seems to have a low priority in spatial planning for, and the realisation of, residential areas? There are several angles from which to tackle this question. Political processes, administrative difficulties, opposing market forces all come to mind. Public greenspace, for instance, almost per definition constitutes a public good. And due to free-rider problems, public goods tend to be difficult to provide for other than by authorities that have the interest of the community as whole at heart. However, in this paper focus is more on the low priority itself. One reason for this low priority may the type of empirical evidence collected thus far (for an overview, see Ten Wolde 1999). Most of the studies thus far have been experimental in nature and/or focused on short-term restorative effects of exposure to natural environments. However, little is known about the long-term health effects of having green space in one's residential environment. What is the 'ecological validity' of the experimental results? A related reason for the low priority may be a lack of clear criteria for the amount, the type and the layout of the green space within the living environment, based on maximising its health effects. Especially when it comes to the more macro level that is the domain of policy makers and physical planners. Most previous studies focus on the micro level of a specific location or view. Consequently, even if policy makers and physical planners would acknowledge the idea that green space in urban environments contributes to public health, they would have difficulty implementing this idea. In this paper focus is on a different type of study.

In our first study a positive relationship between the amount of green space within the living environment and human health was established (De Vries et al. 2003). However, due to its correlational nature the causal mechanism behind this relationship is unclear. The operating mechanism is important, because it will provide us with clues regarding the ways to optimise the health benefits of green space in the urban environment. Our previous study already suggested that the amount is a relevant aspect. Other aspects may be relevant as well, however, and perhaps more easy to realise. The present paper is mainly agenda setting: it introduces a number of possible mechanisms, without corroborating them thoroughly. Special attention is being paid to spending time in green environments as a possible mediating factor. Some new results are presented regarding this mechanism. But firstly the results that the proposed mechanisms try to explain are described in greater detail.

2 Brief overview of the previous study on local green space and health

Based on a large-scale health survey in which over 10,000 Dutch residents participated and a national land cover database, the relationship between the amount of green space in the living environment and three self-reported health indicators was investigated (De Vries et al. 2003). The health indicators were:

- The number of health-related complaints during the last fortnight (headache, fever, fatigue, nervousness, nausea, et cetera).
- Judgement of one's overall health condition on a five-point scale.
- The score on a scale developed to measure the chance on psychiatric morbidity (GHQ).

The living environment was defined as the area within a three-kilometre radius from the midpoint of the respondent's residential neighbourhood. The definition of green space included the following three categories: urban green (parks, etc.), forests & nature areas, and agricultural areas. To rule out selection or composition effects, e.g. green environments attracting healthier people, statistical corrections were made for several socio-economic and demographic characteristics, e.g. education, type of health insurance, age, and gender.

Multilevel (logistic) regression analyses showed significant contributions of the amount of green space for all three health indicators. Although generally positive, the results were less consistent for 'blue space' (fresh & salt water). Having a garden often had a contribution of its own. There were no indications that the different categories of green space are related differently to health. For example, although forests & nature areas are generally preferred to agricultural areas, there was no support for the first category being stronger related to health. There were also no indications that green really close to home, i.e. within one kilometre, has a much stronger relationship with health than green somewhat further away (between one and three kilometres). There was some weak support for exposure to the amount of local green space as a mediating factor. Two groups that in general spend more time in the living environment, namely housewives and the elderly, showed stronger relationships between green space and some of the health indicators than the public in general. However, for a third such group, i.e. children, no such effect was found. Moreover, the relationship seemed to be somewhat stronger for groups with a lower socio-economic status.

Relevancy and causality of the greenspace-health relationship

The existence of a positive relationship between the amount of greenspace in the living environment and health has been confirmed, even after controlling for some likely selection or composition effects. However, two questions remain to be answered before health may be used as a powerful argument to promote urban greening:

a. Is it a strong relationship? and
b. Is the observed relationship causal in nature?

The first question is: How strong was the observed relationship? To begin with, it may be pointed out that in our study the relationship between the amount of green space in the living environment was stronger related to the health indicators than the level of urbanity of the municipality of residence. Prior research on spatial differences in public health has paid considerable attention to differences associated with urbanity. The level of urbanity, of course, is negatively related to the amount of green space in the living environment. This makes it interesting to note that urbanity no longer had any predictive value once the amount of green space was also introduced into the equation. One possible interpretation of this finding is that it is precisely the amount of green space that is responsible for the relationship between urbanity and public health.

The predictive value of green space for health may also be compared with that of an individual characteristic, such as age. When looking at the number of self-reported health complaints, a change in the amount of green space of 10 % has the same 'effect' as a change in age of 5 years (i.e. 0.15 complaint, on an overall average of 3.61 complaints per person). On a less serious note it might be stated that 10 % more green space makes you 5 years younger. However, for another indicator, the overall own health judgement, 20 % of green space that 'equals' 5 years in age. To complete this overview, for the third indicator (for mental health) no such comparison can be made: age has no predictive value for the GHQ-score. Our conclusion based on these comparisons is that the relationship between the amount of green space and health is not only a statistically significant, but also a socially relevant one.

A final remark regarding the relevancy issue relates to the scale of interventions. Unlike a change at the individual level, an intervention at the level of the living environment does not only change the (predicted) health of one person, but of many persons. Suppose, for example, that the well-known Vondelpark in Amsterdam would be transformed into a residential area. This park has a size of approximately 40 hectares, or less than 1.5 % of a living environment. However, it is a part of the living environment of approximately 300,000 residents. According to our prediction model, transforming the Vondelpark to a residential area would lead to an increase of over 6,000 health-related complaints per fortnight. This brings us to our other question: how likely is it that the amount of green space in the living environment is causally related to public health, and that the predicted effect will actually emerge?

3 Possible causal mechanisms

Several types of mechanisms may explain the observed relationship between green space and health. To start with, despite our efforts to statistically correct for selection or composition effects, it may still be the case that more urban residential areas attract a particular type of inhabitants, and that these inhabitants are inclined to a less healthy lifestyle. Or vice versa: specific groups with a healthier lifestyle are inclined to go and live in the countryside, or at least in less urban areas. This is called here the *preferred-lifestyle* mechanism. To the extent that this mechanism prevails, the relationship between green space and health may not be causal at all. This type of mechanism remains likely to the degree that the preference for an urban lifestyle (and matching residential area) does not coincide with any of the socio-economic and demographic characteristics that were included in our statistical correction procedures.

An implicit assumption behind this mechanism is that people have a large choice regarding the type of environment they want to live in. The mechanism suggests that they are able to go and live wherever they want to. The validity of this assumption may be questioned, certainly in the Dutch case. On the other hand, there is some empirical support for people living in more urban environments having a less healthy lifestyle. However, although these observations are consistent with the preferred-lifestyle mechanism, they may not be taken as evidence for this mechanism. The lifestyle itself may as well be a *consequence* of the type of living environment, as a *result* of individual preferences for such a lifestyle. If people living in a certain type of environment display a certain type of behaviour, their behaviour very well may have been influenced by their environment *regardless* of whether or not they have chosen to live in this environment.

Implicitly, the previous paragraph already contains the argument for another possible explanation, which is called the *lack-of-congruency* mechanism here. It is based on the assumption that not everyone is able to live where he or she prefers to live. The preferred and the actual residential area may not always be congruent. Furthermore, it assumes that especially green residential areas are favoured by more people than there are (affordable) dwellings in this type of environment to accommodate them. In that case a lack of congruency will occur more often in more urban environments. Lack of congruency between preferences and reality may easily lead to negative feelings, such as dissatisfaction and lack of control. This is especially likely if the living environment may be considered important to the individual. The final step in this suggested causal chain of events is that these negative feelings lead to a deteriorated (mental) health. Empirical data consistent with this mechanism are that in the more urbanised Dutch provinces (a) fewer people are satisfied with their residential environment and (b) more residents indicate that green areas within the neighbourhood are lacking (VROM 2000).[1]

[1] People may not have to be aware of such a mechanism in order for it to be operative. For example, they may have resolved the cognitive dissonance resulting from the 'mismatch' by adjusting their expectations. In other words: circumstances may influence preferences. This raises questions whether stated satisfaction about the living environment should be taken at face value. In our case the question is whether the cognitive dissonance reduction, which itself is triggered by negative feelings, succeeds in eliminating *all* negative feelings. In other words: how good are people at fooling themselves, at all levels of consciousness? See De Vries and De Bruin (1998) for a more thorough discussion of this issue.

A totally different type of mechanism is the *air-quality* mechanism. Especially for trees and forests there is evidence that these have a positive impact on the air quality. For example, they reduce the amount of fine dust (PM10) in the air (see e.g. McPherson et al. 1994; De Heer et al. 1998). This mechanism requires no particular preferences or activities to be operative. On the other hand, the amount of time spent in the living environment, especially out-of-doors, is likely to be an important mediating factor. It is not clear whether other types of green space, especially agricultural areas, have a similar positive effect on the air quality. On the whole, however, urban environments appear to be more polluted than rural environments (Kruize et al. 2000). Apart from the latter issue, it seems clear that the mechanism is operative. The question remains to what extent this mechanism is responsible for the earlier observed relationship between the amount of green space and public health. Other mechanisms may be relevant as well.

The fourth possible explanatory mechanism is the *nature-experience* mechanism. A variety of experiments have shown that experiencing a natural environment has positive health effects. In fact, only a representation of a natural setting may already lead to lower stress levels (for an overview see Ten Wolde 1999). Based on these findings, the British government already advised hospitals during spring 2001 to plant more trees in places where patients can see them. With more green space present in the living environment, it is likely that inhabitants will experience natural settings more frequently. Assuming that more and/or longer experiences will have a stronger health impact completes this mechanism. However likely, empirical evidence to support the latter is still lacking. Another issue that remains is whether the health effect of experiencing nature depends on how attractive this nature is to the individual. Especially the wilderness type of nature may be too threatening for some people. On the other hand, this is not a type of nature one is likely to encounter in the average Dutch living environment[2]. With regard to experiencing the more common domesticated type of nature, the health effect appears to be quite universal. It may once again be pointed out that the amount of time spent in visual contact with the local green space is likely to be an important mediating factor. This brings us to the following mechanism.

The fifth mechanism suggested deals with the amount of time spent out-of-doors. From the literature it is well known that a green setting is generally considered more attractive than a built-up area (see Van den Berg & De Vries 2000). Consequently it is not unlikely that people with a greener living environment spend more time out-of-doors, precisely in the green parts of their living environment. It may be the case that spending more time out-of-doors itself is already beneficial for one's health. This either because the (green) outdoor environment is more healthy than the indoor environment, or because most people spend a great deal of time indoors and especially the *change* of air or environment is beneficial. Furthermore this *green-exposure* mechanism is highly likely to strengthen the two aforementioned mechanisms, dealing with air quality and experiencing nature.

The sixth mechanism in our exposé is the *physical-exercise* mechanism. In the Netherlands, as in many other developed countries, the population suffers from a lack

[2] Besides threats from nature itself, a related issue is the social safety of green areas. This issue does seem relevant in an urban context.

of physical exercise. This leads to obesity, which is an important health risk factor. Recently it has been discovered that strenuous or intensive physical activities, such as sports and fitness exercises, are not needed to achieve health benefits. Moderately intensive activities, such as recreational walking and cycling, already have clear health benefits (Westerterp 2001). Furthermore, the health benefits of physical activity appear to be largest for those with the lowest exercise levels (Hildebrandt et al. 1999). Whereas physical exercise used to be included in all kinds of daily activities, nowadays many people do not need to be physically active to perform their daily duties. In other words: people have to be enticed to become physically active (Van der Poel 2000). An attractive local environment can help to lure people out of their homes to go for a spin, by foot or by bicycle. Since it was already stated that green environments are generally considered more attractive than built-up environments, this completes the physical-exercise mechanism.

The seventh and final explanatory mechanism suggested deals with social cohesion. In our modern day society social isolation is not uncommon. This social isolation may increase the chance of becoming depressed. In the Netherlands depression nowadays is a public disease. Several studies have shown that green spaces within the neighbourhood may influence the social cohesion of the neighbourhood population. (Burgess et al. 1988; Coley et al. 1997; Kweon et al. 1998; Taylor et al. 1998). Because of their attractiveness, these green spaces may function as hot spots for uncoordinated, informal social interaction between neighbourhood residents. Here the implicit assumption is that these social interactions are predominantly positive in nature. However, this assumption does not seem to be farfetched, since expected negative interactions may be avoided to a large degree, simply by staying at home. In other words, one is not obliged to go and interact with other neighbourhood members. Also here the amount of time spent out-of-doors is a likely mediating factor: it heightens the probability of chance meetings with other local residents. In the remainder of this paper one of the suggested mechanisms is explored a little further, namely the effect of the amount of green space on the amount of time spent in a green environment.

4 The green-exposure mechanism

Although the hypothesis that more green space in one's living environment will lead to a greater exposure to natural surroundings does not seem farfetched little research has been devoted to this issue. What is relatively well known, is the distance-decay effect: the further away a destination is located from one's home, the lower on average the frequency with which this destination is visited (see e.g. Coles & Bussey 2000). However, the visitation of a specific destination, or even type of destination, does not tell us what the overall level of visitation to all types of green space will be, and how it depends on the amount of green space in the living environment. By means of a secondary analysis of data gathered by De Boer and Visschedijk (1994) it was attempted to gain more insight into this relationship. In this study about 4,000 people living in four relatively large Dutch cities participated. Within each city four types of districts were selected: city centre, pre-World War II (WWII), post-WWII, and new developments. From each district a random sample of about 250 persons was drawn. Participants were questioned regarding their frequency of visitation/use of small green areas in the vicinity of their home, city parks, and green areas outside the city limits. The latter category included forests, nature areas and recreation areas. It is important to note that agricultural areas were not included in this latter category. Frequencies were recorded in classes, that - for the purpose of the present analysis - have been transformed into an interval variable (see De Vries 1999).

By means of the postcode of the respondents it was determined in which neighbourhood they lived. Subsequently the database was enriched with the same physical characteristics of the three-kilometre living environment that were used in the health study. Finally, to control for the difference in the composition of the neighbourhood populations, a segmentation specifically designed with regard to outdoor recreation was used (De Vries 2000). Based on the available data it was determined to which segment a respondent was most likely to belong. The five segments can be distinguished based on their position on the following three characteristics: age, type of household (family stage), socio-economic class (see Table 1). See De Vries (1999) for more information this procedure and the differences in the composition of the districts according to recreation segment.

From the health point of perspective the total frequency of green space usage appears to be the most interesting dependent variable: the earlier health study indicated that the type of green space was not relevant. However, the recreational usage or visitation of agricultural areas was not available. Consequently, clearer relationships may be expected between the local supply of a specific type of green space and the visitation or usage of this same type. Therefore it was decided to construct two dependent variables: frequency of use of green areas within city limits and frequency of use of green areas outside city limits. The first is the sum of the frequencies of use of small green areas in the vicinity of one's home and of visits to city parks. The corresponding local supply factor is the amount of urban green. The second dependent variable is simply the last of the three frequencies. The amount of forests & nature areas ('real nature') describes the local supply for this category. At this point it should be stressed that visitation is *not* limited to the local environment. For example, also visits to forests outside the three-kilometre living environment are included in the frequency of visits to green areas outside the city. Because many respondents came from the same neighbourhood, a multilevel analysis was performed.

First findings for the usage of green areas within city limits are presented. The overall average for this frequency was M = 126. A basic model was constructed, consisting of four indicator variables representing the recreation segmentation as predictors at level 1. The five segments differ considerably in their average frequency of urban green usage (see Table 1).

Table 1. Frequency of usage or visitation by recreation segment (times a year)

Segment	Brief description of the segment	Urban green	Forests and nature areas
Busy	Relatively young. Often single, or couple without children. Relatively high social status on average.	96	27
Reluctant	Mostly middle-aged. Household with children, including adolescents. Relatively low status.	140	20
Family oriented	Mostly middle-aged. Household with (young) children. Relatively high status.	145	37
Satisfied	Often in their late fifties. Couples without children within the household. Relatively high status.	150	36
Weary	Mostly elderly. Often single-person households. On average the lowest status.	106	16

In the next step the percentage of urban green was added as a level-2 predictor. The analysis showed that the addition led to a significant improvement of the model (Chi-square (1) = 5.45; $p < 0.05$). The regression parameter was B = 4.46: one percent more of the living environment consisting of urban green leads to a predicted increase of about 4.5 in the frequency of use of this type of green. In a third model the amount of 'real nature' was also added. This did not result in a significant improvement. Furthermore, the regression parameter also did not show a tendency to go in the negative direction (B = 0.92; not significant). Consequently, a larger local supply of green areas outside the city limits does not seem to lead to a lower level of usage of urban green.

Based on the observed differences in the relationship between green space and health for lower and higher educated people in our health study, in a final model an interaction between urban green and disadvantaged segments was included. The interaction variable consists of the percentage of urban green, but only for two of the five segments with a relatively low level of education and income: the Weary and the Reluctant. Adding this interaction variable to the model did not lead to a significant improvement.

The overall average for the number of visits to green areas outside city limits was 27.5. The analysis for this frequency showed that adding the amount of 'real nature' to the basic model improved the model significantly (Chi-square (1) = 15.72; $p < 0.001$). The regression parameter was B = 0.90. So one percent of more 'real nature' within the living environment is predicted to lead to an increase of 0.9 visit to this type of nature per year. Adding the amount of urban green to this second model did not lead to a further improvement. In this case the parameter tended to go in the negative direction (B = -0.19; ns). Finally, a similar interaction variable was constructed as for urban green. This time the interaction variable did improve the model: Chi-square (1) = 6.59; $p < 0.05$. The parameter for the 'overall' effect of 'real nature' increased to B = 1.19. The interaction parameter was negative: B = -0,73. This result signifies that the amount of real nature within the living environment has a lower effect on the visitation frequency for this type of nature for the disadvantaged segments than for the wealthier and better-educated segments. Table 1 shows that this is not because these groups always have high visitation frequencies, regardless the local supply. On the contrary, both the Reluctant and the Weary have relatively low averages for visiting 'real nature'.

In summary, although limited to people living in (Dutch) cities, the results clearly show that the amount of a specific type of green space has a positive effect on the frequency of usage or visitation of this type of green space. Furthermore, while no difference was found in the effect of the local amount of urban green between different segments of the population, such differences were found for the local amount of 'real nature'. The observed difference suggests that 'real nature' is either less attractive or more difficult/costly to visit for disadvantaged groups. Regarding the latter it might be added that, although the local supply is limited to a three-kilometre radius for all types of green, for neighbourhoods within cities 'real nature' is likely to be located further away on average than urban green within this living environment. This notion is supported by the much higher overall frequency of use of urban green, compared to that of natural areas outside the city. Moreover, green areas outside the city are likely to be more difficult to reach by public transport than green areas within city limits.

The number of visits cannot be equated with the amount of time spent within a specific type of green environment. For example, visits to areas located further away are likely to last longer on average. Nevertheless the author feels that the results support the green-exposure mechanism. Furthermore the results also indicate that disadvantaged groups living in cities are less inclined or able to visit natural areas outside the city. This makes the amount of urban green especially important to them, because it determines their overall usage of green areas to a larger degree. The data offer no insight in the effect of the local green supply on the green exposure of people living in towns, villages or the countryside. It might be hypothesised that also in those cases disadvantaged groups are stronger influenced by the (very) local supply of green areas.

From a social perspective the fact that a statistically significant relationship was observed, is not very compelling. It is especially the strength of this relationship that makes it relevant. First this is examined for the amount of urban green. For the neighbourhoods involved in the study, the average percentage of the living environment that is covered with urban green is 15.3 %, with a standard deviation of 4.8 %. A difference of two standard deviations (9.6 %) in the part of the living environment that is covered with urban green results in a predicted difference in the frequency of use of about 43 times a year. When relating this difference to the overall average frequency of 126 times a year, its size is about 34 % of this overall average. Furthermore, let us assume a normal distribution of the amount of urban green within the living environment for urban neighbourhoods. Then residents of neighbourhoods in the highest quarter of this distribution are predicted to use urban green about 1.25 as often as those of neighbourhoods in the lowest quarter of the distribution (140 versus 112 times a year). Based on these data it is concluded that the effect of the local supply of green space on its usage is sizeable enough to be of social relevance (or at least to make further study warranted). At the same time it is pointed out that the absolute values of the frequencies should not be taken at face value. When asked to estimate yearly frequencies in retrospect, people tend to overestimate them (Jensen 1999). However, there seems no compelling reason to assume that this overestimation will also affect the *relative* differences just presented.

Although tempting, the above results can not be taken as evidence that people with more green space within their living environment will spend more time out-of-doors. They also do not have to have higher levels of physical activity, not even when this is limited to the leisure domain. It may also be the case that they just spend a larger part of their time out-of-doors within a green environment, and/or perform a larger part of their recreational activities within a green environment. Preliminary conclusions of ongoing research suggest that the local supply of green space has little or no effect on the frequency of going for a walk or a spin.

5 Discussion and some preliminary conclusions

What has been learnt so far? At the local level of a neighbourhood, nature and public health are related. To be more precise: the amount of green space within the three-kilometre living environment and self-reported health indicators are. Given that it was observed for all three health indicators, the relationship appears to be quite robust. Furthermore it was concluded that the relationship is not merely statistically significant, but also of social relevance: it is strong enough to matter. Whether it really matters, however, also depends on whether the observed relationship is causal in nature, in the sense that more green space leads to a better public health. In the aforementioned study itself care was taken to rule out the reverse effects as well as possible, such as healthier people choosing to live in greener living environments. However, explanations of the observed relationship based on selection or composition effects remain possible. An example was given by means of the preferred-lifestyle mechanism.

How likely this type of explanation is, depends to a large degree on the amount of choice we are willing to assume with regard to living environments. Are the preferred environments available at affordable prices? The amount of choice is likely to differ by group. For example, high-income groups are more likely to live in residential areas that are more congruent with their preferences, whatever these preferences may be. It may be pointed out that also the importance assigned to the greenness of the living environment by the person(s) making the choice is relevant. Even if there is considerable freedom of choice, there may be other criteria that influence one's choice more strongly, such as nearness to one's place of work, one's relatives, and/or the presence of secondary schools and other types of basic facilities. It is argued here that in general, (the most important of) these other criteria are (still) likely to favour more urban settings. Consequently the opposite mechanism, lack-of-congruency, seems at least as likely. This mechanism assumes lack of choice in the place of residence, combined with more people preferring green residential areas to 'stony' areas. This is a matter of some importance, because of the difference in the expected net health effect of building more compact cities. According to the first mechanism, people preferring a green living environment will move out and people preferring a more urban environment will move in. According to the second mechanism a lot of people are likely to stay and live in an area that is less congruent with their preferences than it was before. In the first case 'only' a spatial redistribution of health takes place. In the second case, however, there is an actual health loss involved.

The other five suggested mechanisms behind the observed nature-health relationship all assume that the local amount of green space is positively and causally related to public health. The available empirical support differs by mechanism. For most of the mechanisms there is at least partial support, i.e. for one step in the suggested chain of events. Taken together, the suggested mechanisms make it very likely that the observed relationship between the amount of green space and public health is at least partially causal in nature. Moreover this causality is positive. The possible negative health effects of nature, such as an increased chance of getting Lyme's disease, have not been discussed yet. The reason for this is the sign of the observed nature-health relationship started with: the sum of all underlying mechanisms, whatever they are, is a positive relationship. Nevertheless, it is considered useful to be aware of potential negative effects, so that they can be avoided as much as possible. As with sports, all in all its health effects are positive, but it helps to keep the injuries down to a minimum.

Thus, given the state of the art, what recommendations regarding urban greening can be made, based on its health effects? Admittedly, the evidence is not always conclusive and more research is clearly needed. On the other hand, it is well known that transforming a residential area into a park or a forest is much more difficult to realise than the reverse. Given that net positive health effects are quite probable, in our opinion urban green space deserves to be treated as more than a luxury. Maybe because of its association with leisure and enjoyment, urban green space does not tend to be viewed as a necessary requirement for a healthy living environment. However, the author feels that green space in urban environments is highly likely to do more than 'just' make the living environment attractive. According to this line of reasoning, special attention should be paid to the living environment of people that have little choice in their place of residence, depend on/are exposed to the living environment strongly, and/or are likely to succumb to whatever activities the living environment is best suited for. These groups are likely to benefit the most from urban greening.

An issue that remains is the design and layout of green spaces in or nearby urban areas. Which design and/or layout is optimal with regard to maximising health benefits? The answer to this question depends on which mechanism is (most) responsible for the nature-health relationship. By way of example, the green-exposure mechanism could be in focus. First of all the suggestion can be made that for the health effect the aesthetic quality or visual attractiveness of the green space is not very important. Quite ordinary natural settings seem to suffice. A few findings point in this direction. The first one is that in the health study carried out by the author and others a more positive relationship with health for generally higher appreciated types of nature was not observed. It appeared to be the total amount of green space that was relevant, even though this characteristic was dominated by agricultural areas (De Vries et al. submitted). Another finding pointing in this direction is that in the visitation study reported in this paper, there was no evidence that a larger supply of 'real nature' quite nearby had a negative effect on the use of urban green. This although in general people find forest and nature areas more attractive environments than urban parks (see also Kaplan 2001; Ulrich 2002). At the same time the effect of the size of the local supply on visitation or usage has been clearly demonstrated. Quality seems to be clearly outweighed by the combination of quantity and nearness (see also Coles & Bussey 2000; Hörnsten 2000). A system of small, nothing out of the ordinary neighbourhood parks seems more in line with these conclusions than one sizeable central park with an innovative, prize-winning design. Especially when, helped by a cost-efficient layout of the small parks, a larger total acreage may be achieved than that of the central park. Although the latter may be more important for (the image of) the city, the former is likely to be more beneficial to the citizens.

A question that remains open is whether just visually experiencing the greenery will be the most effective way of promoting health. Experimental research has clearly shown that viewing green space by itself already has beneficial effects. However, it may be that the health effects are stronger when one is surrounded by natural elements. This is of quite some practical importance, because it determines to what extent street trees and private green (that can be viewed by others) also may be expected to have a positive health effect.[3] Also for public green space it matters whether it has to be 'usable' or just 'viewable'. Should one be able to walk

[3] These types of green have not been included in our urban green category of supply thus far.

through it or not? For example, Coles & Bussey (2000) suggest that for use a minimum size of two hectares is required for woodland. Furthermore it should have an open structure, whereas species was not a significant factor. Another question with considerable practical implications is whether the number of other people that simultaneously view or use the green space is of importance for the health effect.

The reader is reminded that the green-exposure mechanism was selected for illustrative purposes, and not because it has been ascertained that is the most important mechanism behind the observed green space-health relationship. Other mechanisms are likely to suggest other planning and design guidelines. For example, if lack of congruency is an important mechanism, then the green space should be designed according to local people's preferences. If it's air quality, then maybe urban woodlands are the most obvious choice, but not as open as seems recommendable for use-purposes. Furthermore, the species may become important, with a preference for coniferous trees, because they will also do their job during wintertime (Beckett et al. 2000). If it is social cohesion, then the green space should facilitate informal interaction with fellow neighbourhood members, e.g. by providing enough benches, and grouping them, rather than scatter them over the area. This mechanism is also likely to require small green areas nearby. The smaller the service area of the green space, the higher the probability of meeting other neighbourhood members. Of course one could also strive for distinct types of green space for each of the mechanisms. However, where space is scarce, as it usually is in the urban context, it should be used efficiently. The author believes that, regardless of the many questions that remain unanswered, this paper helps to show that urban green might be a more efficient use of space than it is often thought to be. Moreover, it is hoped that it does so in a way that appeals to policy makers and physical planners.

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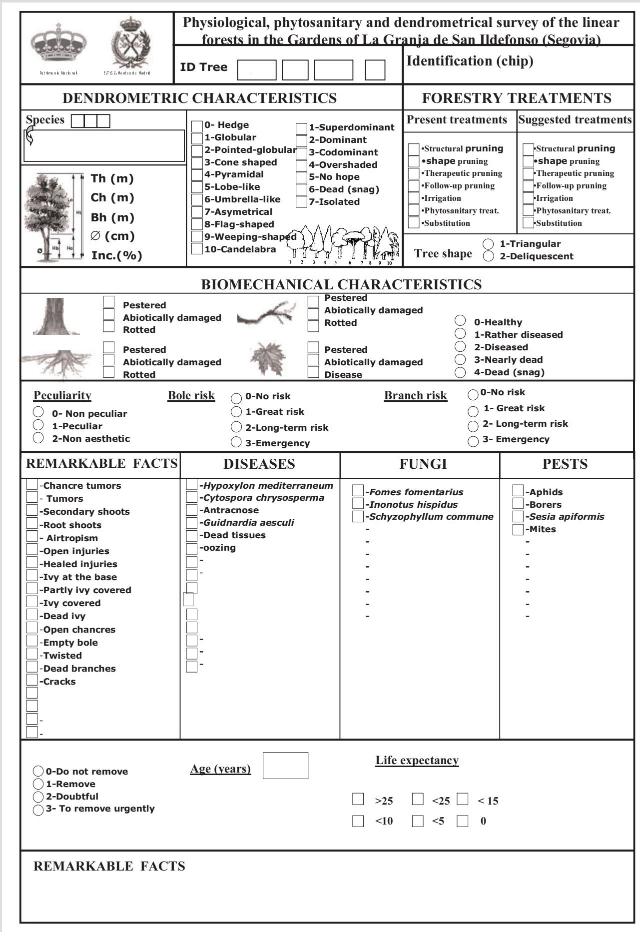

Physiological, phytosanitary and dendrometrical survey of the linear forests in the Gardens of La Granja de San Ildefonso (Segovia)

ID Tree

Identification (chip)

DENDROMETRIC CHARACTERISTICS

Species

Th (m)
Ch (m)
Bh (m)
∅ (cm)
Inc.(%)

0- Hedge
1-Globular
2-Pointed-globular
3-Cone shaped
4-Pyramidal
5-Lobe-like
6-Umbrella-like
7-Asymetrical
8-Flag-shaped
9-Weeping-shaped
10-Candelabra

1-Superdominant
2-Dominant
3-Codominant
4-Overshaded
5-No hope
6-Dead (snag)
7-Isolated

FORESTRY TREATMENTS

Present treatments	Suggested treatments
•Structural pruning	•Structural pruning
•shape pruning	•shape pruning
•Therapeutic pruning	•Therapeutic pruning
•Follow-up pruning	•Follow-up pruning
•Irrigation	•Irrigation
•Phytosanitary treat.	•Phytosanitary treat.
•Substitution	•Substitution

Tree shape
1-Triangular
2-Deliquescent

BIOMECHANICAL CHARACTERISTICS

Pestered
Abiotically damaged
Rotted

Pestered
Abiotically damaged
Rotted

Pestered
Abiotically damaged
Rotted

Pestered
Abiotically damaged
Disease

0-Healthy
1-Rather diseased
2-Diseased
3-Nearly dead
4-Dead (snag)

Peculiarity
0- Non peculiar
1-Peculiar
2-Non aesthetic

Bole risk
0-No risk
1-Great risk
2-Long-term risk
3-Emergency

Branch risk
0-No risk
1- Great risk
2- Long-term risk
3- Emergency

REMARKABLE FACTS	DISEASES	FUNGI	PESTS
-Chancre tumors	-*Hypoxylon mediterraneum*	-*Fomes fomentarius*	-Aphids
- Tumors	-*Cytospora chrysosperma*	-*Inonotus hispidus*	-Borers
-Secondary shoots	-Antracnose	-*Schyzophyllum commune*	-*Sesia apiformis*
-Root shoots	-*Guidnardia aesculi*		-Mites
- Airtropism	-Dead tissues		
-Open injuries	-oozing		
-Healed injuries			
-Ivy at the base			
-Partly ivy covered			
-Ivy covered			
-Dead ivy			
-Open chancres			
-Empty bole			
-Twisted			
-Dead branches			
-Cracks			

0-Do not remove
1-Remove
2-Doubtful
3- To remove urgently

Age (years)

Life expectancy
>25 <25 < 15
<10 <5 0

REMARKABLE FACTS

Mensuration and modelling in the context of urban forestry

The application of GIS to the management of parks

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Abstract

The increasing demand for open, green areas near big cities implies a large range of problems related to the management of wide, open spaces whose main purpose is to provide satisfactory recreation experiences for visitors. These recreation areas must also offer a minimum of safety. The first aspect is comprised within the idea of landscaping. The second involves aspects such as pests and diseases, which may endanger the health of visitors.

In order to achieve these purposes it is essential to take both an overall and a specific approach, both linked with individual demands. It is not an easy task to reach such goals using traditional management tools. Nowadays, however, it is possible to apply systematic management methods, which combine digital cartography with Geographic Information Systems (GIS).

In Spain GIS is already used in the gardens belonging to Patrimonio Nacional. The information collected on each tree through this technique is computerized, which makes the work easier on both aspects: introducing new data and singular and comprehensive managing of vegetation.

Key words: garden management, landscaping, safety, GIS.

1 Introduction

Traditionally, foresters have been committed to managing forest in connection with all the aspects and elements related to manufacturing, transformation and marketing of the products resulting form their activity. During the last decades, however, our societies have increasingly been demanding new functions from the forests and the range of foresters' activities has been broadening to new extents. New areas have been brought to management and new criteria have been introduced for managing woodlots such as peri-urban parks and riparian forests. New elements such as preservation of biodiversity, social function, total protection of the stands (against fire, pests, disease, wind storms, pollutions and so on) in addition to landscape preservation and carbon dioxide fixation are now included in forest management.

One of the aspects in which foresters scarcely played a role in bygone times was the relationship between park and garden woodlands and other elements relevant for the scenery. Fortunately, things are changing due to an increased number of specialized foresters who, either through the service for parks and gardens belonging to Public Organizations or through private corporations of service, are related to the parks and woodland sector. This sector gradually strengthens its activities, asks for better-qualified staff and gains greater economic importance.

2 Methodology for the management of parks and gardens

Historical gardens are characterized as places where nature and culture, work and leisure merge in a unique way; in a unique way as places where human beings have developed ideas and good taste for their use and enjoyment. But these gardens today have added public interest one because they are usually spots where history and memories come together to fulfil the following functions (Engelking 1995):

- Preservation of former customs and traditions.
- Preservation of vegetal species introduced and protected by care of several generations of gardeners.
- Preservation of outstanding elements of the scenery.
- Places for pleasure which interest is based on the aesthetic purposes shown by their elements.

Because of the above, the preservation of historic parks seems to be important. Unfortunately, many of them were never adequately managed as a result of lack of interest or financial resources. Parks and gardens gained a major relevance for citizens during the 1970s when a new concern about quality of life and environment developed. This acknowledgement has led some countries to create specialized agencies in order to establish and carry out specific policies for the whole country. The French government, for example set up a new service of gardens within the Dirección del Patrimonio, which belongs to the Ministry of Culture in 1991. These policies have come to reality in the national inventory of historical gardens.

The methodology for practical execution of park and garden management can be itemised as follows:

1. Knowledge about former management actions and about the functions they performed when they were devised. Additionally decisions must be made whether these functions should be continued or not.
2. Inventory, which should include a quality - (species, tree shapes, colors etc.) and quantity description (number of trees, main sizes, health condition, etc.) in addition to the present state of the garden sections and sets of flowerbeds - parterres - as well as their location.
3. Restoration, taking the general structure of the park or garden (its peculiarities or scenery) into consideration. Its natural evolution with the passing of time, the modifications introduced, the advantage of maintaining it and the cost of the advisable actions to be performed should all be considered.
4. Management. Although the gardens are considered historical monuments, they cannot be managed as conventional state property because of their natural

characteristics, which makes them evolutionary and short living. The management goal should be the long-term preservation of the landscape peculiarities of their stands, their proportions, shapes, colours or settings and their historical features (species and management methods) i.e. for a period greater than a normal tree life cycle.

These rules imply that it is not only unavoidable to continue sustaining a relatively acceptable condition for these gardens (for as long as it can be possible), but that the aim established at their origin should be reached and supported at the same time. These principles and characteristics are the ones inspiring management of the woodlands in the historical gardens at La Isla and El Príncipe in Aranjuez (Madrid) and also at La Granja (Segovia). They all belong to Patrimonio Nacional (National Trust). The applied management approaches for these gardens are described in the following.

3 Description of gardens

In the following, the gardens will be described that have been managed by means of GIS VJ2002. They are La Isla and El Príncipe in Aranjuez (Madrid) and La Granja (Segovia).

La Isla and El Príncipe

La Isla and El Príncipe are two gardens located at the Real Sitio de Aranajuez, an ancient royal estate on the confluence of Tajo and Jarama rivers. The microclimate of the area, its soil fertility and the abundance of water (early channelled for the irrigation of orchards and gardens) made it a favourite resort for the Spanish kings and queens especially during springtime. Thus, the first palace was

Table 1. Species present in La Isla and Príncipe Gardens in Aranjuez.

Acer campestre	*Dyospiros virginiana*	*Platanus hispanica*
Acer negundo	*Eleagnus angustifolia*	*Populus alba*
Acer pseudoplatanus	*Fagus sylvatica*	*Populus nigra*
Aesculus hippocastanum	*Fraxinus angustifolia*	*Populus tremula*
Ailanthus altissima	*Fraxinus cf. americana*	*Prunus cerasifera var. atropurpurea*
Arbutus unedo	*Fraxinus ornus*	*Pyracantha coccinea*
Berberis julianea	*Fraxinus pendula*	*Pyrus malus*
Brousonetia papirifera	*Gleditsia triacanthos*	*Pyrus sp.*
Buxus sempervirens	*Gymnocladus dioicus*	*Quercus petreae*
Calocedrus decurrens	*Ilex aquifolium*	*Quercus robur*
Carpinus betulus	*Juniperus turiphera*	*Quercus sp.*
Carya illionensis	*Koeleria paniculata*	*Robinia pseudoacia*
Cedrus atlantica	*Lagerstroemia indica*	*Sequoia sempervirens*
Cedrus deodara	*Laurus nobilis*	*Sophora japonica*
Cedrus libani	*Ligustrum aeropeus*	*Spiraea cantoniensis*
Celtis australis	*Ligustrum lucidum*	*Syringa vulgaris*
Celtis occidentalis	*Ligustrum vulgare*	*Taxus baccata*
Cercis siliquastrum	*Liquidambar stiraciflua*	*Tilia platyphyllos*
Chamaeciparis lausoniana	*Magnolia grandiflora*	*Tilia x vulgaris*
Cornus sanguinea	*Morus alba*	*Trachycarpus sp.*
Cupressus arizonica var. glabra	*Olea europaea*	*Ulmus glabra*
Cupressus sempervirens	*Photinia serrulata*	*Ulmus minor*
Cydonia oblonga	*Phytosporum tobira*	*Ulmus pumila*
Crataegus monogyna	*Picea abies*	

built during Philip II´s reign and it was King Charles IV, who ordered the new structure of the gardens (based on the former ones) in the way we can enjoy them today.

El Príncipe covers a total area of 140 ha and although there are some altitude differences, the territory is relatively flat. In order to manage it, the garden has been divided into 66 sections or groves where GIS have been used to manage tree lines for approximately 7,444 trees. La Isla, on the other hand, extends over 25 ha and altitude differences are not noticeable in it. It has been divided into 82 sections, which comprise a total amount of 3,000 trees, including both the interior and external ones. So, we can say that a total amount of 10,444 individuals belonging to different species has been managed by means of GIS VJ2002 in the gardens at Aranjuez (see Table 1).

The area falls under the classification Continental-Mediterranean climate, which is defined by its dry summer seasons followed by scarce winter rains, with spring and autumn being rainy periods.

La Granja

La Granja gardens are possibly the best documented ones among the largest garden lots established by the Spanish crown. This may be so because they are the newest in our history. They were formerly used as a farm belonging to the religious order of St. Jerome, from where it takes its name (the Spanish Granja = farm).

This property was later acquired on behalf of Philip V who ordered the gardens established shortly after 1719, the same year in which the building of the palace was initiated. Architect Boutelou was in charge of the works. The main facade of the palace, which was the favourite residence of the Spanish royal family along over two centuries, faces southward on the shady side and towards the gardens. The gardens were designed according to the ones at Versalles, where the first member of the Borbón dynasty in Spain was brought up and with which he was well familiar.

La Granja gardens cover a total area of 146 ha of which 67 belong to what is

Table 2. Species present in La Granja Garden (Segovia).

Abies alba	*Fraxinus ornus*
Acer campestre	*Liriodendron tulipifera*
Acer platanoides	*Picea abies*
Acer pseudoplatanus	*Pinus sylvestris*
Acer sp.	*Platanus hispanica*
Aesculus hippocastanum	*Populus alba*
Carpinus betulus	*Prunus sp.*
Calocedrus decurrens	*Quercus pyrenaica*
Chamaecyparis lausoniana	*Robinia pseudoacacia*
Cedrus atlántica	*Sequoiadendron giganteum*
Cedrus sp.	*Sorbus atrocinerea*
Crataegus monogyna	*Sorbus sp.*
Fagus sylvatica	*Tilia x vulgaris*
Fraxinus excelsior	

called »bosque« (forest) and 79 to the actual garden. They are both placed on a Northwest-facing slope, their altitude being between 1,172 and 1,364 m. The average steepness is 5 % in the garden area and 14 % in the forest. In order to perform its management, the garden has been divided into 104 sections or groves where 8,827 individuals belonging to different species have been already treated (see Table 2). The whole area falls into the phytoclimatic subregion IV (VI) »Subhumid Mediterranean Climate with a Central – European tendency«, according to Allue´s classification (Allué 1990).

The area suffers from physiological droughts along June, July, August and September what makes irrigation a real need to avoid the damage of dryness. The most relevant elements in La Granja gardens are:

a) The fountains

- Del Caracol (the winkle)
- Del Abanico (the fan)
- Andromeda´s
- Los Dragones (The dragons)
- Las Tazas (the basins)
- El Canastillo (the small basket)
- Las Tres Gracias (the three graces)
- Los Baños de Diana (Diana´s toilets)
- De la Fama (the fame); this last displaying the most spectacular fountain jet in the gardens

b) The ponds:

- el Carro de Neptuno (Neptune´s carriage)
- Apollo and Minerva´s
- La Media Luna (the creccent)
- Los Baños de los Dioses (the toilets of the gods)

c) Cascades

- la Vieja y la Nueva (the old and the new cascades)

d) Brooks

These are all supplied with water from a large reservoir that is called the Sea.

Basically, vegetation is arranged according to water availability, especially at the lower levels; but it does not mean that other remarkable elements such as statues, amphorae, promenades, the Maze, the Arbour, etc. have not been taken into consideration. The most characteristic sections in the garden (which are delimited by tree lines of linden, hornbeams, horse–chestnuts and other species in addition to hornbeam and beech hedges) frame a more natural vegetation, sometimes crossed by interwoven footpaths where native species such as oaks can be found, very often together with other exotic ones. Thus, from the box parterres in front of the palace up to the wild forest surrounding the gardens, everything encourages the feeling of peace intended by the creators of these gardens.

4 Management of the gardens

In order to perform good management, the National Trust (Patrimonio Nacional) together with the Laboratory of Dasometry, Forest Management and Agricultural Assessment belonging to the Escuela Técnica Superior de Ingenieros de Montes

Table 3. Physiological, phytosanitary and dendrometrical survey of forests.

Patrimonio Nacional — E.T.S.I.Montes de Madrid

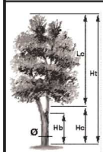
Physiological, phytosanitary and dendrometrical survey of the linear forests in the Gardens of La Granja de San Ildefonso (Segovia)

ID Tree ☐☐☐☐

Identification (chip)

DENDROMETRIC CHARACTERISTICS

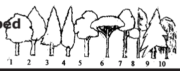
Species ☐☐☐



Th (m)
Ch (m)
Bh (m)
∅ (cm)
Inc.(%)

☐ 0- Hedge
☐ 1-Globular
☐ 2-Pointed-globular
☐ 3-Cone shaped
☐ 4-Pyramidal
☐ 5-Lobe-like
☐ 6-Umbrella-like
☐ 7-Asymetrical
☐ 8-Flag-shaped
☐ 9-Weeping-shaped
☐ 10-Candelabra

☐ 1-Superdominant
☐ 2-Dominant
☐ 3-Codominant
☐ 4-Overshaded
☐ 5-No hope
☐ 6-Dead (snag)
☐ 7-Isolated

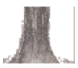


FORESTRY TREATMENTS

Present treatments	Suggested treatments
☐ •Structural pruning	☐ •Structural pruning
☐ •shape pruning	☐ •shape pruning
☐ •Therapeutic pruning	☐ •Therapeutic pruning
☐ •Follow-up pruning	☐ •Follow-up pruning
☐ •Irrigation	☐ •Irrigation
☐ •Phytosanitary treat.	☐ •Phytosanitary treat.
☐ •Substitution	☐ •Substitution

Tree shape ○ 1-Triangular ○ 2-Deliquescent

BIOMECHANICAL CHARACTERISTICS



☐ Pestered
☐ Abiotically damaged
☐ Rotted

☐ Pestered
☐ Abiotically damaged
☐ Rotted

☐ Pestered
☐ Abiotically damaged
☐ Rotted

☐ Pestered
☐ Abiotically damaged
☐ Disease

○ 0-Healthy
○ 1-Rather diseased
○ 2-Diseased
○ 3-Nearly dead
○ 4-Dead (snag)

Peculiarity
○ 0- Non peculiar
○ 1-Peculiar
○ 2-Non aesthetic

Bole risk
○ 0-No risk
○ 1-Great risk
○ 2-Long-term risk
○ 3-Emergency

Branch risk
○ 0-No risk
○ 1- Great risk
○ 2- Long-term risk
○ 3- Emergency

REMARKABLE FACTS	DISEASES	FUNGI	PESTS
☐ -Chancre tumors	☐ -*Hypoxylon mediterraneum*	☐ -*Fomes fomentarius*	☐ -Aphids
☐ - Tumors	☐ -*Cytospora chrysosperma*	☐ -*Inonotus hispidus*	☐ -Borers
☐ -Secondary shoots	☐ -Antracnose	☐ -*Schyzophyllum commune*	☐ -*Sesia apiformis*
☐ -Root shoots	☐ -*Guidnardia aesculi*	-	☐ -Mites
☐ - Airtropism	☐ -Dead tissues	-	-
☐ -Open injuries	☐ -oozing	-	-
☐ -Healed injuries	☐ -	-	-
☐ -Ivy at the base	☐ -	-	-
☐ -Partly ivy covered	☐	-	-
☐ -Ivy covered	☐	-	-
☐ -Dead ivy	☐	-	-
☐ -Open chancres	☐		
☐ -Empty bole	☐ -		
☐ -Twisted	☐ -		
☐ -Dead branches	☐ -		
☐ -Cracks			
☐			
☐			
☐ -			
☐ -			

○ 0-Do not remove
○ 1-Remove
○ 2-Doubtful
○ 3- To remove urgently

Age (years) ☐

Life expectancy

☐ >25 ☐ <25 ☐ < 15
☐ <10 ☐ <5 ☐ 0

REMARKABLE FACTS

NOTE: options vith a circle admit only one shoice, optionss with a square admit various ones.

at Universidad Politécnica de Madrid are developing a computerised survey on the dendrometrical, biomechanical , phytosanitary and safety condition of the trees.

A databank has been set up for each tree. The databank includes information on species and location, both the general inside the garden and the specific situation within each section or parterre by establishing the exact lane and side on which they are located, identifying the spot with a cm accuracy. It also includes dendrometrical features such as average diameter, total height, crown dimensions, tree shape, crown shape, phytosociology, age, peculiarities and bole inclination. Biomechanical and phytosanitary characteristics such as disease, insect damage, decay, abiotic damage, general health condition and practical life expectancy are also included together with the treatments and growth care (pruning, watering and fertilization) in addition to establishing branch or trunk risks for visitors. As a supplement, a digital cartography has been carried out to identify tree location in the garden. In different seasons, digital photos have also been taken in order to record tree shape, crown shape and the major abnormalities present for each individual tree (see also Table 3).

All the previous information is compiled by means of a GIS VJ2002 program, specifically designed for this survey. The information is stored in subdirectories, which are easily available through graphic or text windows. Thus, by double-clicking on the tree icon shown on the cartography, all the available information about it is accessible. The program also allows to apply filters for selecting those individuals that may be of interest as a result of a specific common characteristic (species, dimensions, rotting, hazard, and so on); everything leading to easy handling, follow–up treatment and management of the actions performed on the woodlot.

Another innovation introduced in woodlot management is the use of a computerised label. The label assists in identifying each individual and in storing all the

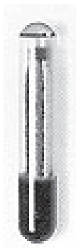


Fig. 1. Transponder.

Fig. 2. Transponder activator.

Fig. 3. Software can be adapted. (computer intercommunication)

Fig. 4. Transponder introduction.

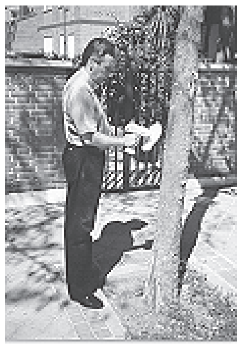


Fig. 5. Data reading.

information including treatments given to it over time. Thus, when the woodlot is inventoried, a short-living passive transponder is introduced in each tree (Figures 1 and 4). Its dimensions are 11.5 x 2.2 mm; it can bear hard external conditions and complies with ISO 9001 quality standards. This device is equipped with a 10-digit key and thus its reading, together with VJ2002 program, supplies the whole existent information, which allows quick consulting and updating, saving time and financial resources. In this way, the data collection and processing may be automated by means of readers (Figures 2, 3 and 5).

5 Conclusion

The survey presented in this paper is aimed at a better description and understanding of the various types of tree vegetation in historical parks and gardens. It also focuses on the management and restoration of these parks, paying respect to their original compositions and to the objectives they were originally devoted to. In addition, this paper presented the idea of establishing basic elements for technical management of the forests stretching over historical parks and gardens. It has shown how new data integration techniques have made it possible to simplify management of parks and gardens.

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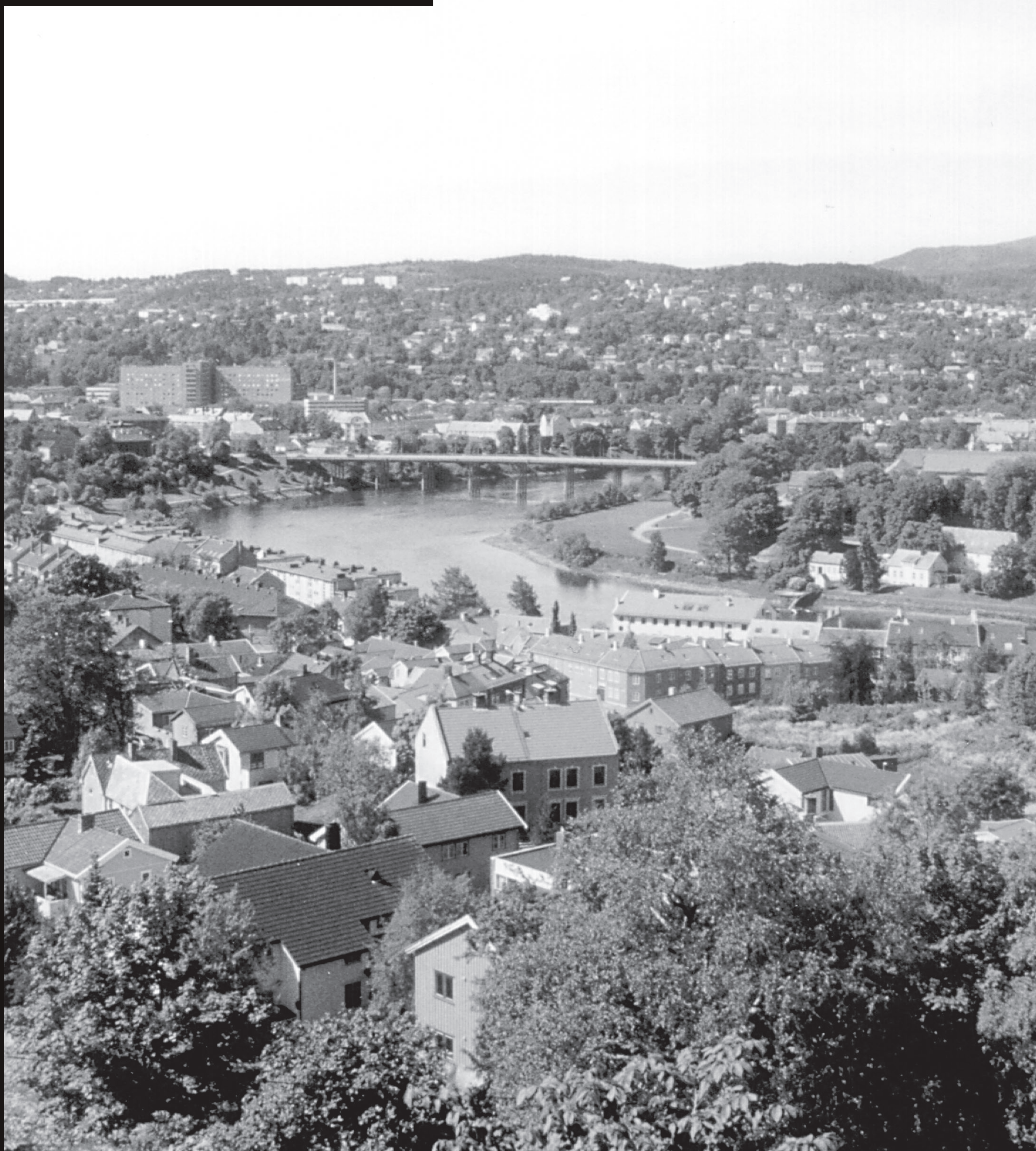
Working Group 6.03.02



Trends in forest terminology - Urban forestry

A collaborative approach to developing a multilingual forestry thesaurus

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Abstract

With the current and anticipated explosion in online information, controlled multilingual vocabularies are being recognized as more important and necessary to improve access to relevant information. Thus, a controlled, multilingual forestry thesaurus is recognized as having significant potential for the Global Forest Information System (GFIS), which is currently being developed by IUFRO and the forestry community as a whole. We describe a collaborative small-scale project to initiate and develop the preliminary phase of a multilingual forestry thesaurus. The principal aim of this project is to develop a tool for harmonizing Metadata in GFIS and thereby enhancing the usability of information provided through GFIS. In order to achieve this, we aim to provide mapping between AGROVOC and CAB Thesaurus forest-related terminology and examine possibilities of mapping these harmonized terms to commonly used multilingual library classification systems, e.g. the Forest Decimal Classification (FDC), Dewey, etc. Our intention is also to build on IUFRO's *International Bibliography of Dictionaries, Glossaries and Terminological Publications in Forestry and Related Sciences*; take an inventory of existing digital and non-digital thesauri, glossaries, wordlists and dictionaries in the forestry domain; and create an online database of these resources. We will also examine current terminology usage by researchers, starting by examining a subset of bibliographic references in the forestry subfile of the CABABSTRACTS database to determine the feasibility of developing a methodology for identifying subject gaps in existing thesauri. Outputs from this project will enable us to produce a complete project proposal and work plan to create a multilingual forestry thesaurus, while also providing a reference tool that will be immediately available to GFIS and to the forestry community as a whole.

