Biomass for energy - lessons from the Bioenergy Boom
24-25 November 2014, Leipzig

at the KUBUS, Leipzig, Germany

Future energy demand requires renewable energy sources produced in a social and environmental friendly way at a reasonable cost. At present, bioenergy is the most important renewable energy source holding a great potential for further development. The complex inter-linkages amongst the landscape, energy demand, society and policy-making presents a great challenge of establishing a sustainable system with minimized negative side-effects.

The aim of this workshop is to discuss the state of the art developments for the understanding of the interactions among bioenergy, environment and society at different levels and areas: from the impacts of bioenergy crops on water bodies, soils and biodiversity, to impacts and challenges in the political, legal and societal fields, as well as to the challenges in the system integration and in the evaluation of potential environmental impacts at a regional scale.

The workshop features the presentation of keynote lectures followed by 6 sessions on environmental effects and social-political challenges, including:

- Effects of energy crop cultivation on watercourses, soil functions, land-use, biodiversity and ecosystem services
- Flexible (bio-) power - The future for biomass in the energy system?
- Biomass to biofuels - policy, markets, effects
- Regional & spatial LCA's for biomass resources

The sessions will be composed of presentations of original research based on some guiding questions as framework. At the end of each session a panel of experts will engage with the audience in further discussion of the topic and generate a synthesis. On the end of the workshop, there will be a podium discussion on the topic "Bioenergy 2.0 - recommendations from different perspectives".

The workshop is organised by the Department of Bioenergy of the Helmholtz Centre for Environmental Research (UFZ) in cooperation with Deutsches Biomasseforschungs-zentrum (DBFZ) in Leipzig, Germany.

How to reach the Leipziger KUBUS in Leipzig

Leipziger KUBUS
Helmholtz Centre for Environmental Research - UFZ
Permoserstrasse 15
04318 Leipzig
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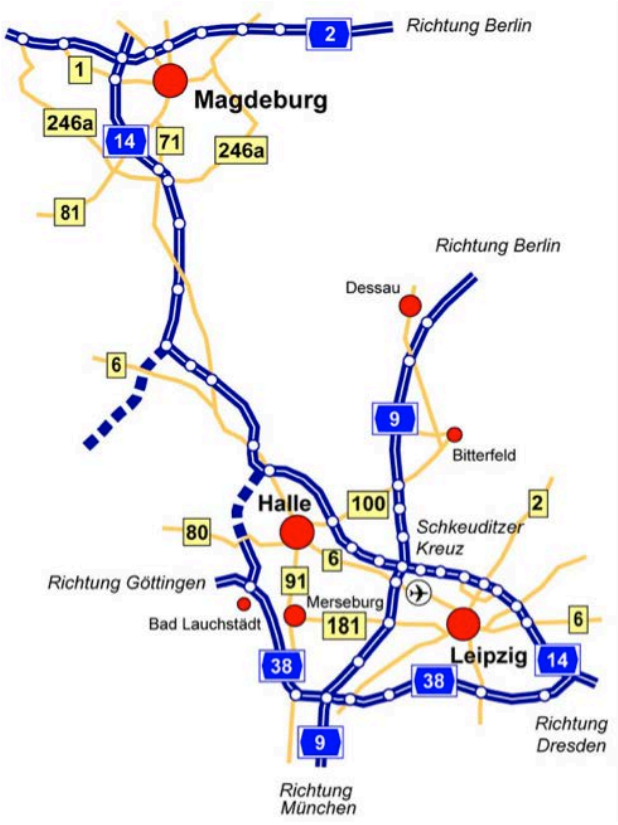
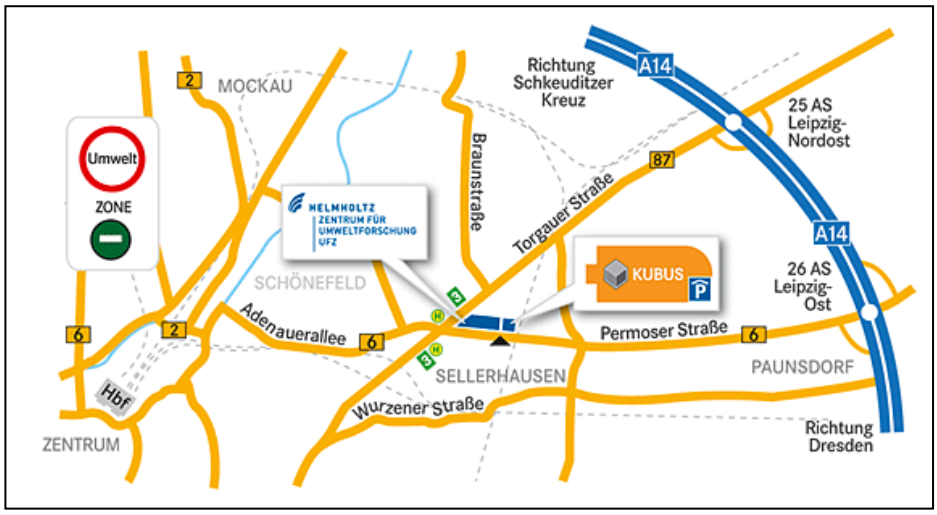


By car
On A14 motorway take exit "Leipzig-Ost" and head for Leipzig Stadtzentrum/City Centre; follow Permoserstrasse up to the underground parking sign for conference Leipziger KUBUS on right hand side.
Leipzig has an "environmental protection zone". Note: Vehicles must have a green badge ("grüne Umweltplakette") in order to be permitted entering the city zone!

By rail
In front of Central Station tram No. 3 (heading for "Sommerfeld" or "Taucha"); after about 15 minutes alight at stop "Torgauer/ Permoserstraße"; walk Permoserstraße 300 metres eastward to find the entrance of KUBUS.

By plane
From Airport take train (regional express) to Central Station; from the Central Station take tram No. 3



24 November 2014

10:00 am: **Start of Registration (KUBUS Foyer)**

11:00 - 12:00 am (Room 1C/D):

Welcome by Georg Teutsch (UFZ) and Michael Nelles (DBFZ)

Keynote lectures

Daniela Thrän (UFZ):
Bioenergy unlimited? Challenges, opportunities and critical control points for a sustainable bioenergy use within the German Energiewende

Jeremy Woods (Imperial College London):
Global bioenergy - a stepping stone to a sustainable future or a key component for the foreseeable future?

12:00 am - 01:00 pm: **Lunch**

01:00 - 03:30 pm: **Sessions**

Session 1 (Room 1C)

"Effects of energy crop cultivation on watercourses"

Presentations:

- Introduction
- 01:10 - 01:35 pm: Katja Bunzel: *Energy crops and pesticide contamination*
- 01:35 - 02:00 pm: Seifeddine Jomaa: *Effect of increased bioenergy crop production on instream water quality in central Germany*
- ***Short break***
- 02:10 - 02:35 pm: A. Pouyan Nejadhashemi: *Water quality impact assessment of large-scale energy crop expansion*
- 02:35 - 03:00 pm: Cornelia Fürstenau: *Short rotation coppice as riparian buffer strips*
- ***Discussion***

Session 2 (Room 1D)

"Flexible (bio-) power – The future for biomass in the energy system?"

Presentations:

- Introduction
- 01:10 - 01:35 pm: Philip Tafarte: *Can flexible power production from biomass complement the fluctuating feed-in from wind and solar power? Results from a case study for a German region*
- 01:35 - 02:00 pm: Alexandra Purkus: *Incentives for demand-oriented renewable electricity production – lessons learned from the sliding market premium and perspectives*
- ***Short break***
- 02:10 - 02:35 pm: Eva Hauser: *The role of bioenergy during the energy system transformation – whose demand should be satisfied by bioenergy?*
- 02:35 - 03:00 pm: Birger Lauersen*: Green District Heating*
- ***Discussion***

03:30 - 04:00 pm: **Coffee break**

04:00 - 06:30 pm: **Sessions**

Session 3 (Room 1C)

"Effects of energy crop cultivation on soil functions"

Presentations:

- Introduction
- 04:10 - 04:35 pm: Humberto Blanco: *How does soil respond to energy crop production?*
- 04:35 - 05:00 pm: Mehmet Senbayram: *Emissions of greenhouse gases from biogas crop production systems*

Session 4 (Room 1D)

"Biomass to biofuels - policy, markets, effects"

Presentations:

- Introduction
- 04:10 - 04:35 pm: Christina Plank: *The Agrofuels Project in Ukraine*
- 04:35 - 05:00 pm: Anna Mohr: *The control of socio-ecological criteria through private governance mechanisms*

