GLOBAL CHALLENGES:
ACHIEVING SUSTAINABILITY

Global Challenges: Achieving Sustainability
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ABSTRACTS

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Opening session

The opening session emphasised why research is an essential partner to politicians and private enterprise in shaping the societal response to global sustainability challenges. The need for interdisciplinary research – especially in the educational system, understanding behavioural responses in the public, integrating economics and rethinking how we understand growth was stressed.

Talks by:

- Professor Katherine Richardson, Professor and Chair of the Scientific Steering Committee
- Ralf Hemmingsen, Rector of the University of Copenhagen
- Helle Thorning-Schmidt, Prime Minister of Denmark
- Connie Hedegaard, EU Climate Commissioner
- Cheikh Mbow, Member of the Future Earth Science Committee

Moderated by Lykke Friis, Prorector for Education, University of Copenhagen

Closing session

The closing panel debate focused on the next steps for mobilising a more system based approach in science, competitive sustainable investments and public-private partnership. The session looked ahead towards the Sustainable Development Goals and discussed the tension between consumption, growth and emissions.

Talk by Rasmus Helveg Petersen, Danish minister for Climate, Energy and Building

Panel with:

- Guido Schmidt-Traub, Executive Director of the UN Sustainable Development Solutions Network
- Lindiwe Majele Sibanda, Chief Executive Officer and Head of Mission of Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN)
- Xuemei Bai, Professor of Urban Environment and Human Ecology, Fenner School of Environment and Society, Australian National University
- Torben Möger Pedersen, CEO of PensionDanmark
- Sue-Lin Wong, Student at Australian National University

Moderated by Katherine Richardson, Professor and Chair of the Scientific Steering Committee

World Development on a Stable Planet: The scientific quest for a safe operating space within planetary boundaries. *By Johan Rockström*

Presenter: Johan Rockström, Stockholm Resilience Centre

The great acceleration of human pressures on Earth, the rising evidence of risks of Earth system tipping points, and the recognition of the extraordinary importance for the development of modern human civilizations of the last 10000 years of planetary stability during the Holocene epoch, has triggered science to raise the question of how far environmental processes, which regulate the resilience and stability of the planet, can be pushed before risks arise of tipping critical sub-systems or the entire Earth system outside Holocene-like conditions. The planetary boundary framework attempts to identify these processes and based on our current scientific understanding, identify boundary levels for each process, placed at the lower end of the range of scientific uncertainty. Transgressing a planetary boundary does thus not mean that a threshold is crossed, but it indicates that the world enters a danger zone where abrupt changes can no longer be excluded. The planetary boundary analysis enables the definition of a safe operating space for human development, with regards to environmental processes that regulate Earth resilience within a Holocene-like planetary state. Since the planetary boundaries research was published in 2009, scientific advancements have been significant, as has the interest and response within policy and business. This presentation provides a scientific update of the planetary boundaries research and reflections on its significance for global sustainable development.

Carbon abatement, environment regulations and economic sustainable development in China. *By Shiyi Chen*

Presenter: Shiyi Chen, China Center for Economic Studies, Fudan University

Environmental pollution emissions have become an extremely serious problem in China that makes its 30-years rapid economic growth unsustainable now. Thus, it is very critical to precisely evaluate China's actual situations of sustainable development in different regions under the restrictions of environmental pollutions and carbon dioxide emissions. To the end, we estimate the energy and emission- adjusted total factor productivity (TFP) and reveals the sustainable economic transition by provinces in China in the light of their contributions to output. The results indicate that China's sustainable development fluctuated before 1992, then turned to improve, and peaked between 1999 and 2002. Due to the reappearance of heavy industrialization and rapid land urbanization, China's sustainable development process has reversed course since the beginning of this century. In terms of the evaluation results, it is very important for China nowadays to implement market mechanism based environmental policies, including the levy of appropriate carbon taxation, to re-start its sustainable development process in the near future.

Business as the leading solution provider for sustainable development. *By Peter Bakker*

Presenter: Peter Bakker, World Business Council for Sustainable Development

The world is facing a systemic crisis. It is high time the key actors (governments, business and science) start to collaborate to find the holistic solutions we need.

It is widely accepted that business can and must be one of the main drivers of transformation towards a more sustainable global society. Peter Bakker will explore how business can deliver against this responsibility, developing scalable solutions addressing critical sustainable development challenges, as well as the support that it will need to succeed.

At the foundation of any move towards more sustainable societies will be a set of priorities, based on the latest and most robust scientific evidence and understanding. WBCSD's Action2020 is a science-based agenda for business action. It forms the platform upon which WBCSD works with its 180 member companies to develop business solutions that will move us towards quantifiable societal goals, against which progress can be measured.

Companies want to take action based on an agenda informed by scientific data because it is clear to them that the 'environment' – business, social and natural – is changing, dramatically. Business-as-usual, as we know it, is dead. Leading companies understand we cannot continue to push against ecological and societal limits.

Forward-looking companies are leading efforts to change the way in which corporations measure their growth – creating a world in which the business case for more sustainable corporate behaviour is unavoidable, where more sustainable companies are recognised and rewarded, because their cost of doing business is lower, and their management of future opportunities and risks is better.

The role of science is changing and remains vital. In the last part of his speech Peter Bakker will challenge and encourage the scientists in the room to think about new ways to contribute to the solutions the world needs now.

Climate, Development and Security in the Age of Adaptation. *By Adil Najam*

Presenter: Adil Najam, the Pardee School of Global Studies, Boston University

The premise of the presentation is that we have already entered the age of climate adaptation. Adaptation is the cost that the failure to mitigate on time by the affluent of the world has imposed on the already marginalized. It is a failure of aspiration by climate negotiators but it is also a reflection of the tendency to kick the climate can down the road by all of us as citizens and consumers. We need to confront this reality, including the fact that in the age of adaptation the way we look at security, at development, and indeed at the climate change problematic itself changes substantively. In fact, the very meaning of sustainability and sustainable development in the age of adaptation needs to be re-examined. The technical question is no longer how to avoid systemic change but how to manage its impacts. The political question is one of justice and equity. The age of adaptation also changes the nature of the climate change policy enterprise from one that was specifically – sometimes solely – focused on managing carbon (and therefore energy) to one that will increasingly be about managing the impacts of carbon excess, which will all too often show up as challenges related not to carbon management, but to water management. The Age of Adaptation does not lessen the import of Mitigation – since the less we mitigate the more we will have to adapt, including to possibly non-reversible changes. However, it increases manifold the technical, financial and political challenges that we will confront in our quest for sustainability. Use a developing country perspective – rooted in particular in a South Asia and Pakistan focused experience – the presentation will look at what it means to live in the Age of Adaptation and why it increases the urgency of action at the exact same time when the nature of actions required also become much more complex than what was needed for mitigation alone.

Delivering on Science's Social Contract: Ocean biodiversity, threats and prioritized solutions. *By Jane Lubchenco*

Presenter: Jane Lubchenco, Oregon State University, USA

Science is more relevant and urgently needed than ever before and opportunities for scientists to deliver useful knowledge have never been greater. But unleashing the full power of science will require engaging with society in new and different ways. Society's social contract (Lubchenco 1998[1]) includes engaging with society and sharing knowledge widely, with humility, transparency and honesty. As environmental, social and health challenges loom, use-inspired science (cutting edge science that is immediately relevant to societal problems, Donald Stokes, 1997[2]) is tackling a rich portfolio of sustainability problems, creating both new knowledge and solutions. Interdisciplinary approaches are proving particularly productive in identifying pathways to more sustainable practices and policies. The lecture will describe new scientific advances that are transforming attitudes, behavior, management and policies that affect ocean health and therefore the future of humanity. In light of the importance of healthy oceans in providing food, medicine, jobs, recreation, cultural values and transportation, reversing the current degradation in oceans and returning them to health while continuing to benefit from their bounty is paramount. Progress has been impressive, and provides inspiration and models, but success will require a far more Herculean effort.

[1] Lubchenco, J. 1998. Entering the century of the environment: A new social contract for science. Science 279: 491-497.

[2] Stokes, Donald E. 1997. Pasteur's Quadrant: Basic Science and Technological Innovation. Brookings Institution Press.

Historical Evolution of Infrastructures and Future Perspectives. *By Nebojsa Nakicenovic*

Presenter: Nebojsa Nakicenovic, Vienna University of Technology and International Institute for Applied Systems Analysis

Building of major infrastructures dates to the dawn on human civilization at the time when the Neolithic revolution diffused around the world. Ever since, infrastructures were the backbone of the development processes. Energy played a central role along other essential needs such as mobility, food or water. Infrastructures are long-lived and can block change if they are developed without regards for future. Today, this is more important than ever before because the transformational changes toward achieving sustainable futures, which require full decarbonization of energy, may be blocked by a lock-in effect of old infrastructures and could be promoted with the emergence of new ones.

Education and Capacity Building for a Sustainable Future. *By Kazuhiko Takeuchi*

Presenter: Kazuhiko Takeuchi, Integrated Research System for Sustainability Science, the University of Tokyo

Keywords: sustainability education, transdisciplinarity, global leader, education for sustainable development (ESD), Future Earth

The significance of sustainability science lies in its focus on, and utility in, building a better relationship between human society and natural environments. Sustainability science brings a transdisciplinary approach to complex global challenges, which can develop unique solutions by taking into account both common, global perspectives and local, specific aspects.

In order to develop sustainability science and realize these benefits in the longer term, it is extremely important to promote the holistic understanding of problems — a very different approach to those of traditional academic disciplines. Through education and capacity building it is essential that we develop global leaders with this perspective, who are able to understand and address pressing challenges at different scales.

This plenary presentation explores several examples of such education and capacity building initiatives, and the future direction of sustainability education. Among these examples are Education for Sustainable Development (ESD) developed by UNESCO and the United Nations University (UNU), the Graduate Program in Sustainability Science – Global Leadership Initiative (GPSS-GLI) of The University of Tokyo, and the Future Earth initiative promoted by the International Council for Science (ICSU) and other international organizations.

Sustainable Land Use in a Changing World: Evolving Goals, Decisions and Metrics. *By Tony Simons*

Presenter: Tony Simons, World Agroforestry Centre

Land is the ultimate limited asset, whose nominal price ranges from near zero in the Sahel to US$8000 m2 in downtown Beijing. Although land has inherent boundaries its' functioning is inherently transboundary in nature across local, subnational, national and regional scales. The 44,000 Bangladeshis, who live precariously in a square km of land in Dhaka City, can only do so by importing food, energy and water from neighbouring agricultural areas in their country and from wilderness catchments in adjacent countries.

Sustainable land use is not an option but an imperative if natural and human systems are to survive, function well and co-progress. Pockets of unsustainable land use, whilst undesirable, may be tolerable within a broader scope of sustainable land use but significant expansion of these pockets threatens the sustainability of the whole. And with changing climates comes greater uncertainty of what sustainability thresholds we have to work within. Already emissions from land use amount to roughly one quarter of global emissions and land use is the dominant source of emissions in many developing countries. Mitigation in land use requires a multiple objective approach, which maximizes positive linkages with sustainable development and social inclusion, as well as with adaptation.

Given that those who govern, own, manage and depend on land are largely trying simultaneously to maximize the stability, utility and return from the land there seems inadequate dialogue or agreed approaches to try and achieve this. Even more so when we consider the case- and location specific nature of land use. We continue to exist within the Tragedy of the Commons and the Prisoner's Dilemma of individual versus collective interests. How far we can push our social contract with each other, with other groups and with different societies is uncertain but without clearer goals, more informed decisions and better metrics for sustainable land use we invite even more human conflict.

This paper explores the evidence and actionable knowledge base for better informed policy and investments decisions across different land use options. Win-win outcomes for efficiency and equity (especially gender) are possible across different scales and actors, although higher multiple

win scenarios are less apparent. This indicates greater prioritization and trade-off analyses are required. Despite the often disconnect between price, cost and value of land use we are in need of agreed metrics of sustainable land use. The resource provision and flow of commodities through product value chains offers one arena where government, private sector, civil society and individuals' motivations might be able to coalesce and better align.

Just sustainabilities: re-imagining e/quality, living within limits. *By Julian Agyeman*

Presenter: Julian Agyeman, Urban + Environmental Policy + Planning (UEP), Tufts University

In his keynote, Julian will first outline the concept of 'just sustainabilities'. He will argue that integrating social needs and welfare, offers us a more ‘just,’ rounded, and equity-focused definition of sustainability and sustainable development, while not negating the very real environmental threats we face. He will define it as ‘the need to ensure a better quality of life for all, now and into the future, in a just and equitable manner, whilst living within the limits of supporting ecosystems.’ He will then look at examples of just sustainabilities in practice in the real world focusing on ideas about 'fair shares' resource distribution globally; planning for intercultural cities; achieving wellbeing and happiness; the potential in the new sharing economy and finally the concept of 'spatial justice' and how it complements the more established concept of social justice.

Africa's Rainbow Revolution will feed Africa and the world – It can be done. *By Lindiwe M. Sibanda*

Presenter: Lindiwe Majele Sibanda, Agriculture and Natural Resources Policy Analysis Network (FANRPAN)

Africa has the potential to feed Africa and the world, and yet it remains the continent with the highest number of hungry and malnourished people. The Asian Green Revolution was led by public institutions with heavy investments on irrigated large farms supported by improved technology for seeds, pesticides and fertilizer to promote cereal production. The African revolution to feed the current population and the next generation is being championed by smallholder farmers on less than two hectares of land, producing a variety of commodities that includes cereals, fisheries, livestock and trees; mostly under rain fed conditions. The policy framework that is driving investments is informed by the Climate Smart Agriculture initiative which is being championed by Africa Union NEPAD and regional economic communities such as COMESA under the African Union Comprehensive African Agriculture Development Programme (CAADP). Already there are scalable results, and visible signs of realising Africa's potential. This session will unpack Africa's strategy, policy frameworks, investments, partnerships and the early results of Africa's rainbow revolution.

Innovations in arid land food production systems. *By Nina Fedoroff*

Presenter: Nina Fedoroff, King Abdullah University of Science and Technology and Penn State University

Co-author: Evan Pugh, Penn State University

Extraordinary gains in global agricultural productivity have been achieved over the past two centuries through science and technology, allowing the human population to grow from 1 to 7 billion. Yet the vast global expansion of agriculture has resulted in profound losses in biodiversity. Continued human population growth demands a further substantial increase in the world's agricultural productivity even as accelerating climate change expands drylands. Reducing the water demands and ecological impact of agriculture and developing crops suitable for a hotter world while increasing the overall food supply will require unparalleled developments and improvements in agricultural and food sciences and technologies.

Biodiversity – Putting biodiversity concerns into operation

A session on the status and trends of biodiversity globally, the link between ecosystem services provision and biodiversity and the position of biodiversity within the forthcoming Sustainable Development Goals.

Session 1:

Session 2:

Posters:

Biodiversity and Ecosystem Services: Evidence for a link. *By Taylor Ricketts*

Presenter: Taylor Ricketts, Gund Institute for Ecological Economics

Keywords: biodiversity, ecosystem services, policy, pollination

The relationship between biodiversity and ecosystem services is of wide interest to scientific and policy communities. In a crowded, changing world, managing ecosystems for both is a key to sustainability. In this talk I will examine the evidence for the linkages between biodiversity and ecosystem services, paying particular attention to spatial, management, and mechanistic questions. Do areas of importance for both tend to overlap? Does management for one improve the other? Do more diverse systems actually provide greater benefits to people? I will link the findings emerging from this area of research to early assessments by IPBES, other policy efforts, and the ongoing debate about a “new conservation”.

State of global ecosystem services and biodiversity: What is worth the anthropogenic transformation of biosphere? *By David Vačkář*

Presenter: David Vačkář, Global Change Research Centre, Academy of Sciences of the Czech Republic

Keywords: ecosystem services, biodiversity, footprint, indicators

Human society is transforming ecosystems to harness valuable ecosystem services. While human well-being is continually increasing, ecosystems and biodiversity are being degraded, often beyond sustainability limits. The reasons for the anthropogenic transformation of biosphere have roots in the complex nature of social-ecological systems, where different aspects of human-environment interactions (biophysical, economic, social, governance) shape the final outcomes for the state of ecosystems. The aim of the presentation is to synthesize current information on the state of global ecosystem services and biodiversity and major drivers of increasing human appropriation of ecosystem services. In this contribution, we illustrate global trends in biodiversity and pressures driving the increasing appropriation of ecosystem services. Global patterns in human appropriation of net primary production and ecological footprints are illustrated in connection to biodiversity threats and ecosystem services values. In the contribution, directs as well as indirect effects of socio-economic metabolism on ecosystems are analysed, including the hidden (embodied) footprints in international trade. Relationships between different correlates of the appropriation of ecosystems, such as population or wealth, are presented. Finally, as the prosperity of socioeconomic systems is supported by an incessant flow of ecosystem services, we illustrate economic costs and benefits of anthropogenic transformation of ecosystems. Several recent processes, such as The Economics of Ecosystems and Biodiversity (TEEB), aim to make visible the value of nature for the socioeconomic system to decrease the pressure of human society on biosphere. Based on review of different categories of ecosystem pressures, costs and benefits associated with the degradation or enhancement of ecosystem services and biodiversity are presented and discussed in the context of navigation of Earth´s system towards sustainability.

Opportunities for and constraints to adopt better agricultural practices - the producers´ perspective. *By Agnieszka Latawiec*

Presenter: Agnieszka Latawiec, International Institute for Sustainability

Co-authors: Helena Nery, International Institute for Sustainability; Bernardo Strassburg, IIS-Rio

Keywords: decision-making, deforestation, cattle ranching

Brazil has one of the biggest deforestation rates worldwide: more than 16.9 million hectares were deforested in the Amazon biome between 2000 and 2010. Deforestation results in losses of ecosystem services, and has been identified as the single major cause of species extinctions worldwide. The main driver of deforestation in Brazil is cattle ranching. Currently, 75% (approximately 172 million ha) of all agricultural land uses in Brazil are dedicated to this activity, generally in extensive, low productivity systems. Sustainable increase in cattle ranching productivity and the adoption of Good Agricultural Practices (GAP) by the farmers are considered viable solutions for deforestation reduction. However, to provide long-term benefits of any intervention aiming at increasing cattle ranching productivity coupled with reducing deforestation, socioeconomic concerns cannot be overlooked and it is paramount to understand factors underpinning farmers´ decision-making. Therefore, in this study we investigated factors behind farmers´ decision-making associated with increasing agricultural productivity and adopting GAP. To do so, we performed a series of Focus Groups and applied an anonymous questionnaire to cattle-ranching producers in the municipality of Alta Floresta, Mato Grosso state. We found that the financial aspects, lack of qualified labour and credit access were indicated as the most important difficulties associated with the adoption of GAP. The main obstacles for credit access were due to long delays of the process, bureaucracy, and because of lack of relevant information available to producers. Our results show that in order to develop better policies and effective interventions, it is necessary to consider the difficulties the farmers face when transitioning to better land management. In the context of sustainability, this study confirms that social component cannot be overlooked if any interventions aiming at decreasing deforestation with simultaneous increase in agricultural productivity and human well-being is to be successful.

Creating space for large-scale restoration in tropical agricultural landscapes. *By Bernardo Strassburg*

Presenter: Bernardo Strassburg, International Institute for Sustainability

Co-author: Agnieszka Latawiec, International Institute for Sustainability

Keywords: competition for land, restoration

Habitat restoration has been promoted to convert cleared areas of land, often in areas previously under some form of agriculture, to native vegetation. However, poorly planned restoration projects at large spatial scales may displace agricultural activities, inducing deforestation elsewhere, and may risk potentially negative consequences for original landowners. Despite such concerns, few studies have considered how restoration forestry may compete with other land-uses under conditions of land-scarcity. Here we present a case study of the Brazilian Atlantic Forest and ask whether large-scale restoration is likely to drive increased competition for agricultural land, and if so, how displacement of agricultural activities that may drive deforestation elsewhere can be avoided. We found that while the risks of indirect land-use change are high when reforestation is planned in areas with high agricultural productivity, they can be minimized through a combination of various approaches including improved use of agricultural land (here productivity of cattle ranches), a regional restoration planning framework, the prioritization of restoration on marginal agricultural land, coupled with the generation of income from regenerating forests through the exploitation of timber and non-timber forest products, and establishment of possible ecosystem service payment schemes. Realistic improvements in the productivity of cattle ranching can be a key strategy to accommodate the expansion of both agriculture and habitat restoration in cattle producing regions with high competition for land and to provide long term environmental and economic resiliency. In the particular context of the Atlantic Rainforest, a densely populated (65% Brazilian population), high deforested and fragmented biome that is expected to be severely impacted by climate change, the large scale restoration can be a powerful measure to increase the resiliency of both natural and social systems.

Status, trends and projections of indicators of biodiversity and ecosystem services: The importance of the 20 Aichi Targets. *By Neil Burgess and Carsten Rahbek*

Presenters: Neil Burgess, UNEP-World Conservation Monitoring Center and University of Copenhagen; and Carsten Rahbek, Center for Macroecology, Evolution and Climate, University of Copenhagen and Imperial College London

Keywords: Convention of Biological Diversity, Aichi

One of the global societal and political measures of the sustainable state and use of biodiversity and ecosystem services is encapsulated within the process of tracking the achievement of the 20 Aichi targets under the convention of biological diversity. During 2013 and 2014 teams of scientists have brought together multiple datasets to evaluate their utility as indicators of each of the 20 targets. Past trends and short term projections of the indicators of the Aichi Targets to 2020 show state, pressure and response measures at the global scale for 17 of the 20 targets. This talk will summarise the political need, the methods and data sources, the results and the conclusions in terms of whether the world is on track to meet these targets or not. Comments are also provided on what need to done before 2020 to fully measure all targets and the extent of their achievement.

Tracking our own decline – current biodiversity indicators do not capture global ecosystem risks. *By Sarah Cornell*

Presenter: Sarah Cornell, Stockholm Resilience Centre

Co-authors: Matt Walpole, UNEP-WCMC; F.S. (Terry) Chapin, University of Alaska Fairbanks

Keywords: planetary boundaries, thresholds, biosphere

Despite 20 years of international agreements, biodiversity destruction is far from being halted. We argue that a planetary boundary for biosphere integrity is an important complement to current policies and metrics, which are vulnerable to the problem of a shifting baseline (e.g., MDG 7 is framed in terms of reducing rates of acceleration of loss). We present our rationale for setting a biodiversity boundary, drawing on recent debates about the nature of ecological thresholds and regime shifts. We also use the planetary boundaries framework to highlight what the current unsustainable use of biodiversity means, from an Earth system perspective. We discuss different possible approaches to developing boundaries, which capture different aspects of the critical role of biodiversity in ecosystem stability at different scales.

Can human population growth, food security and climate-change mitigation be achieved sustainably? Models and projections of local biodiversity loss. *By Tim Newbold*

Presenter: Tim Newbold, UNEP World Conservation Monitoring Centre

Co-authors: Lawrence Hudson, Natural History Museum, London; Andy Purvis, Natural History Museum, London

Keywords: biodiversity, land-use change, predictive model

Models and future projections of biodiversity under global change are needed to inform efforts to achieve human demands sustainably. We present global models of the response of local biodiversity to anthropogenic land-use changes, developed as part of the PREDICTS (Projecting Responses of Ecological Diversity In Changing Terrestrial Systems) Project. This project is gathering data on abundances of species in ecological communities from around the world. These data were related to data describing drivers of change (land-use, land-use intensity, proximity to roads and human population) to make models of the response of local community composition (including trait composition), diversity and turnover. The models were applied to global estimates of the relevant drivers to make projections of change in community composition and biodiversity at a global scale for the past, present and future, under different socio-economic scenarios.

Present Status of Mediterranean marine biodiversity and potential threat. *By Gabriel Reygondeau*

Presenter: Gabriel Reygondeau, Centre of Macroecology, Evolution and Climate

Co-authors: Camille Albouy, Université du Québec à Rimouski; Tarek Hattab, Centre de recherche Halieuthique (IRD); Jean Olivier Irisson, Laboratoire Oceanographique de Villefranche sur mer (Sorbonne Universitas); Sakina Ayata, Laboratoire Oceanographique de Villefranche sur mer (Sorbonne Universitas); Philippe Koubbi, Museum d'histoire naturelle (Sorbonne Universitas)

Keywords: biodiversity, Mediterranean Sea, anthropic pressures

Growing evidences show that anthropogenic pressures had strongly influenced the physical and biological systems of the Mediterranean basin. Indeed, the Mediterranean basin surrounded by land had been increasingly exploited over the last 2000 years. In addition, the IPCC has recently indicates that the Mediterranean Sea might be one of the hotspot of climate change. Since marine resources are crucial for the economy of several countries around the basin, a growing demand of effective ecosystem management is requested for a sustainable exploitation. In this context, a quantification of the global biodiversity, from low to high species trophic level is needed in order to identify the most endangered marine ecosystems and species. In the framework of the MERMEX/PERSEUS European projects all existing data on the environmental condition, biological observations (from phytoplankton to top predators) and anthropogenic pressures are integrated and processed in order to define the Mediterranean' ecosystems and characterize their perturbation status. A comprehensive database informed on environmental conditions (22 parameters), biological observations (more than 1500 species from plankton to whales) and human pressure (Halpern et al., 2008) is gathered from online database, cruise and published article. These various dataset associated to novel exploratory methods allow the multidisciplinary view required to understand the interactions between climate, biodiversity and anthropogenic activity in the Mediterranean marine ecosystems. Results provided by this study allow us to evaluate and map the global biodiversity at for each trophic level and study the relation between environment, biodiversity distribution and anthropic pressures. The present work reveals that all part of Mediterranean biodiversity is presently endangered and a map of potential marine protected areas is provided.

Balancing practicality with credibility in land stewardship: A company approach to assess progress and strive for positive change for biodiversity. *By Rashila Kerai*

Presenter: Rashila Kerai, Holcim

Keywords: biodiversity, solutions, monitoring, business, indicators

How can a company that relies on the extraction of limestone and aggregates be responsible stewards of the land under its control and demonstrate positive change for biodiversity over time? Holcim has asked these questions. Working together with IUCN and an independent panel of experts (Panel), we have implemented an integrated biodiversity management system that helps us understand the importance of biodiversity on our sites. It further helps us identify the level of risk based upon the potential impact and to know which sites are sensitive. This helps prioritise efforts and allows us to focus them and resources into developing Biodiversity Action Plans where these are needed and appropriate. Today, about 90% of our sensitive sites have such Plans in place. However, having a system in place is not enough in itself. What is also required is a simple and standardized way to monitor the effectiveness of our actions at all our sites. We wanted a system that is simple and practical that can be applied at all our sites, irrespective of the type, age, location of extraction site. With this in mind, the Panel has been working with Holcim over the last three years to develop an indicator system to ascertain the condition of biodiversity on our sites and to measure how it is changing over time. The resulting system provides a defined classification of habitats and an assessment questionnaire for each habitat which can consistently be applied at every site. The resulting biodiversity condition index can be aggregated nationally, regionally and globally collated, allowing us to establish robust benchmarks and to set meaningful targets and monitor progress over time. We aim to be responsible stewards of the land under our responsibility, and now we have a tool to measure the effectiveness of our biodiversity management.

Poster presentation

Biodiversity and associated traditional knowledge and wisdom in sustaining agriculture and livelihood in rural Nepal. *By Khem Raj Dahal*

Presenter: Khem Raj Dahal, Institute of Agriculture and Animal Science (IAAS), Tribhuvan University

Keywords: biodiversity, traditional knowledge, livelihood, sustainability

Nepal possesses a large diversity of flora and fauna at genetic, species and ecosystem levels. Livelihood of the majority of the people depends on agriculture, which has high reliance on the level of biodiversity present both in the farmland and natural ecosystems. In recent years several studies were conducted in different villages to enumerate number of higher plants and animals being used by the farmers followed by a detailed study in Tarkukot village of Lamjung District in western Nepal to assess the role of plant biodiversity (higher plants) and associated traditional wisdom of the villagers in sustaining rural life. The study showed that many farming households use more than sixty plant species to sustain livelihood. The study in Tarkukot revealed that there are more than ninety plant species growing in the jungles and open lands close to the village, which people are using traditionally for various purposes. Twenty seven plant species were being used for fodder; ten for fuelwood; twenty seven in local medicine; four for timber; four for thatching; five for fencing; four for religious purposes; three for green manuring and mulching; one for making domestic baskets' two for rope making, ten for fruits and some, including few lower plants, for preparing local salads and vegetables. Some of the plant species were found to have more than one use being the multipurpose. This indicated the high dependency of rural people on the locally available plant resources using their traditional wisdom and knowledge for sustainable community life. The result also indicated that the availability of the resources is becoming less and the traditional knowledge in managing the resources is in the verge of disappearance. Review of the past works in the subject revealed that the result was similar in most of the hilly areas with similar climatic conditions in Nepal.

Biomass – The multiple demands on biomass

The session addressed the global limits of biospheric production, the multiple future demands on plant production and whether several of these objectives are possible to achieve simultaneously.

Session 1:

Session 2:

Session 3:

Posters:

Terrestrial net primary production as a planetary boundary of the global carbon cycle. *By Steven W. Running*

Presenter: Steven W. Running, NTSG, University of Montana

Keywords: net primary production, planetary boundary

The recent framing of global habitability issues as a set of "planetary boundaries" first suggested by Rockström et al in 2009 has received wide attention, and particularly has engaged the global change policy community. While the boundaries chosen in the original paper were compelling, none specifically defined a key metric for the global carbon cycle. The U.S. NASA Earth Observing System began producing an annual terrestrial net primary production dataset in 2000 with algorithms developed by my team. We have since computed global annual NPP for a 32 year time series by reprocessing old satellite data consistently with the new records that now extend thru 2013. Although our early papers concentrated on detecting time series trends in NPP, most recently I noted that global terrestrial NPP has averaged 53.6 PgC over this time period with only a 1-2% interannual variation. In effect, within our measurement ability, terrestrial NPP seems rather fixed on multi-decadal time frames despite all the efforts of modern agriculture and the green revolution. We may thus think of terrestrial NPP as a planetary boundary, and that we have a global annual measurement with which to monitor. The policy consequence of this assertion would be that humanity only has a fixed amount of plant growth and biomass to work with each year, and that competition for food, fiber and fuel will intensify in the future. This Session will explore the developing tension, particularly between food security and bioenergy for use of the future global NPP.