Key words: thesauri, terminology, classification, information processing, metadata, forestry.

1 Introduction and background

The volume of globally generated forestry information is enormous and growing, as are the sources of this information. Increasingly, such information is published using electronic means, but a substantial part of it remains inaccessible to users. The major problem facing information seekers worldwide is locating information sources corresponding to their needs. Equally important, information providers often do not find appropriate venues for presenting their information, which then remains inaccessible to others.

To help address these problems, the International Union of Forest Research Organizations (IUFRO) established a task force in 1998 to »develop a strategy for, and implement, an Internet-based Metadata service, that provides co-ordinated worldwide access to forest information«. The result of the work of the task force is the development of the Global Forest Information Service (GFIS) (See Box 1).

To promote accessibility, credibility, quality and permanence of forest information, GFIS adheres to the following principles:

- Visibility of global forest information through GFIS will be simple, equitable and timely for all.
- Agreed standards will be followed to ensure that a consistent level of quality and relevance will be achieved to serve the needs of GFIS users.
- GFIS emphasizes partnerships, cross-sectoral and international, to develop skills, for technology transfer, and to maximize the value of all forest information resources and providers, worldwide.
- The protection of intellectual property rights, confidentiality and security is held in the highest regard.

As a global network of distributed information resources, GFIS suppliers will retain full managerial control of their information.

Box 1. Principles of GFIS.

This explosion in online information requires information management tools to facilitate access to relevant information. Users need to be able to locate information by subject and they need to locate information in multiple languages. Sustainable forest management, for example, is a global concern and we need to ensure that users around the world can use their own language to access forestry information that is of relevance to them and which may or may not be in a language they use normally. We need to improve existing tools to retrieve the information we are looking for. A tool that will help retrieve forestry information is a multilingual forestry thesaurus. We need to build collaboratively on existing mechanisms to develop this tool, which will help a variety of stakeholders to locate the forestry information they are searching for.

2 What is a forestry thesaurus?

Information experts have found that better consistency is obtained over time and space if standards are used for controlling the terms in an information repository. Terms can be controlled through key word lists, glossaries or thesauri. A thesaurus is a hierarchical controlled vocabulary, meaning that the terms within the vocabulary are somehow related to each other. »Controlled vocabulary«, in the context of information management, means bringing together different terms used for similar concepts so that resources about that concept can be readily identified and accessed. For example, authors of three different scientific papers may have used the following keyword phrases when they posted their papers on the Web: »forestry policy«, »forest policy« and »forestry policies«. Users who look for the phrase »forest policy« will find only one of the three papers. If their papers are included in an online database or gateway that uses the controlled vocabulary phrase »forest policy«, however, then their papers will have been re-indexed with that phrase and a user searching for »forest policy« will locate all three papers without having to perform multiple searches. The relationships between terms in a thesaurus can be in the form of broader or narrower terms, e.g. »coniferous forests« is a narrower term (nt) of »forests« and conversely »forests« is a broader term (bt) of »coniferous forests«. Related term (rt) is used for two terms that are related, but are not broader or narrower – an example would be »forest litter« and »humus«. A third relationship is a non-preferred term. These are often synonyms or near-synonyms of descriptors. They guide a user to the preferred term used in the Thesaurus. Designating a word a non-preferred term in a Thesaurus does not imply that it is not a valid term; it is a mechanism to reduce the number of words that can be used to describe the same or similar concepts in any database using a controlled vocabulary.

3 Why should we develop a multilingual forestry thesaurus?

A major barrier to effective international collaboration and effective information access and dissemination is differences in terminology and language among different contributors. While the potential to overcome differences in software and hardware have made significant advances, information access still relies heavily on a common terminology between the searcher and the language used in an information system to describe its resources. To date, there is no unified forestry thesaurus to facilitate information retrieval among multiple forestry information providers.

A thesaurus is primarily used to enrich the Metadata[1] of a resource. Metadata provide the necessary auxiliary information needed to understand, locate and search for data. In systems that use Dublin Core, a standard content description model intended to facilitate discovery of electronic resources, there are 15 basic elements: title, creator, subject and keywords, description, publisher, contributor, date, type, format, identifier, source, language, relation, coverage and rights (see http://dublincore.org/). Recommended best practice for the »Subject and Keyword« element in Dublin Core is to select a value from a controlled vocabulary or formal classification scheme.

The multilingual forestry thesaurus will fulfil this function.

More specifically, the multilingual forestry thesaurus will do the following:

- It will be able to take advantage of the current ability of the software and hardware of different information systems to communicate with each other. While different software and hardware can be compatible, the thesaurus will enable the languages between systems also to be compatible by harmonizing the language used to subject index resources across multiple languages and systems.
- It will enrich Metadata in forestry information systems. Previously something most closely associated with libraries and bibliographic databases, Metadata, are central to information management and discussions about Metadata abound.

[1] Metadata are »data about data«. One common example is a library catalogue that creates Metadata for the title, author, year of publication, subject, etc. of a resource that users can search for.

Search engines can search the Metadata associated with a resource to retrieve more relevant and precise results. The multilingual forestry thesaurus will improve the value of Metadata for forestry resources by providing a tool for describing the subject of the information.

- It will significantly improve the Global Forest Information System (GFIS), recently launched by IUFRO for both users and information managers. GFIS will collect and support the creation of Metadata for forest information resources to improve information access in the forestry domain. Because users search for information in a variety of ways, including concept or subject, it is important to have a tool for facilitating subject access. GFIS utilises the Dublin Core protocol as its Metadata standard and the multilingual forestry thesaurus will be the authority file for the Subject and Keyword element in GFIS. This will significantly enrich the Metadata collected by GFIS by allowing information to be accessible by concept across different languages.
- It will improve multilingual access to forestry information by ensuring all broad level concepts in the forestry domain exist in multiple languages. This will allow information managers all over the world to index in the language of their choice and users to search for information in the language of their choice.

Therefore, the multilingual forestry thesaurus will increase interaction and knowledge sharing within the forestry community by improving searching across different information systems, improving GFIS, and supporting multilingual access.

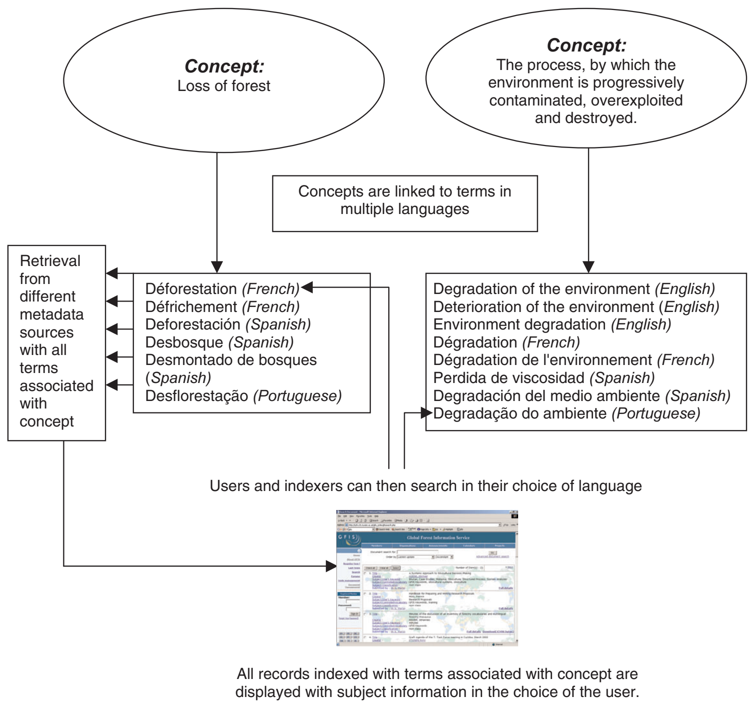

Figure 1. Practical functioning of the multilingual thesaurus.

When the thesaurus is multilingual, the terms exist in multiple languages and are coded or linked across those languages (Figure 1). Although most multilingual thesauri are constructed so that each term in a language version has an equivalent term in the other languages of the thesaurus, the number of non-preferred terms (sometimes called non-descriptors), which are most often synonyms or near-synonyms, can be very different from one language to another one. A good example of this is apparent in the recently launched ETB (European Treasury Browser) Thesaurus, which is used to index educational resources for schools in Europe where the number of non-descriptors for each language was as listed in figure 2.

French	859	German	178
Italian	496	Greek	174
Spanish	361	Swedish	24
English	257	Danish	5

Figure 2. Number of non-descriptors for languages in the European Treasury Browser Thesaurus. See also http://www.en.eun.org/eun.org2/eun/en/etb/content.cfm?lang=en&ov=3813

It is important to note that we see it as a central tenet of any new multilingual forestry thesaurus that all its languages will have equal status and that it will not be a set of translations of an English-language thesaurus. However, in this small-scale collaborative project, we have for pragmatic reasons had to work largely, though not wholly, with sources that have been translated from English.

4 Developing the thesaurus collaboratively

Forestry information encompasses a broad cross-disciplinary coverage; therefore a forestry thesaurus needs to reflect this in its coverage of disciplines, addressing social, environmental and economic issues across national boundaries. Terms relating to landscape and ecosystem management, wood science, bioenergy, harvesting practices, climate change, forest fires, governance and institutional issues in forestry, agroforestry and community forest management all need to be included in multiple languages. There are many boundary and overlapping disciplines that need attention in order to provide adequate access and exchange to forestry resources across all relevant disciplines and information systems.

Additionally, the thesaurus will be used by a wide number of people; both information managers with different language preferences, who wishes to index information, and a vast range of users, from foresters to students to policy makers and people from »bordering« disciplines. Many will prefer to search for information in languages other than English, even if the resource only exists in English.

A third challenge is to enable different resource types to be indexed using the thesaurus. Traditionally, thesauri were developed to allow indexing of published and printed documents, but increasingly Internet gateways, portals and directories need to index resources such as Web pages, mailing lists and newsgroups. GFIS has a collection policy that identifies a diverse range of resource types, including statistical data, satellite mapping data, and projects.

We need to ensure that concepts from a wide range of related disciplines are included in terms that are recognized and up to date. We also need to allow for differences between different approaches and specialities and ensure that each language has the necessary concepts adequately represented. No one organisation will have all those needs itself; therefore, we need to develop this tool collaboratively to ensure its usability by a wide audience. IUFRO with its large network of global research Institutions; FAO with its unique global mandate for forestry; and CABI with its comprehensive coverage of published research literature make good companions in this endeavour. The organisations have collaborated on bibliographic issues since the early part of the last century, publishing jointly the Oxford System of Decimal Classification for Forestry in 1954, a work whose time may yet come again in the new Internet publishing age where the demand for improved Metadata runs high.

5 Principal aims of the project

Summarising, the principal aims of the project are to

1) Map AGROVOC and CAB Thesaurus forest-related terminology as a starting point for harmonizing Metadata in GFIS (see figure 3). We will also examine possibilities of mapping these harmonized terms to commonly used multilingual library classification systems, e.g. the Forest Decimal Classification (FDC).

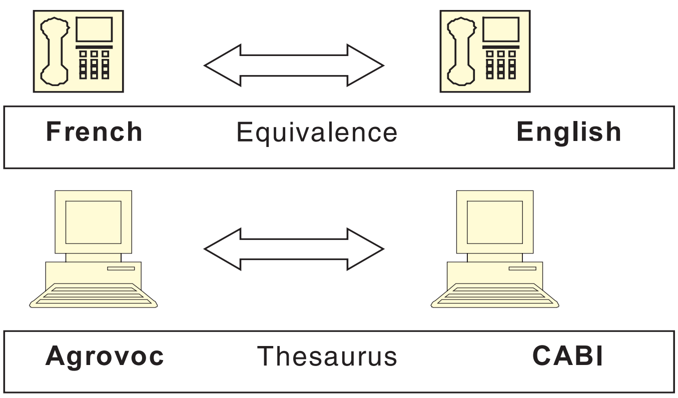

Figure 3. Harmonising forest related terminology.

2) Examine current terminology usage by researchers by examining a subset of bibliographic references in the forestry subfile of the CAB ABSTRACTS database and identifying the subject gaps in existing thesauri.
3) Solicit feedback on missing or outdated terms by posting mapped terms on a web site and encouraging feedback and additions from IUFRO's network of scientists, forestry librarians and information professionals and others in the forestry information community.
4) Provide GFIS with mapped terms (probably between 1500-2000) to start using and provide feedback on preferred terms and language translations.
5) Based on the above analysis and compilation of the database, produce a complete project proposal and work plan to create a multilingual forestry thesaurus.

Thus, this project will directly contribute to the development of a multilingual forestry thesaurus, while immediately providing a reference tool to the forestry community and a valuable tool to GFIS.

6 Major project goals

1) The major goal of this project is to *develop the thesaurus collaboratively* and incrementally.

This will ensure adequate subject coverage, appropriate preferred terms, good multilingual access, and the ability of different information systems to communicate with each other. The weaknesses of some existing thesauri are that they cater to only one audience (e.g. scientists at the expense of accessibility for non-specialists or vice versa), they use outdated terms, and they are almost exclusively developed by information managers without a high degree of subject expertise. A thesaurus that involves collaboration between subject specialists, indexers, users of the system, native speakers and information managers will ensure a tool that serves the needs of many users.

2) Another goal of the thesaurus is to provide a means of cooperation and communication between systems and providers without excessive rigidity.

The thesaurus should provide a comprehensive overview of subjects related to forestry at a broad level, while allowing information providers to use their own local and/or more specific subject access. A group working, for example, on forest entomology may need to incorporate in their database a much larger set of key word terms than we need in the multilingual forestry thesaurus. Their specialized terms can be up-posted to broader-level GFIS terms from the thesaurus and their database will have inter-operability at the Metadata level without compromising their own level of subject detail. In other words, it will provide shelves of broad terms on which local forest information providers can place their specialized terms. Another way of looking at it is that the thesaurus will provide a country map of major forestry concepts and specialized forestry information systems will be responsible for providing city maps to their areas of expertise. The goal of the thesaurus is to ensure that there are no gaps at the broadest level. Compatibility between other thesauri will be ensured by mapping specialised terms within specialised information systems to a broader concept in the multilingual forestry thesaurus (Figure 4).

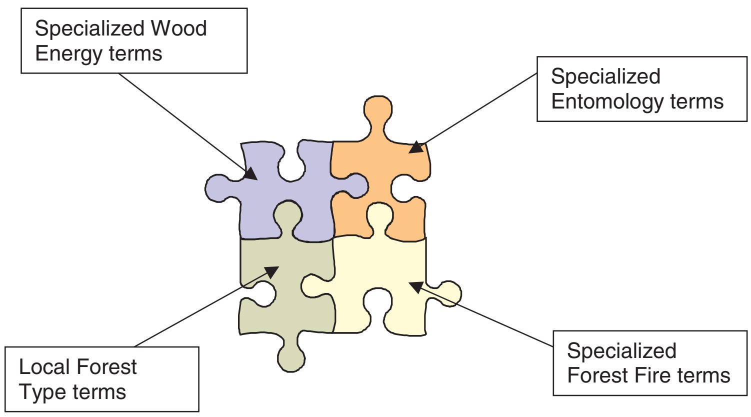

Figure 4. Ensuring compatibility between thesauri.

3) The third major goal of the thesaurus is to ensure that users all over the world are able to access sustainable forestry information effectively and embrace a truly global community of foresters by providing subject access to forestry information in as many languages as feasible.

With a multilingual thesaurus, all existing resources - regardless of their language - can be browsed in the user's language of choice. For example, if users are browsing for information on »Forestry policies« in FAO's Information Finder that uses AGROVOC, a multilingual agricultural thesaurus, they have the following browse choices:

- Forestry ⇨ Forestry - General aspects ⇨ Forestry policies
- Foresterie ⇨ Foresterie - Considérations générales ⇨ Politique forestière
- Ciencias forestales ⇨ Ciencias forestales - Aspectos generales ⇨ Política forestal

The results retrieved for each are the same. The only difference is that the user can choose what language to use to locate the information.

When a resource exists in only one language, a multilingual thesaurus will allow users to view the subject words in all languages of the thesaurus, facilitating the identification of subject of material in other languages. When a resource exists in more than one language, a multilingual thesaurus will allow indexers to index all language versions simultaneously in the language of their choice.

A minimum requirement for the proposed forestry thesaurus would be for a complete set of terms in English, French, Spanish, and Portuguese with a numerical identifier assigned to each concept. Other languages should be made available according to demand and resources. In order to ensure an exact equivalence between the various languages, there may be a need to map terms to agreed concept definition. Definitions and terminology usage have highly political overtones and we will need to ensure that collaboration in this area is representative and sensitive. Extensive use will be made of non-preferred terms, which are largely synonyms or near synonyms and which will allow within-language variations of terminology for concepts to be richly expressed (see above).

7 Collaborative methods using existing resources

Significant existing resources to build the thesaurus collaboratively can be mobilised.

- The CAB Thesaurus is an agricultural thesaurus of over 48,000 descriptors and 10,500 non-preferred terms, which is used to index over 160,000 records a year for the CABABSTRACTS database. Over 20,000 of these records are added to the forestry domain each year. The database covers mainly scientific citations in agriculture and related life sciences, including forestry and human health. A trilingual version (English, Spanish and Portuguese) of CAB Thesaurus was prepared for a collaborative project and information resource, Agroambiente, with the National Agricultural Library, USA. From CABABSTRACTS index, we extracted terms from the Thesaurus, which had been used to index forestry information in the last three years. From this list, we again selected 1851 terms that were present in the trilingual version of the CAB Thesaurus.

- AGROVOC is a multilingual agricultural thesaurus used to index agricultural information, including forestry. All terms exist in English, French, Spanish and Portuguese. Many other language versions exist or are underway, such as Thai, Czech, Chinese and Arabic. AGROVOC terms used to index forest information in two major databases (the FAO Documentation and the AGRIS database) were extracted to add to the basis of the forestry thesaurus.
- GFIS Africa subject indexing key words were made available as a resource for the forestry thesaurus. Five centres in Africa are entering Metadata into GFIS. They use a very short multilingual key word list of 100 terms compiled as a draft GFIS Thesaurus. These were extracted from the CAB Thesaurus and AGROVOC . Resource indexers can use their own keywords in addition to the GFIS keywords and we will look at these terms as potential additions to the multilingual forestry thesaurus.
- Matches between terms extracted from CABI and AGROVOC . Of the 1800 terms extracted from CABI's forestry database, 900 match with Agrovoc terms, thus providing 900 multilingual terms that can be used to subject-index forestry information. More »near«-matches (e.g. »polluted soils« from CABI and »polluted soil« from AGROVOC) are being mapped to generate a set of potential non-preferred terms.
- Identification of terms in CABI to be considered for the multilingual thesaurus »leftover« terms, i.e. terms where no mapping exists are potentially available for the multilingual thesaurus, but currently have only Spanish and Portuguese equivalents. These terms would need to have FAO language equivalents in order to be included into the thesaurus.
- Expertise within FAO, IUFRO and CABI to check for gaps in concept and currency and validity of the terminology in all languages.
- IUFRO's SilvaVoc clearinghouse for multilingual forest terminology. This is a comprehensive and multilingual bibliography that can be consulted in choosing terms and concepts (http://iufro.boku.ac.at/iufro/silvavoc/).

The wide recognition of the partners (FAO, CABI, IUFRO) as international centres of excellence for forestry activities positions them well to lead in the growth and improvement of knowledge representation systems in the forestry domain, and to lead in developing tools that offer more functionality for users looking for information. It is also fitting for international organisations to be setting standards such as thesauri and terminology. It also promotes cooperation and collaboration between these institutions themselves and their respective networks.

8 Conclusion

One of the main benefits of the approach taken in this project is that, instead of a »top-down« approach, GFIS can take advantage of IUFRO's, FAO's and CABI's network and harness the views of people on the ground – the eventual users of the system.

While the Multilingual Online Forestry Thesaurus will function as a reference tool that structures and standardizes forestry terminology in multiple languages for use by GFIS, it will be able to be used in any number of different systems. Some examples are national forestry collections, forestry libraries, forestry web sites, and agricultural ontologies[2] and thesauri. It will be made freely available to the forestry community and provide opportunities to improve information management, retrieval, and consistency in information and knowledge sharing throughout the forestry domain.

Because it involves such a wide number of stakeholders, it is necessary that the thesaurus be developed collaboratively – with the people that will eventually use it - both information managers and users with different language preferences.

9 Related links

AGROVOC (http://www.fao.org/agrovoc)
CABI (http://www.cabi-publishing.org)
FAO Forestry (http://www.fao.org/forestry)
FAO Terminology (http://www.fao.org/faoterm)
GFIS Thesaurus (http://www.iufro-gfis.net/)
IUFRO (http://iufro.boku.ac.at/)
IUFRO SilvaVoc Terminology Project (http://iufro.boku.ac.at/iufro/silvavoc/index.htm)

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[2] An ontology can be viewed as an »enhanced thesaurus«, with increased and richer relationships between terms.

Appendix 1

Terms used to index Forestry domain of CABABSTRACTS

ENGLISH	PORTUGUESE	SPANISH
FORECASTING	previsão	técnicas de predicción
FOREIGN INVESTMENT	investimento estrangeiro	inversiones extranjeras
FOREST ADMINISTRATION	administração florestal	administración forestal
FOREST BORDERS	limites florestais	límites de bosque
FOREST DAMAGE	dano florestal	daños forestales
FOREST DECLINE	declínio florestal	declinamiento forestal
FOREST ECOLOGY	ecologia florestal	ecología forestal
FOREST ECONOMICS	economia florestal	economía forestal
FOREST FIRES	incêndios florestais	incendios forestales
FOREST HEALTH	sanidade florestal	sanidad forestal
FOREST INFLUENCES	influências de florestas	influencias forestales
FOREST INVENTORIES	inventários florestais	inventarios forestales
FOREST LITTER	cobertura florestal	hojarasca forestal
FOREST MANAGEMENT	manejo florestal	ordenación forestal
FOREST NURSERIES	viveiros florestais	viveros forestales
FOREST OWNERSHIP	propriedade florestal	propiedad del bosque
FOREST PESTS	pragas florestais	plagas forestales
FOREST PLANTATIONS	plantações florestais	plantación forestal
FOREST POLICY	política florestal	políticas forestales
FOREST PRODUCTS	produtos florestais	productos forestales
FOREST RAILWAYS	estradas de ferro florestais	vías férreas forestales
FOREST RECREATION	recreação em floresta	recreación en el bosque
FOREST RESOURCES	recursos florestais	recursos forestales
FOREST SOILS	solos florestais	suelos forestales
FOREST STATISTICS	estatísticas florestais	estadísticas forestales
FOREST STEPPE	estepe florestada	estepa forestal
FOREST TAXATION	taxação florestal	impuestos forestales
FOREST TRAILS	trilhas florestais	caminos forestales
FORESTRY	ciências florestais	ciencias forestales

Terms are from the CAB Thesarurus.

Appendix 2

CABI - AGROVOC matches; Stage 1 of mapping process.

Microsoft Access - [CABIMatches : Table]

ID	CABITerm	Stat	AGROVOCTerm
1	ABANDONED LAND	E	
2	ABNORMAL DEVELOPMENT	G	FUNCTIONAL DISORDERS/ABNORMAL BEHAVIOUR*
3	ABNORMAL HEARTWOOD	N	-
4	ABSCISSION	N	-
5	ACARICIDAL PROPERTIES	U	Use PESTICIDAL PROPERTIES
6	ACARICIDES	E	
7	ACCESS	G	RIGHT OF ACCESS
8	ACCIDENTS	G	ACCIDENT PREVENTION
9	ACCLIMATIZATION	U	Use ADAPTATION
10	ACCOUNTING	E	
11	ACCURACY	N	-
12	ACETYLATION	E	
13	ACID DEPOSITION	E	
14	ACID RAIN	E	
15	ACID SOILS	E	
16	ACIDITY	E	
17	ACOUSTIC PROPERTIES	N	-
18	ACTIVATED CARBON	E	
19	ADHESIVES	E	
20	ADMINISTRATION	E	
21	ADSORBENTS	G	ABSORPTION/ABSORBANCE
22	ADVANCE GROWTH	N	-
23	ADVENTITIOUS ROOTS	E	
24	AERIAL APPLICATION	E	
25	AERIAL PHOTOGRAPHY	U	Use AERIAL SURVEYING; Use PHOTOGRAPHY

Record: 1 of 1849

E=exact match

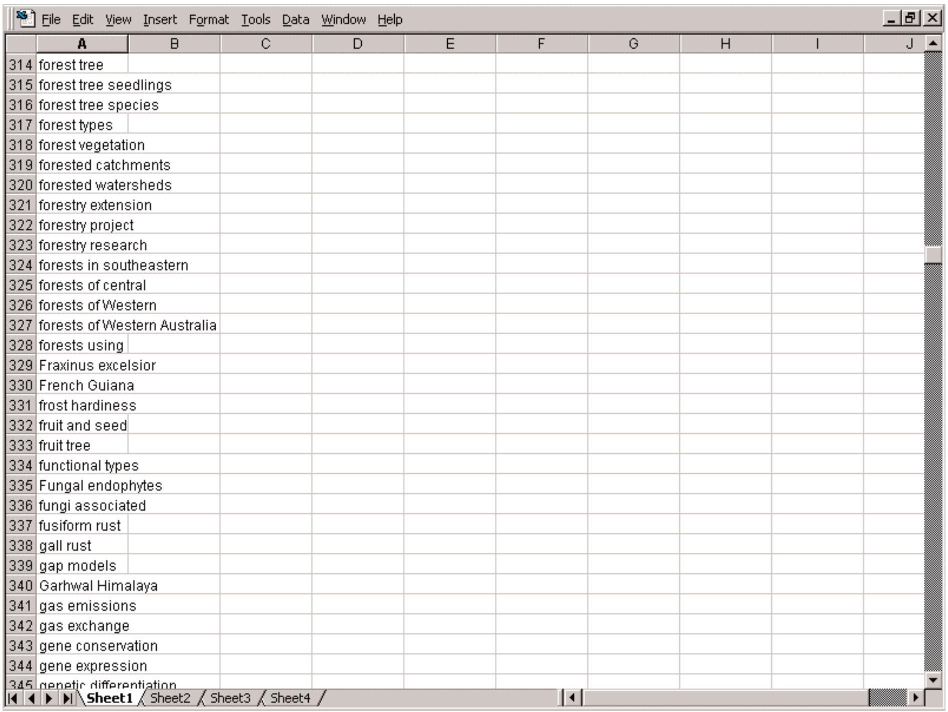
G=near match to check

U=AGROVOV has the term as a non-descriptor

N= no match yet verified

Appendix 3

Gap Analysis – preliminary work on phrase identification.



	A
314	forest tree
315	forest tree seedlings
316	forest tree species
317	forest types
318	forest vegetation
319	forested catchments
320	forested watersheds
321	forestry extension
322	forestry project
323	forestry research
324	forests in southeastern
325	forests of central
326	forests of Western
327	forests of Western Australia
328	forests using
329	Fraxinus excelsior
330	French Guiana
331	frost hardiness
332	fruit and seed
333	fruit tree
334	functional types
335	Fungal endophytes
336	fungi associated
337	fusiform rust
338	gall rust
339	gap models
340	Garhwal Himalaya
341	gas emissions
342	gas exchange
343	gene conservation
344	gene expression
345	genetic differentiation

Phrases identified by Dr. A. Rauber from some 7000 English-language titles of research papers extracted from the forestry domain of the CABABSTRACTS database.

Appendix 4

NAL Thesaurus currently under construction.

Forestry

Narrower Term(s): Afforestation and Reforestation - Agroforestry - Arboriculture - Forest Ecology - Forest Economics - Forest Engineering - Forest Health - Forest Inventories and Mensuration - Forest Management - Forest Policy - Forest Resources - Forest Trees - Forests - Pulp and Paper Products - Silviculture - Sustainable Forestry - Tree Farms - Tropical and Subtropical Forestry - Urban Forestry - Wood and other Forest Products

Earth and Environmental Sciences

Narrower Term(s): Ecology - Energy - Environment - Environmental Programs - Environmental Science - Fire Science and Management - Geography - Geology - Hydrology - Natural Resource Management - Natural Resources - Soil Science - Weather and Climate

Plant Sciences

Narrower Term(s): Botany - Crop Models - Cropping Systems - Disease and Pest Management - Plant Anatomy - Plant Ecology - Plant Genetics - Plant Physiology - Plant Products - Plant Protection - Plant Science - Plant Variety Protection - Plants

Working Group 6.14.00(1)

Urban forestry - Advances in social and health aspects

Some hidden benefits of the urban forest

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Abstract

While such popular concepts as stress, recreation, and aesthetics help explain some of the psychological benefits of the urban forest, these traditional concepts are not adequate for explaining what is in fact a great diversity of benefits. Economic approaches, too, have been unable to successfully put a value on this diverse collection of positive influences. Attention Restoration Theory provides an approach for uncovering a wealth of hidden benefits. Research dealing with health challenges, overcoming social and economic disadvantages, and stages in the life cycle demonstrate not only the pervasiveness of the psychological benefits of nature, but also their significance in people's lives. These studies also support the emphasis of Attention Restoration Theory on the central role of attention and the fatigue of attention in competence and quality of life. An unexpected bonus of this review of research is the discovery that many of these benefits have a moral quality; in other words, they represent qualities that societies value and encourage. This way of looking at the urban forest thus has implications not only at the individual level, but for meeting social goals as well, thereby providing new opportunities for collaboration among government agencies, urban foresters, and community leaders.

Key words: attention restoration theory, directed attention, mental fatigue, nature benefits, well being.

1 Introduction

There is growing recognition worldwide of the significance of the intangible values of the urban forest. In part this recognition is based on an intuitive sense that nature has remarkable beneficial effects on people. While this intuitive understanding has advantages, it has its difficulties as well. The intuitive concept that many people hold implies that nature is relaxing, that it is a way to recover from stress. The problem is not that this is incorrect, but that it represents only a small part of what nature does for people. To the extent that this intuitive notion stands in the way of a serious and careful study of the full range of benefits, it hinders the recognition and appreciation of how pervasive the contribution of the urban forest is to human well being.

The popularity of the intuitive notion of nature benefits is but one of several ways in which overly simplified analyses leave many important benefits hidden.

The all-too-human tendency to force new concepts into old categories has a similar effect. Thus, for example, the urban forest is acknowledged as playing an important role in recreation. Its aesthetic contribution is also noted. But neither of these familiar categories adequately acknowledges the profound importance of this resource. »Recreation« is a rather broad, diffuse concept. People participate in sporting events and watch TV as part of what they consider their recreation. The urban forest plays a special role in the lives of many people that is profoundly different from these activities. Comparably aesthetics also fails to capture the special contribution of the urban forest. A number of studies have shown that even natural environments that are not highly preferred (i.e. not considered particularly aesthetic) are effective with respect to the psychological benefits they provide (Kaplan 2001a).

The attempt to capture the benefits of nature in economic terms has similar difficulties. From an economic perspective, nature is often viewed as an aesthetic addition, an »amenity« that, while nice, is not essential. However, as we shall see from a review of some of the research in this area, the effects of a nature experience can be life-changing, not what one would expect from an amenity. Further, there is a problem inherent in the economic analysis, due to its dependence on the concept of substitutability, i.e., how much would one be willing to trade for access to nature. Many people whose lives have been altered by nature experiences would be no more willing to trade anything for nature than they would for the air they breathe or the water they drink.

There are a thus a number of reasons why many of the psychological benefits of the urban forest are hidden. Perhaps if we had a clearer understanding of the way nature plays a role in human experience and functioning, some benefits that are currently hidden might become evident.

2 Stress vs. mental fatigue as alternative ways of looking at nature benefits

Many people have an intuitive sense that contact with nature is beneficial; that it helps one become whole again, helps one feel better and perform better. While a portion of this benefit is due to the stress-reducing power of contact with nature, this is only part of the story. Stress is a bodily reaction to harm or to threatened harm. Among its most characteristic expressions are sympathetic nervous system reactions such as rapid heart rate, increased blood pressure and sweaty palms. However, one can feel »worn thin«, not necessarily because of bad things, but simply as a result of too many things. People can benefit from nature even though they are not anticipating harm and have none of these sympathetic nervous system symptoms.

An important benefit of the nature experience, which is often overlooked, is the effect nature has on reducing *mental* fatigue and thereby restoring competence. When the capacity to put forth effort is reduced, when it is exceptionally difficult to do things we regard as hard, one is in a state of fatigue. But this fatigue is not of the body, but the mind. It might appropriately be called »mental fatigue«. The difference between mental fatigue and stress might seem to be a subtle one, but it is not. Imagine that you are boarding a plane for a trip to a conference. You notice that there is a discussion going on among members of the flight crew. Is there a difference between overhearing that »the pilot has been feeling a bit stressed lately« and »the pilot has been feeling a bit incompetent lately«?

Admittedly the term »stress« is far more familiar than »mental fatigue«. This very familiarity can cause considerable confusion. For example, when research participants are asked about feeling »stressed«, they readily endorse this popular term even though what they include under this heading is often more appropriately called mental fatigue. Even if the term is unfamiliar, however, the experience of mental fatigue is familiar to most of us. Unlike stress, which is evoked by a present or anticipated negative event, people can become mentally fatigued by doing what they like to do, but for too long without a break.

3 An analysis of mental fatigue

While »mental fatigue« is a useful and easily graspable concept, it is also somewhat misleading. It allows one to distinguish the condition from physical fatigue as well as from stress. The difficulty, however, is that the name suggests that the mind as a whole has fatigued, and this is not the case.

What is it that fatigues?

William James (1892), the great American psychologist and philosopher, provided important insights into the issue of mental fatigue in his analysis of attention. He distinguished between two kinds of attention, which in modern terms, might be referred to as »directed attention« and »fascination«. Directed attention is what it takes to get through a difficult or boring task. It is the kind of attention we call upon when working in a distracting surrounding or when trying to make a decision about a complex situation. It takes effort, and it is susceptible to fatigue.

Fascination, by contrast, is effortless. It is the kind of attention that is called forth by exciting events or interesting tasks. Far from being hard work, it is often difficult to tear our attention away from something fascinating. Thus the basic distinction between these two kinds of attention revolves around three themes. Directed attention is effortful, it is subject to voluntary control, and it is susceptible to fatigue. Fascination is at the opposite pole on each of these dimensions. In terms of our analysis of „mental fatigue“ then, it is more useful to name the syndrome in terms of what is actually becoming fatigued – hence we call it Directed Attention Fatigue (DAF).

It may seem strange that so important an aspect of the human mind as directed attention should be so fragile. Yet, in evolutionary perspective, this apparent limitation might have been quite reasonable. To be able to pay attention by choice to one particular thing for a long period of time would make one vulnerable to surprises. The capability of being vigilant, of being alert to one's surroundings may have been far more important than the capacity for long concentration. Further, much of what was important to the evolving human – wild animals, danger, caves, blood, to name a few examples – was (and still is) innately fascinating and thus does not require directed attention. It is only in the modern world that the split between the important and the interesting has become extreme. All too often the modern human must exert effort to do the important while resisting distraction from the interesting. Thus the problem of fatigue of directed attention may well be of relatively recent vintage.

Costs and causes

Directed attention fatigue can have many consequences. These pervasive costs undermine an individual's competence in many ways. They can be summarised by the following four concepts:

- Individuals with DAF are readily *distracted*; maintaining focus on a goal, a line of thought, or a conversation is difficult and unreliable.
- Individuals with a high level of DAF are planning impaired. They are neither effective at exploring possible futures nor at making plans, furthermore, they have difficulty sticking to plans they were able to formulate (or those provided by others).
- An inclination to be impulsive is another characteristic of individuals with a high level of DAF. They have little patience or capacity for delay and are inclined to act on the first thing that comes to mind.
- Another symptom of DAF is the inclination to be *irritable*. While people are often unaware of their DAF state, unprovoked irritability is perhaps a more easily recognised indicator to recognise. It is also, of course, rather quickly noted by others.

Such consequences of directed attention fatigue would not be a matter of great concern if they were a relatively rare condition. Unfortunately, quite the opposite is the case. Although frequently unnoticed or mislabelled, DAF is widespread and pervasive. The number and variety of conditions that can lead to directed attention fatigue is, unfortunately, substantial. Consequently the symptoms can be found in a wide variety of individuals. Leading the list of such individuals are those suffering from serious illnesses as well as the caretakers of the ill. Another category of individuals for whom DAF is a likely pattern are people experiencing grief over a major loss, whether it be a significant other, a job or one's home. Far more prevalent causes include overwork, sleep loss, and coping with prolonged attention-demanding situations (like urban traffic, for example).

It could be argued that DAF is a plague peculiar to modern life. It is a reflection of adapting to a world in which there are more people and more information than ever before. In particular, environments that are distracting and that are deficient in needed information lead to DAF, as do tasks that are difficult or dangerous. In addition, the demands of carrying out onerous duties also fall in this category (Kaplan 2001b).

4 Nature and the recovery from DAF

The connection between the urban forest and the recovery of competence may not be immediately intuitive. Why might time in nature help in the recovery from DAF? One explanation of how this might work is provided by Attention Restoration Theory, whose focus is on the way restorative environments allow fatigued directed attention to recover. The version of this framework presented here is brief; fuller discussions are available in a number of sources such as Kaplan & Kaplan (1989) and Kaplan (1995; 2001b).

As we have seen, prolonged use of directed attention leads to its fatigue. In order to rest directed attention it is necessary to find an alternative basis for maintaining one's focus. Fortunately there is such a source, and, equally fortunately, it is widely available. The other form of attention, fascination, provides a way for directed attention to rest. Since fascination is itself resistant to fatigue and takes no effort, being in its presence permits DAF to recover. This, in essence, is the mechanism proposed by Attention Restoration Theory.

There are many sources of fascination. Fascination can come from *content*, and that content can be of various kinds. It can be noisy, like watching auto racing, or quiet, like walking in a natural setting. Fascination can also come from *process*. Recognising despite uncertainty and difficulty, like bird watching, is an example of a process that allows one to pay attention without effort. Predicting despite uncertainty, as practiced by gamblers, provides another process example. Quiet fascination, characteristic of certain natural settings, has a special advantage in terms of providing an opportunity for reflection, which can further enhance the benefits of recovering from directed attention fatigue. I will refer to such opportunities for reducing directed attention fatigue as »restorative experiences« or »restorative environments«.

Fascination is thus a central component of a restorative environment because it permits directed attention to rest. Restorative environments, however, also require some additional qualities (Kaplan & Kaplan 1989). These are being away, extent, and compatibility:

- Being away is useful, but does not guarantee a restorative environment. People often use »getting away« as shorthand for going to a restorative place. Nonetheless, there are many places that are »away« but would not permit the necessary rest of directed attention. A prison cell provides a vivid example.
- The environment should have extent rich enough and coherent enough so that it constitutes a whole other world. Restorative environments work best when one can settle into them, when they provide enough to see, experience, and think about so they take up the available room in one's head.
- There should be substantial compatibility of the environment with one's purposes and inclinations. In other words, the setting must fit what one is trying to do and what one would like to do. Compatibility is a two way street. On the one hand, a compatible environment is one where one's purposes fit what the environment demands. At the same time the environment must provide the information needed to meet one's purposes. Thus in a compatible environment one carries out one's activities smoothly and without struggle. There is no need to second guess or to keep a close eye on one's own behaviour. What one does comfortably and naturally is what is appropriate to the setting (Kaplan 1983).

5 Is there research support for this hypothesis?

While some aspects of the Attention Restoration Theory make intuitive sense, it must be admitted that it is far from the common sense view of the way in which nature experience leads to psychological benefits. It is certainly reasonable to wonder if there is any empirical support for this approach. Such support ideally would not only cover the issue of whether there are clear benefits beyond the stress concept, but also whether there is justification for the focus on attention as an essential component of these additional benefits.

As it turns out there is a substantial body of research in this area; it is large enough, in fact, for it being necessary to be selective. The three domains I have chosen are useful in demonstrating how pervasive and serious these issues are. These domains are health challenges, overcoming economic and social disadvantage, and life cycle changes.

Health challenges

Care-giver fatigue and burnout. In her doctoral dissertation research for a degree in clinical psychology, Canin (1991) studied AIDS care givers in the San Francisco area. Understandably such individuals are prone to fatigue and burnout. Canin examined what activities were most effective in resisting these hazards. The unambiguous results were that locomotion in nature, whether involving walking, running, biking or canoeing, was the most effective antidote to burnout and fatigue. By contrast, watching or participating in sports was not found to be helpful in this way. And interestingly, Canin found that the worst thing one could to when trying to avoid burnout and fatigue was to watch television.

Dealing with life-threatening illness. Cimprich's (1990; 1992) studies with cancer patients provide particularly striking findings. Cancer patients are generally instructed in self-care when they leave the hospital. They not only tend to have difficulty remembering such information; some even deny that they ever received it. It has also been observed that cancer patients with a clean bill of health from a medical point of view often suffer persisting coping problems of many kinds, including marital difficulties and severe limitations in returning to their former activities (Obrist & James 1985).

Cimprich's observations of cancer patients suggested to her that they were showing serious directed attention fatigue problems. Her studies with post-surgery breast cancer patients thus included a wide range of measures of directed attention. Participants were randomly assigned to either the experimental or control group for the 12-week duration of the study. The former involved having each person sign a contract agreeing to participate in three restorative activities (of at least 20 minutes each) per week. The control group was not told about restorative activities until the study was completed. While the notion of restorative activities was explained in broad terms with numerous examples, participants generally selected nature-based activities (such as walking in nature and gardening) to fulfil their contracted time.

Cimprich found the participants in both groups showed severe attentional deficits shortly after surgery. Over the four times of administering the directed attention tasks the experimental (restorative) group showed gradual but steady improvement; the control group did not. Further, in the restorative group participants went back to work sooner and were more likely to return to full time work. Another striking difference was the inclination of members of the restorative group to start new projects (like learning a language or losing weight). The control group participants reported no new projects. And finally, experimental group members showed significantly greater gains on quality-of-life ratings.

What is particularly remarkable about this study is the effect of a very modest intervention (an activity of at least 20 minutes carried out three times per week) on a problem that, according to the literature in this area, has the capacity to undermine people's lives for a matter of years.

Overcoming economic and social disadvantage

A notoriously dismal public housing facility in Chicago is the setting for a remarkable series of studies carried out by Frances Kuo, William Sullivan and their students. Two features of this setting make it particularly interesting as a context for research. First, it is a situation where finding ways to improve the life quality and life prospects of individuals is exceedingly difficult. Second, from an experimental standpoint, it provided a control that is difficult to achieve in a real world context: the residents are essentially randomly assigned to the apartment they live in and cannot afford to refuse their housing when it becomes available. The real world setting had some other manifestations that are important to mention. The housing tenants would have regarded the research team members with suspicion and mistrust, therefore two residents of the facility were trained to conduct interviews and administer tests of directed attention. In a series of studies the researchers examined the impact of access to the natural environment, with a particular emphasis on trees.

Community and safety. Previous research has indicated the close relationship between people gathering together and the sense of community and safety (Yancey 1971). In the, often bleak, world of public housing, getting people to gather and come to know each other is a major challenge. The question, then, is how to create environments that encourage such behaviour. Coley, Kuo and Sullivan (1997) found nearby vegetation plays an important role in fostering social interaction. Social interaction in such settings, in turn, led not only to stronger neighborhood social ties, but also to a greater sense of safety and adjustment (Kuo, Sullivan & Coley 1998).

A major factor in discouraging gathering in public housing contexts is fear. Such fear has a basis in fact, since aggressive behaviour is not uncommon in these massive, faceless housing complexes. Both fear and aggression have been shown to be responsive to the presence of nearby nature. Kuo and Sullivan (2001a) found that residents who had nature outside their apartments were less likely to use aggression and violence in dealing with problems. Through a careful statistical analysis this effect was found to be due to differences in directed attention capacity. If residents who have nature nearby were less inclined to use violence, one would expect that such settings would be more peaceful. Such was in fact the case; greener surroundings led to lower levels of fear and fewer reported crimes (Kuo & Sullivan 2001b).

Effectiveness at managing life issues. Residents of public housing face enormous challenges in dealing with poverty, discrimination and inadequate education. While it might be difficult to imagine how trees could help in this difficult context, once again ingenious research yields some striking findings. Kuo (2001) found that residents who have the benefit of nearby nature were less likely to procrastinate in dealing with the major issues of their lives. Further, such residents felt more hopeful and less helpless about the issues facing them. Once again, this effect of nature was found to be due to greater attention capacity.

Children who grow up in public housing are understandably at risk; breaking out of the cycle of poverty and inadequate education presents an awesome challenge. Here again these researchers have shown that nature makes a difference. Faber Taylor, Kuo and Sullivan (2002) report that girls with greener views from home had greater self-discipline. They were less impulsive and had better concentration. This in turn led to better life decisions and better school performance. These findings applied only to girls; boys are apparently farther ranging, spending more time farther away from home than girls.

Life cycle challenges
The capacity for directed attention varies over the life span. This capacity develops gradually in young children, probably reaches a peak around the undergraduate years, and gradually declines thereafter.

Children. Since young children do not yet have fully developed capacity for directed attention, one would expect some degree of attention problems in normal children. Patrik Grahn and his students wanted to study the effects of nature on these attention lapses, such as being distracted, not listening to others, interrupting, and not waiting their turn (Grahn et al. 1997). To assess the level of attention problems they used a measure that was devised for children with Attention Deficit Disorder (ADD). While normal children do not have as frequent or severe attention problems, the nature of the problems is similar. The study was carried out at two Swedish pre-schools that were similar in many respects, but had play areas differing in naturalness. The children who played in the more natural play area displayed substantially fewer attention problems.

These results are strikingly parallel to a study of ADD children by Faber Taylor, Kuo and Sullivan (2001). They asked parents of ADD children to describe situations that were most and least healthy for their children. Although in many cases the parents had not categorised them in that way, the findings showed that the most helpful settings were natural environments. In an interesting parallel to Canin's findings, the setting that most strongly evoked ADD symptoms was watching television.

The elderly. Ottosson and Grahn (2002) have studied the effects of nature on elderly people in nursing homes. They report that even an hour outdoors in nature improves directed attention capacity. This effect is stronger the more impaired the individual is.

6 Conclusion: beyond competence

The psychological benefits made possible by the urban forest are pervasive and far-reaching. They range from simple enjoyment to enhancing the quality of life to what could only be described as life-changing impacts. These benefits are indeed impressive. As I attempted to summarise the research findings, however, I realised that a new dimension of benefits has emerged. I was struck that some of the benefits have a strikingly moral flavour. In other words, the decline of directed attention leads to less responsible and less constructive behaviour on the part of the individual as well as to social and interpersonal difficulties, all of which have far-reaching societal implications.

Table 1 places the findings reviewed earlier in three columns. The column on the left represents what appear to be moral concerns while the column on the right represents aspects of competence. The centre column includes benefits that resist confident placement into either of these categories. While one can point to a set of benefits that represent aspects of competence and another set that reflect moral issues, the distinctions are not sharply drawn and the boundaries are fuzzy.

Table 1. Categorisation of urban forest benefits.

Moral virtues	Both	Intellectual strengths
Civility	Find meaning	Focus despite distractions
Self discipline	Patience	Follow through on decisions
Continue in the face of difficulty	Listen to others	Hold multiple perspectives
	Consider consequences of one's actions	

The difficulty of separating the moral from the competent suggests what may be a new perspective on moral behaviour. Many of these desirable characteristics may not simply be a matter of choice based on one's upbringing or having the »right« attitude. Rather they may at least partially depend on competence-related issues, and these, in turn, may depend upon experiences such as those provided by the urban forest. This suggests the importance of a healthiness of mind in order to call upon these socially valued strengths. People lacking such healthiness are not necessarily mentally ill in the technical sense, but their impairment can express itself in moral handicaps as well.

Moral exhortations remain a popular means to improve people's behaviour despite the limited effectiveness of this approach. Perhaps such exhortations would be more effective when falling on the ears of people who are not suffering from directed attention fatigue. In many cases the motivation may already be in place, needing only a healthier state of mind in order to lead to appropriate behaviour.

The urban forest may hold vast potential not only in helping people during difficult times, but in helping bring about a saner, more liveable world as well. This conclusion has numerous implications. First, it suggests why economists have such difficulty providing a money value for the worth of the urban forest; the benefits are far too diverse and too difficult to achieve in other ways. Second, this suggests that the opportunities both for alliances with different groups and for support from community and government for the urban forest are even more extensive than one could have ever guessed. And finally, this unexpectedly vast potential also suggests that there may be the basis here for a new and largely unexplored approach to improving society and reducing social ills.

Acknowledgements

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What do urbanised and rural societies in Europe expect from their forests?

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Abstract

There is growing pressure and demand on woodlands nearby urban areas. While it is generally assumed, that the perspectives of urbanised societies on the role of forest in general and with respect to recreation are different to the ones of more rural societies, this has never before been tested at a pan-European level. Results of a survey completed in sixteen diverse European case study areas indicate that there is a demand for more forests. The demand is not related to the distinction between urban and rural, however, but to existing landscape quality. Across the urban-rural continuum, there is hardly any difference in priorities of forest functions and forests play a small - only ecological - role in preferred future local development. The more urbanised an area gets, the more nature conservation and the less economic activities are considered to be important forest functions. With respect to recreation, there is hardly any difference in recreational visits to local forests and all societies support freedom of access to both public and privately owned forests. However, only a small group of inhabitants approve of financial supports to landowners for opening their forest property for recreation. Although this group is larger in the more urbanised societies, urbanised people show in general a low understanding for landowners' economic viability. Besides recreation, they want local private forests to satisfy their ecological and landscape demands, but are not enthusiastic about financially supporting the forest owners in reaching these societal demands.

Key words: Urban-rural continuum, future role of forests, forest access, recreation, functions and grants.

1 Introduction

While the forestry sciences have traditionally been developed within a rural context, there is growing pressure and demand on woodlands from societies living in and nearby urban areas. As a result, forests are no longer understood in the limited context of natural resource production or protection, but have to provide a wide range of socio-cultural, economic and environmental services. In short, forestry needs to become better at serving urbanised societies (Elands & Wiersum 2000). Environmental, educational and especially recreational aspects are of increasing importance in the planning and management of forests for urbanised societies (Konijnendijk 2001).

The influence of urbanised societies on forests is not only felt in urban and peri-urban areas, but extends to rural and remoter areas where there is growing demand from urban people for countryside recreation, second homes and tourism. Local people in these rural areas often recognise the potential economic benefits of tourism and other urban-based demands on forests (Elands & O'Leary 2002). Nonetheless, it is sometimes suggested that urban and rural people have different perspectives on the value of forests (Elands & Wiersum 2000). This suggestion is counter-acted, however, with the observation that with today's information and communications technologies and globalisation, rural societies are quickly becoming influenced by urban values and lifestyles. Moreover, urban people are increasingly moving to rural areas to live (Kvarda 2002; Schraml et al. 2002).

There is still little comparative information as to whether the forest-related perspectives of urbanised societies are different to the perspectives of their rural and remote brethren. The aim of this paper is to provide comparative information from a European level study on the expectations of both urban and rural people on forests. When considering these opinions and their possible impact on forest management, two major aspects need consideration. Firstly, the overall perspectives on the amount of forests and the desired present and future functions are of importance. It can be considered that interactions between (rural oriented) forest managers and (urban-based) consumers foremost take place in the form of recreation. Consequently, when assessing the social expectations on forests, the question is what the perspectives of both producers and consumers are on recreational use of forests. In this respect, the first issue to be considered is the actual recreational use of forests. In addition, it is important to understand perspectives on public access to forests as well as how the maintenance costs for (recreational) forests should be financed. Thus, in this paper, the following questions will be addressed:

1. General opinions on the role of forests under different rurality conditions
   - What are opinions about the amount of forests?
   - What are the perspectives regarding the functions of forests?
   - What are the opinions about the role of forests in the future of the area?

2. Perspectives of producers and consumers on the role of forests for recreation
   - How much recreational use is made of local forests?
   - What perspectives exist on public access to forests?
   - What are the opinions about government grants for forest management?

2 Methodology

The Multifor.RD project

The data, which are presented in this paper, were collected within the framework of the EC funded "Multifunctional forestry as a means to rural development" project (Multifo.RD). The principal research objective of the Multifor.RD project is to make a comparative European study about the nature and dynamics of landowners' and the public's attitudes towards forests and forestry. Furthermore, to develop criteria for distinguishing region-specific strategies for multifunctional forestry to serve rural development. A group of universities and research institutes in eleven European countries (Austria, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, the Netherlands, Spain, and Switzerland) participated in this project.

Two case study areas were selected in each country, one traditionally forested (TR), and another involved in a process of afforestation (AF). As Greece did not have any area with substantial afforestation, they selected two traditional forest areas, one with mostly privately owned forests and one with predominantly public owned forest. Although the selection of areas was not based on a predefined set of rurality characteristics and thus is in some respects arbitrary, a broad variety of rural conditions in Europe is covered (only the north Scandinavian region is not included). As the research focused in particular on the role of forests in rural areas, the case study areas were selected on the basis of the presence of forests. Consequently, the average forest cover in the study areas is higher than the overall European average and the study results do not present a representative overview of the European forestry situation. However, the main purpose of the study was to obtain a comparative understanding of the perceived role of forestry for rural development under various rurality conditions. Thus, selection of the study areas was based on the aim of gaining insights in comparative trends rather than in obtaining representative data on ideal or typical conditions.

The research consisted of four phases: description and typological classification of case study areas, qualitative interviews with members of different stakeholder groups, quantitative survey among community inhabitants and landowners, and synthesis and development of policy recommendations (Wiersum & Elands 2002). In this paper the comparative results from the quantitative survey will be presented.

Quantitative survey

On the basis of the results of a qualitative, explorative survey, which was carried out in six countries, as well as a literature search, a common questionnaire was developed by the researchers and translated into relevant languages for use in the case study areas (Wiersum & Elands 2002). The questionnaire contained, among others, the following categories of questions:

- Impressions concerning the amount of forest cover in respondents' locality and their level of satisfaction with it.
- Priority of different forest functions.
- The role of forests in the future development of rural areas.
- Recreational use of forests.
- Freedom of public access to both private and State owned forests.
- Level of support for grant aiding land uses, including afforestation, forest management and forest recreation.

The common questionnaire was employed in eight of the countries which participated in the research, i.e. Austria (AU), Denmark (DK), Germany (DE), Greece (GR), Hungary (HU), Ireland (EI), the Netherlands (NL) and Spain (ES). In

France a modified questionnaire was used and the French data are therefore not incorporated in this paper. In total 7,044 people were surveyed in the period between February and April 2001. Two thirds of these respondents are community inhabitants (66%, N=4638) and the remaining one third are landowners (34%, N=2406).