• ***Short break*** • 05:10 - 05:35 pm: Uwe Franko: *Climate change induced carbon competition: bioenergy versus soil organic matter reproduction - an indicator based assessment* • 05:35 - 06:00 pm: Halil Coban: *Contribution of biogas residues to soil carbon and CO_2 emissions when applied to arable soil* • ***Discussion***	• ***Short break*** • 05:10 - 05:35 pm: Judith Verstegen: *Stochastic projection of the effects of an increased biofuel demand on direct and indirect land use change in Brazil* • 05:35 - 06:00 pm: Christian Klassert: *Transregional Land-Use Dynamics of Bioenergy Policies – Agent-Based Economic Analyses with the ILUC-MAP Model* • ***Discussion***

06:30 - 07:00 pm: **Poster Session (Foyer KUBUS)**

07:00 pm: **Get together in the foyer of the Leipziger KUBUS**

25 November 2014

09:00 - 09:30 am: **Poster Session (Foyer KUBUS)**

09:30 - 12:00 am: **Sessions**

Session 5 (Room 1C)	**Session 6** (Room 1D)
"Effects of energy crop cultivation on land-use, biodiversity & ecosystem services (landscape modelling and empirical studies)" *Presentations:* • Introduction • 09:40 - 10:00 am: Felix Witing: *Definition and regionalization of agricultural crop production systems on large scales - an integrated approach for environmental modeling and assessment* • 10:00 - 10:20 am: Christian Dietrich: *Effects of the biomass boom on the crop pest ECB - About the role of landscape structure and the handling of pest infestation* • ***Short break*** • 10:30 - 10:50 am: Sven Lautenbach: *Water related trade-offs of different crop production schemes for biogas production in a German case study* • 10:50 - 11:10 am: Jeroen Everaars: *Species ecology and the impacts of bioenergy crops: an assessment approach with four example farmland bird species* • 11:10 - 11:30 am: Jens Dauber: *The importance of novel energy crops and cropping systems for farmland biodiversity* • ***Discussion***	**"What's your perspective? - Regional & spatial LCA's for biomass resources"** *Presentations:* • Introduction • 09:40 - 10:05 am: Steffen Schock: *LCA of biogas production in Central Germany* • 10:05 - 10:30 am: Stefan Majer: *Regional aspects in LCA for Bioenergy Systems* • ***Short break*** • 10:40 - 11:05 am: Floor van der Hilst: *Regional integrated assessment of environmental and socio-economic impacts of biofuel production demonstrated for Mozambique* • 11:05 - 11:30 am: Stephan Pfister: *Life cycle assessment (LCA) of bioenergy and relevance of regionalisation* • ***Discussion***

12:00 am - 01:00 pm: **Lunch break**

01:00 - 02:00 pm: **Report from the Sessions (Room 1C/D)**

02:00 - 03:00 pm
Podium Discussion (Room 1C/D):
"Bioenergy 2.0 - recommendations from different perspectives"

Keynote 1

Bioenergy unlimited? Challenges, opportunities and critical control points for a sustainable bioenergy use within the German Energiewende

Daniela Thrän[1,2,3]

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[2] *DBFZ - Deutsches Biomasseforschungszentrum, Department Bioenergy Systems, Torgauer Str. 116, 04347 Leipzig, Germany*

[3] *University Leipzig, Institute for Infrastructure and Resources Management, Grimmaische Strasse 12, 04109 Leipzig, Germany*

Bioenergy is in total the most relevant renewable energy source in Germany, responsible for roughly 40 % of greenhouse gas emission reduction from renewables in 2013. The arable land which is cultivated with energy crops has been increased from about 4 % in 2003 to more than 12 % in 2013. This dramatic expansion caused debates about the additional environmental and social effects on a local, national and transnational scale, especially for land use related aspects of energy crop cultivation and use.

Research has been started to provide a deeper understanding of the systemic effects and to conclude optimization approaches and suitable management instruments. For those investigations we included the whole value chain of bioenergy utilization including land use, biomass production, biomass conversion and bioenergy use, as well as the local infrastructural, social and environmental condition. For the German bioenergy boom we analyzed the following different strengths and threats: (i) to realize positive land use effects, additional targeted management of land use might be more relevant than additional emission reduction rules; (ii) bioenergy plant locations need to consider both, biomass availability and an appropriate demand for the provided energy, (iii) the bioenergy boom initiated additional technical improvement for certain biomass conversion technologies, but their integration into the energy market needs clearer definition of the demanded qualities, (iv) the overall impact of bioenergy use strongly depends mainly on the general expectation for the further transition of the energy system and the impact of the substituted supply system, and not so much on the performance of the different bioenergy value chains; (v) on international level energy crop production has comparable lower relevance and is often coupled with feed production. International quality standards for the different bioenergy carriers currently initiate the trade with a wider range of liquid and solid biofuels and – in the longer term – also biomethane.

Our conclusion is that one major challenge for future bioenergy use is the further development of longer term visions and implementation strategies, considering two transition approaches: renewable energy supply and bioeconomy. In parallel sustainability indicators and certification schemes for all bioenergy carriers have to be developed further, including the different dimensions of sustainability and the local and regional conditions of energy crop production.

Keynote 2

Global bioenergy- a stepping stone to a sustainable future or a key component for the foreseeable future?

Jeremy Woods[1], Alexandre Strapasson[1]

[1] Centre for Environmental Policy, Imperial College London, Exhibition Road, London SW7 2AZ, UK, jeremy.woods@imperial.ac.uk

Support for bioenergy has been declining since the economic and food price crises of 2008/09. This lack of support has become evident in recent policy decisions in the European Union and elsewhere. But are the negative perceptions based on fact or fiction? Using a new global model called 'The Global Calculator' the potential role of bioenergy as a tool for climate mitigation and adaptation can be explored within a wider sustainable development context. For example, the Global Calculator can chart pathways illustrating how, by 2050, 10 billion people could eat well, have better mobility, live in more comfortable homes and at the same time emissions could be reduced to levels consistent with a 50% chance of 2oC warming. The technical and organisational innovations, lifestyle choices, policies and investments needed to achieve this future with and without bioenergy will be explored.

Session 1 "Effects of energy crop cultivation on watercourses"
(24 November 2014, 01:00 - 3:30 pm, room 1C)

Overall protection of water quality is vital for human as well as aquatic health. Therefore, we will discuss the effects of large-scale energy crop expansion on water quality and aquatic ecosystems in the Session "Effects of energy crop cultivation on watercourses". Beside the analysis of pesticide and nutrient inputs from energy crops, we will present selected management approaches that can potentially mitigate negative effects or even create synergies between water protection and energy crop cultivation (e.g. short-rotation coppice as riparian buffer strips).

Key questions:

- What are the main stressors on aquatic ecosystems caused by the cultivation of energy crops?
- From a water protection point of view, what are preferred energy crops or management practices?
- Which effects can be expected on a landscape-scale?
- Are their synergies between the protection of water quality and the cultivation of energy crops?

Session chair: Saskia Knillmann (Helmholtz-Centre for Environmental Research, Leipzig, Germany)

Presentations:

- 01:10 - 01:35 pm: Katja Bunzel (Helmholtz-Centre for Environmental Research, Leipzig, Germany): *Energy crops and pesticide contamination*
- 01:35 – 02:00 pm: Seifeddine Jomaa (Helmholtz-Centre for Environmental Research, Magdeburg, Germany): *Effect of increased bioenergy crop production on instream water quality in central Germany*
- ***Short break***
- 02:10 - 02:35 pm: A. Pouyan Nejadhashemi (Michigan State University, East Lansing, USA): *Water quality impact assessment of large-scale energy crop expansion*
- 02:35 – 03:00 pm: Cornelia Fürstenau (Thuringian State Institute of Agriculture, Jena, Germany): *Short rotation coppice as riparian buffer strips*
- ***Discussion***

Energy crops and pesticide contamination

Katja Bunzel[1], Mira Kattwinkel[2], Daniela Thrän[1,3,4]

[1] *Helmholtz-Centre for Environmental Research, Department Bioenergy, Leipzig, Germany, katja.bunzel@ufz.de*

[2] *Eawag, Swiss Federal Institute of Aquatic Science and Technology, Ueberlandstrasse 133, CH-8600 Duebendorf, Switzerland*

[3] *DBFZ - Deutsches Biomasseforschungszentrum, Department Bioenergy Systems, Leipzig, Germany*

[4] *University Leipzig, Institute for Infrastructure and Resources Management, Leipzig, Germany*

Biomass is the major renewable energy source in Europe, providing two thirds of the total energy produced from renewables. The share of bioenergy from energy crops is growing rapidly. Given the environmental pressures arising from pesticide pollution from current agricultural food production, a substantial increase in energy crop cultivation might put additional pressure on farmland biodiversity and on soil and water resources. Based on a case study of Germany, the leading European country in the cultivation of energy crops, we examined the potential of energy crops for pesticide contamination and developed general conclusions and recommendations for the future large-scale expansion of agricultural bioenergy.