Planetary boundaries related to the global human appropriation of net primary production. *By Helmut Haberl*

Presenter: Helmut Haberl, Institute of Social Ecology Vienna, Alpen-Adria Universität

Keywords: human appropriation, net primary production

Humans currently appropriate approximately one quarter of the earth's net primary production (NPP) in terrestrial ecosystems through two processes: (i) a reduction of NPP compared to its natural potential and (ii) biomass harvest. The human appropriation of net primary production or HANPP has roughly doubled from approximately 12% of potential NPP to its current value of 25% from 1900 to 2005. Aboveground HANPP is higher and amounts to about one third of terrestrial potential NPP (NPPpot). It would obviously be destructive if HANPP were to approach 100% since such a high level of human domination of ecosystems would leave no biomass available for food chains of all wild-living heterotrophs as well as for carbon sequestration. But where might planetary boundaries related to HANPP be? Can we determine a "sustainable level" of HANPP? This presentation discusses several questions which seem important in this context. (1) What are the upper limits to HANPP in different land use/land cover categories, e.g. cropland, grassland, forests or infrastructure areas? (2) What maximum NPP levels might be achieved under different types of land use? At present, the available global data suggest that the NPP of agro-ecosystems differs considerably across the globe, from far below NPPpot to considerably higher than NPPpot in intensively fertilized and irrigated lands. (3) To what extent can product supply be "decoupled" from HANPP? Both historical data as well as cross-country analyses suggest that it is possible to raise efficiency, e.g. by reducing losses. (4) What trade-offs with other ecosystem services (e.g. maintenance of biodiversity) might arise should HANPP rise strongly in the future? For example, empirical evidence suggests that high levels of HANPP are associated with low levels of biodiversity.

The long term trends and patterns of wood flows in world regions. *By Anna Liza S. Bais*

Presenter: Anna Liza S. Bais, Institute of Social Ecology, Alpen-Adria University

Co-authors: Karlheinz Erb, Alpen-Adria University; Thomas Kastner, Alpen-Adria University; Christian Lauk, Alpen-Adria University, Tamara Fetzel; Alpen-Adria University

Keywords: wood flows, carbon stocks, bioenergy

Wood is among the most important biomass resources of humanity. Since the beginning of civilization, wood has been used as a source of energy in the form of traditional solid fuel such as fuelwood (or firewood) and charcoal. It also supplies solid raw material for construction products such as lumber and plywood and the fiber for paper, paperboard and panel boards. Recently, the modern use of woody biomass for energy provision, like wood pellets and wood-based ethanol, is gaining a significant share in world market and its share is growing rapidly in many parts of the world. The provision of bioenergy is regarded as a key technology for the mitigation of climate change. However, many knowledge gaps related to the role and conditions of sustainable bioenergy provision, and the potential contribution of wood resources to mitigate climate change remains unclear. The understanding as well as data on global wood harvest and use is limited, and the few existing studies showing large inconsistencies, particularly on the use of wood for bioenergy. Furthermore, the effects of wood use on ecosystem functioning is still not well studied, owing to the large knowledge gaps. By applying the Material- and Energy Flow Analysis framework (MEFA) we aim at narrowing these knowledge gaps and to overcome the inconsistencies in wood flow accounts, in particular on bioenergy provision and consumption. We present a regionalized time series of wood use from cradle to grave and consistently link it to accounts of the Net Primary Production (NPP) and carbon stocks in forest. These datasets will be discussed, in particular with regard to multiple and increasing demands for biomass from forest.

Competing demand for land for food, bioenergy, and environmental services. *By Verena Seufert*

Presenter: Verena Seufert, McGill University, Montréal

Authors: Navin Ramankutty, McGill University, Montréal; Verena Seufert, McGill University, Montréal

Keywords: agriculture, food, bioenergy, environment, land

Agriculture has a large global environmental footprint. Nearly a third of the world's agricultural land is currently used for growing crops or grazing cattle. The resulting deforestation and habitat fragmentation is the largest cause of biodiversity loss. Agricultural land use and land cover change is also responsible for a third of global climate warming, and for depleting and degrading freshwater resources around the planet. At the same time, there are competing demands for land, including timber production, biofuels, and a variety of environmental services such as carbon sequestration and biodiversity. On the one hand it is imperative to improve global food security, while also recognizing overconsumption in many parts of the world. On the other hand, devoting a portion of land to bioenergy production could substantially offset fossil-fuel emissions and mitigate climate change. Moreover "saving land for nature" would also alleviate the environmental damage resulting from our global food system. The question arises: if we limited our agriculture solely to meeting the basic food needs of humanity, how much land would we need to devote to agriculture, and how much could be devoted to other objectives? This talk will review the status of global agriculture today, including land use, production, and end uses, and explore ideas for alleviating the tension between land for food, bioenergy production, and other environmental services.

Global terrestrial vegetation growth and the limits to sustainable bioenergy production. *By William K. Smith*

Presenter: William K. Smith, Numerical Terradynamic Simulation Group, the University of Montana

Co-authors: Steve Running, Numerical Terradynamic Simulation Group; Cory Cleveland, University of Montana; Sasha Reed, USGS

Keywords: carbon, bioenergy, energy, NPP

Increasing global population, energy demand, and standard of living has driven humanity to co-opt a growing share of the planet's natural resources resulting in many well-known environmental trade-offs. Here, we explored the impact of human demand on a basic resource fundamental to life on Earth: global terrestrial vegetation growth (net primary production; NPP). First, we compared current rates of agricultural NPP - derived from crop-specific agricultural statistics - with rates of natural NPP - derived from satellite measurements. Our results show that agricultural conversion has resulted in a ~7% reduction in global terrestrial NPP, suggesting that at the global scale current rates of agricultural productivity are less than the natural potential. Next, based on our previous findings, we apply satellite-derived NPP data computed for 110 million square kilometers of terrestrial plant production as an upper-envelope constraint on primary bioenergy potential (PBP). With this analysis, we estimate that maximum PBP realistically ranges from 12% to 35% of 2009 global primary energy consumption, with yield potential ranging from 6.6 to 18.8 mega joules per square meter per year—roughly four times lower than previous evaluations. Ultimately, our findings highlight the need for new global-scale policies that include an accurate quantification of the availability of biomass and the impacts of land cover conversion. Otherwise, further degradation of this critical resource is likely.

The theoretical limit to productivity on managed lands. *By Evan DeLucia*

Presenter: Evan DeLucia, University of Illinois

Co-authors: Nuria Gomez-Casanovas, University of Illinois; Jonathan Greenberg, University of Illinois; Tara Hudiburg, University of Illinois; Ilsa Kantola, University of Illinois; Stephen Long, University of Illinois

Keywords: NPP, bioenergy, global biomass, water

Human population and economic growth are accelerating the demand for plant biomass to provide food, fuel, and fiber. The annual increment of biomass to meet these needs is quantified as net primary production (NPP). Here we show that an underlying assumption in some current models may lead to underestimates of the potential production from managed landscapes, particularly of bioenergy crops that have low nitrogen requirements. Using a simple light-use efficiency model and the theoretical maximum efficiency with which plant canopies convert solar radiation to biomass, we provide an upper-envelope NPP unconstrained by resource limitations. This theoretical maximum NPP approached 200 tC ha-1 yr-1 at point locations – roughly two orders of magnitude higher than most current managed or natural ecosystems. Recalculating the upper envelope estimate of NPP limited by available water reduced it by half or more in 91% of the land area globally. While the high conversion efficiencies observed in some extant plants indicate great opportunity to increase crop yields without changes to the basic mechanism of photosynthesis, realizing such high yields will require parallel improvements in water use efficiency. Incorporating the potential to improve yields by increasing light-use efficiency and water-use efficiency has the potential to increase global projections of NPP on managed lands.

Global power production scenarios to 2050 and the dual role of forests: Accelerated climate damage or regulating and provisioning ecosystem services?

By Ingeborg Callesen

Presenter: Ingeborg Callesen, Department of Geosciences and Natural Resource Management

Keywords: bioenergy, forest, power production, GEC

The worlds' electrical power production is depending on the current energy infrastructure, and future investments in new power supply facilities using renewable and non-renewable energy sources. Continued growth in power production in the 21st century will cause global environmental change (GEC). GEC with climate change as an important driver will affect the environment and the economy in multiple ways that can be summarized as losses of biodiversity and changing ecosystem services (ES), but with very diverse temporal and spatial impacts. In a simple global growth model for power production, including non-renewable and renewable energy sources, the potential role of forest biomass is investigated. The demands for forest ecosystem services imposed by the global power production are assessed in the present study. Three global power supply scenarios to 2050 with different emphasis on bioelectricity from forest biomass and the associated environmental impacts are outlined using LCA unit process data. The power production is used as a simplified proxy for the global energy supply. It is assumed that the most suitable land under each scenario is reserved for food production, and that changes in human diets can satisfy the food demand in this way. It is further assumed that the transport system is electrified and that mobility is satisfied by the electricity produced. The scenarios outline the combined pressures from increasing atmospheric GHG concentrations, nitrogen enrichment, acidification, and land use changes on global forest areas. These pressures will increase the need for versatile forest management systems. The management options for provisioning ecosystem services (e.g. bioelectricity as a combined mitigation and adaptation strategy) and regulating ecosystem services delivered by forests are discussed under each change scenario.

Biodiesel – a solution or a problem? *By Maria Amelia de Paula*

Presenter: Maria Amelia de Paula Dias, Universidade de Brasilia

Co-authors: João Nildo De Souza Vianna, University of Brasilia; Antonio Sergio Haddad Alves, University of Brasilia

Keywords: food security, energy security, biodiesel

This article aims to discuss the real role of biodiesel in increasing food prices and their responsibility in worsening hunger. The importance and opportunity of this topic stem from its connection with other components of the environmental crisis, such as the fossil fuels share in the global energy matrix, which keeps countries prisoners in a high-carbon economy. Since 2005, the world has witnessed rapid expansion of global biodiesel production because it is a real alternative to mineral diesel. This success raised a concern about land use change for energy crops. During March 2007-2008, agricultural commodities prices increased concomitantly with the global biodiesel production. This strengthened the discussion about the competition between biodiesel and food production. Nowadays, such discussions continue, and due to the political and economical importance of the institutions leading this process, the goals of replacing petroleum by biofuels are being questioned. The deepening of research and analysis does not lead to a definite conclusion. There are studies showing a positive correlation and suggesting that the increase in biodiesel production would have decreased the area devoted to food. On the other hand, different factors were identified as being the cause of the increase in agricultural commodities price. In this article, both arguments are evaluated based on objective evidences, and their consistencies and contradictions are showed. The methodology was the analysis of reports, surveys and publications, confronting them with the data available in the reports of international agencies of energy. Insofar as possible, we used data from the same sources of the arguments analyzed. Concluding, the problem of hunger has structural and historical roots. Also, we conclude that the phenomena are concomitant, but not necessarily correlated. Indeed, the biodiesel production can be an economic development vector in poor countries, with the potential to promote social inclusion and energy security.

Supplying biomass as feedstock for energy – motivations and attitudes among European forest owners. *By Kristina Blennow*

Presenter: Kristina Blennow, Swedish University of Agricultural Sciences

Co-authors: Erik Persson, Swedish University of Agricultural Sciences; Marcus Lindner, European Forest Institute; Sónia Pacheco Faias, University of Lisbon; Marc Hanewinkel, d. Swiss Federal Institute for Forest Snow and Landscape Research

Keywords: biomass, bioenergy, land-owner, attitude, stemwood

The European Commission (EC) has set a legally binding target to cover at least 20% of EU's total energy use from renewable sources in 2020. Today woody biomass is the most important source of renewable energy in the EU and the EC expects the use of biomass for energy in the EU to double between 2010 and 2020. Several studies suggest increasing supply of woody biomass in response to pricing and market mechanisms as the demand increases. We tested the hypotheses that European forest owners' attitudes towards supplying woody biomass are reflecting the profitability of woody biomass and that their attitudes are positive so that the EU 2020 target can be met. Using survey data collected in 2010 from 800 private forest owners in a latitudinal gradient across Europe our results show that the respondents' attitudes towards supplying woody biomass for energy cannot be explained as direct responses to changes in prices and markets. Furthermore, our results imply that the amounts of woody biomass for energy requested to meet the EU 2020 renewable energy target cannot be expected to be supplied by European private forest owners, at least if stemwood is to play the important role as influential studies suggest.

Feed or bioenergy production from agri-industrial residues? An overview of the GHG emissions including indirect land-use changes impacts. *By Davide Tonini*

Presenter: Davide Tonini, Department of Environmental Engineering, Technical University of Denmark

Co-author: Thomas Astrup, Department of Environmental Engineering, Technical University of Denmark

Keywords: bioenergy, feed, land-use changes LCA

Second generation biofuels produced from “residual” biomasses is considered promising ways of producing bioenergy. However, many studies tend to forget that these biomasses are today used for specific purposes, (e.g. feeding). This means that their use for energy would induce cascading consequences on the food/feed market, or on the carbon balance of the soil. The first are commonly called indirect land-use changes (iLUC), as they cause an increase in the international demand of a food/feed product, finally inducing an expansion of cropland into other ecosystems. Failing to account for these consequences may lead misrepresent the actual environmental impacts. This study quantified, by use of consequential life cycle assessment (cLCA), the environmental impacts associated with a number of bioenergy scenarios involving selected agri-industrial residues. Three relevant conversion pathways were considered: combustion, fermentation to ethanol, and to biogas. The iLUC impacts were quantified and included in the assessment. The LCA results revealed that, for all scenarios, GHG emissions from indirect land-use changes were the major contributor to the total GHG impact (up to ca. 40-60% of the total induced GHG emissions). All in all, the use of biomasses that are today used as animal feed (e.g. beet molasses) induced significant GHG emissions through iLUC. These were quantified at between 1-3.5 t CO2/t dry residue depending upon the nutritional value. The recommendation is to avoid the use for bioenergy of those substrates having a significant nutritional value. Conversely, the energy use of substrates having low nutritional value (e.g. straw or residual grass) may provide considerable GHG savings.

Poster presentation

A regional absolute scale for Biotic Production Potential in LCA and the Land Use Optimality Point. *By Koldo Saez de Bikuña*

Presenter: Koldo Saez de Bikuña, DTU

Co-authors: Andreas Ibrom, DTU; Michael Zwicky Hauschild, DTU

Keywords: biotic production, planetary boundaries, LCA

Inherent modelling complexities due to the interconnectedness of soils' ecosystem services have traditionally forced Life Cycle Assessment (LCA) practitioners to content with a mere quantification of Land Use (LU), as surface area and duration (in m2 or ha and years) appropriated by humans, without further analysis of the impact pathways derived from those land uses. Milà i Canals established the first comprehensive, basic framework for taking soil quality aspects into LCIA which reached acceptance among the LCA community. Building on the latest proposal by UNEP-SETAC's special task force on LU and with the aim of bringing the Planetary Boundaries thinking into LCA, the present study proposes a regional absolute scale for the midpoint impact category of Biotic Production Potential (BPP). It is hypothesized that, for an ecosystem in equilibrium (where NPP equals decay), such an ecosystem has reached the maximum biotic throughput subject to site-specific conditions and with no externally added inputs. The Potential Natural Vegetation (PNV) of a certain land gives then the maximum BPP, measured as the total amount of carbon stocks that the PNV can build and hold. It is argued that this maximum BPP is Nature's optimal solution through evolution-adaptation mechanisms, which provides the maximum matter throughput subject to the rest of environmental constraints (without further impacts). As a consequence, this scale rises a Land Use Optimality Point that suggests the existence of a limit regarding the maximization of divergent objectives within the context of bioenergy. It will be attempted to model that beyond this point, and for the land available within a country, if the objective of Climate Change mitigation through bioenergy is further maximized, then the Fossil Fuel displacing objective will decrease, and vice versa.

Poster presentation

Sustainability of using agricultural residues for energy in Denmark – an evaluation based on the GBEP framework. *By Niclas Scott Bentsen*

Presenter: Niclas Scott Bentsen, University of Copenhagen

Co-author: Inge Stupak, University of Copenhagen

Keywords: bioenergy, residues, sustainability, GBEP, bioethanol

European energy policies stipulate a massive increase in the use of biomass for energy to meet targets for climate change mitigation and energy security. The sustainability of bioenergy has, however, been questioned in the public as well as in the scientific debate. In Denmark, the use of agricultural residues for energy has increased continuously since 1975 and today they contribute significantly to the Danish primary renewable energy supply. In order to inform the debate, we used the GBEP framework to analyze the sustainability of using agricultural residues for heat and power or bioethanol in Denmark. The Global Bioenergy Partnership (GBEP) was formed in 2006 as a response to the wish expressed by G8 Leaders in the 2005 Glenangles Summit Action Plan, that sustainable deployment of biomass and biofuels be supported, particularly in the developing countries, which has some of the largest biomass production potentials. GBEP developed a set of 24 indicators to evaluate the environmental, social and economic sustainability of bioenergy deployment. The GBEP indicators have been applied to evaluate the sustainability of the bioenergy sector in a number of developing and industrialized countries. We adapted a subset of the 24 indicators to evaluate the sustainability of using straw for energy production in Denmark. The evaluation showed a number of positive impacts, including income generation in rural areas, diversification of the Danish energy supply, and a reduction of fossil energy resource use and greenhouse gas emissions. Adverse impacts included increased greenhouse gas emissions from land use and decreased amounts of soil carbon and in site fertility. We compare the assessed sustainability indicators, discuss the benefits and drawbacks of using straw for energy, and suggest how the Danish experiences may be used to mobilize this resource in other countries.

Poster presentation

Biorefinery sustainability: linking importance of biomass feedstocks from the food, feed and fuel values. *By Ranjan Parajuli*

Presenter: Ranjan Parajuli, Department of Agroecology, Aarhus University

Co-authors: Tommy Dalgaard, Department of Agroecology, Aarhus University; Marie Trydeman Knudsen, Department of Agroecology, Aarhus University

Keywords: biorefinery, sustainability, biomass, prioritization

Sustainability of biomass production is related to wider environmental and socio-economic repercussions of a farming system. A substantial rise in the use of biomass from agriculture, forestry and waste for producing only energy possess negative ecological impacts, socio-economic impacts and additional greenhouse gas (GHGs) emissions. Sustainable conversion of biomass to produce a spectrum of products through biorefineries is an urgent need in the prevailing energy and agriculture system sustainability. It is important not only in the context of energy security, instead to optimize biomass supply to meet multifold demands (e.g. food, feed, fuel/energy and bio-chemicals). Biomass feedstocks represent a major portion in the total operating cost of a typical biorefinery, and thus in the light of ensuring their year-round supply it is relevant to prioritize them based on their inherent properties and also to identify the determinant biobased products. This study aims to prioritize biomass categories: green (e.g. grasses from grasslands, alfalfa) yellow (e.g. straw, spring harvest Miscanthus) and woody (e.g. poplar and willow). Multi-criteria assessment of potential biomasses is carried out looking into wider environmental and economic parameters: (i) potential environmental gain/losses in the farming system (ii) supply potential and (iii) physical and chemical properties of biomass. We have found that it is difficult to strictly recommend a single biomass, since their sustainability depends on the overall socio-economic and environmental performances compared to the conventional products that they substitute. For instance, clover/grass, alfalfa (from green categories) is better than straw (yellow category), if the main demand is extraction of protein from the biomass favouring the green biorefinery platform over the lignocellulosic. In contrast if the market is aimed at production of bioethanol, C5 molasses and lignin pellets, in an industrial scale, lignocellulosic biorefinery with straw as a feedstock could be better option.

Poster presentation

Biogas as Stepping Stone towards a Sustainable Bioeconomy? Opportunities and Constraints of Biogas Production – Results from a Dutch-German Project. *By Swinda Pfau*

Presenter: Swinda Pfau, Radboud University Nijmegen

Co-author: A.J.M. Smits, Radboud University Nijmegen

Keywords: biogas, bioeconomy, sustainability

In recent years the use of biomass has increasingly been described as solution to various global problems, such as fossil fuel depletion or climate change. Currently bioenergy is the dominant non-food application of biomass, among which biogas production. However, these bioenergy applications are heavily debated. This presentation will identify opportunities and constraints of biogas production as a stepping stone towards a sustainable bioeconomy. Bioenergy is an important pillar of many national renewable energy policies. However, bioenergy production is often depicted as part of a bigger transition to a bioeconomy, where all fossil resources are replaced by biomass. This expected transition results in a competition for biomass resources for different applications. Currently bioenergy applications are dominant, but depending on national subsidies. Recently attention shifted to the application of biomass in other supply chains, where fossil inputs can only be replaced with biomass. It is therefore questionable whether biogas is a useful application of scarce biomass resources, both economically and regarding sustainability. However, more advanced applications of biomass are mostly still underdeveloped. Furthermore, the need to reduce greenhouse gas emissions asks for a timely substitution of fossil resources wherever possible. Currently applicable techniques such as biogas production could thus present a step in the right direction, while advanced applications are still under development. This research will evaluate insights and experiences regarding biogas production gained in a European trans-boundary project, where various aspects of biogas applications such as processing technologies, supply chain issues and legal aspects were addressed. All results will be integrated to identify opportunities and constraints of biogas production as a stepping stone towards a sustainable bioeconomy. This will help to prioritize current efforts and investments into research about biomass applications and energy systems.

Poster presentation

Denmark Can Increase Local Sustainable Biomass Production by 10 Million Tons Annually in 2020. *By Søren Larsen*

Presenter: Søren Larsen, University of Copenhagen, Department of Geosciences and Natural Resource Management

Co-authors: Uffe Jørgensen, Aarhus University, Department of Agroecology; Jørgen E. Olesen, Aarhus University, Department of Agroecology; Tommy Dalgaard, Aarhus University, Department of Agroecology; Niclas S. Bentsen, University of Copenhagen, Department of Geosciences and Natural Resource Management; Claus Felby, University of Copenhagen, Department of Geosciences and Natural Resource Management

Keywords: land-use-change, bio-refinery, ecological-intensification, agriculture, forestry

A growing population, rising standards of living, and an increasing concern over irreversible greenhouse gas emissions raise the question whether there is sufficient biomass to meet future food and feed demands, as well as increased use of biomass to displace fossil fuels. A recent analysis shows that it is possible in Denmark to deliver additionally 10 million tons of biomass by 2020 compared to 2009 which would increase utilization of national biomass 3-4 times. Agriculture and forestry can achieve this through highly productive systems, increased collection of residues and several other initiatives. Three scenarios for future biomass production and supply were developed that either project the current development, were optimized for biomass production, or optimized for environmental protection. In this presentation the +10 million tons analysis has been further elaborated and analyzed for the scenario's GHG emissions (N2O, CH4 and CO2), energy production and feed/food production. Biomass is divided into five categories, which may be converted to feed and energy products through advanced, but realistic, technologies such as 2G fermentation and biogas. Although Denmark is a small country, the analysis has implications for other countries with well-developed and mechanized agricultural and forestry sectors. We show that: 1) GHG emissions and environmental impact from agriculture can be reduced simultaneously with increased production, 2) the energy output from the scenarios is high and rich in energy carriers for which alternatives to fossil energy carriers have been challenging to deploy (liquid and gaseous fuels), and 3) enough food and feed can be produced to offset the production on land taken out for non-food biomass production. The analysis documents that sustainable intensification of agriculture and forestry is a viable option for the future. A high production of biomass for bioenergy does not necessarily decrease feed production and may reduce concerns for ILUC impacts.

Economy – Transitioning to new types of economic growth

The session explored economies under scenarios of comprehensive change. It looked beyond global modelling exercises, to regional and national studies of economic structure and growth. An anchor point was deep decarbonisation

Session 1: Transitions to low-emissions and low-resources economies

Session 2: Country-level deep decarbonization pathways

Posters:

A New Class of Energy and Economic System Capacity Expansion Models Highlights the Opportunities to Develop Low-Carbon Futures. *By Daniel M. Kammen*

Presenter: Daniel M. Kammen, University of California, Berkeley

Keywords: low-carbon, sustainability science, integrated assessment

Meeting 80% or greater greenhouse gas (GHG) reduction targets for the year 2050 compared to 1990 requires detailed long-term planning due to complexity and inertia in the energy and wider economic system. New tools will be needed to make this planning the norm on a full economy-wide basis, encompassing the carbon embedded in the energy, transportation, and goods and services we all consume. We have developed a new class of models that clarify these dynamics in the form of ultra-high spatial and temporal resolution planning tools. We developed this tool initially for western North America, and demonstrate the capacity with an integrated assessment of the requirements for future energy systems for the state of California. Two components developed here build novel analytic capacity beyond existing studies: (1) detailed bottom-up projections for energy demands across the building, industry and transportation sectors; and (2) a variable renewable resource capacity expansion model (SWITCH) that is realistic in terms of representing the electric power sector to model the fully interconnected Western North American grid, including California. We find that multiple pathways exist to a low-GHG future, all involving increased efficiency and a dramatic shift in energy supply from fossil fuels to electrification and low-GHG energy. The electricity system has diverse, cost-effective options to meet aggressive GHG reduction targets, even with increased transportation and heating demands. Optimal wind and solar deployment depend on temporal characteristics of the load profile. Incremental changes and/or partial pathways are not sufficient to meet the 2050 GHG target, with major implications for policy development. We extend these methods to examine addition systems, from Chile, to China, East Africa and India.

The Degrowth Imperative? Reducing energy and resource consumption as an essential component in addressing climate and sustainability challenges. *By John Wiseman*

Presenter: John Wiseman, Melbourne Sustainable Society Institute, Universty of Mebourne

Co-author: Samuel Alexander, Melbourne Sustainable Society Institute, University of Melbourne

Keywords: degrowth, post carbon economy transitions

An increasingly compelling body of evidence from a diverse array of climate and sustainability researchers calls into question the assumption that climate change and sustainability risks can be fully and adequately addressed without a significant reduction in energy and resource consumption – at least in the wealthiest economies. This paper therefore aims to provide a critical overview of the evidence and literature about the necessity, feasibility and desirability of 'steady state', 'degrowth' and 'sufficiency economy' strategies in the achievement of a just and resilient post carbon future. The paper begins with an analysis of evidence about the extent to which climatic and sustainability challenges can be adequately addressed through achievement of even the most ambitious and optimistic renewable energy and energy efficiency targets. This will be followed by a critical discussion of diverse approaches to conceptualizing, framing and implementing 'economic degrowth' strategies, including reflections on lifestyle, social equity and institutional impacts and implications. The paper will conclude with reflections on theories and pathways of social and political change through which 'degrowth' ideas and strategies might plausibly move to a occupy a more central location in public agendas and debates about post carbon economy and sustainability transition strategies.

Low-carbon transitions for high-carbon economies: opportunities and co-benefits. *By Frank Jotzo*

Presenter: Frank Jotzo, Crawford School of Public Policy, Australian National University

Keywords: climate change, mitigation, structural change

Australia has a highly emissions intensive economy, due to its reliance on coal, relatively low energy efficiency, and importance of emissions intensive export industries. But Australia also has ample opportunities for prosperity if the world goes on a trajectory of deep decarbonisation towards a two degree warming target. Using a suite of technological and economic models, we construct a scenario for Australia of transition to zero net greenhouse gas emissions by 2050. This includes a power system based largely on renewable energy, electrification of transport and industry, greater energy efficiency, and selective use of carbon capture and storage. Significant emissions remain in agriculture, mining and processing industries, to a large extent for export. But these are fully offset by carbon sequestration on the land, including through afforestation, for which there is large potential in Australia. Australia's economic growth is projected to remain strong and economic structure almost unchanged at the broad level. There are however deep changes in particular industries and regions. These need to be managed for their economic, social and political implications. To achieve a low-carbon transition with continued economic prosperity, a stable policy framework with clear economic incentives for investment in low-emissions options is needed, along with public support for R&D. The talk draws on Australia's contribution to the UN "Pathways to deep decarbonisation" project, led by ClimateWorks Australia and ANU with modelling by CSIRO and Victoria University.

China's long-term low carbon development option. *By Alun Gu*

Presenter: Alun Gu, Institute of Energy, Environment and Economy, Tsinghua University

Keywords: deep decarbonization pathway, strutural change

Although China has made remarkable progress, it is under heavy pressure to improve environmental protection due its resource-intensive development. China recognizes the problems created by pollution, both from greenhouse gases (GHGs) that cause climate change and from other gases and particles. China is also facing growing constraints due to the limited availability of natural resources other than coal. China's leadership has signaled its intention to accelerate the transformation of China's growth model, to make China an innovative country, and to promote more efficient, equal and, sustainable economic development. In order to achieve the illustrative decarbonization pathway, there are key measures that must deviate significantly from current trends. Some alternative approaches could be envisioned, leading to different emissions scenarios. To realize the target, there are additional measures for deeper pathway: dematerization, technology innovation and economic structural change. The reduction of CO2 emissions is not only a response to climate change, but it also addresses the urgent demand of developing the national economy. If the coordination – including change the concept of development, deepen the energy reform, pricing carbon and reduce coal consumption work well, the strategy of climate change mitigation and sustainable development will lead to a win-win situation.

Pathways to 2050: Deep decarbonization strategies in the United States. *By Benjamin Haley*

Presenter: Benjamin Haley, Energy and Environmental Economics, Inc.

