Book of Abstracts

Governing sustainability of bioenergy biomaterial and bioproduct supply chains from forest and agricultural landscapes

Copenhagen, 17 -19 April, 2018

Sustainability impacts of biomass production

Policies and governance systems to assure sustainability of biobased supply chains

Data and methodologies to verify sustainable practices

Stakeholder perceptions and engagement in relation to sustainability governance

The conference is arranged by the following research networks:

- IEA Bioenergy Task 43 “Biomass feedstocks for bioenergy markets”, IEA Bioenergy and Energy Technology Network.
- SNS-NKJ network activity “Effect of bioenergy production from forests and agriculture on ecosystem services in the Nordic and Baltic landscapes”
- CAR-ES III “Centre of Advanced Research on Environmental Services from Nordic Forest Ecosystems”.

Title
Book of Abstracts – Governing sustainability of bioenergy, biomaterial and bioproduct supply chains from forest and agricultural landscapes.

Editors
Tania Fredborg Nielsen[1], Agnes Matuszak[1], Inge Stupak[1], Martyn Futter[2]
[1]University of Copenhagen, Denmark, [2]Swedish University of Agricultural Sciences, Sweden

Citation
Nielsen, T.F., Matuszak, A., Stupak, I., Futter, M. (eds.) (2018). Book of Abstracts. Abstracts from the conference "Governing sustainability of bioenergy, biomaterial and bioproduct supply chains from forest and agricultural landscapes", 17-19 April 2018, University of Copenhagen, Frederiksberg, 59 pp.

Publisher
Department of Geosciences and
Natural Resource Management
University of Copenhagen
Rolighedsvej 23
DK-1958 Frederiksberg C
Tel. +45 3533 1500
ign@ign.ku.dk
www.ign.ku.dk

Responsible under the press law
Claus Beier

ISBN

Cover
Tania Fredborg Nielsen

Cover Photos
Johannes Ravn Jørgensen, Aarhus University and Inge Stupak, University of Copenhagen

Published
This report is only published at www.ign.ku.dk

Preface

This book includes the abstracts of the oral and poster presentations of the conference "Governing sustainability of bioenergy, biomaterial and bioproduct supply chains from forest and agricultural landscapes" The conference is arranged by IEA Bioenergy Task 43 "Biomass feedstocks for bioenergy markets", the SNS-NKJ network activity "Effect of bioenergy production from forests and agriculture on ecosystem services in the Nordic and Baltic landscapes", and CAR-ES III "Centre of Advanced Research on Environmental Services from Nordic Forest Ecosystems".

Agriculture and forestry produce a large range of goods for the welfare of society. The main commercial products are food, fodder and timber, but the future importance of large scale production of biomass for bioenergy, biochemicals and biomaterials is increasingly recognised. Management activities associated with both traditional and newer bioproducts span over large portions of productive regions and are one of the largest human impacts on nature and the environment. As the global population and its wealth increases, the challenge to find an acceptable balance between economic activities and their impacts on climate, nature, environment and people also increases. Several of the ecosystem services potentially impacted by bioeconomic feedstock production systems do not have a market value and their protection and improvement will often depend on policies, regulation and governance.

Working with sustainability of bioenergy and the bioeconomy involves a high degree of complexity, as biomass is a dispersed resource across the landscape. Also, supply chains often involve a large number of actors and multiple sectors, such as forestry, agriculture, waste and biogas. Furthermore, in order to effectively achieve goals for ecosystem services, it is important that regulations are underpinned by scientific knowledge about the effects of management and mitigation measures. Collection of statistics and monitoring and modelling of sustainability indicators may also play important roles to ensure effective implementation and enforcement, as well as adaptation of the regulations to new conditions.

Considering these challenges, this conference aims at:

- Identifying lessons learned on how data and scientific knowledge may inform development of well-functioning, credible and legitimate sustainability governance systems for bioenergy and the bioeconomy. This also includes their continuous improvement and adaptation to new conditions.
- Exploring and comparing the variety of approaches to sustainability governance that are emerging or exist in different geographical regions, for different biomass-based supply chains, as a basis for building theory on how trust and legitimacy of sustainability governance systems is granted and achieved.
- Providing a forum for information exchange between researchers and other stakeholders involved in developing sustainability regulations and standards, assuring that standards are being met, or implementing standards on-the-ground in the bioenergy and bioeconomy sectors, through which policy advice can be developed.

We welcome you to a discussion about these important topics!

Frederiksberg, April 2018

Inge Stupak, Associate Professor, Department of Geosciences and Natural Resource Management (IGN), University of Copenhagen, Denmark

Nicholas Clarke, Research Professor, Norwegian Institute of Bioeconomy Research (NIBIO), Norway

Tat Smith, Professor, Department of Geography & Planning, University of Toronto, Canada.

Raija Laiho, Professor, Natural Resources Institute Finland (LUKE), Finland

Ioannis Dimitriou, Associate Professor and Deputy Director at SLU Global, Swedish University of Agricultural Sciences (SLU), Sweden

Uwe Fritsche, Fellow at International Institute for Sustainability Analysis and Strategy (IINAS), Germany.

Martyn Futter, Associate Professor, Dept. of Aquatic Sciences and Assessment, Swedish University of Agricultural Sciences (SLU), Sweden

Kaija Hakala, Senior Scientist, Natural Resources Institute Finland (LUKE), Finland

Martin Junginger, Professor, Geosciences, Utrecht University, Netherlands

Vita Tilvikiene, Scientific secretary, Lithuanian Research Centre for Agriculture and Forestry, Lithuania

Liisa Ukonmaanaho, Senior scientist, Adjunct professor, Natural Resources Institute Finland (LUKE), Finland

Contents

Posters

1. Bioenergy risk and risk management in the Nordic countries

Nicholas Clarke[a], Anders Chr. Hansen[b], Atle Wehn Hegnes[a]

[a]Norwegian Institute of Bioeconomy Research, [b]Hansen Economics

e-mail: nicholas.clarke@nibio.no

Bioenergy development continues to progress in the Nordic countries. However, there are concerns about the risks this may entail for future ecosystem services, the future efficiency of the economy and local communities. The purpose of this paper is to identify such risks and review the responses to them. Using a triple bottom line approach and results from the Triborn project, we evaluate risk and risk management in bioenergy development in the Nordic countries. Do environmentally, socially and economically sustainable development paths exist and are they actually followed? There are variations in how risk is understood at different levels and in different regions. Our examples show that how people select, understand, handle and adapt to risk have implications for the development of bioenergy communities. Production of raw materials for bioenergy is to a high degree local and regional, so risk in bioenergy communities must be understood as a combination of the global and the local. How to handle the tension between global regulation and local practice of bioenergy is also a challenge for policy makers and technological entrepreneurs aiming for uniform policies and technologies. Although there are risks involved in bioenergy development, the experience of the Nordic countries suggests that these are manageable, and that local communities with a strong sense of global responsibility have an important part to play in managing the risks.

2. Agricultural Sustainability Governance for the Canadian Bioeconomy

Charles Lalonde[a] and Maria Wellisch[b]

[a]CJ Agren Consulting, [b]Agriculture and Agri-Food Canada, Strategic Policy Branch - Innovation and Growth Policy Division

e-mail: [a]charles.lalonde73@gmail.com and [b]maria.wellisch@agr.gc.ca

The agricultural bioeconomy sector in Canada is small and emerging in several areas including higher value biochemical and new biomaterials, biogas and liquid biofuels. For transportation fuels, Canada maintains federal and provincial regulatory policies for the integration of biofuels into the gasoline and diesel markets; hence these sectors are well established. Bioprocessors relying on agricultural inputs voluntarily provide sustainability information to support trade. A shift is underway at the federal level to reduce the carbon intensity of the fuel supply for the transportation, industry and building sectors. This would require the agriculture sector to report the lifecycle carbon intensity associated with its production, and create competition for fuels with a lower GHG footprint.

The agricultural commodity organizations with mandates to sell canola, soybeans, pulse crops etc., are cognizant of the need to comply with sustainability schemes to support trade. Unfortunately, there are several and not one specific scheme, including for example, Round Table on Responsible Soy, Unilever Sustainable Agriculture Code of Practice and Sustainable Agriculture Initiative Platform being used. Efforts are led by commodity organizations based on each specific market requirement. For example, the Canadian Roundtable for Sustainable Crops has developed a Sustainability Metrics Platform that houses up-to-date information on numerous sustainability indicators for the country's major crops.

Farm organizations are aware of the need for a national system and are examining a platform based on the Environmental Farm Plan, a producer risk assessment tool and documentation of on farm Best Management Practices (BMPs). These efforts are also on a voluntary basis but could provide the necessary governance to satisfy market requirements. The challenge then, for the bio-economy sector, is to satisfy market requirements based on sustainability metrics and platforms designed for agricultural commodities, and to do this cost-effectively as these markets are not offering any price premium for meeting sustainability requirements.

The presentation will focus on key players in the Canadian sustainability area, the emerging tools and platforms, and the legislative base for environmental protection in Canada, including water and air quality, biodiversity, and soil health.

Implications on the supply of sustainable agricultural biomass feedstock for the bio-economy will be presented. The authors will then draw conclusions and offer suggestions on how the agriculture-based bioeconomy sustainability requirements can be reconciled as a subset of the broader agricultural system.

3. Sustainability governance of biofuel and bioeconomic development: Complexity and data barriers

Jianbang Gan[a], Inge Stupak[b], Tat Smith[c]

[a]Texas A&M University, [b]University of Copenhagen, [c]University of Toronto

e-mail: [a]j-gan@tamu.edu

Although sustainability concerns about scaling-up the production of biofuels and bioproducts have been widely recognised, sustainability governance systems are yet to be developed. Given the complex web of connectivity among biofuel and bioproduct production, natural resources (e.g., land, water, air, and wildlife) and ecosystems, and socioeconomic dimensions, it is a difficult task to develop an effective sustainability governance system for biofuel and bioeconomic development. The lack of empirical data to quantify the relationships among all components of the complex web adds an additional challenge to this endeavor. This study, with a focus on the US, aims to: a) examine key driving forces of biofuel and bioeconomic development and major platforms for sustainability governance; b) propose a framework for sustainability governance of biofuel and bioproduct production; and c) identify data limitations and potential remedies for devising and implementing an effective sustainability governance system. We review and synthesise existing literature on the drivers and consequences (environmental, economic, and social) of biofuel and bioproduct production, platforms and instruments for sustainability governance, and data availability and barriers. We then propose a framework for sustainability governance, built on existing platforms and instruments. Finally, we discuss data limitations for transforming the framework into an executable governing system along with suggested remedies.

4. Improvements in nutrient and carbon retention in soils through energy crop integration into agricultural croplands

Shyam Nair[a], Michael Griffel[a], Damon Hartley[a], Gabe McNunn[b], and Ross Kunz[a]

[a]Idaho National Laboratory, [b]AgSolver

e-mail: Shyam.nair@inl.gov

Researchers at Idaho National Laboratory (INL) previously applied the Landscape Environmental Assessment Framework (LEAF) on four U.S. Counties to assess the potential to increase total biomass production in corn-dominated agricultural fields while limiting the releases of soil, soil carbon, and nutrients into the environment through the integration of energy crops in agricultural croplands (Nair et al. 2017). The analysis has been extended to all counties in Iowa and Kansas to estimate the quantities of feedstock, the associated logistics costs to deliver the feedstock to the refinery, as well as the intra- and inter-state variability in these parameters. All predominantly corn-and soybean-growing subfields were analysed in Iowa; in Kansas, all subfields with rotations including corn, soybean, sorghum, fallow, and winter wheat were analysed. As in the previous study, crop production in subfields that were assessed as non-profitable with respect to current crop production were replaced with energy crop production. Miscanthus and switch grass were evaluated as alternate energy crops. Logistics costs and the increase in biomass production were estimated at subfield, county, and state levels. Harvesting costs constituted the largest variability in the logistics cost. To control severe reduction in overall food production, non-profitable subfields that were converted to energy crop subfields were further filtered to allow energy crop replacement only on non-profitable grain subfields that had harvesting costs below and areas above pre-determined thresholds. Nutrient and soil wash-off by precipitation and direct releases to the atmosphere through wind erosion have been the primary causes of deteriorating water and soil quality in the US. To assess the reductions in nutrient loading from integration of energy crops into non-profitable subfields, we also focused on Headwaters Beaver Creek watershed in Hardin County in Iowa using the AnnAGNPS model. AnnAGNPS is a continuous simulation and pollution distribution spatial model used to evaluate watershed management practices and quantify the releases of soil, carbon, nutrients, and chemicals from watersheds into draining water bodies. Two agricultural scenarios, the first with current agricultural production practices and the second with miscanthus production on non-profitable subfields, were analysed using the AnnAGNPS model and the analysis demonstrated significant reductions in the annual loadings of suspended sediments, nitrogen, and phosphorus from the introduction of the energy crop. Loading of organic carbon increased significantly with the introduction of the energy crop reflecting an overall increase in soil organic carbon content. Detailed quantitative results, implications on sustainable bioenergy feedstock production, and conclusions from the two analyses will be presented at the Workshop.

5. Drivers and effectiveness of sustainability governance of the Danish bioeconomy with respect to agricultural biomass production

Niclas Scott Bentsen[a], Inge Stupak[a]

[a]University of Copenhagen, Department of Geosciences and Natural Resource Management

e-mail: nb@ign.ku.dk, ism@ign.ku.dk

Agricultural crop production especially for food, feed, and animal bedding is taking place throughout the globe, and the importance of agricultural crops and residues as raw materials for energy, chemicals, and the bioeconomy more generally, is increasingly recognised. However, agricultural production is also one of the largest human impacts on nature and the environment. Undesired impacts can occur when lands of high biodiversity value or with high carbon stock are converted to agriculture. Other undesired impacts may occur due to use of pesticides and fertilisers, or if invasive species are introduced that pose a threat to sensitive natural ecosystems. Agricultural activities have the potential to reduce the environmental quality of the surrounding ecosystems and the agricultural land itself. Finding an acceptable balance between agricultural production and its impacts on climate, nature and environment is one of the biggest challenges today. Several ecosystem services from agriculture do not have a market value, but may instead be addressed through policies, regulation and governance.

