ACMECS Bioenergy 2015
Three Years of Effort Towards a Regional Bioenergy Network

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KIOES Opinions 5 (2016)

ÖAW AUSTRIAN ACADEMY OF SCIENCES

KIOES Opinions 5 (2016): 1-24.

doi: 10.1553/KIOESOP_005

Impressum:

KIOES Opinions are published by the **Commission for Interdisciplinary Ecological Studies (KIOES)** of the Austrian Academy of Sciences (ÖAW). KIOES publishes current opinions written, initiated or invited by KIOES related to topical subjects on an irregular basis in **KIOES Opinions**. The target audience includes scientists, policy makers and the public. Opinions expressed in this article are solely those of the author(s), and they do not necessarily reflect in any way those of KIOES or ÖAW.

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Layout: Karin Windsteig

Cover photo credit: Fotofolia

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This report is jointly published with the IUFRO Occasional Paper series, Vol. 31, www.iufro.org.

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Biographies of all authors see p. 22.

Received: 20.04.2016, published online: 21.06.2016

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 address global challenges precipitated by the urbanization of rising populations, increased economic development, heightened environmental concerns, and rapid climate changes. Increased demand for food, fiber, shelter, materials, and energy are placing strains on our environment and creating demands for new and sustainable ways to meet these needs. Integrating the sustainable production of these human needs in innovative and renewable ways is becoming increasingly critical. As society's demand for these services increases, the earth's climate is rapidly changing as a result. This, in turn will affect the entire world's population in various ways. While people living near sea level will suffer from rising water levels, more extreme weather events, droughts and subsequently crop failure or reduced harvests are threatening others.

This has led to a number of political debates, initiatives, national and international agreements to regulate the greenhouse gas (GHG) emissions, which are the root cause of the rapid climate changes we are experiencing. For instance, the recent COP 21 negotiations in Paris resulted in commitments of all nations to combat climate change that are more ambitious than ever before. Dispite being underappreciated in early drafts, the important role played by managed forests was recognized in the final version of this agreement. Existing mechanisms, such as REDD+, were considered to be possible tools to achieve the climate goals, especially in the post-2020 framework. To date, most investments have been made to increase national REDD+ readiness levels through the development of adequate monitoring, measuring, reporting, and verification (MRV) systems and the creation of national implementation strategies, even as REDD+ became more complex and fragmented (Gupta et al., 2015). The COP21 agreement recognizes the positive roll that collaboration among governmental, NGO, and private organzations can play in implementing efficient and effective mechanisms to use forests in reaching GHG goals. It is expected that the outcome of the COP21 negotiations will be a strong endorsement of the REDD+ system, and will lead to a shift from funding for preparations for REDD+ readiness

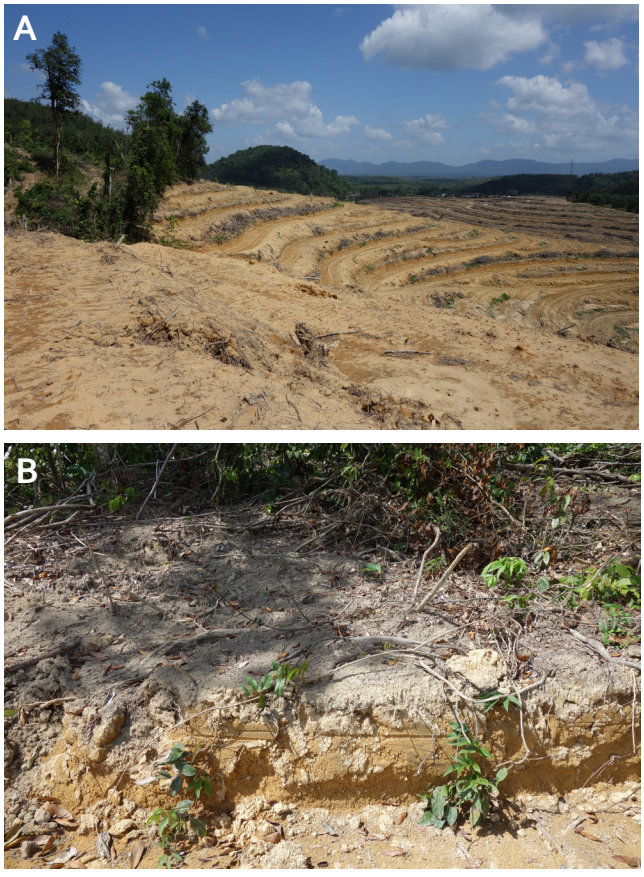
to financing for actual afforestation and forest protection projects that help to mitigate climate change.

GHG emissions must be reduced in order to achieve the 2 degree warming limit by the end of the century envisioned in COP21. Some bioenergy systems are capable of generating negative emissions by sequestering carbon (e.g. by using biochar), but mitigation alone will not be enough. It will also be necessary to consider appropriate adaptation measures, especially in agriculture and forestry. The challenge associated with the transition from the current, fossil carbon based economy towards more renewable resources 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 like wind and solar generated electricity. Biomass is the only renewable source of carbon. It can be obtained from a huge variety of sources (including waste streams), produced almost everywhere, stored, and converted on demand into a range of energy products (e.g. heat, electricity, transportation fuels) and feedstocks for advanced materials manufacture. This was recently acknowledged and the term "bioeconomy" was coined in order to underline the importance of biomass-based feedstocks for industrial resources and energy (European Commission, 2012). A bioenergy system consists of biomass production (harvesting, transportation, pre-treatment), conversion, and the utilization by end users. To be successful in reaching the goals established by COP21, these systems must have positive mass and energy balances and be economically, environmentally, and socially sustainable. Reliable, affordable, and efficient future energy, materials, and food systems must be diversified, and biomass can play a significant role. Individual sources and uses of biomass should not be considered alone, but rather as part of an integrated system. Synergies from the combination of various sources of renewable feedstocks and conversion technologies should be used to enhance the overall efficiency of a renewable system. Such synergies can include biomass feedstock drying by using solar energy, or more integrative approaches where non-dispatchable variable renewable energy (VRE) such as solar and wind power are combined with controllable, dispatchable, and renewable sources of energy such as biomass.

Tropical climates are characterized by high precipitation rates, elevated temperatures and favorable radiation budgets which together provide suitable growth conditions for biomass around the year. This makes the tropics the world's most productive ecosystems with the highest annual biomass accumulation rates of all biomes and they account for two thirds of all terrestrial biomass (Pan et al., 2013). However, native tropical forests are endangered by significant deforestation that has been occurring since the middle of the 20th century. While the extraction of valuable timber was the initial cause of this deforestation, today most forests are being cleared to gain space for agricultural production. Unsustainable agriculture or silviculture practices lead to soil degradation espe-

Fig. 1: Conversion of natural forests and plantations of *Hevea brasiliensis* (rubber tree) into Elaeis guineensis (oil palm) plantations has dramatic impacts to a small village near the plantations (A). Parts of the village were subject to floods twice since the clear-cut took place and local inhabitants report higher temperatures during daytime. The topsoil layer enriched with SOM is very thin (B) and was maintained by the previous forest cover. This picture was taken at the transition between the former Hevea plantation and the natural forest which was recently logged. Photos by V.J. Bruckman.



cially in the tropics. Tropical soils are heavily weathered and fragile. As a consequence, their ability to buffer nutrients is low. Tropical storms with high rates of precipitation within short periods of time contribute to soil erosion if vegetation cover is removed and subsequently soil organic matter (SOM) is lost. SOM plays a key role in maintaining soil fertility in the tropics but soils in these regions usually have very thin SOM-enriched topsoil layers which are easily lost due to erosion (figure 1). In addition, the moist and warm climate leads to rapid mineralization of nutrients which are easily leached during periods of intensive rainfall.

Therefore it is critical to employ sustainable practices that conserve or even enhance SOM during management operations. In the long term, such investments will sustain productivity and income and therefore also are a viable strategy from an economic perspective. There is no doubt that a growing population requires more food, feed and other biogenic raw materials which can be provided from agriculture and forestry production. When biomass energy and carbon sequestration are added to the demands placed on the land, the challenge to produce all these things sustainably increases even more.