Keywords: 2050, energy, GHG, mitigation

This research was conducted for the U.N. Deep Decarbonization Pathways Project (DDPP), which challenged international modeling teams to develop country-specific energy system transformations to 2050 consistent with a global 2° C target. We demonstrate the technical feasibility of such a transformation in the U.S. context under four distinct scenarios in which CO2 emissions from fossil fuel combustion are reduced to less than 750 million metric tons in 2050. This is exhibited by results for four deep decarbonization cases – a high renewables and pipeline gas case, a high nuclear and hydrogen case, a high CCS case, and a mixed case which incorporates technologies and strategies from all mitigation cases. All cases achieve the significant transformation in the energy system required to meet the target, and do so under normal forecasts of economic growth and activity, and without assumptions of sacrifice or lifestyle change. We examine both the technical results of the mitigation cases as well as implications for policymakers seeking to enable this scale of energy system change.

Brazil: Keeping the Economy Growing and Sustainable in the Next Decades. *By Claudio Gesteira*

Presenter: Claudio Gesteira, CentroClima, COPPE, Federal University of Rio de Janeiro

Historically, land use change and forestry have been the main sources of Brazilian GHG emissions. However, recently, this type of emissions has diminished due to government policies. Presently, the pattern is such that energy-related emissions are likely to come to the forefront in the next decades, similar to the pattern observed in most other countries. Nowadays, Brazil uses mostly renewable energy, mainly from hydropower and biomass. Hence, the country's energy emissions remain low for its size. With the social and economic progress that is expected in the future, and the consequent growth in energy consumption, the challenge the country faces is to keep these emissions low. We discuss some measures in this direction. The envisaged pathway is a robust one, since it is not based on untested future scientific and technological breakthroughs. But, in order to render practical initiatives feasible, it is essential that some international agreement be reached, concerning cuts in fossil fuel subsidies, carbon taxes etc. External funding might also be required to speed up technological change.

Transitioning sustainable economies to achieve deep cut of GHG emissions in Japan. *By Mikiko Kainuma*

Presenter: Mikiko Kainuma, National Institute for Environmental Studies

Co-authors: Ken Oshiro, Mizuho Information & Research Institute; Toshihiko Masui, National Institute for Environmental Studies; Go Hibino, Mizuho Information & Research Institute

Keywords: sustainability, decarbonisation, energy, CO2 emission

Japan's long-term mitigation target in 2050 is to reduce Greenhouse Gas (GHG) emission by 80% compared to the 1990 level. This corresponds to the global mitigation target of cutting GHG emissions by half by 2050 which is part of the target of a low-carbon society (LCS). The Cancun Agreements adopted in 2010 explicitly refer to the importance of a paradigm shift towards building an LCS that offers substantial opportunities and ensures continued high growth and sustainable development. However, realizing an LCS entails radical changes in technologies, energy systems, production and consumption patterns, social value systems, and lifestyles, in addition to policy changes that mobilize finance and the willingness of people to achieve such transitions. This paper envisions a future in which advances in technologies and industrial structure have transformed Japanese society by 2050, resulting in deep cut of GHG emissions. It is feasible to reduce 80% of GHG emissions through a combination of demand-side and supply-side actions. On the demand-side, reductions are possible through efficiency improvements, decreased population and the more rational use of energy. On the supply-side, CO2 emissions can be reduced through a combination of the appropriate choice of low-carbon energy sources and improving energy efficiency. After the Fukushima Daiichi Nuclear Power Plant accident in 2011, availability of nuclear power in the future becomes uncertain. Complying with the discussion about Japan's new energy policy, nuclear power may phase out toward 2050. As the potential of renewable energies is unevenly distributed, regional electricity exchange is required. However current electricity interconnection capacity between regions is not high in Japan. Strengthening of interconnection need to be considered. This paper examines the feasibility of achieving 80% reduction of GHG emissions under several scenarios and discuss possible pathways transitioning sustainable economies to achieve deep cut of GHG emissions in Japan.

Deep decarbonization scenario for France. *By Sandrine Mathy*

Presenter: Sandrine Mathy, EDDEN

Author: Patrick Criqui, EDDEN

Keywords: low carbon scenario, France

The energy trajectories for achieving France's Factor-Four (F4) goal – a fourfold cut in greenhouse gas (GHG) emissions by 2050 compared with 1990 – have been discussed in the framework of a deliberative process organized by the French government in 2013. The four energy trajectories identified in this process combine contrasted hypotheses on two structuring dimensions: the rate of final energy consumption reduction and the technology mix required for this "energy transition". After a presentation of the public debate related to energy transition in France, we present a low carbon scenario based on a 50% reduction of final energy consumption in 2050 and on a significant diversification of low carbon technologies and energy sources. The technological transitions and behavioral change in residential, tertiary, industry and transports, sectoral investment costs and the impact on household budget will be analyzed in detail.

Poster presentation

What is a Low-carbon Economy? *By Alexandr Iscenco*

Presenter: Alexandr Iscenco, Moldovan Environmental Governance Academy (MEGA)

Keywords: decarbonization, definition, emissions, low-carbon economy

Low-carbon economy is a popular concept around the world nowadays. It is also a vision that more and more countries set to pursue. But what is a low-carbon economy? While it might seem a straightforward task to provide a definition for this term (probably in one sentence), it is a more complicated task to consider the circumstances under which an economy be classed as "low-carbon". As it turns out, there is no single and commonly accepted definition of it. So, what exactly do such countries, as Denmark, Sweden, France, Germany, the UK, etc. invest their efforts and resources into? In order to answer this question, the article offers the analysis of the key features and characteristics of a low-carbon state of an economy. This is followed by the discussion on how low-carbon should a low-carbon economy be, where there is an attempt to find out the exact level of global warming that a “realistic” low-carbon economy is able to achieve. Finally, this discussion transforms into an assessment of what a country needs to do in order to achieve the low-carbon state of its economy. The article concludes with a summary of the analysis and discussion results that form the key points of the definition of a low-carbon economy.

Poster presentation

Sustainability in the scenario building methods. *By Maria Amelia de Paula Dias*

Presenter: Maria Amelia de Paula Dias, University of Brasilia

Co-author: João Nildo de Souza Vianna, University of Brasilia

Keywords: scenario, sustainability, driving forces, frameworks

In some scenario building methods, driving forces are the base structures, facilitating the collective design process of future images. They follow the STEEP generic formula - Social, Technological, Economic, Environmental and Political. While they make the focus of collective thought easier, actually, these structures work as a framework, delimiting the field of view to these five aspects. Such framework formed by five aspects was designed under the paradigm of development as economic growth, thereby reproducing the hegemonic mental models and their consequences: natural resources depletion, cultural aspects massification, non-consideration of territoriality and increasing inequality among people. The objective of this work is the inclusion of sustainability dimensions in this set of driving forces in order to make sustainable future images easily designed. Thus, it would be possible to generate future images in which some commitment to future generations can be seen. Methodologically, it was necessary to go through the scenario types and classification, the methods that produce them, the concepts of mental maps and the collective psychological framework and, finally, through the criticism of the economic model that is represented by a set of variables STEEP. Alternatively, it is proposed to use the dimensions of sustainability of Ignacy Sachs as a framework for the future images structure.

Poster presentation

Sustainable business models for the developed and developing world based on Jugaad innovation principles. *By Nancy Bocken*

Presenter: Nancy Bocken, University of Cambridge, Department of Engineering

Co-author: Jaideep Prahbu, University of Cambridge, Judge Business School

Keywords: sustainable development, frugal innovation, eco-innovation

To address our global challenges of a growing population paired with increasing levels of consumption, new ways of doing business are required which mitigate our negative impact on the environment and society, and rather create positive, sustainable value for a wide range of stakeholders. Sustainable business models have a strong value proposition for the customer, as well as the wider value network (e.g. suppliers, partners) and specifically include 'society' and 'environment' as key stakeholders. Jugaad Innovation is an "innovative fix" or a "simple work-around" (Radjou et al., 2012), which has been applied in developing countries to provide solutions to contribute to local economies and health in an environmentally sustainable way. Examples of environmentally benign Jugaad innovations include low-cost solar-cookers and solar-energy battery lease systems for electricity provision, both to replace inferior kerosene-based alternatives. Jugaad Innovation has the potential to deliver triple bottom-line sustainable business model solutions for developing countries. Large incumbent manufacturers have used this type of innovation as an entry point to new, emerging markets. Perhaps because of global economic and resource crises, Jugaad Innovation has also gained traction in developed market applications. This research investigates the potential of Jugaad innovation as a founding principle for sustainable business model innovation, both in developing and developed countries. How can Jugaad innovation inspire sustainable business model innovation? Case studies have been developed that draw parallels between developing and developed country sustainable business model archetypes. These provide insights in how Jugaad innovation could provide a resource-efficient source for sustainable business innovation in developed and developing countries. Differences and similarities between the underlying principles between emerging market and developed market types are presented to give insight in future development of sustainable business models.

Poster presentation

Green Growth: Indicator based analsis of Turkish economy. *By Seyithan Ateş*

Presenter: Seyithan Ateş, THK University

Keywords: green growth, environment, sustainability, Turkey

Economic growth is often considered to be a necessary requirement for well-being and quality of life. However, this economic growth is to take place in an orderly fashion so that it does not threaten its own foundations, endangering prosperity and quality of life, instead of promoting them. In this context, Green Growth (GG) means fostering economic growth and development while ensuring that natural assets continue to provide the resources and ecosystem services on which our well-being relies. Like many other developing countries, Turkey faces the dual challenge of encouraging development and reducing GHG emissions. Turkey's rapid and continuing economic growth since 2001 has provided a middle-class lifestyle for a growing number of people, in cities and urban areas. On the other hand, it has created massive and growing environmental degradation. As a tool for assessing the correlation of economic growth and environment, ultimately, for estimating the sustainability of an economy, some form of indicators are developed. Green Growth Indicators (GGI) developed by OECD is seen as an excellent starting point to monitor the economic system in terms of the green growth, sustainability and international benchmarking. In this paper, to trace the development of the Turkish economy towards green growth, we have developed a green growth indicator framework. The indicator framework will include five interrelated groups of indicators including; Sustainability and equity; Environmental and resource productivity; Natural asset base; Environmental quality of life and Policy responses and economic opportunities. Based on relevance for the Turkish situation, 27 sub-indicators are selected. Data sources for the Turkish GG indicators originate from several different data sources, mainly from OECD GG indicator databases. The paper will be the first study analyzing the Turkish economy in terms of GG approach and provide suggestions for the government interventions to ensure a GG path in the country.

Education in sustainability

The session explored the challenges that education for sustainability presents to tertiary education institutions, including approaches to interdisciplinary research led learning

Session 1: Transcending organizational frameworks

Session 2: Design criteria

Session 3: Engaging the community

Posters:

Making ends meet in a changing world: Sustainability, education and university management. *By Lykke Friis*

Presenter: Lykke Friis, University of Copenhagen

Keywords: education, globalisation, students, culture, management

The grand challenges facing mankind – that is challenges which pose threats, risks as well as opportunities that impact vast areas on a global scale – also present challenges for universities and within tertiary education and research in general. Focus on sustainability is one important response when dealing with challenges such as climate change and scarcity of natural resources. University management should facilitate new approaches by encouraging educational initiatives with emphasis on inter and cross-disciplinarily approaches and "the convergence of science". Furthermore, trends of globalisation such as high mobility, digital communication and the need for knowledge of different cultures and languages should also be components when engaging students in these fields of studies and challenges. This talk attempts to discuss dilemmas and possibilities while referring to university initiatives as well as contemplating the nature of some of the current and rapidly shifting agendas on the global political and societal scene. One experience from the University of Copenhagen is the comprehensive climate and sustainability initiative launched in 2007, which combined interuniversity cooperation, joint efforts for creating a greener campus and initiatives within education and research engaging students and faculty across the university. It also reflects on how university management should respond to increased internationalisation as well as society's expectations in regard to education related to the need for sustainability oriented approaches and solutions.

Promoting sustainability science education through a transdisciplinary approach. *By Kazuhiko Takeuchi*

Presenter: Kazuhiko Takeuchi, Integrated Research System for Sustainability Science (IR3S), the University of Tokyo

Keywords: sustainability education, systematic approach

Sustainability science applies a holistic, systems approach to better understand and address complex, global challenges such as anthropogenic climate change, biodiversity loss, and poverty in developing countries. In educating people in such fields, it is important to develop deep knowledge and skills in specific areas, but it is also essential to build a holistic perspective and a systematic understanding of the relationships between issues crossing different disciplines. In order to develop capacity for the latter, an effective approach can be to engage students from different disciplinary backgrounds in field studies. By visiting specific sites and observing how complex real-world problems require integrated approaches, students gain a unique transdisciplinary understanding. Working collaboratively and applying this understanding to practical problems also provides students with valuable experience in developing systematic solutions. An important role of sustainability science is to provide an interface between science, policy and society. As such, it is important that sustainability education actively engages a broad range of different stakeholders, and develops in students the skills necessary for engaging with these diverse groups and acting in a coordinating role.

Reflections on the need for a higher order skills-base to make growth and development in Africa more sustainable. *By Harro von Blottnitz*

Presenter: Harro von Blottnitz, University of Cape Town

Co-author: Emmanuel Mutisya, University of Tokyo

Keywords: education, development, urban, rural, minerals

Africa's development challenges are multitudinous and deep-rooted, with serious signs of multiple sustainability crises. The continent lags furthest behind in the global economic convergence trend, though many countries have recently been experiencing significant economic growth. Concerns remain that this growth may be fuelled by liquidation and export of natural capital, and the benefits shared unequally. Hundreds of millions remain in poverty, both in rural areas and in urban informality, the latter characterized by severe slum urbanism. There is a consensus emerging that African countries need to build up their capacities to cope with these challenges and that their higher education institutions need to improve their education and research programs for turning out professionals and leaders for sustainable development. Human capital investments have long been understood to be a key to economic development and in this sense, it is surprising that investments into tertiary education had been minimal in this region, also in relation to primary and secondary education. The recent upswing in economic activity does correspond with significant increases in university enrolments and funding, which nevertheless remain too small, especially in the postgraduate sphere. So far, there is little sign that social capital investments have been recognized as being required too, beyond those made by 'development partners'. The complexities of sustainable development require higher order skills, also related to the ability to conduct research. As a step to addressing the lack of such a skill base, eight African universities together with the United Nations University partnered under the Education for Sustainable Development in Africa (ESDA) project to elaborate post-graduate programs, covering three areas: Sustainable Integrated Rural Development, Sustainable Urban Development and Management of Mineral Resources. The programs have started in 2014. Their biggest challenge may well lie in turning the recognized interplay between these themes into suitable student research topics.

Designing spaces and processes for transformative learning and change. *By Ariane König*

Presenter: Ariane König, University of Luxembourg

Keywords: sustainability, complexity, disciplines, integrative-inquiry, transformative-learning

Addressing complex sustainability problems requires improved understanding of and acting upon interdependent changes in society and environment that are situated in space and time. This paper will first explore challenges from such complexity to traditional disciplinary approaches of organizing research and teaching at Universities, that include the goal of universal validity, the fragmentation of fields of knowledge associated with the conduct of 'normal science', and notions of expertise that invite a 'transmissive' teaching approach. To answer these challenges the paper develops the concept of 'integrative inquiry' as central element for designing situated transformative learning opportunities for students and researchers. The goal of integrative inquiry is to produce shared new knowledge as the basis for concerted action to reshape our physical environment and our impacts on material and energy flows, and how we relate to these. One fundamental question this goal raises is the relation of situated co-created knowledge to knowledge in disciplinary fields that rely on generalizability as criterion for legitimation. This question is also salient for thinking about the scalability or transferability of local choices of technologies, analytic tools and problem-solving approaches. We present new insights and recommendations for designing processes and spaces for implementing and scaling up such problem-based collaborative learning projects. The paper builds on two strands of empirical work: the analysis of cases of 'living laboratories' established by universities as places for experimentation for sustainability, and a short survey and focus group work on innovative approaches to education for sustainability in universities from five continents conducted under auspices of the International Sustainable Campus Network. Questions for further research on the relation of knowledge and place are highlighted.

The MetaUniversity: Educating the Solutions Generation. *By Katrine Grace Turner*

Presenter: Katrine Grace Turner, Aarhus University

Co-author: Ida Kubiszewski, Crawford School of Public Policy, Australian National University

Keywords: online learning, problem-based learning solutions

Online learning has become a major trend in higher education, but the upfront costs of producing high quality online courses are huge. At the same time, the costs of distributing these courses are trivial. In addition, online courses alone are not sufficient. As decades of experience in Medical Schools and elsewhere have demonstrated, hands-on, problem-based education is much more effective at producing deep learning, skill development, and creativity. We propose that the next stage in higher education needs to take it global and local at the same time. What we call the "MetaUniversity" would be a global alliance of universities, academic societies, and other organizations, providing quality education through a balance of very high quality online courses to deliver content globally and, solutions-oriented, face-to-face workshops that engage students with real-world problem solving locally. The online and solutions-focused courses offered by the consortium of MetaUniversity partners in the right balance, will give students the integrated education in analysis, synthesis, and communication necessary to solve the problems of the coming century.

Developing a design strategy to promote a repair habit and the designing for reparability. *By Andrea Garcia Pazos*

Presenter: Andrea Garcia Pazos, Posgrado de Diseño Industrial, Universidad Nacional Autónoma de México

Keywords: repair, sustainability, society, design

Due to the climate conditions of our planet it is necessary to develop research centered on new forms of life determined by the participation of the society. The research presented develops the subject of reparability, practice that has been lost because of the new forms of designing and the path taken by new technologies, which have a higher degree of complexity and therefore, avoids the approach of users to their objects. Also, market speed and the need to preserve the current economic system have encouraged a society that buys and throws away. The designers have focused on creating objects that do not last, junk design, and they also have put aside their critical stance and their role as problem solvers, instead they are generating a bigger problem, this includes promoting the mass production, extracting more natural resources and designing products with shorter lives. In México there are a lot of small businesses who used to earn their living by repairing, people are losing their jobs because they are no longer able to repair electronics due to microchips. There is a trend for throwing away stuff because it is cheaper to buy a new one than trying to repair it, so people are being force to undersell their work. Because of this it is important to promote a society that is aware of its environment and its waste production by building a bond with their objects through the repairing of their own stuff to be able to generate a change in the industry and in the design world, and with this, promote a more sustainable economic system. By promoting repairing of stuff we can empower the society, making them loose the fear to what they own and making them active and participative users.

Urban Food Production Systems as Sites of Transformative Learning. *By Federico Davila*

Presenter: Federico Davila, Australian National University

Co-author: Robert Dyball, Fenner School of Environment and Society, Australian National University

Keywords: transformative learning, critical consciousness, food

This paper draws on La Via Campesina's definition of food sovereignty and its potential for reconceptualising food as a basic human right within the dominant Australian food discourse. We argue that the educative value that emerges from urban food production in Australia stems from the action of growing food and its capacity to transform individuals' social and environmental concerns over food systems. Community participation in urban food production can promote a learning process that generates political understanding and concerns over food systems. We use the education theories of transformative learning and critical consciousness to discuss how Australian urban food production system can create this social and environmental support for alternative food systems. By having control over their food production practices and building collective understandings of how food choices impact global food systems, elements of food sovereignty can develop in an Australian urban context.

Integrating infrastructure and management to improve sustainability education and achieve environmental sustainability. *By Louise Blessington*

Presenter: Louise Blessington, Australian National Univeristy

Keywords: environmental sustainability, education, organisational alignment

In the necessary transition to environmental sustainability, education is pivotal in enabling paradigm shifts and therefore sustained change. In an Australian city, local government legislated environmental sustainability as a priority. School infrastructure improvements and more sustainable school management plans aimed to reduce resource consumption and induce long-term attitudinal and behavioral change in staff and students. This study assessed the quantative impact of the two approaches on energy consumption, the extent to which sustainability education increased as a result and to what extent there was a systematic approach to implementation. Electricity savings through the installation of photovoltaic cells were determined from the manufacturer's projections and from electricity bills for school management plans. School and departmental staff were interviewed to determine levels of sustainability education and evidence of a systematic approach to implementation. Energy savings were minimal in comparison to the potential educational benefits that could be derived from the initiatives. Lack of systematic implementation and lack of alignment of stakeholders' aims resulted in missed opportunities for education, with the greatest improvements dependent on individual teacher initiative. Improved inter-level communication and a flexible, systematically-implemented framework would improve both energy savings and sustainability education.

Enthusiasm, ideals and participation: Change agents and socio-psychological dynamics in participatory ESD. *By Jonas Greve Lysgaard*

Presenter: Jonas Greve Lysgaard, Department of Education (DPU) Aarhus University

Co-author: Jeppe Læssøe, (MSO) Department of Education (DPU) Aarhus University

Keywords: education for sustainable development, participation

This contribution aims at furthering the understanding of the socio-psychological mechanisms related to notions of 'enthusiasm', 'ideals' and 'participation', when working with Education for sustainable development. With a special eye towards the non-formal setting, NGOs, we aim at critiquing two widespread dogmas regarding 'participation' and ESD: The first of these dogmas is the idealization of participation. At the principal level it is often put forward as a much stronger way to conduct ESD than approaches with focus on behavior modification, but as a matter practice we find research on what actually happens in such participatory processes highly needed and, as part of that, it is needed to take closer look at the socio-psychological dynamics characterizing the participatory ESD processes and the learning outcome of these. The second dogma refers to the one-sided positive ascriptions to the concept of engagement in theoretical contributions on participatory ESD. No doubt that engagement to some extend is a prerequisite for participation and that it may be strengthened by the participatory process. However, we will argue that a strong focus on engagement also risk influencing the participatory process in ways that impede or change the learning outcome Participatory ESD, formal and non-formal, is often planned and conducted by individuals, change agents, with a strong engagement in the notion of sustainability. The paper will describe enthusiasm in generic terms but also make a point out of unfolding and nuancing the concept. It will include identification of different types of enthusiasts as well as exploration of different socio-psychological dynamics in relation to enthusiasts that may influence, fuel and/or impede, the learning outcome of participatory ESD. The final part of the paper will focus on the potential implications for planning and conducting participatory non-formal ESD.

Understanding the challenge of promoting action competence among university students in sustainability education. *By Flora Bonazzi Piasentin*

Presenter: Flora Bonazzi Piasentin, Federal University of the Recôncavo of Bahia, Brazil

Author: Lin Roberts, Lincoln University

Keywords: sustainability, education, action competence, teaching

Sustainability education aims at promoting the knowledge, skills and values needed for empowering students to tackle complex socio-environmental issues. Emancipatory approaches to sustainability education are also concerned with developing action competence in students. In contrast to a behavior change approach, in which students are induced to behave in a certain way determined by a teacher or other external actors, action competence gives priority to collective actions and requires learners themselves to form their own criteria for decision making and choose their actions in a conscious way. In this article, we will study what are the different components of action competence, how they relate to each other, which type of knowledge, skills and values are related to it, which kind of teaching activities have shown to be successful in stimulating action competence in students and what are the main challenges for promoting it among university students.

Students' perspectives: Interdisciplinary learning about sustainability through IARU. *By Sue-Lin Wong*

Presenter: Sue-Lin Wong, Australian National University (ANU)

Co-authors: Olivia Kelly, Australian National University; Jeanine Wong, Australian National University; Alexander Ferguson, Australian National University

Keywords: education, IARU, Copenhagen Competition, interdisciplinary

A commerce student, an Asian Studies student, a science student and an international relations student walk into a 24 hour study room at the law library. What do you get? The Australian National University (ANU) Copenhagen Competition team! The Copenhagen Competition aims to bring together students from diverse disciplines to tackle issues of sustainability. In university-based teams, we compete against students from all over the world, simulating real-life multilateral, trade negotiations. This year, each team is proposing a green product from their country that could be added to the Sustainable Energy Transfer Agreement (SETA), a World Trade Organisation (WTO) Agreement to bolster green energy trade. The ANU Copenhagen Competition team returned two weeks early from summer holidays to hunker down in the library. We read, researched and taught each other about sustainability; climate change; Australia's policies and green energy products; the interaction of international trade law and social policies. We traversed our university speaking to academics in science, engineering and law; emailed classmates who are now working in renewable energy start-ups and government; and worked the phones calling politicians, scientists and green energy companies across Australia. It was a learning experience unlike any other class we had taken. The problems we were thinking about and tackling felt real, immediate and urgent - a far cry from many of our more black letter law classes. At times we struggled wrapping our heads around very interdisciplinary problems but working as a team, we revelled in both unravelling puzzles and stumbling across new ones. In this session, we would like to reflect on our experiences as the ANU Copenhagen Competition team; the benefits and challenges of the Copenhagen Competition; and how IARU can further encourage cross-institutional, interdisciplinary engagement, particularly through online learning.

Tool Boxes for ESD – examples from University of Gothenburg. *By Barbro Robertsson*

Presenter: Barbro Robertsson, Centre for Environment and Sustainability, University of Gothenburg and Chalmers University of Technology

In 2013 and 2014, University of Gothenburg (UGOT) enhances its ambitions within Education for Sustainable Development (ESD), through developing web based ”tool boxes” supporting university teachers pedagogical work within the field.

UGOT is one of the largest universities in Northern Europe, and it comprises research and education within the Humanities, Social Sciences, Natural Sciences, Arts, Education, Health Sciences, Economics, and IT. ESD has been going on within all these fields, from different perspectives and with different levels of ambition. At the Faculty of Health Sciences, The Sahlgrenska Academy, with 17 undergraduate study programmes, a faculty working group developed plans for integration of SD in courses in all programmes on behalf of the Sahlgrenska Council for Undergraduate Studies 2008-2011. As a continuation of that work, the assistant dean of the faculty commissioned the Centre for Environment and Sustainability in Gothenburg (GMV) – an organization funded by UGOT and Chalmers University of Technology – to develop a web based toolbox for teachers at Sahlgrenska Academy during 2013. In 2014 the UGOT Board of Education agreed on trying to coordinate and, if possible, intensify the processes of integration of SD in all education at the University, and GMV and the faculties of UGOT were commissioned to develop web based faculty specific toolboxes. Within the project, the toolbox is thought of as a place for colleagues to meet, for experiences and knowledge to be documented and spread, and for curiosity to be satisfied. During the presentation examples will be given from the pre and post toolbox work at Sahlgrenska Academy as well as from the different parts of UGOT.

Poster presentation

Blending three different models for interdisciplinary sustainability: Local partnerships, Service-Learning and Faculty Workshops. *By Adrienne Schwarte*

Presenter: Adrienne Schwarte, Maryville College

Co-author: Mark O'Gorman, Maryville College

Keywords: interdisciplinary, service-learning, local partnerships, energy

Sustainability education, through a holistic interdisciplinary approach, must encourage multiple curricular approaches, involving new groups. One university has activated a sustainability strategy using varied, but intentional, models to educate the next generation of sustainability citizens. As action steps to our campus' sustainability plan, three models of interdisciplinary sustainability have been activated: local partnerships, service-learning and faculty workshops. Local Partnerships: This model involves a partnership and grant between our institution, Tennessee Valley Authority (TVA), the largest public utility in the United States and Willdan Energy Solutions, a consulting company. "EnergyRight Solutions for Higher Education" (ERSHE), hires student interns to generate energy savings and promote campus awareness of energy efficiency and renewables use through student-focused projects they research, implement and assess. Tangible campus energy savings, professional career and team-building skills and education in sustainable energy auditing are results of this program. This program is research and solutions-based. Service-Learning: In its second term in Spring 2014, this model marries two-advanced courses; one in environmental studies and another in design through campus/community environmental-service projects to present to professional stakeholders. Using the Kolb model for problem-based service-learning, design students serve as consultants/subject matter experts (SMEs) for environmental politics teams to provide visual solutions to the projects. Design consultants complete commitment agreements, develop personal learning outcomes and write reflections to assess the program based on learning goals. This program is active-learning and experientially-based. Faculty Workshops: Started in 2011, this pedagogy-based program is modeled from the Association for the Advancement of Sustainability in Higher Education (AASHE). To increase course offerings connected to sustainability learning outcomes, expert faculty teach workshops for existing faculty on the philosophy of sustainability and provide roadmaps for integrating sustainability into their courses. Faculty then join the network of campus sustainability educators, with 25% of the faculty trained to date.

Poster presentation

Network of Networks: Structuring knowledge and actions in sustainability science: *By Kiko Yamaguchi*

Presenter: Kiko Yamaguchi, the University of Tokyo

Co-authors: Hideki Mima, the University of Tokyo; Makoto Tanji, the University of Tokyo

Keywords: sustainability, network, visualization, citation, search

The Network of Networks (NNs) is the concept of a comprehensive network linking existing networks of universities and research institutions, enabling cooperation that will utilize the respective strengths of its members more effectively. By increasing opportunities for high-level joint research projects and student exchanges among members of existing networks, the NNs aims to provide a framework for the development of a new, integrated base of scientific knowledge leading to solutions for complex global challenges. The NNs website supports this by offering a free search tool that can help users discover the academic papers, programs and networks among institutions in the field of Sustainability Science. Enhanced by MIMA search, a terminology-based knowledge mining and visualization system, the NNs website does not just search for individual pieces of information, but instead, it mines for information based on semantic relations and displays the results graphically.