Denmark is only a small player in the global bio-economy, but it is leading when it comes to the intensity of the agricultural land use and production, and the potential for conflicts that can only be resolved by regulation is high. About 62% of the land is under intensive agricultural management. At the same time Denmark has been a forerunner when it comes to ambitious policies for renewable energy, and the bio- and circular economies, which are all policies that may put even more pressure on land use and land based production systems. For these reasons, agriculture has also been comprehensively regulated for decades in order to ensure environmental protection. However, several conflicts still exist and new arise with additional goals involving and affecting these lands. Regulation takes place both through nationally designed regulations and implementation of ambitious EU legislation. All this together makes Denmark an interesting case for an analysis the governance in place to ensure sustainability of the agricultural crop production, also in a wider EU context.

The paper presents an analysis of the overall governance complex relevant to sustainability of agricultural crop production, as a basis for discussing whether policy incentives and sustainability governance are legitimate and effective in achieving their intended goals.

6. Spatially explicit modelling of biological productivity and economic attractiveness of short rotation woody crops

John Stanturf[a], Tim Young[b], James Perdue[a]

[a] USDA Forest Service, [b] University of Tennessee at Knoxville

e-mail: drdirt48@gmail.com (John Stanturf)

Despite of the key role that short rotation woody crops (SRWC) play in supporting bioenergy and the bioeconomy, questions arise about the sustainability of bioenergy. Is it net energy efficient? Is bioenergy carbon neutral? Do SRWC plantations adversely affect food security by competing for land with agriculture? How will SRWC affect biodiversity and provision of environmental services? Answers are elusive and definitive answers require considering specific technology applied at a specific location. Thus, identifying where dedicated SRWC plantations would be viable in terms of biological productivity and economic attractiveness is a necessary first step in order to begin assessing their sustainability. We present a modeling framework using a process-based growth model, 3PG, and geographic information system technology to begin to answer sustainability questions about bioenergy plantations in the southern United States. We assessed potential profitability of four candidate SRWC species, Pinus taeda, Populus deltoides, Eucalyptus grandis, and Eucalyptus benthamii. Estimated yield (mean annual increment) was evaluated as internal rate of return on investment and land expectation value at the 5-digit ZIP code tabulation area level for 13 southern states. The 3PG model incorporates data on weather, soil, and species specific parameters to estimate potential volume production. This approach can be used for as a coarse filter for bioenergy projects that are under construction, in operation, proposed, or where due-diligence is required and to guide more detailed investigations in bioenergy siting-decision support systems. This approach will be most useful for choosing species to plant on former farmland or where landowners may be willing to change species on cutover forestland. The flexibility of the 3PG model allows for different climate scenarios to be developed and to assess risk of failure or lowered yields from extreme events such as drought, as well as altered future climate effects on sustainability. The silvicultural regime used in the model represents current and emerging practice; however, many feasible management regimes and site adaptations have been proposed. For example, the well-developed value chain for loblolly pine in the southern US provide opportunities for diverse silvicultural systems that could incorporate other biomass/bioenergy components, in addition to dedicated SRWC. The yield estimates can be used for further research on sustainability of carbon sequestration. The approach is useful generally as long as sufficient information on species traits is available to model productivity, silvicultural information to estimate management costs, and spatially explicit data on climate, environmental, and growing site conditions exists.

7. Environmental and economic analysis of novel perennial biogas crops

Moritz Wagner[a], Andreas Kiesel[a], Anja Mangold[a], Iris Lewandowski[a]

[a]Department of Biobased Products and Energy Crops, University of Hohenheim

e-mail: Moritz.Wagner@uni-hohenheim.de

As a base-load provider, biogas can be a valuable addition to other energy sources, such as wind and solar energy, compensating their strong fluctuations. In Germany for example, more than 8000 biogas plants are presently in operation. Currently, most plants are run on a substrate mixture of manure and dedicated energy crops e.g. maize. Maize however, which is cultivated very intensively, is associated with several environmental problems such as a high eutrophication potential. Perennial grasses that produce high yields under a low-input cultivation could be an environmentally friendly alternative to maize. Examples of such novel biomass crops are miscanthus and switchgrass.

The environmental and economic performance of maize, miscanthus and switchgrass biomass cultivation and subsequent utilization in a biogas plant were analysed and compared based on data obtained from multi-annual field trials in south Germany. To assess their environmental performance, a Life-Cycle Assessment (LCA) was conducted. In addition to the impact categories Global Warming Potential (GWP) and Fossil Fuel Depletion (FFD), Freshwater (FE) and Marine Eutrophication (ME) and Terrestrial Acidification (TA) were also assessed. The economic performance was analysed applying a Life-Cycle Costing approach.

The results show clear environmental advantages for miscanthus compared to the other biogas crops tested. Through the substitution of maize by miscanthus as the biogas substrate, an average reduction of −66% CC, −74% FFD, −63% FE, −60% ME and −21% TA could be achieved. As miscanthus requires significantly less inputs than maize to obtain a comparable methane yield, it is also likely to have a more favorable economic performance.

In summary, it was shown that perennial grasses - here in particular miscanthus - are a very promising alternative biomass for biogas production. They can help to significantly reduce the associated environmental burdens and simultaneously improve the economic performance of biogas production, thus increasing the income to the farmer or biogas plant operator.

8. The sustainability of growing agricultural energy crops in changing climate perspective

Vita Tilvikienė[a], Virmantas Povilaitis[a], Kęstutis Venslauskas[b]

[a]Lithuanian Research Centre for Agriculture and Forestry, [b]Aleksandras Stulginskis University

e-mail: vita.tilvikiene@lammc.lt

The bioenergy share in total energy consumption plays important role in most countries, especially Northern European ones. Most Northern European countries have historical traditions in the use of forests and much research is done in this area, but nowadays greater attention is being paid to the agricultural sector and the use of agriculture-derived biomass for the generation of bioenergy. Some years ago Baltic countries and other northern climate countries were a black spot in the world for cultivation of miscanthus or other high-yielding crops, but in past few years it was noticed that for example in Lithuania it is possible to grow this crop and harvest even more than 15 t ha^{-1} of dry matter annually. But not only herbaceous crops are becoming much more interested - the maize or wheat cultivation for bioenergy purposes is also very important. The aim of this study was to evaluate the biomass potential, its quality and energy balance of the cultivation of the most important agricultural crops – maize, spring and winter wheats grown in different management intensity simulate their growing intensity productivity in changing climate perspective. In the present research agricultural crops were fertilised with biogas digestate – as potential organic fertiliser. The field experiments were carried out in 2017. Digestate made from pig as well as from chicken manure in mixture with crop biomass was used for the crop fertilisation; the results were compared to those fertilised with mineral fertilisers. The results of the experiment suggest that the biogas digestate could be a useful fertiliser for crops. The simulations of computer model DSSAT suggest, that increasing September air temperatures, as provided by climate changes projections will become more favorable for productivity of maize, however the risk of early autumn frost remains. The climate change simulation for winter wheat productivity shows, that increasing air temperature could shorten winter wheat vegetation duration, and the productivity decrease also and this effect higher will be under conventional management grown crops. For this reason, new crop varieties with longer vegetation periods for stable productivity of crops are needed.

9. Governing sustainability during the different phases of German biogas sector development

Thomas Horschig[a], Kay Schaubach[a], Daniela Thrän[a,b,c]

[a]DBFZ - Deutsches Biomasseforschungszentrum gGmbH, [b]UFZ Helmholtz Centre for Environmental Research, [c]University of Leipzig

e-mail: thomas.horschig@dbfz.de, Kay.Schaubach@dbfz.de, Daniela.Thraen@dbfz.de

Under the Paris agreement the industrial countries agreed to dramatically reduce greenhouse gas emissions in a very ambitious timeframe (IPCC 2014). Germany, the focus of this study, has decided to cut CO2 emissions from the energy sector by at least 50 % until 2030 and by at least 80 % until 2050. The German transition from a fossil to a renewable resources based energy system commenced in the power sector 15 years ago and supported the rollout of wind, solar and geothermal power as well as biomass plants all over the country. Today more than 9,000 biogas plants are in operation using both, residues like manure and biowaste and energy crops as well. Based on Heuss (1965) four market phases for biogas can be distinguished: (1) Introduction phase, (2) Expansion phase, (3) Maturing/Market integration phase, (4) Stagnation phase. Currently the German biogas market can be considered being in phase 3 of the approach mentioned above. The provision of energy from biogenic sources has a high potential for GHG emission reduction but is often associated with discussions about other sustainability dimensions, such as pressure on land, effects on ecological systems, local emissions of noise and odour. Hence it is crucial to steer sustainability through governance mechanisms during the energy system transformation. With an analysis of how the governance of sustainability in the German biogas sector was managed in the past including a view to other countries, it is possible to draw conclusions on its effectiveness.

We will present preliminary results of our work within the inter task study Measuring, governing and gaining support for sustainable bioenergy supply chains. Our focus is on sustainability governance in the different market phases of biogas market development in Germany with a view to other countries. Two representative show cases are elaborated including the effects of market and framework development, especially the renewable energy act (REA). For the analysis we consider 12 national laws and regulations which affect the sustainability of the biogas sector along the value chains up to final products of power, heat and transportation fuel. Our results focus on the needs and effect for legitimacy over the different market phases and will address the objective: compare and assess the legitimacy, including effectiveness and efficiency of a variety of approaches on how to govern and verify sustainability of biomass and bioenergy supply chains in different conditions.

10. Multi-objective optimization modelling of bioenergy systems and landscape design

Nathaniel K. Newlands[a], David Lee[b], Edmund K. Mupondwa[c], David Zamar[d], Bhushan Gopaluni[d], Shahab Sokhansanj[d]

[a]Summerland Research and Development Centre, [b]Canadian Soil Information Service (CanSIS), [c]Saskatoon Research and Development Centre, [d]Department of Chemical and Biological Engineering

e-mail: [a]nathaniel.newlands@agr.gc.ca and [c]edmund.mupondwa@agr.gc.ca

Sustainable agricultural production and resilient landscape design requires a holistic understanding and integrated assessment of the complexity, risks and uncertainties involved in their management. Sustainable management practices influence how ecosystems respond to multiple impacts and intensification. Optimization models are essential tools to support current and future bioenergy system expansion, and to optimize landscape suitability and the allocation of available ecosystem resources. These models are necessary to achieve multiple ecosystem service benefits and minimize detrimental impacts. Multiple, competing impacts and increasing pressures, may, in the future, require a holistic re-assessment of the way agricultural landscapes are designed and managed. Optimization models need to better incorporate multi-scale, spatially heterogeneous data from a wide array of sensing platforms using novel technology (i.e., precision agriculture), and integrate existing and emerging clean energy and bioproduct value-chains. These models also need to integrate new and improved statistical metrics of ecosystem resource use-efficiencies, sustainability and resilience (e.g., nutrient cycling, carbon sequestration, food production and safety, clean water, air and energy, soil, plant and animal biodiversity maintenance). Regional uncertainty in land suitability and the spatial distribution of feedstock introduces considerable complexity in identifying an 'optimal' biomass supply and feedstock mix. Yet, feedstock cost and its availability are driving factors influencing the location of biorefineries and the rate at which regional bioeconomies expand. To reliably support integrated decision-making for bioenergy systems and landscape design, resource optimization models must be sufficiently generalizable and flexible enough to identify regional needs and ecosystem risks (e.g., distributed resource demands, available energy infrastructure, feedstocks and logistics, climate variability and weather extremes risks, urbanization and invasive pests and diseases). This talk will provide an overview of a national project, led by Agriculture and Agri-Food Canada, supporting the development and sustainable integration of crop residues and dedicated feedstock crops in Canada's Clean Energy and Bioproducts Sectors. These goals may be achieved through the integration of landscape design for purpose-grown crops, maximizing bioresource utilization, using precision agriculture, and the life-cycle assessment (LCA) of feedstock logistics. Optimization modelling research, exploring alternative landscape designs for integrating bioenergy production systems into existing regional-scale agricultural (woody biomass, agricultural residues, energy crops, marginal land) and forestry systems, will be presented. This modelling work aims to provide recommendations and insights on the use and integration of ecosystem landscape data and supply-chain optimization methodologies for verifying sustainable bioenergy practices

11. Regional governance models: Novel multi-stakeholder approaches

Rocio Diaz-Chavez[a] and Jinke van Dam[b]

[a]Stockholm Environment Institute, [b]Jinke van Dam Consultancy BV

e-mail: [a]r.diaz-chavez@mperial.ac.uk and [b]jinke@jvdconsultancy.com

Novel regional governance approaches that enhance commitments and cooperation between multiple stakeholders and sectors are increasingly considered as a way to move towards more sustainable production at larger geographical scales and across sectors independently of their end-use. One of the drivers mentioned for moving towards regional approaches is tackling of the broader societal and environmental issues. There are also challenges like the great complexity imbedded when trying to be inclusive of all stakeholders.

Regional approaches vary in their terminology, objectives, the initiators and in the level of involvement of stakeholders. Examples are the jurisdictional governance model, the risk-based approach or the so-called 'landscape partnerships'. Regional governance approaches – or components of this governance model – are also increasingly mentioned as a possible novel and more effective way for documenting and measuring the sustainability of bioenergy and biomaterial supply chains. However, its nature, suitability, barriers and opportunities – compared to traditional governance systems - are so far little explored for both the bioenergy and the bioeconomy.