There are worldwide efforts underway to develop additional biomass resources, particularly in Southeast (SE) Asia. The balance between domestic consumption and foreign exports of biomass is changing within these countries, and this demands careful attention when developing national plans within this and other regions. One example of a policy change in one country that has profound implications for biomass production throughout SE Asia is the recent introduction of a feed-in tariff for electricity in Japan. This followed the Fukushima incident, the subsequent temporary halt of all Japanese nuclear power plants, and the rapid development of biomass power plants that resulted. Domestic biomass supplies in Japan have already reached the maximum economically viable capacity and can only supply 30% of demand (Yokoyama and Matsumura, 2015) so the demand for imported wood products (particularly from SE Asia) soared. At the same time, in almost every country in SE Asia, the domestic consumption of biomass for various purposes is increasing. This strains the capacity of the region to sustainably meet present and future demands for biomass.

Meeting these demands should include a stepwise approach that first looks to biomass that might be available from agricultural operations, residues from forest products industries, or municipal waste streams. These tend to be available at low cost. However, such resources may already have commercial or environmental uses (e.g. providing cooking fuels or maintaining soil health). Additional harvesting of biomass from natural forests (beyond the recovery of logging residues) is generally prohibited by policy in many SE Asian countries because of rising concerns regarding the protection of the last remaining patches of intact natural forest for wildlife, biodiversity and general ecosystem services conservation. Therefore, wood grown in plantations might be the only viable way to increase biomass production to meet rising demands.

A range of biomass crops is possible within this region and suitable crops might be selected based on local environmental conditions (climate, soils), feedstock demands (regional biomass industries), and the market situation for potential by-products. Such plantations are increasingly promoted, but the establishment of large scale bioenergy plantations across SE Asia needs to be considered in light of a series of limiting factors. Suitable land is scarce and may already be used for other purposes. Land use conflicts may arise with agricultural production and nature conservation if development is not planned properly. Adequate legal frameworks and appropriate stakeholder consultation procedures would need to be enacted and implemented. Knowledge to choose biomass crops, manage plantations, handle and convert feedstocks, and resond to environmental and social pressures in this region is limited. The research and education infrastructure needed to address these issues needs further development.

1. The ACMECS Bioenergy Network – from the idea to the current status

As a consequence of rising biomass demands in the region, a research initiative was started by the well-established Kasetsart University, Kasetsart Agro-industrial Product Improvement Institute – KAPI (Bangkok, Thailand) in 2013. The goal was to esta-

blish a regional bioenergy network to facilitate collaboration among the member countries of the "Ayeyawady-Chao Phraya-Mekong Economic Cooperation Strategy" (ACMECS) which are Cambodia, Lao PDR, Myanmar, Thailand and Vietnam (KAPI, 2015a). In keeping with the original idea of the ACMECS framework, the ACMECS bioenergy network would foster sustainable development of individual national bioenergy development plans that are embedded within a regional strategy. This was to be achieved by scientific collaboration, technology transfer, capacity development and coordinated action among stakeholders from the member nations. It was clear that the process must be situated at the science-policy interface so officials from relevant governmental institutions of all ACMECS countries were involved in it from the beginning. A strong focus was to find the value this initiative could create for local communities. Local solutions were to be sought that would expand the production of biomass from sustainable plantations while simultaneously integrating with domestic, regional, and international needs and markets. The ACMECS bioenergy network modus operandi included a series of workshops with a scientific component and with policy discussions. In addition, field excursions were organized to discuss key issues directly in the field. Excursion points included aspects of the entire supply chain starting from biomass production through fast growing species such as Eucalypt, Acacia, Casuarina etc. to biomass processing companies and finally biomass power plants. The unique combination of presentations and fieldtrips and the diverse background of participants from research, business and policy making created an atmosphere that facilitated lively discussions and exchange and the building-up of a strong regional collaborative network. It was highlighted at an early stage 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.

2. The 1st ACMECS Bioenergy Workshop

The first ACMECS Bioenergy workshop was held in Bangkok during August 2013. With more than 80 participants and dedicated delegations of all ACMECS member countries, it demonstrated a strong commitment towards the joint development of sustainable bioenergy within the region. During this workshop, the current status of bioenergy development in each country was presented and the main challenges in sustainable development were discussed on national level. All participants agreed that the coordination of the network should be facilitated by the Kasetsart Agricultural and Agro-Industrial Product Improvement Institute (KAPI) of Kasetsart University. Among the key findings of this workshop was the heterogeneous level of bioenergy development in the member countries which had implications for the supply structures for biomass commodities. For instance, rural households in Thailand rely to a large extent on wood charcoal for cooking while cooking in most parts of Myanmar is done with fuelwood. Lao PDR is the country with the highest share of natural forest cover among the ACMECS countries. 80% of the country is forested according to World Bank data (World Bank, 2015). Consequently it is also the country with the highest rates of illegal logging. It was recognized that policies need to be developed and enforecement increased in order to reduce this practice. It was noted however, that recently some progress was already achieved, particularly in the North of the country (Kim and Alounsavath, 2015) and this might serve as a model for the future. The workshop showed also that the relationships of demand and supply that cause illegal logging are not trivial. The business of illegal logging is often an important income source for sustaining livelihoods. On the other hand it was clear that a lack of political willingness coupled with other structural problems, such as corruption, can exacerbate these activities. It was acknowledged, that natural forests need to be protected, while biomass should be produced on dedicated plantations. A strong need exists for collaboration between countries, starting with research and extending to policy making and the development of guidelines for landowners and companies engaged in biomass business. It was agreed at this early stage that "sustainability" should be the guiding principle for the development of the region's biomass resources.

3. The 2nd ACMECS Bioenergy Workshop

The second ACMECS bioenergy workshop was held one year later in November, 2014, again in Bangkok, Thailand. The aim of this workshop was to create a platform for exchange of knowledge and collaboration. Based on the key issues identified during the first workshop, the focus was set on small-to medium sized community scale biomass production using scalable technological solutions (e.g. small power plants of around 1 MW capacity, household biogas production etc.). Community forestry, a proven system of joint forest management at small scales, was considered for implementation in suitable conditions (Sunderlin, 2006). Thus, the identification of suitable production strategies, technologies, and technology transfer were all key issues discussed at the workshop. It became clear that simple, but efficient solutions were needed, education and training needed to be increased, and support for developing and financing new ventures was required. It was moreover agreed that a working group should be established in each country with the goal of developing proposals for nationally-appropriate bioenergy development plans. It was agreed that these working groups meet together in one year's time in order to present their coherent strategies and a compatible presentation format for the 3rd ACMECS bioenergy workshop. The following key thematic areas were identified during the scientific discussions as key areas of attention for the 3rd ACMECS bioenergy workshop:

1) The potential impact of Climate Change on the production of biomass (changing patterns of precipitation, increased need for drought resilience, but also opportunities such as carbon sequestration of biomass plantations, mitigation of climate change and climate change adaptation via development of more robust, drought-tolerant and disease-resistant species etc.).
2) The presentation of National Bioenergy Development Plans as mentioned above, which will represent the basis of further collaboration and hence should be developed in context to the regional strategy.
3) Discussions on technologies and technology transfer revealed that physical and chemical standards, applicable to the entire ACMECS region are necessary in order to promote commodity markets. In addition, the 3rd Workshop should also assess the issues concerning certification schemes for biomass plantations on various levels (national, regional, international).

4. Expert meeting for the development of National Bioenergy Development Plans (NBDP)

As agreed, the working groups met again in September 2015 in Pattaya, Thailand, to coordinate the drafting of National Bioenergy Development Plans based on the reviews undertaken undertaken by each country's team since the 2nd ACMECS Bioenergy Workshop. A series of consultation workshops had been held in each country before this meeting in order to prepare their NBDP drafts. These drafts were presented during this meeting in September. The group agreed on a common template for the final plans that would address the most important issues, while allowing flexibility for each country to deal with the unique issues they faced. Each NBDP consists of six sections; i) Basic information about the country, including a rough energy profile and the main stakeholders in the energy sector, ii) results of a SWOT analysis, iii) strategic issues (summary of the key strategic aims), iv) vision, goal or mission, v) key success indicators, and vi) information on links to national policies where applicable, as well as information on implementation tools (reporting, evaluation etc.). The drafts were developed during this meeting with the aim to present and discuss them during the 3rd workshop.

