Biomass Today and Future Perspectives from Global Perspective to a Local Application in the ACMECS Countries

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1. Introduction

Renewable resources are a key element of a sustainable future for our planet. They play a vital role in recent political and scientific approaches to tackle the challenges of global change, which includes population dynamics as well as climate change and environmental concerns. Societal changes (higher demand for energy, changing patterns of consumption with the trend of urbanization) in combination with a growing population pose risks for the environment and ultimately the environmental services humankind relies on. Global warming is a challenge that affects the entire world's population in various ways. While people living at the sea shores suffer from rising sea levels, more extreme weather events, droughts and subsequently crop failure or reduced harvests are threatening others. The recent migration wave in Europe is caused by an ongoing conflict in Syria and other Middle-East countries, emerging due to multiple causes and complex relationships. However, one of the likely reasons is the deterioration of the country's economic conditions due to a shortage of water (Gleick, 2014) caused by a series of years with extreme temperatures and lack of precipitation, likely attributable to climate change. This is a very clear example how climatic conditions may trigger unfavorable events beyond the control of entire regions. Evidence from geological records suggests a number of rapid sudden climate shifts in the Earth's history, sometimes with devastating consequences for life. There is little doubt in the scientific community that the current climate change is largely induced by combustion of fossil fuels that fuel our economy. However, over the course of the past decades, increased demands for energy and natural resources have induced a higher awareness and consideration of alternative and regenerative resources.Evidence of a changing environment caused by anthropogenic influences soon led to a broader public debate on these issues.Scientific consensus is an important step toward public awareness and acceptance and subsequently policy-making (van der Linden *et al.,* 2015). This has led to a number of political decisions to regulate the greenhouse gas (GHG) emissions based on multinational agreements. The term "bioeconomy" gained increasing popularity within the last few years, especially since the European Commission adopted the bioeconomy strategy in February 2012 (European Commission, 2012). The COP 21 negotiations in Paris resulted in even more ambitious commitments of all nations to combat climate change. The role of forests is therein addressed several times, despite it was not well addressed in the initial drafts. Existing mechanisms, such as REDD+, were considered to be key tools to achieve the climate goals, especially in the post-2020 framework. Up to date, most investments were made in ensuring REDD+ readiness trough development of adequate monitoring, measuring, reporting, and verification (MRV) systems and national strategies, while the system became more complex and fragmented (Gupta *et al.,* 2015). However, the authors acknowledge the positive role in bridging organizations across governments and their origin (government, NGO, private etc.). It is expected that the outcome of the COP21 negotiations will be a strong signal for the REDD+ system and therefore can be of significant importance to move beyond the preparations for REDD+ readiness and for financing afforestation and forest protection projects that help to mitigate climate change.

However, there is also no doubt that mitigation alone might not be enough, but it is also necessary to consider appropriate adaptation measures, especially in agriculture and forestry. The challenge associated with the transition from the current, fossil based resource towards more renewable pathways of resource acquisition are drivers and interconnected at global scales. Biomass can play an important role as it has a number of distinct advantages over other renewable resources, e.g. wind and solar power. It can be produced almost everywhere and can be stored and converted into energy according to the demand situation. However, an ideal reliable and efficient future energy system builds on diversification and as such, biomass can play a significant role in the entire renewable energy and raw material supply system.

2. Sustainable Land Use Management is the Key for Biomass Production

The ultimate challenge for a sustainable management of natural resources is to assess and characterize the indispensable environmental (ecosystem) services that a certain site provides, in terms of both tangible and intangible items. For instance, forests represent some of the world's most sensitive but at the same time productive ecosystems and therefore it is necessary to provide a sound scientific basis in order to develop guidelines that protect forest land from degradation and over-exploitation and finally from a loss of biodiversity and the ability to provide services. The same applies for agricultural systems as soil degradation is one of the key challenges threatening a large share of the global population. In addition, degradation is linked with loss of organic carbon, usually to the atmosphere, which further increases greenhouse gas emissions and ultimately

climate change. Biomass production depends on more or less fertile land. Arable land is a limited resource and soils are non-renewable in time scales relevant for human development. Year 2015 was declared the international year of the soils at the 68th UN General Assembly to highlight the important services that soil provides to all living organisms. According to World Bank data for 2012, the global share of arable land is close to 11% of the total terrestrial land area, while that of forests is 31% (World Bank, 2015). While biomass produced in agricultural systems is largely used to produce food and animal feed products, only a limited share (e.g. harvest residuals) may be used as feedstock for other purposes as it was shown long ago that residues fulfil an important function in maintaining soil health and productivity (Cassman, 1999). This suggests that large potentials for biomass as a resource for industrial feedstock materials and energy lie in forest ecosystems (both natural and plantations of fast growing woody species) globally. However, on a regional scale, agriculture can be the most significant biomass resource. Policy decisions have to ensure that on regional scales, biomass production has to be performed in a cascade approach by favoring food over feed and finally biomass for energetic/material utilization purposes.