Data analysis

In order to account for possible differences between countries and types of areas in terms of rurality and forest history, the areas were categorized into four groupings for the subsequent analysis. Apart from *country* (k=8) and *traditional* versus *afforestation* (k=2) groupings, *rural typology* (k=5) and *Euro-zones* (k=3) groupings were developed. The "rural typology" was derived from a classification of the case study areas based on a list of parameters. A cluster analysis on these parameters classified the areas into five socio-economic categories of rurality: (i) rural areas with urban characteristics, (ii) diversified rural areas, (iii) growth areas depending on the agriculture sector, (iv) decline areas depending on the agriculture sector, and (v) remote areas (De Deugd & Elands 2001). The remote area class includes only one case study area, whereas the diversified class includes five case study areas (Table 1). The "Euro-zone" refers to a geographical grouping of the countries into three European zones: Atlantic (DK, EI, NL), Central European (AU, DE, HU) and Mediterranean (ES, GR). The initial analysis of survey data (Elands & O'Leary 2002) indicated that the survey data were variably correlated with the country, rurality class and Euro-zone characteristics. This indicates that not only specific socio-economically defined rural conditions influence the perspectives of local people on the rural development role of forest, but also national and regional conditions regarding history of land-use, forestry sector organisation and legal frameworks.

Table 1. The case study areas classified according to rural typology (K=16; N=7,044).

Rural area typology	Characteristics	Case study areas
Rural area with urban characteristics	High population density (at least 70 to over 300 persons/km^2) Forest forms important part of land-use Significant tertiary sector	**Ede** (NL) (N=407) **Haderslev** (DK) (N=615) **Staufen** (DE) (N=330) Toroella de Montgri (ES) (N=330)
Diversified rural area	Medium population density (50 – 80 persons/km^2, only Stadskanaal higher) Agriculture main form of land-use Equally developed secondary and tertiary sector	Hvorslev (DK) (N=596) Kerekegyhaza (HU) (N=404) **Konitsa** (GR) (N=375) Stadskanaal (NL) (N=436) **Wicklow** (EI) (N=522)
Growth area dependent on agriculture	Medium population density (50-60 persons/ km^2) Both forest and agricultural land-use Dominance of primary sector, but growing importance of tertiary sector	Pfullendorf (DE) (N=266) Weinviertel (AU) (N=570)
Decline area dependent on agriculture	Low-medium population density (20-70 persons/ km^2) Both forest and agricultural land-use Important, but stagnating tertiary sector	**Kolindros** (GR) (N=484) Leitrim (EI) (N=549) **Szentgal** (HU) (N=390) **Waldviertel** (AU) (N=640)
Remote area	Very low population (less than 10 persons/ km^2) Dominance of forest land-use Dominance of primary sector	**Navès** (ES) (N=119)

Bold printed areas are traditional forest areas. Those not printed in bold are afforestation areas.

When case study areas are grouped, the different sample sizes (ranging from 119 to 640 respondents) can heavily influence the results. However, each area should be equally dealt with in the analysis. Therefore, to correct for dissimilar sample sizes, a weighting factor was constructed and applied in the analysis. Besides, the sample sizes of both *community inhabitants* and *landowners* do not necessarily reflect the real distribution of both target groups. A weighting factor has therefore been developed and used in order to correct for over- and under-sampling. It appears that the weighting of the target groups does not change the results substantially. The only differences, though small, can be found in the more urbanised case study areas. High population densities and people that are no longer connected to land use activities but are more consumers of rural space can display different ideas with respect to forests in the development of the locality than land owners. For this reason, weighing of target groups has not been used in the main analyses.

3 Opinions on the role of forests under different rurality conditions

In this section three topics will be discussed: the perception of present forest cover as well as the satisfaction with it; the functions people prefer for local forests; and the potential role of forests in the future development of the locality. They will be explored in general terms, as well as for differences between community inhabitants and landowners and between urban and rural societies.

Opinions about the amount of forests

Respondents in the Multifor.RD study were asked to give their impression about the amount of forests in their locality. Taking both community inhabitants and landowners collectively and weighting for case study area sample sizes, 20 % have the impression there are too few forests, 72 % feel the current forest area is OK as it is and the remaining 8 % say there are too many forests. At the European level, therefore, the majority is satisfied with the present forest cover in their locality.

The area categories with the highest indicator of too few forests were "diversified rural areas" (35 %) followed by "urbanised areas" (19 %). Most of the diversified areas are afforestation areas that are degraded in terms of nature and landscape quality but with a good level of services[1]. Consequently, the associated people have a strong wish for more forests (Elands et al. 2003). The area category, where most feel there are too many forests, is where the primary sector is in decline (17 %). This is relevant in both the traditional and afforestation areas: in the traditional areas, the overwhelming amount of forests is eroding the agricultural character of the area and in the afforestation area the dominance of plantation forests established by outsiders is perceived as threatening the self-control and identity of the area.

The question whether people feel there are too few / many forests is strongly related to the present forest cover, which in turn is related to whether the area has a long forest history (traditional area) or a short forest history (afforestation area).

[1] In earlier papers we have named these areas 'bland & viable'(Elands & O'Leary 2002).

Table 2. Perceptions about the present forest cover in the locality compared to the satisfaction with it per rural area type and traditional/afforestation areas (all respondents; N=6,781; weighted for dissimilar sample sizes).

	Rural area type				
	Rural area with urban characteristics	Diversified rural area	Growth area dependent on agriculture	Decline area dependent on agriculture	Remote area
Traditional forest area					
- present forest cover	2.4	2.3	*	2.3	2.7
- satisfaction about amount of forests	2.1	1.9	*	2.0	2.0
Afforestation area					
- present forest cover	2.0	1.8	2.2	1.9	*
- satisfaction about amount of forests	2.3	2.5	2.1	2.0	*

Present forest cover: 1=low, 2=medium, 3=high.

Satisfaction amount of forests: 1=too much, 2=okay as it is, 3=too low

** = no data available*

In Table 2, the perception of the present forest cover as well as the satisfaction with it is presented for each rural area type and forest history.

The traditional areas all tend to feel that the amount of forests is medium to high, compared to the afforestation areas where the perception of forest cover tends to be closer to medium. Next, it can be concluded that all traditional forest areas are satisfied about the amount of forests, despite the varied perception of the present forest cover. With respect to the afforestation areas, there is a tendency to be slightly dissatisfied ("too low") with the amount of forests. People from diversified areas are the most dissatisfied taking into account their perception of the present forest cover. Although the forest cover in urbanised afforestation areas is perceived as being medium, residents still think they need more forests. Not so in the declining afforestation areas, however, where people generally feel that the current cover is "okay as it is".

Figure 1 does not split the areas according to forest history but, instead, according to the perception of present forest cover:

- If people feel the present forest cover is high, there is hardly any difference between the different areas. All rural residents are more or less satisfied with the present amount of forests; some of them even thinking there are too many forests (diversified and decline areas).

- When people perceive that the amount of forests is either low or medium, urbanised areas demonstrate a greater demand for more forests, decreasing with increasing rurality. People in more urbanised locations, therefore, tend to be more concerned about low or medium forest cover, expressing a preference for an increase, whereas those living in more rural areas tend to be more satisfied with the level of cover as it is, expressing no great desire for more.

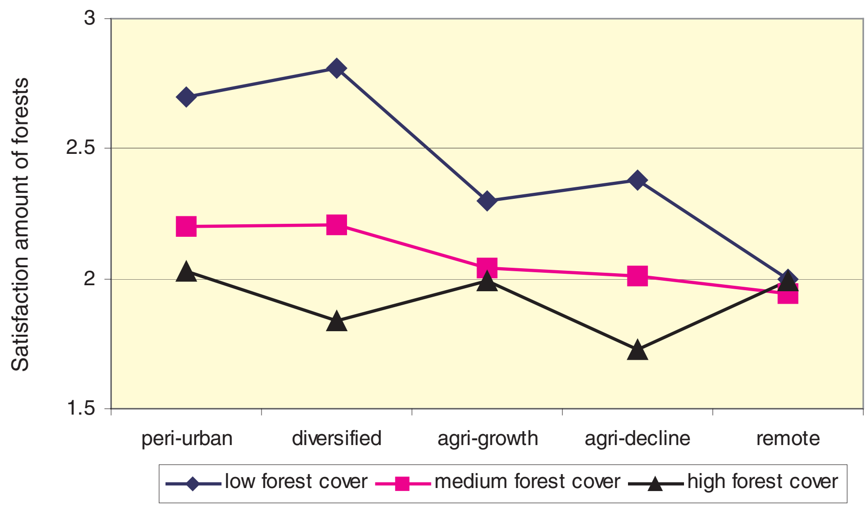

Figure 1. Satisfaction with present amount of forest cover (1=too much, 2=okay as it is, 3=too little) related to the perception of the present local forest cover per rural area type (Pearson correlation too much: -0.152, okay as it is: -0.188, too little:-0.333).

Perspectives regarding forest functions

When analysing what future potential benefits people expect from their local forests, the ecological arguments dominate. The respondents considered 5 alternative potential benefits of forests, indicating the relative priority of each (1 = low priority, 2 = medium priority and 3 = high priority). The benefits can be put in two groups:

- Protection, nature conservation and landscape benefits are regarded as top priority (2.8, 2.7 and 2.6 respectively);
- Recreation for local people and business activities, including providing jobs, are valued as medium priority with recreation slightly higher than business (2.4 vs. 2.2 respectively).

Environmental and landscape functions are valued lowest by farmers, along with recreation. Not surprisingly, therefore, farmers prioritise business activities the most. Landowners give relatively more priority to production whereas community inhabitants tend relatively towards consumption and public services.

Not much difference exists between rural area types with respect to the valuation of forest functions. The two most discriminating functions are recreation and business activities. Business activities are considered higher priority in diversified, declining and remote areas reflecting higher dependency in more rural areas on incomes from forests. The converse relationship is found for recreation: The more prosperous areas attribute more importance to recreation functions than other area types.

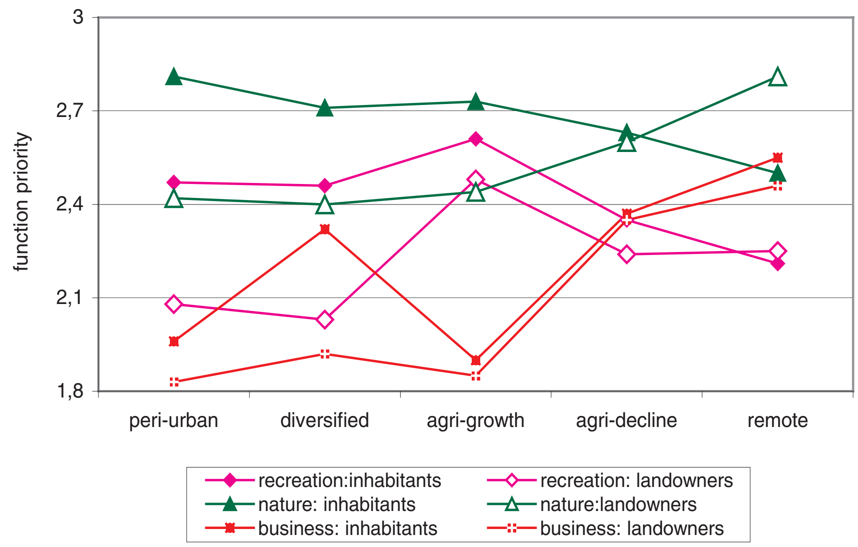

Figure 2. Future priority of forest function (1=low, 2=medium, 3=high) of community inhabitants and landowners per rural area type (Pearson correlation (a) recreation inhabitants: -0.073, landowners: -0.125, (b) nature inhabitants:-0.138, landowners:0.182, (c) business activities inhabitants: 0.170, landowners: 0.302).

In Figure 2 the opinions about recreation, nature conservation and business activities are depicted for landowners and community inhabitants respectively. It can be concluded that:

- Community inhabitants tend to place a higher priority on each of the functions than the landowners. The only noticeable exception to this is found in the remote area where landowners are more concerned than inhabitants about nature quality.
- Differences between community inhabitants and landowners are greatest in the two most urbanised areas, with much smaller differences in more rural areas.
- The importance of both nature and recreation increases among landowners with increasing rurality, whereas it decreases for inhabitants.
- Both groups are in general agreement that the importance of business activities increases with increasing rurality. A curious exception to this is found with the inhabitants in diversified areas.
- Inhabitants of the peri-urban and diversified areas attach surprisingly more priority to nature conservation than to recreation. At the same time, however, these inhabitants value recreation much higher than landowners.

Role of forests in the future of the area

To understand the relative importance of forestry compared to other functions within a local community, it is useful to analyse what kind of future options people think could be developed for their locality. On the basis of a cluster analysis, six groups of respondents indicating their preferred future developments was identified[2]:

1. *secondary sector economy development*: increase in industrial activities, employment opportunities, availability of services (25 %)

[2] As the variables are stochastic dependent (scale-ticking alternatives), this has repercussions on the results of the cluster analysis.

2. *tourism development*: increase in the number of visiting tourists (20 %);
3. *agri-business development*: increase in intensive factory farming and employment (14 %)
4. *organic-economy development*: increase in organic farming and employment (13 %)
5. *ecological development*: increase in organic farming, amount of nature, landscape scenic beauty, and to a smaller extent forests (19 %), and
6. *traditional development*: increase in services and in friendship and strength of bond between neighbours (10 %).

It can be observed that forests as a future option hardly emerges in the above clusters. An increase in forest cover is primarily associated with environmental and ecological functions and not with economic functions (O'Leary & Elands 2002).

With respect to differences between community inhabitants and landowners, it can be concluded that inhabitants more often prefer ecological development, whereas landowners choose agri-business development. This is especially true in urbanised areas, where the differences between both groups are biggest. Inhabitants are more consume-oriented with a hedonistic attitude.

Residents from rural areas with urban characteristics more often prefer an increase in nature and wildlife areas (37 %) and scenic beauty of landscape than an increase in forests as such. Residents from diversified areas ask much more frequently for more forests in the future (28 %) than residents from the other rural areas (Elands & O'Leary 2002).

According to Wiersum et al. (2002) the agri-business and secondary sector development options can be equated with the traditional approach of agricultural modernisation, whereas the tourism, ecological and organic-economy development can be equated with the more recent considerations of rural restructuring. The more remote the area gets, the more prevalent is the agricultural modernisation perspective (Figure 3).

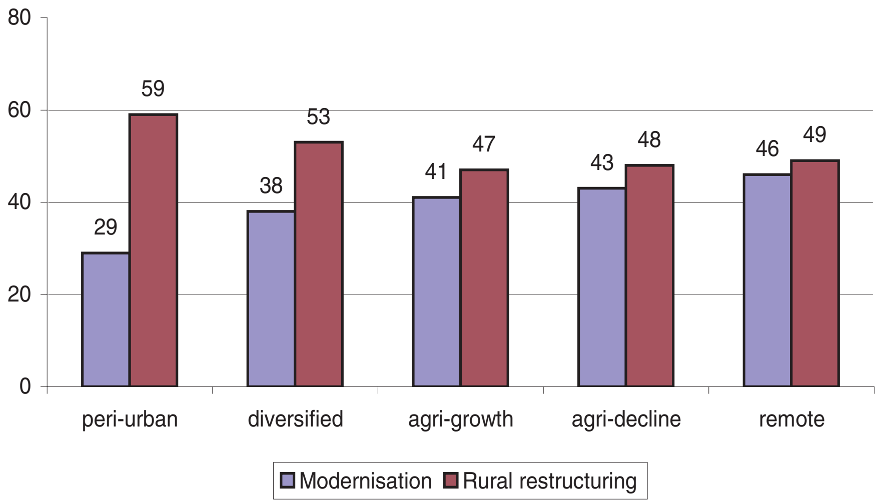

Figure 3. The share of agricultural modernisation of rural restructuring approaches as a future development option per rural area type.

In all areas, the restructuring perspective (47-59 %) predominates over the modernisation perspective (29-46 %), although in both agricultural areas and the remote area, differences are not so large. In the remote area, there is a very strong wish for an increase in agri-business activities (38 %), whereas in both agricultural areas groups of people prefer an increase in either agri-business activities (on average 17 %) or secondary sector development (on average 25 %). The latter development is also equally desired in the diversified area.

More than 50 % of the urban and diversified societies ask for restructuring perspectives, with one third (on average) preferring modernisation. It is remarkable that landowners share more or less the same opinions as community inhabitants (sometimes even more in favour of restructuring). It might be that landowners recognise at first hand the difficulties facing farming in the future and have more faith in restructuring than modernisation. Community inhabitants, on the other hand, may have a more nostalgic view of modernisation, keeping the farmers as caretakers of the countryside and associating restructuring with great change and deterioration of traditional rural lifestyles.

The most preferred approach to restructuring varies between the different rurality classes: in rural areas with urban characteristics, ecological development is preferred. In diversified, agricultural decline and remote areas tourism development is most highly appreciated. Tourism is likely perceived as a direct cash injection to the rural economies whereas it is more difficult to improve economic welfare on the basis of ecological development alone.

Conclusions on the role of forests under different rurality conditions

It has become clear that satisfaction with present forest cover is highly dependent on the forest history of the area and the perception of present forest cover. People from traditional forest areas and people who feel the present forest cover is high are content with the present forest situation. On the contrary, people from afforestation areas and those who feel the present forest cover is low or medium think their locality needs additional forests. The demand for more forests increases with increasing urbanity.

Concerning future benefits of local forests, environmental, nature and landscape functions have high priority, whereas business activities and recreation have medium priority. This is irrespective of rural area type and target group. More specifically, it is interesting to observe that the more "rural" an area gets, the higher priority is placed on nature and recreation by landowners, whereas the lower priority by inhabitants. Besides, inhabitants of peri-urban and diversified areas attach surprisingly higher priority to nature conservation than to recreation. At the same time, however, these inhabitants value recreation much higher than landowners.

Forests play a minor role in the preferred future development of rural areas. Only within an ecological development perspective, preferred by one fifth of rural residents, do forests appear. Two major future development perspectives can be distinguished: agricultural modernisation and rural restructuring. The latter perspective consists of ecological (nature and landscape), tourism or organic-economy (organic farming combined with more employment) development. In all types of rural areas, this perspective predominates over the agricultural modernisation perspective.

4 Perspectives of producers and consumers on the role of forests for recreation

The most immediate relation between consumers and producers concerning forests and forestry occurs via recreation. Therefore, in this section three topics will be discussed: The actual recreational use of the forests; perspectives on public access to forests; and opinions about government grants for forest and land management. They will be explored in general terms, as well as for differences between consumers (community inhabitants) and producers (landowners) and between urban and rural societies.

Recreational use of forests

One of the objectives of the Multifor.RD questionnaire was to identify the variety in frequency of forest recreational visits across Europe. In this respect, the respondents were asked to indicate how often they visited forests for recreational purposes in the year 2000, whether daily, weekly, monthly, 2-4 times, once or never. On average people visit forests almost once a month and at least one quarter visit forests on a weekly basis. There are no big differences in recreational visits to forests between community inhabitants and landowners.

Some strong relations exist.

- The amount of visits is linearly correlated with the distance have to the nearest forest. Those who live immediately besides a forest go either weekly or monthly and those who live further than 2 km away from the nearest forest go only 2-4 times a year.

- The attachment of people to their local forests is strongly correlated with their behaviour: the more attached people are, the more often they visit the forests.

- Visiting frequency is negatively correlated with the opinion that forests in the locality offer very few possibilities for recreation and sports: the more often people visit forests, the stronger they disagree with such a statement. The opposite is true as well, namely that the less frequently people visit forests the more they are dissatisfied with the opportunities for recreation and sports.

There are some differences along the urban-rural societal continuum (see Table 3). First of all, people from the remote area visit their forests the most, which in this case is not surprising as almost all people live next to or even within a forest. Secondly, the most prosperous societies (the urbanised and agricultural growth areas) visit the local forests much more frequently than the diversified and agricultural decline areas. In the afforestation areas in urbanised and decline area types, the recreational use of local forests is lower, most likely due to the fact that forests there may not be as mature as those in traditional areas and therefore do not offer the same recreational opportunities. The lowest visiting frequency of all is found in the agricultural decline area, where most forests are planted for production and therefore have become a symbol of economic relapse in the area (O'Leary et al. 2002).

Table 3. Frequency of outdoor activities in local forests per rural area type and traditional/ afforestation areas (all respondents; N=6,781; weighted for dissimilar sample sizes).

	Rural area type				
Recreational use	Rural area with urban characteristics	Diversified rural area	Growth area dependent on agriculture	Decline area dependent on agriculture	Remote area
Traditional forest area	4.0	3.3	*	3.4	4.4
Afforestation area	3.7	3.4	4.1	2.3	*

Mean visits: varies from 1=never, 2=once, 3=2-4 times a year, 4=monthly, 5=weekly, 6=daily

Traditional area: eta^2=0.09 (P < 0.001), afforestation area: eta^2=0.12 (P < 0.001)

** = no data available*

Perspectives on public access to forests

The issue of public access to forests for recreation is highly topical in Europe presently. Particularly the question whether the public should be allowed to visit privately owned forests freely, given that most forests are planted with substantial support from public funds in terms of grants and premiums. The Multifor.RD quantitative survey sought to investigate this issue and some of the key results are presently below.

Looking firstly at the general population level and comparing just between community inhabitants and landowners, it can be seen from Table 4 that there exists much greater support for freedom of public access to public owned forests (e.g. State owned forests) compared to forests, which are privately owned (irrespective of respondent type). There thus appears to be some appreciation that private forest owners have a greater right to limit free public access to their forests, whereas public forests should be openly accessible to all for recreational purposes. Nevertheless, some 60% (i.e. the majority) of all respondents support the idea of privately owned forests being made freely available for public recreation. Forest owners should realise, therefore, that there exists a considerable expectation among the public for access to their forests for recreation.

Table 4. Support for freedom of public access to private and public/State owned forests for recreation (%; N= between 1,163 and 5,728; weighted to correct for dissimilar sample sizes; Cramer's V = 0.03 and 0.07 (P < 0.001)).

Support for public access to	All	Community Inhabitants	Landowners
Privately owned forests	60	61	57
Public owned forests	89	90	84

Landowners are generally less supportive of free public access to both private and public owned forests forest. Landowners are thus more cautious about allowing members of the public to freely visit land for recreation, whether that land is privately or public owned. This result is not unexpected, however, given that landowners may wish to receive payments for services and amenities provided to the public.

Opinions relating to the above issue among forest owners is also worth considering, given that they stand to be most affected by policies on public access to privately owned forests. Foresters (only) are found to be equally supportive as community inhabitants for freedom of access to both private and public owned forests (59 % and 90 % respectively). It would appear, therefore, that this group does not have any great concern over possible access to their forests. Not so with forest-farmers, where the level of support for free public access to private and public owned forests is considerably less (44 % and 84 % respectively). Forest owners who also are engaged in farming, therefore, are likely to be much less supportive of policies aimed at opening up privately owned forests for public recreation, compared to their forester (only) counterparts. This may reflect their understanding that services such as recreation and amenities provided to the public should be paid for.

Moving from the general European level, attention will next be focused at different rural area types and the differences or similarities therein (Table 5). Firstly, we see that rural area typology does not influence the fact that there is much greater support for freedom of public access to public owned forests than private forests. Neither does rural area typology influence the fact that landowners are less supportive than community inhabitants of allowing the public free access to either private or public owned forests (not in the table) and that in general the differences between landowners and inhabitants are not very large. The exception to this trend concerns landowners in the agricultural growth area, who are much less enthusiastic about public access to private forests than inhabitants are (49% vs. 71 % respectively).

Table 5. Support for free public access to private and public owned forests per rural area type (all respondents; %; N=6,839; weighted to correct for dissimilar sample sizes; Cramer's V = 0.14 and 0.18 (P < 0.001)).

	Rural area type				
Support for public access to	Rural area with urban characteristics	Diversified rural area	Growth area dependent on agriculture	Decline area dependent on agriculture	Remote area
Privately owned forests	50	54	65	66	32
Public owned forests	90	90	86	87	70

Secondly, comparing across rural area types in relation to private forests, respondents in the two areas dependent upon agriculture are the most supportive of allowing free public access, whereas the remote area is least supportive. The two most urbanised areas are somewhere in between. Generally, acceptability of open access of privately owned forests increases with increasing rurality. The remote area is, however, an exception. The reverse can be concluded for support for general access to public owned forests: the mean level of support decreases with increasing rurality. The more urbanised a society gets, the more they appreciate that public forests are for their enjoyment.

Opinions about government grants for land & forest management

Grants and subsidies are important means to stimulate afforestation and management of existing forests. On the other hand, there are other financial measures, which are used to stimulate agriculture. The respondents have been asked to qualify five purposes for the provision of grants and subsidies: farming practices, enhancement of landscape, planting of trees, management and protection of existing forests, and finally, the accessibility of forests for recreation. Table 6 presents the results.

Table 6. Opinions about government grants for land & forest management per respondent type (%; N = between and 2,407; weighted to correct for dissimilar sample sizes).

		Respondent type	
… should be paid grants or subsidies…	**All**	**Community inhabitants**	**Landowners**
a) Farmers…. to enhance and sustain the landscape	85	82	90
b) Farmers…. to support their farming enterprises	73	67	84
c) Private landowners…to plant trees on their lands	69	65	76
d) Private landowners… to manage and protect their forests	68	63	75
e) Private landowners…to allow people to visit their forest for recreation	47	46	50

Cramer's V = (all P < 0.001): a) 0.11, b) 0.18, c) 0.12, d) 0.13, e) 0.04

Firstly, it can be seen that the majority of the respondents agree with the provision of grants and subsidies to landowners for both farming and forestry activities. The most endorsed purpose is landscape enhancement (85 % agreement). There is also, however, high support for farming enterprises. Afforestation and protection /management of forests are equally endorsed and there is relatively low support for forest recreation (47 %).

Opinions of inhabitants and landowners differ. In each case, landowners are more supportive of grants than inhabitants. Next, we can conclude that as soon as farmers are met with demands that are not connected with their core business, such as landscape enhancement, both community inhabitants and landowners think that provision of grants and subsidies is reasonable and there is hardly any difference in opinion between both target groups. The same is true for grants for opening private property for recreation. When asked whether farmers should receive grants to support their farming enterprise, on the other hand, there is a very strong divergence of opinion between respondent types, with community inhabitants being much less supportive.

There is only a small difference between the level of support exhibited for either afforestation or management of existing forests among both community inhabitants and landowners. However, while community inhabitants regarded these two forestry activities as equal to supporting farming enterprises, farmers are comparatively less concerned about them.

Regional differences in grant-aiding land uses

In Table 7 the regional differences in support for land use grants are depicted. First of all, it can be seen that support for agriculture grants increases linearly with increasing rurality (strong relationship), clearly reflecting people's increasing dependence on farming. Secondly, landscape grants are almost equally supported in all areas, with areas in decline being the most supportive. This finding is expected, at least in the Irish case study, given that many of the locals complain about adverse landscape impacts arising from afforestation of farmland with commercial conifer forests of limited species diversity. Thirdly, relatively low support is demonstrated in urbanised areas for both the protection and management of existing forests and afforestation. Support for protection/management grants increases linearly with increasing rurality (strong relationship), clearly reflecting the strong connection of local people with their natural surroundings. With respect to afforestation grants there is little difference between rural area types. While those in urbanised areas who expressed a desire for more forests in the future are more supportive of afforestation grants (64 %), it can still be seen that people in urbanised areas are less supportive than diversified, growth or decline areas (70-75 %). Notably, in diversified areas there is a strong support for afforestation, probably to be explained by the fact that most of them have a low nature and landscape quality. Finally, the approval of grants for forest recreation is highest in peri-urban and diversified areas and lower in the other areas.

Table 7.Opinions about government grants for land & forest management per rural area type (%; N=between 6,044 and 6,399; weighted to correct for dissimilar sample sizes).

	Rural area type				
… should be paid grants or subsidies…	Rural area with urban characteristics	Diversified rural area	Growth area dependent on agriculture	Decline area dependent on agriculture	Remote area
a) Farmers…. to enhance and sustain the landscape	84	84	84	90	86
b) Farmers…. to support their farming enterprises	58	71	72	87	89
c) Private landowners…to plant trees on their lands	59	75	69	71	72
d) Private landowners… to manage and protect their forests	60	68	62	73	81
e) Private landowners…to allow people to visit their forest for recreation	49	54	44	40	44

Cramer's V = (all P < 0.001): a) 0.07, b) 0.25, c) 0.14, d) 0.13, e) 0.12

Grant-aiding recreation: in general and regional differences

If private forest owners are to allow the public to visit their forests for recreational purposes (see section 4.2), it is interesting to consider whether or not they should receive additional financial support. Firstly comparing different respondent types at the general European level, it can be said that the greatest support comes from foresters (only), at 53 %, followed closely by community inhabitants, farmers (only) and forest-farmers (47 %, 51 % and 50 % respectively). It would appear, therefore, that aside from foresters (only), the type of respondent has little influence on opinions regarding whether private forest owners should be paid to allow public access to their forest. Though the difference between foresters (only) and forest-farmers is small, it is also curious, given that they both own forests and would thus stand to gain similar benefits financially from such a scheme. Apparently, forest-farmers want their property to be exclusively used by themselves more often and not to be shared with others.

It appears there may be some relationship between support by private forest owners for recreational grants and the size of their forest, with larger forest owners (irrespective of whether they are just foresters or forest farmers) tending to be more in favour. The mean size of forest for foresters and forest farmers who are in support of recreational grants is 13ha and 33ha respectively, compared to 6ha and 10ha respectively for those who are not in favour.

At country level, there are interesting differences of opinion regarding support for recreational grants, with considerably lower support in the three central European countries of Hungary (21 %), Austria (41 %), Germany (32 %) compared to the others (53-58 %). This may be due to the fact that these countries have a long history and tradition of forestry and, accordingly, public use of forests for recreation. Forests in these countries might already be well developed for recreation and thus the provision of grants may not be so critical. In the Atlantic countries, on the other hand, where there is a much shorter history of forests, a considerably higher support for recreational grants has been demonstrated, perhaps reflecting the perceived need to assist forest owners in improving the recreational quality of their holding. This interpretation is supported by the relative frequency of forest visits, where people in central Europe visit significantly more often than those in the Atlantic countries.

Having concluded that there is not much difference between respondent types concerning support for recreational grants at the general European level, it is next worth considering whether there are distinctions to be made at the level of rural area type (Table 8) between community inhabitants and landowners.

Table 8. Support for providing grants to forest owners to allow the public visit their forest according to rural area and respondent type (%; weighted to correct for dissimilar sample.

		Rural area type				
Support for providing grants to forest owners to allow the public visit their forest …	All	Rural area with urban characteristics	Diversified rural area	Growth area dependent on agriculture	Decline area dependent on agriculture	Remote Area
Community inhabitants	47	48	51	39	37	39
Landowners	51	55	57	54	44	46

Looking firstly to the community inhabitants, there is greater support for recreational grants in the two most urbanised areas, with no difference whatsoever between the three most rural areas. It would appear, therefore, that urbanised community inhabitants are most willing to pay for recreation in private forests. Referring back to the results in Table 5, it will be remembered that these two urbanised societies had lower expectations regarding freedom of access to private forests than the two agricultural areas. Considering next the opinions of landowners, the greatest level of support for forest recreational grants is found in the peri-urban, diversified and growth areas.

Conclusions on the perspectives of producers and consumers on the role of forests for recreation

People pay on average a monthly visit to their local forests. The closer their residence is to the forests, the more frequent they go there. There is hardly any difference between respondent type and rural area type. People in traditional forest areas go more often than people in afforestation areas.

In general, it can be concluded that there is a much greater support for freedom of access to public owned than for privately owned forest as well as that inhabitants are more in favour of public access to both forest types than landowners. Besides, with increasing urbanity there is a decreasing support for public access to private forests, whereas the reverse is true for public owned forests. It seems that urbanised societies have lower expectations regarding access to private property and more appreciation of public forests for their enjoyment.

With respect to grant-aiding land uses, it can be observed that a very high support exists for farming and landscape measures, a high support for protection/management of forests and afforestation, and a relatively low support for recreational access to forests. Landowners are always more supportive than inhabitants. Support for protection/management of forests, afforestation and farming increases with increasing rurality, reflecting the high dependency between natural resource production processes and local people in the more rural areas. Although recreation is not highly supported, community inhabitants from peri-urban and diversified areas are the ones most willing to pay for recreation in private forests. These two societies perhaps appreciate more than the others that landowners cannot be expected to freely open their property for the general public but, instead, that they should be compensated for this.

5 Conclusions

The way forests are perceived within localities exhibits similarities and differences. In Table 9 the main findings with respect to the differences between the rural area

Table 9. Main differences between the rural area types with respect to the general role of forests within the locality and on the role of forests for recreation.

Rural area typology	Opinions on the general role of forests in the locality (amount, function, future)	Perspectives of consumers and producers on the role of forests for recreation (use, access, grants)
Rural areas with urban characteristics	*Likely to feel there are too few forests *Along with all areas, nature and landscape functions are rated highest. However, in peri-urban areas production function is lowest. Recreation rated relatively high, especially by inhabitants. *Highest demand for rural restructuring. Residents more concerned with an increase in nature and wildlife and better scenery (ecological development) than an increase in amount of forests	*Monthly use *Along with diversified areas, highest support for access to public owned forests and lowest support to private owned forests *Least supportive of providing most types of grants to landowners, increasing linearly with increasing rurality. Inhabitants –along with inhabitants from diversified and growth areas- most supportive of forest recreation grants
Diversified areas	*Most likely to feel there are too few forests, especially in the degraded yet well serviced areas *Production function is relatively important. Inhabitants rate recreation especially high. *High demand for rural restructuring perspective. Along with remote and decline areas, highest demand for tourism development	*2-4 times/monthly use *Along with urbanised areas, highest support for access to public owned forests and lowest support to private owned forests * Highest support for afforestation grants. Inhabitants –along with inhabitants from urbanised and growth areas- most supportive of forest recreation grants
Agricultural growth areas	*Present amount of forest = okay *Productive function is rated low in importance, recreation relatively high. *Comparatively high demand for development of secondary economy and maintaining traditional values	*Monthly use *Along with declining areas, highest support for public access to private forests and medium support to private owned forests *Relatively high support by landowners for forest recreational grants. Inhabitants –along with inhabitants from urbanised and diversified areas- most supportive of forest recreation grants
Agricultural decline areas	*Present amount of forest = okay, but most likely to feel there are too many forests *Relatively high priority put on production and protective functions *After remote areas, greatest demand for development of agri-business. Along with remote and diversified areas, highest demand for tourism development	*2-4 times/monthly use *Along with growth areas, highest support for public access to private forests and medium support private owned forests *Most supportive of landscape related measures and high concern for management/protection of forests and farming activities
Remote areas	*Present amount of forest = okay *Relatively highest priority put on productive/commercial and protective functions *Highest demand for modernisation perspective, i.e. more agri-business activities, with comparatively low concern for ecological development. Along with decline and diversified areas, highest demand for tourism development	*Weekly use *Lowest level of support for public access to either private or public owned forests *Most supportive generally of financial assistance for landowners. Special concern directed towards management/protection of forests.

types are presented. In the following text, both the similarities and differences will be elaborated.

With respect to similarities, it is clear first of all that in general there is not a great demand for more forests and that demand is to a large extent related to the present landscape quality of areas and less concerned with the rural area type. Environmental and aesthetic functions of forests are of high importance, whereas recreation and commercial functions are of medium importance. Forests in themselves do not play any role within the future perspectives of rural areas; they only feature when people prefer an ecological development for their area, which is one of the six major future options.

In every rural area forests perform an essential role in recreation. People visit the local forests on a monthly basis. There is a broad support among inhabitants and landowners for general public access to privately and public (state) owned forests. Two qualifications should be made, however: the support for access to private forests is less than for public forests and inhabitants are always more in favour of public access than landowners are. It can be concluded that the general public has high expectations to forest owners regarding free access to any kind of forest. It is remarkable to observe, however, that there is a relatively small group of people that at the same time supports the provision of grants for private landowners to allow people to visit their forests for recreation compared to the high support for grants stimulating landscape enhancement, farming activities, afforestation and protection and management of existing forests.

In rural areas with urban characteristics, there is higher demand for more forests, in which ecological functions as well as recreation should be the central focus. As there is in general a low concern for landowner support and for forest economy, a discrepancy exists between inhabitants' wishes and their understanding of landowners' economic viability. The public want local private forests to satisfy their ecological and recreational demands, but are not enthusiastic about financially supporting the forest owners in reaching those goals. Although inhabitants from urbanised areas are the ones most willing to support grants for forest recreation opportunities, still, half of them and even more in the other rural area types do not think landowners need financial support.

In diversified areas, there is a high demand for more forests with equal priority upon recreation and production. This quest for more forests is strongly related to the forest history and the present landscape quality, which is limited in its recreation possibilities. As the support for afforestation and recreation grants is the highest among people of diversified areas, conflicting views might not be expected as long as new forests are not mono-functional nor comprise solely of non-locally accepted species. Moreover, as there is a broad support amongst the residents for future tourism development, the establishment of new forests could contribute to reaching this development objective.

People from agricultural growth areas are not really concerned with more or less forests. The residents value the recreation function of forests relatively high as well as freedom of access to public owned forests. As these areas are relatively prosperous, the non-productive values of forests are highly esteemed. So, there is a relatively high support for recreational grants. For the area in general, a majority of the people ask for a more traditional (agricultural) modernisation approach, although the voice of more environmental oriented people can be observed as well.

In the agricultural decline areas, people ask for developments that boost the local economy, rather than local ecology. The way the area should develop is varied: some prefer a classical agricultural modernisation future, whereas others prefer a restructuring perspective by means of tourism development. From this perspective, it is understandable that people favour development of the economy of existing forests rather than the afforestation of more land. There is high support for management, protection and landscape related subsidies for private landowners.

Residents from the remote area show a great concern for the protective and productive functions of their forests as well as for the economic viability of their area. There is a pronounced wish for more agri-business activities in the future. In general, these people are most worried about the economic viability of landowners and are therefore the most supportive of any kind of financial assistance for landowners. They also show a special concern directed towards management/ protection of forests. But, although the protection of the forests is highly valued, there is a low support for a more ecological development of the area. Most probably people think the area is "rich enough in nature" already.

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Children and the urban landscape - neighbourhood as setting of children's everyday life

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Abstract

It is a well-known fact that outdoor playing possibilities are important areas of experience for children. But in planning of the urban environment children's needs have been a matter of concern only since the 1930s. In Denmark, the famous adventure playground was a milestone. In the 1980s the work of the Danish Children's Commission established that outdoor possibilities for children are important for their health and well-being. Environmental psychological studies confirm that children's ability to have sensation is stimulated by nature. The urban landscape therefore needs to provide not only facilities for sports and play, but also natural areas for nature experience and stimulation of children's senses and creativity.

Within the frame of the Welfare Research Program set up in 1998 by the Danish Research Councils, a project with focus on children's every day lives in different urban neighbourhoods was carried out. Special emphasis was given to green areas to illuminate the challenges and experiences children are offered in cities today.

The overall idea of the study was to bring the physical and the experienced environment together and investigate to which extent children's interests have been incorporated into urban design. On that background guidelines for changes supporting children's everyday lives can be produced. The children's use and interest were expressed with there own voice through interviews, drawings and photos. A main question was to what extent children's requirements for peace, activities and creative play are covered in the modern urban environment. The project has investigated four different neighbourhoods built in the period 1880 - 1990 and typical for housing in Denmark. This was done to make a wider study perspective possible. The study has involved 60 children between 5 and11 years.

The project has shown that most children point at an outdoor area when asked where they prefer to play. All children use green areas in their spare time and have clear opinions of likes and dislikes. But children's mobility is restricted by the traffic structure and potential dangers associated to this in the neighbourhood. In densely populated neighbourhoods, a large variety of possibilities exist due to the multifunctional organisation, but children are dependent on adults since they are not allowed to move around on their own. In neighbourhoods where detached housing is dominating there is a high percentage of green, but variation in the functional pattern and the visual impact is limited. Nature experience to support

children's contact with their senses, ecological understanding and fantasies are needs that are not met in many neighbourhoods in cities today.

Among the challenges to actors on the political scene - politicians, planners and parents - are the creation of conditions for a variety of activities and possible experiences in urban neighbourhoods. Furthermore threats have to be limited to make it possible for children to recapture freedom and independence during their spare time between the many duties and responsibilities characterising children's lives today.

Key words: green areas, landscape planning, housing schemes, urban nature, children's play.

1 Introduction

The study referred is an interdisciplinary study involving architects, town planners, sociologists and psychologists. It has been financed by the Danish Research Councils within a frame of the Welfare Program set up in 1998. The project is divided into three parts, which together constitute an integrated whole.

The project has three main analytical angles:

- a town planning and architectural angle
- a sociological and psychological angle
- a green planning and landscape angle

This article takes its point of departure in an analysis of neighbourhood structures and urban space including green space. The analysis seeks to describe the physical and functional organisation of different urban settings. The children's possibilities of using, experiencing and moving about independently are investigated in a survey and emphasis has been given to the differences and similarities between one type of neighbourhoods as opposed to another and to the possibilities children have regarding use and experience with green areas and nature.

The children's daily routines and interests have been expressed with their own voice through interviews, drawings and photos. The interviews have taken place on walks along the "institutional triangle" - as we call it - between home, school and day-care.

A main research question has been to what extent children's requirements for peace, activities and creative play are covered in the modern public urban environment. Special emphasis has been given to questions related to the open space end green areas in the urban setting.

In terms of practical relevance, the project focuses upon a group of citizens often neglected in town planning, and aims to apply project results to future schemes on urban development and renewal by producing new knowledge about how children perceive urban quality.

Key words: architecture, psychology, landscape planning, urban green space, creative play.

2 Background

Three out of four Danish children today grow up in urban surroundings. We know very little about what it is like to be a child in the city, and it is therefore relevant to more closely investigate the interaction between urban structures and children's daily lives.

It is generally accepted that outdoor playing possibilities provide important experiences for children. But in planning urban environments, children's needs have been a matter of concern only since the 1930s. In Denmark, the famous "adventure playground" was a milestone. In the 1970s, researchers stated that children's outdoor activities contribute essentially to their health and welfare and in the 1980s the Danish Children's Commission established that outdoor possibilities for children are important for their health and well being.

Today, it is well-documented that impressions from nature contribute to reducing mental tiredness deriving from stress (Ulrich 1984; Grahn et al 1997). Wilderness in parks provides possibilities for tranquillity and nature experiences, which applies to children also. Within the institutions, children are frequent visitors of urban parks and children are stimulated when there is access to natural areas and forest from the schoolyard. Psychological research shows that children's senses are stimulated by nature and that those experiences form children's relation to nature and is often remembered in adult life (Kaplan & Kaplan 1989; Nordström 1994). Furthermore, this research shows that experiences influence the senses most strongly when children move about on their own - or so to say, when they are beyond adult gaze. The urban landscape therefore needs to provide not only facilities for sports and play, but also natural areas for nature experience and stimulation of children's senses and creativity.

The focus of the study as a whole is on that part of children's everyday live, which concern the use and meaning of the physical environment. Special attention is paid to interaction between the organisation of urban outdoor space and children's everyday life within this space, i.e. life, which takes place outside and in the neighbourhood. By examining how children use the concrete physical frameworks, as well as the meaning of these for the way in which children move around, we emphasise features in the physical environment that may impede or promote children's independent mobility (Figure 1).

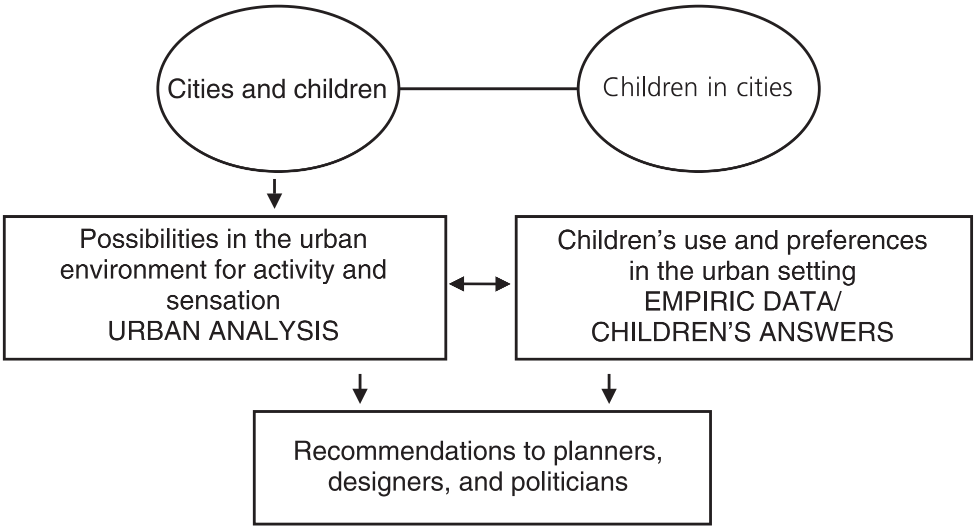

Figure 1. The overall idea of the study has been to examine the relations between the physical and the experienced environment to support children's interests in future planning.

3 Methodology and materials

The four selected urban neighbourhoods were examined from two different perspectives -the adult/ planner's and the children's perspective. The neighbourhood is considered a unit of special importance for children because children in their everyday lives are less mobile than adults and therefore more dependent on nearby possibilities. Also, it is presumed that children experience differently in different types of neighbourhoods.

The investigation of the four selected neighbourhoods is carried out as a multiple case study (Yin 1994). The four neighbourhoods involved are situated in the Greater Copenhagen Area and are historically covering the urban expansion period from 1880 to 1990. To make a wider perspective possible, they all are typical for housing in Denmark (Knudstrup & Marling 1998).

The four neighbourhoods are:

- High-density flats in central urban area. Construction period 1880-1920
- Low-density single-family houses in suburban area. Construction period 1950-1960
- High-density bloc of flats in suburban area. Construction period 1965-1970
- Low and dense terraced housing in suburban area. Construction period 1990-1995

The study involved 61 children between 5 -12 years. Empirical data from interviews was collected on a walk within the neighbourhood creating the outdoors environment of the children on days where they go to school and institution. Children were also asked to draw their house and their favourite place to play and to take photos on the walk.

By relating the urban analysis to empirical data from interviews with children, we can communicate children's needs and wishes to the planners and subsequently create better environments for children.

Urban analysis

To create an overview of the four neighbourhoods, an urban analysis relevant for the project was carried out. A number of analytical parameters were chosen. The urban analysis had to illuminate the opportunities of physical action and sensation in the neighbourhoods. By using well-known references of urban analyses (Norberg-Schulz 1980), it was possible to describe how and to what extent children activities, creative play and experiences with senses are made possible in the urban environment. The green structures constitute a significant element in many urban areas, e.g. as gardens, parks, nature grounds, playgrounds and sports-fields. These structures are in focus in the analysis of the urban landscape.

Empirical studies

The questions and subjects brought forward and illuminated in the interviews were formed to reflect the activities in children's daily lives during the time they spend in the urban environment. The methodology aims to apply and develop methods that make children active informants in the collection of data. The empirical data gained have to match the analytical parameters of the urban analysis. In order to make this possible, corresponding parameters were chosen for analysing empirical data. These refer to children's physical activities; physical training; development of skills; and experiences made involving body and senses.

4 Results

Presence in the urban landscape

First of all children spend time in their neighbourhood on their daily routes. They walk, bike or go by car with their parents and travel relatively long distances (i.e. 1,5 - 2,5 km or more) every day. By doing that, they experience the neighbourhood with their body and with their senses. They have to accept many restrictions to avoid danger and risks, mainly from traffic. Roads form a severe barrier to children's mobility. Another important fact is that children love to be outside. When they are asked to draw their favourite place, almost all children draw a place outside. There is no recognised relationship between having a garden or not, but of course having a garden relate to different possibilities and experiences.

Facilities in the neighbourhood

Playgrounds are children's places and are favoured by children until the age of 10 -11 years. By then, girls in particular state that they are (far) too old to enjoy playgrounds. Children talk about the playgrounds, rank them and identify them by names as "the big one", "the one with three swings", "crocodiles place" etc. Children meet at the playgrounds and many children express that they like climbing, to get overview and to experience a little danger. In the dense urban neighbourhood the number of public playgrounds are restricted and it is therefore essential to have at "good" yard. Such a yard is best if it has been renewed and supplied with children's facilities. But the lack of space and room for activity is expressed as a problem. A boy asks for more space in his yard in the central urban area to support his wishes for playing football. In low-density single family housing areas, there are no public children's facilities in the neighbourhood and some children therefore use possibilities available in nearby dense housing areas.

Football is a very important activity in many children's lives. 75 % of the interviewed children say something about football. With some of the boys, one gets the impression that football takes up almost all their spare time and constantly is on their mind. They draw the football fields as their best place to play and sense the neighbourhood from a football point of view and many children train football in clubs one, two or three times a week. There are different aspects on the influence of football in a neighbourhood. Football requires space, captures territory and excludes other activities. Where space is limited, for instance in schoolyards and in dense neighbourhoods, this is a problem. Those not playing football - mainly girls and some of the boys - have little room for their activities when the football-game is on.

Adults also want the territory for their purposes. A boy relates that he plays in the garden sometimes but often he is not allowed because his parents like flowers and do not want the flowers destroyed. In some spatial neighbourhoods, there is enough space. Here football brings children together – some playing and some preferring to watch the game.

Spontaneous use of urban green

Lawns useable for football are useful for less wild and dangerous games as some girls express it. These girls are attracted for other reasons to the lawn and say they enjoy the lawn because it is nice and free. Not all boys enjoy lawns as football fields. One boy says: "I wish, we could have more than just a lawn".

Other elements of green create important possibilities for children. Trees and shrubs in neighbourhoods make contact with nature and experience of sensation possible. Half of the children report that they have a place of their own – a secret place. This place is often in a vegetated area. Not a big place, maybe only a couple of shrubs in a corner where you can hide and keep secret things. Secret places related to urban green are a general phenomenon relevant in all four neighbourhoods.

In all four neighbourhoods, there are children who explore nature. Both boys and girls pick flowers and pay attention to animals. Wild animals in the inner city are for instance mouse/rat, fox and birds like pigeon and sparrows but children also care and takes responsibility for domestic animals in the city and help dogs and cats to find there homes if they are lost. In the suburbs there are a larger variety of wild fauna. The children watch and play with e.g. frogs, snails, and worms. The imagination of a boy was inspired from a visit to a nature playground where he learned about frogs - he sees frogs everywhere on his walk the following day with the interviewer. But some children express alienation towards nature and talk about unpleasant smells and other dislikes.

5 Conclusions

It is not possible to point out one of the neighbourhoods as the best one for children, since all four have possibilities, advantages and limitations in relation to children's daily lives. Also, children are different and their demands differ depending on individual preferences and personalities as well as age and sex. Boys are mainly "football children", other children are "nature children" and some are "outgoing children" with a lot of activities outside the neighbourhood and with capacity to move around. Figure 2 sums up the recommendations for city planners with regards to children's needs.

- Children's independent mobility in their neighbourhood ought to be improved by traffic regulations.
- Attention should be made to create functional and spatial variety in the urban environment in order to stimulate children.
- Playgrounds with a wide range of activities and creative playing possibilities are important as part of good growing up conditions for children.
- Children like to climb and have overview.
- Exiting playgrounds are points of identification for children in the urban environment.
- Football is a dominating activity and needs a lot of space.
- Football and other ballgames need to be separated from other activities to avoid conflicts.
- Places with animals and plants attract children.
- Greenery where you can hide and have your secret place are important for most children.
- Places, which challenge children's imagination and fantasy, ought to be integrated in the urban environment.

Figure 2. Ten statements to planners and designers dealing with improving living conditions of children in urban environments:

Playgrounds are created for children's activity or creative plays and are very important as children's places in most children's lives. Children identify with their places and call playgrounds by nicknames. But public playgrounds are not available in all neighbourhoods and therefore, the physical and social benefits from playgrounds are limited for some children. Private ownership and small gardens and yards are limiting children's activities. Barriers such as distance and traffic limit children's movement and make it essential to focus on accessibility.

Football plays an important role in many children's lives, both for those who are active and for those who are watching, but football is a dominating activity, which exclude other activities. Football and other ballgames need special places where necessary measures can be taken to support the interest without limiting activities for other children.

Nature plays an important role for many children and they express their experience with enthusiasm. These children are often playing alone or with only one or two friends. Girls bringing rabbits to the lawn to graze is an example. A boy explains how he has created a parrot trap to catch his lost beloved pet. Many children pick flowers or collect leaves with beautiful colours and give or show them to adults or friends.

Most children have a secret place of their own or shared with a few friends. These secret places can be characterised as small enclosures between shrubs or in a wooded area. The importance for the child is expressed in the interviews and can be explained as excitement of sensing the unknown dynamic of the wilderness and the experience of being alone for a while.

Not everything is regarded positively. Some children express that they find their environment boring. One possible reason is lack of visual diversity and variety in functions and design according to their age and interests. But social reasons could also be of relevance e.g. where children are isolated by traffic structures. In many neighbourhoods, children's interests have not had sufficient influence neither on planning and design nor on management and maintenance of the areas.

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Urban forest resources and advances in ecological research

History and age of old limes (*Tilia* spp.) in Tallinn, Estonia

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Abstract

The historical park areas in Tallinn, Estonia contain many large lime trees (*Tilia* spp.) of unknown age. Since the available historical sources on these parks offer only fragmentary data, we decided to estimate the age of the limes using the tree-ring method and the bark method, along with the data from written documents and maps. Many of the limes grow on former bastions and their origin is related to the history of the fortifications of the city. Twelve lime trees were cored with an increment corer and their tree rings were counted and measured. The age of the trees was estimated by using cumulative graphs of annual increment. The ages of four trees were measured using the bark method of age estimation. This method relies on the counting of bands of phloem fibres in the outer bark. The age estimations of the trees by different methods were compared with historical data on the area. Despite some inaccuracies in the age estimations due to hollow tree trunks, the age estimations by tree rings and the bark method often coincided and was supported by historical sources. The accuracy of the graphical method of age estimation, and especially of the bark method, still needs to be verified in further studies.

Key words: bark, dendrochronology, phloem layers, Tilia spp., tree age.

1 Introduction

Trees in many ways are the antithesis of urbanisation. As surrogates for and fragments of nature, they are earnestly desired and yet paradoxically so gravely deficient in cities (Jim 1994). There are a number of functions that trees perform in cities (Mayer 1978).