5. The 3rd ACMECS Bioenergy Workshop

The 3rd ACMECS Bioenergy Workshop was held in Ubon Ratchathani, Thailand in December, 2015 and the main task was the presentation and discussion of the NBDP's (KAPI, 2015b). The first day was devoted to presentations relating to the scientific issues identified as crucial during the 2nd workshop. On the 2nd day, the NBDP's were presented and discussed in a scientific context. The following section represents a summary of the workshop results. In the case of the NBDP's we focus here on a short summary of each country's energy profile followed by condensed results of the SWOT analysis, with emphasis on the strategic issues each country identified as main focal

areas. We did not consider more detailed information, such as the key success indicators for this report, as these are very detailed and their suitability for implementation need to be verified in a future step in the NBDP development process. The full drafts, including all presentations, can be obtained from the workshop proceedings (KAPI, 2015a).

The keynote presentations introduced the general conditions for a sustainable development of bioenergy. This includes a perspective on the entire supply chain, including five elements (figure 2).

Fig. 2: The essential elements of a bioenergy supply chain.

The development of a regional bioenergy network needs to address all five elements simultaneously in order to ensure successful implementation. Without a market there are no customers and there will be no need to develop other parts of the chain. Feedstock production is needed before feestock handling is needed, and so forth down the chain. Additionally, there are feedback loops within the chain. For example, new products create demand for the production of specialized new feedstocks. Governmental incentives may help to guide the development in a specific anticipated direction and avoid negative consequences. However, challenges need to be overcome at multiple levels, especially when using plantations as the main source of biomass feedstocks. Plantations represent the most promising source of renewable biomass in this region. The environmental challenges of plantations include breeding of more adaptable and robust species and the establishment of inventory databases. The social challenges include market development, certification, and infrastructure development. The techno-economic challenges include the improvement of feedstocks and the integration of bio-products. One of the major needs for developing a meaningful bioenergy strategy is a reliable set of data, comprising spatially explicit information on land use, biomass resources, and soil productivity. Remote sensing can be an efficient tool for deriving such information on country or regional levels at reasonable costs. Remote sensing data need to be calibrated using inventory data at the stand or management unit level. A reliable dataset is necessary in each vegetation unit. The challenge in many tropical regions, including the ACMECS countries, is that such information is largely missing and therefore remote sensing data is inaccurate (Schimel et al., 2015). For instance, global biomass maps are very inaccurate and the two most widespread ones have an aggregated difference of 16% between them, ranging from -2% to 26% by continent. Moreover, these maps represent the actual biomass stocks, which may considerably differ from potential biomass stocks.

5.1 Learning from other regions and examples

One of the aims of the workshop was also to compare the situation in the ACMECS countries with other regions with similar conditions. Central Africa has a similar climate and biomass is still the most important source of energy, and a large share of the population depends on biomass. The continent accounts for 20% of the global wood demand and the per capita fuelwood consumption is the highest compared with all other continents. Biomass development has received little attention, resulting in low investments. Traditional kilns with low efficiency are extensively used for conversion of biomass to charcoal (similar to conditions in SE Asia). Modern, efficient kilns are available but they are expensive and have a low adoption rate. Most wood fuel is extracted unsustainably, leading to low prices that do not reflect the true costs of regeneration. In turn, these low fuelwood prices lead to little incentives for sustainable production. Poor regeneration is exacerbated by climatic impacts, such as droughts and by heavy grazing. However, despite all these challenges strategies for sustainable biomass production are being adopted in a number of countries. These include improved technologies (charcoal kilns, fuelwood stoves), policy development, an improved biomass energy database, and strengthened institutional frameworks. For example, community forestry and participatory forest management (PFM)

have been implemented since 2002 in Ethiopia. The aim was to integrate traditional management and to empower local communities at the same time. Problems were identified that are instructive if these management systems are to succeed among ACMECS countries. PFM was donor driven and unfortunately declined after external support ceased. Additionally, it also supported land-grabbing due to unclear tenure. Eucalypt plantations were most preferred, but without alternatives, this led to a certain dependency on these plantations. While it was shown that these plantations were able to contribute to poverty reduction, a number of considerable negative environmental effects (like excessive water consumption) were reported. Perhaps this can be avoided by stronger efforts in capacity building and by developing and following better management practices. Ethiopia had a number of advantages that fostered increased biomass development, including large resources of land, high potential yields, suitable infrastructure, low population density and currently low rates of crop residue consumption. Another comparison was made with the situation in India. The country shifted entirely to short-rotation plantation forestry for producing biomass after harvesting from natural forests was banned. This has led to a current deficit of 150 million m^3 of wood annually. India's GHG reduction goals require an increased reliance on bioenergy. Various industrial agroforestry combinations have been tested and shown to generated considerable additional employment. However, because the biomass in these systems is so completely consumed, a significant loss of nutrients from the system has occurred. This creates sustainability issues to be overcome. In India, electricity prices are low and biomass production prices are high. This creates market conditions today that are unfavourable to the expansion of biomass feedstock supplies.

5.2 National Bioenergy Development Plan Myanmar

In Myanmar, 70% of the rural population heavily depends on biomass, and this is a key driver of deforestation. The National Energy Policy was drafted in January 2015 by the National Energy Development Committee consisting of eight ministries and two NGOs. Their task is to elaborate laws, regulations, and policies for the energy sector. However, only a small component of their work deals with biomass energy development and there is no regulatory framework for biomass energy production. Ten different ministries are involved in energy related issue, underpinning the cross-disciplinary nature of the energy sector, while four ministries are directly involved in the development of bioenergy. The National Energy Management Committee (NEMC) was installed on ministerial level to coordinate tasks and responsibilities among the ministries.

Fig. 3: Summary of the SWOT analysis for bioenergy development in Myanmar with country-specific key issues.

The analysis of Strengths, Weaknesses, Opportunities and Threats (SWOT) for bioenergy development in Myanmar (figure 3) reveals that there is a great potential for bioenergy. Since biomass is the most important domestic resource of energy, there is widespread knowledge and technology for traditional biomass use. However, this technology does not represent the current state-of-the-art and therefore the efficiency is low. Capacity building is necessary also in terms of management strategies that allow a sustainable development. Despite the fact that a legal infrastructure has been installed, it is seen as unstable, due to political situation. Under such circumstances, the further degradation of natural forests has been a

severe problem. Five strategic issues for the biomass energy development were identified:

1) Development of institutional infrastructure
2) Public awareness
3) Encouragement of investments
4) Increasing waste utilization
5) Increase in utilization efficiency

The main goal of the bioenergy development plan is to increase the share of domestic energy consumption from biomass, while particularly targeting the needs for the poor and ensuring that sustainable practices are introduced and followed.

5.3 National Bioenergy Development Plan Cambodia

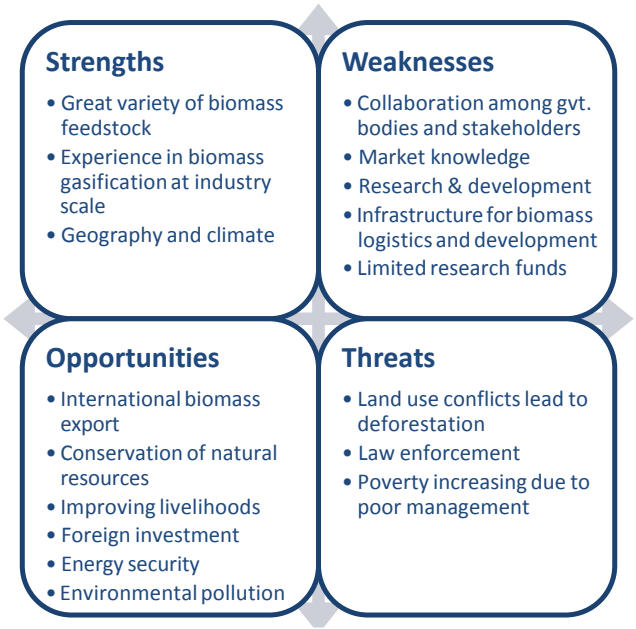
Fuelwood and charcoal are the main source of bioenergy in Cambodia and by far the largest part of it (82%) is used for household-scale cooking. Biomass provides 85% of the total national energy consumption. Almost all biomass residues from agriculture and the forestry sector are currently being used, therefore it is expected increases can only be achieved through increased efficiency of biomass utilization and from the establishment of additional biomass plantations. Deforestation is still a problem and large areas of natural forest were recently converted into plantations, especially for rubber (*Hevea brasiliensis*). It was reported that deforestation and degradation have shifted away from smaller areas and individual private landholders to large-scale, commercial agricultural conversions by concession holders (Forest Trends, 2015). Consequently, this development has to be carefully addressed, specifically as the report states that there is no legal basis to do so at the moment.