We will present a selection of regional governance approaches that are being used or have been developed around the world, to discuss their suitability, barriers and opportunities for different bioenergy and biomaterial supply chains and their linkages with more traditional systems, such as certification and governmental governance. Based on a benchmarking assessment that we are working on, we will discuss the key characteristics and the most noticeable similarities and differences between these initiatives. We will give an indication on which regional initiatives are most effective and legitimate to measure and document sustainability, and which ones are not. We will also provide an insight in the key criteria and elements that determine the effectiveness and legitimacy of regional governance systems.

From preliminary results, we will give an indication on which regional initiatives are most effective and legitimate to measure and document sustainability of bioenergy and biomaterials supply chains, and which ones are not.

12. Trust and legitimacy in governance of sustainability of bioenergy supply chains

Maha Mansoor[a], Inge Stupak[b], Tat Smith[c]

[a]York University, [b]University of Copenhagen, [c]University of Toronto

e-mail: [a]mmansoor@yorku.ca, [b]ism@ign.ku.dk, [c]tat.smith@utoronto.ca

Public and private initiatives for the regulation of the sustainability of bioenergy have emerged in many forms including public regulation, international processes, certification systems, best management practices, and internal company policies. These systems aim at alleviating sustainability concerns, but despite high ambitions, academia and civil society question whether these systems can be authoritative, comprehensive, and effective regulators of sustainability. This creates uncertainty if both private and public institutions can be trusted as legitimate and effective regulators of sustainability of bioenergy, and, consequently, in the bioenergy sector. This paper proposes three frameworks to describe, classify, and analyse the trust and legitimacy of sustainability governance systems with a special focus on those developed for the bio-economy. It is the intent that these frameworks form a basis for discussions on how regulatory systems emerge, transition, and develop trust in their authority and effectiveness. To reach this goal, we define governance comprehensively to include public and private, mandatory, and voluntary regulation. We define sustainability governance; input, throughput, and output legitimacy; and trust. We first provide a system to identify the type of regulatory system based on Abbott and Snidal (2006) c.f. Mansoor et al. (2016), followed by a framework on how the trust and legitimacy given to a governance system can be understood based as part of a four-phase process first outlined by Bernstein and Cashore (2007). We then suggest a three-part framework to understand how the trust and legitimacy of various aspects of a governance system can increase (i.e. supply chain control systems, monitoring systems, enforcement systems). To conclude, we consider the challenges of gaining trust and legitimacy in the global context.

13. Forest certification in the context of different national regulatory frameworks – a comparative analysis of the identified non-conformities

Liviu Nichiforel[a], Bogdan Buliga[b], Ramona Elena Scriban[a]

[a]University Stefan cel Mare Suceava, [b]University Babes-Bolyai Cluj Napoca

e-mail: [a]nichiforel@usv.ro

Forest certification is a voluntary tool used as a market instrument to provide a guarantee to the consumers that the timber production is done in agreement with an international standard setting the frame for the sustainable forest management. On the European market there are two voluntary schemes, Forest Stewardship Council (FSC) and Programme for the Endorsement of Forest Certification (PEFC). Both system rely on third-party audit for the verification of the compliance with the requirements of the standards.

At the European level, depending on the region and forest type, different aspects of sustainability are prioritised, such as “sustainable yield” which focuses on sustained timber production, “multi-purpose forestry” which highlights multiple goods and services, or “ecosystem management” which stresses the status and evolution of forest ecosystems. This creates a very diverse setting of the national and regional regulatory frameworks despite the fact that most of the European countries are mandated with implementing a plethora of European Union legislative and policy instruments. In the countries with a highly restrictive regulatory framework, the policy instruments are focused on command and control instruments which mainly impose the obligation that forest owners implement a forest management plan, designed according to imposed technical requirements. Other countries make more use of economic instruments (such as subsidies) or voluntary instruments (such as certification schemes) to motivate the responsible use of forest resources.

In this context, the aim of this paper is to analyse the implementation of the Forest Stewardship Council (FSC) certification system in six different countries characterized by different national regulatory frameworks: Romania, Bulgaria, Poland, Sweden, Germany and the UK. The objectives of this paper are: 1) to identify the differences between the standards used in the context of the existing legal requirements; 2) to make a comparative analysis of the identified non-conformities and thus to assess the practical implementation of the principles of sustainable forest management. To do this, we have analysed the public reports existing in the FSC data base.

The results of the analysis show that for example in Romania, in the period of 2011-2017 a total number of 748 non-conformities and observations have been recorded by the auditors. By comparing the non-conformities with the existing regulations, 57.69% of the non-conformities identified represented a violation of the national legislation. Most of the non-conformities are identified in the area of respecting health and safety in harvesting, negative effects of harvesting on soil and erosion and the monitoring of High conservation values forests.

The analysis shows the potential use of FSC public reports, by different stakeholder groups, for assessing the main problems that the implementation of forest management brings in practice, in a cross-country comparative perspective.

14. Governance and issues related to wood-based pellet production in the Southeast United States

Virginia Dale[a], Keith Kline[a], Esther Parish[a], Don Hodges[b] and Neelam Pouydal[b]

[a]Oak Ridge National Laboratory, [b]University of Tennessee

e-mail: [a]dalevh@ornl.gov

Forests are valued for a variety of reasons depending on stakeholders' perspectives, backgrounds, and interests. Forests in the United States (US) have been protected by a growing body of regulations since the early 1900s, as understanding has increased about benefits from and risks to forest systems. As the production of wood-based pellets has increased in recent years in the southeast (SE) US, principally for export to Europe, concern has been raised about effects on forests of the SE US.

Our review of the regulations and policies protecting biodiversity and ecosystem services and an analysis of data reveal that current levels of wood pellet production in the SE US have had a benign effect on forest ecosystem services. Mills that export wood pellets require feedstock to originate from sites where the logging is supervised by professionals trained in wildlife habitat conservation, water quality protection, and other Best Management Practices (BMPs). Logger training is a component of the Sustainable Forestry Initiative's (SFI's) certified Fiber Sourcing Standard, which sets expectations for responsible procurement of all fiber and is audited by an independent third party. Previous analysis has found that loggers who received training are more likely to implement BMPs during harvesting operations.

It is important to realize that the forests from which these wood pellets are produced are privately owned, with most being non-corporate. Therefore, we conducted a survey of non-corporate land owners in the SE US and found that the majority of owners are willing to supply woody biomass for energy if their environmental concerns are addressed and suitable and stable markets exist to make it profitable for the forest owners. The majority agreed that increasing the number of owners supplying woody biomass would require providing technical assistance and/or assurances that bioenergy production would increase forest productivity and species composition and reduce fire and disease risk. Additionally, the respondents noted the need for expanded, stable markets. They also agreed with statements indicating that an expanding bioenergy markets would boost regional economic growth and forest productivity.

Together, the review of current policies and practices and the survey results suggest the wood based pellet production can occur while maintaining and protecting diverse ecosystem services, including environmental protection, jobs and economic growth in the region. While regulatory and voluntary provisions exist to protect forests, ongoing monitoring and assessment evaluation of SE US forests is necessary.

15. Governance of sustainable forest management and bioenergy in Ontario, Canada

Quentin Cheung[a] and Tat Smith[a]

[a]University of Toronto

e-mail: [a]tat.smith@utoronto.ca

Utilization of forest biomass for wood pellet export in Canada is largely driven by European carbon abatement policies and rising bioenergy demand in East Asia. There is interest in the export potential of Ontario's abundant primary and secondary forest sector residues. However, such interest calls into question the ability of the existing regulatory complex to identify and mitigate potentially negative effects, accommodate for environmental and social change, and ensure full supply and value chain sustainability. This paper examines current regulatory policies for sustainable biomass harvest in Ontario to identify policy designs, institutional configurations, and outcome evidence to support a sustainable bioenergy sector. Ontario forest reports have identified a surplus of forest biomass across the province resulting from a general downturn in forest sector economic activity resulting in underutilization of the AAC, including unmerchantable species for which no market exists. Existing policies were evaluated through application of a policy analysis framework developed by McDermott et al. (2008 & 2009) based on comparison of policy type and threshold values to determine prescriptiveness. Requirements for four criteria affected by biomass harvesting -- riparian buffers, residual retention, skidding, and high value conservation forest -- were analyzed in relation to existing provincial guidelines and the forest management guidelines for Ontario's three most common certification programs: the SFI, FSC, and CSA. In general, the Ontario Stand and Site guide provided the most frequent and restrictive use of quantitative (substantive) thresholds, whereas the CSA and SFI were primarily systems based. Of the three certification systems, the FSC standards were the most prescriptive and yielded the most substantive requirements; all three systems stipulate compliance with provincial rules and regulations. Our analysis also identified similar policy approaches and threshold values across international government regulations and forest certification standards. Analysis of chain of custody requirements of the three systems revealed similar performance requirements and policy type. Mechanisms and methods for monitoring and policy revision, which are elements of Ontario's adaptive management framework, were also evaluated. The use of iterative policy setting may reduce policy uncertainty, alleviate negative outcomes and improve effectiveness. This paper presents recommendations for a continued adaptive and precautionary approach, but also for expanded monitoring to establish direct impacts of long-term biomass removal on sustainability goals. Increasingly complex governance interactions under new policies and existing provincial regulation may restrain biomass harvest through limitations and increased costs for assessment and mitigation of threats to endangered and rare species habitat.

16. Sustainability Assurance Systems for Woody Biomass

Christian A. Rahbek[a], Ondřej Tarabus[a]

[a]NepCon

e-mail: car@nepcon.org, ot@nepcon.org

We are a certification body, working with different verification systems in the field of woody biomass. We are an approved organization for provision of SBP certification but we are also using other schemes in biomass sector such as Danish Biomass Framework Agreement, where we cooperate with number of generators across whole Denmark. We have cooperated closely on the development of the risk based system of the Dutch Verification protocol and we have also conducted field test for this system in Baltic countries.

We are working with many biomass producers as well as energy plants to help them provide the sustainability assurance, mostly through SBP but also by other systems.

We would like to present current legislation requirements, their differences across Europe, and their link to already existing certification schemes. We would like to share our experience with risk based certification systems (such as SBP) and provide the audience with the strengths and weaknesses of this system as well as the main difficulties and obstacles during implementation of such certification and the compliance of this scheme with sustainability requirements in different countries.

In connection with this, we would like to present the results of the national risk assessments for sustainable biomass, which we have produced in several countries (such as Latvia, Lithuania, Estonia, Denmark and Portugal). Using these examples, we would like to show the possible challenges in different regions and future trends in this field.

As an outcome of our presentation, the participants should gain a clear overview where the risks are in term of sustainability assurance, overview of legislation framework for different countries and what the options are to provide assurance of compliance with current obligations.

17. Sustainability of wood-based biomass supply chains - the role and practical application of certification

Simon Armstrong

Sustainable Biomass Program (SBP)

e-mail: sarmstrong@sbp-cert.org

This presentation addresses 'Risk Based and Regional Approaches' to verification of biomass sustainability, 'Assurance and Accreditation', and 'Cascading, Carbon and Conservation'. The certification of woody biomass combines a multitude of complex issues and raises some fundamental operational, strategic and policy questions. The presentation will start to tease apart this complexity by drawing on the practical application of certification schemes including one developed specifically for woody biomass, the Sustainable Biomass Program. This process should help provide a framework for evaluating the best options on the way forward, especially given the changing biomass policy landscape.

18. Experiences with, and challenges in, Danish biomass sustainability governance – an industry perspective

[a]Sune Balle Hansen and Anders Evald

[a]HOFOR A/S

e-mail: subh@hofor.dk, aev@hofor.dk

Denmark is currently in the transition of converting its coal-based district heating into biomass-fired plants. Sustainability in the Danish biomass based heat and power industry is regulated by the 'Industry agreement to ensure sustainable biomass (wood pellets and wood chips)'. Documentation that the requirements of the industry agreement are met, can be achieved through procurement of biomass certified in accordance with the criteria of the forest and biomass certification schemes Sustainable Biomass Program (SBP), Forest Stewardship Council (FSC) or Programme for Endorsement of Forest Certification (PEFC). The industry agreement is developed by the industry, endorsed by the Government and is generally perceived as a step in the right direction by Danish environmental NGOs. And very importantly: it is applicable. However, the industry is faced with three major concerns in the operational efforts of ensuring sustainability: 1. Complex sustainability aspects like carbon debt, indirect impacts and cascading are not quantifiable in operational and decision-making contexts, 2. The robustness of sustainability documentation can in some geographies be called into question due to e.g. corruption and 3. There are significant knowledge gaps between academia, industry, society and policy makers, which often derail the debate and threaten the transition away from fossil fuels. These concerns pose very specific challenges to decision making in biomass procurement processes. In the industry, we are striving to tackle these challenges in our daily operation – partially in partnership with universities. Academia is producing some very interesting data and guidelines, which the industry is following with great interest. However, operational application of the data in decision-making is often not feasible on company level. The biomass industry calls for a closer link between academia and industries in an effort to generate applicable, robust and operational solutions to the biomass sustainability challenges.

19. Governing deforestation from afar: How can the EU address sustainability in global forest risk commodity supply chains?

Asger Strange Olesen[a] and Simon Bager Laursen[a]

[a]Cowi A/S

e-mail: asos@cowi.com, slba@cowi.com

More than a decade ago, the EU adopted a Deforestation Action Plan, which identified a number of actions that could be taken to halt or stop deforestation associated with EU consumption. Updating the Action Plan brought up the question: How do governments and intergovernmental organisations design and implement cost effective, politically acceptable, and growth-friendly interventions that can deliver on this agenda?

The presentation is based on COWI A/S (2018), "Feasibility study on options to step up EU action against deforestation. PART I: Background analysis: scale and trends of global deforestation and assessment of EU contribution, and PART II: A potential EU initiative on deforestation: Possible interventions. FINAL REPORT", <http://ec.europa.eu/environment/forests/pdf/KH0418199ENN2.pdf>.