Our findings reveal that there will not necessary be an increase or decrease in the amounts of pesticides released into the environment as a result of the increased cultivation of energy crops. Due to the great variety of such crops, the potential effects will depend rather on the future design of the agricultural systems and whether the energy crops can be successfully integrated into the existing food production systems. Possible risks are associated with the increased cultivation of pesticide-intensive energy crops, such as rapeseed, especially when grown in monocultures or on formerly set-aside land or converted grassland. Possible opportunities are associated with perennial energy crops (e.g., fast-growing trees and perennial grasses) and innovative cropping systems (such as mixed cultivation), which may add to crop diversity and generate lower pesticide demands than intensive food farming systems. In addition, a further extension of the cultivation of energy crops should be accompanied by mandatory restrictions to protect the remaining permanent grassland. Optimised cultivation systems with diverse crop rotations that integrate food and energy crops could help to improve monotonous agricultural landscapes, increase agricultural biodiversity and minimise pesticide exposure.

Effect of increased bioenergy crop production on instream water quality in central Germany

Seifeddine Jomaa[1,2], Michael Rode[2]

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[2] *Helmholtz-Centre for Environmental Research, Department Aquatic Ecosystem Analysis and Management, Magdeburg, Germany*

Numerous studies have shown that the changes in land cover/use affect significantly the hydrological regime, which in turn influence the surface water quality. It is known that, at the catchment scale, hydrological modelling is a favourable tool for discharge and nutrients transport (such as Nitrogen and Phosphorus) predictions. The semi-distributed hydrological water quality HYPE (Hydrological Predictions for the Environment) model, has been evaluated for different catchments, and has been shown to reliably reproduce the measured data. The aim of this study was to test the spatio-temporal transferability of the HYPE model in central Germany, and to investigate the effect of increased bioenergy crop production on instream water quality. First, the spatial transferability of the HYPE model was tested using two mesoscale catchments with different physiographical characteristics. To achieve our gaols, the Selke (463 km^2) and Weida (99.5 km^2) catchments, which are two small tributories of the Elbe river basin were utilized. Second, the temporal transferability of the HYPE model was tested in the Weida catchment using different periods, where different patterns of nitrogen leaching were measured due to the difference in the fertilizers applications.

For Selke, the HYPE model reproduced reasonably well the discharge and IN monthly loads (with lowest *NSE* of 0.86 and 0.69 for discharge and IN loads, respectively). Also, results showed that only a *NSE* of 0.30 was obtained for the Weida catchment, in situations where the same best-optimized values from Selke was utilized, reflecting the controlling factors of land use and topography on the runoff generation. However, when the physiographical characteristics of the Weida catchment were considered during the calibration and validation phases (1997-2000 and 2001-2004, respectively), the HYPE model could reasonably predict the measured discharge and IN concentrations with similar performance as the Selke. In addition, the temporal transferability of the HYPE model was tested successfully in the Weida catchment by representing the dynamics of IN concentrations during the periods of 1983-1987 and 1989-1996 by adjusting the fertilizers inputs for both periods, respectively. Also, the HYPE model was used to investigate the impact of different bionergy scanarios on the instream nitrogen leaching. The preliminary results of this study will be discussed and presented.

Water quality impact assessment of large-scale bioenergy crop expansion

A. Pouyan Nejadhashemi[1, 2], Bradley Love[1], and Matthew Einheuser[1]

[1] *Michigan State University, Department of Biosystems and Agricultural Engineering, U.S.A.*
[2] *Michigan State University, Department of Plant, Soil and Microbial Sciences, U.S.A., pouyan@msu.edu*

Production of biofuels can provide many benefits, including reduction of greenhouse gas emissions and decreased dependence on non-renewable energy sources. However, there are environmental challenges in transitioning to large-scale production of biomass for energy production. For biofuels to be a sustainable alternative to fossil fuels, their cultivation must avoid intensifying negative environmental impacts. Most significantly, expansion of cultivated land for renewable feedstock production requires increased fertilizer and pesticide application, which is detrimental to humans and aquatic ecosystem health. In order to evaluate the possible long-term water quality implications of bioenergy crop expansion, the Soil and Water Assessment Tool (SWAT) was used. Crop rotation and management data were collected for the main agricultural regions of Michigan, totaling over 53,000 square kilometers. Fifteen unique bioenergy crop rotations and four land use scenarios were integrated into the SWAT model. Bioenergy crops tested included both first and second generation crops. Land use scenarios were based on replacement of currently cultivated agricultural lands and expansion to marginal land with bioenergy crops. The results suggest that second-generation lignocellulosic bioenergy crops such as switchgrass are the most suitable for large-scale implementation, where traditional first-generation (canola, corn, and sorghum) row crops led to significant water quality degradation. In addition to nutrient impairment, increased canola, corn, and soybean cultivation leads to pesticide contamination that violates safe drinking water standards. Caution should be exercised in expansion of bioenergy crops on marginal lands for both first and second generation crops.

Short rotation coppice as riparian buffer strips

Cornelia Fürstenau[1], Manuela Bärwolff[1]

[1] TLL Thuringian State Institute of Agriculture, Jena, Germany, cornelia.fuerstenau@tll.thueringen.de

The Water Framework Directive established in 2000 commits European Union member states to achieve good qualitative and quantitative status of all waterbodies by 2015 – latest by 2027. To reach this ambitious goal new measures have to be developed to provide sufficient environmental protection. Erosion and surface runoff from agricultural sites are still a source of nutrient input, especially phosphate, to watercourses. Even applying excellent erosion control management on arable land cannot fully prevent the input of soil particles and dissolved nutrients from arable land into waterbodies during intensive rainfalls, snowmelt and times between two crops.

Short rotation coppices (SRC) along watercourses can act as final barrier to protect from erosion induced nutrient contamination. Permanent plant cover slows down the runoff, thereby increases sedimentation and infiltration rate compared to bare arable land. Additionally SRC may enhance soil texture and therefore infiltration because of extensive management without soil compaction, increase of litter input and deep rooting of trees. Only twice in the life time of more than 30 years, during the establishment and after the clearing of the SCR, the strip may not act as buffer.

From a water protection point of view SRC-strips require adapted planting strategies which differ from those of conventional SRCs. Those strips should have a width of minimum 12 - 18 m. The management impact on the site has to be as low as possible to provide soil improvement. Recommended are a reduced tree number (3.000 trees/ha), a rotation period of at least 10 years, and manual harvest. Additional environmental advantages of SCR buffer strips are the improvement of habitat structure especially in the poorly structured, intensively managed agricultural landscape in the Eastern part of Germany. Furthermore those strips contribute to a sustainable production of energy wood and reduction of greenhouse gases.

The project “Short rotation coppice along a watercourse” investigates the anticipated environmental advantages of SRC-strips. The study site, installed in 2011, is situated in Northeast Thuringia. The study compares three management options: cropland, grassland, and SRC (willow). Intensive soil measurements carried out from 2012 until present show initial trends that SRC are a more effective nutrient buffer than cropland and may even outperform grassland.

To realize the establishment of SCR buffer strips along watercourses in the future a higher acceptance by farmers is required. This can only be achieved by public relations work and granting of subsidies to compensate the low income of adequate SCR buffer strips and to value their ecological function.

Session 2 "Flexible (bio-) power – The future for biomass in the energy system?"
(24 November 2014, 01:00 - 3:30 pm, room 1D)

System integration of high shares of intermittent renewable sources (wind power and photovoltaics) into the power system is a big challenge. Beside demand side management, demand oriented power generation from renewable sources is a good opportunity. Bioenergy offers here good potentials since it can be generated if needed. Therefore, we will discuss the potential of biomass to support the system integration of fluctuating renewables, the role of policies or incentives and the design of future electricity markets to activate these potentials.

Key questions:

- What are the potentials of biomass to support the system integration of intermittent renewable sources?
- What incentives or policies are needed to implement flexible bio-power generation?
- How could the future electricity market look like to foster the integration of renewables into the energy system?
- What role could district heating play within a sustainable energy system?