The SWOT analysis in Cambodia (figure 4) confirms that deforestation of natural forests is already a problem due to an ineffective regulative framework and policy enforcement and is expected to become more severe. Land-use conflicts as a consequence of further bioenergy development will probably contribute to additional deforestation. It was also pointed out that both institutional and physical infrastructure is underdeveloped. On the other hand, Cambodia has the potential to produce a great variety of biomass feedstocks from agriculture and forestry due to favorable geographic and climatic conditions. The county already has some technological expertise, especially in industrial biomass gasification. Through the consolidated development of the bioenergy sector, it is also expected that natural resources can be protected as new policies will be developed and enforcement can be ensured. However, political willingness is a key issue that will determe success. It is anticipated that both domestic and export markets will expand in the future. Three strategic issues for the bioenergy development were highlighted:

1) Investment in biomass and bioenergy
2) A coordinated competition can enhance the market development, including biomass sources
3) Research in energy plantations and efficient utilization of agricultural waste

The primary aim in Cambodia is to define the biomass potentials on a national scale. A policy framework should be developed that considers combined heat and power generation (CHP), in order to increase the overall system efficiency. This policy framework is expected to encompass the entire biomass supply chain. By the year 2020, 70% of the energy for heat and electricity should be provided from biomass. Moreover, it is expected that a robust strategy

Fig. 4: Summary of the SWOT analysis for bioenergy development in Cambodia with country-specific key issues.



to improve and deploy new bioenergy technologies will help to decrease environmental pollution and reduce poverty.

5.4 National Bioenergy Development Plan Vietnam

In Vietnam, primary energy consumption is steadily growing. Fossil fuels currently meet 42%, but are expected to increase to 69% by 2030. The share of renewable energy is 58% and expected to decrease to 22% by 2030. Vietnam already has a policy framework for renewable energy development, including development plans & strategies, laws, feed-in tariffs and various bio-energy studies. The environmental protection law was approved in 2005 and included sections for the development of renewable energy which is subject to governmental incentives. Since then, a range of additional policies, regulations and plans were adopted, the most recent being the decision on the mechanism to support the development of biomass power projects in Vietnam. The national plan is targeting 5% renewable energy in the commercial sector, 80% for cooking, and 100% for rural electrification by 2020. The existing regulations for bioenergy development are embedded in a national strategy that includes significant increases in wind power development. The potential biomass resources in Vietnam are large and include agricultural residues, wood biomass from natural forests, energy crops, food waste from the entire food supply chain and industrial biogenic waste. The problem with biomass in Vietnam is its scattered occurrence and the seasonal availability of certain types. Most of the biomass used is currently treated as a non-commercial source of energy and therefore obtained and used locally.

The SWOT analysis for Vietnam (figure 5) reveals that despite the abundance of biomass, it is very scattered. Although a policy framework has been adopted, it still needs to be strengthened in order to ensure a sustainable development of additional bioenergy. Since there is considerable expertise (including scientific research and demonstration plants) further research potentials and new funding instruments will be needed as the energy demand of Vietnam continues to increase. Fossil fuels are likely to continue to supply the majority of energy for years to come. It is also hoped that significant support will come from international organizations and through technology transfer from developed countries. A potential downside to increased reliance on bioenergy could be negative environmental impacts. Relavent, binding, and enforced guidelines must be developed to prevent this. Eight strategic issues were identified in the development plan:

1) Development of a biomass database with a focus on commercially exploitable resources
2) Drafting a national master plan of biomass development
3) Promotion of biomass energy development via approving a new renewable energy law
4) Research and implementation plan that includes technology transfer
5) Installation of qualified research institutions for human resource training
6) Development of a legislation and policy framework that helps to mobilize funds for the biomass energy development
7) Promoting marketing and public awareness
8) Research on tight material cycles with a long-term focus

Fig. 5: Summary of the SWOT analysis for bioenergy development in Vietnam with country-specific key issues.

The strategic focus of the development plan is similar to the aims of the other ACMECS countries and includes the development of a reliable biomass distribution database, a suitable legal framework to ensure sustainable development, deployment of new and efficient technologies, the investment in institutional and human capacity building, and strategic financial investment. The target for biomass power generation is 500 MW by 2020 and 2,000 MW by 2030.

5.5 National Bioenergy Development Plan Lao PDR

Lao is landlocked but has a great potential for energy production from various renewable resources. It has one of the highest forest covers among all ACMECS countries (40%) and therefore, the potential for utilizing logging and sawmill residues is high. The national forest strategy presents a commitment to increase the forest area to 70% by the year 2020 by implementing sustainable forest management and afforestation. It is doubtful, however, that this goal can be reached under the current rates of deforestation. Medium to large hydro-electric plants have the potential to contribute 22,000 MW of renewable power and small-scale plants could contribute an additional 2,000 MW of power in Lao PDR. Biomass from agricultural residues and sawdust is expected to provide 0.5 Mtoe (million of tonnes of oil equivalent). The potentials of solar and wind power are currently being studied. The existing national development plan aims to obtain 30% of the gross national energy consumption from renewables by 2025. The renewable energy plan includes bio-energy, which consists of biomass and municipal solid waste (MSW). It was also pointed out that it is expected that achieving this goal will rely primarily on private sector investments. As renewable energy production increases, total energy consumption is expected to increase by 3.6% each year. The industrial and transportation sectors are expected to be the primary drivers of this increase. Biomass energy might contribute most to industries where heat demand is paired with electrical demand. This increases the efficiency of biomass fuel conversion to energy at large scales. The plan also recognizes the role biomass can play at smaller household and community scales in rural areas. Lao PDR is also interested in exporting energy (particularly electricity) to neighboring countries.

Fig. 6: Summary of the SWOT analysis for bioenergy development in Lao PDR with country-specific key issues.

The SWOT analysis for bioenergy development in Lao PDR (figure 6) confirms that there is a large potential for biomass production. However, there is currently a competition between renewables and it seems that hydropower is the preferred option at this point. Still, biomass development is possible as the demand for energy is expected to rise. Biomass can offer advantages, particularly in industrial applications where heat is demanded. In addition, a combination of various renewables might help to reach the ambitious targets for renewable energy generation. The extensive forest cover implies strengths and potential threats at the same time. While the forest sector can theoretically provide large amounts of biomass, there can be negative environmental consequences if natural forests are cut on order to establish plantations. As the rate of deforestation has increased in the recent years, a strong and enforcable policy framework is urgently needed. The government can promote bioenergy development, education, technology transfer, and more efficient use of biomass. Biomass is still an important resource in small scale applications but the implementation investment costs are high. Therefore well-established examples or demonstration projects are

required along with a set of financing instruments backed with governmental incentives. The national bioenergy development plan identifies five strategic issues:

1) Biomass resources are becoming depleted due to unsustainable use
2) Coordination among government agencies should be improved, including the joint development of a strategic plan
3) Missing technology and therefore efforts should be concentrated on technology transfer
4) Lack of information on biomass resources
5) Efficiency of feedstock allocation and utilization has to be improved, including public awareness

The general aim of the NBDP is to generate income opportunities for local communities, while promoting resource use efficiency and sustainability.

5.6 National Bioenergy Development Plan Thailand

The energy demand in Thailand is satisfied mainly by fossil fuels (76%), while modern renewable energy sources provides only 12%. The rest is covered from traditional renewable energy, e.g. fuelwood (10%) and hydropower. It is expected that the Thai alternative energy policy will lead to a strong increase in alternative energy generation during the coming years. The alternative energy market is currently divided between 64% heat, 20% biofuel and 16% electricity generation. Bioenergy use is expected to grow at an annual rate of 10%. Biomass is already increasing by 5.6% annually, representing one of the fastest gorwth rates in the region. Investments in Thailand's bioenergy sector represent 22.5% (32.1% if biogas investments are included) of all energy investments in Thailand. This compares to 30.4% being invested in the wind power sector. Biomass feedstocks include agricultural waste, agroindustry residues, forest and energy crop plantation, and wood industry waste. The largest share is provided by the agriculture sector as the harvesting and processing of agricultural crops releases large amounts of waste biomass. Thailand, together with Vietnam, is among the leading countries in the development of fast growing forest plantations. These provide both industrial raw materials (e.g. pulpwood and sawtimber) and biomass for energy generation. Purpose-grown biomass, logging residues, and mill residues are all used for energy process feedstocks. The supply chain is fully commercialized and various plans and policies already exist. The share of all renewables in the gross domestic electric demand is projected to double from around 10% in 2014 to 20% in 2036 according to the Thai alternative energy development plan. Biomass contribution alone is expected to increase even more during that same period, from 2,450 MW to 5,570 MW.