20. Storylines for future biomass outtake from agriculture and forestry in the Nordic countries

Martyn Futter[a], Jelena Rakovic[a], Dennis Collentine[a], Seppo Hellsten[b], Katri Rankinen[b], Jan Vermaat[c]

[a]Swedish University of Agricultural Sciences, [b]SYKE, [c]Norwegian University of Life Sciences (NMBU)

e-mail: martyn.futter@slu.se

Storylines are qualitative, internally consistent narrative descriptions of possible futures. As such, they can be a valuable tool for initiating dialogue between stakeholders and the scientific community as they provide a common ground for framing visions of possible futures which can later be implemented as quantitative scenarios in models. Here, we present the development of the BIOWATER storylines for possible futures for agricultural and forestry-related plant-based biomass harvesting in the Nordic countries. The storylines have been developed along three axes related to governance systems for biomass harvesting, demand for plant-based biomass and investment in the agricultural and forest sectors. Each of the BIOWATER storylines can be linked to tradeoffs in ecosystem service delivery including carbon sequestration, water quality and flow regulation. The consequences of the different storylines for terrestrial and aquatic biodiversity can also be assessed. We show how the BIOWATER storylines can be related to the Shared Socioeconomic Pathways (SSP) storylines developed to project possible global-scale societal futures, and address the consequences of climate change for agriculture and forestry in the Nordic countries. In addition to regional differences in the consequences of a changing climate for the two sectors, biophysical and institutional differences between agriculture and forestry mean that the manner in which storylines are operationalized at national and local scales will differ. In some areas of the Nordic countries, climate change will make land use change attractive. The annual timescale of crop based agriculture means that farmers will have many more options in the short term than foresters, who are typically constrained by a 50-100 year rotation period. Governance systems also differ. The strong top-down controls of the Common Agricultural Policy (CAP) means that future patterns of agricultural biomass outtake may be more homogeneous than patterns of forest harvest as forestry is governed more by national regulations. Furthermore, current and future national energy policies as local decisions about energy use are likely to influence the manner in which storylines are operationalized across the Nordic region.

21. Forest guidelines for sustainable forest harvesting residue removals: An international review

B.D. Titus[a], K. Brown[a], I. Stupak[b], H-S. Helmisaari[c], V. Bruckmann[d], A. Evans[e], E. Vanguelova[f], N. Clarke[g], et al.

[a]Natural Resources Canada, [b]University of Copenhagen, [c]University of Helsinki, [d]Austrian Academy of Sciences, [e]Forest Guild, [f]UK Forestry Commission, [g]Norwegian Institute of Bioeconomy Research (NIBIO)

e-mail: brian.titus@canada.ca

Over 30 jurisdictions in the northern hemisphere have developed guidelines for ensuring environmental sustainability when removing forest harvesting residue as feedstock for bioenergy. Although the earliest guidelines were developed in Europe, the largest number are found in the U.S.A., partly because of the jurisdiction of individual states. Residue removal guidelines operate at the site level, but can be considered to be nested within landscapes insofar as they are often explicitly stated to operate within SFM and related water and biodiversity regulations, which are usually cited and referenced. On the other hand, some jurisdictions deliberately choose not to create specific biomass removal guidelines because they consider their SFM guidelines to be adequate. This is especially true for some jurisdictions in North America, especially where development of single-pass full-tree harvesting systems that result in residue piles at roadside preceded development of the bioenergy sector.

The range of actions or environmental objectives within individual guidelines vary within a small number of general concerns that are common to most, such as protection of biodiversity, soil and water; however, when considered together, the guidelines that exist cover a wide range of detailed actions or indicators. Similarly, the level of specificity for any single action or indicator can vary widely, depending on the jurisdiction, from highly detailed to broad generalisations; for example, a “sensitive soil” can be thoroughly described – or it can simply be named as such but with little clarification, which implies that local practitioners understand what is meant by “sensitive soil” in their area. Similarly, operators can be advised to avoid nutrient depletion in general – or there may be tools that can be applied based on quantification of potential nutrient removals using nutrient budget models.

Guidelines are typically developed through consultation with stakeholders, who may vary in number and range of interests. Scientific knowledge is often acknowledged as a foundation of guidelines, but its application is usually tempered by operational experience, expert opinion, policy directions and processes, and sometimes by public input. A corollary to this is that lack of adequate scientific knowledge can also affect guideline development – what is to be done when there is an imperative for guideline development but knowledge is weak or even non-existent? Is the variation in specificity between guidelines partly a function of the amount of scientific knowledge available and applicable to forest operations, or other factors?

Finally, do differences in specificity in guidelines between jurisdictions matter, or should greater harmonisation between jurisdictions be encouraged? As with application of scientific knowledge in guideline development, there can be a gap between development of governance concepts at an inter-jurisdictional or global level and their practical implementation.

22. Evaluation of the potential impact of small-forest sized forest machinery on greenhouse gas emissions in the energy sector

Santa Kalēja[a] and Andis Lazdiņš[a]

[a]Latvian State Forest Research Institute "Silava"

e-mail: santa.kaleja@silava

Bioenergy development continues to progress in the Nordic countries. However, there are concerns about effects on the environment. In order to mitigate global climate changes, scientists around the world are calling for a reduction of greenhouse gas (GHG) emissions in all industries, including the energy sector, where reduction of GHG emissions from transport is one of the most challenging tasks. The proportion of mechanized thinning grows continuously in the Western countries becoming the dominant harvesting technology. Still the most common approach in selection of harvesting technology for thinning is adaptation of machinery initially developed for final fellings instead of utilization of the small-sized harvesters dedicated for thinning. The climate change mitigation targets may become one of the key drivers for considerable alterations in selection of the machines for thinning. The fuel consumption of the harvester engine, fuel used for relocation of the machine and productivity are the main factors affecting GHG emissions in harvesting. According to studies in Latvia small and medium-sized harvesters with engine capacity from 44 kW to 136 kW consumes 5-12 L h-1 of diesel and demonstrate similar productivity in pre-commercial thinning, thus providing considerable potential for reduction of GHG emissions by proper selection of the machines and organization of work. The aim of the study is to estimate GHG and cost reduction potential in forest thinning by utilization of small-sized harvesters in comparison to conventional harvesting technologies.

23. Logging residue harvest in coniferous final felling and thinning stands: Effects on soil organic matter properties

Aino Smolander[a], Tiina Törmänen[a], Veikko Kitunen[a]

[a]Natural Resources Institute Finland (LUKE)

e-mail: aino.smolander@luke.fi

Logging residue harvest considerably decreases the input of fresh organic material for decomposition and nutrient release in soil. This study compares short- and long-term effects of coniferous logging residues on soil organic matter properties in thinning stands and in final fellings. Thinning stands included four Norway spruce stands and two Scots pine stands, where logging residues were either harvested in two thinnings done about 20-30 and 5-20 years before, or left on the site[1,2]. There were also experiments with different amounts of residues. Logging residue harvest in final felling included five experiments where in final felling, done 10 years before, logging residues were harvested or left on the site3. In addition, there was one experiment on a clear-cut site, where the treatments were spruce logging residue piles (40 kg m^{-2}) and control (0 kg m^{-2}). This experiment was followed for the first three years.

In thinning stands logging residues generally increased the rate of net nitrogen (N) mineralization and mineral nitrogen concentrations in the organic layer. However, the rate of net nitrification and nitrate concentrations were always negligible, irrespective of the treatment. On the recently clear-cut site, logging residues strongly stimulated net nitrification during the first years. However, in older clear-cuts net nitrification and nitrate concentrations were low, irrespective of the treatment. Logging residues resulted in some changes in C/N ratio and amount of N in the microbial biomass. Other short- and/or long-term changes in soil organic matter composition also occurred: Residues increased concentrations of certain phenolic compounds and terpenes that, in lab experiments, have been shown to control N cycling processes. Volatile monoterpenes were emitted in large amounts from the residues to the soil but still net nitrification was intense.

To summarize, in thinning stands the results generally point to long-term changes in organic matter composition and decreased N availability due to logging residue harvest. On clear-cuts the piles of logging residue seem to act as hot spots for N cycling with intense nitrate formation when trees and ground vegetation cover are not taking the nutrients up yet. This might be avoided by a more even distribution of residues.

[1]Smolander A., Kitunen V., Tamminen P., Kukkola M. 2010. Soil Biol. Biochem. 42, 1222-1228.

[2]Smolander A., Kitunen V., Kukkola M. , Tamminen P. 2013. Soil Biol. Biochem. 66, 51-59.

[3]Smolander A., Saarsalmi A., Tamminen, P. 2015. For. Ecol. Manage. 357, 117-125.

24. Impacts of bioenergy harvesting on heavy metal load from peatland forests

Liisa Ukonmaanaho

Natural Resources Institute Finland (LUKE)

e-mail: liisa.ukonmaanaho@luke.fi

Increasing demand for production of bioenergy has led to an interest on the forest harvesting method which removes also logging residues (tree tops, branches, stumps) in addition to stem wood. However, the impacts of whole-tree harvesting on biogeochemical cycles, growth and element leaching to surface waters are largely unknown, especially in drained peatlands. In Finland 4.9 million ha of peatlands have been drained for forestry purposes, and much of it will be harvested within 10 to 30 years. This biomass would provide a major source of bioenergy. However, forest harvesting, especially when intensified harvesting method as whole-tree harvesting with stump lifting (WTHs) is used, may increase in addition of nutrients also heavy metal leaching to recipient water courses. This effect can be enhanced if the underlying bedrock and overburden soil contain heavy metals. In addition, anoxic conditions can develop in stagnant water pools formed as a result of harvesting, especially after stump removal. Anoxic conditions may result in mobilization of heavy metals that have accumulated in the soil, and their subsequent transport to surface waters is an eco-toxicological risk. The impact of stem-only harvesting (SOH) and WTHs on the concentrations and loads of Cr, Cu, Ni, Al, Fe and Zn well as several other variables in the ditch water was studied using a paired catchment approach in eight drained peatland dominated catchments in Finland (2008-2015). Four of the catchments were on felsic bedrock, four on black schist bedrock, which is known to be rich in easily weathering heavy metals. Results indicate that there are differences in drainage water quality and quantity before and after harvesting (both SOH and WTHs) as well as between the two bedrock types. The change was strongest in the first two years after harvesting.

25. Bioenergy production side product wood ash for forest fertilisation – results of socially active persons survey

Dagnija Lazdina[a], Andis Lazdiņš[a], Modris Okmanis[a], Kalvis Pužulis[a]

[a]Latvian State Forest Research Institute "Silava"

e-mail: dagnija.lazdina@silava.lv

Research was done within the "Research program on improvement of tree growing conditions, 2016-2021" LSFRI Silava and Latvian State Forest research program, aiming to maximize economic effect of the forest fertilisation practice in the forestry industry of Latvia and to create positive and responsible attitude towards the improvement of tree growth conditions. A questionnaire containing 15 questions about public altitude and understanding about forest fertilisation and potential benefits and risks of this management activity was distributed in social networks and institute web pages. Respondents are socially active persons between the ages 17-74, different levels of education and professional skills, half of them own forest properties. Most of them accept forest fertilisation when it is recycling of nutrient elements, like the use of wood ash for the improvement of forest health or as a preventive action. People are worried about the possible pollution of forests by fertilisers because they have heard that wood ash contains heavy metals and also some minerals could leach from forest soils and disturb water bodies. Better informed people highlighted a problem was that we are not ready to do it in large scale because of lack of wood ash and mineral spreading machines suitable for forest conditions. Some people note that wood ash is characteristic with variable physical and mechanical properties depending on the technology used for energy production. The majority of respondents had a limited understanding of what kinds of mineral and organic elements forest trees require for growing and how wood ash works as a fertiliser. Educational and popular scientific activities are still needed to improve the situation.

26. Gaps in sustainability tools and schemes for biobased products and stakeholders' preferences and expectations

Sergio Ugarte[a], Stefan Majer[b], David Moosmann[b], Luana Ladu[c], Simone Wurster[c]

[a]SQ Consult B.V., [b]Deutsches Biomasseforschungszentrum Gemeinnuetzige GMBH (DBFZ), [c]Technical University Berlin (TUB)

e-mail: [a]s.ugarte@sqconsult.com

Biobased products represent a great opportunity to reconcile sustainable long-term growth through the prudent and responsible use of renewable resources for agriculture and industry. Two problems are identified to promote the market uptake of such biobased products: lack of tools to assess their sustainability and consumer acceptance. The development and use of sustainability assessment schemes for biobased products contributes to an evidence-based view of the economic, social and environmental impact/benefits of biobased solutions. However, the scope of present-day schemes and tools focus on biomass and bioenergy and are limited to the sustainable production and processing of biomass, up to the distribution of end-products. The use phase or end-of-life is in most cases not covered. Regarding consumers' acceptance, biobased products are partially immune to criticisms on use of land, water and other resources that biomass fuel suffers. However, consumers are not fully ready to replace a wide range of traditional products (plastics, cosmetics, fragrance chemicals, etc.) with biobased substitutes mainly because of the perceived lower performance and higher costs. In particular for biobased products originating from waste, acceptance must be progressively built up. The Horizon 2020 funded project STAR-ProBio (2017-2020) supports the development of a horizontally applicable blueprint for improving existing or creating new sustainability schemes. The proposed horizontal approach will provide access to sustainability schemes to a broader set of biobased products including: fibers, cellulose-derived chemicals, composites, plastics and microbeads, biolubricants and hydraulic fluids. This will impact the construction, automotive and health care markets. Research in STAR-ProBio involves desk-work, stakeholders' analysis, qualitative and quantitative assessments, surveys, case studies and alternative scenarios comparison. Intermediate results of two work-packages are presented and discussed in this paper. Identified gaps and missing indicators in existing sustainability tools and schemes are analysed in terms of their relevance for the sustainability of biobased solutions. The preferences and expectations that consumers, producers and public procurers have for the assessment of the sustainability of bioproducts are analysed in terms their importance and efficiency for the priorities of the different stakeholders in the value chain. A discussion of how those gaps and stakeholders preferences are related follows to inform the opportunities and challenges that sustainability tools and schemes serving biobased products face. Finally, a first reflection of how STAR-ProBio envisions the discussion for the integration of tools in European regulation will be presented.