The trees that have the greatest impact on their environment are the larger, more mature specimens. The old trees as living heritage could be equated with the historical monuments of the city, and be listed for special preservation by amending the existing Antiquities and Monuments ordinance. For privately owned selected large trees, consideration could be given to the allocation of public funds as subsidies for tree maintenance (Wicki 1988; Jim 1994; Nelson 1994).

The most valuable old trees in Tallinn are growing on the old bastions, where parks were established during the second half of 19th century. There are also old trees known to be growing near churches. These trees are important also in the European context. However, the age of the trees cannot be ascertained just by their appearance. Here an attempt will be made to assess the age of the trees by using historical sources as well as by measuring tree rings and the bark rings.

2 The study area

Tallinn, the capital of the Estonian Republic, is located in the northern part of the country on the coast of the Gulf of Finland, south of Helsinki (Finland) and to the west of St. Petersburg. Tallinn is the largest Estonian city, with an administrative area of 158.3 square kilometres and about 400,000 inhabitants (in 2001). There are several historical park areas in the city. Limes (*Tilia* spp.) are frequent tree species in these parks. The location of the investigated lime trees is shown on the city plan (Figure 1).

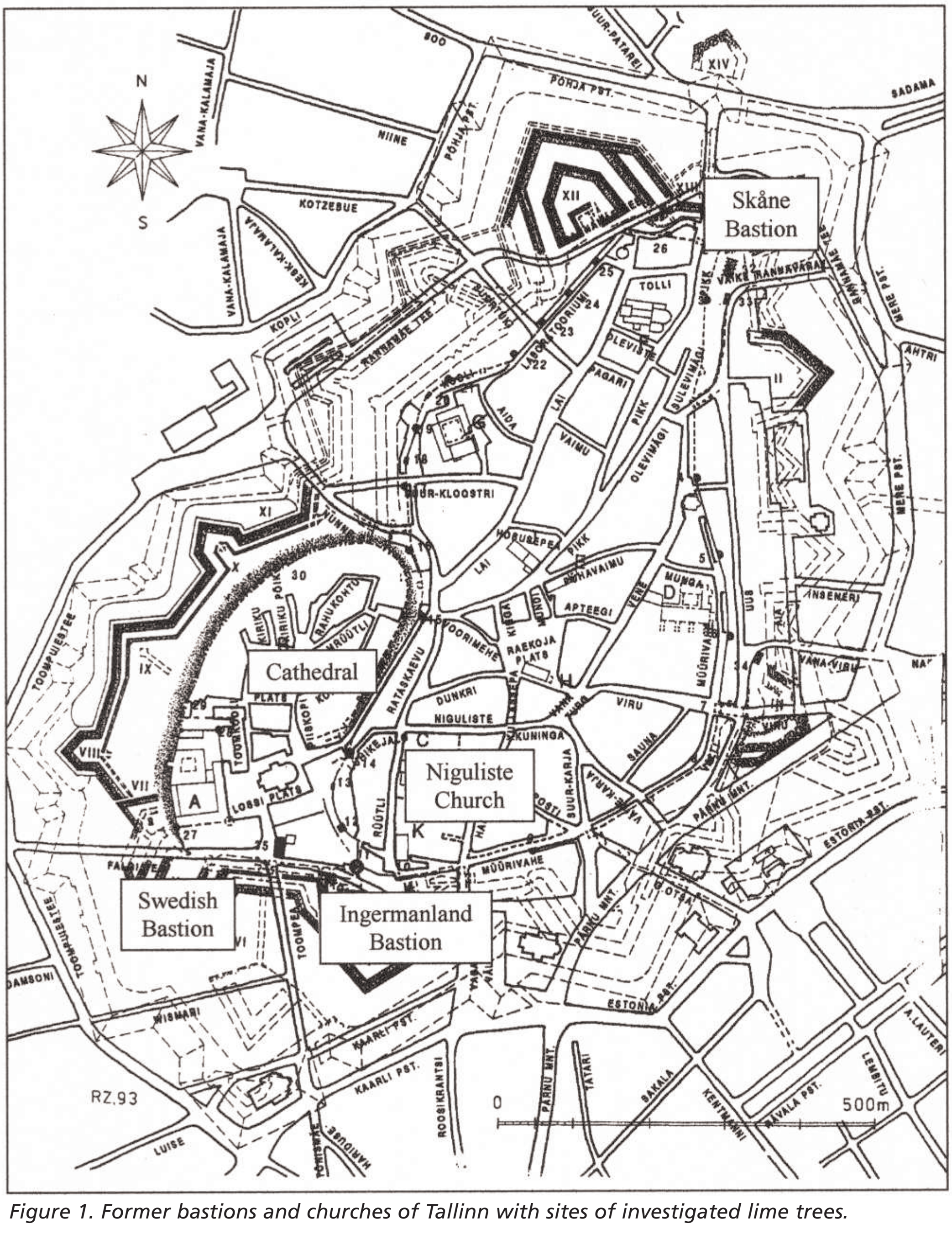

Figure 1. Former bastions and churches of Tallinn with sites of investigated lime trees.

The former bastions are generally favourable sites for tree growth, as the climatic and edaphic conditions are relatively stable there. The most serious threats to the trees on these sites are trampling, acts of vandalism, and air pollution. Nevertheless, citizens have, through the centuries, honoured trees of remarkable size. No doubt this positive attitude has played its role in the preservation of the big trees in the city to date.

3 Methods of determining the age of limes

Three methods were applied for determining the age of the lime trees: the tree-ring method, the bark method, and the historical method.

The tree-ring method

The initial principle of the method is very simple - counting of tree rings in the stem of the trees. The rings are available for counting in cores extracted from the tree trunk with a special age-corer. On the premise that every tree ring corresponds to a growth year, one could ascertain the age of the tree. Pigott (1989) estimated the age of limes from their stem thickness and tree rings.

Actually there are several hindrances in estimating the age of big limes (*Tilia* spp.) by counting their tree rings. Firstly, limes belong to diffuse-porous tree species. The boundaries of the tree rings of a diffuse-porous tree like lime are often hardly distinguishable even under the microscope. Secondly, an old and slow-growing lime tree can miss rings in some years (at least in some radii of the trunk) which means that the number of counted rings does not necessarily correspond to the actual age of the tree. Thirdly, as mentioned above, big lime trees are mostly hollow; they lack tree rings in the inner portion of their trunk altogether.

In these circumstances we had to elaborate a method for the assessment of the age of thick hollow trees like limes. This method is based not only on counting but also on measuring the widths of the tree rings of the lime tree. The measured ring widths are then cumulatively summarised and the cumulative sums of annual increment are represented as a line graph (Figure 2). The length of the missing part of the radius of the tree trunk (the portion of the radius in the hollow) is calculated from the girth of the trunk. The graph line of the cumulative increment can be extended back to the theoretical centre of the stem (the pith), taking into account the smooth increment tendency. The crossing of the graph line with the abscissa shows the probable onset year of the tree, i.e. the zero age at the height that the core was extracted from the tree trunk. The cores were usually taken from a height of 1.1 to 1.3 m above the base of the tree. As the limes were presumably planted, the established onset years at a height of 1.3 meters should not differ much from the planting year of seedlings of a similar height.

The bark method

It has long been known that the thickness of the bark of tree species with non-abscissive bark is related to tree age (Trendelenburg & Mayer-Wegelin 1955). Besides, the non-conducting outer part of the bark, or the rhytidome, contains layers in some tree species (Esau 1953, 1964). Fritts (1976: 68) notes: "The thickness of bark is a function of the tree's heredity, the vigour of the tree, and its age”. In his voluminous handbook on dendroecology, Schweingruber (1996) also remarks on the growth zones in the phloem and bark of many tree species. It was established that in Central Europe 55 of 77 species exhibit distinct phloem-tree rings (Holdheide 1951, after Schweingruber 1996). However, the above-named authors still remain sceptical about using the counting of bark rings for estimating tree age.

The bark method of establishing the age of limes and oaks was developed by Mart Rohtla, Institute of Cybernetics of Tallinn Technical University (Rohtla 1998; Läänelaid et al. 2001). It is an original method of counting the fine layers of fibres of the phloem in the bark sample of a tree. This method has some disadvantages as well as advantages compared to the tree ring method. The difficulties are that firstly, lime trees can form several layers of phloem fibres during one vegetation period, especially when young. An additional fibber layer may also appear as a reaction to browsing of the tree crown in the park. Secondly, the outermost layers of the bark ribs of old limes are often weathered away and the approximate number of the lost growth layers can only be assessed by the fan-like shape of the converging pith rays in the cross-section of the bark rib.

The main advantage of the bark method over the tree ring method is that, regardless of the hollow tree trunk, its bark can be available for study almost in its entirety. This makes the bark method especially valuable for determining the age of hollow trees. Rohtla determined the age of some big lime trees in Tallinn using both the tree ring and the bark method in parallel.

History of old planted trees

In the 17th century, a Dutch type bastion front was founded, which was completed at the beginning of the 18th century. The Northern War between Russia and Sweden (1700-1710) ravaged the whole country, and Tallinn became the centre of a province (gubernia) of the Russian Empire. The Tsarist government of Peter I was not much interested in fortifying Tallinn. In 1710-1721 the Great Coast Gate and Skåne bastions were strengthened. Between 1750-1790, construction works were carried out (Vilbaste 1965; Zobel 1994, 2001).

It has been noted that trees made their first appearance on the fortification plans of Tallinn in 1728 (Kenkmaa & Vilbaste 1966). The plans show that 19 or 20 trees were planted on the Skåne bastion. Zobel (2001) agrees that the trees on Skåne bastion represented on the city map in 1728 were planted during the Swedish period.

The fortification plan from 1728 shows large amounts of trees inside the city wall near churches (the Cathedral, the churches of Niguliste and Oleviste) and along the streets of the old Town. Trees near the Cathedral have obviously been planted after 1684, when the buildings on Toompea Hill perished in fire and were subsequently mostly demolished.

The best overview of the trees growing in the city centre as of the early 19th century is given by the city plan of 1825, prepared by Üprus (1965). The plan shows many private and church gardens, trees on the bastions, and one City Park (founded in 1822). 145 trees were growing on eight bastions and 67 of them on the following three former bastions: Skåne bastion - 39, Swedish bastion - 17, and Ingermanland bastion - 22 trees. We do not know if the trees originating from 1728 were still growing on Skåne bastion at that time or not.

The trees on the bastions have probably been planted during the period 1750-1790, when the bastions were restored and renovated (Kenkmaa & Vilbaste 1965). Unfortunately, there is no data available about the planting of the trees. Trees are not depicted on the city plans of that period.

After the demilitarisation in 1857, some of the ramparts were preserved, some levelled, and some turned into green or residential areas.

According to the data of Viirok (1930), trees were still growing on only three former bastions in 1928 - the Skåne (since 1884 park of Rannamägi), Swedish (since 1862 park of Lindamägi), and Ingermanland (since 1862 park of Harjumägi) bastions, with a total of 55 old limes; 34, 10 and 11 trees growing on each, respectively. In 2001, 23 of these limes were still obviously growing, 10, 7 and 6 trees on the respective bastions. Of course, it is difficult to guess which trees on Skåne bastion originate from 1825.

4 Results

Let us explain how, using the cumulative graphic line and the growth rate of younger limes, we assessed the age of a lime tree. Here are some examples to illustrate the method.

Figure 2 serves as a good example of how the graphical method of age assessment works. Small-leafed lime (*Tilia cordata* L.) No. 10, next to the Cathedral, yielded a series of 146 tree rings. From the perimeter of the trunk, 342 cm, the radius of the trunk was calculated as 54.4 cm. To get the radius of the xylem or wood, the

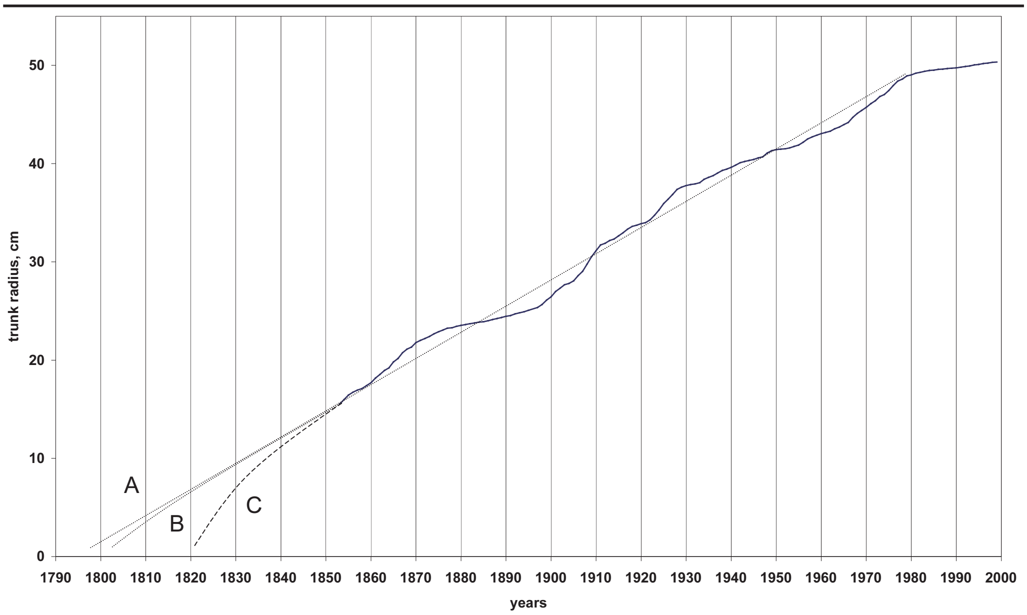

Figure 2. Cumulative annual increment of trunk radius of common lime (Tilia cordata L.) No. 10, growing next to the Tallinn Cathedral. Dashed lines - extrapolated growth models.

thickness of the bark was subtracted: 54.4 - 4.0 = 50.4 cm. The length of the raw sample core, or the cumulative sum of the measured tree-ring widths in it, 34.9 cm, gives us the existing portion of the radius. As the last ring, formed in 1999, located at the end of the radius of the tree trunk, we can easily find the radius of the missing inner part of the trunk: 50.4 - 34.9 = 15.5 cm. This is the distance we have to fill with tree-rings of hypothetical widths. First, assuming nearly constant annual increment of wood throughout the lifetime of the lime tree, a linear line was drawn as an extension of the cumulative curve to the x-axis (the fine dotted line A). We know that the annual increment of trees at a younger age is greater than at an older age, hence the number of wider tree-rings in the same radius of tree trunk is smaller at a greater distance from the centre of the trunk. Therefore, the linear graph obviously overestimates the age of the lime tree.

The question arises how big the annual increment of wood in limes at a younger age is. To answer to this question, we also sampled six younger lime trees in Tallinn. These European limes (*Tilia × europaea* L.) grow on the same bastions and near the churches together with the older trees. They have been planted there later, between the older trees; they have no hollow in the trunk and their increment cores extended very close to the pith. Two of these younger trees grow on the Ingermanland Bastion, one on the Skåne Bastion, one on the Swedish Bastion, one near St. John's church and one next to the Niguliste church. The cumulative growth curves of these limes look similar (Figure 3): during the first thirty to sixty years of their life radial increment is higher and then stabilizes smoothly at a lower level. Some exceptional growth can be seen in lime No. 17, growing on Ingermanland Bastion: the increment increases again in the last decades of the life of the tree. This feature is probably caused by changes in the light conditions of the tree.

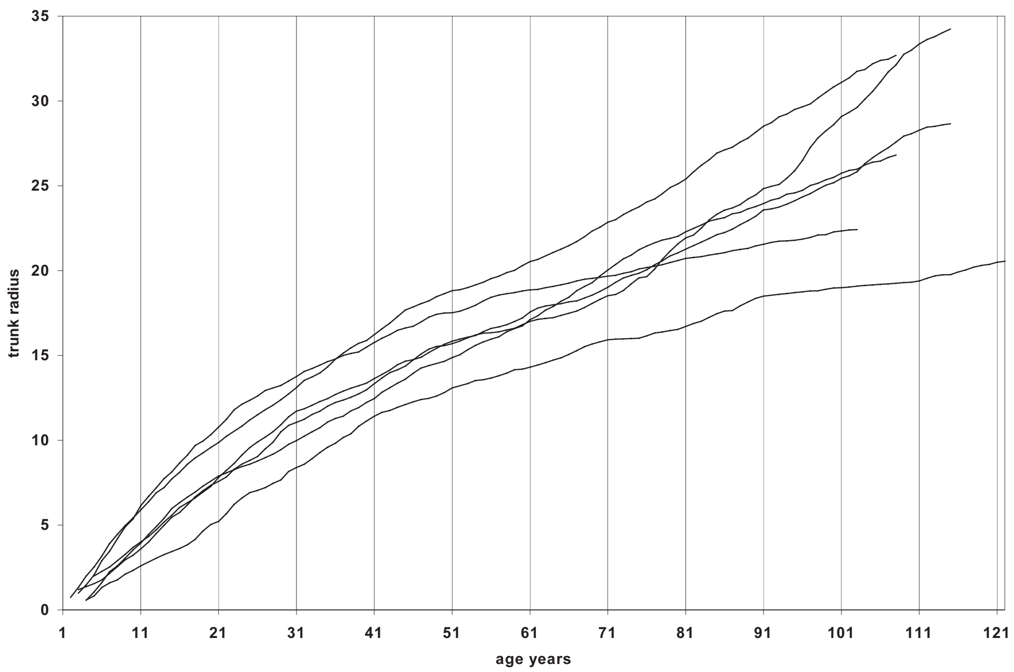

Figure 3. Cumulative increment of limes (No. 7, 9, 17, 18, 19, and 22) at a younger age. Abscissa - age of tree in years, ordinate - radius of the tree trunk.

The average annual increment of the younger trees during their first 100 to 121 years of life extends from 0.17 cm to 0.29 cm (for comparison: the average ring width of the old limes is 0.12 cm). During this period the wood radius of their trunks reached from 20.5 cm to 33.0 cm. In most of the older lime trees, the inner, missing part of the radius (hollow) has just about the same size. Hence we can use the increment rate of the younger limes as a model for the older limes, to fill the gap in their radius. If we assume the same growth conditions during the young age of the now older limes, we can apply the same average growth rate, from 0.17 to 0.29 cm per year, for the inner portion of their trunk. This is the first hypothesis. In Figure 2, curve B shows the hypothetical growth in the case of an average tree-ring width of 0.30 cm, while in the case of average tree-ring width of 0.17 cm the curve would start from the year 1762. This means that the growth of this lime was even slower at a younger age than at an older age. This seems unlikely. The trees on the bastions had initially been planted on an open area, without competition for light between the neighbouring trees. In such a case their ring widths could be even larger than 0.30 cm. This is the second hypothesis. But how wide can the tree-rings of young limes be? Neglecting extremes, rings of 1 cm width are possible, but not especially probable here: if the recorded outer tree-rings in the core are about 0.2 cm wide, it seems unrealistic that before they were on average five times as wide, and then suddenly decreased. In this case, smooth extension of the graph curve can help to restore the hypothetical growth of the tree at a younger age (hypothesis three: line C). In the case of lime No. 10, the third hypothesis, curve C, seems to be the most appropriate for restoring the growth curve of the tree. Lime No. 10 appears most probably in about AD 1820, making the tree about 180 years old at the time of sampling.

Here we have to take into account that the crossing point of the growth curve with the x-axis indicates the zero-year of the tree at the sampling height. For the actual age of the tree, one has to add the number of years the tree needed to grow to reach the sampling height (1.2 m in this case). That period could last approximately ten years. So the actual zero-year of this lime can be about 1810. Nevertheless, this result unfortunately does not coincide with the age determined by the bark method, i.e. zero-year AD 1719. The difference between the two age estimates is 91 years. We can state that, in this case, the age obtained by the bark method is possible (the period after the city fire of 1684), but not especially probable.

Wider tree-rings mean that the age of the trees is smaller for a given perimeter. Table 1 shows the ages of the limes as probable intervals of the zero-years. The first year of each interval shows the zero-year of the tree assuming minimal tree-ring widths (average 0.17 cm) during the younger age of the tree. The last year of the interval marks the probable zero-year in the case of maximal ring widths (average 0.30 cm) during the younger age of the tree. Assuming wider than 0.30 cm tree-rings in youth, the limes can be even younger than indicated in the table.

Figure 4 represents a more complicated case, namely the cumulative growth of the radius of the tree trunk (the solid thick line) of European lime (*Tilia × europaea* L.) No. 14, growing on Ingermanland Bastion (Harjumägi). As the tree was hollow inside, we could not obtain a core covering the whole radius. The growth of wood in the inner part of the radius has been extrapolated. First, if we assume the lime tree has grown with a stable average growth rate throughout its lifetime, we can extend the linear trend of growth, A, until a radius of zero. The crossing with the abscissa points to the onset year of the tree, in this case - AD

Table 1. Age of large limes (Tilia spp.) in Tallinn, determined by tree rings and the bark method.

Sample No., direction, sampling height	Location of the tree in Tallinn	Sampling date DD.MM.YY	Perimeter of the trunk, cm	Thickness of bark, mm	Length of raw wood core, mm	Number of tree rings in the core	Age in 1999 and onset years	
							By tree rings	By bark method
Tilia × europaea L.								
1 S 1,1 m	Skåne bastion	19.08.99	**251**	**28**	**162**	**194**	317-264, 1682-1735	-
2 W 1,1 m			**246**	**28**	**86**	**136**	229-299, 1700-1770	-
3 SW 1,0 m			**241**	**28**	**136**	**137**	210-266, 1733-1789	-
4 SW 1,4 m			**295**	**28**	**175**	**147**	236-304, 1695 1763	-
6 N 1,1 m			**350**	**28**	**226**	**ca 175**	276-353, 1646-1723	-
8 N 1,25 m			**404**	**28**	**146**	**121**	277-397, 1602-1722	-
13 W 0,7 m	Ingermanland bastion	29.10.99	**274**	**20**	**141**	**117**	209-279, 1720-1790	-
14 W 1,1 m			**360**	**15**	**171**	**158**	287-386, 1613-1712	426, 1573
15 SW 1,5 m			**347**	**15…10**	**189**	**135**	251-340, 1659-1748	-
20 S 1,2 m	Church of Niguliste		**313**	**27**	**145**	**147**	256-339, 1660-1743	225…245, 1754-1774
	Church of Niguliste		**-**	**-**	**-**	**-**	**-**	340, 1659
T. cordata L.								
10 1,2 m	Next to Tallinn Cathedral	29.10.99	**342**	**40**	**349**	**146**	198-237, 1762-1801	280, 1719

1500. As trees usually grow faster at a younger age, the graph line should be steeper than the average. The opposite possibility is that we assume that the trees have grown with maximum speed during their younger age. Let us assume that the average ring width was up to one centimetre. In this case the graph line would look like E. Such a fast growth during forty years does not seem probable. This line obviously does not fit in with the next part of the graph. It does not seem likely that there has been so abrupt a decrease in growth rate at around 1840. Assuming an average annual increment of 0.5 cm, the growth curve looks like D, with starting point at AD 1764. The next curve, C, assumes an annual increment of 0.3 cm (the biggest average increment in the younger limes) and fits much better with the later part of the growth curve. It crosses the abscissa at about AD 1712. Curve B assumes average ring width of 0.17 mm (the smallest average increment in the younger limes); the crossing point with the axis is at AD 1613. It may be suggested that the actual zero-year lies anywhere between the years 1613 and 1712. The bark method yielded an onset year of 1573 for this lime, which presumes a slightly slower increment of wood than in the case of curve B, but is possible. So, in this case the tree-ring age and the bark age nearly coincide. It means that European lime No. 14 already grew on Ingermanland Bastion before other trees were planted there in 1750-1790. If, as found by the bark method, the planting of the

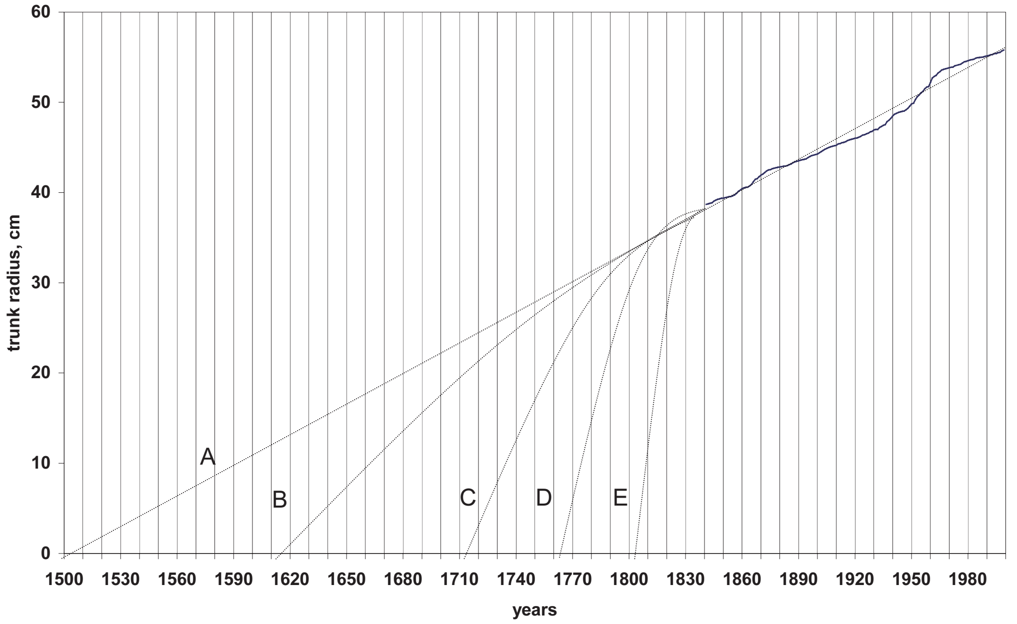

Figure 4. Cumulative increment of Tilia x europaea L. No. 14 on Ingermanland Bastion. Dashed lines A - E - extrapolated growth models (see explanation in text).

other trees was begun in 1750, this lime tree would have been about 177 years old at that time. The age of this lime at the time of sampling was thus about 426 years.

The ages of the remainder of the lime trees were estimated in the same way. The bark method sometimes yielded a greater age (for limes No. 14 and 10) and sometimes a smaller age (for lime No. 20) than the tree ring method.

5 Discussion

The stems of the limes growing on the bastions and near the churches are knotted and hollow. So it is very difficult to find out their age by counting tree rings. Usually the increment core contained only the outermost tree rings just under the bark, while the inner part of the tree trunk was hollow. However, the age of eleven trees was assessed by the tree ring method. The calculated age of seven trees lay in the interval 220-300 years and that of two trees probably exceeded 300 years (Table 1). Those two trees grow on the bastion of Skåne and Ingermanland. Unfortunately there is no historical evidence about these trees of high age. Maybe, the tree on Skåne bastion is represented on the city plan from 1728.

The old common-lime trees (*T.* × *europaea* L.) growing in the Niguliste churchyard (former cemetery) were also investigated. The age of one of them, calculated by the bark method, appeared to be 340 years. The age of another lime, calculated from tree rings, was 339-256 years (onset AD 1660-1743).

Probably the oldest introduced tree in the whole of Tallinn is the first common-lime that stands near Niguliste church (in the former yard of the pastor's house). Its height is 16 m and trunk perimeter 480 cm (2001). This tree is known as the

Lime of Kelch. Its indicated planting time is the year 1680 (Sander, 1993). Under this tree Christian Kelch (born 1657), the famous chronicler and pastor of Niguliste Church, has reportedly been buried on December 13, 1710.

Next to the Tallinn Cathedral, a small-leafed lime tree (*T. cordata* L.) was investigated both by the tree-ring and the bark method. The calculated age of this tree was 237-198 and 280 years, respectively.

The large hollows in the tree trunks can explain the different age estimations of limes growing even on the same bastion, and hence the big gap in the radius to be filled with tree-rings of hypothetical width. Therefore it is reasonable to present the age estimation as a period in which the tree could start its life.

Figure 5 shows the relationship between radius of the wood in the trunk and the maximal and minimal number of tree rings in it, based on the data from the six younger European lime trees from Tallinn. This graph can be used as a guide to estimate the number of rings absent in the hollow trunk of a lime tree, depending on the radius of the hollow. We see that for the smaller hollows, with radius up to 15 cm, the amplitude of fluctuation of the number of tree-rings is relatively small, while it increases in greater hollows, mainly due to the increase in the maximum number of tree-rings. The minimal number of tree rings occurs when they are the widest. The latter occurs when a lime tree grows up as a solitary tree, without having to compete with other trees for light and nutrients. In certain cases we can venture a guess as to whether the tree under investigation has grown up in the open or in a dense stand. For instance, the first small trees planted on the former bastions enjoyed plentiful light and grew well, whereas the trees planted additionally between the older ones suffered from shading and grew slowly during many decades. Depending on that assumption, we can decide if the actual number of

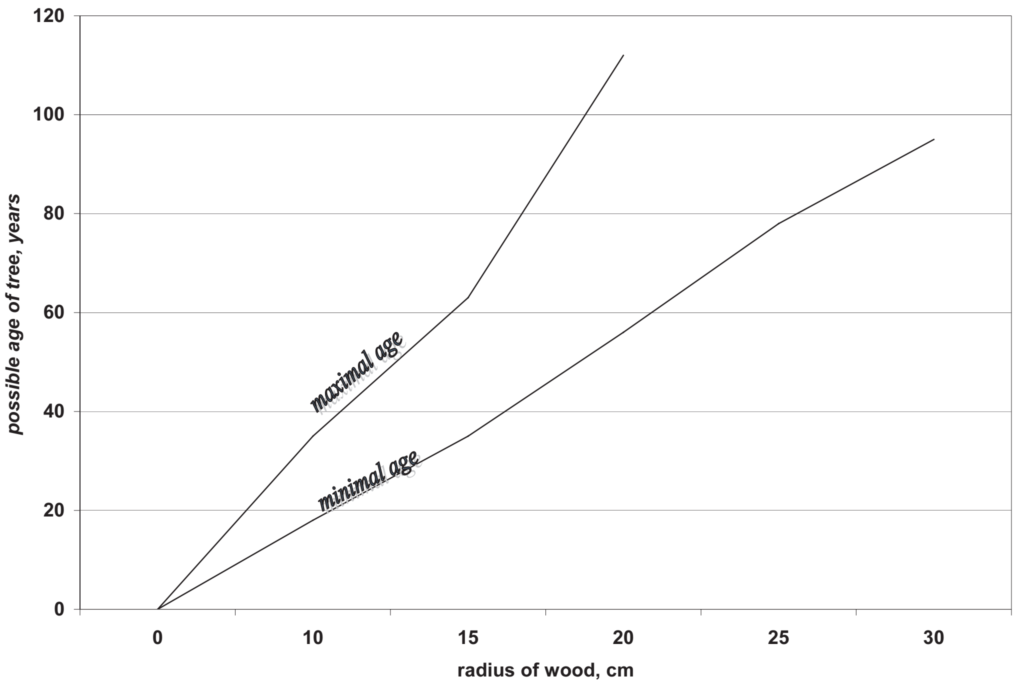

Figure 5. Minimal and maximal age of studied lime trees at different trunk radii. Abscissa - radius of wood in the trunk of lime, ordinate - corresponding possible age of the tree.

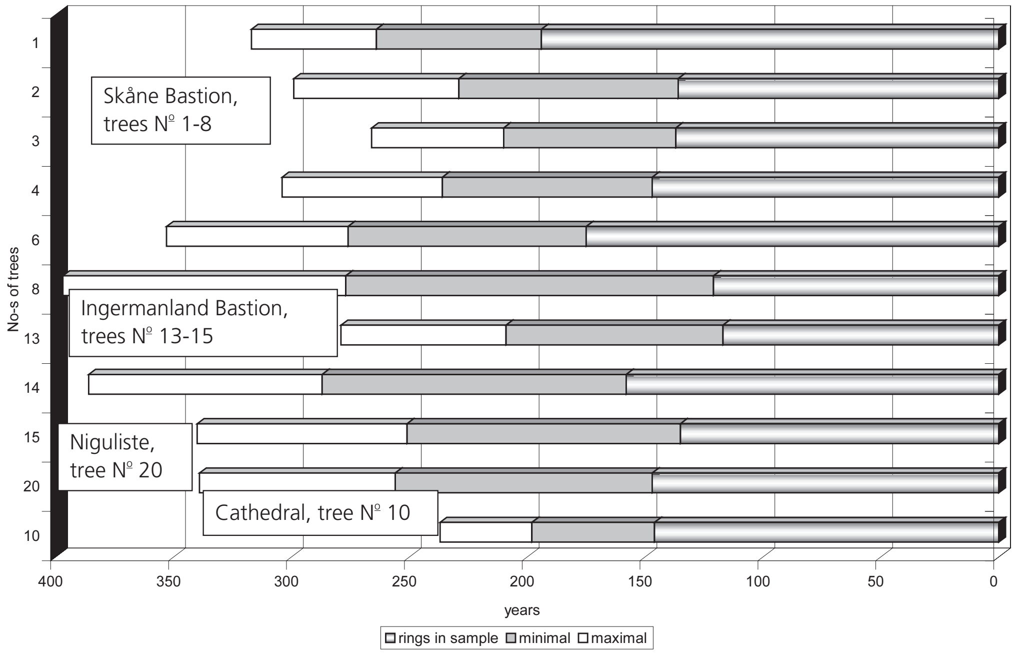

Figure 6. Temporal extension of ages of limes derived from cumulative graphs of ring widths. The extension of the white part of the bars at left is the possible onset period of the lime trees. For trees growing at Skåne Bastion the coinciding part of the white bars covers a period approximately 300-280 years before the present day. For three limes growing at Ingermanland Bastion the coinciding part of the white bars for two trees is about 340-290 years before the present day, while lime No 13 is younger, with onset about 280-210 years before the present day.

absent tree-rings in the hollow of the tree trunk tends more to minimal or maximal values.

Figure 6 shows a bar diagram of the extensions of the ages of lime trees, derived from the perimeter of the trunk and average ring widths in the sample cores and in the younger trees. The right part of the bars shows the counted number of tree-rings in the core. The middle part of the bars shows a minimal amount of tree-rings to be added to the counted rings, assuming the trees grew fast (0.30 cm/yr.) in their youth. The left part of the bars shows the maximal amount of tree-rings to be added, assuming the trees grew slowly (0.17 cm/yr.) in their youth.

We can see that of the six sampled trees from Skåne Bastion, three limes (No-s 1, 6 and 8) originate from a time more than 250 years ago (or before AD 1750), and three were planted between AD 1750-1790 (250-209 years ago).

Of the lime trees growing on Ingermanland Bastion, two were probably planted between 1750-1790, but lime No. 14 seems to be older.

Regarding the bark method, we have too little data at present to evaluate the appropriateness of the method. Apparently, the formation of several fibre bands during one vegetation period has in some cases increased the age estimate of the limes.

6 Conclusions

The age assessment of big lime trees (*Tilia* × *europaea* L. and T. cordata L.) growing on the former bastions and near the churches in Tallinn, using the graphical method of tree-rings and the bark method, has produced probable age intervals rather than the exact ages of the trees. The main reason for this is that old lime trees often have hollow trunks. Tree-ring samples can be extracted only for the outermost portion of the tree trunk, while the number of tree-rings in a big portion of the inner part of the radius remains to be guessed from the later growth rate. Together with old limes, six younger lime trees (*Tilia* × *europaea* L.) were sampled in the same sites, their increment cores extending nearly to pith of the trunk. These six lime trees served as a model of growth rate in young trees, which could be applied to the older limes. The relation between radius of the trunk of limes and the probable number of tree-rings in it is shown graphically. This relation helps to assess the number of tree-rings in the hollow trunks of old lime trees. Growth curves on graphs show the increment of the radius of the trunk visually, and help to correct the age assessments.

Although there are few references about growth layers in the bark of trees, our results from using the bark method generally agreed with the results obtained by the tree-ring method. At present we still have insufficient data on the reliability of the bark method of age assessment in limes, to recommend this method.

Age assessment of old specimens of European limes by using increment cores of wood is reliable as long as the core extends close to the pith. In the case of trees with a hollow in the trunk, the reliability of the age assessment decreases remarkably when the radius of the hollow exceeds 15 cm. The width of the assessed possible age interval of limes with a hollow of radius 20 cm can already be as great as 60 years. Historical sources can often give support to one or another age assessment of the trees growing in city parks and avenues.

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The comparison of various methods in urban forestry mensuration in Iran

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Abstract

One of the most important types of information in urban forestry is provided by a basic inventory of green areas. Nowadays different methods are used in different countries for this purpose. In this study, the first of its kind carried out in Iran, different sampling methods including a 100 % inventory with 10 meter strips, simple random sampling, randomised block sampling, systematic random sampling, two stage sampling and dot grid sampling using aerial photographs, were used to assess street tree-cover. The study area was made up by 5,000 meters of the Vali-easr Avenue in Tehran, divided into 500 strips of 10 meters each that covered both left and right of the avenue. The largest length of each tree's crown was measured in the 100 % inventory and used as comparison base for other methods. The strip's areas were calculated using the largest crown length for each method. 50 strips were selected and the measurements were carried out and analysed. Normality of data was tested using a Ç2-test, and a t-test was used to determine the difference between the sampling method and the results of the 100 % inventory. At this stage only block random sampling led to different results; therefor E 2 % ×T value was calculated for the other methods. Results indicate that dot grid sampling may be the best inventory method in urban forestry.

Key words: urban forest inventory methods, dot grid sampling, systematic random sampling, two stage sampling.

1 Introduction

Plants and in particular trees form an important part of a city structure. However, in comparison to other urban investments, design and management of green areas receives less financial support. This may be caused by the lack of essential information about the significant values of urban forests.

Management of the urban forest begins with an inventory. Many studies, for example in North America, have assessed and developed inventory methods for street trees. The usage of dot grid and aerial photography to determine the percent of the total crown cover and dispersion of crown cover of the trees has become recommended. In this research, the different ways of inventory to assess the street trees resource and its surface were used for the first time in Iran. The study's aim has been to find the optimum method of street tree inventory.

2 Methods

The study area included green space on the two sides of Vali-asr street leading from Tagrish square toward Vanak square, with an approximate length of 5,000 meters, as well as of smaller streets leading from it. Plane tree is the main tree in this area, its cultivation dating back to 1924. The plane trees on the two sides of the Vali-asr street are even-aged and planted at a very small distance from each other. The different inventory methods that were used for assessing green area and its function were:

(1) 100 % Inventory in strips of 10 meters

100 % inventory was used as a basis for comparison of the different inventory methods in assessing green space area. The 100 % inventory followed an initial street survey. The total number of strips for the Vali-asr street and bordering minor streets was 500, thus implying that 5,000 metres of street were inventoried. The largest crown diameter (i.e. crown width in the direction perpendicular to the street, similar to the width of the green area strip at that point) was assessed over a distance of 10 metres. In order to calculate total green area surface, the average of the width at the beginning and end of the strip was measured and multiplied by the length of the strip. Finally, average, standard deviation and total area of tree canopy were calculated.

(2) Simple random sampling

To perform this method, 60 strips were randomly selected among the 500 strips and calculations were done as their basis.

(3) Random and block inventory

This method was applied in two ways:

- Firstly, the 500 strips were divided into 50 blocks of 10 in such way that strips 1 through 10 were placed in block 1, 11 through 20 in block 2, and so forth. Next, 5 blocks were selected at random and measurements and calculations were made for all strips among these.
- Secondly, the 500 strips were divided into 100 blocks of 5 and then 10 blocks were selected randomly among these. Strips of the selected blocks were measured and used for calculations.

(4) Systematic random sampling

One number was selected randomly among 1 and 500 and its area was measured and calculated. Then the strip 10 places up from this was selected and assessed, and so forth until 50 strips in total were selected and assessed.

(5) Two stages sampling

The 500 strips of 10 metres were divided in 10 sections (M=10) of 50, starting with strips 1 through 50 forming section 1, and so forth. Next 5 sections (m-10) were randomly selected among these. Finally, 10 strips were randomly selected for each of these sections and subsequently inventoried.

(6) Dot grid sampling

Aerial photographs were used for this purpose. Photos came from the most recent aerial photography of Tehran in 1996, with a scale of 1: 6,000. After that the area to be studied was outlined on the photographs, the usual dot grid was placed on this part of the photo, and in such a way that the centre of the grid was on the centre of the photograph. By using two photographs and stereoscopic vision, the sum of dots placed on the crown of roadside trees was calculated, i.e. 93 out of a total of 1932 dots. Then the proportion of green space and its percent of land cover were calculated according to the formulas:

$$P = n \div N \quad \text{and} \quad P\,\% = (n \div N) \times 100$$

With P being the proportion of green space in the region), P % the percent of green space in the region), n equalling the numbers that were placed on the crown of the trees, and N the total number of interpreted points for the total region. Thus the proportion of green space in the region was estimated to be 0.048 and green area percentage 4.8 %. To calculate the standard error for proportional area, the following formula was used:

$$Spi = \pm\sqrt{\frac{pi\,(1-pi)}{N}}$$

The standard error equalled ±0/004863, with a standard error percentage of ±10.1. Due to this high standard error and the need to enhance accuracy (by having a standard error < 5 %), the following formula was developed:

$$N = \frac{t^2 \times (1-pi)}{Pi\,(0.01 \times E\%)^2}$$

N stands for the necessary number of dots for the total region, pi for the proportion of green space in the region, E for confidence limit), E % for the percent of confidence limit with a probability of 95 %, and with t depending on the number of samples or dots that must be counted. As the total number of samples is high, N was found to be 32,000; as two photos were used, 16,000 dots were needed per photo. As a result, a new dot grid was designed with a distance between the dots of 1.25 mm. The total number of dots became 31,992, i.e. close to the target. Out of these, 1,143 dots were placed on tree crowns along the streets. This implied a greenspace proportion of 0.036 or 3.6 %, with a standard error of 2.89 %. The error of inventory (E %) was 5.6 % and regarded to be of acceptable accuracy.

3 Results

The statistical results obtained from the different methods are summarised in Table 1.

Table 1. The obtained results from different inventory methods of street trees.

	100 % inventory	Simple random	Block random (A)	Block random (B)	Systematic random	Two stage sampling	Dot grid sampling
Total area (ha)	6.49	6.16	6.17	6.36	6.36	6.30	6.33
Mean area of strips (m^2)	130.06	123.21	123.49	127.34	127.21	126.03	-
Standard deviation of strips (m^2)	27.40	27.22	18.78	30.36	24.37	-	-
Standard error of strips (m^2)	n/a	3.84	2.65	4.29	3.44	6.14	0.0010415
Standard error percent	n/a	3.116%	2.15%	3.36%	2.71%	4.86%	2.89%
Inventory error percent	n/a	6.26%	4.32%	6.77%	5.44%	13.51%	5.66%

Analysis of time and costs

After statistical analysis and specifying the accuracy of the different methods, the different methods were also compared from the perspective of cost and time required. In the 100 % inventory total time used was 4 working days (or 32 hours, 115,200 seconds) for assessing the 500 strips; 230 seconds were used to assess 1 strip. By using average staff costs of 140,000 Iranian rials (with 1,000 rials equally 0.64 Euro in August 2002 per day) for a team of three (one leader and two technicians), total cost of inventory cost were determined to be 558,900 rials.

Similar analyses were done for all other methods, resulting in a comparative overview of total time used and total cost of labour (see Table 2). Time used included selection of the strips to be mentioned, measurements on the ground, moving between the strips, and wasted time.

Table 2. Comparison of time use and labour cost for each of the inventory methods used.

	100 % inventory	Simple random	Block random (A)	Block random (B)	Systematic random	Two stage sampling	Dot grid sampling
Total time used (in seconds)	115,200	20,350	20,950	21,130	20,290	21,550	9,600
Total cost of labour (in rials)	558,900	98,901	101,817	102,692	98,609	104,733	72,000

Moving to the right in the table, the methods generally required more time for selection of the strips to be measured, while less time was required for actual measurements. In the case of the dot grid methods, only one technician was needed for the 'desk assessment', leading to much lower cost.

Test of normality of obtained data from 100 % inventory

First, the areas assessed for the 10-metres strips were placed in classes of 15 m^2 and the frequency of each class was determined (Figure 1). As the number of samples was not higher than 40 and the absolute frequency in the classes was not less than 2, the $\div^2$ -test was used for testing the normality of the distribution. $\div^2$ equalled 13.016, implying that the data followed a normal distribution at a probability of 95 %.

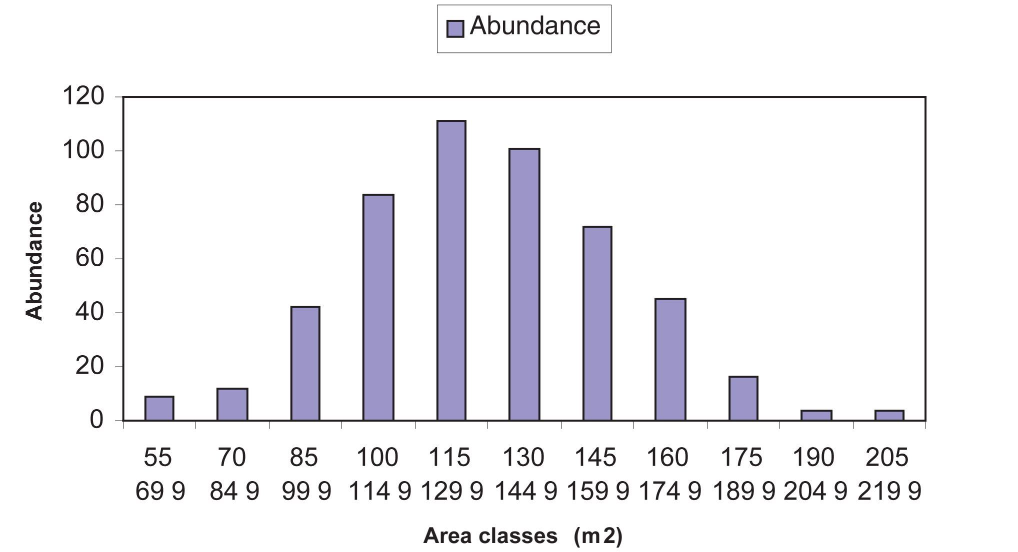

Figure 1. Abundance of green area classes of total measured strips.

Testing the normality of obtained data from the different methods of sampling and their significance

As the number of the samples for each of the sampling methods was around 40, the Kolmogrov - Smirenov test was used for testing the normality of the obtained data. The values of 2-tailed for the methods of inventory, i.e. simple random sampling, random blocking (first state), random blocking (second state), systematic random and two stages sampling were found to be 0.625, 0.923, 0.738, 0.907, and 0.655, respectively. As all values are higher than 0.05, data were found to be distributed normally.

For determining the significance of the differences between the different sampling methods and the 100 % inventory, method, the t-test was used. The result of the calculations is shown in the Table 3. Only when comparing random blocking (first state) with 100 % inventory, the difference between these two methods at p = 0.05 was found to be significant. Therefore this method was omitted from the comparisons.

Table 3. Results of t-test used to compare the different urban forest inventory methods.

Inventory method	Calculated t	Table t
Simple random sampling with 100% inventory	1.78	2.010
Block random sampling (A) with 100% inventory	2.47	2.010
Block random sampling (B) with 100% inventory	0.63	2.010
Systematic random sampling with 100% inventory	0.82	2.010
Two stage sampling with 100% inventory	0.65	2.010
Dot grid with 100% inventory	0.89	1.96

To determine the optimum method of inventory for urban forestry, the value of E^2 % × T for all of the remaining methods had to be calculated. T here stands for the total cost of inventory in 1000 Rials, and E % for the percent of the error of inventory at a of 95 %) (see Table 4). As the lowest value of E^2 % × T refers to the best method in terms of accurateness, time and cost, the dot grid method was found to be the best method.

Table 4. Comparison of accurateness and cost of different urban forest inventory methods.

Inventory method	100 % Inventory	Simple random	Block random (B)	Systematic random	Two stage	Dot grid
Standard error (E)	-	7.72	8.63	6.93	17.03	0.00204
Total costs of inventory (in 1000 rial)	558.9	98.9	102.7	98.6	104.7	72
E %	-	6.26	6.77	5.44	13.52	5.66
E^2 % × T	-	3,884.3	4,707	2,922.2	19,124	2,307.6

4 Discussion

In this research, for the first time in Iran the area of street trees was estimated by applying different inventory methods. The study found that the dot grid was the best in terms of labour and time cost as compared to level accuracy. The method requires only one skilled technician to assess the green area carefully through careful photographic analysis. The method might also be used for assessing private gardens and trees inside residential areas. But it has to be stressed that aerial photographs that are recent and have an appropriate scale are essential. The method seems the most suitable for determining the percentage of greenspace of a city, and thus may be the best inventory tool available for urban forestry.

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Quantitative and qualitative study of afforestations in Chitgar forest park in Iran

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Abstract

Although it is about thirty years since the establishment of the first forest park plantation in the vicinity of Tehran, no comprehensive silvicultural studies have been performed in these parks. Chitgar forest park was selected for the present study because of its historical importance of and proximity to Tehran. The silvicultural study was both quantitative and qualitative. First, using the park tree coverage map and applying a stratification inventory method, a systematic randomised inventory grid was designed and some parameters were measured in the sampling plots. To start with, the park was divided into three distinct forest types: pure softwood, pure hardwood and mixed hardwood. Then measurements were done in sampling plots laid out in the three mentioned forest types. Quantitative studies included the measurement of diameter at breast height, height and crown height as well as slenderness ratio, diameter-height distribution curve, and so forth. Qualitative studies included vitality condition, humus type and thickness, regeneration condition, stem quality, crown form, and other. Results have indicated that in order to improve the park's condition, silvicultural operations such as thinning of the softwood stands, leading the pure even-aged stands toward mixed uneven-aged stands and other operations such as the reduction of irrigation should be carried out.

Key words: afforestation, inventory, hardwood, softwood.

1 Introduction

Three decades after the establishment of Chitgar forest, it was necessary to carry out a quantitative and qualitative study of the park's condition. In the 1960s, the vast extent of afforestation with softwoods monoculture affected the park. Today we need to establish whether and how plantations on the urban interface need to be managed and what methods and activities are suitable in these plantations. With its proximity to Tehran, Chitgar forest park provides an excellent study site for this purpose.

Chitgar is located 15 km west of Tehran and covers 1420 ha. Mean annual temperature is 17.4°C and mean annual precipitation is 242 mm. Between April and November, the area is affected by drought. The Park's climate is arid (according to Amberjuet formula).

2 Methods

Firstly, using a tree cover map, the forest was divided into three distinct types: pure hardwood, mixed hardwood and pure softwood. The most important trees were *Pinus eldarica* (Eldar pine) and *Robinia pseudoacacia* (Locust) (45% and 23% of all trees, respectively). A stratified inventory was performed using a systematic random grid. The grid was rectangular (200 m x 125 m slides). Secondly, 30 circular and 0.2 ha plots were delineated in every tree type. Qualitative and quantitative parameters were measured in the plots and finally data were analysed.

3 Results

Results are summarised in Table 1. Some of them are explained in the following.

Quantitative results

Trees slenderness (h/d): Trees were divided into three classes; Tall tree: h/d > 100, middle tree: 100 > h/d > 50 and short tree: 50 > h/d

Table 1. Summary of research results.

Tree type	Mixed hardwood	Pure softwood	Pure hardwood
Area (ha)	107	218	409
Dominant tree	Robinia pseudoacacia	Pinus eldarica	Robinia pseudoacacia
Mode (cm)	5	5	5
Diameter average (cm)	7.15	13.52	8.73
Height average (cm)	6.98	7.39	6.99
Slenderness	short	short	short
Number of trees (ha)	1405	835	930
Slope average (%)	11	15	15
Regeneration (%)	5	1	9
Number of saplings (ha)	397	89	556
Plant cover average (%)	64	20	70
Crown cover average in row (%)	54	78	44
Crown cover average between rows (%)	34	38	25
Fire damage average (%)	0.14	8	1
Other damages average (%)	42	45	41
Crown length average (m)	4.8	5.2	4.9
Litter thickness	without litter	average	without litter
Litter decomposition	non-decomposed	non-decomposed	non-decomposed
Dominant layering	two layers	one layer	one layer
Bark thickness	average	average	average
Branching	hard	hard	hard
Green crown length	good	good	good
Leaf (needle) colour	average	average	average
Leaf (needle) density	average	average	average
Straightness	with curvature	straight	with curvature
Two-branching	without two-branching	without two-branching	without two-branching
Some-branching	without some-branching	without some-branching	without some-branching
Declination of stem	with declination	without declination	without declination

In-depth studies revealed the following reasons for lack of natural regeneration:
- Hard compactness of soil;
- thick layer of litter without decomposition;
- unsuitable soil and high volume of stone in soil;
- dense plant cover.

For comparing litter thickness, the following categorisation was used:
- Thin litter: thickness < 2 cm;
- middle litter: thickness between 2-5 cm;
- thick litter: thickness > 5 cm.

and for litter decomposition:
- Fully decomposited litter;
- half decomposited litter;
- undecomposited litter.

A separate study focussed on fire and other damages; biotic and abiotic destruction such as human damages, pollution, pests and disease. Fire constituted little damage in the hardwood forest while causing considerable damage in softwood forests. Also notice the strong relation between litter thickness and decomposition and percentage natural regeneration and fire.

Qualitative results
Trees were categorised into three classes of bark thickness: thick, middle and thin, compared across species.

Branching was labelled »normal« and »hard« (more than normal). If there was one branch for every one meter of stem, it was considered normal branching for hardwoods, otherwise it was considered hard branching. In softwoods if there were branches between two branch circles, it was considered hard branching.

Three parameters were studied for vitality:
1. Green crown length
   - First class: more than 50 % of crown length was green.
   - Second class: 25 %-50 % of crown length was green.
   - Third class: less than 25 % of crown length was green.

2. Leaf (needle) colour
   - First class: leaf colour was richly coloured green.
   - Second class: leaf colour was usual green.
   - Third class: leaf colour was faint coloured green.

3. Leaf (needle) density
   - First class: dense leaves (needles)
   - Second class: usual leaves (needles)
   - Third class: sparse leaves (needles)

To describe stem form, the study looked at the declination of stem, its straightness and whether the stem branched off in two from the lower (below 1m) or upper part or not at all. Similar categories were applied for classifying the degree of branching.

4 Conclusions

Both the quantitative and qualitative condition of the trees in the forest park was found to be disturbing. It is necessary that the forest be converted to a mixed forest, generally displaying higher biodiversity and better health conditions. The conversion will be achieved through gradual replacement of species, implementing approved cutting methods and correct silvicultural principles. Considering the high density of trees and trees crown in rows, thinning operations are necessary in all areas. It is recommended to carry out high thinning with positive selection. At first, thinning with different densities should be tested in some plots, subsequently the most appropriate thinning density can be chosen. The exceptional compactness of the soil was the main reason for lack of natural regeneration. Surface furrowing is essential for sapling establishment. The above management interventions are recommended for all forest types in the park.