Fig. 7: Summary of the SWOT analysis for bioenergy development in Thailand with country-specific key issues.

Thailand has a large potential to provide biomass especially from agricultural residues and it already has a well-established industry with a number of companies in the bioenergy sector (figure 7). Additional biomass might be developed on marginal land that is widely available in Thailand due to a high saline content of soils in some regions. Income can be generated from exporting biomass commodities (charcoal, pellets) to international markets (particularly in Japan and South Korea). Thailand has experience with foreign investments and the country is seen as a safe region which may attract international investors. Development of the biomass ecomony has received strong support at the ministerial level. However, capacity building is necessary, especially downstream,

to establish biomass as a valuable product. This can best be achieved by implementing a participatory processes. Relevant existing policies need to be revised as some are complex and may cause barriers in biomass trading. Moreover the cooperation among different governmental agencies needs to be improved to ensure an efficient process. Three strategic issues were identified:

1) Biomass production has to be targeted in terms of quality and quantity to meet demand of users
2) Efficient utilization of biomass
3) Increasing biomass industry performance and competitiveness

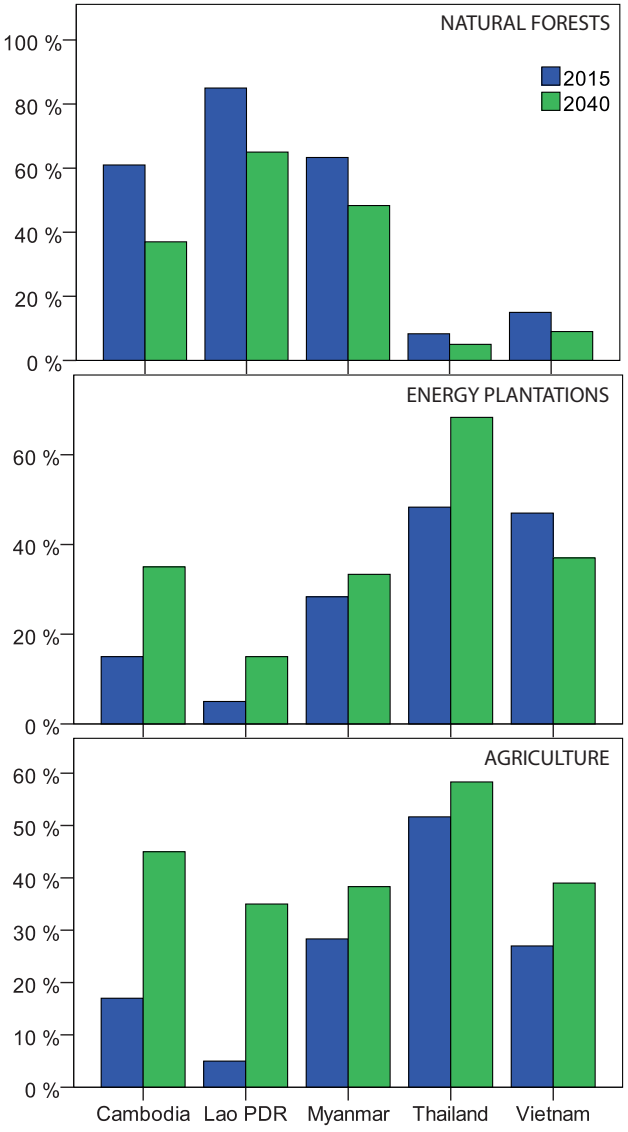
The aim of the bioenergy development plan reflects the aims of the Thai alternative energy development plan (5 570 MW electricity and heat equaling 22 100 Ktoe). In addition, it should ensure additional income for farmers and entrepreneurs.

5.7 Questionnaire insights

A questionnaire was distributed during the 3rd ACMECS Bioenergy Workshop in order to gain insights into the expectations and perceptions of participants relative to the development of a regional ACMECS bioenergy network. The questions were distributed electronically and the order of the answers within defined sections was random in order to avoid any potential bias. Selected results are presented here as a summary of the 20 responses received from all ACMECS countries.

A review of the current resources for bioenergy suggests that fuelwood and charcoal are the dominant commodities used in households and in small-scale applications in the ACMECS countries. It is believed that these commodities remain important and will still be the dominant source in 2040. Diversification will probably take place with woodchips, pellets and liquid biofuels gaining a greater share or the market. In the industrial sector, woodchips are dominant followed by fuelwood, charcoal and pellets. According to the responding participants, a remarkable shift will occur within 25 years, where pellets will be the most important feedstock, followed by woodchips, liquid fuels charcoal and fuelwood. Figure 8 depicts the current distribution of biomass resources coming from natural forests, biomass plantations and agriculture in 2015 (dark blue bars) and the change respondents expect during the next 25 years, by 2040 (green bars). The participants agree that the share of biomass coming from natural forests will decline over the next 25 years, hopefully due to protection and conservation. Lao PDR together with Cambodia and Myanmar expect a considerably higher share of their biomass to be coming from natural forests than do Thailand and Vietnam. Energy plantations will provide more biomass in the future in all ACMECS

Fig. 8: Mean estimated share of biomass provision from natural forests, biomass plantations and agriculture in different countries for 2015 and 2040 as reported by the participants (N=20).



countries except in Vietnam, where they expect agriculture to contribute equally as much. Agriculture will be probably be the most important growth sector, as all ACMECS countries (especially in Lao PDR and Cambodia) project a significant increase there. Here it becomes clear that the individual plans for bioenergy development must be based on the specific conditions within each sector and country, even as the plan interacts with neighboring countries and the whole region.

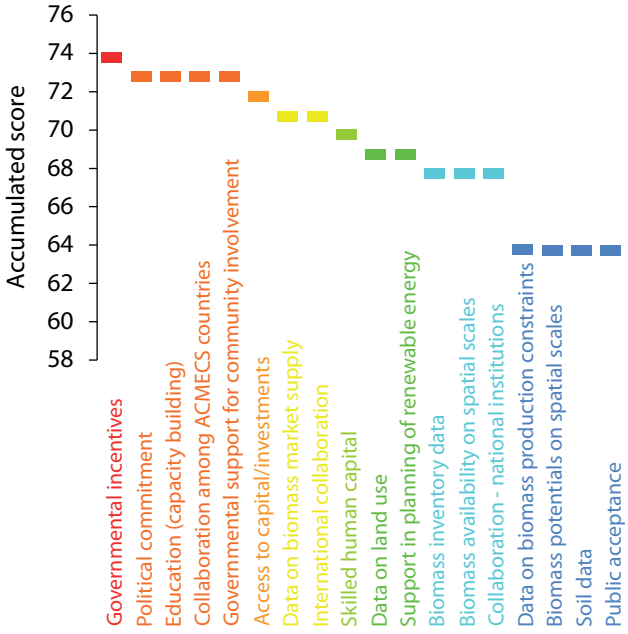
5.8 Expectations and preconditions for the implementation

Most of the ACMECS participants agreed that the bioenergy network should promote; 1) the sustainable use of natural resources, 2) technology transfer among the members, 3) income generation for rural communities, and 4) foreign investments of capital and knowledge into the region.

The participants were also asked to identify the key elements needed to ensure an efficient network structure that would support bioenergy development within each country in the ACMECS region. These responses are summarized in figure 9. While all the points raised were similarly ranked, there were slight differences that allowed us to identify the highest priority ideas. The participants agreed that the network definitely needs governmental incentives in order to get started and long-term political commitment to the NBDP to succeed. Increased public understanding of the bioeconomy via education and participation and human capacity building were also identified at top needs. Collaboration both among ACMECS countries and between national and local community governments was also deemed to be critical. Support in planning of renewable systems, collection of land use data and inventory data, and improved access to capital were identified as less important but still needed.