Poster presentation

Merging marine eutrophication, LCA and DPSIR into a learning tool for sustainability. *By Nuno Cosme*

Presenter: Nuno Cosme, Technical University of Denmark (DTU)

Co-author: Stig I. Olsen, Technical University of Denmark (DTU)

Keywords: DPSIR, eutrophication, LCA, management, tool

The Drivers-Pressure-State-Impact-Response (DPSIR) is formally an adaptive environmental management approach that integrates the environmental and human systems into a common conceptual framework. The environmental impacts from marine eutrophication may be caused by anthropogenic emissions of nitrogen from human activities, e.g. agriculture and industry. The DPSIR approach applied to marine eutrophication can help identifying the key relevant aspects when assessing and managing specific impacts arising from those emissions. At the same time, DPSIR provides a good conceptual understanding of environmental processes making it suitable for sustainability teaching and communication purposes. Life Cycle Assessment (LCA) has increasingly become a valuable tool to quantitatively assess sustainability and support decision making. The indicator for marine eutrophication in Life Cycle Impact Assessment (LCIA) is built on ecosystem processes (both biogeochemical and ecological) and applies models based on causality and effect, in a similar way to the DPSIR's approach. The inclusion of this causality chain between human activities, emissions, and impacts, integrated with environmental/ecological processes is the focus of many educational and professional training programmes. Such programmes could benefit from practical examples of applied science that intentionally integrate transversal applications. Merging the conceptual framework of DPSIR with a modelling framework from LCIA to assess the impacts from marine eutrophication seems an effective tool in environmental impact management. It may also contribute to informed decisions by producing knowledge supported by evidences from causality and valuable alternatives for management. Furthermore, the approach described here seems relevant and useful as a communication and learning tool, as it bridges science and management while promoting the sustainability of solutions in a practical and educational application.

Energy in a resource-constrained economy

A session looking into strategies and policies that can best promote the transition to alternative energy forms and the wider sets of changes in society that an energy transition will bring about.

Session 1: Challenges of large, low-carbon energy systems

Session 2: Decentralized and rural energy systems

Posters:

Is Germany's energy transition a case of successful green industrial policy? *By Anna Pegels*

Presenter: Anna Pegels, German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE)

Co-author: Wilfried Lütkenhorst, German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE)

Keywords: green industrial policy, renewables, Germany

In this paper, we address the challenge of Germany's energy transition (Energiewende) as the centrepiece of the country's green industrial policy. In addition to creating a sustainable foundation for Germany's energy supply and contributing to global climate change objectives, the Energiewende is intended to create a leading position for German industry in renewable energy technologies, boost innovative capabilities and create employment opportunities in future growth markets. The success in reaching these aims, and indeed the future of the entire concept, is fiercely debated. The paper aims to provide an up-to-date and balanced assessment of costs and benefits of renewable energy support measures. However, since costs and benefits can differ widely between targeted technologies, we compare solar photovoltaic (PV) and wind energy to illustrate critical elements of green industrial policy success. We find mixed evidence that Germany reaches its green industrial policy aims at reasonable costs. Wind energy seems to perform better against all policy objectives, while the solar PV sector has come under intense pressure from international competition. However, this is only a snapshot of current performance, and a dynamic and systemic perspective may nonetheless make the support of various renewable energy sources advisable.

National strategies for the renovation of EU buildings – the key to cutting carbon emissions and improving energy security. *By Dan Staniaszek*

Presenter: Dan Staniaszek, Buildings Performance Institute Europe

Keywords: renovation, buildings, strategies, ambition, co-benefits

By the end of April 2014, all 28 EU Member States are meant to have submitted their strategies for the renovation of national building stocks, in accordance with article 4 of the Energy Efficiency Directive. Given that nearly 40% of energy use and over a third of all EU's CO2 emissions are accounted for by the building sector, these strategies will give an important clue, for the first time, of how seriously the Energy/Climate issue is being taken around European capitals. This paper will present a critical review of a cross section (at least 10) national renovation strategies to benchmark them against the following key criteria:

- Do they include an effective building stock characterisation and appraisal of renovation options?
- Do they include an investment horizon, with plausible sources of funding identified?
- Over what timescale is the strategy intended to have an impact?
- Do the strategies have a credible chance of transforming the renovation market in a given territory?

Renovation strategies will be assessed and ranked according to their level of ambition. Furthermore, interesting or innovative aspects of individual strategies will be described, including the identification of co-benefits. Finally, an idealised "best practice EU strategy", comprising the best elements of the individual national reports, will be presented.

New tools to evaluate land, water and air quality impacts of energy futures: Application to Western North America. *By Tessa Eve Beach*

Presenter: Tessa Eve Beach, University of California, Berkeley

Co-author: Daniel M. Kammen, University of California, Berkeley

Keywords: renewable energy, pollution, water, landuse

The types, quantities, and timing of generation technologies deployed in future energy scenarios involving a shift from conventional to principally renewable sources of primary energy can engender significantly different environmental implications in terms of criteria air pollutants (CAP), water consumption, and land use. We estimate for the years 2030 and 2050 the CAP emissions, water consumption, and direct land requirements of future energy generation scenarios modeled for the western United States and designed to achieve decarbonization objectives under a range of policy, economic, and environmental assumptions. Overall impacts as well as the spatial distribution of impacts across 50 regional load areas are evaluated against a 2016 baseline, business as usual (BAU) in 2030 and 2050, and across scenarios. We show that while 2030 and 2050 CAP emissions and water consumption are lower than the 2016 baseline and BAU across all scenarios, land requirements in 2030 and 2050 are higher. Moreover, there is significant variation in overall impacts across the future scenarios and in the spatial distribution of impacts across load areas. For example, 2030 annual CAP emissions across future scenarios (excluding BAU) show a range of 700,000 metric tons while 2050 annual water consumption (excluding consumption associated with hydropower) shows a range of 1.3 million acre feet. While policymaking focuses largely on decarbonizing the energy sector to mitigate the effects of climate change on the environment, our results suggest that carbon emissions alone do not necessarily serve as a useful indicator of other environmental consequences associated with various energy generation sources. To fully evaluate pathways to a low-carbon economy policymakers must understand the potential short- and long-term air pollution, water, and land use implications of energy scenarios intended to achieve significant carbon reductions because tradeoffs in these impacts will affect the sustainability of society's energy generation choices.

Rivers of commons: Understanding community-run hydro development in Nepal. *By Mine Islar*

Presenter: Mine Islar, Lund University

Keywords: renewables, energy access, Nepal, commons

The proposed project 'Rivers of Commons', aims to provide alternatives and counter narratives to business-as-usual energy governance (either state or market-run) by analyzing the case of Nepalese community-run hydropower development. Analyzing the central role of communities in microhydro development in Nepal and its impacts on participation, environment, rural livelihoods as well as water and land rights, paper's objective is to show whether or not decentralized resource management in renewable energy can be one of the pathways towards a more participatory sustainable energy development. Nepal offers a relevant alternative, since many energy facilities are built and run by communities themselves. Decentralized control over resources is almost a necessity in places like Nepal where rural communities are highly differentiated and stratified in terms of power, income and wealth as well as social status. Due to the inequalities derived from the stratified character of rural, Nepalese communities, paper aims to use Ostrom's collective action approach with the theory of access developed by Ribot and Peluso. Using this framing, it identifies the differentiated patterns of means, relations, and processes that enable/disable community members' opportunities to have access and to derive benefits from decentralized energy production. Empirical evidence is based on interviews and observations during the field visits. The pilot case is the in Myagdi district and Ruma Khola run-of-river-hydro facilities that are built and run by the communities. These facilities supply electricity to 700 households in five villages.

Swarm Electrification - Suggesting a Paradigm Shift through Building Micro-grids Bottom-up. *By Sebastian Groh*

Presenter: Sebastian Groh, TU Berlin

Co-authors: Daniel Philipp, TU Berlin; Brian Edlefsen Lasch, TU Berlin; Hannes Kirchhoff, TU Berlin

Keywords: bottom-up electrification, micro-grid development, microfinance

This paper outlines a bottom-up concept for micro-grids. It investigates how a grid can be build bottom-up in an economically sustainable way and how this approach relates to the current trend on micro-grids. A case study for Bangladesh illustrates the potential for building on the existing infrastructure of solar home systems and underlines the strength of the approach: it aims at economic and infrastructure development created from the communities themselves. Individual stand-alone energy systems are linked together to form a micro-grid that can expand towards and eventually interconnect with national or regional grids. This approach can be likened to the concept of swarm intelligence, where each individual node brings independent input to create a conglomerate of value even greater than the sum of its parts.

Low-energy, low-carbon futures – challenges and perspectives. Some reflections on energy in a resource-constrained world. *By Lars Josephsen*

Presenter: Lars Josephsen, Private

Keywords: low-energy, low-carbon, economy, boundaries, resilience

Transition towards global sustainability in a resource-constrained world will undoubtedly require almost inconceivable transformation of well-known activities like consumption, food-production, transportation, trade etc. The broader societal consequences are largely unknown, but should certainly be explored. Energy constraints will - due to present highly complex technical-organizational structures and economic conditions – represent enormous challenges. Continued growth of global economic activity implies increased world energy demand - and prices. Energy is a 'master resource' in the sense that general global resource constraints (on e.g. special metals, food, arable land, etc.) reinforce energy demand rise. Low-carbon strategies imposed by climate change abatement will further boost overall pressure on energy systems. While impossible to quantify the extent of future global resource constraints, this paper considers ‘moderate’ and ‘strict’ constraints as premises. Transition under ‘moderate’ constraints will call for diverse adjustments of the energy sector. Promotion of ‘green’ economy and ‘green’ energy will undoubtedly be conceived as necessary for the transition. Sceptics might ask: Will green economy ensure genuine sustainability? Conceptualizing transition under ‘strict’ constraints, including an overall low-energy perspective, must be significantly different, involving new principles for guiding thorough transformation of the entire energy system, including basic structural changes. Re-examination is needed of e.g. energy supply-demand systems, consumption patterns and life-styles, particularly in highly industrialized countries. The paper addresses some fundamental issues concerning the way in which 'energy in society' traditionally is considered. Sustainability transition will require new thoughts on e.g. decentralization, self-supply, energy/food relations, communication modes, etc. The analysis re-introduces some basic ideas on economy originating from Karl Polanyi, and promotes the concepts of planetary boundaries and ecological footprint. Further, it highlights aspects of the so-called ‘energy trap’, that may represent a challenge to any future energy planning. Finally, systemic resilience and community energy are drafted as possible future sustainability strategy guidelines.

Poster presentation

Less Energy and More Efficient Design with a Pro-Social Framework. *By Adrienne Schwarte*

Presenter: Adrienne Schwarte, Maryville College

Keywords: energy efficiency, design, social change

This poster presents results from a case study, including survey and data analysis of a design studio to determine the most effective ways to reduce energy use and maintain optimum productivity. It also discusses design curricula, pedagogy and projects alongside the energy reduction measures to educate design students on conscientious energy use, environmental and social responsibility. Energy consumption was measured in the studio using an electricity usage monitor and reported in kilowatt hours (kWh) comparing 'active', 'idle' and total time for an accurate representation of energy consumption. Using a formula based on responses from a student survey regarding average hours of use weekly on the desktop computers outside of class, and average hours of use weekly outside of class for laptop users, a weighted average was generated, based on class type and the total number of hours spent on computers outside of class per week. Calculations were also generated for laptop use that measured battery life less than 20% and battery life fully charged. For total energy consumption in the lab, desktop use generated 108.93 kWh per week compared to 1.48 kWh per week with a laptop battery fully charged and 2.43 kWh per week for the studio when battery life less than 20%. An anticipated 98% reduction in energy for the studio is possible if the studio converted desktops to laptops, while still maintaining satisfaction by the students (per survey data results), and potentially increasing productivity. In parallel with this research is design curricula and projects that provide a pro-social framework with practical education about energy efficiency. This poster includes samples of assignments and action research from Design II/Sustainable Design such as packaging, social action posters, and design work for non-for-profit environmental organizations. These projects follow the Design Ignites Change program guidelines by Adobe® Foundation and Worldstudio Projects.

Poster presentation

Environmental impacts of global and regional electricity generation from 1980 to 2010: What can we learn for sound energy transition plannings? *By Alexis Laurent*

Presenter: Alexis Laurent, Technical University of Denmark - DTU Management Engineering - Division for Quantitative Sustainability Assessment

Co-author: Nieves Espinosa, Technical University of Denmark - DTU Energy Conversion and Storage

Keywords: life cycle assessment, energy planning

The generation of electricity is known to cause important damages to environment and human health. The political awareness of the global challenges posed by climate change and resource depletion has guided several countries to gradually move from a dominant use of fossil fuels towards more utilisation of renewables. However, has such moves led to burden-shifting from these environmental impacts to others as relevant? Considering the whole spectrum of environmental problems, are there any identifiable patterns across regions or impact categories that could serve to draw recommendations for energy planning? To address these questions, we collected annual data on electricity generation for 199 countries and territories for the period 1980-2011, differentiated per types of energy sources. These data were combined with region-specific life cycle inventories of pollutant emissions and resource consumptions to assess ten environmental impact categories, e.g. climate change, water use or chemical pollution. The results show that, for several regions, the majority of these impacts have increased between 1980 and 2011. Asia and the Middle East – and to a lesser degree, Africa and Latin America – thus show steep increase, up to more than one order of magnitude, in nearly all indicators when compared to their 1980-baseline values. To estimate the "environmental cleanness" of the grid mixes over time, the impact scores were normalized by the electricity generated yearly within each country. This revealed burden-shifting occurrences in almost all regions within the period 1980-2011. For example, in Asia, normalized impacts of particulate matters on human health have more than doubled, while increase in climate change scores have been limited to ca. 35%,. Based on our findings, we therefore recommend that electricity planning be accompanied with quantification of all relevant environmental impacts of the foreseen energy systems to prevent or minimise problem-shiftings ensuring an environmentally-sound energy transition.

Poster presentation

Increasing Private Capital Investment into Sustainable Energy Access: A Case for Project and Finance Pooling. *By Dimitry Gershenson*

Presenter: Dimitry Gershenson, University of California, Berkeley

Co-authors: Daniel M. Kammen, University of California, Berkeley; Ashby Monk, Stanford University; Matthew Tilleard, CrossBoundary; Jake Cusack, CrossBoundary

Keywords: finance, microgrids, sustainable, renewable, energy

Estimates by international researchers and development institutions suggest that microgrids will play a significant role in supplying universal energy access to impoverished populations in emerging markets. However, current levels of investment into decentralized energy services are insufficient to reach the development goals identified by initiatives such as the UN's Sustainable Energy for All. In order to reach such levels of deployment, new models of financing need to be designed. In this paper, we provide a conceptual framework for the development of a private sector facility to pool and cross-collateralize diverse capital to support international microgrid portfolios. We begin by discussing the current state of access and approaches to financing and implementing electrification in developing countries. We then qualitatively estimate the risk profile of microgrids in emerging markets and discuss the standard mitigation instruments that are employed today to handle many of these risks. In the third section, we explore the concept of finance pooling and project bundling, develop multiple designs for bundling facilities, and discuss the benefits and drawbacks of each approach, including the potential to further reduce investor risk through novel hedging approaches and strategic combinations of diverse sources of capital. We conclude by discussing the opportunities for academic researchers, in partnership with financial institutions, to improve on this concept, as well as expand the understanding of the risks and returns in the microgrid space.

Feeding future generations with limited resources

A session exploring how food system activities, such as transport, processing, packaging and consuming food, in addition to food production can be modified to enhance food security while limiting further GHG emissions and other aspects of environmental degradation

Session 1:

Session 2:

Posters:

Adapting future food availability and stability to the impacts of environmental change. *By Mark Howden*

Presenter: Mark Howden, CSIRO

Co-authors: Marta Rivera-Ferre, Central University of Catalonia; John Porter, University of Copenhagen

Keywords: climate change, food systems

The potential challenges from environmental change to our food systems are substantial. We will address primarily climate change issues, but acknowledge the interactions with other potential drivers of change. We will focus on food availability and stability while recognising that drivers of change will also affect the other elements of food security (access, utilization). The key potential impacts of climate change on food production are increasingly well-documented and will be summarised, drawing from inter alia CCAFS research and the recent IPCC Working Group 2 report. This report however identified a substantial gap in the literature which we will address, on how climate change may affect the food system beyond production, affecting potential impacts on food availability and food stability. Additionally, the IPCC report identified a range of potential adaptation measures and ways of measuring adaptive capacity but acknowledged the lack of progress in developing implementation pathways for these: in essence noting the need to move from assessment to adaptation action. The fundamental proposition behind adaptation is essentially common-sense: that failure to respond to emerging changes results in either underperformance or increased risk. Hence, there is both an inherent private interest in being well-adapted to change as well as a broader public interest through enhancing food availability and stability. However, this proposition contrasts with the apparent implementation challenge noted above. We approach this looking at adaptation as a problem of transition (what degree of what change at what time, to what, by whom), looking at issues of path dependency and institutional framing. We suggest that our existing agronomic, production focus will not allow the full contribution that science can make to resolve the food availability and stability challenge and that there is an increasing need for greater diversity of types of research is needed in this domain.

Food beyond the farm gate: Environmental change, adaptation and mitigation.

By Sonja Vermeulen

Presenter: Sonja Vermeulen, CCAFS

Keywords: post-farmgate, value-chain, food, adaptation, mitigation

Post-farmgate activities are responsible for an increasing proportion of "food system" drivers of environmental change across the world. At the same time, systems of food distribution currently struggle to supply affordable and nutritious food to all people, and will see stability of supply being increasingly challenged by rising frequency and intensity of extreme climatic events. "Climate-smart" solutions for food, which seek to improve food security and adaptive capacity while lessening intensity of greenhouse gas emissions, have to date focused almost entirely on agricultural production. Our knowledge of adaptation and mitigation measures in post-farmgate activities remains underdeveloped – particularly for the supply chains and value chains that feed food-insecure rural and urban people. Yet, encouragingly, emerging lines of both research activity and development investment are providing a clear agenda for knowledge, policy and practice to move forward on post-farmgate issues.

The role of dietary change in addressing environmental and food security challenges. *By Tara Garnett*

Presenter: Tara Garnett, Food Climate Research Network U of Oxford

Keywords: sustainable diets, nutrition, environment, consumption

The food system today is inequitable, environmentally unsustainable and fails to feed people adequately and effectively. If we are to address our environmental problems, adapt to climate change, reduce the economic costs of unsustainability and create a more food-secure, fairer and nutritionally adequate food future then the current food system needs to change. While this much is recognised, the political and industry response so far has been inadequate. Most of the efforts to date have focused on improving the efficiency of production. However, evidence is mounting that while 'production-side' approaches may be necessary, they do not represent a sufficient response to the multifaceted nature of the problem. To address the multiple challenges we face three additional approaches are needed. First there is a need to address power imbalances in the food system. Second, food losses and waste need to be reduced. Third – and the focus of this paper - diets will need to change. What and how much we eat are directly related to what, how much and in what ways it is produced. We therefore need to consume more 'sustainable diets' – eating patterns that have lower environmental impacts, that deliver broader societal benefits, and support good health. This paper considers first: what we know so far about the characteristics of such diets and where the knowledge gaps lie; and second: what research is needed to support policy action in shifting eating patterns in a more sustainable direction.

New paradigms for development of sustainable food systems: A discussion of emerging innovations for a significant reduction of food loses and waste. *By Barbara Redlingshöfer*

Presenter: Barbara Redlingshöfer, INRA

Keywords: sustainable food systems, emerging innovations

Sustainability of food systems is often addressed through issues related to agricultural production or supply chain. This presentation aims to show that it is necessary to take into account all the steps, including food transformation, packaging, storage, distribution, and domestic preparation and consumption modes. The paradigm shift necessary for a more sustainable food system requires a circular approach focusing on economies of "food mater" ("calories" or "commodities"), "functions" (functional properties such as gelling, foaming or emulsifying properties) and "specialties" (such as micronutrients and biological activity). It also requires a constant arbitration and optimization of the biomass products and co-products usages (food and non-food) and of the fluids (energy, vapor, water, etc.) fluxes. This streamlining requires the establishment of numerous innovations, in order to optimize the functionality of intrinsic food component (instead of supplementation and complex formulation approaches of the “fabricated” foods issued from the dominant agro industrial system) and to develop clean reliable, resilient, efficient and flexible industrial and domestic processes, to reduce losses and environmental impacts while addressing the variability of local raw materials, whatever the season or the supply. Many technical innovations are also needed to maximize the exchange of energy, heat and material on industrial and urban sites and to organize the food systems across a territory in convergence with other systems localized (energy production, tourism, handicrafts, NICTs, etc.). Various examples of emerging organizational and technological innovations and technologies addressing reduction of losses and wastage in industrial eco-systems, food industry, catering system and home food storage and preparation are presented and discussed.

Food security and sustainability: A vulnerability/resilience framework for food systems. *By Thomas Allen*

Presenter: Thomas Allen, Bioversity International

Co-authors: Prosperi, IAMM/CIHEAM - University of Catania - Montpellier SupAgro

Keywords: food security, vulnerability/resilience, food-systems, metrics

Recurrent food crises and climate change, along with habitat loss and foodborne disease outbreaks, have put food security and sustainability at the top of the political agenda. Analyses of the dynamic linkages between food consumption patterns and environmental concerns have recently received considerable attention from the international and scientific community. Sustainable diets and food systems have emerged as critical issues. In particular, the Mediterranean region, as a geographically interlocked and heterogeneous area, presents several conditions of vulnerability related to food insecurity and unsustainability. Indicators are essential in informing action, but concepts, methods and metrics need to be linked in a coherent and systematic way for a multidimensional joint analysis of food and nutrition security and sustainability. Using the lens of a wide sustainability concept, this paper aims at developing a multidimensional framework, applicable to the Mediterranean countries, to evaluate the sustainability of food systems and diets. Derived from natural disaster and sustainability sciences, the framework is developed following two lines: a vulnerability-based approach, enhanced by inputs from the resilience literature, and an analysis of the key issues or pillars of food and nutrition security in Mediterranean countries. This coupled issue/vulnerability approach results in a coherent structure that disentangles exposure, sensitivity and capacities to respond to specified disturbances or drivers of change. Resilience helps further framing coping, adaptation and transformation possible strategies, and provides the concepts to capture by selecting proxy indicators. Acknowledging the systemic dimension of sustainability, the approach allows considering causal factors dynamics. A DELPHI technique is applied in order to select the final cluster of indicators. Use of participatory and consensus-based approaches allows implementing assessments beyond subjective considerations. The subsequent framework improves the design of information systems or metrics assessing the joined environmental, economic, social and health dynamics of food systems.

How do we actually change the business as usual management of agricultural systems? A methodology for building climate smart agriculture. *By Aslihan Arslan*

Presenter: Aslihan Arslan, FAO-UN

Co-authors: Leslie Lipper, FAO-UN; Andrea Cattaneo; Nguyen Van Linh, FAO-UN; Misael Kokwe, FAO-UN; George Phiri, FAO-UN

Keywords: agriculture, climate-change, food-security, adaptation, mitigation

Climate change fundamentally alters how we should manage agricultural systems for food security as the recently released IPCC Working Group II report on Food Security and Food Production Systems has made clear. Climate change is already threatening food systems and agricultural based livelihoods through a range of impact pathways, and these are likely to increase in the absence of adaptation. Agricultural growth is essential for increasing the availability and access to food, but historically such growth has resulted in significant increases in GHG emissions. The climate smart agriculture (CSA) approach was developed in 2010 in recognition of the need to address food security, agricultural development and climate change holistically. CSA was defined as an approach to developing the technical, policy and investment conditions to achieve sustainable agricultural development for food security under climate change. This approach is now being piloted in three countries based on a process developed for a country driven CSA methodology. This involves the development of an evidence base, dialogue and policy harmonization, participatory scenario development, investment analyses and links to climate finance. The paper lays out the methodology and the variation in its implementation across varying circumstances in the three countries. Strengths and weaknesses of the methodology are presented, as well as indications of early outcomes. The paper concludes with a discussion of what will actually be needed to support broader implementation of the CSA approach.

Greenhouse gas emissions from agriculture and land-use change could plateau despite increased food production. *By Eskild H. Bennetzen*

Presenter: Eskild H. Bennetzen, University of Copenhagen

Co-authors: Pete Smith, University of Aberdeen; John R. Porter, University of Copenhagen

Keywords: global agriculture, GHG, climate, mitigation

Since 1970 global agricultural production has more than doubled contributing ~1/4 of the total anthropogenic Greenhouse Gas (GHG) burden in 2010. Food production must be increased to feed our growing human population and changing food demands, but to address climate change agricultural emissions must decrease. Using a modified Kaya identity (the KPI) we estimate and analyse GHG emissions from global agricultural production and land-use change, by including all the determining factors affecting GHG emissions from crop and livestock production on an area- and on a product-basis in one single analysis. We show that agricultural production and GHGs have been decoupled and that global emissions from agriculture and land-use change peaked in 1991 at ~12 Pg CO2-eq. yr-1 and have not exceeded this since – resulting in a 38% reduction in the average carbon footprint per agricultural product since 1970. Although all world regions show a drop in emission per produced unit, it is in the rapid expansion of GHG intensive agricultural activities and the conversion of land to agriculture in Asia, Africa and South America we find reasons for the increase in agricultural emissions. Also, these regions show a relatively slow rate of emission/production decoupling. On the other hand Europe and North America illustrate low emissions intensities on from all sources and figures as the most climate friendly production systems. If current rates of global emission/production decoupling continue, agricultural emissions could initially plateau and decline to 11.5 Pg yr-1 by 2030 and 8.2 Pg yr-1 by 2050 – even in the absence of additional mitigation policy. These findings cast doubt on arguments that agricultural GHG emissions are inelastic, and suggest that sustainable intensification (fewer emissions per unit product) may deliver a significant portion of required GHG mitigation in the agricultural sector.

Poster presentation

Exploring Potentials of a Data-Intensive Approach for Sustainability Quantification. *By Ali Kharrazi*

Presenter: Ali Kharrazi, University of Tokyo

Co-author: Yarime Masaru, Tokyo University

Keywords: sustainability quantification, resilience, economic flows

Research towards the quantification of sustainability can help clarify the concept, track its progress, and assist policy makers objectively make decisions. While the concept of sustainability remains elusive, various attempts to construct a framework towards the quantification of sustainability have been made. In this paper, we review the attempts of emergy, exergy, ecological footprint, and the ecological information-based approach towards quantifying the concept of sustainability. Specifically, these methods are reviewed based on their ability to address three criteria namely, the integration of ecological and economic dimensions, the long term resilience of a system, and the consideration of both extensive and intensive properties, e.g. properties that depend on system size and properties that do not. Furthermore, this paper develops and explores a data intensive approach to quantifying the intensive dimensions of sustainability using the ecological information-based approach. We demonstrate that actual human socio-economic networks show a pattern of commonality when viewed through the introduced metrics and that an intensive dimension of sustainability can be explained through a phenomenological rationale. Specifically, it is demonstrated how the network metrics of effective connectivity and effective number of roles can convey boundaries where economic resource networks are robust. Furthermore, the temporal trends of these metrics suggest multiple basins of attractions and provide clues on the resilience of these networks. This paper can help towards establishing a new computational data-intensive branch in the field of sustainability sciences.

Poster presentation

Studies on safety and low carbon production of rice in China. *By Bai Pu*

Presenter: Bai Pu, Wenzhou Vocational College of Science and Technology

Keywords: safety, low carbon, rice

China is a populous country with a big consumers and on a large scale production of rice. It has very significant to food security, environmental improvement in our globe by increasing rice yield per unit area, reducing the negative effects on the environment because of using pesticides and chemical fertilizers, decreasing emissions of greenhouse gases during rice production. In this paper, on the experience of research and extension on super rice for many years, the author put out applying excellent combinations of super hybrid rice, optimize cropping patterns and discussed the techniques of water management, fertilization and pest control with super-high-yielding, and low-carbon, from taking into account on cutting down emission of greenhouse gas, decreasing inputs and increasing efficiency.

Poster presentation

Food Security and Food Sovereignty for Sustainable Food Systems. *By Federico Davila*

Presenter: Federico Davila, Australian National University

Keywords: food security, sovereignty, socio-ecological systems

This paper, based on Masters Research and current PhD theoretical frameworks, argues that the food security and food sovereignty discourses currently pose challenges and opportunities to global food development programs. A critique of both food security and food sovereignty is first posed. Following this, I present the possible linkages that exist between both discourses, and how they can facilitate rural livelihood donor program development in the future. At its core, this paper contends that social systems cannot be ignored when developing agricultural programs – focusing on environmental outcomes will be insufficient to change the pathway towards sustainability. This can contribute towards the path of alternative 'business as usual' agricultural models. Food production globally has profound sustainability implications from both ecological and social justice domains. A range of development programs tend to facilitate smallholder farmers' uptake of modern technologies, varieties, and agricultural inputs, as well as focus on food products solely as a market commodity to be sold for income, which may eventually lead to profitably business models. This, however, has implications for the socio-ecological systems in which these farmers operate. Sovereign decision making capacity amongst these farmers can be reduced if particular focus to production methods is given. Furthermore, the simplification of landscapes can take place throughout focusing on particular agricultural commodities. Food security drives a large number of bilateral and multilateral food programs. Food security tends to frame food as market commodity, and assumes food producers will be able to profit from their harvests in order to financially access a diversity of products from markets. This assumption, however, fails to include the environmental implications of growing food commodities, as well as the deep cultural and political contexts in which food is produced. It is in this gap that food sovereignty can contribute towards changes in dominant agricultural discourses.

Poster presentation

Can new organic cropping systems produce vegetables with lower use of resources and losses of nitrate? *By Hanne Lakkenborg Kristensen*

Presenter: Hanne Lakkenborg Kristensen, Aarhus University, Dept. of Food Science

Co-authors: Livia Ortolani, Italian Association for Organic Agriculture; Gabriele Campanelli, Consiglio per la Ricerca e la sperimentazione in Agricoltura; Peter von Fragstein, University of Kassel; Franci Bavec, University of Maribor; Stefano Canali, Consiglio per la Ricerca e la sperimentazione in Agricoltura

Keywords: organic farming, vegetables, energy, nitrogen

To secure a sustainable production of plant foods for the future, there is a need to develop new cropping systems. These systems should have reduced needs of external resources and reduced environmental impact, while product yields are maintained at high level. Therefore, field trials were performed in Italy, Slovenia, Germany and Denmark with the aim to study new organic cropping systems for production of vegetable crops; and the systems' effect on labor and energy consumption and the risk of losing nitrate to the water environment. The cropping systems included an in-season living mulch to exploit ecosystem services by attracting beneficial insects, suppressing weeds, and taking up excess nitrogen during production of two high-value crops of leek and cauliflower. The first year results show that high yields and quality were maintained if the living mulches were properly managed e.g. by sowing date or root pruning to control plant competition. The systems including living mulches changed the costs from +22 to -2% and total energy consumption from +14 to -4% compared to sole cropping depending on the change of management techniques in each country. The proportion between human power and fossil fuel consumption was changed. The risk of nitrate leaching was affected to a minor degree depending on the spatial layout of living mulch and crop rows. The study indicates that new cropping systems can be developed based on in-season living mulches for organic production with high yields, weed suppression and reduction of the risk of nitrate leaching. However, the management of the living mulches in terms of machinery, agronomic techniques and timing needs to be developed to optimize outcomes for food security, energy use and environmental impact. The study is part of the INTERVEG project.