27. The European Union Timber Regulation (EUTR) – Compliance behaviour analysis of German timber traders

Steven Doerr

Albert Ludwigs University Freiburg and University of Toronto

e-mail: stevenluisdoerr@gmail.com

Illegal logging is a globally pervasive problem that entails far reaching ecologic, economic and social impacts. Its effects include deforestation and forest degradation with a concomitant loss of respective ecosystem services, undermining governance (let alone sustainability governance) and the rule of law, promoting corruption and armed conflicts- thus posing barriers to sustainable development worldwide. In order to address this issue, the international forest policy regime recently initiated a series of policy and governance measures in afflicted producer countries ("supply-side") as well as consumer countries ("demand-side"). One such measure is the legally binding European Union Timber Regulation (EUTR), representing the EU's demand-side policy tool contributing to international efforts of combating illegal logging and related trade.

To exclude illegally harvested timber and timber products from entering the EU market, the EUTR obliges timber traders (operators) to exercise due diligence to ensure the legality of their imports from outside the EU. This poses a challenge to operators as the requirements under the EUTR are complex, case specific and not yet fully understood. However, operators' compliance with the EUTR requirements plays a central role for its effective functioning and success in interdicting illegal timber imports. Yet little research has focused on the policy targets, operator compliance and their perception and attitude towards the regulation.

Taking a German perspective as one of Europe's frontrunners regarding the implementation of the EUTR, the study aim is to gain an understanding of German operators' compliance behavior and the factors influencing it. Based on concepts of new institutionalism (Scott 2013) and compliance theory (Wrong 1961, Becker 1968, Grasmick and Green 1980, Vandenbergh 2003), a framework to analyze motivations and inhibitions to comply with a governmental regulation is developed. It offers several factors, both external and internal, that may influence compliance decision-making. Results of the qualitative interviews conducted with German operators indicate that their compliance behavior is influenced by costs and benefits of implementing the regulation, the regulatory penalty system, external social actors and internal norms. The extent of the influence of these factors varies with respect to individual operators and their institutional context. While costs inhibit and benefits motivate compliance behavior, the other factors represent both motivations and inhibitions for compliance yet predominantly take effect in a motivational manner. On the basis of these findings, further policy recommendations aimed at strengthening the compliance behavior of policy's targets with regulatory systems can be derived. This may enhance the effective functioning of policies and regulations which ascribe an essential role to private businesses and actors in achieving their objectives.

28. Stakeholder perceptions on bioenergy development in Midwestern U.S. state of Iowa

Keith L. Kline[a], Virginia H. Dale[a], Tom L. Richard[b], Douglas L. Karlen[c], William W. Belden[d]

[a]Oak Ridge National Laboratory, [b]Penn State University, [c]U.S. Dept. of Agriculture-Agricultural Research Service, [d]Antares Group Inc.

e-mail: klinekl@ornl.gov

The development of biofuels is a key component of many renewable energy strategies which aim to displace fossil fuels and simultaneously strengthen rural investment and jobs. Emergent industries typically require support from policy-makers to get established and political support depends on demonstrating that the new technologies are environmentally preferred and economically sound. Potential effects of biofuel industries are wide-ranging and include changes to water and soil quality and risk management. Effects can be assessed by monitoring and evaluating changes in indicators selected to track progress compared to targeted outcomes. Some indicators or targets (minimum threshold values) are dictated by legislative mandates associated with renewable transportation fuels. However, stakeholders' input is necessary to identify meaningful indicators. Stakeholders are those positively or negatively affected by changes in ecosystem services associated with a project. Stakeholders across the bioenergy supply chain are diverse and range from rural suppliers and producers to final consumers of renewable energy.

We describe potential implications of production of feedstocks for bioenergy in a case study landscape design project, focusing on "supply sheds" for two cellulosic ethanol plants in the Midwestern U.S. state of Iowa. We apply an approach involving stakeholders to prioritize indicators and identify targets, against which to assess progress toward social, economic and environmental goals. Our approach identified 11 categories considered important to stakeholders associated with production, harvest, storage, and transport of cellulosic feedstocks. Five categories focus on environmental concerns (soil quality, water quality and quantity, greenhouse gas emissions, biodiversity, and productivity) and six on socioeconomic concerns (social wellbeing, energy security, external trade, profitability, resource conservation, and social acceptability). Top priorities were soil and water quality, and profitability. We consider the regulatory framework applicable to the selected indicators and agricultural production in Iowa, and data for indicator baselines and targets. We conclude by reviewing lessons learned regarding what is working well, key limitations, and near-term opportunities for improving the effectiveness of "sustainability governance" associated with cellulosic-derived biofuels in the Midwestern U.S. Systematic monitoring and ongoing stakeholder engagement are necessary to support continual improvement, a foundation for more sustainable productive systems.

29. Stakeholder perception and Influence in the German biogas sector

Kay Schaubach[a], Thomas Horschig[a], Daniela Thrän[a,b,c]

[a]DBFZ - Deutsches Biomasseforschungszentrum gGmbH, [b]UFZ Helmholtz Centre for Environmental Research, [c]University of Leipzig

e-mail: kay.schaubach@dbfz.de, thomas.horschig@dbfz.de, Daniela.Thraen@dbfz.de

Under the Paris agreement the industrial countries agreed to dramatically reduce greenhouse gas emissions in a very ambitious timeframe (IPCC 2014). Germany, the focus of this study, has decided to cut CO_2 emissions from the energy sector by at least 50 % until 2030 and by at least 80 % until 2050. The German transition from a fossil to a renewable resources based energy system commenced in the power sector 15 years ago and supported the rollout of wind, solar and geothermal power as well as bioenergy all over the country. Today more than 9,000 biogas plants are in operation using both, residues like manure and biowaste and energy crops as well. Based on Heuss (1965) four market phases for biogas can be distinguished: (1) Introduction phase, (2) Expansion phase, (3) Maturing/Market integration phase, (4) Stagnation phase. These stages are preceded by a R&D/Experimental phase that leads to market ready products and frameworks. Currently the German biogas market can be considered being in phase 3 of the approach mentioned above. During the different market phases, different stakeholders drive or impede the development of biogas value chains and their sustainability. With biogas set out as sustainable form of energy, the perception of the very same sustainability is crucial for its success. In this context, this study aims at understanding the roles, influence and attitudes of the stakeholders in the different market phases. Our analyses use a combined system of stakeholder categorization, encompassing the nominal structure (i.e. state and non-state actors); stakeholders within the value chains considering various feedstock supply chains and final product distribution; finally the spheres of influence: Direct or indirect. Following this mapping, stakeholders are characterized in the two dimensions “influence” and “interest”, resulting in four clusters. These clusters show the importance and hence need of involvement of the analysed stakeholders. Main identified stakeholder groups, such as biogas plant operators have been subjected to surveys and interviews to obtain a broader insight into their perception of sustainability. The results may be used for designing stakeholder involvement strategies to facilitate continuous sustainability scrutiny.

The work is carried out within the IEA study Measuring, governing and gaining support for sustainable bioenergy supply chains. Among other case studies, two aspects are covered for the German biogas sector: The governance structures of sustainability and the involved stakeholders with their different perceptions of sustainability, which are closely linked

30. Positions, perceptions and influence of stakeholders on bioenergy sustainability

Thuy Mai-Moulin[a]; Uwe Fritsche[b]; Ulrike Eppler[b]; Martin Junginger[a]

[a]Copernicus Institute of Sustainable Development; Utrecht University, [b]International Institute for Sustainability Analysis and Strategy (IINAS)

e-mail: t.p.t.mai-moulin@uu.nl

Bioenergy has an important role in the current energy landscape. The European Union and many other countries have recognised the bioenergy role in reducing greenhouse gas (GHG) emissions, in helping countries to become less dependent on fossil fuel supply and in making a significant contribution to the biobased economy. However, there are still discussions about bioenergy such as the impact of harvesting woody biomass on forest carbon stocks; low and/or delayed GHG savings compared to fossil fuels; and competition of biomass used for food, feed and materials. Also, lack of unbiased information and lack of involvement of local communities in bioenergy projects may hinder the sector development.

As part of the measuring, governing and gaining support for sustainable bioenergy supply chains project, a methodology was developed to identify stakeholders' perceptions, positions and influence directly and indirectly on (possible) bioenergy value chains. The methodology has been used to map the positions of stakeholders having interests in bioenergy sector; relevant stakeholders in specific local case studies; supra-national stakeholders having influence on the general sector development both for the current situation and the near term future (up to 2030). For this, four steps have been carried out:

- Identification of relevant and interested stakeholders
- Communication with stakeholders via questionnaires, and/ or interviews and meetings
- Comparison of stakeholders' positions, viewpoints and influence in different bioenergy value chains
- Provision of recommendations on how bioenergy sector can gain (further) support

Results are presented to understand under which sustainability conditions stakeholders have neutral views, oppose or support the bioenergy sector development, what the underlying main concerns are and under which circumstances this positon might change. Although perceptions, viewpoints, and influence of local and supra-national stakeholders vary; the results collected so far indicate that in general stakeholders have a slightly positive view on bioenergy. The results also show the key barriers and challenges for the bioenergy development are a lack of general societal acceptance and unresolved sustainability issues resulting in unstable policy and market. Most stakeholder groups agree on identified sustainability issues and the implementation of agreed sustainability requirements will help the sector gain (more) support and grow further. A number of stakeholders demonstrate that the bioenergy sector should form collaboration with other sectors (biomaterials; biochemicals) as parts of the biobased economy. Stakeholders are in principle mostly favourable towards limited bioenergy supply chain development, but this depends largely on amongst others specific feedstocks, end-uses and other limitations.

P1. Resource management in the bioeconomy – a system dynamics approach for sustainable food

Andreas Nicolaidis

Research Institutes of Sweden (RISE) and Swedish University of Agricultural Sciences (SLU)

e-mail: andreas.nicolaidis@ri.se

Expansion of the bioeconomy and a growing world population is putting biomass and bioresources at the centre of potential conflicts. Production of food and feed has been the core of bioeconomy throughout history but with increasing demand for bioresources to replace non-renewables the balance is about to change. The pressure on ecological systems is growing and calls for careful governance in order to avoid degradation of natural capital and conflicts between different users and objectives. Many researchers, government agencies and companies advocate the use of Life Cycle Assessment (LCA) as a key approach in measuring the environmental impact of the bioeconomy. LCA is well documented as a powerful tool for assessing the sustainability of products and processes. However, multiple authors are now questioning the usefulness of LCA when it comes to certain aspects of sustainability assessment and its suitability in policy development for sustainable bioresource management. LCA is described as being static, unable to capture social-ecological interactions, and missing the important causal mechanisms between systems which are necessary for sustainable bioresource governance. Dynamic system features are not well covered with current LCA methods even though they are known to be of great importance in the purpose of sustainability assessment. This has been shown for e.g. marine resource use, fresh water management, biodiversity conservation and ecotoxicity impact assessment. Complementary tools and methods are needed in order to ensure systemic dynamic features and location specific information are included in management of bioresources.

In this PhD thesis I investigate the limitations of LCA as expressed in the scientific literature and put these in relation to the ongoing development of the bioeconomy and sustainable bioresource management. Further, I investigate what complementary approaches have been put forward to overcome these limitations and identify areas in need for further research. Through a set of case studies, based around future food production and food security, my objectives are to develop a framework where LCA is combined and complemented by selected system-oriented methods. It is my belief that this will allow for a stronger integration of social-ecological interactions (e.g. competing stakeholder interests, demographic impacts, technology development, and conflicting sustainability targets) and systemic features in the sustainability assessment in bioeconomy governance.

I see my participation in this conference as an opportunity to receive feedback from the scientific community on my planned research and I strongly hope for constructive input in terms of methods, potential cases and future opportunities for collaboration.

P2. Understanding Indirect Effects of Bioenergy: Science-based ILUC Assessment

[a]Keith L. Kline, [b]Hans Langeveld, [c]Virginia H. Dale, [a]Rebecca A. Efroymson

[a]Oak Ridge National Laboratory, Environmental Sciences, [b]Biomass Research, [c]University of Tennessee

e-mail: klinekl@ornl.gov

Managing terrestrial systems to enhance carbon storage and to reduce emissions from deforestation and land degradation are among the most prominent and cost-effective strategies identified by the Intergovernmental Panel on Climate Change (IPCC 2014). Bioenergy is a key component of pathways to reduce reliance on fossil fuel combustion, the principle source of anthropogenic GHG emissions and higher valued biomass creates incentives for better management of terrestrial systems. However, social and public support for bioenergy has waned due to perceived limitations and concerns ranging from food security, to deforestation and ineffective emission reductions. Major concerns are tied to assumed effects of indirect land-use change (ILUC). Contentious debate and policy uncertainties cannot be resolved until a more consistent and science-based approach is accepted and applied for assessing indirect effects of policy on land cover and climate forcing dynamics. The strengths and weaknesses of existing approaches for ILUC quantification merit a more systematic review in light of empirical evidence. The purpose of this work is multifold: to review theory, models and drivers of Indirect Land-Use Change (ILUC); elucidate the importance of terms and definitions in conceptual frameworks; assess the scientific validity and methodological robustness of existing approaches for ILUC assessment; and provide recommendations for improvement. An IEA Bioenergy Inter-task team is working to identify variables most responsible for uncertainty and variability in results; and identify better tools and approaches for quantifying all LUC and attributing causation.