In the view of the workshop participants, rural public acceptance will be a natural outcome if income generation in rural communities is achieved. The general public, who are not a direct stakeholders (i.e. urban population) will also likely support conservation of natural resources, poverty reduction and mitigation of climate change. Here it is important to note that the results represent the background of the participants and other stakeholders, e.g. local community representatives might deliver different answers.

Fig. 9: Accumulated scores for important issues that need to be addressed in order to facilitate an efficient implementation of the ACMECS bioenergy network. A score of 80 would indicate that all responding participants (N=20) would indicate the issue as being "extremely needed", while a score of 20 would mean that it is "not needed".



5.9 Potential risks

Successful implementation of the final NBDP's will depend largely on the funding and support they receive from their parent governments. If stable policies are not clearly defined and vigorously enforced, these plans are not likely to succeed. Participants identified three major groups of potential risks that could cause these plans to fail: 1) financial risks, 2) political risks, and 3) environmental risks (figure 10).

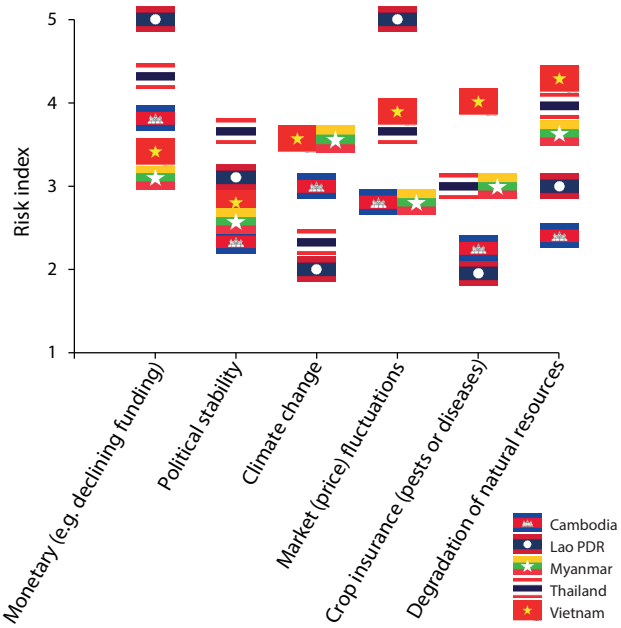
Financial risks (including delining funding and market fluctuations) were identified by everyone as the most likely to cause problems. Indeed examples of agricultural crops such as rubber have shown that the market price may be subject to great fluctuations and hence counteracting a sustainable development. But there seems also a significantly different percep-

tion among ACMECS countries. While market fluctuations were reported as a potentially very high risk in Lao PDR, it was not seen a major concern in Cambodia and Myanmar, where it received an average level on the risk index scale. The domestic market has a leading role at current, followed by the international and the regional (ACMECS) market. However, the domestic market would be the least important market in 2040 according to the participant's expectations. 25 years from now, the international market is the most important one, followed by a regional market and finally the domestic market. A closer look at the answers reveals an interesting trend: While Cambodia strongly expects that international and regional markets will be the most important ones in 2040 and therefore follows a clear export strategy. Thailand expects the most important market to be domestic. Nevertheless, international and regional markets were still classified as "very important" by Thailand.

Political stability and the associated continuity of policy were also identify a major risk factors. This was confirmed by the fact that governmental incentives and political commitment were also the two issues ranked highest in figure 9. Participants from Thailand and Lao PDR seemed to be more concerned about this, relative to other risks, than those from Myanmar, Cambodia, and Vietnam. In addition, the market conditions, in specific the market price fluctuations and the demand structure were seen as an important potential risk in the financial category.

A third category of risks identified by survey respondents were environmental in nature. Degradation of natural systems as a result of increased use of biomass was of most concern. Previously discussed ideas recognized that policies and proceedrues must be in place to guard against this, otherwise the degradation of soils and natural systems will threaten more than just energy policy. Another concern brought forward was the risk posed to biomass crops from pests, diseases, and climatic disturbances (like global climate change and draughts). Where several presentations pointed out potential negative consequences of environmental degradation due to unsustainable management, climate change was not a focus of the presentations and subsequent debates. Evidence suggests, however, that yields of some crops (e.g. maize and sorghum) will decline as climates change to become warmer and drier (Jerry et al., 2012). Some of these environmental risks to growers could be mitigated through the issuance of crop insurance but others can only be avoided throught the development, slection, and use of more robust and diverse crop varieties.

Fig. 10: The risk index represents the perception of different types of risks associated with the implementation of the NBDP's and the establishment of the ACMECS bioenergy network by workshop participants. A risk index of 1 corresponds to a low level of risk, while 5 represents a very high risk level. The average risk index for each risk type is shown by the country's flag.



5.10 The role of standardization and certification

Standardization of bio-feedstocks, bio-fuels, and bio-products was one of the key issues discussed at the 3rd ACMECS Bioenergy workshop. Indeed standardization of bioenergy commodities is extremely important as it defines the properties and hence the quality and value of a product. If a bioenergy commodity fulfils a certain pre-defined standard, it can be used in a certain way and it can be also traded at negotiated uniform prices. Some markets (especially international markets) require standardization as a precondition of entry. We asked how important na-

tional quality standards are for certain biomass commodities and the survey respondents were clear. National standards were seen important especially for pellets, woodchips and to lesser extent for briquettes. Standards for charcoal, sawdust and residuals were seen as less important since they are usually used locally in less sophisticated and less complex systems (i.e. for residential cooking or in boilers to generate process heat).

Certification was seen as an important tool to generate trust in regional and international markets and to ensure that feedstock production was being done in environmentally sustainable ways. This type of certification must be auditable and trustworthy. While international schemes, such as FSC, were recognized as among the most important and recognized of the certification systems that assure sustainability in global markets, less complicated regional or national systems, which are highly adapted towards local conditions, might be substituted when trading will be more local. These schemes might be developed by the ACMECS network for instance, but this idea requires much further development.

5.11 Financing instruments

Another important issue identified by the survey was the need to develop financing instruments for regional bioenergy development. Access to capital by private companies is an impediment to widespread development of the bioeconomy in SE Asia. Initially government loans, microcredit models, and the engagement of international development banks could become important tools for financing small-scale projects in the near term. As the sector matures, private companies and development banks will still be an important financing tool but large scale development will require international large-scale investments in the long run. The role of small-scale and microcredit tools will decrease and commercial banks will becoming more important. Interestingly, some respondents, particularly from Myanmar, did not expect REDD+ to play a major financial role in these projects although other participants, especially from Vietnam and Cambodia, see a great potential in this tool.

5.12 Summary and key messages of the 3rd ACMECS Bioenergy workshop

It is clear that the ACMECS countries are diverse; in terms of their potential for developing bioenergy, in the nature of the biomass crops they can grow, in the role renewables play now, and in how they are expected to expand in the future. This diversity has to be considered as potential synergies are sought to link the markets and interests of the entire region. An efficient network can help to monitor and balance changing domestic, regional, and international demands for biofuels and bioenergy. This was identified as a key challenge to expanding the regional bioeconomy. It was also clear that participants hoped the network could help coordinate the efforts of regional actors as they attempt to advance the bioeconomy in each member country. Beyond this, the main goals identified for the network are clear and it was mutually agreed that these are:

1) To reduce poverty and enhance the livelihood of the rural population
2) To protect natural resources and reduce deforestation, degradation and illegal logging
3) To ensure a sustainable use of natural resources, with a focus on soil health
4) To contribute to climate change mitigation by developing a bio-economy

Biomass production operations need to be carried out according to a management plan to be defiend in each counrty's NBDP. These national plans should state clear objectives and the means to achieve them. Implementation of the plants should be monitored closely and progress should be measured by a set of clearly defined indicators. High conservation value forests and other land valued for biodiversity protection need to be preserved. It was agreed that energy plantations should be established on existing managed land and managed following clear sustainability guidelines. In this way biomass production can be increased while sensitive lands are protected. nternational certification schemes can help to ensure sustainable practices and generate trust on the market. According to FSC principles, forest management needs

to comply with all national legal provisions, as well as applicable international treaties (CITES, ILO, ITTA, CBD) and FSC standards. Long-term land tenure and user rights need to be clearly defined by these plans and emphasis has to be given to indigenous people's rights to their lands. Land management also needs to contribute to social and economic development of workers and local communities and the benefits from land management should build a viable economy and lead to social benefits. Land management needs to minimize negative environmental impacts, maintain biodiversity and ecological functions as sources of ecosystem services.