Poster presentation

Urban agriculture - part of the solution. *By Henrik Vejre*

Presenter: Henrik Vejre, University of Copenhagen

Co-authors: Frank Lohrberg, University of Aachen; Dona Pickard, Bulgarian Academy of Sciences; Marian Simon Rojo, Universidad Politécnica de Madrid; Sebastian Eiter, Norwegian Forest and Landscape Institute; Lionella Scazzosi, Politecnico di Milano

Keywords: Urban agriculture, sustainability, food, markets

Urban agriculture (UA) covers a wide variety of activities pertaining to food production in and around cities. Producing food as part of urban metabolism has been a very common phenomenon of most urban areas through history. Today UA plays a prominent role in many urban areas of developing countries, while UA gradually lost its role during the industrialization of the OECD countries in the 19th and 20th centuries. UA has remained inside many cities as allotment gardens, and in the fringe areas of many cities agriculture completely adopted to the proximity to the city prevail. In the last couple of decades UA has gained momentum in the post-industrial countries. New forms of UA emerge such as community gardens, roof top gardens, and guerrilla gardens. New actors are entering the UA sector. The role of UA in terms of production, market orientation, social benefits, ecosystem services etc. is largely unknown. A European COST action has mapped various forms of UA and suggests a new and comprehensive understanding of the concept. UA deals basically with food production which one way or the other enters the local food markets - substituting food products otherwise imported from a distance. UA has a spatial component; it takes place in close contact with urban life. UA is oriented towards local markets. UA involves typically local urbanites in networks and plays important social roles. A very crucial question is how UA can contribute to a more sustainable world. With growing cities, growing middle classes with unprecedented demands of food, UA may play a significant role in supplying food to local markets. Shortening food chains, diminishing transport needs, and alleviating the alienation to food production may be key outcomes of UA in the near future. The COST action identifies critical policy needs if UA are to fulfil this.

Poster presentation

The trade-off between short term yield and long term sustainability. *By Jacob Weiner*

Presenter: Jacob Weiner, University of Copenhagen, Department of Plant and Environmental Sciences

Keywords: agriculture, sustainability, ecology, production

Basic principles of ecology and engineering lead to the conclusion that there is an unavoidable trade-off between short term agricultural yield and long term agricultural sustainability (i.e. long term agricultural yield). Research resulting in improved agricultural practices can move the position of the negative relationship between short term yield and sustainability in a favourable direction and perhaps change its shape to some degree, but the relationship will still be negative for any "state of the art". Therefore farmers, agronomists and policymakers must be willing to pay a price to increase sustainability. Agricultural research can reduce this price, but it will never be zero. While this principle is well understood in the management of some renewable natural resources (e.g. fisheries) it is not widely accepted in mainstream agricultural research. Understanding this trade-off is necessary if we are to optimize agricultural production to meet human needs in future generations locally and globally.

Poster presentation

FoodPrinting - A tool for planning and testing sustainable food strategies in cities and regions. *By Julian Cottee*

Presenter: Julian Cottee, 3Keel Ltd.

Co-authors: Richard Sheane, 3Keel Ltd.; Tom Curtis, 3Keel

Keywords: city, food, footprint, strategy, resources

Food sustainability can be measured through a range of lenses and metrics. Each of those measures is highly dependent on numerous factors across the agri-food value chain, and perhaps most significantly of all, the type of foods being consumed and wasted. FoodPrinting involves the characterisation and analysis of regional food consumption and production; quantifying the impacts across supply chains, and identifying the best opportunities to address those impacts. For this to deliver meaningful outputs, based on data, rather than a set of default assumptions about food sustainability, a simple yet systematic and quantitative approach is used. The approach provides an assessment of the scale of resource use underpinning city food systems (energy, water and land use) and reports on a key measure of environmental impact: global warming potential. This is then compared and contrasted with the capacity of regional agricultural systems to produce food. The presentation is an exploration of key findings and lessons from applying the FoodPrinting approach in two UK regions (including Oxford and Greater Manchester). The case studies explore how civic initiatives have used the tool as a means to develop an evidence base and engage with local people, businesses and government on developing more resilient, lower impact food systems.

Poster presentation

The Economics of Land Degradation – Methods and models to establish the benefit of sustainable land management. *By Katrine Grace Turner*

Presenter: Katrine Grace Turner, Aarhus University

Co-authors: Robert Costanza, Australian National University; Ida Kubiszewski, Australian National University

Keywords: degradation, management, sustainability, ecosystem services

Recent studies have established that land degradation decreased the productivity of the world's terrestrial surface by approximately 25% between 1981 and 2003. This is despite the need to meet projected future demands of productivity by a growing human population. Already, between 1-1.5 billion people live with the negative effects of land degradation on a daily basis. The Economics of Land Degradation (ELD) is a global initiative for sustainable land management that aims to increase political and public awareness of the economic costs and benefits of healthy and productive land. This paper looks at the methods and models for quantifying the economics of land degradation on national level. It condenses existing knowledge on land degradation and sustainable development to create compelling economic incentives for policies, business models, and schemes that adopt sustainable land management practises. The last decades have enhanced our understanding of ecosystem goods and services, and how market and institution failures cause unintentional depletion of natural and ecological assets. If we are to improve the performance of these complex systems we need a different approach, a systems approach. It is not achieved by modifying individual parts of the system, particularly where they exhibit high degrees of complexity and are sensitive to efforts aimed at regulation or taxation. The paper identifies drivers and indicators, as well as the stocks, flows, feedback mechanisms, the balancing and reinforcing loops needed to create a systems dynamics model. Improved understanding of these mechanisms is an important step in reversing the declining trend and may help to identify solutions to the problem. This will enable policy-makers and practitioners alike to determine costs of land degradation, land restoration, and identify sustainable management practices and their economic benefits.

Poster presentation

Role of agro-biodiversity conservation and utilization approaches at the local level to address the food security and sustainability. *By Kiran Mani Basnet*

Presenter: Kiran Mani Basnet, International Maize and Wheat Improvement Center (CIMMYT)

Food security and food sustainability have been the intertwined topics and great issue of discussion in today's world where there is disparity among the human populations with respect to the access to and need for food. The choices for food types are getting limited reducing the essential nutrients from the variety of foods. There are instances in parts of the world where people cannot make enough choices for the food types of their demand while in other sector of the world; people just remain stick to sole or very few food crops for survival and even for prestige. In these parts of the world, the national and international development agencies are making the situation even worse by emphasizing these few food crops either through mere distribution or promotion. This has made the local people dependable on external sources for food like never before. As the farmers have put less effort in farming matters involving local crops, the Traditional Knowledge (TK) surrounding these crops is getting lost at a rapid state. This has resulted the Neglected and Underutilized Species (NUS) and crops to remain at the verge of extinction at present which once used to be crops of importance sustaining life there. To tackle this alarming state of emergency, there is a need for the developmental parties to come together and build such a consensus to work locally in the farming communities across the globe digging out the immense Agro-biodiversity (ABD) lying there and explore various ways to conserve and utilize them to establish a sustainable food system. Among different approaches of ABD conservation and utilization, Participatory Crop Improvement (PCI) is a sustainable tool involving local people, especially the farmers.

Poster presentation

Rethinking Organic Waste Management – Integration and upcycling into new bio-based fertilisers. *By Lars Stoumann Jensen*

Presenter: Lars Stoumann Jensen, Dept. of Plant & Environmental Sciences, Univ. of Copenhagen

Co-author: Myles Oelofse, Dept. of Plant & Environmental Sciences, Univ. of Copenhagen

Keywords: nutrients, bio-waste, recycling, upcycling, fertilisers

Intensification of European and global crop and livestock production is driven by an increasing demand for animal protein by a growing and wealthier world population. European livestock produces about 1,270 million ton manure/year, and direct re-use for crops occurs for max. 50% and if not used appropriately, manure represents an eutrophication threat in nitrate vulnerable zones. Concurrently, global urbanization concentrates food and biomass consumption, leading to intensified organic waste generation (around 100 million ton/year in the EU), necessitating appropriate management and recycling of valuable resources, in order to save minerals and energy. Without adaptation of agricultural production and urban waste management systems, current practise is unsustainable and a threat to global development and human health and environment. Furthermore, the production of food, feed and biomass relies on nutrient inputs to crops in the form of synthetic fertilisers. The EU is heavily import dependent for synthetic fertiliser: ore for P, and fossil energy for N, and their provision results in large environmental impacts at both local, regional and global scales. Manure nutrients in the EU have a potential value of €11 billion/year, and farmers currently spend €15 billion/year for synthetic fertilisers. There is an imminent need for increasing substitution of nutrients in synthetic mineral fertiliser with waste derived nutrients formulated into bio-based fertilisers. However, current manure and bio-waste treatment technologies are costly, adds little or no value to the product in return. We must therefore integrate basic chemical and biological knowledge about nutrient dynamics into the industrial processes for the production of bio-based fertilisers from waste resources. The presentation will illustrate current scientific advances in this field and outline a vision for how we can manage waste streams much more intelligently, upcycling valuable waste nutrients and organic matter into new bio-based fertilisers.

Poster presentation

A transdisciplinary approach to food system transformation: chefs as innovators for agro-biodiversity. *By Laura Pereira*

Presenter: Laura Pereira, University of Cape Town

Co-authors: Alexandra Littaye, University of Oxford; Avery McGuire, Nordic Food Lab; Michael Bom Frøst, Nordic Food Lab

Keywords: agro-biodiversity, innovation, chefs, food security

Projections of a burgeoning population coupled with global environmental change offers an increasingly dire picture of the state of the world's food security in the not-too-distant future. The business-as-usual scenario is no longer viable, but what are the means by which we can transform the current food system to become more sustainable, more equitable and more just? Enhancing agro-biodiversity has been proposed as a potential mechanism for shifting the current food system onto a more sustainable pathway, but there are barriers to innovation that will enable systemic uptake of diverse plant species in the formal food system. However, recent research on grassroots and social innovation has uncovered new ways of leveraging innovation to address societal needs, such as sustainability and food security, rather than as a mere techno-centric exercise of calculating the rate of return on investment in R'nD. The objective of this paper is thus to expand on the potential of 'orphan crop innovation' by focusing on what happens in the kitchen as a site of innovation for 'neglected and underutilized' or 'orphan' plant species. Cooking has been said to lie at the intersection of tradition and innovation. We explore this idea using the notion of the chef as innovator, where the 'wow' factor of unique species challenges the chef to creativity that can then be disseminated for wider use. Using research that has been conducted on the identification, collection and preparation of these orphan plant species in the Nordic regions (e.g. chenopodium, sweet clover) and southern Africa (e.g. amaranthus, morogo, Bambara groundnut), we showcase how important this diversity is in creating a more sustainable and equitable food system. Consequently, we identify kitchens as new sites of transformative innovation in the food system, requiring as much consideration as conventional areas of agricultural production, food pricing and calorific content.

Poster presentation

Women, food insecurity and climate change in Central Uganda: Multiple challenges and future directions. *By Vanmala Hiranandani, Runa Midtvåge and Ransom Lekunze*

Presenters: Vanmala Hiranandani, Metropolitan University College; Runa Midtvåge, Global Nutrition and Health, Metropolitan University College; and Ransom Lekunze, Metropolitan University College

Keywords: Uganda, climate change, women, land

Uganda is one of the poorest countries in the world with high-level food insecurity and malnutrition that has alarmingly increased by 30% over the past two decades (FAO, 2012). Most Ugandans depend on agriculture for their livelihoods; however, agriculture has been hit hard by loss of labor due to HIV/AIDS and climate change. Furthermore, food security is gendered in Uganda and relies directly on access to land. The most food insecure households are headed by low-income women and widows of HIV/AIDS patients: women have limited access to land due to cultural norms. There is sparse research on the nexus between women's food security, HIV/AIDS, climate change and land access in Uganda. Overall, research on how women can enhance their food security by mitigating risks and adapting to climatic challenges has only recently picked up (CGIAR & FAO, 2012). This paper presents preliminary findings from a larger research project that examines to what extent and in what ways low-income women's food security in central Uganda (Kampala and neighboring areas of Wakiso and Mukono) is affected by climate change, changing agricultural practices, and existing land tenure system, and to implement appropriate interventions with the community. Initial findings, based on secondary data and partner consultations, suggest that climate change impacts on agriculture and food production have been multifarious in recent years, adversely affecting women's livelihoods and food security and exacerbating their vulnerability. Despite government efforts to mitigate the impacts of climate change, there have been limited efforts to enhance women's adaptive capacity, resilience, access to land and alternative livelihoods. Sustainable solutions in terms of research, policy and practice are outlined. References: FAO. (2012). The state of food insecurity in the world 2012. Rome: FAO. CGIAR & FAO. (2012). Gender and climate change research in agriculture and food security for rural development. Rome: FAO.

From "climate" to "sustainability"

Solutions to climate change focus on energy systems, but sustainability requires us to consider more diverse aspects of our societies. The session explored transferable knowledge from the climate change challenge to sustainable development.

Session 1:

Session 2:

Posters:

Can carbon footprint be an acceptable indicator of environmental sustainability?

By Alexis Laurent

Presenter: Alexis Laurent, Technical University of Denmark - DTU Management Engineering - Division for Quantitative Sustainability Assessment

Co-authors: Stig I. Olsen, Technical University of Denmark - DTU Management Engineering - Division for Quantitative Sustainability Assessment; Michael Z. Hauschild, Technical University of Denmark - DTU Management Engineering - Division for Quantitative Sustainability Assessment

Keywords: life cycle assessment, problem-shifting, climate

In the debate on ecological sustainability, climate change has been raised as an important environmental problem that requires global immediate attention. Policy and decision-making communities currently have a dominant focus on it, extensively drawing on carbon footprint as an easy-to-use indicator for quantifying climate change impacts. Yet, anthropogenic activities cause other – potentially equally important – impacts on ecosystems and human health, like nutrient enrichment or chemical pollution. Can carbon footprint serve as a good proxy to reflect those other environmental impacts in decision-making processes or does the strict focus on this one impact bring the risk of inadvertent problem-shifting to other important environmental impacts? To investigate this question, 13 different indicators of environmental impacts were quantitatively assessed for approximately 4000 life cycles of commodities and services that support our daily life, taken from various sectors like energy production or material production. Comparisons between climate change impact and other impact scores show that some impacts, like acidification or photochemical ozone formation, correlate well with carbon footprint. However, for most product categories, the sole use of carbon footprint cannot inform about the trends for other impacts. In particular it fails to represent those impacts driven by emissions of toxic chemicals or depletion of natural resources. Putting these results in a decision-making perspective, where comparative assessments of environmental performances are typically performed on products or services that provide us similar functions, carbon footprint is generally a poor metric for overall environmental impact. Its use as an indicator in environmental sustainability assessments introduces a non-negligible risk for policy- and decision-makers to inadvertently overlook other relevant impacts on environment and address some impacts at the expense of others. In our striving towards more sustainable societies, these results thus call for a systematic use of more broadly-encompassing tools when assessing and managing environmental sustainability.

Coastal urban futures in Southeast Australia: Partnerships between science, planning and cultural practitioners in developing sustainable solutions. *By Barbara Norman*

Presenter: Barbara Norman, University of Canberra and Australian National University

Co-authors: Will Steffen, The Australian National University; Tony Capon, United Nations University's International Institute for Global Health; John Reid, The Australian National University

Keywords: climate, coastal, urban, community, partnerships

Coastal Urban Climate Futures in South East Australia from Wollongong to Lakes Entrance is an investigation into possible coastal urban futures to 2030 and beyond. The research is on coastal adaptation in the context of climate change. It is broad in its scope by considering environmental, demographic, health and economic change in the southeast coastal region of Australia. It is multi-disciplinary in its approach to the spatial and temporal dimension in considering action on the ground. It involves seven local government areas, two states and several regional organizations and explores some of the critical governance issues. The time horizon is 2030 but longer time frames have been considered where appropriate, for example, when the risks of sea-level rise are included in the analysis. An important dimension is the integrated process in developing solutions. The outcome is an integrated framework for describing what a climate-adapted coastal community may be like in 2030 which incorporated an aesthetic communication strategy involving creative art responses to the research. The process of developing partnerships throughout the project with government, business, cultural agencies and community leaders has subsequently provided a foundation for further collaborative investigations in planning for climate change in coastal urban environments. Coastal Urban Futures received the 2014 national award for cutting edge research and teaching by the Planning Institute of Australia and is part of a broader South East Coastal Adaptation project for Australia.

Analytical framework of the role of agroforestry in sustainable development challenges. *By Cheikh Mbow*

Presenter: Cheikh Mbow, World Agroforestry Centre (ICRAF)

Co-authors: Meine Van Noordwijk, ICRAF; Sammy Carsan, ICRAF

Keywords: agroforestry, climate change, food security

In current literature*, there is a clear dismantled thinking on the impact of agroforestry or similar agro-ecological land use because of the complexity of scientific, political and socio-economic challenges. In the context of climate change and emerging requirements for resilient productive systems, land related issues become central to sustainability challenges. Agroforestry defined as the knowledge and set of practices that combine trees and crops and/or animals needs to be given a full gear for climate responses and climate smart development. Firstly, there is a need to find ways to bundle the multiple benefits of agroforestry and incidentally on mitigation and adaptation. Secondly, there is a clear need to define conditions under which agroforestry can support the trade-offs between mitigation and adaptation and identify new frontiers for safety nets that are beneficial to local vulnerable communities. Thirdly, we need to find frameworks for improving the various policy domains on land use planning in relation to climate change. These policies are mostly related to food security or poverty alleviation and do not always single out agroforestry. Fourthly, the dual need for food and cash have driven three main intensification pathways: 1) rampant use of agrochemicals, 2) judicious use of inputs, and 3) ecological intensification. These are not mutually exclusive, but most of the time there is an imbalance between rent-seeking and livelihood promotion that bring more investment and attention to industrialized productive systems based on high inputs of fertilizers with long term adverse impacts on the environment and the social systems. In order to have a wider attention for agro-ecological intensification, greater adoption of sustainable land use is needed to address both food security and climate change challenges. Based on the discussion of the above this presentation will raise research gaps in the context of the SDGs indicators particularly for Africa.

Adapting climate change in least developed countries: Demonstrating Nepal from sustainability perspective. *By Dipak Bishwokarma*

Presenter: Dipak Bishwokarma, Australian National University

Co-authors: James Pittock, Australian National University; Stephen Dovers, Australian National University

Keywords: adaptation, mainstreaming, sustainability, development planning

Least Developed Countries (LDCs) including Nepal have prepared their national adaptation programme of action (NAPA) based on the conference of parties (COP)-7 decision 29, with the financial support from United Nations Convention on Climate Change (UNFCCC) to address their immediate and urgent adaptation needs. However, sustainable and effective implementation of NAPA in LDCs is always challenging mainly because of limited financial and capable human resource availability. Donor based project and their support is always for a certain period. So, they don't have alternative to adapt climate change utilising their available resources to ensure sustainability. We agree that community based adaptation and mainstreaming adaptation plans in development planning process could be a best option from sustainability perspective. However, we argue that double linkage between local and national level adaptation planning process has to be clearly defined. Nepal, being a pioneer, has been preparing local adaptation plans (LAPAs) in the local government unit level aiming to implement NAPA effectively. LAPA has been preparing in the bottom up approach with the direct participation of local community. NAPA was prepared in top down approach mainly through experts' knowledge. So, we found very thin linkage between NAPA and LAPA since their planning approach was completely different. LAPA implementation seems to be more sustainable since local people have owned it, endorsed on their local development planning, and could use their local resources. However, NAPA implementation is being more donors driven and is very less progress on mainstreaming it on national development planning process. So, we argue that the bottom up mainstreaming approach and double linkage between national and local level adaptation plans is the foundation for sustainability of adaptation actions in LDCs.

Southeast Asian peatlands, climate change and long-term sustainability. *By Choon Nam Ong*

Presenter: Choon Nam Ong, Environmental Research Institute and National University of Singapore

Co-authors: Liya Yu, National University of Singapore; Sanjay Swarup, National University of Singapore

Keywords: food resources, peatlands, climate impact

Southeast Asia is rich with natural resources that support both human lives and natural ecosystems. IPCC (2014) has listed this area as one of the most vulnerable regions in the world for climate change and food security. Irrational human activities could be a major threat to the natural resources in this region and contributing significantly to climate change, and affect food resources. Natural peatlands serve as areas for carbon sequestration and thereby help in slowing the increasing atmospheric concentration of CO2, and hence weakening anthropogenic impacts on the Earth's climate system. Peatlands are formed in low-lying areas due to the accumulation of partially decayed vegetation matter in blocked water. They form 70% of global wetlands, hold 10% of global freshwater resources, and they remarkably sequester 1/3rd of the world's soil carbon. SE Asian peatlands occupy nearly 12% of land area in this region and has 70 Gigatons of soil carbon deposit. Huge biodiversity (1.4-1.8 million species) takes refuge in these peatland forests. At present, these peatlands are under threat from human pressures mainly through drainage and deforestation accompanied with natural and man-made forest fires to clear land for agricultural use. The drainage exposes the woody sequestered biomass to air. Thereby, oxidizing the biomass to CO2 at a rate of ~1.5 Gigatons CO2 per year. This rate constitutes nearly 3-8% of global emissions due to fossil fuels. In addition, other important greenhouse gaseous are perturbed by this microbial action. The oxidation of drained peat is causing rapid subsidence by the disappearance of the peat's surface layers. The impact of peatlands on climate and sustainable food resources thus become a highly delicate issue. This paper attempts to offer an overview on some of challenges facing this region.

Science into policy – Achieving sustainability by adopting low carbon blueprint planning in Malaysian cities. *By Chin Siong Ho*

Presenter: Chin Siong Ho, Universiti Teknologi Malaysia

Co-authors: Yuzuru Matsuoka, Kyoto University; Mikiko Kainuma, National Institute Environmental Studies; Akimasa Sumi, National Institute Environmental Studies

Keywords: sustainability, low carbon society, urbanization

Malaysian government aims to reduce 40% reduction of carbon emission intensity by the year 2020 using 2005 as the base year. Sustainable planning policies were introduced in Malaysia since 1980s focusing mainly on environmental quality improvement and regional land use planning. Several mitigations and adaptation strategies in addressing environmental and climate change are formulated at national, regional and local level to reduce greenhouse gases. This paper aims to examine regional and local resilient policy actions to reduce Greenhouse gases using the empirical case of Iskandar Malaysia. This case is selected because it is one of the fast developing economic corridor regions in Malaysia. In this study, a low carbon blueprint is initiated to guide the rapid development of this economic corridor towards low carbon green growth. The low carbon blueprint provides the sustainable green growth roadmap with major 12 actions for the region. It presents comprehensive climate change mitigation policies (carbon emission intensity reduction actions and sub-actions) and detailed strategies (measures and programs) to guide development of the metropolitan region towards achieving its vision of ‘a strong, sustainable metropolis of international standing’ by 2025. The integration of two competing goals – ‘strong’ and ‘sustainable’ – in a single development vision poses great challenges to IM’s growth policies and development planning. It is done through a bottom approach where focus group discussions are carried out to allow stakeholder participation in the plan formulation.

Understanding disaster risk and resilience for effective policy: Requirements and ways forward. *By Reinhard Mechler*

Presenter: Reinhard Mechler, IIASA

Co-authors: Adriana Keating, IIASA; Junko Mochizuki, IIASA

Keywords: risk management, resilience, climate change

The management of extreme events is heavily debated in discourses on sustainability, risk management and climate change. All of these discourses are expected to deliver tangible outcomes in 2015 at the World Conference on Disaster Risk Reduction in Sendai, UNFCCC's COP 21 in Paris and as part of the Sustainable Development Goals process. Natural disasters are considered game changers for national and international policy, yet, "true" action has not been substantial and investment into pre-event disaster prevention is trumped heavily by post-disaster assistance. In order to help take a combined agenda forward, we suggest enhanced understanding of risk and resilience will be essential to this debate. Climate-related risks are twice caused by anthropogenic interference. Anthropogenic climate change, in addition to causing gradual shifts, is modifying many climate extremes. A second -very different- anthropogenic contribution is through the interaction of socio-economic exposure and vulnerability with hazards. These two components are often mixed up, and not examined sufficiently in terms of what they mean for disaster risk management, climate adaptation and sustainability-related policies and implementation of options. Once risk is understood, risk management can address the drivers as well as identify options that build. We consider resilience as the capacity of a system, community or society to pursue its social, ecological and socio-economic development objectives, while managing its disaster risk over time in a mutually reinforcing way. In a dynamic environment, to continuously grow and develop in the face of risk implies the need for a risk management process that also considers learning, innovation and transformation. Iterative Risk Management is an approach to risk management that links expert risk analysis together with stakeholder participation. Our presentation discusses ways forward including systems-based modelling analysis co-generated with development practitioners and stakeholders in disaster-and climate hotspots in Peru, Nepal and Indonesia.

Re-framing climate change as sustainable development: An investigation of the IPCC assessment reports. *By Rishikesh Ram Bhandary*

Presenter: Rishikesh Ram Bhandary, the Fletcher School of Law and Diplomacy

Keywords: climate, sustainability, IPCC, assessments

This paper investigates the attempts by the Intergovernmental Panel on Climate Change to integrate sustainable development into its assessment reports. By a careful text analysis and interviews with authors involved in drafting chapters of these assessments, the paper identifies barriers that have prevented a greater integration and re-framing of climate change as an issue of sustainability. Some of these barriers include: cognitional, ideological, tactical and strategic. The AR5 has tried to cast the exercise of climate policy as being conducted within the larger framework of sustainable development to allow the assessment of trade-offs including equity issues. This has most notably been supported by the cross-chapter emphasis on co-benefits. Key questions including larger themes that remain are: how does the understanding of 'expertise' change with the reframing and what this means for subsequent assessment reports; if climate change is seen as a symptom of a set of root causes of a global sustainability crisis, beyond sustainable development being a framework for trade-offs, how do we operationalize pathways; and apart from equity, what does the reframing mean for principles and more concretely for decision-making?

Effective adaptation strategies for reducing climate change related disaster risks in the coastal region of Bangladesh. *By Sarder Shafiqul Alam*

Presenter: Sarder Shafiqul Alam, Bangladesh Centre for Advanced Studies (BCAS)

Keywords: climate change, adaptation, sustainable development

Effective adaptation options are needed to reduce the risks of climatic disasters in coastal communities in Bangladesh. Traditionally, coastal people practice a number of adaptation actions to reduce climatic disaster risks and vulnerabilities. The programme “Action Research for Community Adaptation in Bangladesh” recently carried out a baseline study that provides knowledge on climatic disaster risks and vulnerabilities and on community adaptation strategies that are required to enhance resilience of communities and support their sustainable development. Household surveys and different participatory exercise findings reveal that the Shymanagar Upazila (sub-district) in Satkhira district, Koyra Upazila in Khulna district, Barguna Sadar Upazila in Barguna district, Galachipa Upazila in Patuakhali district and Sandwip Upazila in Chittagonj district (coastal regions of Bangladesh) are all highly vulnerable to climate change related disasters such as coastal flooding associated with tropical cyclone (with storm surge), sea level rise, and high tides, coastal erosion, torrential rainfall and consequent flooding, salinity intrusion; and drought. People’s perception is that climatic disaster frequencies and impacts are increasing over recent decades in those Upazilas and possibly will increase further due to climate change. Present adaptation strategies and actions need to be revised and made effective. Importantly, adaptation strategies need to be integrated with the broader goal of poverty reduction and sustainable development. Communities and other stakeholders identified a number of adaptation strategies and actions which formed the basis for Community Based Adaptation (CBA) to climate change action plan. The CBA plan will provide a sound framework for implementation by government departments, NGOs

Co-evolutionary approach for regional scale sustainability. *By Sarwar Hossain*

Presenter: Sarwar Hossain, Geography and Environment, University of Southampton

Co-author: John Dearing, Geography and Environment, University of Southampton

Keywords: sustainability, co-evolution, trend, tipping point

Humanity is in a new phase of sustainability challenges because of the anthropogenic activities are dominantly influencing the earth climate and ecosystems over the past two centuries. Even though, climate change has attained most of the attention among those challenges, we need to address all challenges simultaneously for regional scale sustainability. Therefore, we have attempted to show empirically how we can address sustainability challenges in regional scale by applying co-evolutionary approach in the south west coastal area of Bangladesh which is one of the most climate vulnerable regions in the world. Time-series data for a range of ecosystem services and drivers are analysed to define the range of trends, the presence of change points, slow and fast variables, and the significant drivers of change. Since the 1980s, increasing GDP and per capita income mirror rising levels of food and inland fish production. As a result, the size of population below the poverty line has reduced by ~10%. In contrast, non-food ecosystem services such as water availability, water quality and land stability have deteriorated. Conversion of rice fields to shrimp farms is almost certainly a factor in increasing soil and surface water salinity. Most of the services experienced statistically significant change points between 1975 and 1980 and among the services, water availability, shrimp farming and maintenance of biodiversity appear to have passed tipping points. An environmental Kuznets curve analysis suggests that the point at which growing economic wealth feeds back into effective environmental protection has not yet been reached for water resources. Sequential principal component analysis applied to investigate the historical connectedness in the system. Trends in indicators of ecosystem services and human wellbeing point to widespread non-stationary dynamics governed by slowly changing variables with increased probability of systemic threshold changes/tipping points in the near future.