Session chair: Marcus Eichhorn (Helmholtz-Centre for Environmental Research, Leipzig, Germany)

Presentations:

- 01:10 - 01:35 pm: Philip Tafarte (Helmholtz-Centre for Environmental Research, Leipzig, Germany): *Can flexible powerproduction from biomass complement the fluctuating feed-in from wind and solar power? Results from a case study for a German region*
- 01:35 - 02:00 pm: Alexandra Purkus (Helmholtz-Centre for Environmental Research, Leipzig, Germany): *Incentives for demand-oriented renewable electricity production – lessons learned from the sliding market premium and perspectives.*
- ***Short break***
- 02:10 - 02:35 pm: Eva Hauser: (Institut für ZukunftsEnergieSysteme gGmbH, Saarbrücken, Germany): *The role of bioenergy during the energy system transformation – whose demand should be satisfied by bioenergy?*
- 02:35 - 03:00 pm: Birger Lauersen (Danish District Heating Association, Kolding Denmark): *Green District Heating*
- ***Discussion***

Can flexible power production from biomass complement the fluctuating feed-in from wind and solar power? Results from a case study for a German region

Philip Tafarte[1], Marcus Eichhorn[1], Subhashree Das[1], Daniela Thrän[1]

[1] Helmholtz-Centre for Environmental Research, Department Bioenergy, Leipzig, Germany, philip.tafarte@ufz.de

The on-going energy transition in Germany aims at a power system dominated by renewable energy sources (RES) with more than 80% in 2050. With the mainstay of future RES expected to be provided by inherently variable sources like wind and solar photovoltaics (PV), the temporal mismatch in demand and supply is becoming a mayor issue for a secured power supply. Under currently insufficient storage capacity and rapidly increasing power installations from variable renewables like wind and solar PV, options for the integration of increasing shares of vRES are urgently needed.

Biomass as a potentially demand driven source originating from storable energy carriers is seen as a major element to provide power whenever fluctuating wind and solar are insufficient to ensure a balanced power system. On the basis of historic time series data of demand as well as of supply from wind and solar PV of one of the 4 German grid areas, we have modelled future variability from increased installations in wind and solar PV to assess whether fluctuating supply from these sources can be complemented by flexible power generation from biomass. Assuming a flexible operation from power generation from biomass, the ability of today's concepts for the flexible operation are checked against the challenging task to enable a secure power system in the year 2030.

Incentives for demand-oriented renewable electricity production – lessons learned from the sliding market premium and perspectives

Alexandra Purkus[1], Erik Gawel[2], Marc Deissenroth[3], Kristina Nienhaus[3], Sandra Wassermann[4]

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Increasing the market and system integration of renewable energy sources (RES) is regarded as key for reducing the costs of RES support and the transformation of the electricity system. The Renewable Energy Sources Act 2012 introduced the optional, sliding market premium in order to improve the alignment of RES production with electricity prices and enhance the efficiency of RES marketing by increasing direct participation of producers in electricity markets. The 2014 reform of the law has made direct marketing mandatory except for small RES plants, establishing the sliding market premium as the new primary instrument of RES support. This contribution evaluates the experiences with the optional market premium scheme, and examines what efficiency gains can be realistically expected from the changes implemented in the 2014 version of the Renewable Energy Sources Act. First, we assess how well the instrument performs in incentivizing demand-oriented feed-in of dispatchable biomass plants on the one hand, and intermittent wind and solar power plants on the other. Then, we discuss whether marketing efficiency is improved compared to feed-in tariffs with their central marketing of RES electricity. Lastly, we give an outlook on further development perspectives.

The role of bioenergy during the energy system transformation – whose demand should be satisfied by bioenergy?

Eva Hauser[1]

[1] *IZES gGmbH, (Institut für Zukunftsenergiesysteme), Saarbrücken, Germany, hauser@izes.de*

The transformation of the energy system - and especially the electricity system - into a renewables based system implies changes in the functions to be fulfilled by the different system components. The planned progressive decommissioning of fossil or nuclear based power plants implies that renewables' based power plants need to take over these functions. This contribution examines the role that could be taken over by bioenergy plants during the different phases of the energy system transformation. At first, it seems to be necessary to distinguish different phases of the transformation with different types of demand from a systemic point of view. This presentation presents the thesis that it currently seems to be more urgent that bioenergy covers necessary ancillary services for the electricity network and the system stability. This can be done by bioenergy with simultaneously covering the electricity and heat demand through cogeneration. Only in a later stage of the transformation, it seems to be necessary to operate in a mainly demand-oriented mode. This evolution needs to be accompanied and directed with corresponding regulatory or market rules who are to be sketched out in the second part of this presentation.

Green District Heating

Birger Lauersen[1]

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District heating plays an important role in the Danish energy system, with an energy delivery almost matching the total national electricity supply, despite only covering about half the heat market. 63 % of all households are connected to district heating systems. The presentation gives an overview of the background for this and the development of the district heating sector over the last 40 years as well as the results achieved. The huge penetration of district heating makes it a valuable and essential asset in the future integrated and sustainable energy system by providing flexibility and cost effectiveness. Part of the flexibility will be provided by biomass based electricity and heat systems, especially in major towns and cities in Denmark, and especially in the decades towards 2035.The current political background for further development of district heating and its integration in the energy system will also be covered.

Session 3 "Effects of energy crop cultivation on soil functions"
(24 November 2014, 04:00 - 6:30 pm, room 1C)

Soils provide many important functions for plants, animals and humans. In the Session "Effects of energy crop cultivation on soil functions", we will analyze the main impacts of energy crop cultivation on soil functions. In particular, we will discuss to what extent biogas digestate application is influencing the soil organic carbon, an essential component of soil fertility.

Key questions:

- Application of biogas waste into soil as fertilizer: impact on GHG emissions, soil processes (denitrification, nitrification), soil microbial growth kinetics
- How does the cultivation of energy crops affect soil properties, soil organic carbon sequestration?

Session chair: Anja Miltner (Helmholtz-Centre for Environmental Research, Leipzig, Germany)

Presentations:

- 04:10 - 04:35 pm: Humberto Blanco (University of Nebrasko-Lincoln, Lincoln, USA): *How does soil respond to energy crop production?*
- 04:35 - 05:00 pm: Mehmet Senbayram (University of Goettingen, Goettingen, Germany): *Emissions of greenhouse gases from biogas crop production systems*
- **Short break**
- 05:10 - 05:35 pm: Uwe Franko (Helmholtz-Centre for Environmental Research, Halle, Germany): *Climate change induced carbon competition: bioenergy versus soil organic matter reproduction - an indicator based assessment*
- 05:35 - 06:00 pm: Halil Coban (Helmholtz-Centre for Environmental Research, Leipzig, Germany): *Contribution of biogas residues to soil carbon and CO2 emissions when applied to arable soil*
- ***Discussion***

How Does Soil Respond to Energy Crop Production?

Humberto Blanco[1]

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Corn stover and dedicated bioenergy crops are two potential cellulosic feedstock sources for producing biofuel. Excessive corn stover removal for biofuel may, however, increase risks of water and wind erosion, reduce soil C pools, and degrade soil quality in the long term. Dedicated bioenergy crops such as perennial warm-season grasses (switchgrass, miscanthus, and others) can be potentially low-input and alternative cellulosic feedstocks to corn stover removal. The dedicated bioenergy crops can provide biomass for biofuel production while maintaining soil and environmental quality and providing other ecosystem services. Current research on dedicated bioenergy crops is mostly focused on developing technologies for conversion of cellulosic feedstocks into ethanol and assessing biomass production potential. As a result, changes in soil properties ans processes in response to growing bioenergy crops have not been widely discussed. The changes in soil properties including soil structural and hydraulic properties, organic C pools, fertility parameters, and water and wind erosion potential can directly affect the soil's capacity to function or provide ecosystem services. The few studies have found that perennial grasses may increase soil organic C pools, dry and wet soil aggregate stability, proportion of macropores, water infiltration, and soil water content compared with row crops. Impacts of perennial grasses on soil properties are, however, inconsistent, depending on management length, grass species, initial soil condition, land type, and climate. For example, dedicated energy crops may not increase soil C pools compared with row crops in the short term (<5 yr). Future research should include the following. One, further assessment of the impacts of monocultures and polycultures of perennial warm season grasses on biomass production, nutrient cycling, and soil properties to select the best species and mixtures for feedstock production and soil quality improvement. Two, marginal lands are being considered as potential candidates for cellulosic biomass production, but little or no information is available on the impacts of dedicated bioenergy crops on soil properties under marginal lands. Three, because, in most cases, establishment of energy crops requires fertilization, assessing how N, P, and K fertilization of energy crops for biomass production affects soil properties will be important to guide recommendations for optimum levels of fertilization that sustain biomass production and improve soil and environmental quality. In general, dedicated energy crops may have beneficial effects on soil and environment, but further research is needed to ascertain the extent of such benefits for different land types, climatic conditions, and management scenarios.