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Tree conditions and soil properties of Moscow sites

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Abstract

During the growing seasons of 1999 and 2000, a number of trees (*Tilia Cordata*) were measured and sampled in Moscow, Russia. The measurements included, among other, visual tree condition assessment, leaf area, weight and dimensions, and contents of heavy metals, nutrients and Cl in the leaves. Leaf evaporation (loss of water as a function of time) was measured for individual leaves after separation of the leaves from their branches. These evaporation data were compared with the results of the visual tree assessment, in order to find an objective measure for tree condition. Soil near trees was sampled. Soil samples were analysed for heavy metals content, nutrients, salt, organic matter, grain size distribution. Water holding capacity was estimated from grain size distribution and organic matter content through so-called pedotransfer-functions. A water balance was estimated for the tree-grass-soil system that is usual in Moscow. It appeared that the main causes for sub-optimal tree conditions in Moscow are de-icing salt and water shortage. Air pollution by heavy metals is another threat that influences the condition of trees.

Key words: urban trees, tree condition, evaporation, soil properties, Moscow.

1 Introduction

Moscow, the capital of Russia, is one of the world's largest cities. Its size is about 105 000 ha. Moscow is situated around 55^0-56^0 northern latitude and 37^0-38^0 eastern longitude. Its main part lies 30-35 m above the Moskva river level. Green areas take up around 30 % of the total city area. Generally, Moscow trees cannot benefit from capillary rise of groundwater. The average annual temperature is $+3.5^0$ C, the absolute minima and maxima are -48^0 C and $+35^0$ C, respectively. Average annual precipitation is 575-600 mm, of which 375-425 mm falls in the warm period (April - October). The duration of the growing period is 151 days. The main bedrock of the Moscow soils are red-brown Dnieper moraine; cover clay and loam; fluvio-glacial sands; and ancient alluvial deposits. The following types of soils are formed from them: soddy-podzolic, soddy-podzolic half bogged soil, and bogged soil. The Soddy-podzolic soils prevail. The Moscow soils and sub-soils are very intensively changed by anthropogenic influences. E.g. construction activities for the Moscow underground transportation system reached down to 100m below the surface. A number of river parts were filled with soil or led through underground tubes.

In Moscow, street trees in pavements do occur, but the major part of the city trees is growing in lawn or turf areas covered by grass. Tree-grass combinations can be street line plantations, public gardens, boulevards, yard plantations, etc. Street line plantations are widespread. Table 1 presents the relative importance of a number of tree species in Moscow. An analysis of the Moscow vegetation showed that the urban trees and shrubs are in a deep crisis. The condition of the trees is often sub-optimal. The state of street line plantations of small-leafed lime trees (*Tilia cordata*) is the most unsatisfactory in comparison with other types of plantations. Generally, sub-optimal conditions of urban vegetation may be caused by many factors. The paper describes a study, for selected line plantations of *Tilia cordata* in Moscow, on the relations between visual estimates of the tree condition, leaf evaporation, available water, type and amount of heavy metals, de-icing salt, available nutrients, and pH (Makarova 2002).

Table 1. Relative number of tree species in Moscow.

Tree species	**percentage**
Tilia cordata	29
Acer platanoides	10
Populus balsamifera	9
Acer negundo	6
Fraxinus pensyvanica	6
Betula pendula	6
Fraxinus excelsior	5
Sorbus aucuparia	4
Pinus silvestris	4
Ulmus laevis	3
Quercus robur	2
Aesculus hippocastanum	1
Malus pumila	1
Picea pungens	1
Picea abies	1
Other	12

2 Methods

Street line plantations of small-leafed lime (*Tilia cordata*), which were situated in the Northeast and East administrative »okrugs« districts of Moscow, were chosen as study object. The eastern part of Moscow has, just as the city centre, low ecological indices. This area is highly polluted with heavy metals, chloride contents and other toxic pollutants. The chosen study objects were situated in two of the city's ecological zones: in an ecologically unsuccessful zone (the city centre and a circle around it) and also in a relatively ecologically tense zone (further away from the centre and in the suburbs). A clearing in the forest in the vicinity of Moscow was chosen as a control site. Lime plantations in a public garden in the suburbs of Moscow (in a zone with relatively good environmental conditions) served as relative control site. There were seven main objects in total. Among them: Object 2 - single lime plantations in grass-plots in Khabarovskaya street; Object 3 - lime plantations in a public garden near Otradnoye metro station; Object 5 -single lime plantations in grass-plots near Sokolniky metro station; Objects 7, 11 -single lime plantations in grass-plots in Prospect Saharova avenue; Object 10 - single lime plantations in grass-plots near Mayakovskogo metro station; Object 9 - lime-trees in the forest clearing near Moscow (Shchyolkovskoye teaching-experimental forest, Chkalovskoye forestry station, wood lot 12, plot 24). In each object 6 or more trees were selected.

Sample trees were chosen to determine the leaf transpiration (loss of water) in pre-set time intervals after the leaf has been torn off: every 3 minutes (up to 30 minutes) and every hour (up to 5-7 hours). Transpiration indices were determined by the weighing method. Leaves were chosen after the shoots had stopped growing (when the top leaf-bud was formed) from the middle part of the shoot on the southern side of the tree. Leaf fresh and oven-dry weights and leaf dimensions were also measured.

Visual assessment of tree condition was done using a visual estimation of the degree of withering. This assessment followed Table 2. The degree of withering was named 'Leaf Drying Index' (LDI), and expressed as a percentage.

Table 2. Leaf Drying Index LDI (after Mozolevskaya).

Class	Description
0	Good condition without withered shoots
1	Up to 25 % withered shoots
2	25-50 % withered shoots
3	50-75 % withered shoots
4	More than 75 % withered shoots
5	All shoots of current year are withered
6	All shoots of current and previous years are withered

Leaf samples and soil samples were chemically analysed in order to determine the tree nutrient status, the heavy metals contamination, and the de-icing salt threat. Soil samples were taken from the zones where the main root-mass of the limes is located. The chemical analyses, as well as a number of soil physical/mechanical analyses, were performed in laboratories in Mytischi and Moscow, Russia, and in Wageningen, the Netherlands. Pedotransfer-functions from Woesten et al. (2001) were used to estimate water retention curves and available water holding capacity (AWHC, volumetric water content at pF2 minus volumetric water content at pF4.2) from organic matter content and grain size distribution.

3 Results and discussion

The measured amounts of N, P, K and Mg in leaves were compared with criteria for *Tilia cordata* that were given by Kopinga & van den Burg (1995). According to their criteria the found amount of N was optimal, the amount of P was normal or optimal, the amount of K was normal or optimal, and the amount of Mg was normal or optimal. According to their criteria, the measured pH values were not too low or too high.

The measured values of water loss of separated leaves were processed in order to obtain, for each measured tree, the leaf transpiration rate (in mg water per cm^2

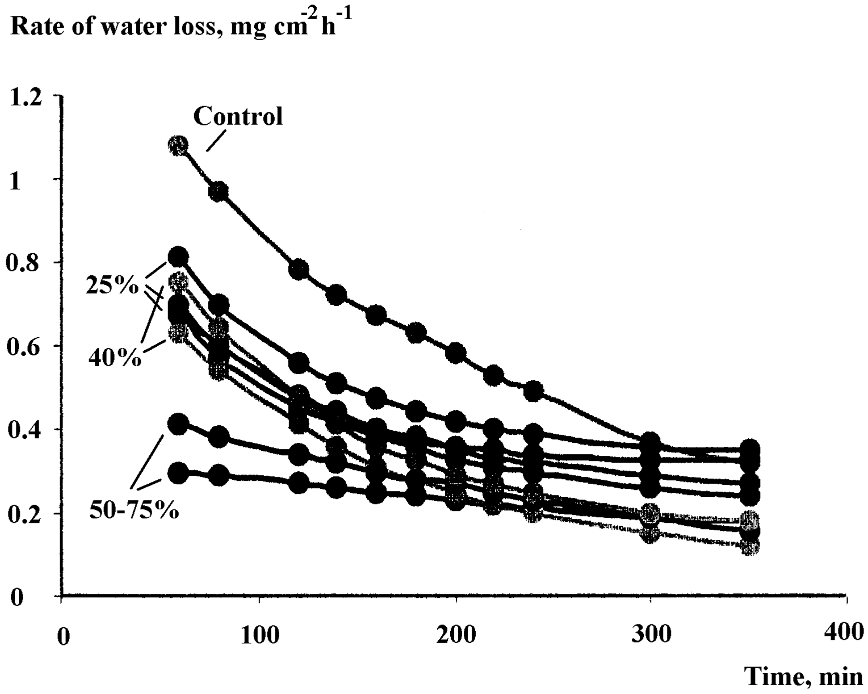

Figure 1. Rate of specific water loss of tree leaves as a function of time after leaf separation. Data from 1999. At the curves: Leaf Drying Index (%).

leaf area per hour) as a function of the time after the leaves have been torn-off. Figure 1 presents processed data from the year 1999. It can be seen in Fig. 1 that there is a connection between LDI and shape and level of the curves. Measurements from the year 2000 were processed in the same way. It appeared that the 2000 curves were similar, but it also appeared that there was no full resemblance between the 1999 curves and the 2000 curves. So, there is a year-effect in the curve-families. Figure 1, together with the fact that amount of leaves of a tree decreases with increasing LDI, shows that the actual evaporation of many trees is much lower than the potential evaporation. Although there is little known about the relation between tree ornamental value and water supply, the low evaporation values indicate that a lack of water is at least one of the reasons for high LDI values (Bakker 1992; Kopinga 1998).

The AWHC values, estimated by the pedotransfer-functions, ranged from 0.167 to 0.294 (cm^3 cm^{-3}). We could not find a correlation between these values and LDI values, probably because AWHC is only one of the factors that determine water supply. The average value is 0.197. This value applies to soil samples from zones that were enriched with peat at tree planting. As mean soil quality of the entire root zone is likely less, we estimated the average AWHC of the tree root zones as ¾ of 0.197 = 0.15. AWHC is one component in a water balance that can be determined for the studied tree-grass-root zone system. Assuming a root zone depth of 1m, the estimated available water holding capacity is estimated to be 150 mm water. The available water in the root zone during the growing season is equal to the amount of water that is present at the start of the growing season (150 mm) plus the rainfall during the growing season (400 mm) minus interception by tree (30 % of rainfall = 120 mm) and grass leaves (15 % of rainfall = 60mm). So, the available water in the root zone during the growing season is 370mm. Assuming that Moscow and Dutch conditions are similar, the potential water take up by a tree in the growing season may be estimated as 675 mm (0.3 * E_0 * LAI where E_0 is open water evaporation = 500 mm in an average Dutch growing season, and LAI is Leaf Area Index, being 4.5 for an average tree; Bakker 1992). And the potential water take up by the grass in the growing season may be estimated as 340 mm (0.8 * Open Water Evaporation minus Interception by grass canopy; Hellinga 1962). So, the potential water up take of tree and grass from the root zone is 675 + 340 = 1015 mm. This value can be compared with the available water in the root zone during the growing season (370 mm). This 370 mm is 36.5 % of the 1015 mm. Bakker (1992) states that a forest tree in Dutch conditions should transpire 50-75 % of its potential transpiration in order to stay alive and be decorative. This corresponds with a growth rate of 40 %. The above water balance shows that, for Moscow trees, the occurrence of water stress is very likely. At the same time it should be realised that the water balance is not very accurate. Root zones may be larger, and the flow of rainwater from surfaces outside the root zone surface may contribute to the root zone water. Also, the Leaf Area Index may be lower due to stress.

Measured contents of Cd, Cr, Cu, Ni, Pb, Zn in the soils were compared with Dutch legal criteria (Huinink 1998). These criteria depend on clay and organic-matter contents. According to the Dutch legal criteria the heavy-metals contents in the soils were not too high. Measured values of contents of many heavy metals in the leaves were compared with LDI. It was found that contents of Cr, Br, Pb, Rb, and Ni increased with increasing LDI, if these contents were expressed as microgram per gram dry matter per cm^2 of single leaf (single leaf area ranged between 10-40 cm^2). See Table 3. The values in the Table are higher than normal, which is most likely caused by air pollution (Treshow 1985; Treshow & Anderson 1989; Glimmerveen 1995).

Table 3. Leaf Drying Index (LDI) and amount of heavy metals in tree leaves (ppm per cm^2 single leaf area). Data from2000.

LDI	Cr	Br	Pb	Rb	Ni
20 %	0.38	0.13	0.17	0.17	0.17
40 %	0.48	0.18	0.18	0.18	0.15
60 %	1.84	0.19	0.35	0.40	0.20
70 %	2.61	0.32	0.39	0.54	0.30

Table 4. Leaf Drying Index (LDI) and amount of Chlorine in tree leaves (g/kg dry matter). Data from the years 1999 and 2000.

LDI	Chlorine in 1999	Chlorine in 2000
20 %	7.17	3.66
40 %	9.32	9.19
60 %		9.80
70 %	13.22	10.65

Table 4 presents measured Cl in the tree leaves und LDI. The Cl valus are high and show a high correlation with LDI. According to Burg (1987) visual damage to *Tilia cordata* should be expected if this value is higher than 7 g/kg dry matter. It must be concluded that the application of de-icing salt during wintertime is an important cause of bad tree condition in Moscow. In addition, the Na has a negative influence on soil structure, and thus an indirect negative influence on tree condition. A further factor is that salt in soil water makes it more difficult for plants to take up water from the soil.

4 Conclusion

Excessive use of de-icing salt on roads, pavements, etc. in Moscow during winter periods causes serious damage to street trees, deterioration of soil structure, and a more difficult water take-up from the soil. From a water balance, estimated for conditions without this salt influence, it appeared that the street trees of Moscow very likely suffer from drought too. This is exaggerated by the de-icing salt problem. Air pollution in Moscow increased heavy-metal contents in tree leaves, which is a further stress factor of trees.

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Reverting urban exotic pine forests to *Macchia* and indigenous forest vegetation using cable-yarders on the slopes of Table Mountain, South Africa

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Abstract

This paper discusses some of the issues faced during the initial phases of a 12-year long project, which will ultimately result in the transformation of 53 ha of urban pine forests to a more natural mixed vegetation cover. Public sentiment, harvesting procedures and future management practices are addressed. The forests are currently managed for recreation and are a heavily utilised public amenity. Efforts have been made at every opportunity to minimise disturbances to the recreational and biological capacity of the forest area. Public participation was encouraged at all stages, and from local to national level.

Harvesting operations were planned to generate the transition from high open pine forest to mixed scrub Macchia and moist high indigenous forest. The operation plans should ensure as gradual, though complete, conversion as possible within the given time frame. An aerial cable extraction system with a fixed skyline was applied in extracting the timber to minimise site impact. Successful marketing of the timber together with the application of industrial harvesting technology meant that the project could be self-financing, which was an important prerequisite.

Both public and vegetational response has been encouraging, and the inevitable unforeseen problems and compromises that have had to be met since project inception have been dealt with in an open and constructive participatory forum.

Key words: strip-cutting, cable yarding, participatory planning, shelter wood, urban forests.

1 Historical background

Records show that when the first European settlers landed on the Cape of Good Hope in 1652, there were probably pockets of high forest on the slopes of Table Mountain. These were, however, most likely confined to gulleys and the lower reaches of the Silverstream and Platteklip Gorges and were insufficient to fulfil demands for timber for shipping and fuel wood. The first large tracts of forest they would have encountered would probably have been at what today are the suburbs of Newlands and Constantia, on the south-eastern slopes of Table Mountain, stretching towards Hout Bay.

By 1660, the area of Newlands was already being cleared for agriculture, as the forests had all been felled and removed for dockyard use and housing in Cape Town. The steady destruction of the forest continued and by 1663, exploitation had begun in the Constantia forests. By 1679, the more distant forests in Hout Bay had become the main source of timber for the young colony.

The need to preserve the forests from destruction was recognised early by authorities and the first reference to this was a notice dated October 1658 (Shaughnessy 1980). The then governor of the Cape, Simon van der Stel, made a determined effort to restore the denuded forests and forbade the felling of timber without permits. This had little effect and by 1665 no utilisable forests were left in the Cape Town area and sawyers began to move into the country.

Augmentation of natural timber supplies by afforestation began in 1889. Tokai plantation was established in 1893 and Devils Peak plantation shortly afterwards. Exactly when the Newlands plantings started is not clear but by 1886 there were reports of *Pinus pinaster* and *Pinus pinea* stretching along the South-eastern slopes of Table Mountain. According to historical research by Shaughnessy (1980) this constituted a remarkable feature in the landscape and Newlands Forest was well wooded by both these species.

In 1912, the Department of Forestry drew up a working plan for the management of the forests. The plan, which advocated the replacement of *P. pinaster* with *P. radiata*, was first implemented in 1915 and these plantings are the forebears of what can be seen in Newlands Forest today.

2 Introduction

Newlands Forest, part of the Cape Peninsula National Park (CPNP), is situated within the metropolitan area of Cape Town, South Africa (Figure 1). Newlands Forest is a central and well-utilised public amenity, conveniently accessible for the 2.6 million inhabitants of greater Cape Town. The "forest" today is a plantation consisting primarily of exotic *Pinus* species interspersed with smaller pockets of indigenous moist-forest (McDowell 1994). It currently provides one of few opportunities for recreation in a forest atmosphere in a region naturally dominated by *Macchia*.

The forest, consisting mostly of large diameter trees, is open and visually appealing. It is transsected by a network of hiking, walking and biking routes, narrow gorges and mountain streams. The forest also adjoins two of South Africa's most renowned tourist attractions, Kirstenbosch National Botanical Garden and Table Mountain itself. Both comprise important aesthetic, historical, topological and botanical landmarks for South Africans and foreign visitors alike. Newlands Forest alone receives 1.2 million visits per year (Prins 2002).

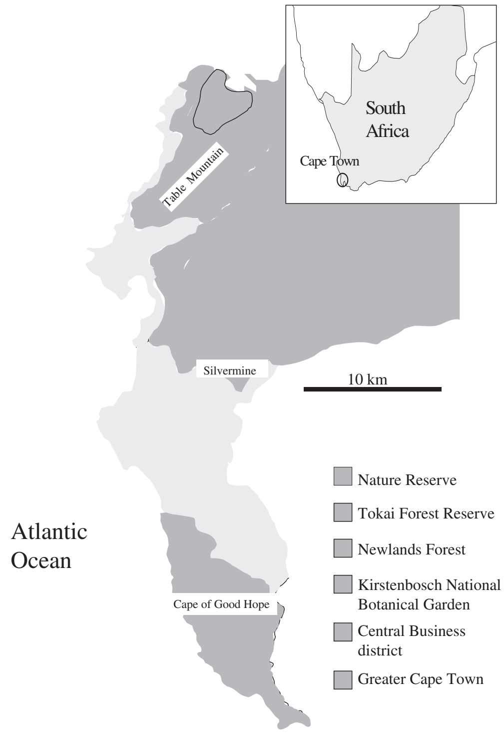

Figure 1. The location of Newlands forest on the Cape Peninsula.

The management of each one of these resources is a sensitive and important issue for recreation and tourism in the region. The Cape Town City Council took over formal management of Newlands Forest and surroundings in 1913. Apart from a working plan compiled in 1912, which, amongst other prescriptions, advocated the replacement of *P. pinaster* with *P. radiata*, the first comprehensive and holistic planning document to be generated and applied was only produced in 1996. This document was produced under the auspices of the Cape Town City Council. Ownership changed once again in 1998, when the South African National Parks Board (SANPB) took responsibility for the area and it was amalgamated under the larger Cape Peninsula National Park (CPNP).

The first Draft Policy compiled by the CPNP defined a planning goal, which gave priority to the conservation of indigenous forest within its jurisdiction. The policy made provision for the removal of all exotic plantations, mainly *Pinus* and *Eucalyptus* species, from the slopes of Table Mountain in general and Newlands Forest in particular. This would facilitate the natural conversion of these areas to *Macchia* and indigenous high-forest over time.

Stakeholders did not, however, favour the *carte blanche* removal of the exotic pines. Although the public supported the removal of the pine plantation in general, they strongly expressed the opinion that gradual systematic removal as opposed to clear felling should be used and that any form of damage to residual vegetation should be limited. A publicly approved plan was to be tabled to govern all phases of the work in order to limit unfavourable externalities.

A procedure of strongly undulating strip cutting was recommended in which each stand receives at least three cuts in three phases. Progressing in a Northwest to

Southeast sequence was suggested. In order to complete the total 53.3 ha in 12 years, each of the three phases was scheduled to go on for four years. Felling of subsequent phases is determined by the satisfactory regeneration of the adjacent completed cuts. The minimum time period for the total operation is 12 years. An airborne cable-yarding harvesting system has been applied in order to reduce the impact on the growing site and preclude vehicular in-stand traffic.

Public response and natural regeneration are considered the primary gauges of success. The project is currently in its second operational year. This paper discusses operational efforts made in minimising all possible forms of disturbance within the economic, social and ecological mandate provided.

3 Planning issues

The following planning goal was set in 1996:
»Newlands Forest will be managed to conserve, protect and maintain maximum natural bio-diversity for the area within stable, dynamic, self-sustaining natural ecosystems with particular emphasis on indigenous forests, while retaining a core area of pine plantations for recreation.«

Ten policy statements were tabled within the Newlands Policy Framework of 1996, of which only the first is relevant for the purposes of this paper.

Policy 1: Within the area designated for future management as indigenous forest, conserve and maintain the indigenous flora and fauna to sustain biological diversity. Guidelines (selected bullets):

- Remove exotic plantations in the indigenous forest area according to a publicly approved well-founded plan, over an acceptable time frame, to encourage regeneration of indigenous vegetation.
- Apply timber extraction methods, which will cause a minimum of damage to natural vegetation, limit soil erosion and disturbance and limit visual impacts.
- Keep the public informed of all operations.

Implementation of this policy required that an appropriate management plan, which detailed priority actions, be drawn up within a public review process. Secondly it required that as these policies were driven by public opinion, it would be incumbent on the National Parks Board to continue to apply these policies. No changes were to take place without having been through a public consultation process.

It was agreed that the recreational pine plantations, 36.0 ha, would be maintained as even aged stands. Sufficient management intervention would be applied to maintain the vigour of the stands and they should be allowed to reach maturity and senesce. Dead trees will not be replaced and dead and dying trees will be removed for the sake of public safety. Being exotic, standing dead trees would not be retained for reasons for their role in promoting biodiversity.

The remaining 53.3 ha, were designated for removal in a scientifically ordered fashion, according to guidelines stipulated in the policy framework of 1996 (Britton 1996).

4 Public sentiment

Newlands forest is facing increasing demands for outdoor recreation. Although the plantations are no longer managed for their timber resources, they are still in dire need of silvicultural treatment to ensure their continued vitality. Public sentiment over the pine "forest" has been very emotional in the past and managers have been prevented from carrying out even sanitational silvicultural measures, e.g. thinning. This sentiment has led to deterioration of stand health. There are currently numerous dead and dying trees due to overstocking. If the pine forest were to be retained, some form of silvicultural treatment would be essential for ensuring continued vigour.

As there was no stated management objective for Newlands forest and no management plan, many *ad hoc* management initiatives have been undertaken in the past decades. Clearly defined policies, guided by public opinion, in order to formulate such management plans for the area, were urgently needed if the project were to succeed.

The first draft policy framework defined a planning goal, which made the conservation of indigenous forest a priority, and stated that all exotic plantations would be gradually removed to encourage regeneration of indigenous forest (McDowell 1994). Public reaction to this, in the form of an intensive public participation exercise, however, required that this planning strategy be amended.

It became apparent that although there was consensus that the pines did not belong in the area, immediate and complete removal was not favoured. Pine plantations have an ambience, which certain sectors of the public enjoy and a number of areas should be retained bearing in mind that the stands have a limited lifespan (Britton 1996).

The original proposal to remove all exotic trees was thus amended and it was agreed to retain a core area of pines for recreation and to manage the remainder of the area as indigenous forest or at least indigenous forest in transformation.

5 Stakeholders and stakeholder participation

Two prominent and vocal interest groups are the »Friends of Newlands Forest« and the Afro-Montane interest groups. Of the two, Friends of Newlands Forest are the most active and supportive of the Newlands Policy Framework. Most of the volunteers active in the Forest are members of his group. The voluntary services cover, to name a few, monitoring of visitors, illegal activities and intrusion; eradication of alien vegetation; and observing forest health in general. This group was also involved in building a stakeholder database in conjunction with CPNP.

Other more obvious, though passive, stakeholders are the people of greater Cape

Town, provincial and central government and national conservation bodies, NGO's as well as academic institutions.

Two stakeholder meetings were planned. The first was a public meeting at which the work plan was to be presented. The public would be notified of the meeting through the media, both written and radio; as well as mail postal drop invitations to the residents in the more immediate area of Newlands Forest. Once this process was completed and unanimity reached, the systems could be applied and work could commence.

When the systems had been selected and formulated, they would have to be presented at a series of public meetings at which all stakeholders were present or where stakeholders had the opportunity of attending and voicing opinions, for final approval of the operational plan.

The second initiative was an effort to obtain national exposure through radio, printed media and television. This was to take place within the first week after commencement of work on the site. The objective with this exercise was to introduce the live operations to interested and non-interested parties and to foster further support and constructive criticism in order to improve on future operational techniques. The rationale behind this being that the general public could not have been expected to envisage the true nature of the operation *a priori*. It was expected that this coverage would motivate any persons or interest groups who had not yet participated in the public debate, to do so.

Follow up communication with stakeholders carried high priority and a strategy of regular information bulletins conveying the progress of the operations and results of vegetation regeneration monitoring were, and are still being, produced. Additional dissemination of information includes indications of which areas are excluded for public use due to harvesting operations and the expected time frames. A regularly updated commentary on the purpose and envisaged results is posted for people who were not present at any of the consultation processes. This information is posted both at the forest entrance and in the written media.

6 Silvicultural management

Although these plantations were originally planted to replenish forests devastated by early colonisation, the indigenous forest is now re-establishing itself in the form of an understorey beneath the pines to varying degrees and a number of pioneer species are such as *Podelaria spp, Kiggelaria africana* and *Diospyros whyteana* are evident. As these pioneer species react favourably to openings in the forest canopy, removal of the pines would allow indigenous forest to continue to develop. According to McDowell (1994) the presence of a number of the indigenous species observed in the understorey is a strong indication that the transformation will ultimately succeed. On the other hand plantations also suppress regeneration of indigenous forest over most of the area and their removal to conserve the largest remaining patch of indigenous forest in the Peninsula is thereby warranted.

Squires et al. (1991) define silviculture as using ecological, economic and social knowledge to manipulate a forest ecosystem to achieve specific sustainable benefits specified for it. Silviculture can also be defined as the art of producing and tending a forest (Smith 1962), or in particular, as the theory and practice of controlling establishment, composition and growth of forests (Ford-Robertson 1971).

Silvicultural systems are most commonly classified according to the reproductive method employed since it has a decisive influence on the form and treatment of the stand. This refers to the method of carrying out the felling that removes the mature crop with a view to the regeneration of the desired future crop.

Different techniques used for harvesting are, amongst other, clearfelling (i.e. clear-cutting, clearcutting with residuals, block cutting, patch cutting, alternative strip cutting and progressive strip cutting) seed tree and shelterwood systems.

Due to the desired regeneration consisting of completely different species than the current standing, no seed trees are immediately available. Shelterwood systems require more than one entry onto the site, which is discouraged as far as possible to limit damage to emerging and existing regeneration. Owing to the economic restrictions of the project, the steep slopes and large tree sizes also impeded establishment of shelterwoods.

The alternative was to apply a derivative of clearfellings within the constraints of the planning goal of the CPNP. No clearcutting (> 2 ha) or regular shaped block cutting (areas < 2 ha) would be considered due to visual impacts on both a micro and macro scale. With patch cutting however, there is the danger of creating gaps through which the notorious northwesterly wind could cause wind-throw. The solution was to deal with the problem with alternate strip or progressive strip cutting.

Stand structure data

Newlands forest was, at various times of its existence managed in such a way that the forest was divided into management units (compartments) equivalent to those commonly used in most commercial plantation management. This implies that each compartment was even aged, of similar species and the forest structure uniform.

Within the area designated for conversion, enumerations established individual tree dimension, compartment and total volumes. The exact work object size, in terms of diameter-breast-height (dbh) and tree height is required in establishing equipment capabilities and functioning within the Newlands Forest environment, as well as for marketing indications (Table 1).

Records detailing planting dates were not available and some confusion as to the exact ages of the various compartments exists. By selective felling and annual ring counts, it was established that the ages range between 45 and 70 years. All stands are even aged. Age at this stage of the stand development, where all stands are at or nearing maturity is of little importance, though detailed knowledge of individual tree volumes were essential for operations planning.

Table 1. Stand structure data.

Stand reference	Species	Area (ha)	DBH (cm)	Ht (m)	M^3/tree	Total vol. (m^3)
A	*P rad*∗	0.8	42.22	24.83	1.292	570
B	*P.rad*	5.8	35.12	20.58	0.763	2430
C	*P.rad*	4.8	52.36	24.00	1.897	2260
D	*P.rad*	2.9	52.00	28.67	2.167	1510
E	*Syn glom.*†	0.4				
F	*P.rad*	2.5	52.30	27.13	2.094	1610
G	*Euc clad*•	2.5	36.44	25.85	0.838	1000
H	*P.rad*	1.7	38.71	29.62	1.247	950
I	*P.rad*	5.9	38.55	29.62	1.247	3300
J	*E.clad*	2.7	36.34	25.85	0.899	1080
K	*Sten*‡	0.8				0
L	*P.pin*♦	Retained				0
M	*P.rad*	5.9	36.60	18.42	0.755	1670
N	*P.rad*	4.5	43.06	21.83	1.195	2160
O	*P.can*⁕	0.5	24.96	17.58	0.23	110
P	*P.rad*	4.3	52.00	28.67	2.167	2450
Q	*P.rad*	3.2	40.56	31.83	1.245	1790
TOTAL		53.3				22890

∗*Pinus radiata* †Syncaroia glomulifera •*Eucalyptus cladocalyx* ‡Stenocarpus sinuatus
⁕*Pinus canariensis* ♦*Pinus pinaster*

7 Situation analysis

In order to arrive at appropriate systems a comprehensive situation analysis was conducted of the area. A situation analysis is a thorough investigation into the status of the area in question in order to establish the exact work parameters, risks and opportunities peculiar to Newlands Forest. Once completed, sufficient information should be available in order to take all factors influencing decisions into account and arrive at a feasible plan of action that will satisfy all stakeholders.

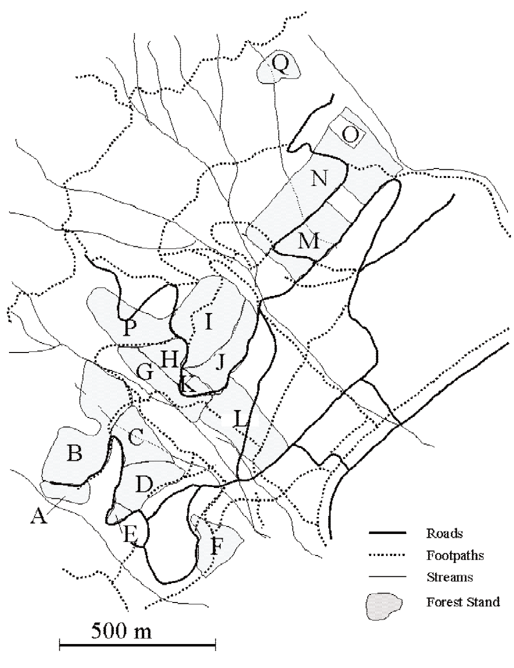

Figure 2. Structure data: Area and compartments identified for removal.

Table 2. Compartment list: areas, volumes and terrain classification.

Stand Reference	Area(ha)	Total vol.(m^3)	Slope (%)	Ground roughness	Extraction system*
A	0.8	570	50	Rough	Tower yarder
B	5.8	2430	10-30	Uneven	Ground skidding
C	4.8	2260	15-40	Uneven to rough	Tower yarder
D	2.9	1510	20-40	Uneven to rough	Tower yarder
E	0.4		10	Even	Ground skidding
F	2.5	1610	20	Very uneven	Tower yarder
G	2.5	1000	30	Rough	Tower yarder
H	1.7	950	20	Slightly uneven	Ground skidding
I	5.9	3300	25	Very uneven	Tower yarder
J	2.7	1080	25	Very even	Tower yarder
K	0.8		10	Slightly uneven_	Ground skidding
L	4.9	0	10-20	Very even	Retain for recreation
M	5.9	1670	15	Slightly uneven	Ground skidding
N	4.5	2160	10-25	Very even	Ground skidding
O	0.5	110	15-25	Very even	Ground skidding
P	4.3	2450	30-40	Uneven	Tower yarder
Q	3.2	1790	40-60	Very even	Tower yarder
TOTAL	53.3	22890			

* Technically feasible systems. All felling carried out motor-manually.

The situational analysis involved the identification and analysis of the following (for the sake of brevity only the most important factors dealt with are detailed below)

Terrain

In order to choose the most suitable harvesting system/s for individual compartments and the area as a whole, a detailed terrain analysis was completed. Use was made of the National Terrain Classification System for Forestry (Musto 1993).

Once terrain had been established (Table 2), a functional terrain classification was introduced in order to determine the boundaries within which equipment could operate effectively and efficiently within the guidelines of the policy statement (Table 2). The equipment limitations guidelines are as they appear in the Southern African Harvesting Codes of Practice (Forest Engineering Southern Africa 1999)

The structure and object data indicated timber of large dimensions. Tree volumes generally ranged from 0.8 m^3 to 2 m^3 per tree and individual log volumes will inevitably range between 0.4 m^3 to 0.7 m^3. Stem counts per hectare (sph) varied between 400 to 450 sph generating a yield of between 400 and 500 m^3 per hectare. These statistics were reminiscent of industrial forest stands, indicating that the equipment required to extract and handle the timber would need to be similarly robust. This requires the application of a certain level of technical sophistication coupled with trained and experienced operators who holds expertise in handling large trees within the confines of the environmental constraints.

Availability of harvesting expertise and equipment

A survey of available harvesting expertise, suitable logging equipment to match the terrain, and the expertise to operate this equipment under limiting circumstances, was concluded among contractors of the Western Cape region. Not only their expertise, but also operator attitude required for undertaking work as sensitive as the Newlands operation was taken into account. They would undertake operations unique to southern Africa, in the face of a discerning public, and it was crucial that operations were perceived as successful in order to pursue similar operations of equally sensitive nature in the future. The operation was to be regarded as a benchmark exercise under severe public scrutiny and was to be followed with interest by other management authorities in the country.

The Western Cape Region is geographically separated from the commercial forestry hubs in South Africa, which resulted in a low level of interest from the majority of contractors (nationally) with sufficient expertise and equipment. A survey revealed only two possible contractors fitting the requirements. Neither of them operated both cable yarders and ground skidding equipment. Both had received formal technical forestry training with plantation management experience, in the form of a recognised South African National Diploma (Forestry). One of the applicants had, however, been involved in harvesting on National Parks Board property, in equally environmentally challenging and socially sensitive areas (Silvermine and Orangekloof). He had considerable experience in steep terrain harvesting with cable yarders, and was eventually appointed to the project.

It was subsequently decided that no ground-skidding operations would be implemented, mainly due to the poor operational standards and the selected contractors' lack of ground skidding equipment. The poor performance could probably be ascribed to the predominance of steep terrain areas and resultant low volumes coming off ground skidding areas in the Western Cape. In other words contractors have not placed much emphasis on this type of logging system and made no effort to acquire what was considered an acceptable level of proficiency.

It must be borne in mind that if a suitable contractor, with a proven record of ground skidding expertise is found, it would be prudent to use ground skidding in Newlands forest. The functional terrain classification model allows entrance to this type of equipment to a percentage of the terrain. Within these parameters harvesting is managed and risks and damage can be limited.

Marketing

Market analysis was done in order to ascertain if the timber being produced under these circumstances would be attractive to sawmillers and board mills within the region, bearing in mind that volume deliveries would be relatively erratic, small and restricted to the summer season (see environmental constraints).

The analysis indicated that the timber was valuable and would deliver significant peeler and high-grade structural timber volumes. The single industrial sawmill in the region had indicated interest in the wood and would purchase the timber standing and arrange transportation of the logs to the mill site (c. 50 km). Because of the large dimensions of the logs yielded, there was little contention for the timber in the ensuing tender process.The State Forestry Department is currently in a process of privatisation and the supply of timber of these large dimensions is expected to diminish under private forest ownership.

Because of a frugal operating budget of the CPNP, it was important that the transformation process had the potential to be economically self-sustaining throughout the operational period. This implied a trade-off between harvesting having to proceed in a semi-industrial manner, so that it was economical, and the level of environmental/social regard that could be observed. The incentive of tendering on the timber standing provided financial benefit for the CPNP.

Environmental influences

It was important to bear in mind that even very low-resolution operations, single-tree treatments for example, have an impact on the environment, which cannot be avoided. The very nature of harvesting makes it unavoidable that some amount of damage to remaining forest floor vegetation will occur. One can therefore expect some damage to the existing under-storey during harvesting activities in the pine compartments. Fortunately many of these pioneering species are resilient and will generally re-shoot after such impacts (Geldenhuys 2001).

These potential impacts can however be minimised by the choice of the most appropriate harvesting technique, equipment and harvest planning, for a given situation. Additional potential impacts, which need to be recognised and avoided are the following.

- Soil compaction
- Soil surface disturbance
- Soil erosion

The presence of these impacts is an indicator of poor harvesting equipment selection and improper harvesting techniques. The soils of Newlands are generally poorly leached and thus fertile. Any disturbance will negatively affect this natural state. The exclusion of wheeled traffic from marginal compartments (slope and soil conditions) must be maintained. Rutting and displacement of soils will severely affect uniform regeneration. Achieving uniform soil coverage in the shortest period is important for two reasons:

- Create shading to limit weed growth once light penetrates and soil temperatures rise.
- To limit the delays between cutting phases due to inefficient growth, thereby prolonging the project and jeopardising the economic feasibility thereof.

As much processing must be done in field (debranching and topping) to leave limbs and other non-utilisable biomass on site. There are two reasons for this; maintenance of nutrient status of the site and soil cover/shading for temperature and soil moisture regulation.

Also of importance was the limitation of visual as well as audio impacts or disturbances (externalities) on a macro and micro level. The Newlands forest remains heavily used throughout the year and it would be unfeasible to exclude the public from the area in order not to subject them to these externalities. An effort would be made to restrict disturbances to the immediate confines of the operation and at that scale, limit them to the absolute minimum.

Volumes stored on landings would be restricted to a maximum of two truckloads, i.e. $50m^3$. This prevents spillover of operations into adjacent areas, as the mountain roads are narrow and relatively long stretches would be needed for timber storage, and avoids unsightly and potentially dangerous timber stacks. The systems applied would have to take the frequent visitor into consideration and plan around them in order not to impact on their daily or routine activities within the forest. Safety of visitors remained priority and signage depicting the presence of dangerous harvesting operations, were displayed around the operation itself in order to prevent public excursions into the operational area.

Newlands is a high rainfall area. Mean annual rainfall measured over 22 years is 1672 mm. Although rainfall occurs during every month of the year, 75% of the total falls from April to September, the winter months (Britton 1996). This high rainfall coupled with narrow, and in places poorly aligned and drained roads, which are not gravelled or permanently surfaced, restrict logging and transport to the dryer periods of the year. Timber transport during the winter months would cause irreparable damage to the roads and their pass-ability for walkers/cyclists or further primary or secondary transport activities. More importantly, it would cause excessive sedimentation of the pristine steams, which arise here and flow through suburban areas.

8 Harvesting procedure

Harvesting systems are defined as the tools, equipment and machines used to harvest an area and the harvesting method and the form in which wood is delivered to the logging access road, and depends on the amount of processing which occurs on the worksite (in-stand). In South Africa cut-to-length and tree-length methods are dominant in pulpwood and sawtimber operations respectively. Due to current expertise and equipment availability and because of the economic framework and standardised sawmill specifications it was not considered prudent to deviate from current practice.

With information gathered from the situation analysis it was apparent that the following harvesting system would be implemented:

- Cable-yarding harvesting systems will be used exclusively at Newlands
- Harvesting and transport operations will be restricted to the dry months of October to March

CPNP also found it prudent to exclude ground-based operations from this harvesting operation. The reasons for this have been outlined in the section »situation analysis«. Cable yarding, coupled with the selected contractors' expertise and experience, will have the least impact on the site and the greater environment of Newlands Forest within current parameters.

Seeing that the main product is large sawtimber and that cable yarding would perform the majority of the work, tree-length harvesting methods would be applied. There would however be occasion to process stems in the cut area, for cable yarder deflection improvement, into shorter lengths to facilitate extraction and limit potential damage.

In order to limit macro and micro impacts a system of progressive, strongly undulating strip cuts would be applied as opposed to alternative strip cutting silvi-

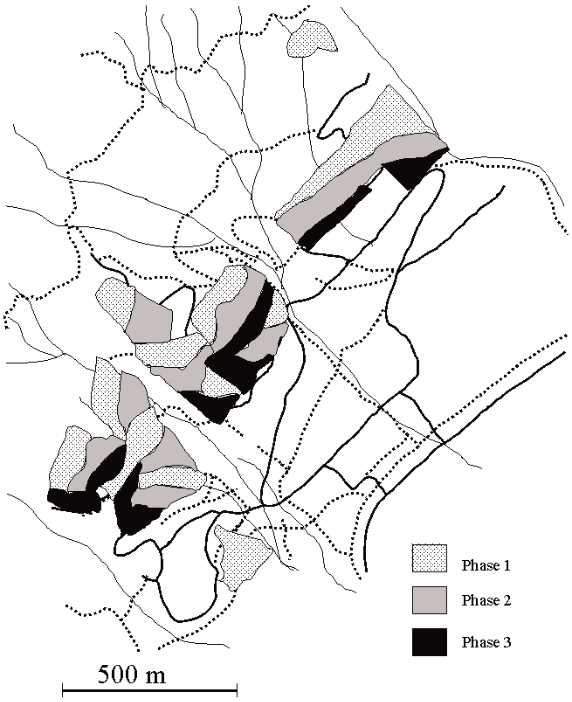

Figure 3. Harvesting phases of individual compartment and area identified for clearing.

cultural system. The strip width will range between half and one and a half tree lengths. No felling into the adjacent remaining stand will be allowed in order to maintain a sense of no disturbance or non-intrusion.

The progressive strip cutting will proceed from the north (the higher elevation) towards the south (the lower elevation) with most of the strips cut parallel to each other in a southwesterly - northeasterly direction (Figure 3). The cut strips will progress, in individual compartments, from northeast towards the southwest. The reason is to hide preceding strips behind uncut areas. This procedure hides the entire operation on a macro level from the well-populated areas south and west of Table Mountain. Once the final strips have been cut, the preceding strips should have greened sufficiently to damper the effect, and the recreation plantation would still shield them from below.

One compartment had to be felled entirely in one operation. Compartment T108E (Figure 3), posed problems due to extremely steep slopes (40 % to 60 %) and only one landing area for cable yarder placement. This would not allow strip cutting to proceed normally and the cutting faces would be perpendicular to the prevailing wind direction with the potential of wind throw.

An additional advantage of the orientation and width of the progressive cut strips is the maintenance of lower soil temperature and increased relative moisture content by maintaining partial shading from the adjoining uncut strip. One other advantage is that the mountain itself assists in shading of almost the entire Newlands Forest by mid-afternoon. By utilising these two factors, both pioneer and shade tolerant species will have an opportunity to occupy the site.

The undulation of the progressive strip cuts improves the aesthetics of the operation. The undulations, although not entirely visible from a macro point of view due to the shielding of the cuts, has a pleasing micro visual element. The undulation distances, between trough and crest, are as much as 35 metres. These undulations blend in with the surrounding perimeter of the existing indigenous forest and at the same time create a positive micro-climate and zones of specific regeneration.

The felling strip widths will dictate the average number of strips in each compartment. A maximum of three and a minimum of two strips will be catered for. This means that there are to be three phases of cutting throughout the area.

The speed of the progression is determined by the environmental sensitivity of the work and no more than 2,500m^3 will feasibly be removed in one seasons' cut. This implies that each phase will be at least three to four years in duration. A total period of 11 to 12 years is envisaged to complete the entire operation.

The cutting of the second and third phases will not commence until sufficient stocking has been obtained in the immediately preceding cut. With present regeneration successes it is estimated that the three years allocated per phase will be sufficient and that the phases will be executed without delay.

The stocking requirements at this stage are undefined. The only benchmark at present is that the area must have greened sufficiently for it to be visually acceptable and biologically diverse. Suggestions are that the mean height of the pioneer species, *Diospyros whyteana*, *Kiggelaria africana, Rapanea melanophloeos* and *Halleria Lucida should* be one metre and that there is "sufficient" representation of follow-up species such as *Cunnonia capensis, Podocarpus latifolius, Ocotea bullata* and *Apodytes dimidiata*, in evidence. In reality if the pioneer species have shown themselves, other species emergences are taken for granted (Geldenhuys 2001). Extensive future research will be able to indicate the optimal stocking requirements in time.

Technical specifications

As suggested the harvesting system will by and large be limited to the cable yarder. A cable yarder of at least 6,500 kgs mainline breakout and 2,800 kgs continuous working capacities operating over a distance of no less than 600 metres, equipped for both down and uphill yarding (number of drums) was required. A skyline clamping carriage is needed in order to keep lines static, during timber breakout, to reduce damage to adjacent residual pine stems and valuable indigenous vegetation.

9 Results

The project is now in its second season after a late start in the first year, and all findings are therefore intermediate. The result of the late start has delayed the first phase by an estimated one year, so that phase-one will run for four instead of three years. This is not of concern, as caution and prudence will maintain the favour of the participating public and one additional year over a total time frame eleven to twelve years is acceptable.

The public perception and acceptance of the work is the one main gauge of success at this stage. There have been no negative reports or commentaries what so ever, despite the fact that park administration has daily contact with visitors. In fact the active stakeholders have been instrumental in gaining even more voluntary support for the removal of invasive aliens as the cutting has progressed, by undertaking a public awareness campaign, of the threat of unwanted seed dispersal in sensitive areas.

There was no difficulty for the contractor to adapt his normal industrial or commercial pace to the more sedate but careful environmental approach to the operations. Approximately 40 m^3 of good quality timber has harvested per day on average over 9 months.

It is still too early to judge the indigenous regeneration successes with the removal of the pines, although follow-up surveys on two similar earlier projects have given promising results. As was expected, with the opening-up, a certain degree of accelerated germination of the seed bank of *Eucalyptus longifolia* and *Acacia melanoxylon* (both species are exotics) occurred. Hand pulling of saplings at this early stage remains a very effective method of control, and it is hoped that this will remain a viable alternative to herbicidal control. Voluntary interest groups primarily carry this out. Bramble (Rubus spp) is also expected to create problems in the short-term due to the nutrient rich soils.

Harvesting productivity remains low relative to similar industrial operations. Productivity is constrained in all phases, from felling to merchandising and storage.

Felling remains the basis of the success of the operation and at any one time a maximum of a single shifts' production is available on the ground. Directional felling to facilitate stem extraction with the minimum damage to residual indigenous flora has so far been successful. Achieving acceptably low stump heights and logging residue management by chainsaw operators proved difficult, but intensive on-site training rectified the situation.

During extraction it was important to limit the amount of break-out force used. The more force used the less control the operator had over the extracted pieces and the more potential impact on the environment. To facilitate this all timber had to be felled to lead and no two stems crossed each other. If potential impacts were predicted, cut-to-length was used to reduce piece sizes. Shift volumes extracted were thus erratic and the average daily volume over ninety days of harvesting amounted to a mere 41 m^3. In terms of the result this is considered acceptable, but remains difficult to predict particularly with changing terrain and cutover geometry.

Merchandising and storage remains the success story of the operation. By integrating regular transport of logs to the mill site, these two operations remained isolated, compact and non-intrusive.

By implementing »just-in-time« felling and applying limited force to breaking out and extraction, minimal damage to indigenous flora resulted (this was also dependent on the volume of flora originally residing in the cut area). With the lack of scientific data this is difficult to quantify. Trials are in place and qualified data will become available as to what percentage was damaged and to what extent they were damaged (fatal or partial) relative to the original stocking.

Preliminary results show that the indigenous flora is resilient and if present will emerge rapidly and with vigour (Geldenhuys 2002). The increase in soil temperature and availability of additional moisture contribute to this emergence (Geldenhuys & Potgieter 2002).

Two distinct emergence patterns are visible at this early stage. The dryer more rapidly draining areas have an abundance of the pioneers *Podalaria* and *Kiggelaria* present and dominate the site at this time. There are indications that sufficient follow up species are making an appearance, e.g. *Apodytes dimidiata* and *Curtisia dentata* among others. On the warmer dryer sites, true *fynbos* (macchia) species are much more in evidence than on the less drained sites.

On the other wetter sites, pioneers, who were already in evidence under the pine canopy, are showing encouraging results. *Cunonia capensis*, *Curtisia dentata*, *Rapanea melanophloeos*, *Ilex mitis, Kiggelaria africana* and *Apodytes dimidiata* are all evident and have achieved encouraging heights and site domination considering their "age" since the clearing of the pine canopy.

Preliminary results have also shown that damaged plants revive and grow, albeit with an unnatural form. Trees that were damaged and treated with wound sealer have also shown potential as species fulfilling a role in the emergence of the indigenous flora. In the early stages it was thought that if the indigenous flora would regenerate sufficiently despite being damaged during felling and extraction and subsequently cut-back to encourage re-sprouting, it would not be of cardinal importance to evade each and every indigenous plant. It was found that the browsing of these new shoots by antelope poses a significant hurdle for the transformation process. The result is that the plants at times do not achieve heights above 30 or 40 cm, and some areas may have to be fenced.

10 Discussion

Regular and on-going operational discussion group sessions are held between contractor, consultant and land owner, at which all, no matter how irrelevant, suggestions of improvement are tabled and discussed, to stimulate and maintain awareness in an environmental and social context. What was of key importance was for the contractor to take ownership of the operation. This was facilitated by empowering him to act as chief spokesman when information sessions were being held, which also gave the public direct access to air their concerns regarding operational aspects. Also, the contractor should be sufficiently compensated for the additional, often non-tangible, regard he is required to take. It should be attractive for him to experiment and work with ideas and plans. The good prices being obtained for the timber have fortunately provided the means to allow this.

Browsing by antelope posed a bigger problem than anticipated. The result is that even greater care, within reason, be taken where the resident flora is of significant height (above browsing height) not to damage them. Experimentation went as far as propping up damaged stems and treating wounds with fungicidal sealer, in order to maintain a canopy at about two to three metres. One problem encountered with this was that no provision for such restorative work was made in the original contract with the harvesting agent, and that it very soon became prohibitively expensive.

Environmental resource policy in South Africa has been subjected to a considerable and rapid transition from one of puritan scientific foundation to one of social inclusion, utilisation and benefit. Initiating a 12-year project within this political atmosphere has required an open, frank and willing forum. The novelty of this project in South Africa has meant that it was impossible to foresee all eventualities. At this early stage, a number of 'grey areas' in terms of contractual expectations and obligations are evident. The modular nature of the project (phases) facilitates amendments to be made intermittently.

Rapid and massive urbanisation in the greater Cape Town area over the past decade has resulted in another unanticipated threat to the continued existence of indigenous forest in the region. Traditional healers rely on natural remedies, many of which are derived from the bark of some of the most important forest tree species. Illegal bark stripping for commercial sale is presently occurring at a rate, which cannot be maintained even in the short term, and the futility of the project is thereby being jeopardised.

11 Acknowledgements

We would like to acknowledge the efforts of Prof. Walter Warkotsch, Technical University of Münich, Freising, for his role in the conception of the project, as well as the staff of the Cape Peninsula National Park for the close co-operation they have afforded the unit of Forest Operations at the University of Stellenbosch

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Fire in the wildland-urban interface in the USA South

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Abstract

Population and urbanisation are rapidly expanding in the southern US, increasing human influences on forests that are considered highly productive and essential for supplying future wood and non-timber benefits. Challenges created in the wildland-urban interface relate to changing biodiversity, wildfire protection and mitigation, invasive species movement, and increased forest fragmentation, among others. The South has the fastest population growth in the US with a 13.7 percent increase in population between 1990 and 2000. This growth rate threatens the sustainability of Southern forests. In this region, Florida is the most acutely impacted state with a projected population of nearly 25 million by 2020. In 1998 alone, wildfires cost Florida over US$ 600 million in fire suppression, timber and home losses, and business disruption in the urban interface. In response to this situation, the US Department of Agriculture (USDA) Forest Service, the University of Florida and the Southern Group of State Foresters formed a partnership to create the Southern Center for Wildland-Urban Interface Research and Information. The Center addresses needs identified in a south-wide assessment of the wildland-urban interface. The critical problem of fire in the interface was chosen to be the first focal point of the Center. A suite of projects is addressing landowner risk assessment, post-fire assessment, structure and flammability of native plants and options for fuel management in the interface. A website (www.intersouth.org) was created and a fact sheet series initiated to facilitate technology transfer to end-users. Literature analyses and research designs for generating information for reducing risks in the wildland-urban interface are discussed.

Key words: flammability, forest fuels, forest landscapes, risk-assessments.

1 Introduction

The southern United States (US), which stretches from Texas to Virginia, is undergoing change unlike any other region in the US. As population and urbanisation expand in the region, human influences on southern forests are increasing. These areas of increased human influence and land use conversion are termed the wildland-urban interface. The trend to move to the outskirts of urban centres near to more natural settings has led to the partitioning and fragmentation of forested lands and wildlife habitat. The fragmentation of forests and other factors, such as increased recreational demands in wildlands, are impacting the character and health of forests. Ultimately, air and water quality is affected. The end result is a threat to the values that attract people to the wildland-urban interface.

Natural resource managers are faced with critical management challenges in the interface, such as changing biodiversity, watershed management and protection. Perhaps the most critical challenge in the interface is that of managing fire in the wildland-urban interface. In 1998 alone, wildfires cost the state of Florida over $600 million in fire suppression, reduced tourism, and damage to commercial timber, businesses, and homes (Mercer et al. 2000). These challenges have a direct impact on public policy, safety, welfare, and quality of life. Furthermore, natural resource managers, policy makers, and communities often do not have adequate information and technology to make science-based resource decisions about these issues.

This paper first describes key wildland-urban interface issues and needs identified in a region-wide assessment of the Southern US. It then describes approaches that the US Department of Agriculture (USDA), Forest Service and University of Florida with guidance from the Southern Group of State Foresters are jointly undertaking to address wildland-urban interface fire research needs and information dissemination.

2 Methods

To address this need for new research and information, the USDA Forest Service conducted an assessment of the wildland-urban interface, titled »Human Influences on Forest Ecosystems: The Southern Wildland-Urban Interface Assessment« (Macie & Hermansen in press). This assessment identified factors driving change, consequences of change, and resulting research and information needs.