Land use and cover trends for periods prior to biofuel expansion (1990s), during biofuel expansion (2002-2011) and recent periods of reduced growth in biofuel production (2012-present) provide an international “natural experiment.” The task underscores the importance of science-based causal analysis methods for determining attribution of clearly defined effects. We focus on testing hypotheses and generating results that can be replicated with consistency. Better practices for assessment can be developed based on historic data, causal analysis, and new conceptual models driven by learning.

P3. Wood-CO_2. A key figure for wood CO_2-footprint

Per Bjerager

University of Copenhagen

e-mail: pebj@ign.ku.dk

Energy Wood is normally regarded as a neutral energy source justified on the basis that carbon contained in wood is part of a natural biological cycle, where CO_2-removal from atmosphere by forest growth is balanced with CO_2-emission during release by burning for energy or biological degradation. But cumulative CO_2 footprint of wood is in reality either CO_2-emission or CO_2-removal – not precisely neutral. Fossil energy used in the supply line from forest to use of wood has CO_2-emission, and there are changes in carbon stocks in the landscape, where wood is harvested. Impact of harvest on forest carbon stock in a given landscape depends on Net Forest Growth (NFG) = Brutto growth – Harvest.

Within the United Nation Framework Convention on climate Change (UNFCCC) the account principle is that energy wood is neutral, because CO_2 emission from use of fossil energy has its own account, and changes in forest carbon stocks is a part of the account for Land Use, Land-Use Change and Forestry (LULUCF). This way of accounting is very suitable for national submission of climate accounts to UNFCCC, but it can´t be used to quantify CO_2-footprint for traded wood. This problem is a source of misunderstanding in the global debate about the CO_2 neutrality of wood for energy (e.g. Chatham House report, Brack, 2017).

This study presents a key figure called Wood-CO_2 defined as delta ton CO_2 equivalents per ton wood dry matter. CO_2-removal is accounted negative in line with UNFCCC. Wood-CO_2 is a sum of three subfigures: Wood-CO_2 = Forest-CO_2 + Supply-CO_2 + Use-CO_2.

The study focus on quantifying Forest-CO_2 in Denmark with a landscape based approach using National Forest Inventory. Forest-CO_2 is NFG divided with harvest in the landscape. Supply-CO_2 is related to use of fossil fuel in the supply chain. Use-CO_2 can be negative when wood is used for constructions, and zero when wood is burned. Future use of wood for bioenergy with carbon capture and storage (BECCS) to meet climate targets in Paris Agreement will count negative in Use-CO_2 due to permanent storage of CO_2 from burned wood.

Wood-CO_2 can be used by end users to document CO_2-footprints. Energy companies can use Wood-CO_2 to calculate energy CO_2-footprints, and energy consumers can use this energy footprint in their own climate accounts.

P4. The influence of design and management technology on hybrid aspen – perennial grass agroforestry system productivity

Dagnija Lazdina[a], Sarmite Rancane[b], Toms Sarkanābols[a], Kristaps Makovskis[a]

[a]Latvian State Forest Research Institute "Silava", [b]Institute of Agriculture

e-mail: dagnija.lazdina@silava.lv

Since 2011 aspen is an eligible agriculture energy crop with a rotation period up to five years in Latvia. The research aim is to determine productivity of hybrid aspen (*Populus tremula* L. x *Populus tremuloides* Michx.) at the fifth year rotation period after managing it as agroforestry system together with perennial crops - reed canary grass (*Phalaris arundinacea* L.), Festulolium (*Festulolium pabulare*) and Fodder galega (*Galega orientalis* Lam.) as intercrop and when fertilised by biogas fermentation residues, waste water sludge and wood ash. In the current study were used system with trees of high growth rate – hybrid aspen, by choosing clones with significantly different productivity (No 4 high yield and No 28 – low yield, both were used as reference clones for breeding of hybrid aspen). The trees were planted in the 2.5×5 m planting design with 2.5 m wide intercrop stripes between tree rows. The plantation was established in 4 replicates with each fertiliser, intercrop and control. Such systems are more sustainable and have several advantages – sustainable use of municipal waste water management or green energy production residues, which contain plant nutrient elements; use of area between trees for production instead of just cutting vegetation during cleanings; faster turnover of investments by seed production or biomass production for solid biofuels like pellets (RCG, Festulolium) or for biogas plants (Galega, Lupin) as well all grasses could be used as animal feed. It is recognised that best effect on tree growth for both clones is achieved by fertilising with biogas fermentation residue and waste water sludge, on average giving 30 – 31% better tree height compared to control. The best effect on tree growth is achieved with a Reed canary grass and fodder Galega intercrop, compared to control the average tree height is 16% higher. It is recognised that hybrid aspen clone No 4 is significantly (+33%) more productive than clone No 28. The most important impact on plantation productivity is achieved by clone selection, although there is relevant impact on the tree growth from fertiliser and intercrop as well. All kinds of fertiliser significantly increased seed yield of Festulolium by 30%, but Fodder galega showed positive response just to wood ash fertilisation with a 15% increase in seed yield.

P5. Integrating Kenyan smallholder beekeepers in local bioenterprise initiatives: Socio-economic hindrances to rural livelihoods improvement and sustainability of biobased economic solutions

Peter Musinguzi[a,b], Aske Skovmand Bosselmann[b], Mariéve Pouliot[b]

[a]The University of Oxford, [b]University of Copenhagen

e-mail: ktp990@alumni.ku.dk

Wide spread poverty and natural resources loss in arid and semi- arid lands (ASAL) necessitate pathways of poverty reduction and livelihood improvement that integrate due consideration of the environment and natural resource base. Bioenterprises provide feasible options for livelihood diversification and natural resource conservation in ASAL. However, sustainability of such bioenterprises greatly depends on local socio-economic and environmental benefits accrued to producers involved. This study investigates the contribution of local certified organic honey production (a rural bioenterprise) to the livelihoods of Kenyan smallholder beekeepers living within an acacia woodland area organised in a producer cooperative. Data collection took place from December 2015 to February 2016 and included a survey of 303 beekeepers from 54 smallholder beekeeper groups, 38 organic certified and 16 non-certified, using stratified random sampling. Data were collected for 2015 and 2008 (retrospectively) for the investigation of the situation before and after certification. Data analysis was done using STATA and graphical presentations in Excel. Results indicate no significant impact of certification on certified households' incomes, quantity, price of honey produced and migration incidence. The results further indicate that non-certified smallholders were more diversified, more food secure and sold fewer assets compared to the certified. Only 17% of the certified attributed their better wealth/welfare status to certification. In Mwingi from the foregoing, certified organic honey production does not pay off and therefore does not promote a biobased development initiative because of: i) no continuous support to certified farmers, ii) low premiums for certified organic honey, iii) strong presence of middlemen, iv) lack of governmental support and iv) poorly managed cooperative where marketing of smallholders' organic honey is coordinated. Therefore, this calls for organic bee keeping policy formulation, technical and financial support to the organic cooperative to benefit smallholders for their continuous involvement and hence sustainability of the biobased enterprise.

P6. Lessons learned in the German biogas sector: Expert's perceptions for a resilient risk governance in biogas

Johanny Perez Sierra[a], Claudia Bieling[a], Cordula Kropp[b], Dirk Scheer[c]

[a]University of Hohenheim, [b]University of Stuttgart, [c]Karlsruhe Institute of Technology (KIT)

e-mail: [a]j.perezsierra@uni-hohenheim.de

The German biogas sector has gone through multiple phases of development, steered primarily by a legislation, the so-called "Renewable Energy Source Act (EEG)." In its expansion, this branch has been accompanied by critical structural changes in the agricultural sector, dispersed accidents and derived negative impacts on the environment. A boom in biogas also generated many attitudes in the general public, which has linked the technology among other things with extensive maize monocultures, increased energy prices and odor emissions. In the context in which biogas lost its legitimacy in the population, the German government has been systematically reducing subsidies for biogas, and the conditions for which it is being supported. Currently, the sector finds itself in an uncertain perspective for its future. Biogas is a technology that has a significant potential to help treat agricultural residues and organic waste, reduce substantial greenhouse gas emissions by treating manure, and recently with an adaptation, by potentially integrating the concept of Power-to-Gas, it could help balance out the electricity grid, storing energy in the form of biomethane. A complete rejection of the biogas sector would eliminate all these possibilities, however, as a bioenergy branch, it encompasses risks, especially of environmental, socio-political and techno-economic nature. In this study, we analyse with the help of expert interviews the lessons learned in the development of the German biogas sector over the last years, and also focus on the aspects that went wrong among the multiple actors involved: politicians, biogas producers and the general public, as considered by relevant stakeholders. From this assessment, we collect elements that should be taken into account for a resilient risk governance in the management of the biogas sector, as indicated by experts from science, industry, associations and politics in Germany. These aspects provide some suggestions on what to consider when confronted with bioenergy projects like biogas, strongly influenced by socio-cultural and political contexts, with environmental and energy roles, but also carrying significant risks, which have to be identified and managed sustainably.

P7. Governance of environmental sustainability of manure based centralised biogas production in Denmark

[a]Teodorita Al Seadi, [b]Inge Stupak, [c]Tat Smith

[a]Biosantech, [b]University of Copenhagen, [c]University of Toronto[1]

e-mail: [a]teodorita.alseadi@biosantech.com

Centralised biogas production based on co-digestion of animal dejections (slurries and manures) with other biomass is the original Danish concept of sustainable biogas production, which is well known today around the world. Biogas was introduced in Denmark back in the 1970s, during the oil crisis as a pioneer technology, on an experimental/demonstration basis, aiming to provide an alternative solution to the need to increase security of energy supply through utilisation of national, renewable resources. The first biogas plants were designed only for energy generation. Later, it became clear, that biogas can make a significant contribution to solving some important environmental problems of the conventional, intensive agriculture, and of the energy and the waste management sectors. Consequently, centralised biogas plants were considered as integrated solutions for energy production, manure and organic waste treatment and manure/nutrient redistribution. Nowadays, manure co-digestion is a mature and well-established technology, and includes a variety of technical solutions and a broad range of co-substrates aiming to enhance methane yield of manure digestion. A number of specific factors and beneficial pre-conditions have influenced the development of the Danish manure based biogas production. Among these are the governmental bottom-up development strategy, the existence of the district heating system, the policies for de-centralised CHP production, energy and environmental protection policies, energy taxes, waste treatment strategies, a long-term support for biogas development, stimulation of cooperation among manure suppliers, learning and knowledge sharing between different categories of stakeholders, to mention only some of them. Regulatory initiatives, policies and strategic planning, promoting sustainability of biogas production and use emerged with time, including national and international/EU legislation, regulations, positive lists, best practices, certification systems, etc. The deployment of biogas from manure co-digestion in Denmark shows that it is not the maturity of the technological and the economic conditions are important but not sufficient, unless there is public support and awareness about the benefits and challenges of the technology. In the case of biogas, sustainability governance should not only ensure that the development is on a sustainable path, but also enhance public trust in biogas from manure co-digestion and improve the public perception of biogas and renewable fuel in general.

This paper reviews the development of the governance frameworks to ensure environmental sustainability of manure based centralized biogas production in Denmark, with a special focus on how the governance systems emerged and developed over time, which were the main drivers, and how they impacted the further development of the biogas sector. We discuss how sustainability governance can develop in the future, for increased trust in its legitimacy and effectiveness.

P8. How logging residues of different tree species affect soil nitrogen cycling after final felling

Tiina Törmänen[a], Antti-Jussi Lindroos[a], Veikko Kitunen[a], Aino Smolander[a]

[a]Natural Resources Institute Finland (LUKE)

e-mail: tiina.tormanen@luke.fi

As a result of modern harvesting techniques logging residues are piled on the forest floor instead of earlier more even distribution. Both logging residue harvesting and uneven distribution of logging residues influence decomposition in forest soils and release of nutrients from organic matter.

The aim of this study was to determine how logging residues of Norway spruce (*Picea abies*), Scots pine (*Pinus sylvestris*) and silver birch (*Betula pendula*) affect nitrogen (N) cycling processes in forest soil after clear-cutting, and how nitrogen losses are changed. A spruce-dominated stand was clear-cut in September 2014. Plots with fresh logging residue piles of different tree species, and control plots without logging residues, were subsequently established. To monitor soil nitrogen and carbon cycling, samples were taken from the humus layer in spring and autumn until 2016, and rates of C mineralization, net N mineralization, net nitrification and the amount of N and C in the microbial biomass were determined. Denitrification activity and the contribution of nitrification and denitrification to nitrous oxide (N_2O) production were determined once. In addition, losses of nitrogen via leaching and N_2O emissions were monitored.

Logging residue piles increased the pH and organic matter content (%) of the humus layer. No consistent changes of C:N ratio due to logging residues were found. Logging residues accelerated net nitrogen mineralization. Also net nitrification was stimulated but not much before the last year. Logging residues clearly increased the amount of mineral nitrogen. Changes in microbial biomass N were small in all treatments. Some changes due to logging residues were observed also in mineral soil. In addition, logging residues increased nitrate concentrations in soil percolation water and N_2O fluxes. There were some differences between tree species although major trends were similar.

Currently we are studying the effects of large logging residue storage piles on nitrogen mobilization.