Emissions of Greenhouse Gases from Biogas Crop Production Systems

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There is a growing concern that greenhouse gas (GHG) emissions during agricultural energy crop production might negate GHG emission savings (CO_2 neutral) which was not intended when promoting the use of renewable energy. Most bioenergy cropping systems require intensive fertilizer inputs including nitrogen. As soil nitrous oxide (N_2O) emissions are likely to be the dominating greenhouse gas emissions associated with bioenergy crop production, better estimation of N_2O fluxes (site-specific or crop-specific) is needed to make reliable life cycle analysis of bioenergy production. In spite of their high relevance, we still have limited understanding of the complex underlying microbial processes that consume or produce N_2O and their interactions with soil types, fertilizers (rate and types), plants, and other environmental variables. Therefore, present study aims to contribute to the understanding of the complex relationships between factors influencing especially N_2O emission in different bioenergy crop production systems.

In a 2-year field experiment, we compared two important biogas crops in two different agro-ecological regions of northern Germany for their productivity and GHG emissions, using the closed chamber technique with high time-resolution sampling. Additionally, we conducted number of laboratory incubation experiments, with the objective to test the impact of the application of various N containing organic substrates (e.g. cattle and pig slurry) including biogas residue on the denitrification rate, N_2O emission, and the $N_2O/(N_2O + N_2)$ product ratio of soil. In the incubation experiments, stable isotope labeling study clearly showed that denitrification was the major source (over 90% of emitted N_2O) of large N_2O peaks that occurred immediately after fertilizer application. Application of organic fertilizers with large amounts of labile C induced drastic increases in the soil denitrification rate, however biogas residue was more recalcitrant to decomposition than other organic fertilizers tested, despite a high concentration of soluble organic C. Overall field experiments, N_2O emissions were 20–30% higher in soils planted with energy crop maize than with grass. However, energy yield (methane production per unit acreage) was almost threefold higher with maize crop than with grass. We summarize present knowledge on GHG emissions which is relevant for development and implementation of mitigation measures focusing on high input bioenergy crop production systems.

Climate change induced carbon competition: bioenergy versus soil organic matter reproduction - an indicator based assessment

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For the region of Central Germany global change scenarios predict a growing risk of declining amounts of soil organic matter (SOM). The production of bioenergy is one strategy to counteract the growing anthropogenic CO2-emissions. Both issues have a close connection: SOM is one important base of soil productivity and requires a steady reproduction flux. Bioenergy production requires productive soils and partly consumes plant biomass carbon thus reducing the available amount for SOM reproduction. We will present a methodology for the large-scale identification of areas with possible conflicts between bioenergy production and SOM reproduction based on i) the prediction of climate change impact on SOM reproduction and ii) an analysis of the regional distribution of biogas plants. With the carbon demand index (CDI) and the capacity index (CAP) two indicators have been developed that enable the identification of hot spots of high carbon demand for SOM reproduction due to climate change and the usage of bioenergy. Due to the low data requirements, the indicators are widely applicable and transferable. The proposed algorithm is applied for the region of Central Germany as a pilot region.

The quantification of climate change impact was based on regionalized climate data from the IPCC scenarios A1B, A2 and B1 as prognosis for 2001 – 2100 in relation to the retrospective C20 data for 1961-2000 calculations. For downscaling we used the regional climate models REMO and WETTREG, the latter with 3 different subsets for wet, normal and moist conditions. For all resulting datasets the annual sum of rainfall and the average of air temperature were calculated.

Soil impact is represented by means of the top soil texture that has been taken from the German soil map (BUEK1000; scale 1:1,000,000). The map shows 71 different soil mapping units in the study area. Each soil unit has been assigned a characteristic soil

profile ("Leitprofil") where soil texture was derived by using the guidelines for soil mapping (KA4).

Results indicate a growing demand (10%-40%) of fresh organic carbon from biomass for SOM production on the current level. The analysis reveals that bioenergy carbon demand is not evenly distributed over the study region and is showing some regional clustering. There is no significant correlation between matter demand for bioenergy and carbon amount required for SOM reproduction. However, the analysis identifies certain hot spots of high carbon demand where high capacity of biogas production may conflict with rising demand for biomass to mitigate climate change effects on SOM storage.

Contribution of biogas residues to soil carbon and CO2 emissions when applied to arable soil

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Biogas residues (BGRs) are by-products of biogas production process and consist of mainly microbial biomass (residues) in addition to non-fermented feedstock leftovers. High nutrient content gives BGRs the potential to replace other organic fertilizers. However, the knowledge on the impacts of BGRs on soil carbon balance and greenhouse gas emissions is limited. We produced stable isotope labeled BGRs with a novel technique using highly enriched $KH^{13}CO_3$ together with substrate in the biogas reactors in order to label the anaerobic microorganisms taking part in the process. The labeled BGRs were then applied to arable soil and incubated for 378-days. Concentrations and isotopic compositions of CO_2, bulk Carbon, as well as phospholipid and total fatty acids were determined. Overall results showed that CO_2 production was stimulated with BGRs addition in the beginning of experiment but this effect lasted for a short-term. An important portion of the BGR-derived carbon was stable in soil until the end of experiment. The C flow in living biomass during the incubation was from the G^+ bacteria into G^- bacteria, fungi and other G^+ bacteria. In addition to that, we studied other additives (biochar, compost and farmyard manure) in order to improve the stability of BGRs with further tests. It is shown that BGR-labeling method can be used in studying BGR-soil carbon interactions even though there are some disadvantages. This research gives a clear result about the impact of the BGRs on the soil organic matter and contributes to recommendations about the use of BGRs as fertilizers in agriculture.

Session 4 "Biomass to biofuels - policy, markets, effects"
(24 November 2014, 04:00 - 06:30 pm, room 1D)

The transregional effects of the European policy on biofuels were discussed controversially in the last years. Different scientific approaches were tried to answer the questions: (1) if the EU biofuel policy was a major driver for e.g. land use change, deforestation, displacement of land user groups, land grabbing and food shortages in the producing countries and (2) how these transregional effects can be tracked and captured. In the session "Biomass to biofuels - policy, markets, effects", computational modeling as well as political science approaches and results will be discussed to evaluate possibilities of their mutual completion to enable a better analysis of transregional effects.

Key topics:

- Socio-ecologic/ land-use effects of biofuel promotion in different countries
- Role of international trade and the European Biofuel Policy within these effects
- Methodological perspectives (e.g. model-based, empirical analysis, political science) and connected scope of studies and results

Session chair: Linda Bausch (Helmholtz-Centre for Environmental Research, Leipzig, Germany)

Presentations:

- 04:10 - 04:35 pm: Christiana Plank (University of Vienna, Vienna, Austria): *The Agrofuels Project in Ukraine*
- 04:35 - 05:00 pm: Anna Mohr (University of Bremen, Bremen, Germany): *The control of socio-ecological criteria through private governance mechanisms*
- ***Short break***
- 05:10 - 05:35 pm: Judith A. Verstegen (Utrecht University, Utrecht, The Netherlands): *Stochastic projection of the effects of an increased biofuel demand on direct and indirect land use change in Brazil*
- 05:35 - 06:00 pm: Christian Klassert (Helmholtz-Centre for Environmental Research, Leipzig, Germany): *Transregional Land-Use Effects of Biofuel Policies – Agent-Based Economic Analyses with the ILUC-MAP Model*
- ***Discussion***

The Agrofuels Project in Ukraine

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Agrofuels are considered to contribute to energy security, local development and to mitigate climate change, in other words to solve the multiple crisis. As a consequence, their production and consumption have evoked controversial discussions, which question the sustainable character of agrofuels. Worldwide, the agrofuels project is part of the agroindustry. In Ukraine, it gains of importance since the mid-2000s. According to McMichael the agrofuels project can be described as a state-capital nexus. In order to understand this tie as well as the project's possible unfolding I examine social forces in Ukraine. By drawing on a neo-Poulantzian understanding of the state I address state-economy relations on different scales taking society-nature relations into account.