2.1 Factors driving change

Among the major factors influencing rapid urbanisation in the South, population growth and changing demographics are the social trends that will likely have the most profound effect on forest ecosystems and their management. The South is the fastest growing region in the US, with a 13.7 percent increase in population between 1990 and 2000. The South's population is projected to increase by 24 percent over the next 20 years, from 91 to 114 million. Florida is the most acutely impacted State with a projected population of nearly 25 million by 2020 (www.floridainformation.com). These changes will create greater demands and pressures on southern forests.

The ageing of the US population also has important implications. Average life expectancy has increased from just below 70 years for people born in 1950 to around 74 for males and just over 80 for females when born in 2000. This is significant because forested and other natural areas are popular as retirement, second home, and recreation destinations, all potential causes of new interface areas. Additionally the influx of people from other nations is helping to create a society that is more culturally and ethically diverse. People from diverse backgrounds and age groups have different perspectives, values, and attitudes with respect to the use and management of forests.

Significant is the rate at which rural land is being converted to urban uses. More rural acreage is converted to urban uses in the South than any other region in the US Out of the 10 states in the US that are experiencing the greatest total acreage of land developed for urban uses between 1992 and 1997, 6 were in the South. Also significant is that the majority of land in the South is in private ownership. And while the number of landowners is increasing, not surprisingly the tract sizes of land are decreasing. Of the South's approximately 432 million acres of rural land, 78 percent is in individual private tracts or corporate ownership, with 66 percent owning less than 500 acres. A 12 % increase in forest landowners was observed from 1978 to 1993 (Wear & Greis in press). Smaller tract sizes, more diverse management objectives, and increases in absentee and retiree ownership are creating unique challenges and opportunities for natural resource professionals.

Economic conditions and tax policies also greatly influence the rate of land-use change in the wildland-urban interface. The Southern economy has shifted from being based primarily on agriculture and natural resources, to being dominated by service, industry, and computer manufacturing sectors. Largely due to this shift, 4 out of every 10 jobs gained in the US since 1978 have been in the South. This has helped to fuel migration to the region and the unprecedented growth of many cities both large and small.

Land use planning and policy is another major factor driving change in the South. Some public policies have created incentives for urban development and further expansion of the wildland-urban interface. For example, the US Federal Government subsidised the creation of the National Interstate Highway system, which opened up vast areas of previously rural land to urban development. However, there are also numerous Federal policies that attempt to conserve and protect natural resources. The Clean Water Act, for example, was created to decrease water pollution.

While federal policy can influence land-use planning, authority to guide land use decisions lies mainly with each State, which may choose to delegate this power to local governments. Among Southern States, only Florida has a comprehensive growth management plan, but this has not been successful in preventing sprawling development. Local zoning decisions in Florida, as elsewhere, favour low-density and large-scale developments, further expanding the interface.

2.2 Consequences of change

The most obvious direct influence of urbanisation and other human activities on forests is the reduction of total forest area and fragmentation of remaining forest parcels. Human influences indirectly alter forest ecosystems by modifying hydrology, altering nutrient cycling, introducing non-native species, modifying disturbance regimes, and changing atmospheric conditions. These changes significantly affect forest health and modify the goods and services provided by forest ecosystems.

These urban influences, along with decreases in tract size, increases in land ownership, and more diverse forest management preferences, are setting the stage for new challenges, as well as new and innovative approaches to forest resource management in the interface. Specifically, managing forests for traditional forest products and managing fire are becoming increasingly complex.

Southern forests are an important national source of timber, making up 40 percent of US timberland (Faulkner et al. 1998). The management and conservation of these forests, however, become increasingly difficult in the interface. Production costs are higher due to higher land costs, which can discourage landowners from making investments in forestry. Selling and subdividing the land can be more profitable, and the rapidly changing land use patterns that are characteristic of the interface may discourage landowners from making long term forest investments. Furthermore, Southern forest landowners increasingly have a variety of reasons for owning forests. Landowners are placing higher values on aesthetics, wildlife, soil, and other non-timber forest resources. Only 7 % of Southern landowners emphasise making money as their primary management objective. Forestry agencies need new skills and approaches for meeting these diverse management objectives.

Decades of fuel build-up and population growth in the interface have created many challenges for managing fire in the wildland-urban interface. Using fire to enhance ecological processes is increasingly difficult, which heightens the challenges associated with preventing and suppressing fire. Negative public opinion regarding fire is one of the biggest obstacles that fire agencies must overcome. People may not understand the benefits of fire or may be concerned about public health and safety. For these reasons fire management cannot be the same in the interface as in rural areas. Different firing techniques and ignition patterns may be needed. Weather and fuel characteristics that are optimal for prescribed fire in rural areas may not be practical in the interface due to concerns over excessive smoke production and risk to structures. Thus, smoke management becomes more of a priority due to increased health, safety, and liability concerns near urban environments.

Because wildland-urban interface fires combine characteristics of wildland fires and structural fires, they present unique challenges to fire suppression personnel. Federal and state agencies are charged to first protect human life and structures, then natural resources. However, wildland fire fighters do not usually have sufficient training in structural fire fighting, and municipal fire departments are not usually equipped or trained for wildland fire suppression (Davis 1986). The challenge in the interface lies in combining fire fighting expertise in both areas and providing cross-training opportunities.

Many other critical management challenges exist in the interface, such as managing water resources, recreation, and wildlife. New adaptive strategies for managing these resources are essential.

2.3 Research and information needs

Four main areas of needed wildland-urban interface research and information were identified in the Assessment.

- *Explaining and adapting to human influences on forest ecosystems*. The influences of land use conversions, pollution, forest fragmentation, and invasive species on forest ecosystem structure, function, composition, and process needs to be better understood. Research in this area would not only help us understand the effects of urbanisation on forest ecosystems, but also help with development of management techniques for multiple, small-scale ownerships.

- *Identifying the influences of public policy on forest ecosystems and their management*. The relationships among public policy, land use change, and resulting changes to forest ecosystems are still poorly understood. Research in this area could help us to better understand the roles, strengths, and weaknesses of various policies at different governmental levels that affect natural resource management and conservation in the interface.
- *Identifying and reducing risk to ecosystems and people in the wildland-urban interface*. Fire, invasive species, groundwater contamination, and other environmental changes present risk for human and forest communities. Controlled experiments, historical studies, modelling, and long-term monitoring are needed to better understand, predict, and avert risk.
- *Understanding and communicating public attitudes, values, and perceptions*. Information about the preferences, values, and attitudes of the diverse Southern society with respect to resource management and conservation is a critical element of any natural resource program. Research in these areas will lead to a better understanding of how differences in age, ethnicity, and cultural backgrounds influence public use and management of forests.

3 Outcomes

A Southern Center

To address these research and information needs, a partnership was created between the USDA Forest Service, the University of Florida, and the Southern Group of State Foresters to establish the Southern Center for Wildland-Urban Interface Research and Information. The Center opened in January 2002 in Gainesville, Florida, with an initial focus on research and technology transfer needed to address fire in the wildland-urban interface in the Southern US. The center's goal is to develop, apply, and exchange information about critical interface issues, serving as a clearinghouse of information. Utilising an integrated, customer-driven approach, the Center hopes to serve a diverse audience including natural resource agencies, planning departments, local policy-makers, and private forest land and home owners. Taking an interdisciplinary approach, the center will expand its focus in future years to include social, economic, policy, land use planning, forest resource management, and other issues identified in the assessment.

The Center's interactive web site, Interface South (www.interfacesouth.org) provides a wide array of information about fire and other interface issues and will help to coordinate and facilitate exchange of information across the Southern US. One of the main features of the web site is the literature database, which includes references and abstracts from over 1,000 journal articles and other publications that were collected for the Southern Wildland Urban Interface Assessment. The web site also features a month-by-month calendar of interface conferences and events; brochures, related web links, and much more. In the future the assessment publication and brochures, as well as other Center publications, will also be added.

The Southern Wildland Urban Interface Network (SWUINET) electronic mailing list (instructions for joining are on the site) provides an opportunity to exchange ideas and information, share opportunities for funding and collaborative projects, facilitate networking, and build a base of information about the wildland-urban interface.

A series of fact sheets about wildland-urban interface issues was initiated as a second vehicle to disseminate information. The first three fact sheets in the series focus on fire issues and will provide basic information that will assist homeowners in assessing and mitigating fire risks on their property.

The first fact sheet, entitled »Understanding fire behaviour«, describes the key factors controlling fire movement and fire intensity, and outlines how interface landowners can use such information to develop home protection strategies. »Considering fire in Florida's ecosystems«, outlines the role of fire and associated fire risks in nine Florida ecosystems. This fact sheet will serve as a precursor to more specific hazard assessment procedures that are currently being developed. A third fact sheet is currently being developed that outlines the key characteristics of fire-resistance in plants. Scientific literature to date includes no species-specific lists on flammability of plants in the southeastern US. Therefore, this fact sheet focuses on general characteristics of plant flammability or fire-resistance, and describes how regular maintenance of landscape plants can lower flammability regardless of species.

Future fact sheets on fire will incorporate data from a study currently being conducted through the Center titled »Assessing and mitigating fire risk for landowners in the southern wildland-urban interface«. Similar extension series on other important wildland-urban interface issues, such as invasive species and land use planning and policy, will be developed in the future.

Fire research projects implemented

Homeowner risk assessment

In order to respond appropriately to the potential fire danger in the wildland-urban interface (WUI), homeowners must be able to understand and assess their individual risk. A variety of guidelines for risk assessment have been produced in the past by both private and public agencies, at national, state and local levels. Most of the guidelines apply to the western US and attention has only recently begun to focus on the Southeast. Risk assessments vary in detail, but most include some evaluation of vegetation around homes or other structures. Common variables included in the assessments are the general vegetation type (e.g., shrubs, forests or landscape plants) and proximity of vegetation to structures. More detailed assessments may recognise some aspect of the density or size of the natural vegetation (or try to differentiate between native and non-native plants). Most assessment procedures are modelled after the hazard rating systems outlined in the National Fire Protection Association publication »NFPA 299: Standard for the Protection of Life and Property« (NFPA 1997).

Risk assessment procedures often incorporate existing guidelines for WUI fire protection, including information about the appropriate size of defensible space. Defensible space refers to an area between homes and adjacent wildlands where vegetation has been removed or modified for fire protection (NFPA 1997). Defensible space guidelines are based on research on the effects of radiant heat (e.g. Cohen 2000) and surveys of homes threatened by WUI fires (e.g. Abt et al. 1987; Graham 1988). However, the geographic distribution of this research is limited, as are the ecosystems in which it was conducted. Few studies have been conducted in the southeastern US.

In 2000, a general brochure (Monroe & Long 2000) was disseminated, which gives homeowners some general descriptions of surrounding natural vegetation that would be considered low, medium or high risk in the case of an approaching fire. Our current research will take that general approach and expand it to major vegetative ecosystems across the southeastern US, ranging from wet hardwood forests, to dense pine stands, to open grasslands and pastures. Within those ecosystems, WUI residential areas represent a continuum of vegetation patterns and associated fire risk that cannot be readily classified into a few risk categories by simply measuring the distance to, and size of, surrounding vegetation.

We are taking a somewhat unique approach to this classification. For each of the general vegetative ecosystems and physiographic regions in the southeastern US, we will define the most critical fire weather conditions that might occur in that region. Those weather conditions will be used as inputs to standard fire behaviour models for Southeast fuel types. Model outputs will include fireline intensity and rate of spread for a wide variety of fuel loads and conditions. These fire behaviour results can then be aggregated into groups of ecosystems and fuel conditions that represent several categories of fire risk. This unique approach to defining WUI home fire risk will also allow us to provide more prescriptive recommendations for mitigating risk, depending on whether the risk is from fire intensity, rate of spread or a combination of the two.

Post-fire assessment

A critical area of fire research in the wildland-urban interface examines the multiple factors that influence the survivability of homes threatened by wildfire. Most studies to date on structural survival are based on field observations of homes that were threatened by fire, examining both houses that burned and those that survived. Using single factor and regression analyses, these observational studies help us to identify the most important factors determining structural survival. Multiple studies have been conducted in the US and in Australia following major wildland-urban interface fires, with most research focusing on the western US. In addition, a few controlled experiments have examined structure ignition in the western US (Cohen 2000).

Several factors have consistently been shown to influence structural survival in wildland-urban interface fires. Fire intensity, vegetation clearance, and building construction properties, such as roofing, are of primary importance (Wilson & Ferguson 1986; Abt et al. 1987; Foote & Gilless 1996; De Witt 2000). With high intensity wildfires, fire services can do little to protect homes at the head of the fire (Roussopoulos & Johnson 1975). Only changes in weather conditions or fuels can alter the fire's path. Most observational post-fire research includes some measure of landscape vegetation, often simply recording the clearance distance of flammable plants. Data from these studies support the common recommendation that a minimum area of 30 feet (1 feet equals 30.3 cm) around structures be cleared of flammable vegetation (Howard et al. 1973; Wilson & Ferguson 1986; Abt et al. 1987; Foote & Gilless 1996; NFPA sa a; b; c). Living and dead vegetation serves as the primary fuel in wildland fires, and by clearing flammable vegetation around homes, fire behaviour can be altered and the associated risk of structural ignition reduced (Cohen 2000).

When wildfires come within a critical distance of structures, building materials can significantly influence structural survivability (Cohen 2000). While heat from an approaching fire or direct flames can ignite structures, floating burning embers (referred to as firebrands) are also a common source of structural ignition. In wildland fires, the roof is often the most vulnerable part of a home (Wilson 1962; Wilson & Ferguson 1986; Graham 1988; NFPA sa b). Other characteristics of building construction may, however, also be important, including window type and exterior siding (Wilson & Ferguson 1986; Ramsay et al. 1996).

Many natural resource agencies have developed documents for homeowners, developers, fire services, and politicians with information on protecting homes from wildfires. However, most guidelines contain no documentation of how they were developed and are often based on publications developed in other states or at the national level. While recent studies have attempted to validate current home protection strategies, more observational data on structural survival must be collected to test current guidelines (De Witt 2000).

One example of a mitigation practice that may warrant modification is the common recommendation of 30 feet of defensible space. The factors that influence the effectiveness of defensible space, including fuel type, fuel loading, and topography, vary significantly geographically. In recognition of this variation, the state of California developed an ordinance, Public Resource Code 4291, which requires a minimum of 30 feet of defensible space around homes in high fire hazard areas, but the law allows local regulatory agencies to increase the required area up to 100 feet under certain conditions (e.g. steep slope). However, in Florida, as in many other states where wildfires occur, the recommended area of defensible space is 30 feet regardless of local conditions. Testing current fire hazard mitigation recommendations under a variety of local conditions will help fire professionals identify potential improvements and supply policy makers with the empirical data required to develop and implement public policy focused on fire prevention.

In this research project, post-fire assessments are being conducted to improve our understanding of factors determining structural survival during wildfires. The methodology being implemented was based on past observational studies on the subject; however, our characterisation of the vegetation around homes will be more detailed incorporating spatial arrangements and species. Improving basic knowledge of the relations between vegetation landscaping and structural fire hazard is one of the studies primary goals.

Preliminary data were collected in 2002 in Florida communities that had multiple homes threatened by wildfire and at least one home damaged. Plans are underway to expand this study in 2003 to other states in the southern US. Each threatened and/or damaged home is visited immediately following the fire, and field data are collected on multiple variables associated with structural loss. Measured variables include structural properties, landscaping characteristics, and community design/layout. Fire reports on weather and defensive actions that were taken are obtained from fire service agencies. Homeowners of threatened or damaged homes are also interviewed for information on the use of preventive or defensive actions and to better characterise the property prior to the wildfire event.

Finally, all vegetation is described and mapped within a 100-foot radius of each threatened house. By collecting detailed information on the landscape vegetation and layout, the study was designed to examine the fire risks that accompany individual plant species and mulches, as well as their spatial arrangement.

Flammability of shrub species from Pinus sp. flatwood and hardwood hammock ecosystems

Residents in interface areas are instructed to remove flammable vegetation as part of defensible space strategies for wildfire protection. However, lists describing the flammability risk of different plant species are rarely available. The lists that do exist in the Southeast US are from unknown origin or were generated using data from different geographic regions. Many characteristics are known to affect flammability, making it difficult to generalise flammability based on a few characteristics. To complicate the situation further, no standard method of quantifying plant flammability exists, therefore comparing results from plant flammability studies is difficult. In many cases, the landscaping around interface homes includes many species native to the surrounding ecosystem. The brush or shrub clearance is an important factor determining structural survival during wildfires in the Southeastern US (Abt et al. 1987; De Witt 2000). Determining the flammability of shrub species will help in defining defensible space strategies specific to ecosystems.

Plant flammability can be simply defined as the ability of a plant to spread fire to surrounding vegetation or structures. More specifically, flammability is collectively ignitibility, sustainability, combustibility (Anderson 1970), and consumability (Martin et al. 1994) of a fuel. Ignitibility is defined as the time to ignition at a constant temperature. Once ignited, sustainability is the ability of a fuel to sustain fire with a constant heat source. Combustibility relates to how fuel is consumed and consumability is the proportion of the mass or volume consumed by fire. Environmental conditions, such as weather and climate, can influence the flammability of a plant. However, there are many intrinsic and structural plant characteristics that affect plant flammability.

At the chemical level, major influences on flammability are moisture content (Countryman 1974; Gill et al. 1978); percent cellulose, hemicellulose, and lignin (Philpot 1970); volatile extractive concentration (Shafizadeh et al. 1977; Susott 1982; Owens et al. 1998); and silica-free mineral content (Mutch & Philpot 1970; Philpot 1970). These components interact to influence ignitibility, sustainability, combustibility, and consumability. The arrangement of fuel on a plant also influences these components of flammability. High surface-area to volume ratio and low particle density of plant tissue increases flammability (Montgomery & Cheo 1971). Bulk density (total above ground mass per plant volume) and porosity (canopy volume to fuel volume) also affect flammability (Rundel 1981). The chemical and structural components of fine fuels are important for flammability in the context of home landscaping as fine fuels often ignite first and facilitate the advancement of a fire front (Anderson 1970).

Structural and chemical characteristics of flammability are being studied in the context of shrub species in two Florida ecosystems with very different fire behaviour. *Pinus sp.* flatwood ecosystems have a fire-return interval of 1-8 years, whereas in hardwood hammock ecosystems the interval is 30-50+ years (FNAI 1990). The objectives for this study are 1) to develop a methodology for studying flammability of individual species, 2) to increase information on factors influencing flammability, 3) to rank the species studied by flammability, and 4) to determine if shrub species from hardwood ecosystems are less flammable than shrub species from flatwood ecosystems.

Four shrub species in each ecosystem are being analysed for structural and chemical characteristics of flammability. In addition, *Serenoa repens* and *Myrica cerifera* are being studied in both ecosystems. Species used in this study include those thought to be highly flammable: *Serenoa repens* (saw palmetto), *Myrica cerifera* (wax myrtle), and *Ilex glabra* (gallery); and those thought to be less flammable: *Vaccinium arboreum* (sparkleberry), *Calicarpa americana* (beautyberrry), and *Quercus nigra* (water oak). To control for cultural methods, data are being collected in the plants' natural settings; multiple sites of each ecosystem were used in North Central Florida. Three plants of each species are randomly selected at each ecosystem site. For each individual plant, multiple characteristics related to flammability are measured.

Data to be collected includes; litter depth and density; percent total mass in fine fuels (leaves, fallen debris, stems <0.6 cm diameter); moisture content of all plant components (litter, fine fuels, stems (>/= 0.6 cm diameter), and flowers and fruits); bulk density; specific leaf area ($cm^2 \cdot g^{-1}$); leaf volatile solids ($mg \cdot kg^{-1}$); and leaf energy content ($cal \cdot g^{-1}$). To examine the contribution of individual species to the overall site flammability, the density of each species will be measured at each site. Using ANOVA, data will be analysed to test ecosystem, site, and species effects on the characteristics measured. Further analyses may be performed using multivariate statistics. By quantifying multiple variables that contribute to plant flammability, a more complete assessment of plant flammability will be made.

Fuel reduction method

Because fuels rapidly build up in this region with high lightning frequencies, fires are inevitable unless an active fuels management programme is implemented. Structural characteristics of wildland fuels, beyond the landscaping that surrounds homes, often contribute to intensity and spread of wildland-urban interface fires. Fuels may include living shrubs, vines, grasses and trees of all sizes as well as dead material from these components. Dense shrub layers or continuous vertical structures often present the most difficult problems. One very important approach to reducing homeowner risk from wildfire is to reduce the amount of wildland fuels around homes; on adjacent lots; or to create larger fuel breaks through the vegetation around communities. Individual homeowners and community associations need information on how best to accomplish this task

Chemical herbicides, mechanical systems such as mowing, crushing or manual cutting and removal, prescribed burning and grazing animals have all been used for decades to reduce fuels on large wildland areas. Research has documented some of the advantages and problems associated with several of these methods (Brose & Wade 2002). For example, prescribed burning is often the method of choice because of its natural role in most ecosystems and its low cost per acre for most burns. The use of herbicides and fire are not limited by slope, as are most mechanical systems. Plants readily resprout following all treatments but herbicides. Considering fuel reduction options in the context of the WUI adds additional concerns of cost for treating small areas, public issues and safety, and invasion of a variety of exotic plants after treatment. Although many different fuel reduction methods have been used in the wildland-interface, comparisons among them are much more limited than for treatments on large wildland areas.

We have taken two approaches to addressing the need for more information on fuel management in the interface. The first was an extensive review of treatment options, including effects, and costs using published literature and agency reports. We focused on treatments that can be implemented in small areas. As this information is compiled and summarised for landowners, it will emphasise relative costs and effects of each practice as well as their application. The second approach involves the installation of side-by-side comparisons of mowing, herbicides, prescribed burning, and a no-treatment control in one of the most problematic shrub communities in Florida. The first treatments will be applied in late summer, 2002. This field study will be augmented with additional information collected at sites across Florida where one or more of these fuel treatments have been used operationally.

4 Discussion

The catastrophic fires occurring in 2002 throughout the US reconfirm the importance of understanding the problems in the wildland-urban interface and the need for their mitigation and prevention. Creating defensible space around homes has been required for years in California under its California Public Resources Code 4291. Experience has shown that many residents do not comply since they do not think a devastating wildfire could affect them. Because of the complexity of situations that have led to fuel build-ups in rural areas and conditions that have caused urban spaces to be less defensible, the problem has become much more complicated.

The Southern Center for Wildland-Urban Interface Research and Information seeks to provide useful interface information to a variety of audiences. Two methods of disseminating this information are through the Center web site and through a series of fact sheets that are made readily available to the general public.

The body of literature is also being analysed to provide guidelines for homeowners and land managers to assess their risk of wildfire and provide them with the best available methodologies for mitigating hazardous conditions. At the same time research has been initiated to better understand the conditions associated with fire risks and to serve as a basis for developing prescriptive management opportunities. Following wildland-urban fire events in the Southern US, a team is immediately visiting the sites to make a careful post-fire assessment to document those landscape and structural features that led to or prevented fire spread. Common forested ecosystems involved in the wildland-urban interface in Florida are being characterised for flammability of key shrub species that could contribute to fire development and spread. With this knowledge, managers can devise practices to reduce the highly ignitable plants in the landscape. Armed with this information defensible space and building standards can be better defined for those living in or managing lands in the interface.

Fuel mitigation practices include the removal of vegetation in order to reduce fuel available for fire. Physical, human health, environment, or attitudinal reasons frequently limit some well-known fuel reduction procedures like forest thinning and prescribed burning. In these situations mechanical mowing and crushing or herbicidal treatments may be feasible. It is the object of this research to define the comparative advantage of each treatment for specific wildland urban interface conditions.

It is the goal of the Southern Center for Wildland-Urban Interface Research and Information to promptly transfer information from this and other research to those directly involved or affected by fire. The Centers website and fact sheet series will be refined, expanded and enriched with workshops seminar and other specialised tools for technology transfer. Problems in the wildland urban interface have existed for a long time.It is imperative that appropriate political, social and environmental solutions are addressed immediately to protect both human and forest communities as the situation is becoming increasing complex.

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Application of bio-waste compost in urban forests – chances and risks

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Abstract

In Vienna about 80,000 to 105,000 tons of organic waste are collected each year as input for the municipal bio-waste compost production. This recycling product is applied as humus and soil conditioner for soil improvement in private gardens and as organic slow release fertiliser on municipal owned organic farming land. For proposed applications of bio-waste compost in urban tree sites an ecological compatibility evaluation was carried out. Two field experiments were established in the vicinity of Vienna: a planting pit experiment and a surface application treatment experiment. When comparing different batches for most chemical properties the quality of the bio-waste compost is very inhomogeneous. Calculations of appropriate application doses have to be accompanied by extended quality controls not only to prevent exceeding heavy metal threshold values but also solubility and nutrient element ratios. Mortality rates in the planting pit experiment increased with application doses up to more than 40 % over 3 years, possibly because of high ammonia concentrations of the used bio-waste compost batch during the establishment phase. Growth increment decreased with compost application. In the surface treatment experiment no significant influence of low bio-waste compost application on biometric parameters was observed except for *Fraxinus*. N-contents as well as K-contents of foliage increased with higher application doses, Mg-contents decreased. Nutrient contents of tree foliage reflect the element mobility and solubility as well as unbalanced element ratios of the applied product. Shortly after application nitrate concentrations in soil solutions exceeded the threshold values three times for drinking water in the upper 30 cm of the soil. The product bio-waste compost can be used as amendment for urban forest sites that are poor in humus content and compacted; it improves organic contents of soils and enhances soil biota. Because of likely high plant available Na- and K-contents, low Mg-contents and generally high pH it is no ameliorative additive to improve de-icer contaminated soils in Vienna. For improving nutrient depleted urban tree sites the product can be recommended with some exceptions.

Key words: bio-waste compost, nitrate, potassium, magnesium, tree growth.

1 Introduction

In Vienna up to 35 % of the household waste is organic. The bio-recycling-management concept of the municipality requires separate collection of 80,000-105,000 tons of organic waste per year. In two compost preparation plants between 25,000 and 30,000 tons of bio-waste compost are produced (Spet et al. 1998). The input material is sorted and composted in turned piles in an open rotting process with an average production time of 3-4 months. This simple classical process may have some disadvantages; e.g. control of moisture and aeration (oxygen) is bad, and compost maturation is inconstant (Gomez 1998). Quality control is provided for the input material as well as for the ongoing rotting process and for the final product (Rogalski 2001). Up to 50 % of the produced compost fulfils the Austrian quality standards for application in biological organic farming (A+, according to the Council Regulations EEC No 292/91). The remaining part fulfils the criteria for compost quality class A. Quality standards are defined according to threshold values for total heavy metal contents (Mochty 2001).

The municipality owns 1,800 ha of mostly organic farming land, where bio-waste compost is used as slow release fertiliser and as compensation for humus losses. Furthermore it is used as soil improvement material for city owned gardens, parks and urban woodlands. Bio-waste compost is distributed free of charge for soil improvement in privately owned gardens (Spet et al. 1998).

A further possible application field of this recycling product may be the improvement of soil quality in degraded urban forests and urban tree sites. These sites show high humus losses and nutrient depletion and deterioration of nutrient balance due to common management and maintenance practices of litter removal or wind erosion. They are often highly impacted by different stresses like de-icers, soil compaction and soil pollution. To ensure save application of bio-waste compost at urban tree sites, an environmental compatibility assessment was carried out focussing on growth reaction of trees, nutrient balances and chemical quality of soil solution.

2 Material and methods

Establishment of field experiments

In 1999 two field experiments were established in the vicinity of Vienna. In a planting pit experiment the natural soil material, an Anthric Fluvisol, was mixed with respectively 0, 20 and 40 vol. % bio-waste compost and afforested with *Acer platanoides* and *Tilia cordata* with 12 replicates per species and treatment. A second experiment was carried out in an existing, on average 15 years old, mixed deciduous tree-stand (*Acer pseudoplatanus, Tilia cordata, Prunus avium, Fraxinus excelsior, Robinia pseudacacia*). The bio-waste compost was applied on the surface in treatments of 0 cm, 1 cm (equivalent to 700 kg N per ha) and 2 cm (equivalent to 1400 kg N per ha) respectively. The soil type is shallow Anthrosol or Anthric Chernozem (the upper humus rich soil horizon has been removed). The fine soil horizon is 30-40 cm deep with an underlying calcareous gravel layer. During the experiment biometry and phaenology of trees were monitored for both experiments as well as soil and foliage chemistry. In the surface application experiment 4 suction cups (Soil Moisture Equ.) for each treatment in two different soil depths (15 and 30 cm) were established and soil solution was sampled continuously depending on precipitation.

Chemical analysis

Soil solution samples were analysed for cations and metals after filtration with membrane filters (0.45 µm) and stabilisation with chloroform, using simultaneous ICP-AES (Optima 30000 XL, Perkin Elmer), anions with Ion Chromatography (DIONEX).

Foliage was sampled in autumn from all trees in the planting pit experiment and from at least 9 trees from each species (except for *Tilia*) in the surface application experiment. The samples were analysed for N_{org} using the semimicro-Kjeldahl-method, all other elements were determined after pressurised microwave digestion (Multiwave, Perkin Elmer) in $HNO_3/HClO_4$ with simultaneous ICP-AES.

Bio-waste compost samples were cored in three replicates and homogenised by grinding in an achat mill for total contents, for cold-water extracts homogenised by hand. Soil samples were cored in at least 3 replicates for each treatment and separated in the respective horizons. Fine soil (< 2mm) was taken for further analyses and calculations.

Analytic methods consisted of: C_{org}: C/S-Element Analyser; N_{org}: Semimicro-Kjeldahl; direct soluble cat ions and metals: cold water extraction, ICP-AES; soluble anions: cold water extraction, Ion chromatography. For total contents of cations and metals: microwave digestion in $HNO_3/HClO_4$, ICP-AES.

3 Results and discussion

The most important quality criteria of composted material for application in urban tree sites and degraded urban forests are the following (see also Mayr 1999):

- stabilised rotting process, high maturation
- high organic content with a low C/N ratio
- slow release of nutrients, especially slow mineralisation of N-compounds
- balanced nutrient contents and ratios
- low salt content
- low content of heavy metals and toxic substances

Quality of bio-waste compost

Table 1a and 1b provide information on the chemical properties and homogeneity of the product »bio-waste compost« and on the chemical properties of the batch used for the experiments. Even after input quality control the product is quite inhomogeneous for both macro elements and for micro- and trace elements and metals. Overall these are within the frame of contents for composted additives in Europe (Gomez 1998). Threshold values for heavy metals relevant for quality standards are in some cases exceeded. The batch used for our experiments (Table 1b) is within the threshold values of heavy metals for quality standard A+ according to EG regulation 2092/91 (Öko-Verordning (EWG)). K and Na are highly water soluble, Cl reaches high water soluble concentrations: these values indicate the household origin of the input material. The high water solubility of Cl corresponds to the alkaline pH of 7.9. The high Cl content of the concerned bio-waste compost might be problematic as ameliorative for de-icer affected soils.

Table 1a. Mean values and standard deviations of respective chemical parameter of bio waste compost (n = 75); analytical results from MA 22, Vienna.

Parameter	Mean (DW)	Std
C org mg/g	250	45
N total mg/g	17	5,4
Nitrate-N mg/g	-	-
Ammonium-N	557,6	1029,8
C/N	16	8,3
P total mg/g	3,1	0,8
P available mg/g	1,4	0,7
K total mg/g	11,2	3,4
K available mg/g	8,3	2,8
Ca total mg/g	53,6	10,4
Mg total mg/g	12	2,3
Fe total mg/g	15	2,8
Mn total µg/g	427,7	80,97
B available µg/g	12	5,8
B total µg/g	35,5	13,57
Cu total µg/g	67,3	17,9
Zn total µg/g	248	66
Cr total µg/g	30,4	15,6
Ni total µg/g	25,1	8,8
Cd total µg/g	0,5	0,2
Hg total µg/g	0,4	0,2
Pb µg/g	64	29,6

Table 1b. Chemical analyses of the experimentally used bio waste compost batch (n = 6).

Parameter	Total content	Water soluble (%)
C org mg/g	199	
N / NO3 mg/g	16,3	0,40 (2,42)
NO2 mg/g		0,14
C/N	12,2	
P mg/g	2,58	0,22 (8,63)
S mg/g 2,39	0,25	
K mg/g	9,59	6,83 (71)
Mg mg/g	5,47	0,14 (2,56)
Ca mg/g	37,8	0,55 (1,46)
B µg/g	30,9	12,65 (40,8)
Fe µg/g	8912	145,60 (1,63)
Mn µg/g	337,8	4,28 (1,27)
Na µg/g	916,9	782,5 (85,3)
Cl µg/g		3400
Cd µg/g	0,29	0,15 (52,6)
Co µg/g	3,80	0,17 (4,76)
Cr µg/g	17,97	0,16 (0,89)
Cu µg/g	51,7	2,65 (5,13)
Ni µg/g	13,02	1,03 (7,91)
Pb µg/g	42m9	0,15 (0,35)
Zn µg/g	85,3	3,69 (4,33)

After a severe winter in Vienna up to 1200 µg Cl/ g soil was measured. Total nitrogen contents are within the values reported by Gomez (1998).

The breeding experiment (Table 2) reveals that after 6 weeks incubation at 20 °C the cold water extractable nitrate content increased significantly. The N_{min} fraction of N_{tot} increased from 2.4 % to 4.2 %. This can be seen as an indicator for possible N-losses via nitrification during the time of inactive vegetation. The low C/N ratio (12) makes it unlikely that N_{min} is immobilised (Kehres 1991). More than 80 % of the soluble nitrite is nitrified. Breeding increased sulphate-S concentrations as well as salinity, the later significantly. Phosphate-P, Cl and all soluble cation-concentrations (except Na) decreased during breeding as well as the soluble amount of heavy metals. These elements are incorporated into soil biota. The data reveal that, in contrast to agricultural use where high amounts of different elements are removed by harvesting, applications in woody long-lasting vegetation require not only control of heavy metal threshold values as quality standards but also control of contents of other nutritional elements (Hartl & Erhart 1998). For long-lasting vegetation not only the total content should be taken into account for quality control standards, but also the percentage of water solubility or exchange availability.

Urban soils are often highly compacted. By applying an organic additive soil physical properties might be improved indirectly. Compost produced from town waste generated a positive impact on hydraulic conductivity, water retention capacity, bulk density and aggregate stability (Aggelides & Londra 2000). Caused by maintenance practice and natural erosion, soils in urban forests and on tree sites have a low content of soil meso-fauna like earthworms, which are able to improve soil structure in compacted tree sites. Application of bio-waste compost with a low

Table 2. Water soluble fractions of bio waste compost before and after breeding at 20 °C for 6 weeks.

parameter	untreated	breeded	?????	significance
Cl µg/g	3400	2499	- 26,5	yes
NO3 µg/g	1747	3049	+ 74,5	yes
NO2 µg/g	475	73	- 84,6	yes
PO4 µg/g	843	667	- 20,9	yes
SO4 µg/g	1578	1716	+ 8,8	no
Ca µg/g	545	444	- 18,5	yes
Mg µg/g	144	111	- 23,0	yes
K µg/g	6831	6814	- 0,3	no
B µg/g	12,6	12,5	- 0,8	no
Mn µg/g	4,3	3,2	- 25,6	no
Na µg/g	783	812	+ 3,7	no
Fe µg/g	145,6	76,4	- 47,5	yes
Cd µg/g	0,15	0,11	- 26,7	yes
Co µg/g	0,17	0,15	- 11,7	no
Cr µg/g	0,16	0,07	- 56,3	no
Cu µg/g	2,65	2,46	- 7,2	no
Ni µg/g	1,03	0,89	- 13,6	yes
Pb µg/g	0,15	0,04	- 73,3	no
Zn µg/g	3,69	2,78	- 24,7	no
el.cond. ms/cm	1,07	1,40	+ 30,8	yes

C/N ratio improves living conditions and reproductiveness for earthworms feeding on micro-organisms (Kromp et al. 1995; Schwaiger & Wieshofer 1996). As soils in urban environment are said to be a pollutant sink (Paterson et al. 1996) their heavy metal contents are generally higher when compared to agricultural soils. In absence of industry this can be mainly attributed to traffic and heating systems. Even if we assume that the heavy metal content of the bio-waste compost is low, its addition may lead to an increase of heavy metal loads at urban tree sites (De Miguel et al. 1998).

Impact of bio-waste compost application on biometric parameter

Figure 1 reveals that the mortality rate of young trees (*Tilia cordata*) in the planting pit experiment increased significantly after three growing seasons (1999-2001) with increasing compost application. Courtois (1979) reports increasing mortality rates for pine with increasing waste compost application caused by pathogen fungi. In the case of *Tilia* the trees did not sprout. This can be interpreted as an effect of toxic ammonia concentrations caused by an unstabilised rotting process. As indicated in table 1a the mean Ammonia value of 557.6 with a standard deviation of 1030 might haven been toxic for young tree roots (Feng et al. 1997). Figure 2 demonstrates the growth reaction of *Tilia* to bio-waste compost application. The diameter at 0.3 m, the DBH and the total tree height increment show a negative impact of the compost application throughout three growing seasons. These effects are statistically significant for the 40 vol. % treatment. Nitrogen is the most growth limiting and determining element. Compost addition was expected to have affected tree growth positively. Because of unbalanced nutrient ratios (low soluble N and Mg, high soluble K-content), the growth reaction of surviving, slow growing young trees was detrimental (Chapin 1983).

Growth reactions during three growing seasons of five tree species of the surface

Table 3. Height increment and diameter increase at breast height after 3 years (1999-2001, surface application experiment). Different letters indicate statistical significance at level p=0.05.

	Compost					
height increment (m)	**0 cm**		**1 cm**		**2 cm**	
Acer	1,46	a	1,61	a	1,38	a
Fraxinus	1,88	a	2,33	b	1,90	a
Robinia	1,43	ab	1,60	a	1,23	b
Prunus	1,28	a	1,58	ab	1,67	b
Tilia	1,40	a	1,31	a	1,15	a
DBH-increment (cm)						
Acer	1,23	a	1,54	a	1,57	a
Fraxinus	1,65	a	12,11	ab	2,42	b
Robinia	2,39	a	3,12	a	2,65	a
Prunus	1,76	a	2,08	a	2,21	a
Tilia	1,98	a	1,38	a	1,41	a

application experiment are given in Table 3. Bio-waste compost as a slow release fertiliser produces for all tree-species, except for *Tilia,* a tendency of increasing tree height for the lower (1 cm) compost application, but a decrease for the 2 cm application, in some cases the tree height was lower then for the control trees. Only for *Punus* a statistically significant increase of tree height with the higher compost application was found. Similar results were reported for pine-trees 10 years after application (Curtois 1979). Kern (1984) reports a similar limited improvement of tree growth for a mixed pine-beech stand. All tree-species except *Fraxinus* showed no statistically significant DBH-increment with increasing compost application; *Fraxinus* only showed significant increment for the 2 cm treatment.

Impact of bio-waste compost surface application on tree nutrition

Figure 3 provides information on the N-content of the tree leaves in late summer 1999 and 2000 respectively with lower and upper threshold values for appropriate nutrition (Bergmann 1993). Most control trees were below or at the lower threshold value, in late summer 1999 after compost application for all tree-species N-contents of leaves increased with compost application, in all cases significantly for the 2 cm treatment, for *Fraxinus* and *Robinia* also for the 1 cm treatment. At the

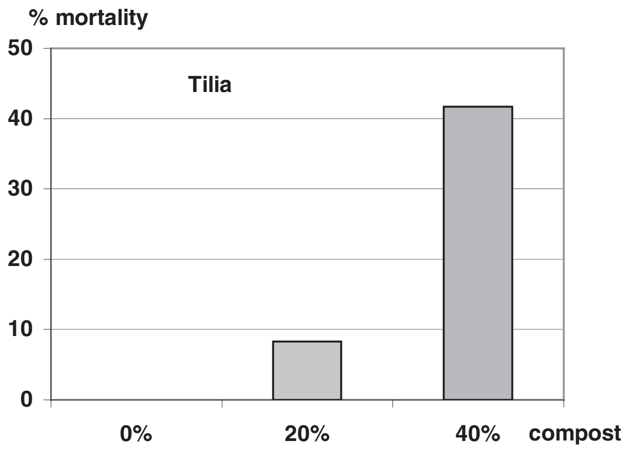


Figure 1. Mortality rate for Tilia cordata *in the planting pit experiment after 3 vegetation periods (1999-2001).*

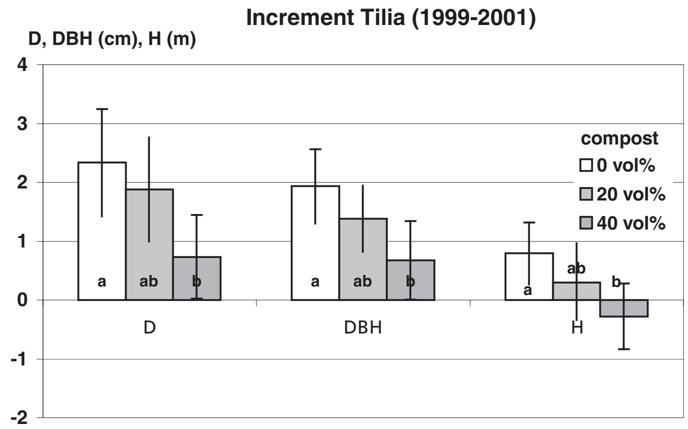
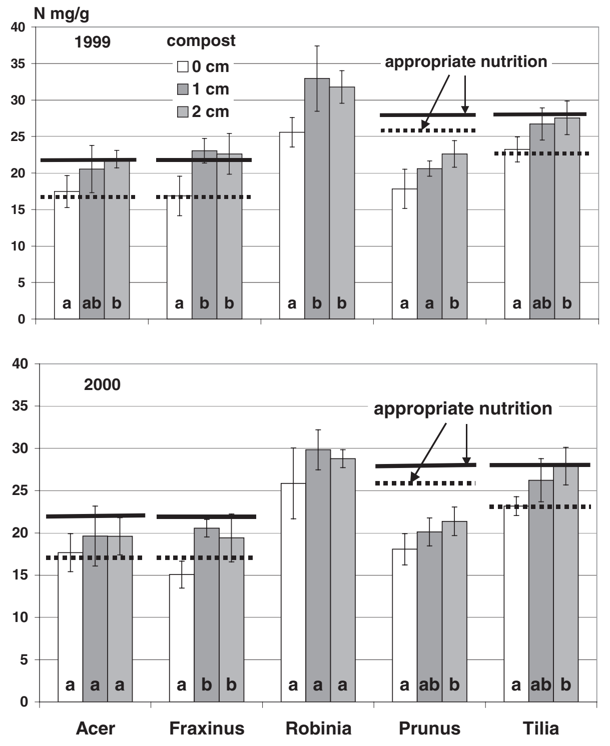


Figure 2. Biometric parameter for Tilia cordata *in the planting pit experiment after 3 vegetation periods. D = diameter (cm) at 0,3 m, DBH = diameter (cm) at breast height, H = height (m). Different letters indicate statistical significance at level p=0.05.*

end of the growing season, the N-content of control trees remained comparable to 1999, the significance's between the treatments was about the same except for *Acer* and *Robinia*. Absolute values show a different picture: for *Acer, Fraxinus, Prunus* and *Robinia* both treatments decreased, for *Tilia,* a slowly reacting species, a small increase for the 2 cm treatment occurred. All examined tree species showed K-supply, which is below or at the lower threshold value for appropriate nutrition (Figure 4). The high K-solubility of the applied bio-waste produced significant increases of K-content in late summer leaves (1999) except for *Fraxinus* and *Tilia*. In September 2000 K-contents of all trees were lower than in 1999 independent from compost application. This may have been caused by insufficient water supply because of low precipitation in 2000. The treatment effects disappeared in *Robinia*. In late summer 1999, Mg-contents of untreated trees exceeded the upper threshold value for all species (Figure 5). For all species a decreasing trend with compost application occurred, but was statistically significant only for *Robinia* and *Prunus*. This trend remained for all species in autumn 2000 except for *Fraxinus*. In autumn 2000 the Mg-contents of all trees decreased independent from treatment except for *Robinia.* Compared to untreated trees 18 month after compost application, the Mg-contents was significantly lower in compost treated *Acer* and *Robinia,* for *Prunus* only in the 1 cm treatment. Antagonistic relations between K and Mg are reported by different authors (e.g. Bergmann 1993) and might be causal. Under field conditions the interactions between water availability, nitrogen and potassium supply are of particular importance. Potassium is highly mobile in soils and plants and has great importance for stomata aperture. Growth response curves are strongly modulated by interaction between mineral nutrients and other growth factors like water supply (Marschner 1995). As the soluble K-content of the soil was 10 fold for the 1 cm and 16-30 fold for the 2 cm treatment in the upper 10 cm compared with control plots, the extremely high K-influx may have induced a late stomata closure and unproductive water consumption and reduced growth increment of treated trees (Leonardi & Flückiger 1986). For a nutrient deficient *Pinus sylvestris* stand Deschauer (1995) reports that 2 years after bio compost application a negative trend of N-supply as well as for K and Mg was observed. Concurrence for nutrients by understorey vegetation has to be taken into account too.



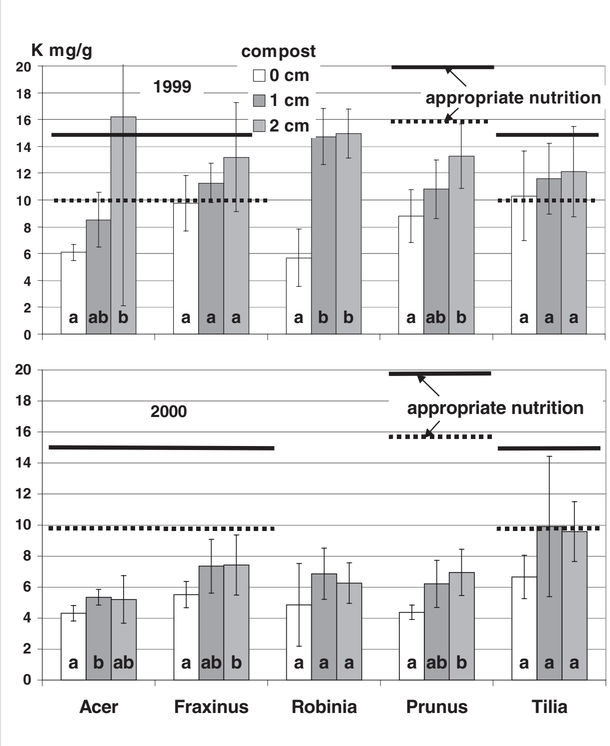


Figure 3 (left). N-content of leaves in late summer 1999 and 18 month (2000) after surface treatment. Threshold values for appropriate nutrition according to Bergmann, 1993. Different letters indicate statistical significance at level p=0.05.
Figure 4 (right). K-content of leaves in late summer 1999 and 18 month (2000) after surface treatment. Threshold values for appropriate nutrition according to Bergmann, 1993. Different letters indicate statistical significance at level p=0.05.

Impact of bio-waste compost surface application on soil solution chemistry
Figure 6 shows the development of nitrate concentrations in soil solutions of different compost treated plots from spring 1999 to end of September 2001 for 15 cm and 30 cm soil depth in a logarithmic scale. Only 3 times shortly after 2 cm compost application in the upper soil horizon, nitrate contents of the soil solutions exceeded the Austrian threshold values for drinking water (50 mg/l), up to more than 4 times. For the lower compost application the nitrate values remained below the threshold values. In 30 cm soil depth 2 values, one from each treatment, exceeded the threshold values 1.3 fold. In spring 2000 nitrification without consumption by active vegetation lead to a small nitrate peak, which is highest in the 2-cm treatment (16 mg/l). Concerning K-contents of soil solution (Figure 7), in both soil depths the concentrations are positively correlated to the treatment and to high solubility and mobility of this element. In both treatments and soil depths a decrease within the 30 months of observation was observed, concentrations in soil solutions of compost treated plots were always higher than in untreated due to high mobility and wash out of leaf litter with a high potassium content. For Mg (Figure 8) in both soil depths for the first year, the concentrations in soil solution correspond with the treatment, due to slow mobility the values in the upper horizon remain higher. From summer 2000 to the end of the observation period the values are about the same in both horizons. Meiwes & Bauhus (1992) report that 3 years after bio compost application in a *Fagus sylvatica* stand no increase of nitrate-concentrations occurred. Deschauer (1995) reports a nitrate concentration of 70 mg/l in 40 cm soil depth after bio compost application in a nutrient depleted 80 years old *Pinus sylvestris* stand. Similarly K-concentrations increased to 100 mg/l. These peak values vanished quickly and K was washed out to deeper soil horizons.

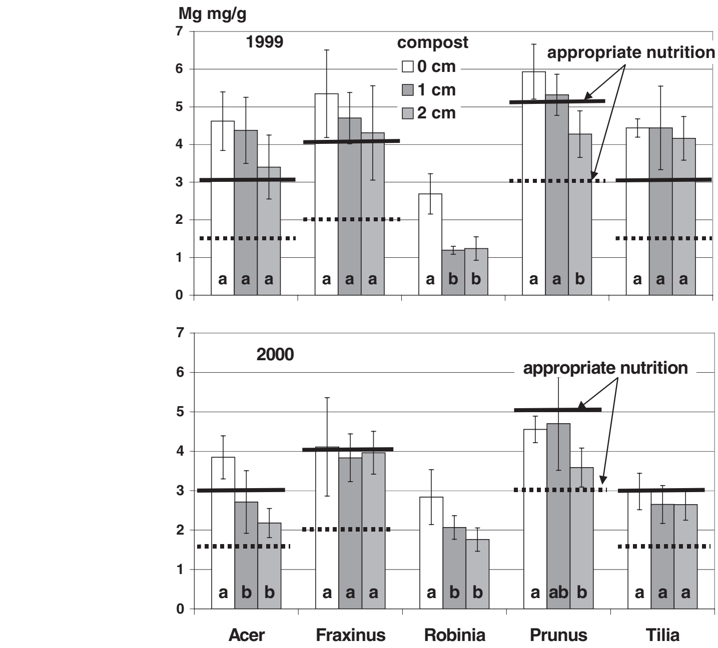


Figure 5. Mg-content of leaves in late summer 1999 and 18 month (2000) after surface treatment. Threshold values for appropriate nutrition according to Bergmann, 1993. Different letters indicate statistical significance at level p=0.05.

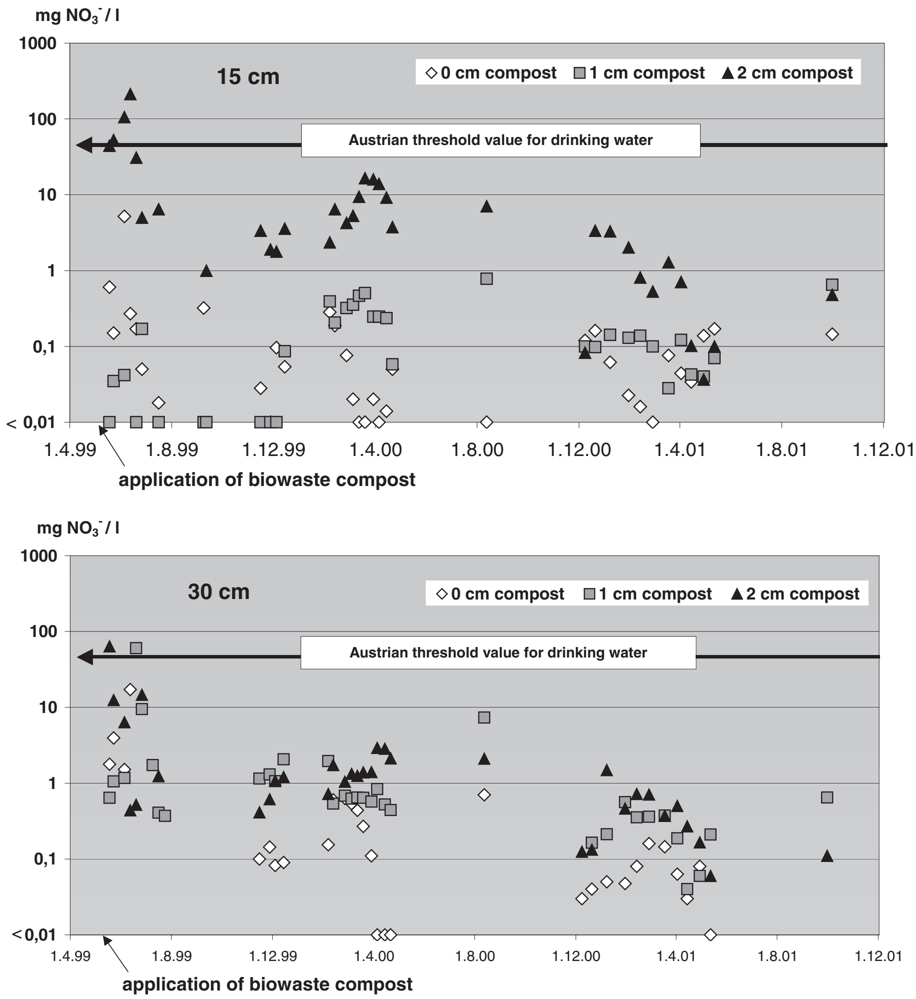


Figure 6. NO_3-content of soil solution from different bio waste compost treated plots: spring 1999 to end of September 2001 in 15 and 30 cm soil depth.