P9. Variation of macro- and microelement occurrence in a fertilised juvenile hybrid aspen (*Populus tretmula* L. *× P. tremuloides* Michx.) tree rings

Arta Bardule[a,b],Dagnija Lazdina[a], Lauma Busa[b], Arturs Viksna[b]

[a]Latvian State Forest Research Institute "Silava", [b]University of Latvia

e-mail: [a]arta.bardule@silava.lv

As plants, especially different tree species, have evolved to be extremely proficient in mass transfer with their surroundings and to survive as the Earth's dominant biomass, they also accumulate and store not only nutrients, but also some contaminants from the environment, acting as passive samplers. Trees of temperate and boreal regions usually form visible annual growth rings, which can be accurately dated. Hence, it is possible to analyse their matrix and trace element content in order to obtain a chronological record of macro- and microelement prevalence in the tree's environment. This method of retrospective biomonitoring is called dendroanalysis. An important assumption in dendrochemistry is that the element concentrations in a given growth ring are the result of environmental conditions at the time of wood formation. Agroforestry combining short rotation woody crops and phytoremediation could be an environmentally friendly and cost-effective approach to not only ensure sustainable biomass production but also to mitigate a negative impact on the environment caused by more intensive management to promote additional biomass increment.

Laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) was used to determine the relative amount of macro- and microelements in fertilised juvenile hybrid aspen (*Populus tremula* L. × *P. tremuloides* Michx.) tree rings. Stem disc samples were collected from six year old hybrid aspen trees growing in agricultural land in the central part of Latvia (hemi-boreal climate conditions) and initially fertilised with biogas production residues: digestate (dose 30 t ha-1), sewage sludge (dose 10 tDM ha-1) and wood ash (dose 6 tDM ha-1). We concluded that relative amount of analysed macro- and microelements in hybrid aspen tree rings varied considerably not only within the analysed stem plane (across tree rings) of one sample tree but also within one annual ring. Significant differences of macroelement relative amount in early wood and late wood of annual tree rings were detected. The results highlight significant impact of initially used fertiliser (especially wood ash) on average macro- and microelement relative amount in hybrid aspen tree rings as well as confirm the effectiveness of hybrid aspen usage as a bioindicator to characterise both management or treatment activities and growing conditions in general.

P10. The effect of different fertilisation types on common osier and cup plant productivity in Western Lithuania

Gintaras Šiaudinis[a] and Danutė Karčauskienė[a]

[a]Lithuanian Research Centre for Agriculture and Forestry

e-mail: gintaras.siaudinis@vezaiciai.lzi.lt

By the increasing the role of renewable energy, the demands of plant biomass gained particular attention in many European Countries. Basic requirements for perennial energy crops are their longevity, high productivity, low energy input for their cultivation and low nutritional requirements. Field and laboratory experiments with perennial crops – common osier (*Salix viminalis* L.) and cup plant (*Salix viminalis* L.) were studied in Vėžaičiai branch of the Lithuanian Research Centre for Agriculture and Forestry (Western Lithuania). The soil of the experimental site was a Bathygleyic Dystric Glossic Retisol, pH 4.2-4.4. The research aim was to evaluate the dependence of both crops productivity and make energetic evaluation of growing technology. At the 1st experiment, the traditional mineral fertilisation (different N levels) was performed; at the 2nd experiment – unconventional granulated sewage sludge was applied as alternative organic matter. Common osier's stems were cut off once after a four-year rotation. Meanwhile cup plant stems were cut each year at the end of vegetation. The results of 2 subsequent growing rotations revealed, that the application of 60 kg ha^{-1} N rate is sufficient to gain the optimal common osier's dry mass (DM) yield. As for cup plant, the highest DM increment was obtained by the application of annual 120 kg ha^{-1} N rate. Although for both crops, the use of a high nitrogen fertilisation rate (120 kg ha^{-1}) is energetically and economically unprofitable. Sewage sludge had a positive effect on common osier first dry mass (DM) yield (at 1st rotation) and annual cup plant DM yield. In both cases, the optimal was 45 t ha^{-1} sewage sludge rate. The doubling sewage sludge rate up to 90 t ha^{-1} had no significant impact on crop productivity. Contrarily, their energy as well as economic impact was substantially lower.

P11. The use of forest biomass for energy production in Lithuania

Lina Beniušienė[a], Diana Lukminė[a], Iveta Varnagirytė-Kabašinskienė[a], Kęstutis Armolaitis[a]

[a]Institute of Forestry, Lithuanian Research Centre for Agriculture and Forestry

e-mail: lina.beniusiene@mi.lt, diana.lukmine@mi.lt, iveta.kabasinskiene@mi.lt, kestutis.armolaitis@mi.lt

Engaging in a global context, Lithuania together with other European countries commits to a fossil fuel exit to stop the further growth of the CO_2 concentration in the atmosphere. During the period of the 10-12 years, biofuels gained a dominant position in Lithuania. By 2020, the share of centrally supplied heat energy produced from renewable energy sources (RES) was planned to increase up to at least 60%, the share of RES in final energy consumption - up to 23%. More than 60% of the heat was produced from biofuels already in the heating season of 2015-2016. Biomass is delivered in various physical forms and moisture content, and converted into many energy commodities such as heat, power or transport fuels. In Lithuania, the main industry sectors, which use biomass energy, include PET pellets production, wood processing, paper reproduction, also flour, frozen food, milk products and wheat starch production, flower greenhouses, etc. The price of forest biomass, mainly wood chips, is 3 times lower than the price of natural gas. The sector also provides by 30% lower cost of produced heat for consumers, lower CO_2 emissions, increasing number of jobs (about 7500 employees), development of technologies, improved cooperation of science and business, rural development, also improved foreign trade balance. According to the National Heat Sector Development 2015-2021 program, the upward trend of sales of forest felling residues in State forests was observed in 2006-2007 with significant increase from 2011-2013. To achieve the goal of reducing the heat price and environmental pollution, giving priority to local and renewable resources in a fuel balance, the following issues were addressed: to promote high efficiency cogeneration in order to increase local competitive electricity output, to reduce heat generation plants pollution and ensure the development of renewable energy sources usage, to set the transparent district heating systems development planning and regulatory rules. Finally, in 2021, the heat price would be reduced by 20% and renewable and (or) local energy resources part in district heating fuel balance would be 70%. The Program set the goal to reduce transmission losses by modernization of heat transmission networks and to ensure a reliable and high-quality heat transfer. Also, the Program aims to promote trade in energy resource exchange by setting the obligation for regulated energy companies to acquire solid biomass in the Baltpool (the operator of the Lithuanian Energy Exchange entitled to organise trade of solid biofuel products) energy exchange.

P12. Improving the financial performance of solid forest fuel supply using a simple moisture and dry matter loss simulation and optimization

Ari Laurén[a], Antti Asikainen[b], Jyrki-Pekko Kinnunen[c], Marjo Palviainen[d] , Lauri Sikanen[b]

[a]Faculty of Science and Forestry, University of Eastern Finland, [b]Natural Resources Institute Finland (LUKE), [c]Makumäentie 27, 83500 Outokumpu, Finland, [d]Department of Forest Sciences, University of Helsinki

e-mail: ari.lauren@uef.fi

We constructed a computation scheme that combines GIS, simulation and optimization techniques for assessing the moisture change, dry matter loss, transportation costs and net present value of solid forest fuel piles. This scheme was applied to predict the value of a stock composed of multiple piles, and to find the optimal feedstock allocation strategy, i.e. the selection of piles and the combustion time so that the total energy yield and the economic value of the energy production is maximized. According to the simulation, single Norway spruce energy wood piles reached their maximum energy content during July-August in boreal conditions in Finland. If a pile was created between January-September, the maximum energy content occurred in the same year, whereas for piles created between October-December, the maximum occurs in the summer of the following year. In the optimized combustion sequence, the piles generated in early Year 1 were combusted first. The main outcome of the study was that the simulation-optimization scheme can increase the gained net present value of the feedstock by 2.0 % - 6.4 %, and the benefit increases with increasing heterogeneity of the feedstock. Forest fuel suppliers can get considerable savings by applying the presented system to decide the combustion sequence of the existing feedstock. From a practical point of view this is remarkable because the savings can be achieved without any investments, only by arranging the transportation sequence. The presented computation system uses easily available input, can be modified to different conditions, and can be run with standard IT-resources.

P13. Long-Term Effects of Harvest Residues on Spruce-Fir Site Productivity Following Whole-Tree and Stem-Only Harvesting

Chris Preece[a], Charles Smith[a], Brian Roth[b,c], Russell Briggs[d], Ivan Fernandez[c]

[a]University of Toronto, [b]CFRU, [c]University of Maine, [d]SUNY-ESF

e-mail: chris.preece@mail.utoronto.ca, tat.smith@utoronto.ca

The 1970's spruce budworm epidemic along with energy shortages following the 1973 oil embargo resulted in changes in harvesting system design and associated slash management as well as silvicultural thinning employed in Northern Maine. Proposals to use roadside slash for bioenergy raised concerns regarding potential soil nutrient depletion and reductions in forest productivity. As a result, from 1979-2015, 25 permanent residue study plots were established across three soil drainage classes in uncut (reference) and clearcut watersheds, and subsequently in 1991, 27 permanent silvicultural plots were established to study thinning and fertilisation effects at the Weymouth Point Study Area in north-central Maine to evaluate effects on forest productivity and ecosystem nutrient pools. Twelve 20x20 m plots were treated in 1981 with three harvesting residue treatments: whole-tree harvesting (WTH), de-limbing residues lopped and scattered (LOP), and de-limbing residues chipped and spread (CHP). In 1991, 27 10x10 m plots were treated with: thinning to approximately 2,500 stems ha^{-1} with 200 kg nitrogen ha^{-1} (PCT-FERT), thinning to approximately 2,500 stems ha^{-1} (PCT), and whole-tree harvesting (WTH). All treatment watershed plots were treated with triclopyr in 1985 to release conifer crop trees from hardwood competition. Treatment significantly increased tree size on thinned plots ($\alpha = 0.1$) affecting DBH, height and biomass of the naturally regenerated trees. Tree growth on CHP plots was significantly related to stand density suggesting that chipped residue application reduced advanced natural regeneration seedlings by 600 stems ha^{-1} on CHP treated plots which, in turn, significantly enhanced growth of surviving trees. Silvicultural treatment (PCT, PCT-FERT) average stand biomass was similar to WTH and residue treated stand biomass; but average tree DBH was significantly greater. Analysis of differential N, P, K, Ca and Mg loading associated with residue removal (WTH) or addition (CHP, LOP) 35-years after harvest suggests that whole-tree harvesting has not reduced stand growth at this study area.

P14. Effects of biochar on carbon and nitrogen cycling in boreal Scots pine forests

Marjo Palviainen[a], Frank Berninger[a], Kajar Köster[a], Viktor Bruckman[b], Jukka Pumpanen[c]

[a]University of Helsinki, Department of Forest Sciences, [b]Commission for Interdisciplinary Ecological Studies, Austrian Academy of Sciences, [c]Department of Environmental and Biological Sciences, University of Eastern Finland

e-mail: marjo.palviainen@helsinki.fi

Biochar is a carbon-rich solid which is formed as a by-product in bioenergy production in pyrolysis process where biomass is heated in low oxygen concentrations. The addition of biochar to soil is a potential tool for carbon sequestration and climate change mitigation because biochar is recalcitrant to decomposition. Biochar can also act as a soil conditioner enhancing plant growth by increasing soil microbial activity, water holding capacity, cation exchange capacity and pH. However, these changes in soil chemical and physical properties may increase microbial activity and the decomposition of native soil organic matter. Moreover, part of the biochar carbon is labile which may accelerate the decomposition of old soil organic matter through so called priming effect. Biochar studies are mainly conducted on agricultural soils, and very little information exists about the effects of biochar on carbon and nutrient cycling in boreal forests.

In order to understand to what extent different types and application rates of biochar affect carbon (C) and nitrogen (N) fluxes in boreal forests, we conducted a field experiment where two different spruce biochars (pyrolysis temperatures 500°C and 650°C) were applied at the rate of 0, 5 and 10 t ha^{-1} to *Pinus sylvestris* forests in Finland. We measured soil respiration with portable closed chambers and determined the microbial biomass C and N in the soil by chloroform fumigation extraction method. Net N mineralization rates in the organic layer and upper 10 cm mineral soil were studied in a 42-day laboratory incubation at 15°C. Biological N fixation rates in moss and organic layer were studied by acetylene reduction method by incubating samples at 10°C, 15°C and 25°C for 24 hours.

The results indicated that soil CO_2 fluxes in all biochar treatments were higher than in the control during the first summer (1-4 months after treatment). Treatments with 10 t ha^{-1} added biochar had higher soil CO_2 fluxes compared to those with 5 t ha^{-1} added biochar. The increase in soil respiration rates was attributed to elevated soil temperatures in biochar plots. During the second summer (13-14 months after treatment), soil CO_2 effluxes showed no clear response to biochar addition and soil temperatures were similar in different treatments. The pyrolysis temperature of biochar did not affect soil CO_2 effluxes. Biochar increased soil pH but microbial biomass did not differ between the treatments. Biochar addition did not have a significant impact on N mineralization and biological N fixation rates. Our results suggest that biochar may slightly increase soil respiration initially but it has no detectable effect on key N cycling processes in the short-term in boreal xeric forests. Thus, it seems that biochar is a promising tool to mitigate climate change and sequester additional C in boreal forest soils.