Issues of land tenure are critical in many countries and can be a barrier in sustainable land management, even when internationally recognized mechanisms are involved in protecting forest resources (Sunderlin *et al.,* 2014). Therefore, it must be clearly defined and secured by a stable and reliable policy framework at national level that includes also measures for enforcement. All stakeholders benefit from clear land tenure rights as it ensures a secure basis of livelihood as well as new income opportunities for local communities and a secure and predictable environment for investors. Certification systems were introduced to ensure sustainable production in order to generate trust on the market and indicate sustainable practices. However, it was recently shown that even well-established multi-stakeholder initiatives, such as FSC, weakened over time as a consequence of structural failings and downward pressures on its standards initiated by market forces (Moog *et al.,* 2015). One need to be aware of these issues, and a constant re-evaluation of certification systems might be necessary in order to ensure a long-term reliability on the market.

3. Plantations of Fast Growing Woody Species

A recent study confirms that the biomass production efficiency is indeed higher in managed forest ecosystems and that management as such is the key controlling factor, and not fertility as often perceived (Campioli *et al.,* 2015). Plantations of fast growing woody species can increase site productivity and therefore, more biomass can be produced per unit of area as compared to natural forest ecosystems. Moreover, costs can be reduced as stem densities and spacing may be arranged according to the species characteristics and harvesting methods. The selection of appropriate clones ensures optimal site suitability and minimum variability inquality and quantity of individual trees. Temporary or permanent intercropping may reduce the need for weeding in the stand initiation phase and generate additional income while improving biodiversity. However, intercropping cannot be compared to natural stand conditions and it is not always possible, leading to large plantations of uniform age, species and in case of clones often limited genetic variability. The consequences can be severe in terms of pests and diseases and they can become prominent even in late stages before the anticipated harvesting, which imposes high investment risks. The recent emergence of *Acacia mangium* as one of the key species for short rotation crops in Southeast Asia and specifically in Indonesia for instance, led to the propagation of a number of fungal diseases causing significant mortality (Tarigan *et al.,* 2011) or decreasing yields limiting the number of economically feasible rotations (Francis *et al.,* 2014). During the 3rd ACMECS bioenergy workshop (KAPI, 2015) held in Thailand in 2015, it was therefore concluded that efforts in plantation management should not focus on yield maximization but rather stand optimization which includes plantation health, resistance against diseases and climatic extreme events as well as allowing biodiversity. In general it was recognized that reforestation efforts in tropical countries can have positive effects in terms of climate change mitigation and adaptation (Locatelli *et al.,* 2015), as forest products sequester carbon and bioenergy reduces the carbon footprint. Adaptation can be achieved by reducing the vulnerability of ecosystems and communities to extreme climate conditions.

4. Sustainable Biomass- The Way To Go

Responsible resources management requires a solid scientific basis in order to understand the complex processes and relationships between species and the environment and a well-developed toolbox to practically implement suggestions in daily business operations. Elements of this toolbox might be the formulation of guidelines, best management practices, decision support systems and capacity building (education, exchange of expertise). Existing natural forests need to be protected and conserved to sustain species and habitat diversity. The current epoch, the Anthropocene, is characterized by one of the largest rates of species losses our planet has ever faced, and this is due to human activities. Therefore, new plantations have to be developed on existing non-forest land and both, the biomass production and also the resource use efficiency need to be improved to ensure a safe livelihoodfor further generations. Whenever biomass development is discussed, land availability is an immediate issue. Biomass, a renewable commodity, is produced on soil which represents a non-renewable resource in human timescales.The focus of the development of new plantations should consequently be set on

available and in specific degraded land, as certain crops have the potential to restore such sites over a number of rotations (e.g. nitrogen fixing species). It is clear that from an economical point of view, this might not be the most profitable short-term investment, but plantation business should be directed at longer time horizons. Land use change that improves land as in this example or protects habitats e.g. watersheds from over fertilization (buffer belt between water streams and agricultural crops), or alleys that protect agricultural land from wind erosion are examples for favorable practice and should be focused. In order to achieve this ambitious but not impossible aim to consider these issues, we need a strong political commitment towards a bio-economy, international collaboration and a solid scientific basis that is able to provide solutions in all aspects of energy and raw material transition from fossil to renewable resources. A bio-based economy offers a range of co-benefits to the climate change mitigation potential, such as energy and raw material supply security, lower environmental pollution if efficient systems are being used, job opportunities and income in rural areas which is of particular interest in the light of a global urbanization trend.