Thus, I show that the oligarchs understood as an increasingly financialised inner bourgeoisie play a crucial role in shaping the agricultural and energy economic sector and policies since the 1990ies. They get increasingly engaged in agribusiness and therefore also foster the hidden privatisation of farmland as well as amongst other things the production of agrofuels feedstock (rapeseed and maize) for export. On the other hand, their attempts to enhance the production of agrofuels in Ukraine failed so far due to the fossil energy-driven conflicts among the oligarchs. Although several laws and programmes got adopted, there is no important production of agrofuels taking place in the country at the moment. Instead, other forms of "renewable energies", especially solar and wind, find more support in form of centralised large-scale projects though they represent at the same time a marginal part of the country's energy mix. The paper concludes that the field of renewable energy is highly contested in Ukraine and difficult to develop on a community level. Simultaneously, by supporting the export of cash crops Ukraine's role as a resource exporting country is fostered.

The control of socio-ecological criteria through private governance mechanisms

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The continuous growing global economy bears a consistent pressure on the availability of natural resources. As an answer to sustainability requirements for biomass, various initiatives for global sustainability standards and certification schemes have emerged as new private governance mechanisms. The question is, what are the potentials and limits of those private control mechanisms for a sustainable biofuel production. The impacts of private governance for this study were assessed through case studies of biomass production sites in Brazil, already certified or in the process of certification. The main research focus was laid on the implementation of social and ecological criteria at farm level. During the field visits on the production sites, farm managers were asked about their experience with the implementation process of socio-ecological criteria, the main gains and obstacles and their motivation for certification.

Private governance in form of certification is limited to the criteria addressed in the standards. Therefore the findings from the case studies were assessed against statements of sustainability requirements for biomass production of Brazilian stakeholders such as representatives from ministries and state agencies, certification agencies, farmers, standard organizations, processing companies, farmer organizations, agricultural research organizations and representatives from civil society organizations. Positive influences of certification were found for direct impacts, such as the compliance with national laws, the use and handling of agrochemicals or labour conditions. Indirect impacts of a rising biomass production such as indirect land use change or land price hikes cannot be effectively governed by private control mechanisms which are focusing private biomass production sites and the subsequent supply chain. Additional instruments on national and international level are required to deliver sustainably produced biomass for a rising global demand. Private governance has the potential to enforce the implementation of national environmental and social policies and enhance the discourse and public debate about sustainable production and consumption, but it lacks in assuring a sound sustainability performance of biomass producers.

Stochastic projection of the effects of an increased biofuel demand on direct and indirect land use change in Brazil

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Governments throughout the world have set mandatory biofuel targets for the transport sector. However, large scale biofuel production can have negative environmental and socio-economic impacts. Many of these impacts occur because allocation of the biofuel feedstock causes land use to change from some previous use to the feedstock, direct land use change (dLUC). But it can also cause change of land use outside the biofuel feedstock cultivation area, indirect land use change (iLUC), resulting from expansion of this previous use in order to compensate for the supply shortfall due to its displacement. The magnitude of the impacts of both dLUC and iLUC are steered by the location and spatial pattern of the feedstock and the other land uses. Our aim is to assess the locations and spatial pattern of sugar cane expansion in Brazil as a result of an increased demand for biofuels due to the mandates for a period up to 2030, using a scenario approach to explore different potential developments in policies and markets.

For this assessment we use a coupled model approach. The Modular Applied GeNeral Equilibrium Toolbox (MAGNET), a global Computable General Equilibrium (CGE) model, is linked to the PCRaster Land Use Change model (PLUC), a spatially explicit land use change cellular automaton. MAGNET, simulating the global policy and market related processes, is used project production quantities and cultivation areas of all agricultural commodities, including sugar cane, in the 37 regions MAGNET is divided into. One of these regions is Brazil. The location and spatial pattern of the land use areas within Brazil over time depends on spatial factors such as proximity to hubs, potential yield through biophysical factors like soil type and slope, and neighbourhood effects. We simulate these using PLUC, which spatially allocates the areas of all land uses projected by MAGNET at a 5 km resolution grid.

Acknowledging that scenario assumptions, models, input data, and calibration data contain uncertainties, we apply a stochastic modelling approach to quantify the propagation of these uncertainties through the two models to the output. As a result, an ensemble of time series of land use maps is obtained from which the probability on dLUC and iLUC per grid cell can be derived. In our future analyses, the spatially explicit land use change results will be used to assess impacts on water, carbon stocks, biodiversity and socio-economics, to provide a complete overview of the sustainability sugar cane ethanol.

Transregional Land-Use Effects of Biofuel Policies – Agent-Based Economic Analyses with the ILUC-MAP Model

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Biofuel promotion policies, such as the EU Renewable Energy Directive (RED) and the US Renewable Fuels Standard 2, aim at encouraging the diffusion of biofuels as a low-carbon alternative to fossil energy sources. These policies can, however, also cause adverse (indirect) land-use change (LUC) impacts in countries around the world. This can pose a great threat to natural ecosystems and might even offset the positive climate effects of biofuels. The pursuit of biofuel policy objectives will, therefore, often require combining promotion policies with suitable land-use governance instruments, such as the RED's sustainability certification regime.

The partial equilibrium (PE), computable general equilibrium (CGE), and integrated assessment models currently used to inform biofuel policy-making were, however, mainly developed for the analysis of fungible environmental externalities, such as greenhouse gas emissions. While these models are very efficient at capturing the trade effects of biofuel policies, they have shortcomings in simulating the non-fungible spatial and dynamic aspects of LUC. This is especially relevant for assessing the effectiveness and efficiency of governance instruments in mitigating adverse land-use effects of biofuel promotion. To overcome these shortcomings, Rounsevell et al. (2014) have recently advocated the coupling of neoclassical trade models with agent-based models (ABMs).

Adopting Rounsevell et al.'s recommendation, we have developed a conceptual model named ***M**ulti-**A**gent **P**latform for the Analysis of **I**nternational Trade and **L**and-**U**se **C**hange* (ILUC-MAP). The ILUC-MAP model starts with assumptions closely based on a standard analytical PE model of the neoclassical trade and environment literature. ILUC-MAP then allows for a gradual relaxation of these assumptions to incorporate a more detailed representation of the out-of-equilibrium dynamics and spatial interactions that characterize real-world land-use systems. The model is tested by replicating analytical findings of the trade and environment literature. Subsequently, we analyze and compare

the welfare and land-use consequences of combining biofuel promotion with various governance instruments.

Our policy analyses aim at testing the robustness of the predictions and implications of current biofuel policy models to deviations from their simplifying assumptions about the land-use system. With our systematic analysis of the gradual introduction of ABM elements into an analytical PE framework, we also hope to contribute to theory development for the integration of ABMs into empirical CGE and PE models.

Rounsevell, M.D.A. Arneth, A., Brown, D.G., de Noblet-Ducoudré, N., Ellis, E., Finnigan, J., Galvin, K., Grigg, N., Harman, I., Lennox, J., Magliocca, N., Parker, D., O'Neill, B., Verburg, P.H. and Young, O. (2014). Towards decision-based global land use models for improved understanding of the Earth system. *Earth System Dynamics (5): 117–137.*

Session 5 "Effects of energy crop cultivation on land-use, biodiversity & ecosystem services (landscape modelling and empirical studies)"
(25 November 2014, 09:30 - 12:00 am, room 1C)

Concerning the environmental impacts of land use for bioenergy purposes most studies focus on local or large scales. Our session fills the research gap by analyzing impacts of energy crop cultivation on biodiversity, land use change, and ecosystem services on regional and landscape scales. Within the session we explore on the one hand impacts on biodiversity, e.g. how the spatial distribution of energy crop cultivation may affect bird species. On the other hand we will investigate optimization potentials of energy crop production regarding ecosystem services including the quantification and valuation of trade-offs.

Key questions:

- Impacts of 1st and 2nd generation energy crop cultivation on biodiversity
- What are possible combined impacts of landscape structure and energy crop cultivation on biodiversity?
- Are there optimal landscape configurations for an environmentally friendly energy crop cultivation?
- What are possibilities to quantify and value trade-offs between bioenergy production & other ecosystem services?