Poster presentation

Energy conservation under solar control – An analysis. *By Abhinav Chaturvedi*

Presenter: Abhinav Chaturvedi, Aayojan School of Architecture

Co-author: Joohi Chaturvedi, AARDAS

Keywords: solar passive design technique

The Existing built up structures are consumers of 40% of the global primary energy and generator of 24% CO2 emission. But this Built environment itself offers enormous opportunities in scaling down this energy consumption. In history buildings do not artificial systems of cooling or heating. These buildings, especially in Arid and Semi Arid Climate, are provided with Solar Passive Design Techniques that is the reason of comfort inside the buildings. Present paper describes Various Solar Passive design techniques used in past, and the same could be used in present to reduce the consumption of energy

Poster presentation

Trade-offs between different measures of sustainability – a case study of Indian rice production-distribution systems. *By Alfred Gathorne-Hardy*

Presenter: Alfred Gathorne-Hardy, University of Oxford

Co-authors: Barbara Harriss-White, University of Oxford; D. N. Reddy, National Institute for Rural Development; Deepak Mishra, JNU; M. Venkatanarayana, National Institute for Rural Development

Keywords: SRI, rice, paddy, sustainability, India

Sustainability is an inherently complex and messy concept, yet product/sector sustainability analysis often reduces this to only one or two indicators. In contrast, this research developed and tested a novel method to embrace these complications. We fused life cycle assessment, value chain analysis, and social indicators to understand the impacts of different methods of growing, transporting, milling and retailing rice from the environmental, economic and social perspectives. The research looked at four paddy production technologies (organic, rain fed, conventional intensive, and Systems of Rice Intensification (SRI)); different sizes of mills; different transport types and distances; and three systems of retail (supermarket, informal retail and government ration shops). At each stage nine measures of sustainability where used: greenhouse gas emissions, ground water, total energy, human/animal energy, gender, quantity of labour, quality of employment, costs and profits. Agriculture dominated the environmental impacts of the entire supply chain, and provides the greatest total quantity of employment, independent of production system. Yet agriculture also provides some of the lowest employment quality, and within different agricultural systems trade-offs appear – between social and economic measures, and within environmental metrics too. Transport, even over considerable distances (<700km) had minimal environmental impact, and provided minimal labour. The employment quality was higher than much of the agricultural sector. Different retail outlets differed considerably in their environmental and social impact. The regulated sector (government ration shops and supermarkets) had higher employment quality compared to the informal sector, yet supermarkets had considerably higher GHG emissions – largely due to the air conditioning of stores. Overall, the research demonstrates that it is possible to fuse different tools to understand the wider sustainability implications of a single industry, and that within the case study industry of rice, sustainability trade-offs are inherent, and without such a wide analysis, would occur without understanding.

Poster presentation

Glimpse from northern hemisphere: life evolving during an ancient period of global heating and volcanic activity. *By Bo Schultz*

Presenter: Bo Schultz, Muserum

Co-authors: Niels Bonde, Zoological Museum (SNM); Pi Suhr Willumsen, Department of Earth Sciences, Aarhus University; Franziska Nenning, Institute for Geology and Paleontology, University Muenster; Petra Larissa Schoon, NIOZ, Royal Netherlands Institute for Sea Research; Johan Lindgren, Dept. of Geology, Lund University; Claus Heilmann-Clausen, Department of Geoscience, Aarhus University; Jan Tapdrup, Muserums division of natural history; Rene Sylvestersen, Muserums division of natural history; Barbara Teichert, Institute for Geology and Paleontology, University Muenster

Keywords: global heating, carbondioxid, fauna-changes, PETM, Glendonite

In a world with carbon dioxide-induced climate change, it is necessary to gain insights into the natural variability and climate alterations devoid of human influence. The earliest Eocene is characterized by a 'hothouse' world with tropical and subtropical climates at high latitudes, interrupted by a cooling event. Hence, fossil information is interesting for the corresponding climate zones of the modern world. In the earliest Eocene (56 to 54 million years ago) global heating followed by cooling occurred and partially new biota were established. During the Early Eocene our world experienced massive release of methane or/and carbon dioxide, resulting in a temperature increase of 5–8° C over a brief period of 200,000 years (55.8 to 55.6 my ago), the Palaeocene Eocene Thermal Maximum (PETM). This event lasted until heavy volcanism from the North Atlantic Igneous Province (NAIP) halted the temperature rise about 55.6 to 54 my ago. Glendonites interbedded with volcanic ashes in the Fur Formation (diatomite) suggest significant cooling linked to the volcanic eruptions. Later, when the NAIP was calmer, a greenhouse climate was re-established (termed the Early Eocene Climate Optimum). Polecat Bench in Wyoming, USA, offers a unique terrestrial window into the PETM, showing an important turnover of the mammal fauna during the event. Preserved are fossil leaves reflecting global carbon dioxide fluctuations. The Fur Formation of Denmark comprises similar unique fossil-bearing marine strata that in addition to the PETM also hold nearly 200 volcanic ash layers from the NAIP. The fauna and flora of the Fur Formation includes not only marine taxa (diatoms, many fishes, few turtles), but also elements of nearby terrestrial environments, indicated by 150 spore and pollen species, fruits, leaves and driftwood, 200 insect and over 30 bird species.

Poster presentation

Scarcity, efficiency and the paracommons of natural resource losses, wastes and wastages. *By Bruce Lankford*

Presenter: Bruce Lankford, University of East Anglia

Keywords: efficiency, natural resources, commons, waste

In a world of increasing scarcity, the tracking, amount and ownership of ‘saved’ resources while controlling for rebound (where savings lead to consumption elsewhere) will be of increasing importance as exemplified by Norris (2011) “… the United States Supreme Court’s recent decision in Montana v Wyoming brings to the forefront one of the most complicated and contested facets of irrigation efficiency: who owns the rights to the conserved water?” Using this and other case material, this paper explores the concept of "the paracommons", through which the savings of increased resource efficiency can be viewed as a common pool problem. In effect this asks; "who gets the gain of an efficiency gain?" By reusing, economising and avoiding losses, wastes and wastages, freed up resources are available for further use by four ‘destinations’; the proprietor, parties directly connected to that user, the wider economy or returned to the common pool. The paracommons is thus a commons of – and competition for – resources salvaged by changes to the efficiency of natural resource systems. ‘Liminality’ will be explored signalling the in-betweenness of systems caught between overly optimistic prefigurations of future efficiencies and disappointing outcomes.

Poster presentation

Pursue applied sustainability in agriculture. *By Frank Oudshoorn*

Presenter: Frank Oudshoorn, Aarhus University, Department of Engineering

Co-authors: Claus Grøn Sørensen, Aarhus University; Anke Stubsgaard, Knowledge center for Agriculture; Evelien de Olde, Aarhus University

Keywords: holistic, sustainable agriculture, operational, documentation

Environmental sustainability has been presented as the principal focus for agricultural production of the future. A few decades ago, local toxic pollution of ground water, surface water and acidification were the major concerns, whereas now global GHG emissions and limited resources are in focus. Live Cycle Assessment (LCA) is commonly accepted as the key methodological approach for optimisation efforts, even though the computational issue of scope and system expansion are being discussed. Concurrent assessments on profitability of the production, measured as remuneration per kg, ha or animal unit has always been set as the condition for production performance. But consumers and the processing industry demand documentation beyond singular environmental or economic parameters. They require inclusion of social and governance issues and integration in a holistic assessment. Documenting and visualising social issues (e.g. animal welfare, biodiversity, landscape, product quality) together with environmental and economic issues, pertaining to the society and the consumer, will provide the basis for informed operational improvements at the production level. In organic agricultural production in Denmark, the industry and primary production have allied in developing a sustainability assessment tool which can be used for documentation of sustainability and improvement of specific indicators of sustainability (SI). These can be soil use, animal husbandry, nutrient flows, water use, energy and climate, biodiversity and plant production, working conditions, quality of life, economic viability, and farm management. A three way dissemination of the results aiming at producers, consumers and politics is a challenge, as the requirements for specificity and scope will be different.

Poster presentation

Water harvest for drought resilient agriculture: Prospect and possibilities in Bangladesh. *By Hasan M. Abdullah*

Presenter: Hasan M. Abdullah, BSMR Agricultural University

Keywords: drought, water harvest, adaptation, resilience

Agriculture is the single largest sector of the economy of Bangladesh since it comprises about 18.6% of the country's GDP and employs around 45% of the total labor force. The performance of this sector has an overwhelming impact on major macroeconomic indicators like employment generation, poverty alleviation, human resource development and food security. Bangladesh achieves a position of being able to produce enough rice not only to meet its food, feed, and seed requirements, but also to be left with some exportable surplus. Yet, the agriculture sector is extremely vulnerable to disaster and climate induced risks. Climate change is anticipated to aggravate the frequency and intensity of extreme weather events in Bangladesh. Drought is one of the major problems for the agriculture and its development in the country. It is a slow extermination can last for days to several years with a devastating effect on the agriculture and livelihood. There are some regions in Bangladesh where every steps of agriculture from field preparation to ripening of crops dependents on rainfall. Consequently, drought affects annually 3.7 million ha. Therefore, drought management is a major challenge in achieving sustainable agricultural development. Cross-country anthropogenic activities (upstream dams) caused a severe negative impact on water resources and eco-systems in the recent years. The water bodies dry up during the dry season and make the people completely dependent on groundwater. Accordingly the contribution of groundwater as a source of irrigation has increased and surface water has declined. It is now inevitable to look for alternate water source for agriculture. Water harvest technologies (WHTs) can play an important role. WHTs can provide an additional source of water for crop at the critical stages of the growing season, thereby increasing yields and food security. Appropriate water harvest technology and its up scaling could contribute to sustainable agriculture.

Poster presentation

Integrating development issues into global supply chain management: The role of multinational companies. *By Ilona Szőcs*

Presenter: Ilona Szőcs, Vienna University of Economics and Business (WU)

Co-authors: Florian Findler, Vienna University of Economics and Business (WU); Norma Schönherr, Vienna University of Economics and Business (WU)

Keywords: MNCs, supply chains, impact assessment

The manufacturing industry in many developing countries is an integrated part of global supply chains. As a result, the decisions of multinational companies (MNCs) on environmental, social, and economic issues are not a local phenomenon anymore, but have strong influences on societies around the world. While several attempts have been made to integrate environmental issues into supply chain management, the aspects of social issues have not been fully implemented into the existing models by now. In this context, we focus on two main aspects: the role of MNCs in global supply chains, and their impact on global development issues in developing countries. Our analysis offers a comprehensive overview of key theoretical approaches, frameworks, and recent paradigm shifts within the area of sustainable supply chain management. Besides the scientific debate, we shed light on the positions of actors from the political, civil society, and business arena. We critically assess the strengths, weaknesses, opportunities and threats of a selected set of three tools with reference to sustainable supply chain performance. The study concludes by suggesting specific criteria for tools to meet in order to measure corporate impact in supply chains. This study is embedded in the GLOBAL VALUE project (www.global-value.eu) and aims at providing substantial input for integrating development issues into the supply chain operations reference (SCOR) model.

Poster presentation

Low carbon pathways for urban transportation: Emission reductions and health co-benefits for the case of Bilbao, Spain. *By Joseph V. Spadaro*

Presenter: Joseph V. Spadaro, Basque Centre for Climate Change

Co-authors: Sergio H. Faria, Basque Centre for Climate Change; Anil Markandya, Basque Centre for Climate Change

Keywords: transportation, biofuels, climate, health impacts

A reliable, efficient and affordable transportation system is crucial to social development and economic growth. The increasing worldwide demand to move people/goods, however, is outpacing the available transportation infrastructure, particularly in rapidly developing countries which will experience a several-fold increase in personal travel by 2050. Transportation is a key driver of increasing global warming (IPCC 5th Assessment Report), contributing one-quarter of carbon emissions, of which surface transportation makes-up 75%. Transportation is the main driver of urban air quality degradation, increasing PM, NOx, CO, VOC, and ozone (indirectly) concentrations. These pollutants have adverse health impacts. Unless there is a major political effort and public willingness to change current energy use patterns and travel modes, world transportation-related energy and carbon emissions are projected to double by 2050 against 2010. We carry out a comparative assessment of potential carbon emission reductions and health co-benefits by considering strategies for decarbonising urban transport. Our results indicate that aggressive changes are needed to reduce 2050 carbon emissions by 30% compared to today. Changes will impact vehicle fuel economy and operation (advanced designs, carpooling, maintenance), material substitution, urban mobility (lower private car demand and greater public transportation use), fuel choice (less petroleum-based fuels and greater biofuels/electrons use), and electricity mix (greater use of renewables/nuclear and decarbonised fossil fuels). Particulate emissions and attributed health impacts are halved. The next generation of biofuels (cellulosic-based and non-food crops such as algae) are expected to have much lower carbon lifecycle emissions than present generation biofuels, significantly higher yield rates, and compete less for croplands. Public acceptance is fundamental to bring about changes in attitudes and behaviour. Given the long lead times to reach political consensus and then to implement mitigation measures to limit the global mean surface temperature increase to within 2℃ of preindustrial levels, the time to act is now.

Poster presentation

A better life with a smaller footprint? Understanding happiness, satisfiers and nature's contribution. *By Lin Roberts*

Presenter: Lin Roberts, Lincoln University

Co-authors: Kevin Moore, Lincoln University; John Quinn, National Institute of Water and Atmospheric Research; Michael Townsend, National Institute of Water and Atmospheric Research

Keywords: wellbeing, happiness, satisfiers, ecosystem services

The desire to increase human wellbeing is the driver for most of the negative impacts humans have on ecosystems and the services they provide. Yet evidence is increasing that many of our actions (e.g. materialistic consumption, pursuit of ever higher GDP) do not deliver the wellbeing and happiness benefits we expect, and also that when ecosystem services are reduced, human wellbeing declines. Some of our actions in striving to improve our wellbeing therefore seem to be actually jeopardising it over the long term. Max-Neef (1991) distinguishes between our basic human needs, which are universal, and how we satisfy those needs, which varies with different individual and cultures. He also recognises that not all 'satisfiers' are equally effective at allowing people to meet their needs, and some may actually inhibit our ability to meet our needs and achieve wellbeing. This paper will report on a recent study funded by the New Zealand Department of Conservation which has gathered evidence of the myriad ways that indigenous ecosystem services help New Zealanders to satisfy each of the nine basic needs identified by Max-Neef: subsistence, protection, affection, understanding, participation, idleness, creation, identity and freedom. This is seen as a first step to promoting discussion about the components of wellbeing (e.g. what really does make us happy?), the effectiveness of different types of satisfiers in contributing to happiness and wellbeing, and our dependence on natural systems for providing it. We believe that fostering such discussion and research will broaden our understanding of the many factors that contribute to personal and national wellbeing, and improve our ability both as individuals and societies to choose satisfiers that both make us happier and reduce the level of impact we have on ecosystems that support us, thus achieving the "double dividend" of enhanced wellbeing and flourishing ecosystems.

Poster presentation

Social and geographical indicators for assessing vulnerability of urban African communities. *By Lise Herslund*

Presenter: Lise Herslund, Institute of Geosciences and Natural Resource Management, University of Copenhagen

Co-authors: Patrik Karlsson Nyed, Institute for Geosciences and Natural Resource Management; Nathalie Jean-Baptiste, Department of Urban and Environmental Sociology, Helmholtz-Centre for Environmental Research, Leipzig

Keywords: vulnerability indicators, adaptation, stakeholder selection

There is no shortage of indicators for vulnerability assessment in Africa, yet there seems to be increasing doubts on how effective they can be and to what extent they can provide a representative estimation of the vulnerability of urban communities. It appears that uncertainties about vulnerability indicators often rest in their modes of developments rather than in their ability to represent what and who is vulnerable. With this in mind, an effort was made to systematically develop context-centered indicators to be applied in two East African case cities, Addis Ababa and Dar es Salaam. This paper focuses on the participatory development and selection of such indicators, their qualitative and quantitative application and what impact they can have in places with difficult access to data and complex dynamics. First, an initial system of indicators comprising of physical, asset, institutional and attitudinal factors was developed with the aim of integrating multiple dimensions to assess the degree to which communities can anticipate, resist, cope and recover to recurrent flooding. Second, an extended list of multi-dimension indicators was then prioritized into a city-specific indicator set for each of the case cities. This was done in a participatory process where multi-level and sector stakeholders collectively selected and weighted the indicators. Third, a system for how to work with the selected multi-dimensional indicators quantitatively and how to integrate them into a GIS was developed. This step explored in particular how geodata, censuses and surveys could be combined to produce vulnerability maps for a city at the resolution of the finest administrative level. The vulnerability maps highlight the most vulnerable areas of a city and are able to convey information inherent to the indicators to the end-users in an easy and comprehensible way. Keywords: Vulnerability indicators, adaptation, stakeholder selection

Poster presentation

Climate Adaptation to Smallholder Farmers – A Sustainable Approach in Gandaki River Basin, Nepal. *By Madan Lall Shrestha*

Presenter: Madan Lall Shrestha

Co-authors: Jeeban Panthi; Nir Krakauer

Keywords: climate, livestock, Gandak, PRECIS

Nepal is experiencing the significant changes in climate, which have a direct and severe impact in various fields. A study has been undertaken to look at the impact to the farmer communities, including the livestock smallholders in the Gandaki river basin of central Nepal. The Gandaki River is one of the tributaries of the Ganges River. The observed climate and the future scenarios using regional climate model (PRECIS) in the basin has shown the increase in temperature with more in the higher than in the lower altitudes. Though the precipitation pattern does not show any significant trend there is a clear indication of increasing variability. In addition, future projections indicate that the dry part is becoming dryer and wet is becoming wetter, which affects the smallholders farmers the most. The survey result in the basin shows that water is the main obstacle for sustainable livestock and agriculture farming in the basin. In such context of climate variability, this study aims to enhance resiliency among livestock smallholders by equipping them with new technologies for managing water in order to grow feed and improve livestock productivity. Few proven technologies like drip irrigation system, nutritional fodder production, experimenting of the drought resistant fodder species, slope stabilization, composting, kitchen gardening have been demonstrated in three demonstration sites in the basin. The combination of legume and cereal fodder species showed improvement in soil nutrient status as well as that of the livestock development. Water consumption result from different irrigation systems and drip irrigation is found effective in saving about 60% of the water consumption than the traditional system of furrow irrigation. With such modifications in their traditional practice smallholder farmers have benefited especially the women who are directly connected to the demonstration sites for transferring the technology to their farms.

Poster presentation

Sufficiency based sustainable business model innovations – towards a typology.

By Nancy Bocken

Presenter: Nancy Bocken, University of Cambridge, Department of Engineering

Keywords: sustainable consumption, frugal innovation, sustainability

Business models define the way a firm does business. As such, sustainable business model innovation may be viewed as an important lever for change to 'business as usual' to tackle pressing sustainability issues. Sustainable business model archetypes are groupings of mechanisms and solutions that may contribute to building up the sustainable business model and include: Maximise material and energy efficiency; Closing resource loops; Substitute with renewables and natural processes; Deliver functionality rather than ownership; Adopt a stewardship role; Encourage sufficiency; Seek inclusive value creation and Re-purpose the business for society/environment (adapted from Bocken et al., 2014). Sufficiency based sustainable business models seek to reduce consumption and, as a result, production. The focus is on influencing consumption behaviour, which may involve product design for durability, a fundamental shift in promotion and sales (e.g. no overselling) and supplier selection based on durability. Profitability would typically result from premium pricing, customer loyalty, and increased market share from better (e.g. longer lasting) products, while societal and environmental benefits include reuse of products and resources across generations, reductions in product use and societal education (Bocken et al., 2014). This research explores the potential of sufficiency based business model innovations using a case study approach. Key business model elements of leading company cases are analysed and important 'sufficiency themes' are observed from the literature. Based on this, a typology for sufficiency-based business models is formed, which may facilitate the process of building up such business models. References

Bocken, N.M.P., Short, S.W., Rana, P., Evans, S. 2014. A literature and practice review to develop sustainable business model archetypes. Journal of Cleaner Production, 65, 42–56

Poster presentation

Implementing the Ecosystem Services Approach at the municipal level: a transdisciplinary project with coastal communities in south Sweden. *By Nils Ekelund*

Presenter: Nils Ekelund, Malmö University

Co-authors: Torleif Bramryd, Lund University; Ingemar Jönsson, Kristianstad University; Thomas Palo, Umeå University; Christine Wamsler, Lund University

Keywords: ecosystem services, municipal planning

In Sweden a unique project supported by the Swedish Environmental Protection Agency will be developed in close collaboration with coastal municipalities in Skåne, and with a coordinating role by Skåne´s Association of Local Authorities. These municipalities face a range of different environmental challenges, from areas along the eastern coast line facing problems related to the Baltic Sea, to municipalities in the Öresund region. In this study a range of different environmental conditions and related ecosystem services, from vulnerability to floods, erosion and sea level rise to strong pressure on coastal systems from urbanization will be investigated. Research questions and directions are built on cases and scenarios which are a part of the local municipality planning process. The approach will be to study the premises of implementing the Ecosystem Services (ES) in municipal planning and decision making of five coastal municipalities. The present study will analyse past decisions, present planning and future challenges for municipality development and management from the perspective of ES, with the aim of increasing our understanding of the ES concept as a tool for sustainable development. A second aim of the project is to evaluate the potential value of connecting the ES approach to ongoing climate change adaptation in the municipalities. The project will use the six-step approach developed by the Economics of Ecosystems and Biodiversity framework (TEEB) as the main conceptual frame. This approach includes the following steps: 1) Identifying and agreeing on the problem with stakeholders, 2) Identify the ES which are most relevant and pressing in municipality planning, 3) Collect and identify the information needs and the method to collect the data, 4) Assess expected changes in ES due to decision and input from society, 5) Identify policy options based on changes in ES and 6) Assess social and environmental impacts of 1-5.

Poster presentation

Vulnerabilities caused by climate change and their adaptation strategies in Mongolia. *By Qinxue Wang*

Presenter: Qinxue Wang, National Institute for Environmental Studies

Co-authors: Masataka WATANABE, Keio University; Tomohiro OKADERA, National Institute for Environmental Studies; Zhigang SUN, National Institute for Environmental Studies; Qingan XIAO, National Institute for Environmental Studies

Keywords: climate change, vulnerability, adaptation, Mongolia

Mongolia is one of the countries especially vulnerable to climate change. According to observations of 41 meteorological stations, annual air temperature has increased by 2.1 °C in last 40 years. About 40% of total population in Mongolia relies on livestock and other climate-dependent sectors for livelihood. Any impact on pasture availability would threaten forage yield as well as livestock productivity. In this study, we evaluated the vulnerabilities caused by climate change in Mongolia and found that the fragile steppe ecosystems are being affected not only by rapid global warming, but also by increased grazing pressures from livestock husbandry. Our simulation shows that global warming and anthropogenic activities might exacerbate the degradation of permafrost, and then cause the water deficit over land surface, and finally lead to the decrease of grassland and livestock productivity. It is also found that different regions are burdened with different sets of risks. Water-related changes associated with climate change will affect people in the arid and semi-arid regions in southern Mongolia. Droughts may have more obvious effects in northern regions and desertification is a major challenge in southern regions. Northern Mongolia is also vulnerable to permafrost degradation, because increased depth of thawing with its seasonal thaw-and-freeze cycle affects infrastructures. Arable land farming is already limited to north central regions, which will be stressed due to land surface water deficit. Thus, we put out some recommendations for climate change adaptation as: 1) strengthening capability of observation and prediction; 2) improving construction technologies to withstand permafrost melting; 3) training herders to keep suitable livestock number; 4) improving pasture use by creating more wells and water points in remote areas; 5) developing and transferring clean development technologies, and 6) establishing social security and insurance policy for herders and farmers.

Poster presentation

Politics of sustainability in the Arctic. *By Uffe Jakobsen*

Presenter: Uffe Jakobsen, University of Copenhagen

Authors: Ulrik Pram Gad, Center for Advanced Security Theory, University of Copenhagen; Jeppe Strandsbjerg, Dept. of International Business and Politics, Copenhagen Business School

Keywords: sustainability, development, policy, governance, Arctic

It is clear from the large amount of conferences and policy reports on Arctic politics and development that sustainability as a concept has taken the centre stage. However, there is little agreement on what 'sustainable' means. For different actors such as NGOs (e.g. Greenpeace), Indigenous people (e.g. ICC), states, and for companies the concept implies different sets of opportunities and precautions. The present paper is a first step in a collective research project that aims to map and analyse the role of sustainability in the various political and economic strategies in the Arctic. Traditionally sustainability invokes technical-rational authority informing decision making on business and development issues. Yet, we argue that the concept plays a more fundamental role. We analyse sustainability as a concept that orders the relationship between development (change), society (identity), the environment (nature) and security (state). In the current paper we, first, present an attempt to capture sustainability as political theoretical concept. Second, we pursue two hypotheses:

1. When sustainability meets the Arctic it changes meaning from a universal concern with a global ecosphere to a particular concern with a more limited environment.
2. Sustainability is undergoing a transformation of meaning from being a concept that limits development to one that allows development to take place in an otherwise fragile Arctic environment.

Hence, in practical governance and pragmatic discourse the concept of sustainability may facilitate particular rather than universal concerns since it refers to local rather than global environments, and since cultural and societal sustainabilities crowd out environmental sustainabilities.

Poster presentation

The gateways to sustainability: Innovation, technology transfer and green development- A developing country's perspective. *By Ujjwal Kacker and Taranpreet Saluja*

Presenters: Ujjwal Kacker, Gujarat National Law University; and Taranpreet Saluja, University of Mumbai

Keywords: sustainability, technology-transfer, innovation, green-development, India

Our ability to address climate change and achieve sustainable development hinges on economic growth that works in sync with the environment. This paper discusses the case of India, that this global challenge provides important local opportunities like developing and using alternative means of energy production, new forms of transport or employing sustainable agriculture and forestry practices for sustainable development. The application of technology at ground level for mitigating climate change is necessary. For instance, Godrej & Boyce Manufacturing, a 100 year old company based in India has invented 'Chotukool' which is a 45-liter plastic container that can cool food to 8-10 degree Celsius on 12-volt battery. It does not use the compressor technology used in domestic fridges and uses a thermoelectric or solid state cooling system. Such frugal inventions are important in developing countries like India where maintaining securities in water, food and energy is becoming a complicated issue, as around one-third of all food spoils and an estimated eighty percent of households do not have access to or use a refrigerator. Governments have a key role to play in supporting green technology dissemination and can influence the flow of technology to their own countries. They can implement sound policies to incentivize the deployment of clean technologies. Governments can increase fair competition by removing local content and procurement restrictions, which tend to raise the price of deployment. Also they can eliminate tariffs and other customs barriers that make clean technology solutions more expensive, including at the regional level, as the Asia-Pacific Economic Cooperation region (APEC) did in 2012. Developing countries should follow the model of participatory financing arrangement. The use of micro-credit in financing and building climate resilient models should be emphasized. The challenge is to boost innovation, and speedier diffusion of sustainable technologies globally with emphasis on developing countries.

From knowledge to action

A session with a focus on specific measures for triggering action in the area of climate mitigation and adaptation based on best available scientific insights.

Session 1:

Session 2:

Posters:

Overcoming the knowledge-action gap: Realising the potential of social technologies in climate change mitigation. *By Jens Hoff*

Presenter: Jens Hoff, Dept. of Political Science, University of Copenhagen

Co-authors: Quentin Gausset, Dept. of Anthropology, University of Copenhagen; Irina Papazu, Dept. of Political Science, University of Copenhagen

Keywords: behaviour, values, governance, community

This paper will firstly demonstrate that there is at least a partial knowledge-action gap in Denmark when it comes to knowledge and action on environment and climate. Secondly, it will argue that in order to overcome this gap, we need to shift our perspective from individual-level drivers of motivation to more community-based solutions involving citizens, public authorities, private companies, etc. We use the concept of 'social technologies' to denote these solutions, as this concept covers the steering (governance) technologies used by public authorities to try to reach their carbon-reduction goals, as well as the concrete arrangements or devices used in this process. We base our demonstration of the partial knowledge-action gap on a questionnaire survey conducted among 2005 respondents from three Danish municipalities. The data shows that people who are knowledgeable about climate change, who hold altruistic values, and who react to social pressure, are more likely to adopt environmentally-friendly behaviour in their homes than others. However, when it comes to transport habits, these relationships disappear. Thus, when it comes to climate change problems at a bigger scale, other types of solutions than information campaigns or subsidies are clearly needed. We support this argument by reviewing different pilot projects conducted in Denmark. Our case studies show that environmentally friendly behaviour can be promoted by creating strong synergies between citizen driven, municipally driven and company driven environmental action. In other words, environmental action can be promoted by complementing the classic focus on individually based "political neutral" knowledge and technological "fixes" with a stronger focus on social groups and political action. The data presented in the paper derives from a 4-year interdisciplinary research project called "Citizen-Driven Environmental Action" (CIDEA), which has been conducted in collaboration with seven Danish municipalities promoting environmental behaviour change through projects involving a variety of stakeholders.