Fig. 1: Intercropping demonstration project of cassava (Manihot esculenta) in an Acacia plantation in Thailand. The plantation is accepted by the local community as they are allowed to manage cassava on government land. In return the governmental institution managing the SRF plantation benefits from intercrop management as no weeding is required and any excess fertilizer may be taken up by the fast growing Acacia and enhances growth.

There is a broad consensus that the development of bioenergy can have positive impacts if sustainability is considered. The technologies for conversion of biomass to energy are well developed and there is a significant amount of experience available on a global scale. At the same time current systems are constantly being evaluated and further improved. Since the provision of energy is the largest contributor of GHG emissions, bioenergy can help to mitigate climate change by reducing the amount of fossil fuels used. This can be of major concern if carbon trading schemes are to be enforced and offers additional sources of national income. Moreover, domestic production of energy contributes to energy security as a consequence of diversification and creates jobs and income, usually in rural areas. This can have an important socioeconomic impact in regard to the above mentioned trend of urbanization. In addition, regions of higher biomass production potentials may be able to export biomass (e.g. woodchips or pellets) to domestic, regional or even international markets.

Scientific research is needed along the entire supply chain to further improve processes in terms of productivity and efficiency as well as sustainability (best management practices). This starts at the production of biomass (soils and climate, species selection and development of new clones that are resistant to environmental influences and increase the productivity, innovative silvicultural and agricultural methods or a combination of both, that allow efficient land use) includes the conversion technologies (efficient conversion technologies and new pathways of biomass utilization, e.g. bioplastics and biodegradable materials, reduction of production costs, development of solutions across scales, e.g. biomass boilers from industrial to household scale) and finally research in the field of efficient material and energy use (cascade utilization, minimizing losses, intelligent systems etc.).

5. The Role of the Sustainable Forest Biomass Network (SFBN) Task Force

There are worldwide efforts in developing further biomass resources, in particular in SE Asia. One of the reasons is the recent introduction of a feed-in tariff in Japan, as a consequence of the Fukushima incident and the subsequent temporal halt of all nuclear power plants. This led to a rapid development of biomass power plants, while biomass supplies have already nearly reached the maximum (economically viable) capacity (Yokoyama and Matsumura, 2015). At the same time, domestic consumption of biomass for various purposes is increasing and biomass plantations are therefore increasingly promoted. In 2013, a research initiative led by the well-established Kasetsart University (Bangkok, Thailand) aimed to install a regional bioenergy network to

foster collaboration within the ACMECS countries Cambodia, Lao PDR, Myanmar, Thailand and Vietnam (KAPI, 2015). The focus here is the development of national harmonized bioenergy strategies while being able to serve domestic and international markets with biomass produced from plantations. It was early mentioned that sustainability is the key for a development that ensures livelihoods and income opportunities for local communities, protects soils and ensures long-term economic viability. The International Union of Forest Research Organizations (IUFRO) SFBN Task Forcerepresents a global network of forest biomass experts (IUFRO, 2015), bringing together some of the world's leading experts in forest biomass issues. It has the capacity to provide state-of the art knowledge and expertise across scientific disciplines including natural sciences as well as social sciences and policy. One of its main aims is to develop a research agenda and a toolbox for implementing research findings into a practical policy framework in Southeast Asia in the region of the ACMECS countries to ensure sustainability. Experts of this Task-Force are situated in key positions in global forest research and can therefore provide valuable inputs from their research background and from practical experience obtained from similar efforts in other countries. Research efforts will be coordinated for a sustainable production of energy in the member countries, which will provide policy implications on energy production and consumption and measures taken in order to ensure sustainability. This includes also potential consequences of increased biomass utilization (especially burning) on air quality, which will be addressed in cooperation with a dedicated group of IUFRO experts on air pollution. Results can also be used to support the REDD+ policy process that has gained momentum at the COP21 meetings in Paris. Responsible government officials were included since the beginning of this process to ensure awareness and recognition during the development of the regional bioenergy strategy. In addition, the implementation of certification schemes for sustainable biomass production may be discussed at some point. The lead mission of the SFBN TF is to develop sustainable biomass resources that provide a multitude of ecological services and raw materials without degrading soils. The livelihood of rural people should be improved by creating income opportunities, which do not pose new risks (e.g. air pollution, etc.).

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