Session chair: Sandro Pütz (Helmholtz-Centre for Environmental Research, Leipzig, Germany)

Presentations:

- 09:40 - 10:05 am: Felix Witing (Helmholtz-Centre for Environmental Research, Leipzig, Germany): *Definition and regionalization of agricultural crop production systems on large scales - an integrated approach for environmental modeling and assessment*
- 10:05 - 10:30 am: Christian Dietrich (Helmholtz-Centre for Environmental Research, Leipzig, Germany): *Effects of the biomass boom on the crop pest ECB - About the role of landscape structure and the handling of pest infestation*
- ***Short break***
- 10:40 - 11:05 am: Sven Lautenbach (University Bonn, Bonn, Germany): *Water related trade-offs of different crop production schemes for biogas production in a German case study*
- 11:05 - 11:30 am: Jeroen Everaars et al. (Helmholtz-Centre for Environmental Research, Leipzig, Germany): *Species ecology and the impacts of bioenergy crops: an assessment approach with four example farmland bird species*
- 11:30 - 11:55 am: Jens Dauber et al. (Thünen-Institute for Biodiversity, Braunschweig, Germany): *The importance of novel energy crops and cropping systems for farmland biodiversity*
- ***Discussion***

Definition and regionalization of crop production systems on large scales - an integrated approach for environmental modeling and assessment

Felix Witing[1], Jörg A. Priess[2], Michael Strauch[2], Sandra Wochele[1], Martin Volk[2]

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Global socio-economic and climate change lead to an increasing number of studies that analyze and evaluate the large-scale impact of land use and land management on natural resources and ecosystem services. Such studies typically struggle with the heterogeneity of agricultural crop production systems at larger spatial scales and the resulting need for generalization. But at the same time there is also a need for differentiation of these various systems that allows the necessary separation of their individual environmental impacts. In consequence, a balance between both needs has to be found, especially under conditions of limited data availability.

To address these issues, we introduce an integrated approach which differentiates agricultural crop production systems on large scales, using commonly available data. Within a modular design, we define and regionalize crop production and crop rotations, farm types and tillage systems on the example of Central Germany, comprising three federal states. Regarding fertilizer systems, the management of individual crops includes options for conventional (mineral fertilizer, manure) as well as new types of fertilizer (biogas digestate). The definition and regionalization of quantities (e.g. crop yields, amount of fertilizer applied) is based on regional statistics and calculations of area-based balances. Suitable crop rotations are selected from a pool of crop rotations currently applied within the region. The design of the selection method ensures a minimum amount of crop rotations while simultaneously matching agricultural statistics (in terms of spatial and temporal distribution). Crop management information is stored in a database and can be combined with crop rotation data according to the demand of the individual project. An exemplary set-up of the methodology will be presented for the region of Central Germany.

The modular design ensures flexibility - the level of detail and the regional differentiation can be adjusted according to individual demands and data availability of the individual projects. The approach can be used for different forms of environmental modeling and assessment which require a differentiation of agricultural crop production systems on large scales, like (eco)hydrological (e.g. water quality & availability, soil erosion) and crop growth modeling (e.g. bioenergy, yield gaps) or environmental assessments (e.g. LCA).

Effects of the biomass boom on the crop pest ECB - About the role of landscape structure and the handling of pest infestation -

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The increasing use of corn as a bioenergy crop has led to strong increase of corn production in Germany. This increase in production has led to a homogenization of the agricultural landscape. Our hypothesis is that this homogenization of the landscape led to improved dispersal conditions for pest species and in turn to an increasing pest pressure.

We study this effect at the example of *Ostrinia nubilalis* (European Corn Borer, ECB) which has become a significant pest in Germany over the last years. Crop losses can be significant, in case of infestation 250-1000 kg/ha crop failure can be expected.

In our studies, we investigate the spatio-temporal dispersal of the ECB on a regional scale (Saxony) in the period 1996-2011 using zero-inflated generalized linear models and spatio-temporal statistics. We examined the question whether the homogenization of the agricultural landscape with respect to corn had a significant impact on the spread dynamics of the ECB in Saxony.

Our results show that besides climate effects and other surrounding conditions the increasing demand of corn is a driver of pest occurrence and thus a potential adjusting lever for pest control.

There is a bunch of possible measures to reduce ECB infestation like the use of pesticides, natural and artificial biological pest control, mechanical treatments and the use of Bt-maize. With our analysis we drive at exploring the potential of spatio-temporal agricultural landscape configurations to avoid crop losses by pests in an environmentally sound way.

Water related trade-offs of different crop production schemes for biogas production in a German case study

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While increasing biofuel production is worldwide on the political agenda, concerns about the involved trade-offs are on the rise. However, the quantification of these trade-offs is typically based on the comparison of a limited number of plausible alternatives. We extended the analysis by applying a multi-objective genetic algorithm to estimate the set of Pareto optimal solutions which describe the trade-offs between the objectives. The Pareto solutions represent the (estimated) best options given the model and the specified control options. Our analysis studied food and fodder based crop rotations and two alternative biogas crop production schemes: a corn based production scheme and a two-culture production scheme which combines a summer and a winter crop. The integrated river basin model SWAT (Soil Water Assessment Tool) was used to evaluate the effects of the different crop production schemes on bioenergy crop production, food and fodder crop production, water quality and low flow discharge. The analysis took place in a medium sized agricultural watershed (~320km^2) in Central Germany. We run the optimization algorithm for combinations of the three sets of crop rotations to identify the trade-offs. The two biogas crop rotation schemes showed significant differences in their trade-offs with water quality and low flow conditions. High corn yields led to increasing nitrate concentrations while high bioenergy crop yields based on the two culture system led to decreases in low flow. But trade-offs depended on the choice of food and fodder crops as well. To assess the robustness of the solutions, we compared trade-offs under current climate conditions with trade-offs under two climate scenarios (A1B and B1 scenarios statistically downscaled by WEREX-IV approach for the time period 2014-2100). The estimated trade-offs differed significantly under the different climate conditions, highlighting thereby that trade-off analysis has to consider changing boundary conditions.

Species ecology and the impacts of bioenergy crops: an assessment approach with four example farmland bird species

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The cultivation of energy crops can cause land-use conflicts, including loss of biodiversity in farmlands.

In our study, we focus on farmland birds and analyse whether the impacts of such bioenergy activities differ for bird species with different ecology. We do this by comparing the impacts on four example species; skylark (Alauda arvensis), yellow wagtail (Motacilla flava), corn bunting (Miliaria calandra) and northern lapwing (Vanellus vanellus).

We used a spatially explicit ecological model, which combines three simplified crop selection criteria (suitability for nesting, suitability for foraging, spatial heterogeneity) that differ between the selected species. We used the model to investigate change in breeding pair density between a baseline and several bioenergy scenarios that differ in intensity and spatial agglomeration. We subsequently simulated scenarios with potential positive habitat effects (maintenance of 10% set-aside or 10% alfalfa) as well as spatial effects (increased crop diversity and reduction of field size) as mitigation strategies to increase the breeding pair density.

The importance of novel energy crops and cropping systems for farmland biodiversity

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There are no generalities about the impact of energy crop cultivation on biodiversity in agriculture, neither on the field nor on the regional scale. Detrimental impacts of bioenergy development on biodiversity are expected or reported when extensive commercial production of bioenergy feedstock is resulting in land-use change, particularly with regard to conversion of natural habitats, high nature value farmland or other priority habitats of nature conservation to energy crops. Concurrently, there are expectations that energy crops could sustain or even boost biodiversity in agriculture, if those crops would lead to an improvement of habitat heterogeneity or result in reduced agrochemical inputs.

We will present findings from our research on the importance of alternative energy crops, the cup plant Silphium perfoliatum L. in particular, as well as of innovative cropping systems such as alley-cropping of short rotation coppice trees, for biodiversity and ecosystem services in agricultural landscapes. We will also highlight the importance of coordinated land use or strategic land-use planning for developing energy crops in agriculture if biodiversity and ecosystem services should be enhanced by novel crops and cropping systems.

Session 6 "What's your perspective? - Regional & spatial LCA's for biomass resources"
(25 November 2014, 09:30 - 12:00 am, room 1D)

Unlike its fossil counterpart, biomass is scattered in a diffuse manner within and across a region and across many regions. Therefore, to identify the potential environmental burdens associated with regional bioenergy production, a life cycle "tool box" approach can be used to assess the sustainability of such regional biobased or bioenergy chains. Therefore, we will present and discuss the approaches taken for assessing regional bioenergy using life cycle thinking and approaches. We also aim to discuss how regionalized life cycle approaches can be used to assess the transition of bioenergy chains towards those of a bioeconomy network.

Key questions:

- Regional biomass production and conversion (bioenergy/biorefinery/others): How do we account for environmental impacts using LCA approaches?
- Regional/spatial approaches in LCA in general: dealing with data quality/resolutions and limitations
- How can we go forward with regionalized/territorial approaches and Life cycle thinking, with biorefinery concepts - Bioeconomy, what are the best alternative options in a finite area, but are we limited just to that?