A regional network can help to explore and balance new markets on regional and international level. It might be difficult, inefficient, and in some cases impossible for a single country to address these issues by itself. The coordination of obtaining fluctuating and scattered sources of biomass, in combination with varying qualities and types of biomass makes logistics a challenge. However, regional planning and stewardship can help to ensure continuous flows to the industries and markets that depend on these feedstocks. Standardization of bioenergy commodities will be a key factor to ensure certain the quality of goods traded on international markets.

While a successful implementation of these NBDPs can generate income, reduce poverty and contribute to a sustainable development and climate change mitigation, all will be lost without strong political commitment and support. A favourable and stable policy framework can create a suitable environment for private companies and smallholders to develop a business in the biomass supply chain. This is all impossible without suitable tools for investment which need to be created. Small-scale financing models are seen to be the most efficient tools in the beginning but large-scale investors must take over in the long run.

6. The role of the Sustainable Forest Biomass Network (SFBN) Task Force in the ACMECS Bioenergy Network

During the first two workshops, it was confirmed that collaboration across borders is indispensable in reaching the ambitious aims of the network. In April 2015, the International Union of Forest Research Organizations (IUFRO) accepted a proposal to establish a Task-Force on Sustainable Forest Biomass, known as "Sustainable Forest Biomass Network (SFBN)". The IUFRO SFBN Task Force represents 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 scientifically guide the development of a research agenda in the ACMECS countries to ensure a sustainable bioenergy development. The task force took an active role during the 3rd ACMECS bioenergy workshop. It can be seen as a scientific advisory board that facilitates exchange and sharing of knowledge and best-management practices developed in other parts of the world (e.g. Africa, India, and China). 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 expertise and from practical experience obtained from similar efforts in other countries. This advice will be focused on the sustainable production of bioenergy in ACMECS countries which may provide policy implications on energy production and consumption and measures that can be taken to ensure sustainability. This includes also potential consequences of increased biomass utilization (especially burning, but also other activities such as charcoal production) on air quality which will be addressed in cooperation with a different IUFRO group with air pollution expertise. Advice from the task force can also be helpful to support national progress in implementing the REDD+ process that has gained momentum as a result of the COP21 meetings in Paris. Responsible government officials were included from the beginning of the ACMECS bioenergy process to ensure awareness and recognition during the development of the national plans. 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.

7. Conclusions and outlook

Policies governing the bioeconomy should ensure that on regional scales, biomass production be done sustainably without adverse effects on food and fiber production. These policies would be best if coordinated regionally. Issues of land tenure are critical in many countries and can be a barrier to the sustainable management of land, even when internationally recognized mechanisms are involved in protecting forest resources (Sunderlin et al., 2014). Therefore, sustainability must be clearly defined and secured by a stable and reliable national policy frameworks and enforcement mechanisms. All stakeholders benefit from clear land tenure rights because it ensures a secure basis of livelihood as well as new income opportunities for local communities and a secure and predictable environment for investments. Certification systems are essential to ensure sustainable production and establish trust in markets. However, it was recently shown that even well-established multi-stakeholder initiatives, such as FSC, weaken over time as a consequence of structural failings and downward pressures by market forces on established standards (Moog et al., 2015). Certification systems must constantly be re-evaluated and updated to remain effective.

7.1 Sustainable biomass is the key for a development that can withstand future challenges

Responsible resource management requires a solid scientific basis in order to understand and control the complex processes and relationships between desirable feedstock species, the environment, and socio-economic factors. It requires a robust toolbox for plantation management and for ensuring sustainable practices. 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 habitat and species diversity. The current epoch, called 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 to avoid further encroachment on existing forests. Resource use efficiency needs to be increased to ensure a sustainable livelihood for furture generations. It was highlighted in several workshop presentations that land degradation is a serious issue that is especially threatening in tropical countries as a consequence of biophysical processes and soil conditions. In addition, degradation is linked with loss of carbon, which further increases greenhouse gas emissions and ultimately contributes to climate change. Biomass production depends on the availability of relatively fertile land. Arable land is a limited resource and soils are non-renewable in time scales relevant for human development. 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. The conservation of soil fertility and health should be an aim with priority as it determines the productivity of a certain biomass crop.

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, waste generated during processing) may be used as feedstock for other purposes. It was shown long ago that crop residues fulfil an important function in maintaining soil health and productivity (Cassman, 1999). This suggests that increased biomass feedstocks may come from agricultural systems but that the contribution from forested systems must be increased.

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. Some new biomass plantations might be established on degraded agricultural land. Certain crops have the potential to restore such sites over a number of rotations (e.g. by fixing nitrogen or building organic matter). It is clear that from an economical point of view that this might not be the most profitable short-term investment, but the resoration of these lands to productivity will have long-term benefits. Land use change that improves soil health, protects habitats, protects watersheds from contamination from excessive fertilization, or reduces wind or water erosion of productive soils are all benefitial beyond simple economics and should be encouraged in some way.

In order to achieve this ambitious but not impossible aim, we need a strong political commitment towards a sustainable bioeconomy, international and regional collaboration, and a solid scientific foundation that can provide solutions throughout the entire bioenergy and bioproduct supply chain. A bio-based economy offers a range of co-benefits that include climate change mitigation, energy and raw material supply security, reduced environmental pollution, and job opportunities and income for rural areas.

Research and technology transfer is needed along the entire supply chain. This starts with the production of biomass (soils and climate, species selection and development of new clones that are resistant to environmental influences and diseases, innovative silvicultural and agricultural methods that allow efficient land use) proceeds with conversion technologies (new and efficient conversion technologies, new pathways of biomass utilization like bioplastics, reduction of production costs, solutions at various scales), and finally research in the field of efficient material and energy use (cascade utilization, minimizing losses, intelligent systems etc.).

Fig. 11: Thailand has a leading role in establishing biomass plantations. The image shows a field experiment where acacia (*Acacia mangium*) and cassava (*Manihot esculenta*) are planted together as intercropping. The yields of cassava will decrease as the acacia stand develops, but the area is used most efficiently and cassava provides immediate financial returns. Photo by Maliwan Haruthaithanasan.

7.2 Plantations of fast growing woody species

Due to the local circumstances in the ACMECS countries and the current land use structure, it was concluded that plantations of fast growing species will be an important source of new sustainable biomass. A recent study confirms that the biomass production efficiency is indeed higher in managed forests and that management is the controlling factor, and not soil 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 land area as compared to natural forest ecosystems. By focusing on plantations, there will be reduced pressure on natural forests, facilitating their preservation. Moreover, feedstock costs can be reduced as stem densities and spacing may be arranged according to the species characteristics and anticipated rotation lengths and harvesting methods. The selection of appropriate clones will ensure optimal site suitability and minimum variability in quality 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 (figure 11). It was also shown that intercropping may increases acceptance by local growers because their crops may benefit from fertilizer typically added when biomass plantations are first planted. Excess nutrients would be taken up by intercropping species (e.g. Cassava, rice, wheat etc.) and not leached causing groundwater and stream water quality issues.

However, the extent to which intercropping contributes to or detracts from overall biomass production system performance is unclear. Additional research is needed in this area. Few biomass crop varieties are available for use today and remain untested in many places. This narrow genetic base can vulnerability to pests and diseases and expose grrwers to huge risks. *Acacia mangium* has emerged recently as one of the key biomass species for short rotation crops in Southeast Asia (particularly in Indonesia). This has led to the outbreak of a number of fungal diseases that have caused significant mortality (Tarigan et al., 2011) and decreased yields. This, in turn, has caused resulted in large financial losses (Francis et al., 2014). It was therefore concluded that efforts to improve plantation management should not focus on yield maximi-

zation but rather on 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.