P15. Trickle down impacts on water: Filtering bioeconomy storyline data from the national to the small catchment scale

Dennis Collentine[a], Jelena Rakovic[a], Ida Nordin[a], Katarina Kyllmar[a] and Martyn Futter[a]

[a]Swedish University of Agricultural Sciences (SLU)

e-mail: dennis.collentine@slu.se

The goal of the BIOWATER project financed by the Nordic Council of Minsters is to develop a Nordic Centre of Excellence to analyse the impact on water and water related environmental services of a green shift in the Nordic countries. This will be done by framing future scenarios that accommodate a green shift and climate change. The future scenarios used in the BIOWATER project are storylines based on possible outcomes with respect to governance, biomass extraction and green technological innovation. These bio-economy adapted storylines have been derived in common for the four Nordic countries (Futter et al, submission this conference). This presentation uses these adapted storylines as a starting point and describes how these common results have been complemented with national bio-energy policy and bio-economy strategies for Sweden and then converted into quantitative changes that are consistent with both the Nordic storylines and national policy to model land use change. The changes are transformed into parameters that are used in the CAPRI land use model to model their impact on agricultural land use. CAPRI (Common Agricultural Policy Regionalized Impact modelling system) is a partial equilibrium model for the agricultural sector developed for policy impact assessment of the Common Agricultural Policy. The model is regionalized at NUTS 2 level for each of the Nordic Countries (Fylke in Norway). The regional output will be used in the BIOWATER project to study the effect of land use changes at a small catchment level by transforming the regional results through expert opinion with detailed land use knowledge for each of the project study areas. A similar process will be followed in the BIOWATER project for each of the Nordic countries and be used to evaluate the impact of these land use changes on water resources and related environmental services at the small catchment, regional, national levels and Nordic levels.

P16. Plant diversity and species abundances in two Norwegian spruce forest sites: Short-term effects of whole-tree harvesting and stem-only harvesting.

Tonje Økland[a], Jørn-Frode Nordbakken[a], Holger Lange[a], Ingvald Røsberg[a], O. Janne Kjønaas[a], Kjersti Holt Hanssen[a], Nicholas Clarke[a]

[a]Norwegian Institute of Bioeconomy Research (NIBIO)

e-mail: tonje.okland@nibio.no

In contrast to conventional stem only harvesting (SOH), whole-tree harvest (WTH) for bioenergy purposes includes additional harvesting of forest residues (twigs, branches and crown tops). WTH may lead to biodiversity loss and changes in species composition and abundances in forest ground vegetation, which in turn also may affect soil properties. We have investigated the effects of clear-cut harvesting on ground vegetation at two Norway spruce sites, one in south-east and one in western Norway, respectively. At these two sites that differ in climate and topography, experimental macro plots were either harvested conventionally (SOH), leaving harvest residues spread on the site; or WTH was carried out. In the case of WTH, the residues were collected into piles that were removed after six to nine months.

Vegetation plots ($1m^2$) in the south-eastern site were established and analysed before harvesting in 2008 and reanalysed after harvesting in 2010, 2012 and 2014. In the western site vegetation plots were established before harvesting in 2010 and reanalysed after harvesting in 2012, 2014 and 2016. All vegetation plots are permanently marked. Pre- as well as post-harvesting species abundances of all species in each vegetation plot were recorded each time as percentage cover (vertical projection) and subplot frequency. We used nonparametric statistical tests to analyse effects of WTH and SOH on ground vegetation biodiversity and species abundances: 1) changes from before to the second, fourth and sixth growing season after harvesting and 2) differences between treatments (WTH with and without piles and SOH plots without piles) after two, four and six years after harvesting.

P17. Ecosystem service approach as contribution to sustainability governance in forest management

Edgars Jurmalis[a], Zane Libiete[a], Arta Bardule[a], Martins Lukins[a]

[a]Latvian State Forest research institute "Silava"

e-mail: edgars.jurmalis@silava.lv

Through their ecosystem functions, forest ecosystems offer a wide range of beneficial services, including the supply of wood-based products and non-timber products such as berries or game. Sustainable governance of these resources must consider other, non-material services – carbon storage and sequestration, water protection, as well as cultural and recreational benefits. By classifying, identifying and mapping these multiple services, forest management gains more insight how to deal with trade-offs and maximise synergies between the ecosystem services. Suitable methods and data sources need to be implemented and demonstrated. Mapping of ecosystem services is a key aspect, as declared in various EU and global scale guidelines. Maps can display complex data, and are particularly useful in the process of planning natural resource (forest) management.

A managed forest area (forested catchment in state forest of Latvia) was used to develop and test the evaluation and mapping method of forest ecosystem services at local scale. Ecosystem services were classified according to the Common International Classification of Ecosystem Services (CICES, Version 4.3). As sustainability governance includes stakeholder involvement, a pilot questionnaire was distributed to main stakeholder groups to identify most important ecosystem service classes in each ecosystem service section. Further, the presented approach combined theoretical, literature and field data sources to develop indicators for each ecosystem service class. Geographic information systems (GIS) were then applied, which allows combining spatial data with proxy values corresponding to each indicator. Further analysis can be done using various GIS solutions, for example, applying road buffers for incorporating the accessibility aspect to provisioning and cultural services assessment in the given area.

Finalised maps containing spatial information of selected ecosystem services and their indicators were created and potential trade-offs between different ecosystem service classes were analysed and discussed. Technical solutions and data availability for implementing the proposed methodology were also overviewed in the context of more sustainable decision making concerning management of natural resources.

P18. Feasibility of verifying sustainable forest management of secondary feedstocks to produce wood pellets in Southeastern USA and the Baltic states

Inge Stupak[a], C. Tattersall (Tat) Smith[b]

[a]University of Copenhagen, [b]University of Toronto

e-mail: [a]ism@ign.ku.dk and [b]tat.smith@utoronto.ca

Criteria for Sustainable Forest Management (SFM) have been adopted for biomass used for energy in the United Kingdom (UK), Denmark (DK) and the Netherlands (NL). The required criteria and verification approaches differ somewhat between countries for different biomass categories, but there are diverging opinions on the extent to which it is generally feasible to verify SFM for secondary residues and if there will be an increased pressure on forests in sourcing regions, in the absence of SFM verification for secondary feedstocks. This paper assesses the feasibility of verifying SFM requirements for wood pellets based on secondary residue feedstocks. To analyse this question, we defined four policy scenarios: Secondary feedstock 1) does not require documentation of SFM, 2) requires documentation verifying it comes from non-controversial sources (controlled biomass), 3) requires documentation verifying it comes from sustainably managed and harvested forests, using a risk-based approach to verification; and 4) requires documentation verifying it comes from forests with SFM certification at the FMU level. For these scenarios, we assessed the technical, economic and cultural feasibility, with a focus on forest owners, wood dealers and saw mills. The geographical focus was on feedstocks sourced in the southeastern United States (SE US) and the Baltic countries, with end use in the UK, DK and NL. The assessment was based on peer review literature, reports, information from certification systems' websites, and, to some extent, on interviews with key actors in the supply chain or knowledgeable individuals.

We found that supply chains based on secondary feedstocks are generally far more complex than those based on primary wood and residues, as hundreds of actors may be involved in a single supply chain, and the number of points where mixing and aggregation of material flows may be up to seven links or more. As certification or verification of controlled biomass criteria requires physical separation of these flows from biomass with no documentation, it is a major challenge to separate these flows. This would not be a problem if all forest biomass was certified or controlled, but only a limited amount of certified and controlled raw materials are available, especially in SE US. This situation is not likely to change as long as there are no mandatory SFM requirements for the main forest products. This is especially the case in the SE US, where there is also a well-developed domestic market for uncertified wood pellets. The situation is different in the Baltic countries, where certification has been a tool to reduce illegal logging and thus increase forestry's international reputation. Apart from market access, many Baltic wood suppliers indicate that financial incentives could motivate them to get certified, including adequate price premiums, subsidies, and tax reductions for certified forests. Finally, some actors might want others to audit their forests and businesses regardless of economic incentives. Many forest owners, wood dealers and saw mills, especially in SE US, are not in favor of certification, especially if led by environmental NGOs. This barrier may be less pronounced in the Baltic countries, where forests regulation and other laws under the Soviet period were very prescriptive. During the recent two-decade transition period, substantial privatization has taken place, but these new private forest owners are often poorly organised and often do not have

knowledge of forest management. Decade-long work with implementation of water quality BMPs and logger training programmes in SE US means that some level of confidence and collaboration has been established with some proportion of the private forest owners, but it is questionable how many more will become certified. Prospects might be better for small forest owners in the Baltic countries, if financial incentives are put in place, and education and forest owner organization is promoted. However, past experiences suggest such changes occur slowly, and that it may take many years to achieve significant change. Generally, we found no evidence of region-wide deforestation or forest degradation due to the wood pellet production in SE US or the Baltic states.

P19. The use of LiDAR and sentinel-2 data in the detection of wet depressions in forests on mineral soils

Janis Ivanovs[a] and Andis Lazdins[a]

[a]Latvian State Forest Research Institute "Silava"

e-mail: Janis.ivanovs@silava.lv

Hydrological processes in any given area depend on local topography and sediment characteristics. Water tends to flow and accumulate according to gravitational potential energy and site position in terrain. Spatial information of wet depression distribution is important for forestry management in order to minimize damage on soil by harvesting. Wet depressions are also important for various plant and animal species as habitats and for paleoecology studies as historical data storages about the local environment. Remote sensing data like LiDAR (Light Detecting and Ranging) and multispectral satellite imagery can be used to detect local depressions where wet areas may occur. There are no previous studies in Latvia in context of wet depressions spatial distribution. The aim of this study is to evaluate methods that can be used to detect wet areas in forests on mineral soils and to prepare proposals for forestry management. Study area consists of 25 plots of 1 km^2 on different sediment types. For hydrological modelling purposes each area has a 1 km wide buffer zone. 230 sample plots are made to collect information about local environment, i.e. properties of sediments, forest type, basal area of trees, characteristics of topography and spectral signature of canopy. Raster map examples are made to demonstrate methodology which allows detection of wet depressions with potentially hindered run-off. A fill sinks (Wang and Liu) algorithm has shown best results in depression detection. TWI index is not suitable for study area because of relatively flat topography. Results of this study reveal that wet depressions have significant effect on tree species spatial distribution.

P20. Family owners' restoration of longleaf pine forests around Enviva's Cottondale wood pellet plant

Ben Larson

Enviva Biomass

e-mail: Ben.larson@envivabiomass.com

In late 2017, Enviva announced a partnership with the American Forest Foundation (AFF) and The Nature Conservancy (TNC) to collaborate on a project around our plant at Cottondale, FL to support family owners' restoration of longleaf pine forests (a top priority of the conservation community because longleaf pine forests provide critical habitat to dozens of threatened and endangered spp.) and increase certification to the American Tree Farm System ('Tree Farm').

In developing efficient ways to recruit landowners to restore longleaf and increase certification, our project with AFF and TNC will serve as a pilot project in which we will learn best practices that Enviva can subsequently apply at our other pellet plants.

Our project will recruit landowners through: 1) AFF's targeted recruitment and outreach through the forestry sector across the FL panhandle, 2) establishing longleaf restoration demonstration sites on nearby TNC lands and holding forestry tours, and 3) Enviva's new landowner assistance program which focuses on providing technical and financial assistance, particularly to plant longleaf forests after site-inappropriate and scrubby hardwood stands are removed.

Part of a long-term collaboration between AFF and TNC, our 2018-2019 goals are to:

- Assist 500 landowners in taking steps to restore or enhance longleaf pine on their properties
- Help establish over 1,100 acres of new longleaf forests,
- Enhancing the habitat for at-risk species on at least 2,550 acres
- Set additional 5-year goals for additional longleaf restoration in FL [late 2019]

Through our COT Landowner assistance program, our 201-2019 goals are to:

- assist 50 additional landowners
- help restore 1,200 acres of longleaf
- augment longleaf restoration on public/preserved lands with longleaf restoration on private lands

In 2019-2020, Enviva will implement best practices learned in our FL pilot project at other plants, which are also in the historic range of longleaf pine.

P21. Show me research and demonstration sites for innovation

John Stanturf[a], Emile Gardiner[a], James Shepard[b], Ted Leininger[a], Erik Schilling[c], Stephen Schoenholtz[d]

[a] USDA Forest Service, [b] Auburn University, [c] National Council of Air and Stream Improvement, [d] Virginia Tech University

e-mail: [a]drdirt48@gmail.com

Theoretically, innovation consists of three simple steps: developing an innovation, disseminating knowledge of it, and its implementation and acceptance by a user community and stakeholders. Connecting the dissemination and implementation stages and deciding to implement or accept a new technology often encounters significant hurdles. Closely linked social networks facilitate the effective transmission of innovations, reducing the barriers hindering acceptance and implementation. Demonstration sites have long been used in natural resource management to demonstrate or validate research conducted under experimentally controlled conditions. Our experience has been that the closer (physically as well as psychologically) researchers and stakeholders are when at the crucial step of deciding to try an innovation, the more likely that knowledge will be effectively and efficiently transferred. We suggest that involving resource managers and other significant stakeholders such as environmental groups in the design and installation of the research can be even more effective than just validating research conducted elsewhere. We describe a research and demonstration site where managers and researchers worked collaboratively to answer pressing practical questions while developing a test bed to explore new innovative techniques. The Sharkey Restoration Research and Demonstration Site (SRRDS) near Anguilla, Mississippi represents almost 25 years of collaborative research and science delivery on restoration of forested wetlands in the southern USA. Initially five federal agencies, three forest industry organizations, and three universities were instrumental in funding, establishing, and utilizing the SRRDS and their involvement has ebbed and flowed over the years. The SRRDS has provided a platform where managers and researchers worked together to address important questions on restoration of bottomland hardwood forests. It provided a science-based resource for educating landowners, resource managers, and the general public on appropriate restoration techniques. The SRRDS has been a venue for education and debate among landowners, nongovernmental organizations, and policymakers. Six features of the SRRDS have contributed to its longevity and success and we present them as recommendations for managers and researchers who may plan similar sites in the future: (1) Sites should be located on a neutral and secure area. (2) Selected sites should be representative of the problem. (3) The research and demonstration area should be easily accessible. (4) Sites should house large-scale research and demonstrations. (5) Large-scale experiments should be installed operationally. (6) Experimentation should include innovations as well as comparisons with conventional practices.

Department of Geosciences and
Natural Resource Management
University of Copenhagen
Rolighedsvej 23
DK-1958 Frederiksberg C
Tel. +45 3533 1500
ign@ign.ku.dk
www.ign.ku.dk