Beyond climate paralysis: Why don't senior government and business decision makers take decisive action to mitigate climate change? *By John Wiseman*

Presenter: John Wiseman, Melbourne Sustainable Society Institute, University of Melbourne

Co-authors: Lauren Rickards, University of Melbourne; Yoshi Kashima, University of Melbourne

Keywords: knowledge-action gap, sustainability decision making

While the case for rapid reductions in greenhouse gas emissions is compelling, actions being taken by senior government and business senior decision makers continue to fall far short of the outcomes needed to drive emissions reductions at the necessary speed and scale. There is therefore an urgent need to open up and understand the 'black box' within which many high level climate change decision makers operate. This paper aims to stimulate and inform such work by examining a cross-disciplinary range of literatures to ask: What are the key factors affecting the preparedness of senior government and business decision makers – particularly those with a clear and accurate understanding of climate change trends and implications - to take the decisive actions needed to drive emergency speed emission reductions? The review brings together insights from multiple perspectives into many factors operating at various scales of analysis. In particular, it highlights research in three main overlapping areas: (1) Individual and interpersonal factors: Awareness and understanding of climate change; Disciplinary background and perspective; Political worldviews, values and affiliations; Gender and risk perceptions; Social identities, norms and networks; (2) Organizational and institutional factors: Management paradigms and practices; Organizational culture and ethics; Organizational leadership and governance; Institutional complexity and inertia; and (3) Environmental, societal and political factors: Climatic conditions and extreme weather events; Industry lobby groups and vested interests; Economic and political drivers and incentives; Public opinion and climate imaginaries. It concludes that pervading many factors are problems of reductionism, short termism and the dominance of individualistic values and paradigms. To end, possible research directions and priorities are proposed.

Communicating sustainability science: Normative issues in the science of science communication. *By Clark Wolf*

Presenter: Clark Wolf, Iowa State University

Co-authors: Jean Goodwin, Iowa State University; Michael Dahlstrom, Iowa State University; Mari Kemis, Iowa State University; Christine Hutchison, Iowa State University

Keywords: science communication

Scientists working on climate and sustainability face special communication challenges. In the US and in contexts of international policy negotiation, scientific evidence is sometimes received with scepticism even when results are well-confirmed, and where public action is urgently needed to address negative environmental trends. Studies in the science of science communication are relevant in this context, but most recent work has focused on the values of efficiency and effectiveness: under what circumstances will scientific claims be accepted or rejected and what can communicators do to increase the likelihood that their claims will be taken seriously? Less research has been done on normative constraints appropriate for science communication: when (if ever) and under what circumstances is it justifiable for communicators to frame or spin the message they hope to convey? Under what circumstances (if ever) does the effort to present results in an effective and convincing mode become an unacceptable exercise in hype? When (if ever) does a scientists' involvement in public policy proposals related to her or his work become inappropriate advocacy? Focusing especially on cases from environmental and sustainability sciences, this project provides an analysis several normative categories (especially 'framing,' 'spin,' 'hype,' and 'advocacy') in light of empirical work on effective communication. Using a rational choice model, it examines not only the significance of these categories for effective communication, but also their significance as normative requirements that apply to scientists interacting with media or in participatory public communication. The present paper represents a stage in the development of a more complete theory of science communication for sustainability science. Work on this project has been supported by US-NSF grant number 1237495. Findings, conclusions, and recommendations expressed are those of the authors, and do not necessarily reflect the views of the National Science Foundation.

Changing climate behavior through mobile media – utilizing digital intervention program to obtain the potential private and commercial climate savings. *By Benjamin Suhr*

Presenter: Benjamin Suhr, Mobile Identity

Keywords: behavior change, digital intervention, mobile

The comeuppance of mobile media and the related ability to develop digital intervention programs now opens to apply these programs to helping private and companies for changing behavior and obtain the potential savings in energy consumption and co2-emissions. Since 2005 Mobile Identity have been developing a unique scalable mobile and web based platform for the purpose of scientifically document the effects of digital intervention on people's behavior within health and prevention of lifestyle diseases. Based on the notion that private consumers can lower their CO2-emission and Energy consumption by 10-25 % by small changes in their daily habits, there is a big potential for substantial savings. This platform has, in collaboration with COWI, since 2009 been applied to helping users for lowering energy consumption and co2-emissions. Currently it comprehends functionalities including the measurement of a person's climate behavior, tangible tips and advices on savings, quizzes a.o. With its flexibility it can comprehend to be applied in several climate related issues, such as waste disposal and water consumption for many types of end users. Additionally it is also being applied in a commercial and local setting to help companies and municipalities realize their saving potential through digital intervention at all levels in the organization. The purpose of this presentation is share the vision of Mobile Identity and CO2-Guide in applying the digital intervention platform in numerous different settings both in Denmark and International to obtain and sustain the potential positive changes with very low cost.

Inside the greenhouse: Utilizing media to creatively communicate climate challenges. *By Maxwell Boykoff*

Presenter: Maxwell Boykoff, University of Colorado-Boulder

Co-authors: Beth Osnes, University of Colorado; Rebecca Safran, University of Colorado

Keywords: media, sustainability, climate change, communication

'Inside the Greenhouse' (ITG) objectives have been to collaboratively (1) generate multimodal creative compositions on the subject of climate change, (2) engage with various dimensions and issues associated with sustainability, and (3) create, produce and distribute creative communications through an 'Inside the Greenhouse' series of television and digital media platforms. Through the development and experimentation with creative modes to communication in partnership with students and colleagues, we treat this 'greenhouse' as a living laboratory, an intentional place for growing new ideas and evaluating possibilities to confront sustainability challenges. Through project activities, we wrestle with creative communication possibilities that shape perspectives, attitudes, intentions, beliefs and behaviors among the public citizenry. The ITG project works from the understanding that media serve vital roles in communication processes between science, policy and the public, and often stitch together perceptions, intentions, considerations, and actions regarding the environment and sustainability. Through this project, collaborators Beth Osnes (Department of Theater and Dance), Rebecca Safran (Department of Ecology and Evolutionary Biology) and I have been working with students to deepen our understanding of how issues associated with climate change are/can be communicated, by creating artefacts through interactive theatre, film, fine art, performance art, television programming, and appraising as well as extracting effective methods for multimodal climate communication. Our chosen title for the project acknowledges that we are all implicated in, part of, and responsible for greenhouse gas emissions into the atmosphere. The project is populated by a two-course sequence at the University of Colorado, assessments of efficacy of sustainability and environment messaging, live community events and television episodes. Ultimately, these interventions seek to foster sustained, productive and interdisciplinary creative sustainability and environment communication collaborations, and broaden the spectrum of possibility for responses to sustainability and environment challenges in the 21st century.

Is a breakthrough on climate change governance on the horizon? *By Maria Josefina Figueroa*

Presenter: Maria Josefina Figueroa, Department of Business and Politics, Copenhagen Business School

Co-author: Matthew Hoffmann, University of Toronto

Keywords: climate, governance, multilateral, global response

The recently released Fifth Assessment report of the IPCC has highlighted again with unprecedented scope and insight the urgency of addressing climate change. The international community has pledged to devise the next international agreement on climate change by 2015, while the EU and in particular the Scandinavian countries have forged ahead advancing a variety of policies to respond to climate change. Similarly, regions, municipalities, and private actors across the world are also contributing to climate governance. This paper asks whether the world is reaching a tipping point where a breakthrough on climate change governance is near? The answer is approached by contrasting the governance model within which the IPCC operates and the conditions of policy and governance interaction toward the more scientific foundations laid out by IPCC, with the range of multilateral climate governance, with experimental or transnational attempts at addressing climate change. The results indicate that while the two governance modes are linked, the center of gravity of the global response to climate change has shifted away from the United Nations negotiations. This shift provides opportunities but it also reveals great challenges for developing a pathway from knowledge to governance and climate action that can lead to an effective global response to climate change.

Opportunities, not barriers. *By Asuncion Lera St Clair*

Presenter: Asuncion Lera St. Clair, DNV GL

Authors: Cecilie Mauritzen, DNV GL (Veritas); Anne Louise Koefoed, DNV GL; Asuncion St. Clair, DNV GL

Keywords: communication, opportunities, business, transformation, barriers

Given the key findings of at least the three last IPCC reports – that mankind is on its way to create "dangerous interference with the climate system" (UNFCCC Article 2) unless significant emission cuts are implemented soon – the need for transformation from a fossil fuel dominated world has become indisputable to visionary companies. Nevertheless, the barriers to transformation are seemingly unsurmountable and can loosely be categorized as technical, political/regulatory, economical/financial, cognitive and societal. True stagnation typically occurs when several barriers are present at the same time, as is usually the case in companies and national states alike. At DNV GL, a global classification, technical assurance and risk management advisory company for the energy, maritime and oil and gas industries, one tries to turn barriers into opportunities in the recognition that the "doom and gloom" discourse of climate and environmental research simply does not work. In this presentation we will demonstrate many cases of surprising and wide-reaching impacts that the actions of one single multinational company may yield by turning barriers into opportunities.

Regulating carbon effectively – the case of the EU-US trade relations. *By Laura Nielsen*

Presenter: Laura Nielsen, Faculty of Law, University of Copenhagen

Co-author: Henrik Palmer Olsen, Faculty of Law, University of Copenhagen

Keywords: climate change, law trade relations

'Sustainability' is subject to legal regulation internationally, regionally, and domestically. It is striking, however, that climate change, which, by many is considered the single most pressing global policy issue, is not regulated internationally with a legally binding treaty. Hence there is no international legal framework which incentivizes new carbon reducing innovations in production and hence no legal pressure to facilitate the process 'from knowledge to action'. Meanwhile individual nation States will fear taking on too large carbon reducing obligations as this will put them (their residing carbon polluting companies) at a competitive disadvantage vis-à-vis other States (similar companies) without a comparable 'price on carbon' due to a domestic carbon reducing programme. In short, the multilateral track of dealing with climate change has failed. It may therefore be time to re-think how to solve the issue. Our abstract proposes that economic superpowers such as the EU acting together with the US enact a carbon consumption fee for all products being consumed within their territories. By transferring carbon costs from production to consumption, it will be possible to unilaterally reward carbon reducing initiatives (as products will become comparably cheaper) without fearing reduced competitive strength. Simultaneously, since a carbon consumption fee would also be imposed on imported products, the effect would go beyond the borders of the EU and the US. The effect would in fact be nearly universal when considering that the EU and US purchasing power accounts for approximately 40 % world-wide. Finally our proposed scheme may in effect be a more fair regulation because in this manner polluting production is not 'exported' to developing countries. Other States could therefore very well see advantages in adopting a similar scheme as it does not interfere with their ability to compete.

Policy instruments and countermeasures to reduce CO2 emissions in designated buildings under Thailand's NAMAs. *By Yumiko Asayama*

Presenter: Yumiko Asayama, National Institute for Environmental Studies, Japan

Keywords: NAMAs, MRVs, Thailand, policy, governance

The objective of this study was to examine the necessary policy instruments and countermeasures to reduce CO2 emissions under the framework of Nationally Appropriate Mitigation Actions (NAMAs) in Thailand. Thailand has been preparing its mitigation pledge under NAMAs. Improving the energy efficiency of designated buildings is expected to offer the highest potential for reducing CO2 by 2020 through domestic schemes under the proposal. The challenge that Thailand now faces is how to determine the scope of the proposed NAMAs and the domestic measurement, reporting, and verification (MRV) system for them in line with the existing strategies of the Energy Efficiency Development Plan 2011–2030 (EEDP). In order to examine these points, the barriers hindering energy efficiency in the designated buildings were analyzed from the standpoints of existing ministerial regulations, policies, and countermeasures. It was found that while Thailand has implemented policy instruments combining ministerial regulations, voluntary programs, and incentives, a lack of sufficient and credible data makes it difficult to gain an understanding of the existing situation, make future projections, and evaluate the progress and impact of policy instruments. Limited capacity to verify the data on submitted energy management reports from each designated building prevents the strengthening of ministerial regulations and updating of the energy efficiency performance standards of the designated buildings. This study concluded that the NAMAs target will not be achieved without revising the guidelines for reporting energy consumption under the existing laws and ministerial regulations. There is an urgent need to provide intensive energy efficiency measures and a sequence of technical trainings for the relevant stakeholders to design and operate energy efficient buildings, thereby seeking co-benefits by implementing CO2 emission reduction actions and MRV toward the realization of cost-effective and sustainable low carbon green buildings.

Knowledge use for sustainable transport – developments and limitations in Europe. *By Henrik Gudmundsson*

Presenter: Henrik Gudmundsson, DTU

Co-author: Yannick Cornet, DTU

Keywords: transport policy, knowledge utilization, tools

Sustainability has been accepted as an overarching goal for transport policy in the European Union as well as in many member states and European cities. But the evidence, tools and knowledge practices that support policy and decision making have not been fully adjusted to this emerging perspective. This serves to hamper a timely transition to a more sustainable transport system, evidenced by slow response to the significant contributions from transport to climate change, oil dependence, destruction of ecosystems, and pressures on health and quality of life. Solutions may involve more than simply producing more knowledge, it is also a question of how the mechanism for knowledge production and distribution function and to what extent the knowledge is recognized and utilized. Based on existing research, three challenges can be identified in regard to the role of knowledge linking to action for more sustainable transport: • Lock-in to existing paradigms for decision support tools and decision making procedures in transport, that may obscure or downplay key sustainability dimensions, • Limitations to the ways in which sustainability is conceptually and operationally represented in new knowledge technologies and mechanism applied (such as scenarios, indicators, models) • Limited acceptance, use and influence of knowledge and evidence in general, at various stages in the policy making, decision, and implementation processes for transport The paper will exemplify these limitations; discuss factors that may cause them according to impact assessment, knowledge utilization, and policy analytic literature, and address how they may be overcome. The presentation will be based on recent research in European and Danish projects addressing knowledge use for sustainability in transport policy and planning; perspectives for how to overcome the gaps will be drawing from the ongoing project ‘SUSTAIN - National Transport Planning - Sustainability, Institutions, and Tools’ funded by the Danish Strategic Research Council.

The institutional constraint to widespread adoption of climate smart agriculture in least developed countries. *By Michael Davidson*

Presenter: Michael Davidson, Davidson Consultants

Keywords: climate-smart agriculture, mitigation, adaptation, irrigation

Climate-smart agriculture (CSA), when implemented effectively and in a sustainable manner, solves three critical issues: improved yields and profitability for the grower; adaptability to changing environmental conditions, and; mitigation of agricultural-induced GHG emissions. The products, strategies, and methodologies for achieving the objectives of CSA are readily available and cost effective and evidentiary case studies illustrate their potential generalizability across spatial scales. However, widespread adoption of CSA regimes has not been achieved. Agricultural growth in Least Developed countries (LDCs) has been virtually stagnant over the past decade and data suggest that per capita food production is actually declining in parts of sub-Saharan Africa. Traditional agricultural practices resulting in environmentally deleterious expansion of agricultural land continue to be first options for improved production. This paper examines the social, political, economic and institutional constraints to the widespread adoption of CSA and posits that, key to understanding why CSA has not been adopted, is a Development model that lacks an epistemological awareness of the critical institutions that drive agricultural success. Local, sustainable, institutional capacity to support climate smart tools and regimes has been overlooked and under-valued. Local institutions within this context include the actors and organizations who are financially interconnected and interdependent to the success of the farmer. Farming is a business concern that relies on the reliable and consistent relationship between the manufacturer of agricultural and irrigation products, the local stocking distributor of those products (including cultivars, seeds and nutrients), and the grower. These stakeholder agents drive the success of agribusiness, at all scales, in Developed countries. This paper develops a cost-effective and efficacious model for the implementation of CSA in LDCs and provides case studies of how this model is beginning to emerge in West Africa.

Poster presentation

Incentivizing Consumer Awareness Through Trade Measures. *By Altagracia Cuevas-Arthur*

Presenter: Altagracia Cuevas-Arthur, University of Barcelona

Keywords: trade, climate change, consumer awareness

Today we notice how world's climate patterns are truly fluctuating. To our bewilderment, the sea level is increasing because ice sheets are systematically melting; temperature patterns are changing dramatically over time; species are disappearing and mutating; and even phenomena rarely happening in some parts of the world (tornados, hurricanes, storms, heat waves) are now even more common and untimely. Despite the lack of agreement between scientists on the direct relationship between human action and global warming, scientific evidence points to the fact that these changes are driven by anthropogenic action through the protracted production of greenhouse gases during the process of industrialization. Therefore, there is an urgent need for action to mitigate climate change, which entails several pluri-directional efforts aiming at, mainly, producing and using new technologies and renewable energy, making older equipment more energy efficient, or changing practices or consumer behaviour . This proposal focuses on the need to work on consumer awareness on the phenomenon through the increase of available information on the products they consume and their impact on climate change therefore aiming at triggering changes on practices and consumer behaviour. Through creating incentives in the trade of environmental goods and environmentally friendly goods and services (including lowering the barriers for their trade), economic incentives will be created so more knowledge is devoted and spread towards the research, design, production, and marketing of such products. This will help lowering the knowledge gap and will create more market-driven (and policy-driven) competition between companies. At this point, the initiatives leading to the management of the negative externalities of pollution and environmental harm (such as emission credits) are ineffective and further pressure needs to be put on companies to shift to less polluting technologies and more sustainable practices.

Poster presentation

Artistic counteractions against the 'growth fetish'. Gendered perspectives on China/Nordic interchange. *By Hanne Petersen*

Presenter: Hanne Petersen, Faculty of Law, University of Copenhagen

Keywords: growth fetish, gender, artistic action

Environmental historian John McNeill describes the 'growth fetish' as one of the 'big ideas' of the 20th century, which has a strong influence in all fields of politics, and which restricts collective and individual action for change towards sustainable practices and sustainable masculinities and femininities. This presentation reflects on gendered aspects of the growth fetish in Chinese and Nordic (legal) culture and on examples of counteraction especially in artistic expressions and in artistic Nordic/Chinese interchange, which question and debate the values of growth. Art understood as action both supports, questions and criticizes dominant growth values. It may also open up for an expression of emerging norms and values needed to transform traditions and knowledge into different forms of action.

Poster presentation

Understanding how energy efficiency is achieved in shipping companies: an action research approach. *By Hannes Johnson*

Presenter: Hannes Johnson, Chalmers University of Technology

Keywords: energy management, action research, transdisciplinarity

There seems to be a large knowledge-action gap when it comes to energy efficiency in the shipping sector. Efforts by governmental agencies, researchers and other organizations have shown a large techno-economical potential for improving energy efficiency, improvements which are deemed to be a necessary part in reducing the climate impact of the shipping sector. Such a gap has been observed in many other sectors and is often referred to as an energy-efficiency gap. A large taxonomy of "barriers" and "drivers" to energy efficiency, deduced from theory as well as based on empirics, is in this context discussed in literature. Calls have recently been made by researchers to move beyond surveys and interviews of large samples of organizations, to more in-depth observational and participatory studies. From 2010-2013, I have managed an industry-academia project on understanding and improving energy efficiency practice in shipping companies. We have aimed to produce knowledge of causes on why more energy efficient measures aren't being implemented, as well as generating mitigating strategies. From the university perspective, the project has taken an action research approach: I worked for more than three years as part of a team in each company to improve practice. A key issue has been to translate the ISO 50001 energy management system standard into a shipping company context. This presentation will draw out key lessons from published and yet-to-be published papers from our project. I will argue for the need for researchers to work closely with practitioners. In part to contribute to the furthering of existing practices (which may go beyond the more immediate interests of practitioners, for example in terms of how to reach radical reductions in emissions) but also to contribute to policy-processes. In this latter context, I will discuss recent policy approaches to improving energy management procedures in shipping companies.

Poster presentation

A framework for explaining the different perceptions on REDD+: Mixing sustainability science with political economy of institutions and decisions. *By Pheakkdey Nguon*

Presenter: Pheakkdey Nguon, Clark University

Keywords: sustainability science, REDD+, Cambodia

Academic and policy-oriented literature on policy to reduce emissions from deforestation and degradation (REDD+) has so far mainly focused on addressing technical issues that will improve the design and implementation of the policy so that its outcomes achieve the 3Es criteria (effectiveness, efficiency, equity, and co-benefits). Whether these 3Es criteria – or the underlying logic of REDD+ in general – are as relevant for the different groups of stakeholders in developing countries as they are for the international policy community has, however, been insufficiently substantiated in the literature. In that context, this paper brings together two sets of literature – sustainability science and political economy of institutions and decisions – to construct a heuristic conceptual framework to reveal ways in which perceptions, institutional locations and contextual differences affect patterns of stakeholders' engagement in and assessment of complex environmental governance projects such as REDD+. The main argument of this paper therefore posits that the preferences and perceptions of stakeholders cannot be presumed to coincide with aspirations of scientists and/ or policy makers. Furthermore, understanding how stakeholders interpret, experience and assess REDD+ is central to understanding the appropriateness of REDD+ as an initiative aiming at addressing climate change, deforestation and sustainable livelihood development in developing countries. Methodologically, this paper operationalizes its proposed theoretical framework by drawing from qualitative data collected through archival research, key informant interviews and observations of REDD+ policy processes. The paper makes use of the development and implementation of REDD+ policy in Cambodia as its empirical case study.

Poster presentation

How Sustainability Impact Assessment can support local policies: a case study.

By Salavatore Martire

Presenter: Salvatore Martire, European Forest Institute

Co-authors: Marcus Lindner, European Forest Institute; Diana Tuomasjukka, European Forest Institute; Joanne Fitzgerald, European Forest Institute; Valentina Castellani, Università degli Studi di Milano Bicocca

Keywords: energy, rural, sustainability, impacts, forests

Local energy generation and consumption should be planned analyzing the trade-offs in environmental, economic and social issues. In addition to this, the development of local energy chains causes impacts along the whole supply chain. For the case of forest-energy sector, direct impacts from harvesting activities, transportation, transformation of raw materials, and energy generation must be evaluated. In this context, local decision-making processes must be guided by a careful evaluation of the sustainability of production chains and alternative choices. The aim of the study is to explore if and how an integrated assessment can quantify to what extent bio-energy supplies' development contributes to rural development and energy policy objectives under different scenarios. We applied a Sustainability Impact Assessment (SIA) of energy development for an alpine region in order to measure how much different bio-energy scenarios impact on rural development and energy policy aims. The study shows how rural development policies can be supported by Sustainability Impact Assessment, in order to frame local planning with a holistic approach. In this specific case rural development, energy issues and the environmental compatibility of developing a productive chain have been examined with a comprehensive analysis. The Sustainability Impact Assessment approach allows the scientific analysis of trade-offs in rural development issues.

Poster presentation

Fencing the commons in the lower Omo valley, Southwestern Ethiopia: Saving feed for cattle, Income for people and conflict for both. *By Samuel Tefera Alemu*

Presenter: Samuel Tefera Alemu, Graduate School of Asian and African Area Studies, Kyoto University, Japan

Keywords: commons, conflict, enclosures, grazing, Hamer

Frequent occurrence of drought induced by a pattern of rainfall scarcity and irregularity for over decades aggravated conflicts for grazing land and resources among pastoralist and agro-pastoralist communities within and outside Hamer district in south-western Ethiopia. With such conflicts still on surface, managing land for grazing, crop production and income generation are gradually on the rise. Such practices exist at individual, joint and communal basis. This paper discusses the processes of enclosures development and the aforementioned three basis of engagement in the district along with their opportunities and challenges from the people's and environmental point of view and analyses its short term and long term consequences. Through ethnographic based field work case studies it presents how enclosures development interacts and evolves with existing livestock mobility, farming and social systems.

Poster presentation

Assessing sustainability in service sector: A multi-criteria group decision perspective. *By Seren Ozmehmet Tasan*

Presenter: Seren Ozmehmet Tasan, Dokuz Eylul University

Keywords: assessment, sustainability, service, topsis, ahp

The idea of managing service activates while maintaining sustainability has become a challenging concept for service sector. While the concept of sustainability has been recognized by many companies, most of them have trouble measuring and/or assessing their sustainability. To measure sustainability, United Nations Commission on Sustainable Development (UNCSD) grouped sustainability indicators according to the four pillars of sustainable development; social, economic, environmental and institutional. However, the indicators alone do not measure how sustainable the companies perform. There needs to be an integrated tool for sustainability assessment in the direction of their economic, social and institutıonal responsibilities by using indicators. In this study, this problem has been modeled as a multi-criteria group decision making problems, where several sustainability indicators are evaluated at the same time using the judgment of different decision makers through the company in order to find a compromise solution showing their sustainability performance. For his purpose, topsis and ahp methods are jointly used to propose a framework to support the decision makers in order to assess service sector sustainability.

Poster presentation

Towards a framework for improving the effectiveness of sustainability science.

By Toby Gardner

Presenter: Toby Gardner, Stockholm Environment Institute

Keywords: research strategy, research priorities, sustainability

Despite the investment of significant resources in scientific disciplines concerned with sustainability in recent years, there remains an urgent need to find better ways to bridge the gap between knowledge and action. Much existing sustainability orientated research is varyingly ineffective for a multitude of reasons: important questions are often not given priority, research is often conducted out of context of existing information and work in other disciplines, and the process of acquiring knowledge continues to remain largely isolated from those who may ultimately benefit from, or otherwise be influenced by it. Such well known and systemic problems can lead to a waste of limited resources, provoke partly unnecessary and counterproductive academic debates, and ultimately lead to inappropriate recommendations for the management of social-ecological systems. Here I seek to help clarify the context of specific sustainability research efforts and priorities by proposing a general two-part framework for distinguishing (i) the different (yet interrelated) stages of knowledge acquisition that together comprise a general process of identifying and solving sustainability problems and (ii) a set of decision criteria that can be used to determine both general and specific research priorities in terms of the value, opportunity and feasibility of new opportunities to learn. The framework is also analyzed as a heuristic device to more effectively diagnose the processes by which particular aspects of research and understanding are varyingly connected or disconnected with each other and with the community of knowledge users.

Poster presentation

Building an open-source forest information system in Nepal and its use in practice. *By Tuija Suihkonen*

Presenter: Tuija Suihkonen, Arbonaut Ltd.

Co-authors: Ashwin Dhakal, FRA Nepal Project; Heikki Parikka, Finnish Forest Research Institute; Yam Pokharel, FRA Nepal Project; Michael Hawkes, FRA Nepal Project

Keywords: open-source, forestry, information system, Nepal

In collaboration of Finnish and Nepali governments a Forest Resource Assessment (FRA) project is carried out between 2010-1014. With this support nation's forests were inventoried and mapped, and the data produced were analyzed and stored in custom-made open-source forest information system (OSFIS). This OSFIS complies six different tools, which all are built on open-source code and hence they are free. These tools are database system for storing data, calculation system for forest inventory calculations, reporting system is for pulling out reports in various formats and mapping system allowing users to download ready-made maps and map layers. Beside these four systems there is also a data sharing system, which allows data to be distributed around the world on request, and websites, which gives an access to all public systems mentioned above. In this paper, the OSFIS system is presented in detail and explained how it was customized to Nepal central government's use. A training plan to use the system for central government forest officers is presented, and its implementation to everyday use is analyzed and displayed with details. Sustainable adaptation of OSFIS is also monitored after a period of time, and its success rate is observed. Also visits of the websites are counted and analyzed and the results are presented. Distributed data and times of downloads are also counted and their spatial distribution is presented. The OSFIS greatest obstacles are gathered and discussions on the challenges are aroused. Future recommendations of the use of OSFIS system's implementation are presented. The main aim of implementing OSFIS system to Nepal is to support the government to be an independent data producer and analyzer, and hence bring the sustainability to the forest management and planning. A coherent and reliable forest data also promotes Nepal's participation to the carbon credit system by IPCCC in future.

Poster presentation

Gaining REDD+ funding status by applying LiDAR Assisted Multi-source Programme in forest inventory. *By Tuija Suihkonen*

Presenter: Tuija Suihkonen, Arbonaut Ltd.

Co-author: Katri Tegel, Arbonaut Ltd; Basanta Gautam, Arbonaut Ltd.

Keywords: LAMP, LiDAR, forest, carbon, REDD+

In this paper a LiDAR Assisted Multi-source Programme (LAMP) for accurate forest inventory is presented. It is a method which uses two-step sampling instead of using conventional forest inventory methodology. Materials for the study are LiDAR data, which can be a certain portion (e.g. 5%) from the study area and selected using weighed random sampling, and field mensuration data, which is collected from the area of the LiDAR data as sampled using systematic random sampling, and full satellite coverage of the study area, which is used to extrapolate the estimation to the whole area. The field mensuration data is used to teach the LiDAR data and create a LiDAR-model using a Sparse Bayesian regression model. In the next step another sampling set, surrogate sampling plots, is collected. Sparse Bayesian model is applied again to create a regression model between the surrogate plot and the satellite data. This model is created to each forest type separately, and hence, a precise estimation of AGB can be displayed. And when applied to various years' satellite imagery, the changes in forest cover can be efficiently detected. The purpose of this paper is to not only present the LAMP method, but also discuss the possibilities that the new methodology brings. In this example a case study is shown in Nepal, where the method was applied in southern Terai Arc Landscape (TAL) Area. Due to application of the method the government of Nepal was able to submit an Emission Reduction Program Idea Note (ER-PIN) to Forest Carbon Partnership Facility (FCPF), and was selected to the World Bank FCPF payment scheme in REDD+, as one of the first countries in the world. This paper is displaying the next steps which application of the new funding mechanism REDD+ can bring to the people of Nepal.

Governance in light of planetary boundaries

By integrating social science and Earth system science the session explored if the notion “planetary boundaries” ignites political conflicts and how social actors perceive and respond to “thresholds” in biophysical systems.

Session 1: Panel discussion

Session 2:

Panel discussion

By integrating social science and Earth system science the session explored if the notion “planetary boundaries” ignites political conflicts and how social actors perceive and respond to “thresholds” in biophysical systems.