7.3 Recommendations and further activities

The ACMECS bioenergy network has made great progress since its initiation in 2013, which is acknowledged not only by the members of the network, but also to a large extent by international experts of the IUFRO Task Force on sustainable biomass. The ACMECS network has been instrumental in developing renewable and sustainable bio-resource development plans for the countries in the region. These

Fig. 12: The suggested roadmap for further activities as proposed and discussed during the 3rd ACMECS Bioenergy workshop. The 4 main steps include a range of activities essential for the implementation of a regional bioenergy strategy. There are a large number of feedback cycles involved which are not included in this figure for clarity purposes. Individual activities may be initiated during earlier steps and they can also be active in subsequent steps. Here we try to identify the main issues and their relative temporal appearance.

will ultimately contribute to climate change mitigation, energy security, local added value and income generation in rural areas. The locally and diversely generated income will be used to purchase goods and services. Consequently the development of renewable resources, such as biomass can be a contribution to a stable economy in other sectors as well. This type of positive socio-economic impact was recently confirmed by a regional input-output model for a region in Finland (Lehtonen and Okkonen, 2016).

Bioenergy development requires a clear vision and the policies that are based on that vision. The vision has been clearly developed and expressed by the ACMECS Bioenergy Network members with input from international experts, including members of the IUFRO Task Force "Sustainable Forest Biomass Network (SFBN)." As detailed above, it all started with a broad idea, continued with an open discussion of potential benefits and problems, then looked at various alternatives, set priorities, and eventually reached consensus. Goals are clearly identified and problem areas defined where more work remains to be done. Based on the evaluation of progress made so far, it is highly recommended that this process should continue. The coordinating role of KAPI of the Kasetsart University (Bangkok, Thailand) has proven to be extremely effective and should continue through the next phases of the project.

A roadmap is suggested (figure 12) to continue the process in an efficient and coordinated way and to provide an overview of the most important issues. In step 1, the focus lies on the assessment of the current status which was widely addressed by the previous workshops. We identified a number of cases where additional information is missing, e.g. spatial data on biomass availability, potentials and also environmental services that need to be protected. In step 2, the basic preconditions for successful implementations are created by enabling a policy framework, that attracts companies and financing instruments as well as technology transfer, and the implementation of the national NBDP's. The standardization efforts should be a main issue in step 2 as well. Subsequently, in step 3, the implementation tools should be refined and growing experience will lead to better decisions which can be used to create decision support systems. Planning should be focussed on the systems level while sustainability needs to be ensured. Governmental incentives can be refined to address specific problems and issues at this stage. In step 4, the process needs to be evaluated and for this purpose, monitoring systems need to be developed. International investment schemes may be introduced and the certification focused.

The establishment of such a network is a complex issue, but it can help to secure natural resources while sustainable development can address a range of structural problems. It requires thoughtful planning and good collaboration among the ACMECS countries but also benefits from international involvement to ensure the best results and to avoid any negative implications. Evidence shows that much can be done wrong when managing land and the consequences could be severe. Therefore a combining science and policy in coordinated ways, in exactly the way this network has been operating, is the most promising pathway to success, for the sake of the ACMECS region and further generations.

8. References

Campioli M., Vicca S., Luyssaert S., Bilcke J., Ceschia E., Chapin Iii F.S., Ciais P., Fernandez-Martinez M., Malhi Y., Obersteiner M., Olefeldt D., Papale D., Piao S.L., Penuelas J., Sullivan P.F., Wang X., Zenone T. and Janssens I.A., "Biomass production efficiency controlled by management in temperate and boreal ecosystems", *Nature Geosci,* 2015/8**,** 843–846.

Cassman K.G., "Ecological intensification of cereal production systems: Yield potential, soil quality, and precision agriculture", *Proceedings of the National Academy of Sciences of the United States of America,* 1999/96**,** 5952–5959.

EUROPEAN COMMISSION, Innovating for Sustainable Growth – A Bioeconomy for Europe, [Online], http://ec.europa.eu/research/bioeconomy/index.cfm?pg=policy&lib=strategy (Accessed 01.12. 2015)

FOREST TRENDS, Conversion Timber, Forest Monitoring, and Land-Use Governance in Cambodia. *Forest Trend Report Series – Forest Trade and Finance.* Washington, DC 20036: Forest Trends Association, 2015.

Francis A., Beadle C., Puspitasari D., Irianto R., Agustini L., Rimbawanto A., Gafur A., Hardiyanto E.,

Junarto, Hidyati N., Tjahjono B., Mardai U., Glen M. and Mohammed C., "Disease progression in plantations of *Acacia mangium* affected by red root rot (*Ganoderma philippii*)", *Forest Pathology,* 2014/44**,** 447–459.

Gupta A., Pistorius T. and Vijge M., "Managing fragmentation in global environmental governance: the REDD+ Partnership as bridge organization", *International Environmental Agreements: Politics, Law and Economics***,** 2015, 1–20.

IUFRO, Investigating Potential Risks in Biomass. *IUFRO Spotlight* 34, [Online], http://www.iufro.org/publications/iufro-spotlights/article/2015/11/10/iufro-spotlight-34-investigating-potential-and-risks-in-biomass/ (Accessed 01.12.2015), 2015.

Jerry K., Tim H., Andre D. and Tim W., "Climate change impacts on crop productivity in Africa and South Asia." *Environmental Research Letters,* 2012/7**,** 034032.

KAPI, Future Development of ACMECS Bioenergy: Regional Plan and Standardization. In Haruthaithanasan M. (ed.), The 3rd ACMECS Bioenergy Workshop, Ubon Ratchathani, 2015a.

KAPI, Future Development of ACMECS Bioenergy: Regional Plan and Standardization, Bangkok, Thailand, [Online], http://kubiomass.kapi.ku.ac.th/index.php/en/ (Accessed 19.12.2015), 2015b.

Kim S.B. and Alounsavath O., "Forest policy measures influence on the increase of forest cover in northern Laos", *Forest Science and Technology,* 2015/11**,** 166–171.

Lehtonen O. and Okkonen L., "Socio-economic impacts of a local bioenergy-based development strategy – The case of Pielinen Karelia, Finland", *Renewable Energy,* 2016/85**,** 610–619.

Locatelli B., Catterall C.P., Imbach P., Kumar C., Lasco R., Marín-Spiotta E., Mercer B., Powers J.S., Schwartz N. and Uriarte M., "Tropical reforestation and climate change: beyond carbon", *Restoration Ecology,* 2015/23**,** 337–343.

Moog S., Spicer A. and Böhm S., "The Politics of Multi-Stakeholder Initiatives: The Crisis of the Forest Stewardship Council", *Journal of Business Ethics,* 2015/128**,** 469–493.

Pan Y., Birdsey R.A., Phillips O.L. and Jackson R.B., "The Structure, Distribution, and Biomass of the World's Forests", *Annual Review of Ecology, Evolution, and Systematics,* 2013/44**,** 593–622.

Schimel D., Pavlick R., Fisher J.B., Asner G.P., Saatchi S., Townsend P., Miller C., Frankenberg C., Hibbard K. and Cox P., "Observing terrestrial ecosystems and the carbon cycle from space", *Global Change Biology,* 2015/21**,** 1762–1

Sunderlin W.D., "Poverty alleviation through community forestry in Cambodia, Laos, and Vietnam: An assessment of the potential", *Forest Policy and Economics,* 2006/8**,** 386–396.

Sunderlin W.D., Larson A.M., Duchelle A.E., Resosudarmo I.A.P., Huynh T.B., Awono A. and Dokken T., "How are REDD+ Proponents Addressing Tenure Problems? Evidence from Brazil, Cameroon, Tanzania, Indonesia, and Vietnam", *World Development,* 2014/55**,** 37–52.

Tarigan M., Roux J., Van Wyk M., Tjahjono B. and Wingfield M.J., "A new wilt and die-back disease of *Acacia mangium* associated with *Ceratocystis manginecans* and *C. acaciivora* sp. nov. in Indonesia", *South African Journal of Botany,* 2011/77**,** 292–304.

WORLD BANK. The World Bank IBRD/IDA – Data, [Online], http://data.worldbank.org/indicator/AG.LND.FRST.ZS/countries/ (Accessed 01.12.2015), 2015.

Yokoyama S. and Matsumura Y., "The Present Status and Future Scope of Bioenergy in Japan", *Journal of the Japan Institute of Energy,* 2015/94**,** 1079–1086.

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How to cite this article:
Bruckman, V.J., Haruthaithanasan, M., Kraxner, F. et. al 2016. "ACMECS Bioenergy 2015. Three Years of Effort Towards a Regional Bioenergy Network." *KIOES Opinions* 5: 1–24.