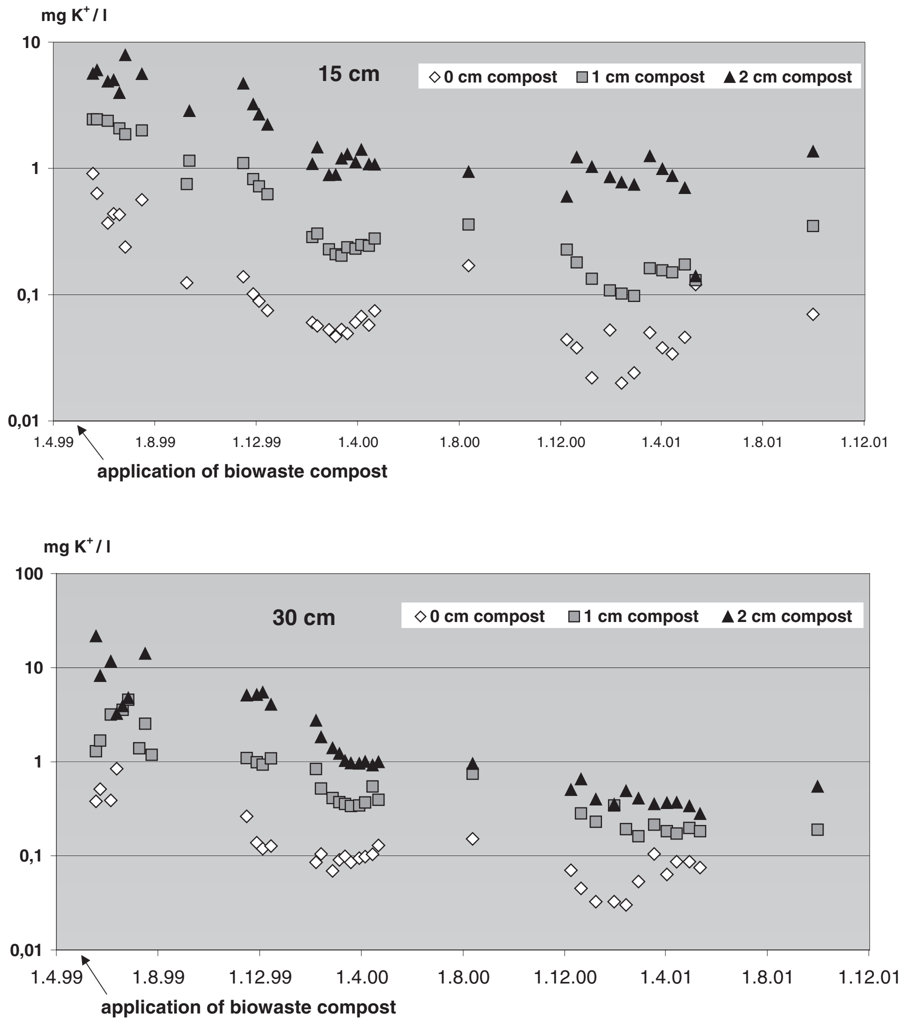


Figure 7. K-content of soil solution from different bio waste compost treated plots: spring 1999 to end of September 2001 in 15 and 30 cm soil depth.

Provided the soils are not too sandy, highly absorbing and deep enough, nitrogen losses and groundwater contamination are no threats for the environment after bio-waste compost application (Vandré 1994).

4 Conclusions

The recycling product »bio-waste compost Gartenland« was tested for future application in urban forests and on urban tree sites. For application on a wider scale the soil on the sites as well as the bio-waste compost should be chemically tested not only for heavy metals but also for plant available element contents and ratios. Nitrate release to the groundwater table is unlikely because of slow N-mineralisation. For application as soil additives in planting pits the most important constraint is a sufficient matureness of the compost. The substrate should be mixed with maximum 20 vol % of bio-waste compost. The mineral soil should be poor in humus and nutrients with a medium texture to ensure good aeration and reduction of the formation of a toxic ammonia concentration in the rooting zone. Planting shortly after substrate composition should be avoided.

Surface application of bio-waste compost in urban forests and urban tree sites is

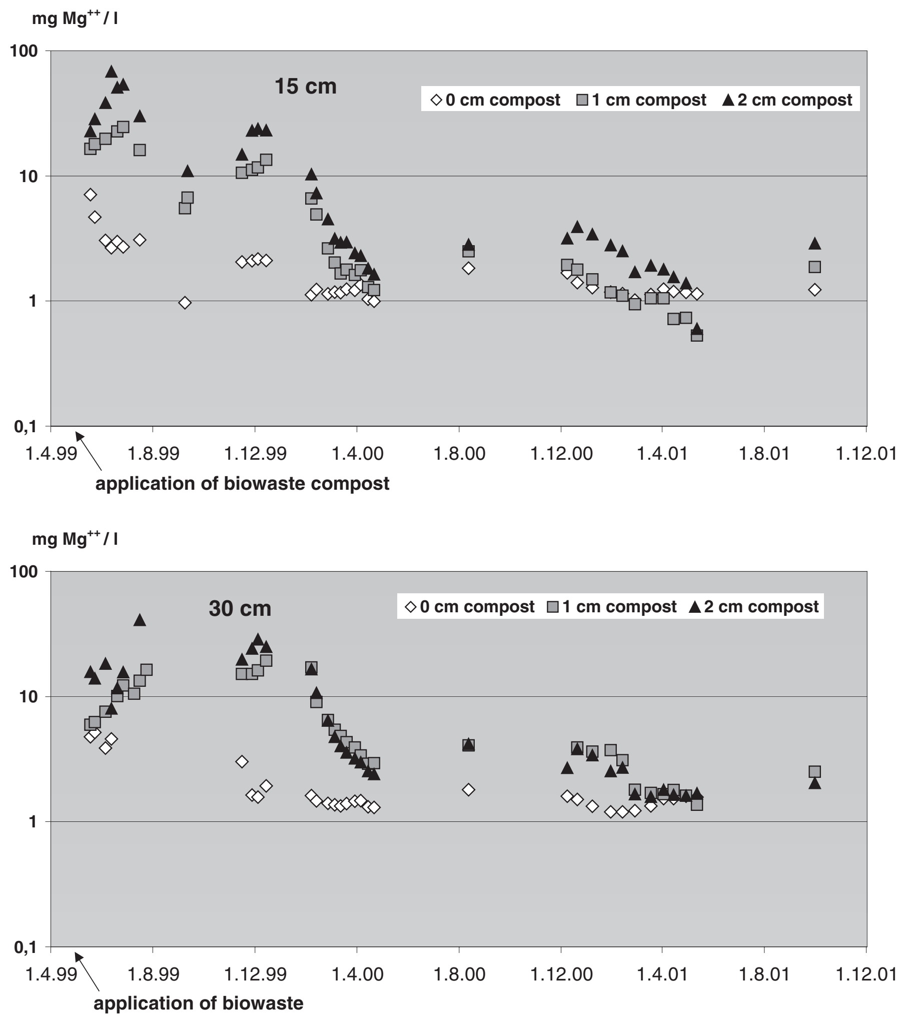


Figure 8. Mg-content of soil solution from different bio waste compost treated plots: spring 1999 to end of September 2001 in 15 and 30 cm soil depth.

possible with some limitations on humus poor and nutrient deficient sites. Because of the high Na and Cl content the product is no remedy for improvement of sites with clay-soils and high Na-adsorption and a de-icer contamination. The K/ Mg ratio of the product is too high. Addition of Mg-containing, soluble fertilisers may improve applicability. It is a good ameliorative for compacted urban soils where it improves habitat quality for soil biota.

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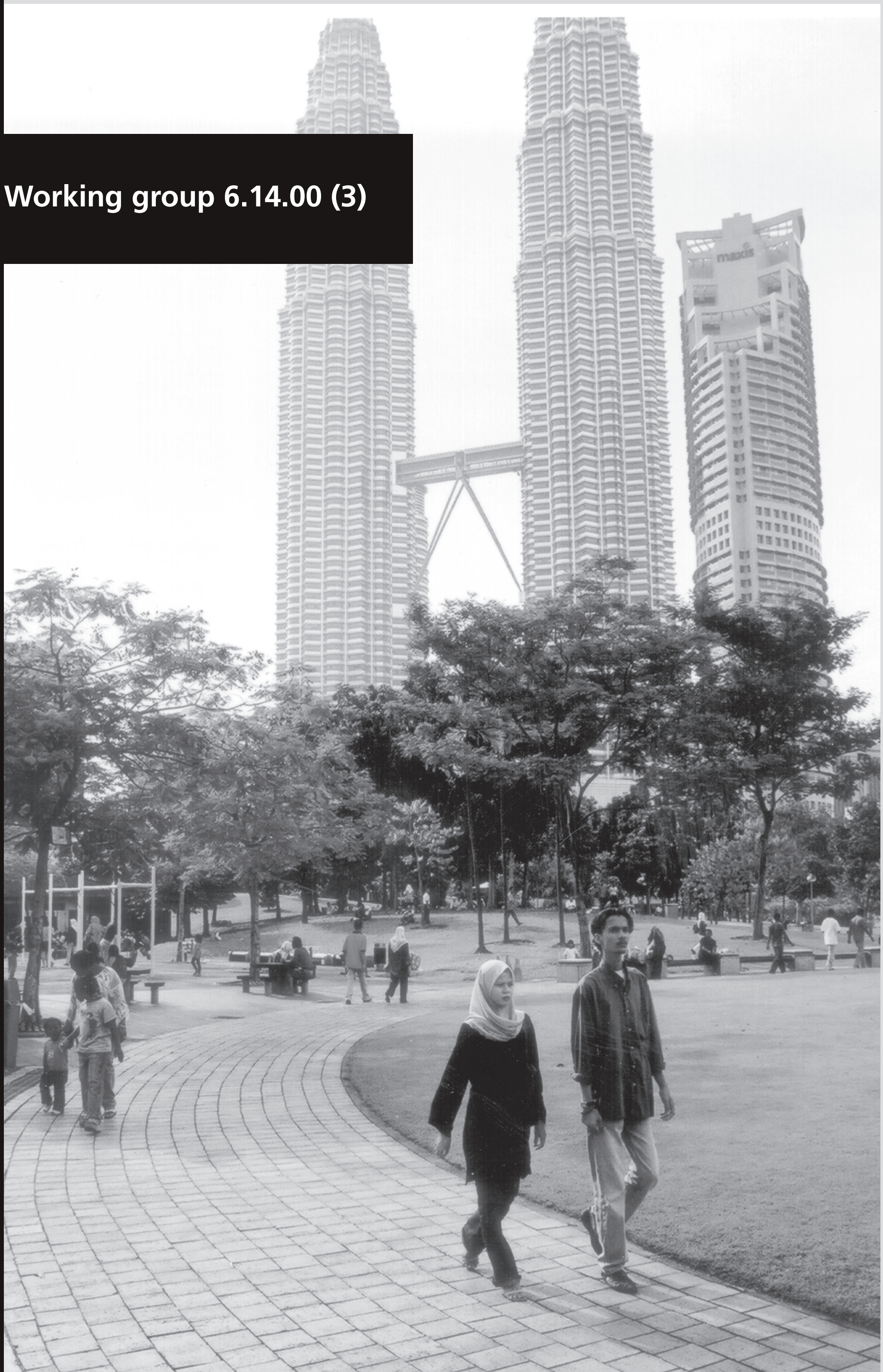

Urban forestry as a development tool

Successful urban forestry in the city centre – Is it all about image?

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Abstract

It has been argued in some quarters that the lack of an agreed definition for urban forestry within Europe is likely to retard the development and acceptance of the concept. This paper does not accept that tenet but suggests that, in an image-conscious age where the demands for both financial and urban spatial resources will become increasingly competitive, it is important to consider exactly what »image« is conjured up by the use of the term »urban forestry«. Examples of successful commercial imaging are considered, together with an applied case study from the City of Leeds, UK that supports the view that »image« is important in developing the concept of urban forestry, particularly in city centres.

Key words: urban forestry, image, communication, urban tree strategy, city centre arboretum, Leeds.

1 Introduction

The benefits that the urban forest can bring to the people of the urbanised areas of Europe, or indeed the world, are increasingly being understood, and yet agreement on exactly what comprises the urban forest remains perhaps slightly more elusive. Definitions of "urban forestry" abound as we know and much time and effort has been expended, particularly amongst academics, on promoting their own pet definition. Early research carried out as part of the EU's COST Action E12, Urban Forests and Trees revealed a plethora of definitions, but wisely it decided not to endorse an all-embracing, pan-European definition of urban forestry (Forrest et al. 1999). It did not have to, because urban forestry was beginning to be accepted as a specific scientific domain, and the quantity and quality of urban tree planting was, generally speaking, increasing across Europe as public authorities strove to improve their cities for the social, economic and environmental benefits of their people. Investigations carried out for the conference 'Forestry serving urbanised societies' by Michèle Kaennel and Renate Prüller (see Randrup et al. in press) involving the collation of the terms and definitions used by professionals associated with urban forestry and green space have confirmed that there is an extremely wide range of such definitions. So does the lack of an agreed European definition of urban forestry really matter?

Each and every one of us will have our own favourite definition of what we do, but this does not inhibit the dialogue between us – we are professionals and our passion for our subject over-rides these idiosyncrasies. But I believe there is a problem looming, and certainly in the UK an increasing problem, when we try to communicate what urban forestry is about to the general public, to the media and to those in positions of power or influence, including sometimes our fellow »non-tree« professionals and developers.

2 A commercial image

The problem that is looming for urban forestry is that we increasingly inhabit a world dominated by image and images, and urban forestry is hard to quantify in terms of image. Imaging is all around us. For example, every one of us here today, either knowingly or unknowingly, has selected the clothes that we have put on to promote an image of ourselves to our fellow delegates. Let me give you two further examples from the world of commerce. First, if some years ago now, I had said the word *Volvo* to you, what image would it have conjured up in your mind? Probably a large, solid, reliable, sturdy, safe vehicle, nothing too extravagant, maybe even a little boring. Volvo were well aware of this of course, and successfully set out to change their image and broaden their appeal by retaining in their cars all the aspects to do with safety and reliability, but adding a more sporty, youthful element to their vehicles. Secondly, amongst the general public in my own country, the initials MFI would, a few years ago, have created an image of a company who sold cheap, flat-pack furniture seemingly made out of reinforced cardboard. Millions of pounds were spent assuring us that there is actually some wood in their furniture, and this has been successful too – the image of MFI furniture has changed for the better and gone more up-market.

So if »image« is so important for commercial success in the marketplace, why should it not apply to us in urban forestry? What image is created by the term »urban forestry« to those people not involved in it? Do they understand it? Are we exempt from the modern forces of »image« because we are the good guys, and because what we do is good for people and somehow this puts us above the rough, tough world of commerce, politics and money? No, I do not think it does.

If urban forestry is to continue to make progress across Europe, particularly in the densely populated countries such as the UK, and in what I might call the hard urban areas of city centre development, it will increasingly be in competition for resources, both spatial and financial. It will also increasingly engage with, and be in conflict with, other users of space, both above and below ground. To win, we need to create a viable image that we can "sell" to the commercial world.

3 The Forest of Leeds

I should like to support this argument by looking at the results of some applied research that we carried out for the City of Leeds where, by giving the potential urban forest a different image, good progress is being made. Leeds is not unique in the UK, in that the character and composition of the issues associated with political reality, commerce, urban design, spatial and financial resource allocation and the general requirement to improve the city are mirrored in many towns and cities up and down the land. Leeds is, however, perhaps one of the few cities that is actively trying to do something about it by incorporating what I would call urban forestry into their vision of a successful city centre (CCUDS 2000).

The City of Leeds aspires to be a city with a high European profile. The rationale behind that is simple – in order to attract the inward investment it needs to maintain and expand its economic base, the city must attract as much investment from overseas as it can. That puts the city in direct competition with dozens of like-minded cities both within the UK and on the European mainland.

One of the hallmarks of such cities is the quantity and quality of the trees and woodland that are to be found within their municipal boundaries. The average tree cover in key European cities is probably somewhere between 10 and 15 %, depending upon which source you choose to consult. The tree cover within Leeds, even now, is about 5 % – low by UK standards and very low by European standards. This deficiency was recognised as long ago as 1983, when the city approved a »Woodland and Trees in the City« strategy, which identified the need for an integrated approach to the provision of urban forestry within the city. Although it had some limited success, it was not until 1993 that it grew into a project called the »Forest of Leeds«. This project proposed an »integration of trees and woodlands with the communities and fabric of the built and natural environment of Leeds«, but unfortunately at the time, it suffered from cautious political support. Even so, after operating for 5 years - it was reviewed in 1998 – it was generally found to be a success, and as a result, received a more enthusiastic response from the city's politicians (Simson 2000).

That said, a significant failing was identified, and that was that although the so-called Forest of Leeds was supposed to cover the whole of the city, and thus benefit all constituencies, it remained a peri-urban phenomenon. The urban forestry concept faltered and petered out long before it reached the city centre. This was deemed to be unacceptable in the wider interests of city regeneration and had to be remedied if the project was to continue to attract viable political and financial backing.

Several reasons for this failing emerged from our investigations, most of them predictable. Leeds is perhaps the fastest growing city in the UK. It became obvious therefore that within the city centre, the commercial competition for space usually precluded space for trees; where they did grace new development, they were all too often used to legitimise poor planning or architectural design decisions. Also, the structure of the local authority itself, where responsibility for tree matters was divided between at least three separate departments, meant that expertise was dispersed and there was no clear urban forestry focus.

However the most interesting problem that emerged amongst planners, urban designers, developers and politicians proved to be the use of the »f« word – forestry. It did not seem to matter whether the »f« word was prefaced by the word »urban«, or »community« or even »social«, it was still forestry. This was deemed to be unnatural, boring, needing space, time and excessive management, unpopular with the green press and, most importantly, unpopular with the tax-paying public – the electorate. The word »forestry« had a negative image and was a liability in matters concerning city centre development.

4 City Centre Urban Tree Strategy

This was unfortunate for a whole number of reasons, not least because a major City Centre Urban Design Study was about to be launched, in consultation with key local interest and professional groups. This study would comprehensively explore the urban design attributes of Leeds City Centre, and would set the parameters for all development policy within the city centre for at least the next ten years. It was vital therefore that the planting and management of trees played a central role in this study.

Accordingly, we were asked to produce an Urban Tree Strategy, to convince the doubters of the many benefits that would accrue to the city centre from a comprehensive, overall strategy for tree planting. Time does not permit me to delve into this in any depth, except to say that it involved us in an audit of the existing situation, researching precedent studies from all over Europe, and creating a vision of Leeds City Centre based upon the spiritual, visual and practical benefits of having a cogent Urban Tree Strategy in place. This involved identifying a number of "key streets" linking the peri-urban areas of forest with other areas of green, stretching from one side of the city centre to the other. Such streets would have to rationalise the mêlée of underground services and utilities found there into common service trenches to enable a continuous tree presence to occur. This would of course be expensive and be spread over many years – there are potentially 52 service providers who have a right to be underground in Leeds City Centre (McGouran pers.comm.).

The Strategy was fairly well received by the professionals involved in the urban design study, but received a polite but luke-warm reception from the politicians and the developers. In short, they remained unconvinced – we had not succeeded in creating an urban tree imagery which could be sold. And so it was back to the drawing board for a re-think. But not for long – the Strategy was re-launched almost immediately, but with two significant changes.

5 City Centre Arboretum

First, it was decided to recommend the adoption of the late Frank Santamour's 10/20/30 % rule for Leeds City Centre. For those who do not know, Santamour (1998) suggested that within a given area, such as in a city centre for example, you should plant no more than 10 % of one species of tree, 20 % of one genus or 30 % of one family. Santamour's rationale behind this rule was that the number and ferocity of the pests and diseases that are waiting in the wings to attack our urban trees are such that if we persist in using the limited number of tree species that we do, we risk considerable and unacceptable losses in the future. I find his argument persuasive, but there was an equally important side effect to adopting such a policy and thus widening the species base, and that triggered the second change, which was a change of name for the project. The City Centre Urban Tree Strategy, now acknowledged as being a rather staid and conservative image (not unlike perhaps our historic Volvos?) became the City Centre Arboretum.

This received immediate political and media acclaim, and although it has yet to go out for full public consultation, early indications are that the public are enthusiastic too. An »arboretum« can be promoted as an ordered concept, which an »urban forest« finds hard to emulate. The concept of having an »arboretum« co-existing alongside successful commercial, retail and city-centre housing developments is an image that can be sold to politicians, to the general public, to developers and to fellow »non-tree« professionals. Now both you and I know that, scientifically speaking, this will not be an arboretum, and I would have to admit that we have been accused by some of my urban forestry colleagues of »selling out« (Thorp pers.comm.). On this occasion however, I do believe the end justifies the means. For example:

- All tree planting in the City Centre, even that which occurred before the concept was even mooted, is now deemed to be part of the »arboretum«.
- Urban trees are now an integral part of the Leeds City Centre Urban Design and Development Strategy.
- Leeds is about to begin the construction of a light rail tram system within the city, and a considerable sum of money (currently £ 65 million or € 93 million) has been earmarked for the diversion of underground utilities in order that parts of the arboretum can be accommodated in these streets.
- And perhaps most important of all, we have been asked to draw up, in consultation with the officers of the city council, a programme of four 5-year plans for the planting and management of the arboretum throughout the city centre.

6 Conclusion

Whether I can legitimately claim that the successful adoption of the concept of a City Centre Arboretum can be attributed to creating an image for people that they could understand is perhaps a moot point. There is no doubt in my mind however that it has helped enormously, and whatever my fellow urban forestry colleagues think of the concept, the Forest of Leeds will now reach into the inner-most parts of the City Centre. However we define urban forestry, I believe it must be a wide, all-embracing definition that allows us the scope to create an appropriate, local imagery for the urban forest. In Leeds, we were lucky, because although we got the imagery wrong the first time round, we were working with politicians and professionals whom we knew, and so we got a second chance. When working with people we do not know, whether they are politicians, professionals or the general public, if we want urban forestry to be accepted as an integral part of the development process, then we have to create the correct image first time round. When dealing with the world of politics (local or national), commerce, urban design or development, urban foresters are not exempt from the old adage that »you never get a second chance to make a first impression«.

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Urban Forestry in Curitiba - A model for Latin-American cities?

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Abstract

Curitiba, the eighth largest city of Brazil and the capital of the Brazilian federal state of Paraná is located on the first highland plateau of Paraná, at an altitude of 905 m asl. In the 1960s and 1970s, modernisation in agriculture in south-eastern Brazil and severe dry periods in the Northeast with a subsequent displacement of small family farmers and sharecroppers led to enormous immigrant fluxes to the main urban centres, such as São Paulo and Curitiba. During those decades Curitiba experienced a demographic expansion of up to 5.7 % annually. The implementation of a progressive environmental policy in Curitiba dates back to that time. The city's authorities began to create parks and preserve remaining gallery forests. The arborisation of the city's streets was intensified. In 1998 already 1100 permanent preservation areas existed within Curitiba's special green area sector. Today Curitiba has about 52 m² of green area per capita, which is under the municipality's control and monitoring. According to current regulations in Curitiba the felling of isolated trees requires a permit from the Environmental Secretary. The city also benefits from a state law, which allows maintaining 5 % of the value-added tax from the state if there is a sound management of conservation areas.

Today, a significant part of the population is involved in Curitiba's environmental programmes to support poverty alleviation and reduce vulnerability, such as 'Olho d'Água' (survey programmes about river quality) or 'Câmbio Verde' (exchange of recyclable trash for food or teaching material). In a project called 'Cesta Metropolitana' fruits are sold 30 % below market price especially for poor people from peri-urban areas. Small producers of the metropolitan area have the right to sell their products on special markets without middlemen. Local stakeholders are involved in planting native fruit trees and are provided with knowledge about the tree or shrub species. These partnerships provide subsistence goods but also indirect benefits for poor people's livelihoods. Moreover, programmes of environmental education were launched to accompany the shaping of an environmentally friendly attitude among the citizens. Despite still severe problems, Curitiba is known beyond the national border for its policy in favour of a well-ordered urban development, sophisticated public transportation system and environmental conservation, attributes, which gave Curitiba the character of a modern model city in Latin America.

Key words: urban green, urban greening, environmental projects, Curitiba.

1 Introduction

According to FAO (Kleinn 2000) trees in parks and gardens, around buildings and in lines along streets, roads, railways, rivers, streams and canals in the most cases are trees on land not defined as forest and other wooded land (so-called trees outside forest, TOF). The importance of TOF in providing goods and services for society is increasingly recognised by institutions involved in land use planning and management. In countries with low forest cover TOF constitutes the main source of tree products. During recent years a great effort was made to collect data on TOF at national and international level and to initiate a broad dialogue on TOF. Thus, also urban forestry issues have been given more attention (Spathelf 2002). In industrialised countries the goals of urban forestry are to provide environmental benefits, such as equilibrated temperature regimes and fresh air sources, and to support recreation. In developing or newly industrialised countries, however, urban forestry caters for important needs, such as soil protection, human nutrition and the creation of new jobs (Kuchelmeister 2000).

The main urban centres of Brazil, such as São Paulo, Rio de Janeiro and Curitiba, experienced a rapid demographic expansion during the past decades. In the 1960s and 1970s modernisation in agriculture in south and south-eastern Brazil, as well as severe dry periods in other regions of Brazil (especially Northeast) with a subsequent displacement of small family farmers and sharecroppers, led to enormous immigrant fluxes. The population growth of Curitiba during that time, for example, was between 5 and 6 % annually.

In every Brazilian city there are some parks and squares. But often a co-ordinated development ("master plan") of the green area sector is lacking and spontaneous measures prevail. The problem is less that of maintenance of trees and parks in downtown areas than an that of an uncoordinated to chaotic urbanisation process in the periphery of the big cities. This horizontal expansion is characterised by clandestine occupations of land which often is unsuitable for buildings. The absence of a sound housing policy and tenural insecurity in most of these areas lead to a strong geographical segregation of residential areas which is accompanied by social stratification. In most cases the basic infrastructure of housing, health or waste deposition can not be guaranteed. Consequently, there is just as little a concern for environmental policy. Nevertheless, in some Brazilian cities major urban forestry activities have been documented (e.g. Rio de Janeiro, Recife, Porto Alegre or Curitiba).

2 The city

Curitiba, the capital of the Brazilian federal state of Paraná, is the eighth-largest city of Brazil with 2.42 million inhabitants (greater Curitiba). It is one of the regional metropoles of Brazil. The city is located on the first highland plateau of Paraná, at an altitude of 905 m above sea level. Towards the East a nearly 2000 m high coastal mountain range delimits the highlands from the coastal zone (distance 80 km). Further urban growth and expansion is still possible towards the North, West and South. The climate is subtropical humid with the occurrence of several frost nights in winter. The natural (forest) vegetation of the highlands in the surroundings of Curitiba is the tropical moist mixed forest ("floresta ombrófila mista") with predominance of *Araucaria angustifolia* in the upper storey and a variety of broadleaved trees in the lower storey. Today, however, only small fragments of mostly exploited Araucarian forests remain. The natural vegetation of the coastal range east of Curitiba metropolitan area is a dense tropical moist (cloud) forest, the so-called "Mata Atlântica". From 61 million ha of coastal rain forest in Brazil only 3 % has survived (FAO 1993). A significant fragment of this forest type near Curitiba is preserved as an UNESCO biosphere reservation.

The implementation of a progressive environmental policy in Curitiba dates back to the 1970s. The demand for recreation and leisure areas increased as the population was growing rapidly. Parallel with urban expansion access roads to residential areas received linear green zones ("jardins ambientais"). Cycleways with "green components" were built along railway routes. Polluted areas with disordered development were treated and transformed into green areas. The city's authorities began to create parks and preserve remaining gallery forests to improve natural draining. Parks and groves were named according to the different immigration ethnics (German grove, pope grove, etc.) to support cultural identification. The arborisation of the city's streets was intensified with the planting of 70,000 trees (average annual number of trees planted since then: 3,000). Moreover, programmes of environmental education were launched to accompany the shaping of an environmentally friendly attitude among the citizens.

Recently the metropolitan area has experiencing another accelerated growth process due to intensified industrialisation (e.g. the establishment of international companies such as Renault and Volkswagen). An interesting current urbanisation phenomenon of many Brazilian metropoles can be observed, too. Especially former suburbs and not necessarily the capitals themselves profit from industrial and population growth. This is the case with São José dos Pinhais, 40 km south to Curitiba, where the establishment of a Volkswagen plant and the new airport have led to an exorbitant growth and land consumption.

3 Urban planning and the green sector

Despite all problems today, Curitiba is known beyond the national border for its policy in favour of a well-ordered urban development, sophisticated public transportation system and environmental conservation. These attributes gave Curitiba the character of a modern model city in Latin America. Already during the past 30 years Curitiba has focused on its urban planning. A master plan for an orderly urban development was implemented beginning with J. Lermer's administration in 1971. The development of the master plan was supported by the IPPUC ("Research and Urban Planning Institute of Curitiba") and permanent discussions throughout society ("Tomorrow's Curitiba" seminars). Today the city is moving forward to extend its solutions to the whole metropolitan area. The special "Municipal Secretary for Metropolitan Affairs" links Curitiba to the governments of 24 surrounding municipalities. Recently the city's administration launched 24 inter-divisional "core ideas projects"for the metropolitan area such as zoning and land use initiatives with time tables for execution.

In 1973 the former Forestry Department (today IBAMA= Brazilian Institute for Environment and Renewable Natural Resources) transferred the legislation responsibility for Curitiba's green areas to the city authority. Green areas were defined to be native forests with the purpose to protect water, soil, fauna and scenic assets, thus excluding plantations of fast-growing exotic species like *Eucalyptus* and *Pinus* (law 6819 of 1986, see Table 1). Next, the former city's park directory became directly connected to the mayor's office. In 1991 environmental policy law was created which established general measures of environmental protection, conservation and melioration within the capital. After several organisational changes, the Environmental Secretary of Curitiba is now in charge of the supervision and monitoring of parks, isolated trees and conservation areas as well as the arborisation of streets. 93 areas of tree vegetation which belonged to former permanent preservation areas, were mapped and registered during 1974. In 1998, already 1,100 forests of permanent preservation existed within Curitiba's special green area sector. (Forests of permanent preservation are native forest remnants on real estates within the municipality.)

Table 1. Important laws and decrees of the environmental legislation in Curitiba referring to urban planning and trees outside forests

Name of law, decree[1]	Subject
Law 4557/73	protection and conservation of trees
Law 5234/75	zoning of land use
Decree 400/76	preservation of riparian zones
Law 6819/86	formation and preservation of green areas, tree compensation planting
Law 7833/91	environmental policy
Decree 471/88	establishment of municipal parks
Law 8353/93 and Decree 782/95	parameters for occupation of real estates, criteria for tree cutting
Municipal Forest Code 1998 (not yet passed)	collection of all environmental relevant legislation

[1] *The last two figures of the number in the first column indicate the year when the law passed (e.g. /73=1973).*

As a special category of green area, sector preservation areas ("Unidades de conservação e lazer") like parks, groves or squares were delimited (for a summary of these areas see Table 2). The specially protected areas as well as the forests of permanent preservation fall under local municipal norms. Today Curitiba has about 52 m² of green area per capita which is under the municipality's control and monitoring. Recent surveys even indicate an increasing trend in green area, but with strong variations throughout the different town districts (e.g. the city centre only accounts for 5 m² per capita). WHO, the UN Health Organization, recommends 12 m² of green area per capita (Secretaria do Meio Ambiente 2000). The legislation development relating to TOF systems in Curitiba is shown in Table 1.

Table 2. Type, number and size of conservation and leisure units in the city of Curitiba (source: Secretaria do Meio Ambiente 2000).

Types of green area	Number	Area [m²]
Parks[1]	14	18,407,873
Forests (groves, "bosques")	12	612,295
Squares	351	2,017,789
Gardens ("jardinetes")	289	303,839
Places ("largos")	52	58,571
Environmental gardens ("jardins ambientais")	6	51,100
Sport centres	2	64,100
Environmental cores	11	6,676
Animation axes	14	417,118
Total	*751*	*21,939,361*

[1] *within the park area, Parque Iguaçu is considered to be the largest urban park in Brazil with a total area of 8,264,316 m².*

The main goals of Curitiba's parks and green area policy are to create compensation areas in the urban ecosystem. Often the parks and groves are connected with leisure areas, thus supporting environmental education of the population, especially of children and youths. In the responsible authority's philosophy *green* areas have to play a pre-eminent role in the urban environment to further guarantee a sound urban development. Another goal is the preservation of typical vegetation (forest) formations of the region. One of these parks, which became the symbol of Curitiba, is the new botanical garden with the famous greenhouse, which was inaugurated in 1991 (see Figure 1). Completed with a botanical museum, this park still shows one of the few remaining native forest fragments of *Araucaria angustifolia* within the urban area. Another example is the "German grove" with a secondary forest mainly consisting of deciduous trees. In the south of Curitiba a new park recently was dedicated to Brazil's 500th anniversary. Some more areas will be laid out soon, especially in the periphery.

Figure 1. Botanical Garden of Curitiba (with Araucaria angustifolia *in the centre).*

According to the current regulations in Curitiba the felling of isolated trees requires a permit from the Environmental Secretary (see so-called "árvores imunes de corte", see Table 3). If cutting permission is obtained, two trees of recommended species (in the case of *Araucaria angustifolia* four) have to be planted or donated to the city by the landowner. The trees and forests in the city's special sector of green areas no longer loose their destination of being forest. That means that in the case of forest degradation or destruction the forest has to be fully restored. Soil occupation of the city's real estate is regulated in detail considering the size and vegetation cover of the real estate. Furthermore, landowners in the special sector of green areas are encouraged to preserve forest fragments with a reduction or suspension of property tax proportional to the forest cover registered on their land. The city also benefits from a state law (so-called "ICMS ecológico") which allows it to keep 5 % of value added tax from the state if it manages conservation areas or forests with sources. Thus Curitiba receives 300,000 R$ (1US$ » 2,86 R$

on July 15th, 2002) weekly which can be spent for ecological purposes. A special fund (Municipal Environmental Fund) was created to allocate the money from surcharges, donations and other sources in order to realise environmental priorities. Currently Curitiba is discussing a further extension of environmental regulations within a municipal forest code.

Table 3. List of tree species which can not be cut ("árvores imunes de corte") in Curitiba.

Scientific name	Popular name
Chorisia speciosa	Floss Silk Tree
Populus nigra	Poplar
Castanea vesca	*Chestnut*
Eucalyptus spp.	Eucalypt
Araucaria angustifolia	Brazil Pine / Parana PIne
Araucaria bedwillyi	Bunya Pine
Tipuana tipu	Rosewood, Pride-of Bolivia
Schizolobium parahybum	Yellow Jacaranda
Olea europea	Olive Tree
Carya illoensis	Tecan Tree

4 Studies about arborisation

There are few detailed studies assessing the situation of green areas and street trees ("arborisation") in Curitiba (Milano 1984; 1988; Roderjan & Barddal 1998). Based on a systematic inventory street trees were sampled and identified including crown and root characteristics, as well as diseases and other damages (Table 4). A total of 4,382 trees were investigated. Of the 93 species found in the study, only 18 species represented 92 % of the population. The two most abundant species (*Lagerstroemia indica* and *Ligustrum lucidum*) account for 39 % of the population, indicating a great risk because *Lagerstroemia* is highly susceptible to fungi. One third of the trees were damaged; 3 % of the trees caused damages on the streets due to superficial root systems. It could be observed that many of the trees had already reached electricity lines, which in most cases led to strong and unprofessional tree pruning. The spacing between the trees in general was found to be sufficient. To summa-

Figure 2. Example of street arborisation in Curitiba (Tabebuia cassinoides).

Scientific name	Family	Native (n) or exotic (e)
Acer negundo Linn.	Aceraceae	e
Aleurites fordii Helmsl.	Euphorbiaceae	e
Anadenanthera colubrina (Vell.) Brenan	Mimosaceae	n
Aspidosperma olivaceum Muell. Arg.	Apocynaceae	n
Balfouodendron riedelianum Engler	Rutaceae	n
Caesalpina leiostachya (Benth.) Ducke	Caesalpinaceae	n
Caesalpina peltophoroides Benth.	Caesalpinaceae	n
Cassia leptophylla Vog.	Caesalpinaceae	n
Chorisia speciosa St. Hil.	Bombacaceae	n
Citharexylum myrianthum Cham.	Verbenaceae	n
Clethra scabra Loisel.	Clethraceae	n
Cybistax antisphilitica Mart.	Bigoniaceae	n
Erythrina falcata Benth.	Fabaceae	n
Eugenia uniflora Berg.	Myrtaceae	n
Hibiscus rosa-sinensis L.	Malvaceae	e
Holocalyx balansae Miq.	Caesalpinaceae	n
Jacaranda mimosaefolia D. Don	Bigoniaceae	e
Jacaranda puberula Cham.	Bigoniaceae	n
Koelreuteria paniculata Laxm.	Sapindaceae	e
Lafoensia pacari St. Hil.	Lythraceae	n
***Lagerstroemia indica* Linn.**[1]	Lythraceae	e
Leucaena leucocefala (Lam.) de Wit	Mimosaceae	e
***Ligustrum lucidum* Ait.**[1]	Oleaceae	e
Magnolia grandiflora Linn.	Magnoliaceae	e
Melia azedarach Blanco	Meliaceae	e
Michelia champaca Linn.	Magnoliaceae	e
Parapiptadenia rigida (Benth.) Brenan	Mimosaceae	n
Peltophorum dubium Taub.	Caesalpinaceae	n
Pittosporum undulatum Guill.	Pittosporaceae	e
Populus nigra Linn.	Salicaceae	e
Robinia pseudoacacia Linn.	Caesalpinaceae	e
Salix babylonica Linn.	Salicaceae	e
Senna macranthera (DC. Ex Coll.) Irwin & Barn.	Caesalpinaceae	n
Senna multijuga (L.C. Richard) Irwin & Barn.	Caesalpinaceae	n
Syagrus romanzoffiana (Cham.) Glassm.	Arecaceae	n
Tabebuia alba (Cham.) Sandwith	Bigoniaceae	n
Tabebuia chrysotricha (Mart. Ex DC.) Stand.	Bigoniaceae	n
Tabebuia heptaphylla (Vell.) Toledo	Bigoniaceae	n
Tibouchina pulchra Cogn.	Melastomaceae	n
Tibouchina sellowiana Cogn.	Melastomaceae	n
Tipuana tipu (Benth.) Kuntze	Bigoniaceae	e
Vochysia bifalcata Warm.	Vochysiaceae	n

[1] *Most abundant species*

Table 4. List of trees-outside-forests vegetal species found in the streets of Curitiba (according to Roderjan & Barddal 1998).

*Figure 3. Example of street arborisation in Curitiba (*Jacaranda copaia*).*

rise. the city's arborisation was considered still to be good (see also examples of *Tabebuia* and *Jacaranda* street arborisation in Figures 2 and 3).

5 Urban forestry in the context of environmental initiatives

Today a significant part of the population is involved in Curitiba's environmental programmes. There are several activities in the field of environmental education like "Olho d'Água" in which municipal students carry out survey programmes about river quality, or "Câmbio Verde" where recyclable trash is exchanged for food or teaching material. For 4 kg of trash one gets 1 kg of fruit. In a programme conducted since 1989 the Municipal Health Secretary supports the production of medicinal plants which are freely distributed to local health stations. In a project called "Cesta Metropolitana" fruits are sold 30 % below market price especially for poor people from peri-urban areas. There are no explicit projects in the fields of urban agriculture in Curitiba, but small producers in the metropolitan area have the right to sell their products on special markets without middlemen.

Curitiba's environmental project with the most success concerning participation of the local people is the communal planting project ("Plantios Comunitários"). Supported by the Environmental Education Department planting of native (fruit) trees is carried out together with the local people. Once suitable areas are localised, the Department gets into contact with local representatives and involves them in the planning process. Areas for planting always are public areas, mostly threatened by erosion or inundation like steep slopes or riparian zones.

The local people are also provided with specific knowledge about the tree or shrub species. The activities described above are not restricted to the city centre but have an emphasis especially on the periphery of the urban agglomeration. Thus urban forestry activities contribute, although to a moderate extent, to poverty alleviation in the greater metropolitan area.

6 Conclusion

In comparison with other Latin American cities, Curitiba can be seen without doubt as a model for Latin American urbanisation. A long-term administration with clear goals for planning, development and environmental concern was able to mitigate some of the problems big metropoles in Newly Industrialising countries have. Urban forestry which is integrated into a sound environmental and social policy can be a means for poverty alleviation and a contribution to a co-ordinated urbanisation. Curitiba's focus on environmental policy but also other examples like Porto Alegre's participatory budget clearly show a way out of the development blockades of Latin Americas cities.

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Gender issues in forestry serving urbanised societies

Local Agenda 21
– A key to gender and forestry?

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Abstract

At the United Nations Conference on Environment and Development in 1992, Agenda 21, a global plan of action for sustainable development, was adopted. Agenda 21 included a call to local governments to develop their own »local« Agenda 21 outlining local priorities, which might differ around the world.

To support and develop the multiple ecological, economic, social and cultural roles and functions of trees, forests and forest lands, Agenda 21 calls on countries to strengthen their forest-related institutions and improve their technical and professional skills through measures such as:

- Promoting the participation of labour unions, rural cooperatives, local communities, indigenous peoples, youth, women, the private sector, users groups and non-governmental organizations in forest-related activities.
- Conducting research on forests, including gathering data on forest cover, areas suitable for afforestation and ecological values.
- Supporting and enhancing technology transfer and specialized training.

The survival of the forests and their continued contribution to human welfare depends on recognizing the social, economic and ecological values of trees, forests and forest lands, including the consequences of damage caused by their destruction. These values should be incorporated into national economic accounting systems.

Chapter 24 of local Agenda 21, refers to the overall importance of the empowerment of women and their participation in Agenda 21 processes. To guarantee the full and equal participation of women in all development activities and particularly environmental management, Agenda 21 proposes that Governments embrace a number of objectives related to women's advancement and education.

Agenda 21 proposes the following:
- All countries should implement the Nairobi Forward-looking Strategies for Women, which emphasize the need for women to participate in ecosystem management and control of environmental degradation.
- Policies are needed to increase the proportion of women in programmes for sustainable development involving decision-making, planning, and technical

and management roles. Women's bureaux and non-governmental organizations must be strengthened.
- Consideration should be given to issuing, by the year 2000, a strategy for eliminating constitutional, legal, administrative, cultural, behavioural, social and economic obstacles to women's full participation in sustainable development and public life.

By 1995, there should be national, regional and international mechanisms to assess the impact of development and environment programmes on women and ensure that they participate and benefit. Educational policies and curricula should disseminate gender-relevant knowledge and promote the enhanced value of women's roles

In 2002, ten years after the Rio Conference the World Summit on Sustainable Development (WSSD) tock place at Johannesburg. In preparation for this World Summit the International Council for Local Environmental Initiatives prepared a worldwide review of local government progress in implementing Agenda 21.

The Nordrhein-Westfalian Agency »Agenda-Transfer«, located in Bonn, has also reviewed the local Agenda 21 progress in NRW and last but not least a review has taken place with reference to the question of women participating in these processes. This presentation summarises the main results of this review and will draw conclusions for further topics of interest.

Key words: sustainable development, women's participation, local development, Nordrhein-Westfalen.

1 Local Agenda 21 surveys – international and Nordrhein-Westfalen

International

From November 2000 to December 2001 The International Council of Local Environment Initiatives (ICLEI) undertook a global survey of Local Agenda 21 processes. The purpose of this survey was to evaluate the progress made in the implementation of Local Agendas 21, to explore the constraints faced by local authorities and to document the support needed for these processes to grow worldwide. Local governments submitted 633 and associations 146 questionnaires, representing 113 countries in total.

Some key findings include the following points:
- 6,416 local authorities in 113 countries have either made a formal commitment to Local Agenda 21 or are actively undertaking the process.
- National campaigns are underway in 18 countries accounting for 2,640 processes.
- Formal stakeholder groups exist in 73 % of municipalities with Local Agenda 21 processes.

- In 59 % of responding municipalities, the Local Agenda 21 process has been integrated into the municipal system.
- Water resource management is the common priority issue for municipalities in all world regions and regardless of economic situation.
- Local authorities in all regions and regardless of economic situation list lack of both financial support and national government political commitment as key obstacles to greater success.

Of the 6,416 authorites involved in local Agenda 21 44 % of municipalities were actively undertaking Local Agenda 21 programmes, while the remaining were committed to the process but may not have moved beyond this stage. This is a significant increase 1997, when the survey reported 1,812 Local Agenda 21 processes in 64 countries.

The European situation

Table 1 outlines the level of initiatives in European countries.

The national UK Local Agenda 21 initiative was established in 1993 and by December 2000 over 90 % of municipalities had produced Local Agenda documents. Sweden has nearly reached the 100 % mark of local authorities involved in Agenda 21 processes whereas in Germany there are only some 12-15 % involved.

Table 1. Country initiatives under Local Agenda 21.

Country	Nº of initiatives	Country	Nº of initiatives
Albania	7	Italy	429
Austria	64	Latvia	5
Belgium	106	Lithuania	14
Bosnia & Herzegovina	1	Luxembourg	69
Bulgaria	22	Montenegro	2
Croatia	20	Norway	283
Cyprus	1	Poland	70
Czech Republic	42	Portugal	27
Denmark	216	Romania	12
Estonia	29	Slovak Republic	30
Finland	303	Slovenia	3
France	69	Spain	359
Germany	2,042	Sweden	289
Greece	39	Switzerland	83
Hungary	9	The Netherlands	100
Iceland	37	Ukraine	9
Ireland	29	United Kingdom	425

Table 2 Issues under the local Agenda 21

	Activities currently underway globally	Priority issues for the next 3-5 years globally
1	Air quality	Natural resources management
2	Water resources	Air quality management
3	Energy management	Water resources management
4	Transportation	Energy management
5	Natural resources management	Transportation

The results of the survey referring to the Focus of Local Agenda 21 processes international is outlined in Table 2. This shows that forests and forestry are not a focal point of the local Agenda 21 processes or that they are ascribed lesser importance. It also shows that gender issues are not regarded an important topic.

With respect to the question of participation of women, the survey clearly indicates the need to continually encourage explicit inclusion of particularly underrepresented groups such as women, ethnic minorities and youth.

Nordrhein-Westfalen
A survey was done in 2001 assesing the Local Agenda 21 processes in Nordrhein-Westfalen (NRW). 141 cities and communities participated in this survey. (In August 2002 there were 261 cities and communities in NRW involved in local Agenda 21 processes. This is more than 50 % of all NRW-communities, including all major cities especially of the Rhein-Ruhr Area).

The topics and projects realized in the local Agenda processes are ranked as follows:
1. Environmental and nature conservation issues
2. Climate and energy management
3. One-world: North-South development issues
4. Children and youth projects
5. Transportation and mobility
6. Cultural aspects, school and capacity building
7. Economy and labour
8. Women's issues

This survey also showed that forests, forestry and wood resources are not a focal point of the processes. On the other hand, it indicated that topics mentioned in the international list are equally important in NRW, with the exception of water management, which is missing in the project list of NRW.

2 Forestry and Local Agenda 21 in NRW

Considering the important and varied issues with which the forestry and wood sectors can contribute to a sustainable development, in 2000 the German state forest administration together with the subordinate forestry offices, carried out an investigation of the role of forests, wood and forestry in the framework of the local Agenda 21 process. The results of the investigation were documented in a Primer. The primer is intended to be a help to the forestry officials in the local Agenda 21 process.

In the framework of 10 workshops, the level of knowledge of the forestry officials was determined, possible themes worked out and evaluated and chances and risks demonstrated, which could be tied to an involvement with Agenda-processes (Figure 1).

Now let us move to the question whether women and gender issues take place in these processes.

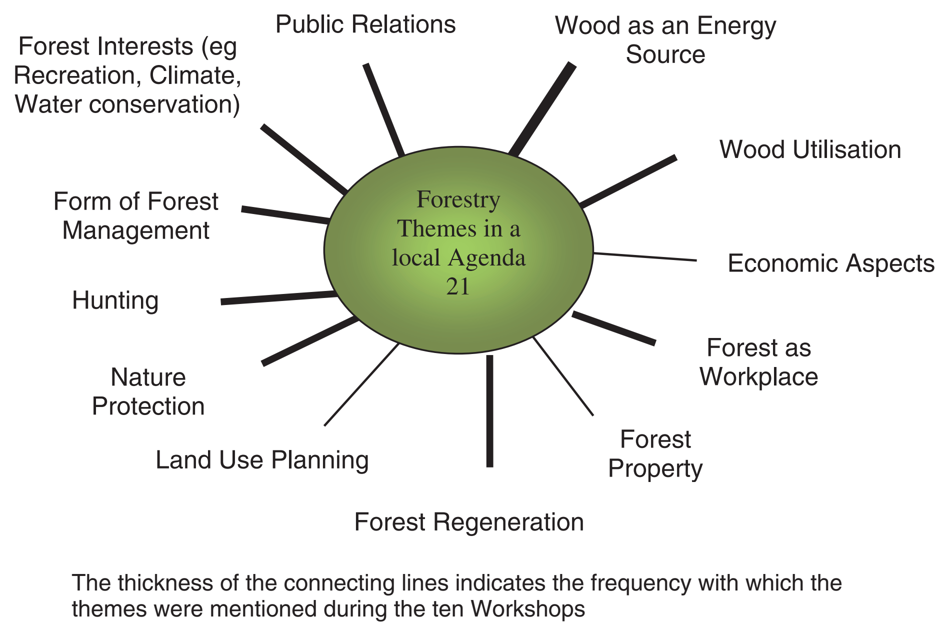

Figure1. Forestry themes in a Local Agenda 21.

3 Women and Local Agenda 21 processes in NRW

Women take part in Local Agenda 21 processes and they often play a major role. Looking closely at their involvement, women often do a lot of basic, non-paid work but are underrepresented in decision-making bodies. None of the examined projects has to do explicitly with ecological or forestry topics. If women get involved in Local Agenda projects, they typically engage in subjects like labour and economic issues, health care issues, migration issues, sustainable consumption, public relations, planning processes within cities, mobility and housing as well as projects with regards to children and children well being. The integration of girls in local agenda hardly takes place at all.

A programme exists carried out by a confederation of all major cities of the Ruhr Area (KVR). The KVR also is a forest owner. Together with an equal opportunities civil servant programme, a project was launched to give schoolgirls the opportunity to choose practical forestry as a practice for one week. This project had to overcome quite a few obstacles but the girls who chose to go out into the forests were quite satisfied to have done it.

Gender related aspects of Local Agenda 21 processes are found in some of the visions formulated or in gender-related data of for example health reports, mobility analysis and labour division reports. As main obstacles, women mention that there is not enough financial support for local agenda activities as well as a lack of support by local politicians. Furthermore, there are only few activists, meaning that the ones who are active face a triple burden: family, work and non-paid work within the local Agenda.

In July 2002, there was a women's conference at Düsseldorf in preparation of the World Summit for Sustainable Development (WSSD) in Johannesburg. One workshop discussed the relationship between Local Agenda 21 and Gender issues/

Gender mainstreaming. The participants, mostly representatives from local administrations agreed, for example, upon the following:

- The process of globalisation needs a sustainable, gender-sensitive, environmental-friendly development perspective. Globalisation has to serve the needs of people.
- Gender-perspectives have to be integrated in all aims, programmes, policies and plans. Women's participation and representation in national and international organisations and bodies has to be raised to at least 50 % by 2010. The participation of women in decision-making bodies has to be ensured.
- A gender-oriented database is needed to implement mainstreaming concepts. Gender Impact assessment and Gender budgets are important tools.
- Agenda 21 processes and projects have to be monitored upon gender equality where women's participation is crucial. Criteria and Indicators of sustainability have to include and consider the gender dimension.

4 Some conclusions and recommendations

Since the Rio Conference in 1992, local governments all over the world have come to support the principle of sustainability. They have started to implement Local Agenda 21 together with major groups, organisations and citizens. In NRW more than 50 % of all municipalities have started a local Agenda 21, a Regional process has been launched.

Women's participation in Local agenda 21 in NRW has to be improved, as is the case for the implementation of forestry issues.

Forestry has to consider its role in local and regional Agenda 21 programmes and has to communicate its interests with other major groups. Regional forest programmes might be developed and considered as programmes in the sense of Agenda 21. They should integrate the gender dimension of forestry.

Research has to be carried out to find best practice examples within the European Local Agenda 21 processes with respect to women and forestry.

Forestry research organisations like the International Union of Forest Research Organisations (IUFRO) as well as forestry institutions such as the European Forest Institute (EFI) should seek to join the European movement of sustainable cities in order to implement forestry and wood resource issues on the Agenda of sustainability. IUFRO and EFI should carry out research on the gender issues of forestry.

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Woman and agriculture - Lessons from agriculture?

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Abstract

This paper will briefly present the history of Danish agriculture, where modernisation and professionalisation is closely linked to a masculinisation of the sector, and the marginalisation of women. This development meant that women began to work off the farm while a few became educated as farmers. Results from an empirical investigation will discuss how women working off the farm contribute to the changing of values in farming, i.e. work values and gender roles. Finally some suggestions for relevant themes and question for gender in forestry will be made, in particular questions concerning gender, values and forestry practice.

Key words: gender roles, agriculture, modernisation, work values.

1 Introduction

Research into gender issues in forestry in the Western world is an almost uncharted terrain. Very little research and documentation exists, which makes it difficult to pursue for anyone interested in the issues. On the other hand it makes it a very interesting research area. To open up the research area of gender and forestry, I will in this paper draw attention to research carried on gender relations in the field of agriculture.

The topic of gender and agriculture has become a well-established field of research by contributions from various European and Scandinavian countries during the 1990s (and before) as well as from the US, Canada and Australia. This is evidenced in the publication of several special issues on gender in the journals “Sociologia Ruralis” (1988; 1999) and “Journal of Rural Studies”, as well as in the publication of books on gender and agriculture (e.g. Brandth & Verstad 1993; Whatmore et al. 1994; van der Plas & Fonte 1994; Sachs 1996). In this literature a number of themes have been taken up, ranging from gender relations on the farm; gender relations in agricultural organisations; gender issues in agricultural education; representations of gender in agricultural magazines; men’s and women’s values in relation to production methods, animals and nature; and many more. Thus the questions of gender in agriculture presents itself as a complex, heterogeneous and multifaceted field, it is not an issue to be seen as somehow separate, a question about “getting women in”, rather gender is a central issue, wholly intertwined in agricultural production, organisation, values and self-understandings.

Here I will draw partly on the literature and partly on my own research on Danish women married to farmers but working outside the farm. The aim is not to present a synthesis or overview of this research and then translate it to questions for forestry. Instead the aim is to show:

1. how gender and agriculture is intertwined through the labour process on the farm;
2. to present a qualitative study of off-farm working women's identity and implications for lifestyle on the farm. This study is presented as an example of how qualitative methods can be used, and what they might tell us about gender and agriculture. However, given that some forests are owned by women married to farmers or owned by farmers, the study also contributes to knowledge concerning family relations in forestry.
3. to suggest some research topics for forestry.

First however, I want to make a case for drawing on research into gender and agriculture and use it as inspiration for forestry. This is partly tentative, as I do not have access to full information about the organisation of forestry.

Both sectors have a similar resource base, as "nature" is their base of production; they share organisational features: both are organised through the system of family farming; and they are locked into similar types of international trade networks.

The two sectors differ in that for most forestry owners, forestry is not a fulltime profession, but is carried out in addition to something else, which is regularly farming. Only a smaller group of forest owners work full time in their forests.

2 The development of modern agriculture seen in the context of gender division of labour

In this section I will sketch the development of modern Danish agriculture seen in the context of how the gender division of labour on the farm developed and was shaped. What was man's and woman's work on the farm? And how did this change? The account is mainly based on Zenius (1982), Falk et al (1989) and Almås & Haugen (1993).