Session chair: Sinead O' Keeffe (Helmholtz-Centre for Environmental Research, Leipzig, Germany)

Presentations:

- 09:40 - 10:05 am: Steffen Schock (Helmholtz-Centre for Environmental Research, Leipzig, Germany): *LCA of biogas production in Central Germany*
- 10:05 - 10:30 am: Stefan Majer (Deutsches Biomasseforschungszentrum, Leipzig, Germany): *Regional aspects in LCA for Bioenergy Systems*
- ***Short break***
- 10:40 - 11:05 am: Floor van der Hilst (Utrecht University, Utrecht, The Netherlands): *Regional integrated assessment of environmental and socio-economic impacts of biofuel production demonstrated for Mozambique.*
- 11:05 -11:30: Stephan Pfister (ETH Zurich, Switzerland): *Life cycle assessment (LCA) of bioenergy and relevance of regionalisation*
- ***Discussion***

Life Cycle Assessment of biogas production in central Germany – a regionalized approach

Steffen Schock[1], Alberto Bezama[1], Daniela Thrän[1]

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The contribution of Biogas production to a climate-friendly and sustainable energy supply plays an integral role in the German "Energiewende". A major argument for the promotion of biogas was the climate change mitigation potential. Heavily subsidized, the installation of biogas plants developed rapidly during the last decade and experienced a massive increase. To the end of 2013, there are more than 750 Biogas plants installed with a total capacity of approximately 370 MWel in the states of Central Germany (Saxony Thuringia, Saxony – Anhalt).

Recently, skepticisms were growing in the public due to increased production of energy crops. The farmers are expected to act prudently also in relation to landscape conservation and economics. Therefore, development options for more diverse agricultural production systems need to be analyzed. A large variety of studies was produced assessing the environmental effects, especially energy efficiency and greenhouse gas (GHG) emissions using Life Cycle Assessment (LCA) based approaches. Most of them are applied on national level using average or case specific input data. This approach leads to inaccurate results when drawing conclusions for environmental effects on a regional level, capturing spatial heterogeneities and effects on the regional systemic level of substrate and biogas production which is required e.g. for the calculation of GHG mitigation potentials in greater detail and the evaluation of potential regulative approaches.

Bringing together regional infrastructure, spatial variation of natural conditions, agricultural management systems and regional characteristics of biogas production, an improved, regional applicable LCA modelling approach is developed. For each region, specific agricultural management regimes are developed. Crop cultivation, biogas production and use are estimated on a regional level using agroclimatic conditions as delimitation for production regions. The regionalization of the agricultural data inventory is based on work developed in the project group by Witing et al. As a first result, substantial differences in the GHG mitigation potential were found between different biogas production pathways for the region central Germany. However, it is quite evident that the overall averaged impact strongly depends on the level of regionalization and data aggregation.

Regional aspects in LCA for Bioenergy Systems

Stefan Majer[1], Sinéad O' Keeffe[2]

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Compared to other renewable energy sources Bioenergy offers a number of advantages such as simple storage, supply of control and base-load energy. Furthermore, Bioenergy is a key element of German and wider European climate protection policy approaches. This is highlighted, for instance, by the ambitious development goals for various energy sectors (such as power generation, transport, etc.) at national and European level. Further expansion of bioenergy use however, also entails major ecological and socio-economic risks. Key aspects which may in fact run counter to bioenergy policy goals include indirect and direct effects of changes in land use, intensive industrial farming, and poor working and production conditions in third-party countries. In order to assess these environmental and socio-economic effects, existing methodologies like the life cycle assessment need to be adapted to the specific (regional) characteristics of biomass value chains. This process includes a number of aspects related to i) the quality and regional resolution of the input data for the modelling of the life cycle inventory, ii) the definition of regional specific reference systems to represent and model the complex relations of product and by-product substitutions and iii) to enhance existing approaches for environmental impact assessment.

Based on an exemplary biomass-to-bioenergy pathway a number of regional aspects for the environmental impact assessment of bioenergy systems by means of the LCA methodology will be introduced and discussed.

Regional integrated assessment of environmental and socio-economic impacts of biofuel production demonstrated for Mozambique

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Dedicated bioenergy crops are expected to become the main contributors to future bioenergy supplies. Large scale deployment of biomass for bioenergy could contribute to GHG emission reduction, energy security, rural development and restoration of degraded lands. However, an increased implementation of dedicated bioenergy crop production could also have significant adverse socio-economic and environmental impacts such as deforestation, loss of carbon sinks, biodiversity and other ecosystem functions and services, increased competition for land and higher food prices. Many of these impacts are related to land use change (LUC). Therefore, expansion of bioenergy in the absence of monitoring and good governance of land use carries the risk of significant adverse environmental and socio-economic impacts.

The type and magnitude of the environmental and socio-economic impacts depend on the design of the biomass supply chain (type of feedstock, plantation management, logistics, conversion plants, and distribution) but also on the biophysical and socio-economic context of the region of implementation. As these characteristics are spatially heterogeneous, the sustainability of biomass supply chains should be assessed at a local or regional level.

A methodological framework has been developed to perform an ex-ante regional assessment of potential environmental (e.g. GHG emissions and impact on soil, water and biodiversity) and socio-economic impacts (e.g. economic viability, rural development, employment) of large scale biofuel production. For all impacts it was aimed for finding an appropriate quantitative method to analyse the potential impacts taking into account the availability of methods and data. The methodological framework is demonstrated for two potential bioenergy supply chains (ethanol production form switchgrass and eucalyptus) in two regions in Mozambique (Gaza-Inhambane and Nampula) under different scenarios (low and high agricultural productivity). The results show large variations in impacts for the different supply chains, the regions, and the scenarios and they show that there are tradeoffs between the impacts.

An ex-ante regional sustainability assessment could help to identify ‘go’ and ‘no-go’ areas for bioenergy production and to select suitable bioenergy crops and management regimes. This could contribute to sound land use planning, informed decision making concerning project investments, and to develop strategies to avoid negative impacts and optimise positive environmental and socio-economic impacts.

Life cycle assessment (LCA) of bioenergy and relevance of regionalisation

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Bioenergy has gained importance in energy supply during the last decade. Along this trend, LCA studies examined their performance and compared them to fossil fuels. The conclusion regarding first generation biofuels is quite discouraging, since even in terms of climate change (carbon footprint) the might not be favorable, while they add additional impacts on ecosystems. Second-generation biofuels are expected to bring improvements of energy conversion efficiencies and waste has been identified as a good resource by LCA. However, a major portion of the environmental impacts are related to the cultivation phase and for "waste" often alternative uses exist that might also lead to increased cultivation e.g. of animal feed.

The proper LCA of bioenergy therefore required advanced developments of regionalized characterization models for impact assessment of water and land use, which are besides fertilizer and climatic conditions crucial for bioenergy production. The high spatial dependence of water use and availability opened a new research field and led to water footprint assessments. Biomass production on "marginal lands" often requires irrigation and therefore reduced the potential in terms of environmental benefits. Avoiding irrigation and expanding biomass cultivation e.g. in tropical areas, where impacts on land use and related biodiversity loss are even more harmful, is at a trade-off with impacts on aquatic ecosystems and water scarcity.

While most effects in LCA are assumed to be linear and not to change in near future, impacts of one unit land or water use typically aggravate in future due to increased stress by increased activity of biomass production for food, fiber and fuels. Resilience of ecosystems decreases. Therefore, prospective analyses need to account for increased specific impacts in future. One insight is to avoid too high intensification in favor of more distributed production in less vulnerable regions.

Regionalized assessment of bioenergy conversion is still limited and mainly addressed by individual case studies. For assessing regional sustainability of bioenergy production socio-economic aspects might be considered as these are often beneficial even if environmentally it might not be the case. The overall efficiency of the system needs to account for all co-products and their use, which again is highly depending on the socio-economic environment. These aspects can help to better allocated impacts to final products of the biomass industry and therefore help better analyzing the system. However, total sustainability assessment must include more detailed analyses of socio-economic aspects and utilize LCA result to account for environmental consequences.

Podium Discussion:

"Bioenergy 2.0 - recommendations from different perspectives"
(25 November 2014, 02:00 - 03:00 pm, room 1C/D)

Moderation:

Daniela Thrän (Helmholtz-Centre for Environmental Research, Germany)

Key issues:

- German bioenergy boom, as seen from the German and international perspective
- A case study for bioenergy implementation - what lessons have been learnt?
- Does hindsight provide sufficient foresight to go forward, but where next - Bioeconomy?

The following speakers will be part of the Podium Discussion:

- Leonardo Nibbi (Centro di Ricerca Energie Rinnovabili, Italy)
- Miriam Natabo (Ministry of Energy and Mineral Development, Uganda)
- Floor van der Hilst (Utrecht University, The Netherlands)
- Jens Dauber (Thünen Institute of Biodiversity, Germany)
- Stefan Majer (Deutsches Biomasseforschungszentrum, Germany)
- Alberto Bezama (Helmholtz-Centre for Environmental Research, Germany)