Agriculture has traditionally been and generally still is based on family farming. It is based on an arrangement where workplace and household, production and family-life coexist, where both men and women (and farm labours) worked, but with specific gender-related divisions of work. On the pre-war family farm, the division of labour was roughly characterised by women being responsible for the household, but also for parts of the agricultural work - particularly work with animal husbandry. Household work on the pre-war farm was extensive and included a large degree of self-subsistence, food preparation etc. Men were responsible for other parts of the agricultural work. Characteristic for this division of labour was that it was seen as complementary. The two genders had different, but equally ranked work. Involved in both genders work were high levels of skills, based on practical learning.

During the 50 years after-war period, agriculture in Denmark has been modernised. Agricultural modernisation has involved mechanisation and the introduction of much farm technology in the labour process as well as commercialisation and economic investment. This modernisation has happened in conjunction with a marked change in gender relations: traditional women's work has been down-skilled and marginalized on the farm, while men's work was professionalised. In consequence of the modernisation process, agricultural education has become statutory. Agriculture is no longer purely based on practical skills and learning, but has become dependent on specialised knowledge, e.g. in agronomy, as well as technology, business, organisation etc.

During the professionalisation process, women were marginalized on the farm. When new technology was introduced, men took over women's work. Prime examples are milking and work with the animals. The mechanisation process therefore meant that women's work on the farm gradually decreased, and her participation was limited to being a "helper", when extra hands are needed. Further, as the availability of pre-prepared food in the same period expanded, workload and skills involved in household work decreased. Not surprisingly, when the labour market in the 1960s onwards expanded, many farmwomen started working outside the farm. This was partly to gain an own working life, but also to earn money to support the modernisation of the farm. This development has meant that most women on farms today no longer are farmwomen in the traditional sense of the word. They have their main working identity outside the farm. Indeed, farmwomen's labour employment is roughly at the same level as other women's.

For the farming profession this has entailed a *masculine* professionalisation. The masculinisation of farming can be seen in the light of the "family farm" and its "modern" version of gender division of labour. Many farms are economically dependent on the women's wage labour; the women continue to be an extra hand on the farm; women carry out most household work on the farm. Further, many farms continue to be passed from father to son, which means that the farm family lives in the home of the husbands family.

This brief account of the gender issues in agriculture in Denmark till today raises a number of questions about the interrelatedness between gender, production, reproduction and values.

3 Changing gender relations and family values in farming

During 1996-1998, I carried out a qualitative study exploring the identity of women married to farmers but working off the farm. This study is an example of how research on gender and women can give knowledge about the current changes in agriculture, but also how one particular qualitative study might look. The reasons for choosing this particular group of women are: 1) this type of women are dominant in Danish agriculture, 2) they are increasingly becoming a feature of European agriculture, 3) hardly no research exists that look at how this group of women experience agriculture.

In my research, I was interested in exploring how women experience living on a farm? How do they contribute to the lifestyle on the farm? These and other questions formed the background for the qualitative study.[1]

When analysing women's perspective, I am drawing on a social constructivist perspective, where women's identity is understood as the interaction between earlier social identities and present identities. A person will use experiences and capacities from earlier periods of her life as well as being limited by cultural competence and present situation. Thus identity can be understood as a continual process to bring together the many experiences of the individual. Further, identity is not a finished product, but a continual and changing process (Gullestad 1996). Using this perspective emphasises that individuals creatively and knowledgeably interact with the context they are situated in. This approach differs from the most dominant approach for farm-studies, which is based on the critical-material perspective. Central to this perspective is the underlying gender division of work, which is central to understand the gendered identity. In this perspective gendered division of labour is linked to the commodisation process on the farm (Whatmore 1993a; b).

I interviewed 11 women in total. The interview subjects were selected with the aim of having as many differences as possible represented: the women had different jobs; lived on farms of varying sizes; productions types; and both part-time and fulltime farms were represented. Women from two different regions were selected. Despite these differences, the women seemed to share the experience of "being married to a farmer", which gave them common ground. The interview was semi-structured and explorative.

A common feature in the stories women told about living on a farm, where stories about difficulties with living on a farm, being married to a farmer. They are stories about how it is difficult to reconcile their early expectations and ideas about what family life should entail with the realities that they live with. Here I will bring up two recurrent themes in the women's stories.

Feeling at home

Most of the interviewed women live in the family home of their husbands. When their husbands took over the farm, it simultaneously involved moving into the farmhouse. For the women, this means that they were not involved in choosing where to live, and this means that they have ambivalent feelings about their "home". One woman says:

"I chose Fleming and on top of that I got a house and a lifestyle"
"I was angry the first year – not because I didn't like the farm, because I do, but I didn't feel I had been involved in the decision. It wasn't something we had chosen together"

The women have an expectation, an ideal that "the house" is something a couple chooses together. The tradition of the family farm contradicts the ideal. As a consequence, the women at least in the beginning feel alienated in their own home, making it more difficult for them to settle, to feel at home on the farm. However, there are counter examples with women living on farms bought on the market rather than taken over the family farm, they tell stories about how the farm became part of "them", how the farm became a home.

Work and leisure

Another theme in the women's stories is that their everyday life is full of work – too much work, and particularly farm work. These stories reflect the contradictory experiences women have on the farm with regard to work. They bring with them understandings of the couple's communal life being organised around the division between work and household, their life in terms of the family. In contrast, the husbands have what can be called "an independent lifestyle", where their whole life evolves around the farm. They do not have a sharp division between work on the farm and the household. This difference in expectations caused the women some tension and confusion, as they cannot understand why the work is taking up so much time. However, they come to accept this, and in response to this conflict, the women formulate aims and wishes for the family's lifestyle. They all mention the need for doing something else together than work on the farm. This can be going for a walk in the evening, taking a weekend trip and a holiday, doing leisure activities like sports, having non-farming friends. The women come to accept that their husbands' work takes up much time, and that they themselves help out and take care of most housework. However, they expect something in return – time for leisure activities in other periods. They therefore seek to make the joint lifestyle on the farm based on other than farming activities.

Discussions

These two empirical examples show how women married to farmers have difficulties in reconciling their ideals of family life with the realities of being married to a farmer. They illustrate the negotiation aspect of identity and gender relations. However, they also show how these women contribute to changing life style on the farm. Some negotiations are difficult, e.g. changes to the family home, whereas others, such as negotiations about work and leisure, are more straight-forward.

Through these negotiations, the women are contributing to a change in the lifestyle on the farm, as well as in the contents of the farming profession. They are changing the lifestyle on the farm to a form where it to a higher degree resembles other jobs, ensuring that the family life has other contents than the farm. Nevertheless, the research also shows that being a woman on a farm entails greater stress and more difficulties in terms of constructing an identity, where expectations, competencies and current situations become integrated into a whole. This also means that the lifestyle on the farm can be seen as more fragile, as its causes more tension.

This knowledge and understanding of gender relations contribute to our understanding of lifestyle on farms: how life style in agriculture is changing in parallel with changes in gender, but also how it is under greater strain because of gender relations.

4 Questions for gender and forestry research

In the following some suggestions on possible avenues for research into gender and forestry are outlined.

Gender and the forestry sector – outline of the situation
As a starting point for any research into gender and forestry it is necessary to obtain some basic knowledge of fundamental characteristics pertaining to the forestry sector and gender. What is the history of the forestry sector and how have gender figured in this? Presumably the sector is multiple: forest workers, skilled forest workers, forest owners, large forest owners etc. What characterises the forestry sector today? How is ownership and production organised and distributed? What kinds of employment possibilities are in the forestry sector? What is the distribution of men and women, and their age? How do women "appear" in the forestry sector now and historically? What kind of work do they carry out? What are the gendered divisions of work?

Gender and the forestry profession/organisation
Forestry is traditionally a very male dominated profession, and can be seen as being masculine. This proposal concerns research into the understandings of what is understood by good forestry workers/forestry professionals and how this understanding is gendered. Here it would be relevant both to look at forestry workers as well as forestry professionals, however they present different cases.

In relation to forestry professionals, more and more women are entering the profession as educated professionals. What happens in the process where more women are entering forestry work places? How is the forestry work place changing, and how is the forestry profession changing?

This could be researched on a general level: Does gender act as a stratifying factor in that women enter into some work places; do some types of job, while men do others? Where do women go to work and why? Are some work places easier for women to get access to than others are? This study would draw on survey methods.

And on a specific level: In individual work places it would important to research how gender is influencing the work place. Does gender matter? What strategies do women adopt to cope? Do women have to adopt masculine practises or are they reshaping practises and values in organisations? This study could draw upon qualitative interviews, observation, and media representations.

In relation to forestry workers, a similar study could be carried out.

Forestry, nature and gender
This proposal concerns the links between gender, values and nature. The aim is to investigate values about the environment in forestry, seen in the context of changing organisational, structural and gendered relations in the forestry sector.

The forestry profession can be seen as a male dominated and masculine oriented profession. However, as more women enter the profession and as gender relations have undergone large shifts in the last 25 years, it can be hypothesised that the forestry profession and organisation itself is undergoing change. Obviously, gendered changes are not the only changes relevant to the forestry profession, as the forest profession operates in a social context where forests are socially contested.

One central element in the forestry profession is “nature” or “the environment”, which is central in the content of work. However, what we understand by “nature” and “the environment” cannot be seen to be neutral, given or as a resource. Instead what we see as nature and the environment is socially constructed through social and material practises. An element of the (gendered) organisational changes is therefore also understandings of “nature” and “the environment” and what is considered appropriate production methods are changing.

The guiding research question would therefore concern “how nature is produced by forestry professionals in a context where the forestry profession is undergoing gendered organisational changes?” The research could use qualitative interviews with male and female forestry professionals, observational studies in work places, surveys, and textual analysis of scientific articles and popular communication.

It is an important premise that the questions asked and research carried out is not based on the assumption that men and women’s values are different and that women are more “environmentally friendly”. Although the research might show this, there might be other explanations than gender to account for this, or “being environmentally friendly” might be a strategy of coping for women in a masculine organisation rather than an intrinsic female value.

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Evaluation of the Book »Kvinna och skogsägare« (Woman and forest owner)

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Abstract

In Sweden 135,000 women are forest owners, i.e. 38 % of the forest owners. Seventeen percent of these leave the management to their husbands. Female forest owners need to be encouraged to take more active part in the management of their forests. Therefore the book »Kvinna och skogsägare« (Woman and forest owner) was produced and released in the autumn of the year 2000. The book is based on narrative accounts from 120 women who responded to a call published in some major Swedish magazines. Seven of the stories were published in full length in the first part of the book. In the second part, statements and reflections from all of the narrative accounts are presented along in six themes. The third part consists of statistics about female forest owners and in the final part the Swedish Federation of Forest Owners discusses family forestry.

According to the evaluation, the book was well received. Many women report that they have got a new attitude to their forest and that they now dare to participate in forest owners meetings. The book, together with seminars and study circles has been a good working concept.

Key words: women forest owners, management participation, study circles.

1 Introduction

Non-industrial private owners own about half of the forestland in Sweden. Out of a total of 354,000 owners 135,000 are women, i.e. 38 % female forest owners (National Board of Forestry 2002). Women tend to own smaller properties than men do. The average size of properties owned by women is 59.5 ha and those owned by men 64.1 ha. Compared to female forest owners, a higher amount of the male forest owners are single owners. Among female owners, 14 % take decisions about the property themselves, while the corresponding figure for male owners is 64 %. 40 % of the women make decisions together with their husband, and 16 % of the men make property decisions together with their spouse. 17 % of the female owners leave the decisions to their partners while none of the male owners leaves the decision-making to their wife (Lidestav 2001).

Women's position in society has changed during the last half century. The impact of the changes has been different in various areas. Forestry is by tradition a male-dominated field and the integration of women in this field is not yet complete. Still, women are more common in forestry today than they were thirty years ago.

Men have created the forestry culture and when women in forestry are described in for example magazines, they are regularly portrayed from a male point of view (Brandth & Haugen 1998).

Most female owners have their forestry knowledge from spouses and fathers. Among the male owners 25 % has got their knowledge from their fathers and just a few from their partners. 15 % of the female owners and more than 25 % among the male forest owners see them self as autodidactic. 15 % among female owners and 25 % among the male owners say that they have their forestry knowledge from "forestry days" (Lidestav & Wästerlund 1998).

In order to develop female forest owners' identity as forest owners and to encourage them to take more active part in the management of their forests, the book »Kvinna och skogsägare« (Woman and forest owner) was produced and published in 2000. The project started in 1998 and a call for narrative accounts was made in the summer 1999. The call was directed to female forest owners. It was published in two Swedish magazines and distributed to members of female forest networks. It was also distributed at forest exhibitions and at different museums around Sweden. 120 narrative accounts were received following this call (Lidestav & Lundell 2001).

Study circles

In Sweden and the other Nordic countries, study circles are an important part of society. In the study year of 1982/1983, 14 % of the Swedish citizens participated in this kind of education (SCB 1991).

The pedagogical form of study circles differs from other types of education. Most often it consists of a group who meets once a week, with the same individuals participating. The students are not called students but participants and the teacher is called a leader. That is important; the participants do not expect any kind of reprisals if they do not have the possibility to show up one week or if they have not done their »homework«. In the study circle, every participant contributes with his or her own experiences. This, mixed with new knowledge from study books, articles and other information, makes the knowledge within the group increase along with the knowledge of each person taking part in the discussions (SOU 1996).

Many study circles in Sweden have some kind of aesthetic topic. The content of these may be anything from watercolour painting or handicraft to hip-hop dancing or guitar playing. There are also circles on language, bird watching, how to handle computers, sailing etc. Circles in forest management and other aspects on forestry and owning forest are also rather common. Reasons to participate in study circles are to get a deeper knowledge in a specific subject; to realise a dream or to get together with other people with the same interests (SOU 1996).

»Kvinna och skogsägare«

The book consists of four parts. The first part of the book is made up of seven narrative accounts, published in their full length. The narratives represent very different types of owners and are selected to show the heterogeneity within the group »female forest owners«.

The second part is a thematic synthesis of reflections and thoughts picked from the altogether 120 narrative accounts and divided into six themes. Each theme has a short summary to describe the common opinions and also the opinions that differs from the others. The themes also have quotations from the narrative accounts. The themes composed were:

- forestry practice - forestry management;
- to experience nature and recreation;
- knowledge, transfer of traditions and models in the chain of generations;
- ownership, relations and fellowship;
- being a woman and forest owner.

The third part contains general statistics about female forest owners, their background and ownership and in the final part, the Swedish Federation of Forest Owners discusses conditions for family forestry in Sweden today.

The book has been a part of the Forest Owners' campaign »Ett lönsamt familjeskogsbruk« (Profitable Family Forestry). The first edition was printed in 2000 copies and a second edition in 1500 copies. Courses and seminars have been held all over Sweden where the book has been presented and used in different ways. In Stockholm, the Swedish Federation of Forest Owners arranged two similar seminars for female forest owners. Writers of some of the full length published narrative accounts participated and talked of their experiences as forest owners. Similar seminars have been held in other places in Sweden as well.

The aim with this study is to determine how the female readers have received the book and to evaluate how the book has been used in study circles.

2 Method

The evaluation was made with a questionnaire, which was sent to female forest owners in Sweden. To reach the female readers of the book, The Forest Owners Federation provided lists of addresses of women who have participated in courses, study circles and seminars. Half of the addresses came from the seminars in Stockholm. Some of the courses had not used the book, which is why women who had not read the book also received the questionnaire.

Personal interviews have also been conducted and I have participated in a weekend course held by Norrbottens Läns Skogsägare (The Forest Owners in the northernmost part of Sweden).

397 questionnaires were distributed to women from all over Sweden and 225 were returned. Among these 80 had read the book. Reasons why some had not read the book were not accounted for in the questionnaire. The results are derived from the answers of the 80 who had read the book, interviews and from the weekend course.

3 The evaluation

The book has been well received; the women give it high grades. They were asked to mark on a scale from one to ten the general impression of the book and also how they found the disposition of the content. The average mark for the general impression was 7.8 (n=76). The average mark for the disposition of content was 8.2 (n=74).

Only 7 % of the 80 women write that they have not participated in forestry activities previously. 54 % had earlier participated in forest study circles. 20 % of the answering women have read the book participating in a study circle. These circles have had from six to 15 participants, which is the normal size for study circles.

Half of the women received information about the book through different associations of forest owners. The seminars in Stockholm are also mentioned as a source of information.

The women were asked which part they found more interesting and which they found less interesting of the four parts in the book. The part of narrative accounts was by far considered the most interesting part (Figure 1).

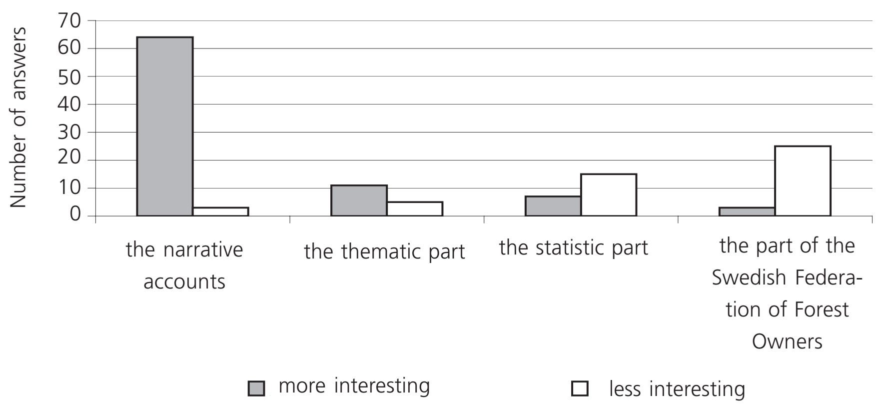

Figure 1. Number of women for which part they found more and less interesting. (n=80) Some women gave more than one answer and some dit not give any answer.

The reasons given to why this part is more interesting are mostly that the women recognize themselves in the stories. Reading the accounts provides a context to forest ownership. Many women express that it is encouraging to read about other women and their relationship to the forest. A small number of women think that this part is the less interesting one. They consider it predominantly entertainment.

The feature that was most interesting about the theme-part was that it gives an overview survey of the aspects of being a female forest owner built on many women's opinions. The participants that rate this part as the less interesting part have given the comment that this part is a repetition of the first part of the book.

Women who considered the statistics the most interesting, did so because it provided distinct knowledge and details about the history of female forest ownership in Sweden.

The main reason given for rating the part of the Federation of Forest Owners Association as most interesting is that it also provides historical knowledge about forest ownership. The women who think that this part is the less interesting part do so because they already know the part, or because they chose it since they felt they had to choose. Some women think this part is less interesting because they have bad experiences with the Federation of Forest Owners Association.

The book has influenced the readers in their attitude to forest ownership and the forest sector (Table 1).

Table 1. How the book has influenced the attitude of Swedish female forest owners (n=80).

Has your attitude changed to:	Yes	No	No answer
your role as a forest owner?	43	25	12
your property?	37	33	10
the forest sector?	30	37	13

In the study circles, the book has been used as a basis for discussions. There have been discussions about being a female forest owner and how to encourage women to take more active part in forest management. In some circles participants read a part and then talked about the issues. One study circle leader describes how she has asked a question related to the statistics part and then started a discussion when comparing the result with the actual statistics provided in the book.

4 Conclusions

Today, managing forests is not necessarily a matter of felling timber and working with heavy machinery. It is common that forests owners manage their forests but leave most of the outdoor work to professionals. Considering this, it should be as natural for women as for men to manage the forest they own.

To change the concept of forestry from a very male dominated to one where the participation of women is natural, women must have the confidence to participate. The more women who become active in the different forest owners associations, the easier it will become for others to take part of the management of their forests.

Many women write that they have been encouraged to take more active part in the management of their forests, after reading the book and participating in seminars and study circles. There are several women that have had a feeling of being alone as a woman in this context. But after courses and reading the book, they have got stronger confidence and have the strength to participate among others as forest owners.

It might be important that the descriptions of female owners in the book are from a female point of view. Since forestry has been a male dominated field, generally it is men who have composed material written about it. It is important that women are not stopped from managing their forests because a lack of role models. With female writers, female readers feel less alienated and instead are strengthened to develop their identity as a forest owner.

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Ways and examples of implementing gender issues into forestry curricula

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Abstract

An introduction is given of the fields to be covered by the new IUFRO unit 'Gender, Education and Forestry', as little systematic information on this topic has been published so far. Next, results and comments from a within IUFRO e-mail survey (see Annex 1) are reported. Seventeen courses from 11 different countries have been named which implicitly or explicitly include gender issues into compulsory and elective courses, mostly offered regularly. Subsequently the example of gender courses at the University of Freiburg is described, starting with proportions of female students, views on their roles at university, then presenting organisation, content and methods of learning and teaching. It is concluded that teaching gender issues seems to be something special, often considered as 'women's business'. Prerequisites are supporting structures, committed teachers and responding students and knowledge from available research. As forestry is a gendered business a thourough understanding of gender issues must be part of the qualification of forestry graduates.

Key words: forestry curricula, modularisation, gender studies, women in forestry, IUFRO.

1 Scope of IUFRO unit Education, Gender and Forestry (6.18.02)

Gender studies are a field of increaing scientific interest worldwide as we may see from current research projects and conferences. In rural development, agriculture and forestry specific situations as compared to urban societies have been revealed. International cooperation has been started through a new IUFRO research group on Gender and Forestry with as its units Gender research in Forestry and Education, Gender and Forestry (http://iufro.boku.ac.at/iufro/iufronet/d6/hp61800.htm).

Mission and scope of IUFRO unit Education, Gender and Forestry (6.18.02) have been presented and discussed systematically using a mind map (Figure 1) during its first session at the conference 'Forestry serving urbanised societies' in Copenhagen.

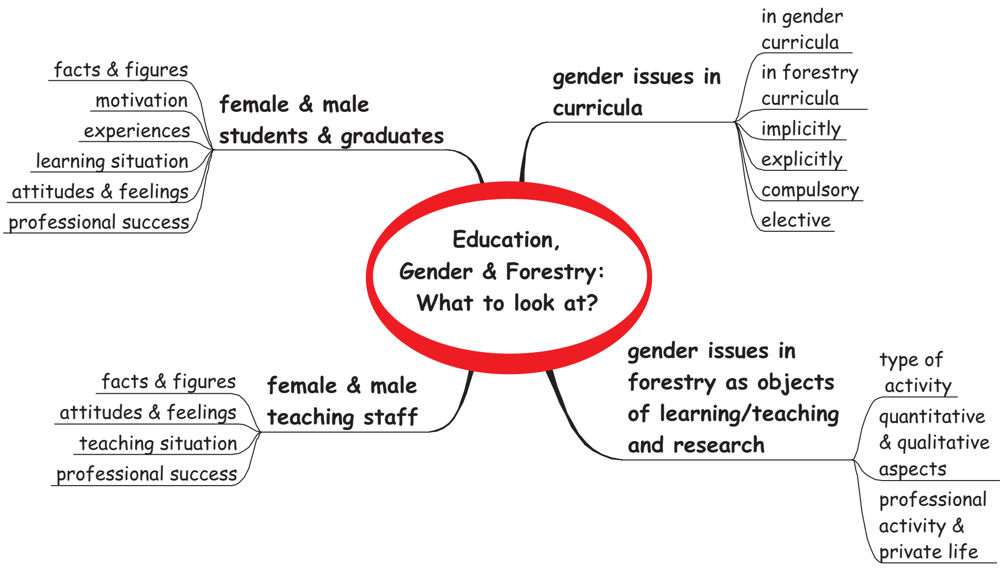

Figure 1. Fields of interest of the IUFRO unit Education, Gender and Forestry (6.18.02) structured in a mindmap.

As forestry is a 'gendered' business a thorough knowledge about gender issues must be part of the qualification of forestry graduates. Therefore gender issues must be integrated into forestry curricula in the core as well as in the elective part. Teaching gender issues will be based on research, which includes graduate analyses including gender separating evaluation. Gender research related to forestry is a new field, but good examples already exist.

As gender studies is a new subject in forestry curricula there is little systematic knowledge about the activities so far, mostly from graduate analyses including gender related statistics (Gerecke 1997; Lewark in press). The first activity of the IUFRO unit set up in 2002 was a survey on ways and examples of implementing gender issues into forestry curricula, the results of which are presented in the next section.

2 Ways and examples of implementing gender issues into forestry curricula: preliminary results from a worldwide survey

The IUFRO unit Education, Gender and Forestry (6.18.02) has been collecting basic information about including gender issues into forestry curricula, as there is no known published information like that. As a first pragmatic approach a basic questionnaire (2002) (Annex 1) was developed and sent to experts using four mailing lists available within IUFRO (gender & forestry mailing list and IUFRO office holders). More than 800 questionnaires were thus circulated including an unknown number of double addresses. This means that individual colleagues have been asked whose interest principally was assumed.

Within five weeks before the conference 'Forestry serving urbanised societies' held at the end of August 2002 (there were holidays in some countries) 39 answers had been received. The numbers of respondents are given in Table 1 for those countries with at least one positive answer (= gender issues included). Because of many e-mail addresses on the mailing lists with extensions like .edu or .gov the knowledge about the distribution of questionnaires according to countries is limited to those with extensions clearly indicating the countries and of course those for the answers given.

Table 1. Numbers of respondents and of positive and negative answers (= gender issues included / not included) by countries (there were 20 negative answers in total –only countries with positive answers are included in the table)

	Number of	Gander studies included	Gender studies not included
USA	23	4	1
Austria	6	2	1
Norway	31	2	
Australia	25	2	
Germany	37	1	1
Sweden	24	1	1
Switzerland	13	1	1
Poland	3	1	1
Honduras	1	1	1
Canada	32	1	
Denmark	16	1	

As the sex of the respondent had not been asked for and the names did not always give a clear clue, the exact numbers of answers by women and men cannot be given, but there seems to be a slight majority of answers from women.

Out of the 39 answers, 17 stated that gender issues are included - to their knowledge - into a course within a forestry curriculum. In most of those cases it were the teachers themselves, who answered. The negative answers came from 20 different countries from colleagues obviously interested in the topic. Twelve courses include gender issues implicitly[1], only 4 explicitly (one not stated).

Out of the 17 courses that included gender issues 13 were indicated as given regulary, for the others it is not clear. 9 are compulsory courses, 5 are elective (3 not stated). All of the 4 courses explicitly including gender issues are elective (figures 2 & 3).

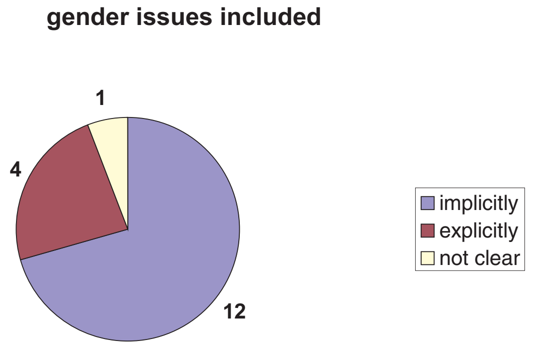

Figure 2 Positive answers according to courses including gender issues implicitly or explicitly.

[1] Implicitly: courses with topics like forest policy including gender issues; explicitly: gender issues main content of course, named in the title.

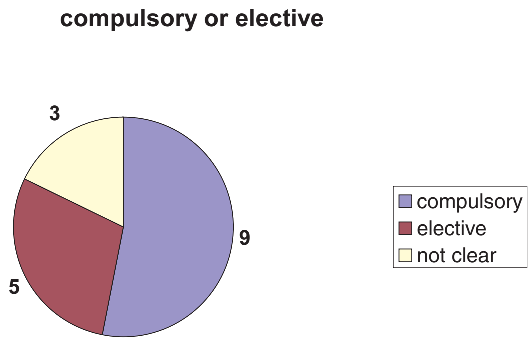

Figure 3. Courses including gender issues according to compulsory and elective ones.

At least as interesting as this first statistical information were the comments given, which are partly cited in Table 2.

Table 2. Quotations of comments from the questionnaires (in order to hide the identities country names have been replaced «in my country»).

„Gender is not a factor when looking at forestry [in my country] so it is not included in the curriculum.“
„Gender issues are not included into curriculum because all the lecturers are men.“
„My reply is fast as I have never heard that gender issues are included into forestry teaching [in my country].“
„None of the 9 Forestry Faculties [in my country] has a program of this kind.“
“Though some courses have been offered at the faculty on gender in the context of behavioural biology and have been touched upon in courses on public outreach / education and nature conservation, these courses were not mandatory. In addition, in core courses and in relation to discussions about values and forests, the gender aspect was generally ignored.”
“A very crucial topic for forestry courses, an urgent need to discuss further –maybe during SILVA Network seminars?”
„Gender issues are included in many of our courses at Zamorano. ... Many of our women graduates are extremely successful professionally and hold positions in public and private institutions throughout Latin America.“
„Gender issues are discussed mainly in connection of perceptions and attitudes towards forests and nature; cultural context of forest uses and practices; access to and management of land and forest resources.“

The survey of individual teachers in forestry curricula is to be expanded with additional addresses. In addition to that an enquiry at the IUFRO member institutions would be desirable.

3 Gender studies - a new subject in forestry curricula: the example of the University of Freiburg[2]

Women studying forestry in Freiburg

The number of female students of forest sciences at the University of Freiburg as well as at the other three German faculties of forestry has been increasing for about thirty years – there were practically no female students before – as described in more detail by Lewark (in press).

The proportion of women is declining considerably from the level of students to that of researchers and of professors, which is a quite typical picture for curricula within traditionally male-dominated education and profession (Figure 4). Though these proportions have been expanding steadily at the levels of students and researchers, one cannot be sure that this also will happen for the professors within a foreseeable future.

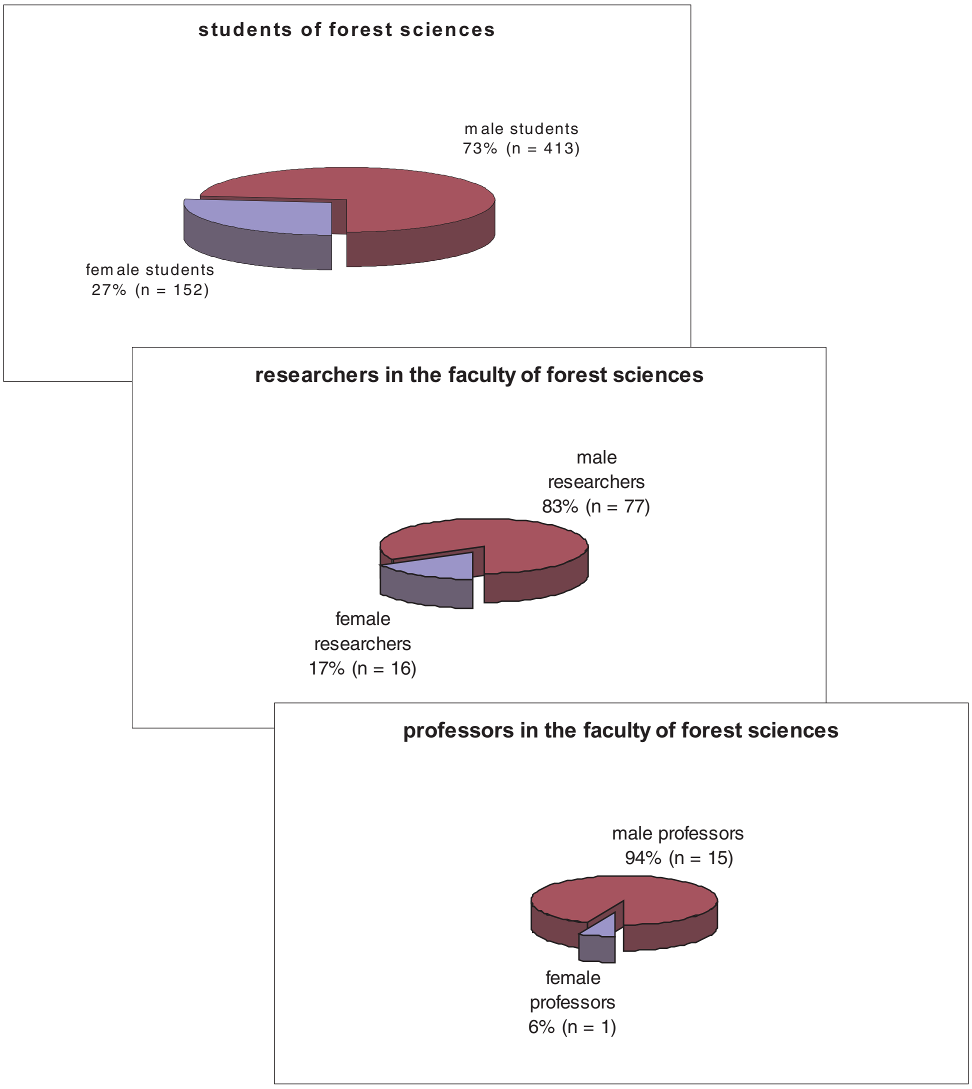

Figure 4. Proportion of women among students (diploma in forestry, master curriculum sustainable forestry and land use management), researchers and professors at the faculty of forest sciences of the University of Freiburg (winter semester 2000/01).

[2] This section has been co-authored by Marion Karmann, external lecturer at the University of Freiburg and deputy coordinator of IUFRO unit *Education, Gender and Forestry (6.18.02)*

During the last few years the proportion of female students was around 30% within a population of about 500 students in the Diploma curriculum of Forest Sciences, and close to 40% in the Master curriculum Sustainable Forestry and Land Use Management.

The Freiburg faculty has a policy of welcoming female students and distributes presentations of itself showing female aside the male students (see Figure 5, right side), but cannot prevent other presenters within and outside the university transporting old clichés (see Figure 5, left side), which in this case led to some excited discussion within the faculty.

Figure 5.
Left: *front page of a Freiburg university magazin including an article on hunting as a subject of forestry education, which enjoys transporting a cliché.*
Right: *brochure of the Freiburg faculty of forestry and environmental sciences.*

Gender issues in the forestry curriculum

At the University of Freiburg in 2000 a Center for Anthropology and Gender Studies (http://www.uni-freiburg.de/zag) was established and a new curriculum Gender studies started. Contributions from the Faculty of Forest Sciences include new courses on women's work and careers in forestry as part of the subject forest work science (six times so far since 1999).

The focus of the courses has changed as the titles indicate:
- Women's work in forestry
- Gender analysis in forestry
- Female careers in forestry
- Introduction to social science methods: the example of women‘s work in forestry

Characteristics of the gender courses in forestry

The course Women's work in forestry[3] has been organised as a one week block, which according to the curriculum regulations in Freiburg means 20 contact hours and 20 hours of self study. 2 ECTS-credits will be given upon successful participation (Figure 6).

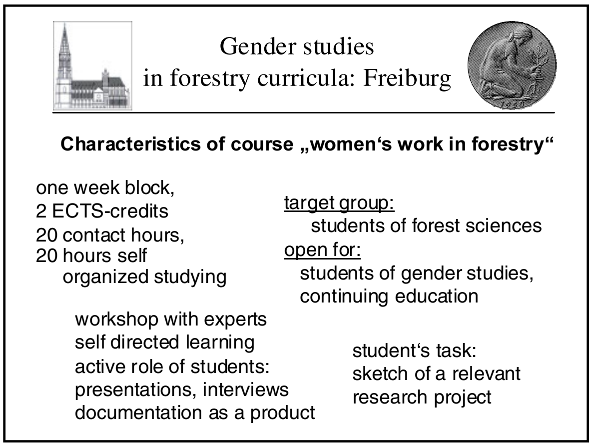

Figure 6. Overview about characteristics of the first gender study course within the forest sciences curriculum in Freiburg in the winter semester 1999/2000.

In the earlier courses the course content was prioritised using a matrix (Table 3).

Table 3. Matrix developed for discussing of content priorities within the first courses.

Female	**Forest workers**	**Foresters**	**Forest owners**	**Contractors**
Careers, employment working profiles				
Working conditions stress & strain				
Motivation & attudes job satisfaction Social relations				
State of kniwledge research questions				

In some of the later courses the students' task was to sketch a relevant research project, which could be realised after the course as an assignment with extra credits.

[3] First developed by Siegfried Lewark and Marion Karmann, with participation of several other teaching staff.

The target group are students of forest sciences including students of the Master curriculum Sustainable Forestry and Land Use Management. The course is open for students of gender studies and for participants from practice as continuing education course.

The learning/teaching form is that of a workshop with experts, and high emphasis on self-directed learning and an active role of the students: presentations, interviews of experts, and a documentation of the whole course as a product which students can take with them are expected.

Female experts from forestry, journalism and related gender study fields shared their professional experience with the male and female students of forestry. Using a 'workshop' format, knowledge was collected on the statistics concerning women in forestry, published experiences, their self understanding in their roles, as well as on organisations of women in forestry in Germany and in other countries.

The gender courses have become accepted as normal courses within the elective part of the forestry curricula. About half of the participants have been male and female students, so the later have been slightly overrepresented as compared with the overall share of female forestry students. The choices of the focus of the respective course, which always have been discussed and set together with the students, and the discussions shown a clear tendency towards reflection on the roles of men and women in forestry, especially on the side of the women themselves. The participants were highly engaged, which can be derived from the active participation and the assigments choosen. Because of this commitment the courses and their contributions are quite well documented in little brochures.

Evaluations by the participants showed the acceptance of the courses as being quite 'normal'. Externally and within the faculty there initially were some discussions referring to a 'knitting club', but these criticisms seem to have disappeared.

The mentioned block courses will find their continuation in the forthcoming semesters, also in order to merge (female) forestry aspects into initiatives for women research and training courses within "Gender Studies" within and outside of the University of Freiburg.

4 Conclusions

From the limited number of 39 answers to our questionnaire and the comments included from obviously interested individual respondents, mostly university teachers and IUFRO officers, we may conclude that:

- There is a limited number of courses including gender issues or explicitly devoted to it in forestry curricula;
- teaching gender seems to be something special; and
- gender issues are very often considered women's business.

The experiences obtained, also from the more detailed example of Freiburg showed that prerequisites for successful teaching of gender issues to forestry students are:

- supporting structure
- ommitted teachers
- responent students

Thus gender issues in forestry are gradually becoming visible and recognised, also in learning and teaching. Does this indicate changes of thinking? The IUFRO unit dealing with this topic will take part in ongoing collecting of information and broadening of views.

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Annex 1

Education, Gender & Forestry

IUFRO Unit 6.18.02

Basic questionnaire (2002)

The research group wants to collect basic information about the state of including gender issues into forestry teaching and would be happy if you contribute by answering our questionnaire.
You will find informations on the objectives and activities of IUFRO Unit 6.18 (Gender and forestry) at:
http://iufro.boku.ac.at/iufro/iufronet/d6/wu61800/newsletter1.htm

Gender issues are
[] included
  [] implicitely (mentioned, treated)
  [] explicitely (objectives, title of teaching module)
[] not included
  into the curriculum: ________________________
  (name of teaching program)
  at university: ________________________
(or other education institution)
If included:
name of course: ________________________
held regularly? ________________________
once per year, semester?
[] compulsory [] elective
name of teacher ____________

I know about other existing or planned courses including gender issues in forestry curricula:
____
Comments:

I want to know about the results of this questionnaire and to be included into the mailing list of IUFRO Unit 6.18:
[] yes [] no
My name:
My e-mail adress:

Please also pass this short questionnaire to colleagues who may be interested.

The information of this survey will be processed in a paper and presented at IUFRO conferences, first at the IUFRO European Regional Conference "Forestry Serving Urbanised Societies" in Copenhagen, August 2002

Thank you for your time and effort to complete this questionnaire.

Please return it to:

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Careers of female forest engineers in Germany - Example from the University for Applied Science and Arts Hildesheim/Holzminden/Göttingen

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Abstract

A graduate analysis of the female graduates of the Fachhochschule in Northern Germany (Department of Forestry and Environmental Management of the University for Applied Science and Arts in Hildesheim, Holzminden and Göttingen) has been carried out. This included their careers and present professional situation as well as the motivations for the choice of studying forestry and gender related problems during education and in the job. 157 out of 202 female graduates from 1979 to 2000 responded to the enquiry. The percentage of women within the students of forestry population was 8 %. They had chosen forestry because they expected a job in and for nature and they wanted to become a district forester. 28 % reached this goal, and another 39 % are working in different positions within forest services. Women have increasingly established their role in forestry education and a professional life at the side of their male colleagues. Gender-related problems during education, practical training and professional life have become smaller in the course of time. But the public does not yet seem to be used to see female foresters.

Key words: women, forestry education, graduate analysis, Fachhochschule.

1 Women studying forestry in Göttingen

The Department of Forestry and Environmental Management of the University for Applied Science and Arts in Hildesheim, Holzminden and Göttingen was founded in 1974 as a school for forest engineers. It took over this responsibility from the forestry schools of the German states. It became possible for women to study forestry at a *Fachhochschule*[1] and in the following years a growing number studied and graduated. This development has been studied in a graduate analysis.

The aim of the investigation presented here was:
a) to reconstruct the career development of women who studied forestry;

[1] The German word *Fachhochschule* will be used in this text, as there is no adequate translation to it; polytechnic perhaps being closest

b) to facilitate recognition of gender-specific problems that may arise during the forestry study and subsequent professional employment;
c) to make these insights available as an aid to women who are starting out on a career in forestry; and
d) to encourage women to study forestry at our institution.

For this purpose, a specially formulated questionnaire was mailed to those 189 out of 202 of the female graduates whose addresses could be traced. 157 women participated in the investigation. Profiles of the professional positions of these 157 women as well as their working and living conditions were analysed with the help of the statistical software package SPSS 9.0.

Table 1. Reasons stated for the low number of women studying forestry (n = 157, more than one answer possible).

Reason	N
Lack of awareness of career	104
Poor career prospects	98
Few allied career opportunities	61
Concern about physical work	37

2 Education and career choice

The first three female forestry students from Göttingen University graduated in January 1979. Between then and the year 2000, the percentage of women among the graduates ranged between 0 % and 26 %. During this time span, a total of 202 women and 2,418 men completed their forestry studies, altogether comprising 8 % women over the years (Figure 1).

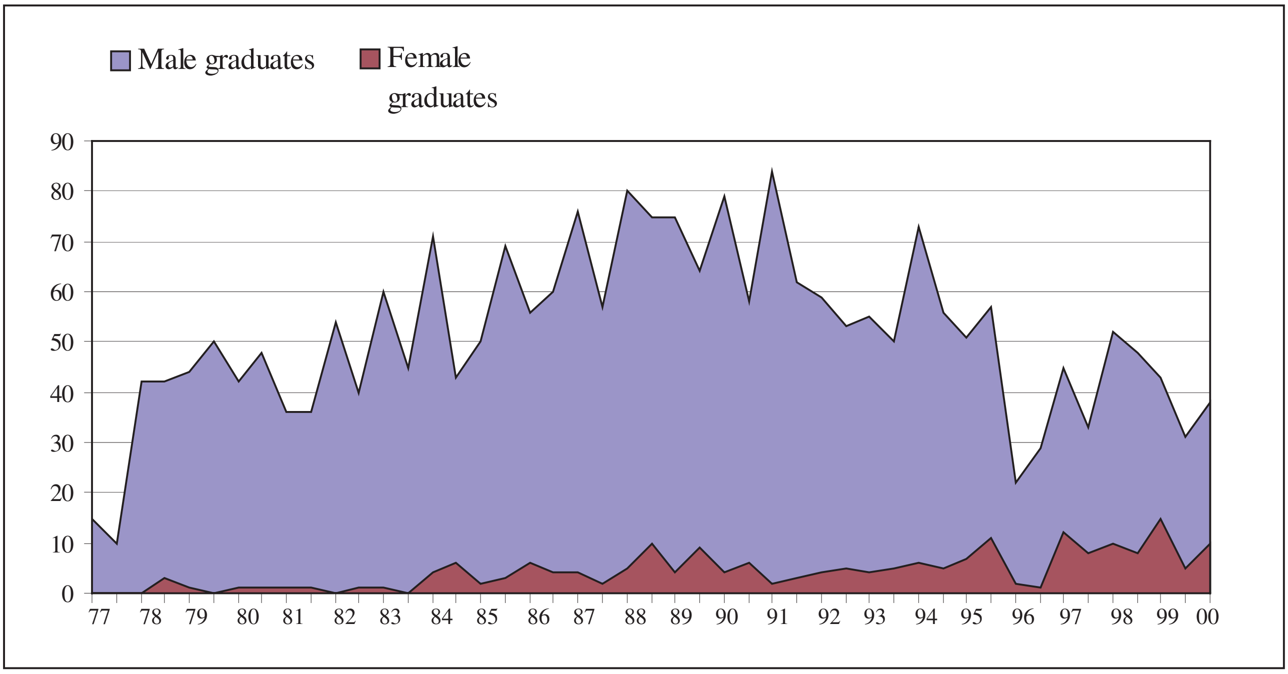

Figure 1. Number of graduates (summer and winter semester 1977-2000).

81 % of the female graduates asked indicated that studying forestry at a *Fachhochschule* had been their preferred choice of study. Various reasons for this choice were given: 108 of 153 emphasized the healthy and physical outdoor work as well as their interest in environment preservation and conservation, and design of landscape planning. 73 women wanted to become district forester, and 28 women were hoping for a creative and diverse career, which allowed them to determine their own work schedule; have time for their family; to be independent, responsible and accountable mostly to themselves (Figure 2).

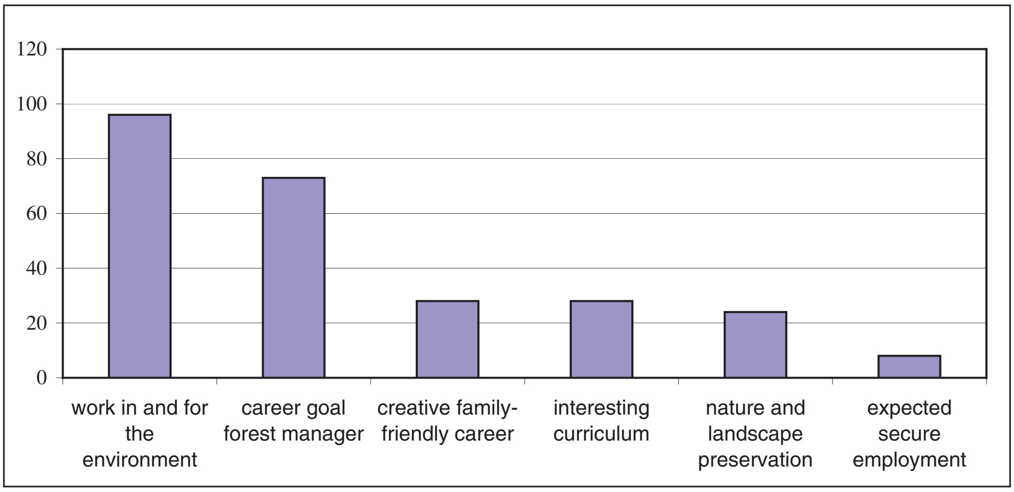

Figure 2. Motives for studying forestry (n = 153, more than one answer possible).

Hunting played no role in the career choices for the majority (80 %). Before taking up their studies, 23 % already had completed other training mounted on a career related to nature.

Table 2. Feelings about working with only few female colleagues during the probationary year in the forest service according to year of graduation (n = 145).

	Year of graduation				**Total %**
	1978-1987 %	1987-1990 %	1991-1996 %	1997-2000 %	
Indifferent	48.3	44.4	60.5	85.7	61.4
Pleasant	10.3	5.6	13.2	2.4	7.6
Unpleasant	34.5	30.6	13.2	7.1	20.0
Both	6.9	19.4	13.2	4.8	11.0

Over the years, female students attached declining importance to having only few female colleagues, but at the same time, with the growing number, female students were less exceptional (Table 2).

3 Current employment

The graduates obtained their first job by virtue of their examination results, but they also believe that currently specialisation (subject of thesis, further qualifications, previous work experience) as well as interviews or references are important for a successful job application (Table 3).

Table 3. Criteria for obtaining the first position in the view of the female forest engineers of all years of graduation (%) (n = 144, more than one answer possible).

Criteria	%
Diploma/probationary year marks	66,7
Work before, during, after graduation	21,5
Equal opportunities quota	19,4
Thesis/further qualifications	16,7

The dream of managing their own district came true for 43 (28 %) of the women (Figure 3).

Altogether, 70 % of the women with forestry engineering degrees who responded presently work in forestry, 13 % hold forestry-related jobs, and 10 % have forestry-unrelated professional careers. The remainder are on leave to raise children and/or are unemployed. 78 % of those with employment have permanent positions, 20 % have short-term contracts and 2 % are self-employed. 82 % work full-time and 18 % part-time.

While 90 % of the women graduating during the first 10 years were immediately offered positions in forestry, only 19 % of today's graduates are.

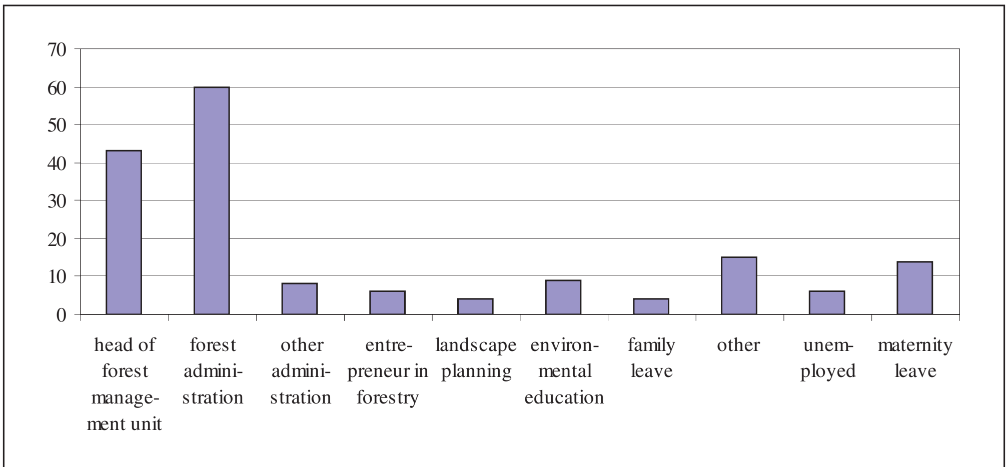

Figure 3. Current employment 2000/2001 (n = 155; absolute numbers, women on maternity leave also named their type of employment).

The most recent female Göttingen graduates feel accepted at work just as well as their male colleagues. They are in a stronger position than the earlier graduates, who to some extent felt discriminated against. In the public eye, however, a female forestry career is viewed as being somewhat atypical.

4 Career and/or family

The majority of the women in the survey (78 %) are married or live with a partner. 61 % do not have children, but many women are still young enough to start families. 58 % of the women who graduated before 1991 currently have children living at home.

The majority of women with children (82 %) manage to combine their career with their families, even though two thirds take care of their children with little help from others. In addition, they do most of the housework and maintenance of social contacts: 94 % of them perform more than half of the domestic work, two thirds even do about 75 % of the work. 51 % of the women manage half of the family's private and business relationships, and 36 % manage 75 % of these relationships.

5 Gender equality

That forestry at a *Fachhochschule* is still a male-dominated study did not affect the career choice for half of the women surveyed. 34 % viewed this fact as a challenge, 5 % felt inhibited, and 11 % initially were not aware of the imbalance. Even during their course of study only 18 % of the women felt negatively affected by being in the minority. For 46 % the issue was of no importance, 23 % saw this as pleasant, and 13 % were ambivalent.

Responses with respect to practical training and preparatory service were similar. Differentiation by graduation year shows that the younger generations perceived significantly better gender equality and acceptance.

Only 18 % think that men receive preferential treatment in job applications. 47 % believe this not to be true and 35 % are undecided. 54 % of those surveyed believe that their good grade average was most significant for securing a permanent job, 31 % mentioned additional occupational skills or job experience. Only 15 % profited from the equal opportunities quota.

Note that during the years surveyed 1981-2000 the grade point average for men was 2.3, while for women it was a little higher, i.e. 2.1, with marks from 1 (best) to 5 (failed).

6 Concluding remarks

During the last decades, women have established their role in forestry education and professional life at the side of their male colleagues. But in private forestry and industry prejudices and reservations related to the compatibility of career and family life still make it difficult for women to gain a foothold. Gender related problems during education, practical training and professional life have become smaller. The proportion of women in education and working life should not be inhibited by prejudices. In order to achieve this it must be made better known that forestry is open for women. But generally the labour market will remain limited, therefore education must prepare for a broad field of activities.

Appendix 1.

A typical female forest engineer's career in the last century

To study forestry was her first choice. She hoped to be head of a forest management unit, a career involving healthy practical work in the forest. She was not really influenced by an interest in hunting, nor by the fact that women are a minority during forestry studies as well as in the profession, but she saw it was a challenge.
She looked forward to enjoying varied studies with a great deal of practical work and the freedom to work on her own. Although both practice and freedom proved to be limited, she would recommend the curriculum to other interested women, provided that the career prospects were better. She thinks that so few women study forestry because few see it as a possible career path and because the career prospects are poor. To bring about the necessary changes, she suggests better publicity, more advertising, more information distributed to young people and, above all, improvement of the career prospects. During the courses, lecturers treated her like the male students, who were friendly and helpful. She enjoyed being the centre of attention but felt she was being observed and under pressure to excel.

When doing practical work and during her probationary year, she enjoyed the recognition and friendly but respectful treatment and sound training she received and took pleasure in being special and receiving greater attention. However, during her work she was sometimes aware of some mobbing and disapproval of women and felt that people were uncertain how to treat her and scoffed at her. She often felt she was being observed and treated with scepticism by her supervisors and thought she must prove herself, and she missed being able to discuss her thoughts with other women in the same situation. She thinks that for colleagues, who went through professional training later, having already some more female fellow students, it made less difference to have only few female colleagues.

She thinks that women and men are both equally suited for a forestry career, but she feels she is better at organisational work, having good relationships with fellow workers and the public, and that men are more suited for dealing with technical matters and work demanding physical strength.

She thinks that in the allocation of jobs, men are sometimes given preference. At the time when every graduate got a chance of employment in the state forest services, she often ended up with a less popular job; this still happens today if she wants to work part-time. It is difficult for her to become district forester. She sees little opportunity in municipal forests. In private forestry and in forest industry women are considered unsuitable, advertisements are for men only, and concern is expressed about possible absence because of pregnancy and childcare.

She obtained her first job by virtue of her examination results. She also considers that specialisation by subject of diploma thesis; further qualifications; previous work experience; interviews and references are important for a successful job application.
She observes that the later female Göttingen graduates appear to be more equally accepted at work. She is in a stronger position than the earlier graduates like herself, who to some extent felt discriminated. In the public eye, however, her career is still viewed a bit exotic.

She as early female Göttingen graduate feels sorry for her young colleagues: She herself may, because of only average high-school grades, have had to wait several years before she, among approximately 1,000 applicants, was awarded one of the 60 college places per year. However after she qualified, she could confidently expect to get a job. Her young colleague profits from the declining interest in the subject and the less sharp competition. But having completed her diploma, a difficult search for a job begins.