Talks and panel discussion by:

- Brigitte Baptiste, Instituto Humboldt de Biodiversidad, Colombia
- Sarah Cornell, Stockholm Resilience Centre, Stockholm University
- Aart de Zeeuw, Tilburg University
- Deborah Tripley, Planetary Boundaries Initiative (UK) and WWF-UK

Moderated by Victor Galaz, Stockholm Resilience Centre, Stockholm University

The Global Gap – what can be done when governance does not add up? *By Sarah Cornell*

Presenter: Sarah Cornell, Stockholm Resilience Centre

Co-author: Björn Nyqvist, Stockholm Environment Institute

Keywords: planetary boundaries, pollution, biodiversity, implementation

The planetary boundaries framework provides a global level "dashboard" for issues where emergent risks arise from human perturbation of Earth system processes. We present an outline analysis of 1) the social impacts of exceeding proposed boundaries; 2) the existence of science and policy forums equipped to develop and use knowledge about the boundaries; and 3) the extent to which current governance recognises and addresses the nature and scale of the problem. For some boundaries, there are immense governance gaps. We discuss this with particular reference to biodiversity destruction and pollution releases. The current state of knowledge and policy addressing the environmental release of chemical pollution illustrates how poorly equipped the world is to deal with global risks relating to novel anthropogenic entities. Chemical pollution has tended to be treated as a local and self-correcting problem (ie, classic ecotoxicology takes the death of poisoned organisms as the metric and endpoint). Very recent efforts (e.g. REACH) recognise that persistent, bioaccumulative and transportable toxic materials are a global problem, and can trigger system-wide feedbacks. We discuss what features of pollution should be considered in a precautionary approach to planetary boundary-setting. We also look at the biodiversity governance gap from a global and precautionary perspective. While regime shifts and thresholds are widely recognised as fundamental characteristics of local ecosystems, it is extremely difficult to characterise and describe larger scale system behaviour and cascading thresholds in ways that can inform governance at these larger scales. We discuss the risks this presents. We also trace the debates and challenges of mainstreaming biodiversity into contemporary international debates on global sustainability, particularly the UN SDG process.

Global governance with sovereign restraints – examples and experiences. *By Linda Nielsen and Anita Rønne*

Presenters: Linda Nielsen, University of Copenhagen, Faculty of law; and Anita Rønne, University of Copenhagen, Faculty of Law

Keywords: governance, biolaw, CSR, climate change, energy

Ensuring long-term sustainability is one of the "grand challenges", which presents dilemmas for governance. It is extremely difficult to achieve consensus worldwide in spite of many attempts. And new innovative solutions are called for. In the presentation we will introduce experiences from different areas of governance and point to some solutions:

- Biotechnology and bioethics. In the area of biotechnology and bioethics the experience has been introduction of processes, soft law and flexible hard law leading to global governance instruments which are dynamic and open up for respecting cultural and other differences.
- Corporate Social responsibility. From the Corporate social responsibility arena developments are reflecting global soft law instruments leading to a "comply or explain" regime and in Danish law an obligation to inform about plans, outcome of initiatives etc. all of which are mandatory in the sense of process, but not in the sense of content. In this way companies are inspired and encouraged to introduce and implement CSR without being obliged to do so
- Climate change. Increasingly there is a growing awareness that traditional international rules on breach of treaty obligations and on state responsibility are not appropriate to address the failure of contracting Parties to implement their treaty obligations. To what extent may non-compliance procedures be adopted and which issues will need to be addressed?
- Energy. Within the European Union a principle of solidarity has developed in the constitutional framework as a general norm and more specifically for energy supply. What does this principle imply for the 28 member states countries and to what extent may it be applied globally

Of course, the experiences from the examples cannot solve the challenge of sustainability, but different models and processes may form part of the puzzle, which is necessary to help solving the problem. Perspectives for the future will be outlined.

Ecosystem structure and function under global change. *By Tim Newbold*

Presenter: Tim Newbold, UNEP-WCMC

Authors: Michael Harfoot, UNEP-WCMC; Derek Tittensor, UNEP-WCMC; Tim Newbold, UNEP-WCMC; Drew Purves, Microsoft Research; Matthew Smith, Microsoft Research

Keywords: ecosystems, structure, function, stability, GEM

The earth's biosphere provides a range of services upon which humanity depends, it is also facing unprecedented changes through simultaneous effects of, for example, climate change, habitat conversion and direct exploitation of resources. Two of the key questions decision makers have for ecological scientists is what are the boundaries within which humanity must constrain itself and following that how far is the biosphere away from collapse of some of the fundamental functions that we rely upon? Here we employ the Madingley General Ecosystem Model (Harfoot et al., 2014) to investigate the changes to ecosystem structure and function across space and through time in terrestrial and marine ecosystems under future scenarios of climate change, land use change and direct exploitation and the impacts of these changes on ecosystem stability.

References: Harfoot, M. B., Newbold, T., Tittensor, D. P., Emmott, S., Hutton, J., Lyutsarev, V. Scharlemann J & Purves, D. W. (2014). Emergent Global Patterns of Ecosystem Structure and Function from a Mechanistic General Ecosystem Model. PLoS Biology, 12(4), e1001841.

Sustainability roundtables in agriculture, food and energy: Outcomes, challenges and long-term prospects. *By Stefano Ponte*

Presenter: Stefano Ponte, Sustainability Platform, Copenhagen Business School

Keywords: sustainability, roundtables, voluntary certification

The increasing willingness of public authority to delegate social and environmental regulation to the private sector has led to the establishment of a large number of 'voluntary' standards and certifications on sustainability. Many of these have taken the form of 'stewardship councils' and 'sustainability roundtables' and have been designed around a set of institutional features seeking to establish legitimacy, fend off possible criticism, and 'sell' certifications to potential users in a market-based system. Sustainability roundtables have also raised higher expectations on accountability, transparency and inclusiveness. In this paper, I examine to what extent these expectations are being met through a comparative case study of sustainability roundtables in the agriculture, food and energy sectors. I show that roundtables entail an ever more complex web of governance systems and procedures to meet 'good practice' in standard setting and management. This is often opening space for competing initiatives that are less democratic, quicker, aligned with industry interests to establish substantial presence in the market for sustainability certifications. These tend to more easily discriminate on the basis of size (against small players) and geography (against actors in the South), and show only limited sustainability achievements. The paper concludes with a reflection on what can be done to ensure that sustainability roundtables achieve equitable sustainability outcomes.

Transformative policy pathways to decarbonisation. *By Matthew Hoffman and Steven Bernstein*

Presenters: Matthew Hoffmann, Department of Political Science, University of Toronto; and Steven Bernstein, University of Toronto

Keywords: governance, decarbonization, climate policy, experimentation

Despite more than two decades of widespread consensus amongst climate scientists that the consequences of global warming will be dire, neither the United Nations treaty-making process nor national governments have been able to put in place mechanisms and measures capable of overcoming the stubbornly locked-in carbon economy and energy systems. Technology is not the problem and policy and governance innovations with the potential to generate pathways to decarbonization abound, but what remains unclear is how those pathways are and can be constructed. In this paper we develop a forward-looking theory of transformation towards decarbonization. We identify pathways through which diverse and multilevel initiatives outside the United Nations process can contribute to disrupting carbon lock-in and develop new, decarbonized path dependencies. This innovative conceptual work draws on the authors' previous studies on climate governance experiments, transnational climate governance, and path dependencies in the governance of super wicked problems, as well as new empirical investigations of multiple, diverse decarbonization initiatives. Pathways to decarbonization are developing amongst cities, regions, provinces, corporations, NGOs, and nations and we thus use the conceptual framework to analyze decarbonization efforts ranging from the Danish national plan to be fossil fuel free by 2050 to the C40 network of large cities efforts to spread sustainable practices amongst its members to the Carbon Trust's efforts to entrench retail carbon labelling. The conceptual and empirical analyses in this paper thus combine to provide insight into how diverse interventions can develop the potential to disrupt carbon lock-in in specific ways and catalyze multilateral cooperation and broader system transformation.

Health – Elucidating sustainability-health interactions

The session elaborated on the relationship between health and environment both in terms of conflicts such as resource use for increased wellbeing and win-win situations such as clean energy and healthier environments.

Session 1:

Session 2:

The nexus between sustainability and human health: Implications for the post-2015 development agenda. *By Anthony Capon*

Presenter: Anthony Capon, United Nations University's International Institute for Global Health

Keywords: health, sustainability, development, post-2015, co-benefits

The United Nations is currently at the pointy end of negotiations for a post-2015 development agenda, including proposed sustainable development goals (SDGs) to replace the existing millennium development goals (MDGs) that expire next year. The intent of this new development agenda is to bring sustainable development together with poverty reduction, which is the focus of the current development agenda. One of the main differences in this new approach is the need for high-income countries to sign up to a set of SDGs that will aim for 'contraction' and 'convergence' in trans-national development trajectories – contractions in consumption and related ecological footprints for high-income countries to allow room, within planetary boundaries, for essential increases in consumption in low- and middle-income countries and enable convergence of social and economic development. The health sector argues that human health should be acknowledged as both an input to sustainable development and an outcome and indicator of progress towards it. The concept of co-benefits for health from action on climate change is very relevant to the post-2015 development agenda because low carbon ways of living are healthy ways of living, provided structural inequities are addressed. Stephen Boyden's elegant 'biosensitivity triangle' offers a compelling way of understanding the co-benefits concept. The triangle is also an excellent communication device and reminder of the essential interdependencies between human health and the health of planetary systems. This presentation will examine relationships between sustainable development and population health and explore the value of human ecology and systems thinking as emerging methods in population health research, policy and practice.

Sustainability and global health: Why we must recognize and reverse "environmental brinkmanship". *By Colin Butler*

Presenter: Colin Butler, University of Canberra, Australian National University

Keywords: health, population, resources, conflict, sustainability

Futurists and visionaries have long warned of the risk to civilization (and thus global population health) from "planetary overload". With the exception of a single decade (the 1960s) these concerns have largely been sidelined by global policymakers. In this they have been supported by most academics, who generally remain indifferent to these risks, as they themselves are mostly captured by, products of, and promoted and in other ways rewarded for their support of the dominant system, even though it undermines the foundations of civilization, including of human health. This conference is evident of a nascent re-awakening of these concerns, but mainstream strategies continue to promote "environmental brinkmanship", whether with regard to the carbon budget, biodiversity, or the global food supply. Magnifying our proximity to these physical boundaries is the size and trend of global inequality, whether measured as income, political power, or access to knowledge. Optimists contend that the creation of solutions outpaces that of problems. But this view is based on the misinterpretation and extrapolation of a three century long "sweet spot" of progress, when, indeed, these principles generally applied. Progress may continue, but now requires fundamental change. If not, catastrophic consequences are probable, not only for the global poor, but potentially for civilization itself, and thus for our descendants; perhaps even for ourselves. Particularly poorly appreciated is how human conflict has the capacity to "bridge" what may appear to the naïve observer (including many modelers) as a margin of safety. That is, we may be closer to the brink than we think. This presentation will provide insight to these issues, including by an integrated discussion of how complacency, profiteering, and inequality have generated policies which maximize population resource mismatch and which threaten future global health. Health workers can and must act powerfully, to reverse these threats.

Use of chemicals: Optimizing an intrinsic conflict? *By Chiho Watanabe*

Presenter: Chiho Watanabe, University of Tokyo

Co-authors: Masahiro Umezaki, University of Tokyo; Hana Furusawa, University of Tokyo; Shoko Konishi, University of Tokyo

Keywords: chemicals, risk, benefit, health, environment

In a variety of ways, chemical products benefitted human life; medicines, agrochemicals, as well as many types of plastic products are everywhere and serving for “better” human life. On the other hand, hazards associated with the use of chemicals have been aware of, where the hazards can be either environmental or human (health). To name a few, we can think of DDT and malaria (would affect both environment and human), antibiotics and resistant bacteria in the environment (mainly human), chemical fertilizers and eutrophication (mainly environment), and residual pesticides in the crops (environment and human). A simple solution is of course to reduce the use of such chemicals, but mere reduction often deprives the society of the benefits brought by the chemicals. Rather, we need to find the optimal by semi-quantifying not only the risks but also the merits of using chemicals. To enable such estimation, we need both the risk-exposure functions as well as benefit-exposure functions. To estimate the risk-exposure functions, usually we assume a life or environment functioning “completely”. Likewise, benefit-exposure functions sometime should be derived from the value added to completely functioning human or environment. In this presentation, feasibility of and issues associated with such evaluation will be discussed. Critical issues include the range of time, area, and domain involved in the estimations, unpredictable consequences, the interactions with “external” factors, and quantification of the added value (benefit).

Global environmental change: next steps for cross-sectoral action to protect global health. *By Kathryn Bowen*

Presenter: Kathryn Bowen, Australian National University

Co-authors: Kristie Ebi, ClimAdapt; Sharon Friel, Australian National University

Keywords: climate change, global-health, cross-sectoral-collaboration, solutions

Effectively addressing the health risks of global environmental change necessitates an active cross-sectoral approach because health risks arise predominantly via sectors such as water, agriculture and energy. Much has been written on global environmental change (particularly climate change) and its impact on health, but little attention has focused on the realpolitik of how to progress the development and implementation of health-relevant strategies and policies to reduce this impact. The objective of this paper is to propose three solutions to address current deficiencies:

i) strengthening the capacity and understanding of health officials in relation to climate change and health;
ii) improving cross-sectoral partnerships with sectors relevant to climate change and health, and
iii) identifying organisations influential in the development of climate change mitigation and adaptation strategies and policies, with a view to better target advocacy efforts.

Practical examples of each solution are provided, via results from a four-year AusAID-funded project in the Asia Pacific region. In conclusion, as a steward of public health, the health sector must take the initiative to encourage a cross-sectoral approach that includes capacity development, coupled with an understanding of influential organisations. If this is done effectively, health, social and economic development goals can be reached more efficiently.

Effects of globalization and development on local ecohealth. *By Kazuhiko Moji*

Presenter: Kazuhiko Moji, Nagasaki University School of International Health Development

Keywords: ecohealth, globalization, liver fluke, malaria

Globalization is threatening local health globally by 1) enhancing global environmental change, 2) spreading gap between the rich and the poor, and 3) destroying traditional societal solidarity, and 4) increasing antagonism among countries. To mitigate this impact, the concept of global health has been introduced in 1990s. It is impossible to stop the momentum/trajectory of globalization. Yet, we can seek the better globalization and reduce the bad impacts of globalization on environment, society and human health by promoting effective local and global health activities. By describing the relation between development and two endemic diseases, liver fluke infection and forest malaria in Lao P.D.R., the relation between sustainability and health would be elucidated in this presentation.

Benefits and risk of active transport and farming in urban environments. *By Steffen Loft*

Presenter: Steffen Loft, University of Copenhagen, Department of Public Health

Keywords: health promotion, air pollution, exposure

Sustainable urban development includes promotion of active transport and urban farming potentially interacting health. The exercise required for active transport is considered beneficial for health with reduced risk of obesity, diabetes, cardiovascular disease, some cancers and related mortality, although evidence regarding active transport per se is limited. Concerns include accidents and air pollution exposure. Although enhanced by increased ventilation during physical exertion the transport-related air pollution exposure is usually a limited part of total integrated exposure assessed at the residence. Health beneficial effects of exercise and active transport are found in urban populations despite higher residential exposure. Moreover, short term exposure studies suggest limited impact of exercise on effects on biomarkers addressing mechanisms involved in health effects of air pollution. Urban farming contributes to sustainability, improved health and poverty alleviation. Transport and storage related carbon footprints are reduced and waste can be a resource. Healthy foods and meaningful physical activity are available, whereas greening space promotes health and reduces air pollution. Household expenditure for food is reduced and surplus can provide an income. Urban farming-associated health risks include 1) Deposition of air pollutants on crops leading to exposure via the oral route and poor nutritional value; 2) Exposure during farm work and contaminated crops from contaminated soil; 3) spread of infection through use of human waste(water) for fertilizer and irrigation. Model estimations based on farmers indicate that near sources the risks associated with ingestion of compounds from particulate matter via crops are comparable to risks via inhalation. Moreover, animal experiments indicate that the effects on the most important mechanistic pathways are larger with oral than with airway exposure to the same amount of particulate matter. To fully benefit from active transport and farming in urban environments it is from a health perspective of utmost urgency that air pollution is controlled.

Measuring up to our common future. *By John D. Spengler*

Presenter: John D. Spengler, Harvard School of Public Health

Co-authors: Dinah Koehler, Deloitte; Eric Hespenheide, Deloitte retired

Keywords: ESG reporting, corporate sustainability

Despite 20 years of sustainability reporting, why is the disclosed information not being integrated into business decisions to trigger the advance of business models more compatible with the needs of nine billion on a finite planet? Many corporate environmental, social and governance (ESG) disclosure reports emphasize how "green" the business has become and document goals and programs that illustrate commitments to use material capital (water, energy, resources) more efficiently. Stakeholders cannot distinguish a high ESG performing company from a low performer who invests little in ESG, but still gets the benefit of looking "green" simply by issuing a sustainability report (i.e., greenwashing). To understand why ESG disclosure has created a "market for lemons", we interviewed 24 corporate sustainability leaders. Many are using an entirely different ESG dataset to make strategic decisions on product design, supplier selection and operational changes. But these efforts are not being disclosed systematically with linkage to business performance, and therefore cannot change the business calculus that prevents massive investment in cleaner, more socially just and less risky business models. The 20 years ESG experiment of voluntary disclosure has reached its limit. A more enlightened era of business management will require mandatory disclosure that establishes 1) minimum ESG reporting standard for information that is actionable, and 2) ESG performance standards that are linked to business outcomes. Once these two elements are in place investors can have greater confidence in the ESG signals companies send in their corporate reports. As with traditional financial reporting, a mandated disclosure framework—along with strong voluntary aspirational standards—can better drive ESG information to investors and ensure that capital markets continue to efficiently serve society's greatest needs.

Sustainability and health promotion. *By Richard Hobday*

Presenter: Richard Hobday

Keywords: indoor chemistry, infection, obesity, ageing

The last 150 years have seen marked changes in attitudes towards health in the built environment. During the 19th and into the 20th century, the view was that homes, hospitals and even cities should be designed to promote well-being and not just prevent disease. Efficient energy use was secondary to health promotion. Improvements in planning and building design during this period are credited with reducing the prevalence of infectious diseases. Today, the position is reversed with greater emphasis now on carbon emission savings than on health. But if the correct balance between health and energy performance is not established the costs to society could be large. It is increasingly recognised that chemical pollutants in buildings pose a significant hazard to occupants; but knowledge of how they interact is limited. Also, the amount of ventilation needed to prevent the spread of respiratory infections indoors is unknown. So the ventilation rates specified in current codes and standards may not be high enough to avoid illness. The impact of heating and lighting on occupant health has been under-researched for decades. And there is growing concern that published data on indoor environmental quality in highly energy-efficient buildings is lacking. This paper examines these and other issues related to health in the built environment.

Managing human health impacts from chemical emissions. *By Alexis Laurent*

Presenter: Alexis Laurent, Technical University of Denmark - DTU Management Engineering - Division for Quantitative Sustainability Assessment

Co-author: Michael Z. Hauschild, Technical University of Denmark - DTU Management Engineering - Division for Quantitative Sustainability Assessment

Keywords: life cycle assessment, air pollution

Anthropogenic activities typically results in emissions of chemicals potentially damaging to human health. Among them are the non-methane volatile organic compounds (NMVOCs), which are primarily emitted from road transport and industrial and domestic utilisation of solvents. NMVOCs can cause indirect health effects by contributing to the formation of ground-level ozone, which induces respiratory and cardiovascular problems. In addition, some NMVOCs like formaldehyde can trigger direct toxic effects, e.g. carcinogenic effects. To which extent do these substances contribute to health impacts and how effectively have their emissions been managed at policy levels in the past? To address these questions, we developed a methodology allowing for building national NMVOC emission inventories disaggregated at substance level. Using recommended life cycle impact assessment methods, we assessed the impacts on human health of NMVOC emissions for 31 European countries over the period 2000-2010. Results reveal that total NMVOC emissions correlate well with their indirect ozone-formation-related impacts, thus implying that total NMVOC emissions can be used to set up legislative frameworks for minimising this type of impact. In contrast, no correlation was observed between total NMVOC emissions and their direct impacts on human health, which are caused by a limited number of substances, such as formaldehyde, acrolein and furan, and primarily originate from transportation sectors and residential sources. The study shows that, although total NMVOC emissions decreased in most European countries between 2000 and 2010, cancer-related effects increased in some. These results evidence that emissions of carcinogenic NMVOCs have not been reduced sufficiently, and that the total NMVOC emissions should not be used as stand-alone indicators to frame legislation addressing their health impacts. We therefore call for the need to support air pollution abatement strategies with quantitative impact assessments, which allow for adapted country-specific management of emissions at sectorial and substance levels.

Human-earth relationship – Reconciling world views on the human-earth relationship

The session explored socio-culturally driven behaviour and perceptions, e.g. if the various perceptions of the relationship between humans and the Earth system can be reconciled or transformed to support earth stewardship.

Session 1:

Session 2:

Session 3:

Posters:

Traditional knowledge as innovation in the food system: A case study from the Wild Coast, South Africa. *By Laura Pereira*

Presenter: Laura Pereira, University of Cape Town

Co-author: Kristen Kennedy, University of Cape Town

Keywords: food security, traditional knowledge, innovation

The definition of food security has recently expanded from a focus on food production to include aspects of livelihood, cultural integrity and sustainability. The food system approach, which recognises the food system as a complex socio-ecological system- whilst providing a framework for negotiating the complex interconnectedness and feedbacks within the system, is starting to incorporate postmodern theories of power and agency in order to make explicit issues of equity and power dynamics in achieving food security. In this paper, we explore these complex issues through a case study on the Pondoland region of South Africa, a former homeland under apartheid. The Wild Coast of South Africa has been home to the Pondo people for centuries; the local crops and traditional food practices that are embedded in this area and in the narratives of these people offer a rare insight into unique knowledge and potentially powerful tools for transformation of the modern food system. Through the lens of orphan crops and novel food preparation techniques, this project identifies new innovation pathways to sustainability, based in socio-cultural appreciations of human-environment relationships. At the same time, it aims to provide agency to local communities, especially in the context of their identified goal to leverage their knowledge for eco-tourism. We argue that the traditional knowledge surrounding food provides a wealth of diversity that can contribute to transforming a food system that is currently unable to provide food security to over 2 billion people. The communities in the Pondoland region offer a case study to test new questions and ideas about the resilience and agency of marginalised groups over their food security, both economically and facing projected climate change impacts. In conjunction with the local people, this project showcases novel ways in which long term sustainable access to nutritious and culturally-acceptable food can be achieved.

Perceptions, Adaptation, Climate Change, Kapenta. *By Mulako Kabisa*

Presenter: Mulako Kabisa, University of Zambia

Keywords: perceptions, adaptation, climate change, Kapenta

Siavonga district has for the last 2 decades experienced declining, unpredictable and poorly distributed rainfall and experiencing climate change impacts. Climate impact on Lake Kariba Kapenta fish stocks has been done by Ndebele-Murisa et al (2011a and 2011b) showing increased temperature and reduced rainfall are the main climatic factors affecting fish catch by affecting upwelling of nutrients from deeper lake layers due to prolonged stratification and reduction of inflow of nutrients from inundated areas. This has led to reduced primary productivity, fish productivity and resulted in reduced Kapenta fish catch. The perception of Kapenta fishers on climate change and their adaptation to its impact, where investigated in Siavonga district, Zambia, using primary data collected by a structured questionnaire and secondary data. A random sampling technique was used to select 90 Kapenta fishers on Lake Kariba. Descriptive statistics, Multiple Regression Analysis and a Likert scale were used to analyze the data collected. The majority of Kapenta fishers (87.5%) were aware of climate change, citing a reduction in rainfall, increase in temperature and reduction in Kapenta fish stocks. Some fishers attributed the reduction in Kapenta fish stocks to the presence of too many rigs on Lake Kariba and lack of a closing season to facilitate fish breeding. Strategies employed by the Fishers to adapt to impacts of climate change included No adaptation (9.5%), Shifting Fishing times (28.8%), Fishing for longer time periods (38.4%), Fishing in waters further away than before (69.9%), Changing fishing gear (8.2%), Catching smaller fish (8.2%), Alternative livelihoods (5.5%) and Specified options (6.8%). Some strategies employed are not climate-smart; they go against the Principles of Code of Conduct for Responsible Fisheries Management.

Human-earth relationship: Cultural and social dimensions of floating rice conservation in the Mekong River Delta, Vietnam. *By Nguyen Van Kien*

Presenter: Nguyen Van Kien, Research Centre for Rural Development - An Giang University, Vietnam

Co-authors: Huynh Ngoc Duc, Research Centre for Rural Development - An Giang University, Vietnam; Le Thanh Phong, Research Centre for Rural Development - An Giang University, Vietnam; Trang Thi My Duyen, Research Centre for Rural Development - An Giang University, Vietnam

Keywords: floating rice, Mekong Delta, cultural-social-ecological-systems

Floating rice is a native variety of rice in the Mekong Delta (MD). It has significant cultural, ecological, environmental and historic values in the region. This variety of rice used to be a main source of high quality of nutrition for people living in the MRD. Floating rice was widely distributed in both shallow and deep flooded areas across particularly the Long Xuyen Quadrangle and the Plain of Reeds. Two typical species of floating rice in the Mekong Delta are Oryza sativa L and Oryza prosative. Before 1975, total area of floating rice was estimated at over 500,000 hectares, of which 50% was distributed in the province of An Giang alone. However, by 2012, there were only 61.2 ha of floating rice growing in Tri Ton district of An Giang province. Traditionally there were more than four different floating rice varieties such as “nang pha, nang tay dum, chet cuc, tau binh and bong sen”. The unique ecosystem of floating rice, and its ecosystem services, is at imminent risk of extinction unless there is a conservation activity to maintain it. Recognition of the eco-social-cultural advantages of the floating rice, a group of farmers in these communes have grown the floating rice for years to keep its traditional farming systems of the MD. This traditional farming system is acknowledged as the unique cultural-social-eco-agro values in the MD. This paper recalls history of living with floods using natural adapted floating rice system, the process of disappearance and preservation of floating rice, and describes traditional knowledge of growing floating rice. This paper explains cultural-social-agro process of floating rice conservation in the MD to illustrate the human-nature relationship in the modern Eva. The socio-economic characteristics of these floating rice farmers, socio-ecological systems and their perception towards conservation are critically discussed in this paper.

"Trust me, I'm a sustainability scientist": The perils of inattention to academic divides. *By Sarah Cornell*

Presenter: Sarah Cornell, Stockholm Resilience Centre

Keywords: transdisciplinarity, reflexivity, sustainability, plurality, integration

International agreements, democratic policy, and real-world interventions all recognize that meaningful engagement and dialogue lie at the heart of sustainability. There is widespread pragmatic acceptance and a wealth of practical experience in reconciling multiple priorities and perspectives, from communities to global, to achieve "harmony among human beings, and between humanity and nature" (Brundtland's expression). But much of academia lags far behind in developing theory and practices that embed and support an understanding of the human-Earth relationship. Ironically, albeit understandably, an intractable divide lies between the fields that most directly pursue knowledge about the functioning of Earth and of society. The worldviews of physical and human/social sciences appear worlds apart. The reasons and consequences are well documented. I will point out one concern: a science that (rightly) describes itself as objective, because its methods are objective within formally specified conditions, risks producing generations of scientists who believe themselves to be objective (even outside of those conditions). The corollary is that divergent views from other scholars, indeed anyone else, risk being dismissed as "merely" subjective. Many of us working across this divide know effective cures for this dangerous "objectivity": a reflexive stance in our work; attention to ontological and epistemological underpinnings, not just the toolkit of interdisciplinarity; and open and inclusive dialogue enabling co-production of knowledge. However, we repeatedly see programs created that promise transdisciplinarity but start the process of bridging disciplinary expertise as if it were the first time. The same mistakes are made again. And (expensively) again. We cannot afford to work this way, precisely when the world is calling for robust knowledge to inform action under conditions of rapid change. While we all ultimately learn-by-doing, we can develop and deploy effective research processes bringing deep biophysical and social expertise together to engage in mutually respectful dialogue within our societies.

Governing for the benefit of our descendants: Exploring the idea of 'guardians for future generations'. *By Rupert Read*

Presenter: Rupert Read, Reader, University of East Anglia (Philosophy)

Keywords: guardians, deliberative democracy, Plato, Habermas

Plato said we should be ruled by guardians ('philosopher-kings'). Deliberative-democrats abhor such autocracy, and rightly so. But what if the guardians were selected democratically, by sortition? And what if their deliberations became a model of what deliberation in a democratic society could be? Still, there seems little case for substituting guardians for normal elected representatives, for decisions which can be made about us, by people representing us. But what about cases where the people who ought to be heard in the decisions have no voice – even over life-or-death matters? Future people are the most obvious case of such people. I will begin my talk by presenting my broadly Habermasian case for powerful guardians for future people. This proposal embodies a radical vision for a particular form of Earth Systems Governance. A democratic (though not electoral) form, which emphasises how essential it is for our descendants to inherit Earth systems that have not been degraded, and that suggests a mode of governance with the powers to act so as to preserve those systems. My proposal for such guardians (http://www.greenhousethinktank.org/files/greenhouse/home/Guardians_inside_final.pdf) has attracted widespread public attention (see e.g. http://www.theguardian.com/environment/damian-carrington-blog/2012/jan/04/climate-politics-future-generation-justice?). In this talk, I explore the proposal further, by (1) outlining how the guardians' proposal takes future people to be our equals, but also (2) does not fixate on justice as the means to realise this equality. The guardians represent future people, but also embody our caring for them. I suggest that there is at least as much need for us to create institutions that effectuate such care as to seek justice for our descendants. Thinking through the guardians' idea helps throw light on why 'Earth Systems Governance' ought not to place too much emphasis on justice. Democracy, equality, and care are enough to secure flourishing earth systems for future people.

Toward sustainability with a new natural contract. *By Thomas Heyd*

Presenter: Thomas Heyd, University of Victoria

Keywords: natural contract, ecosystemic-integrity, environmental-governance, sustainability

A renewed focus on sustainability is needed in order adequately engaged rapidly changing environmental conditions in the Anthropocene. This may seem to constitute an significant challenge because of the inertia of human cultures. Values, norms and worldviews generally are resistant to change but may themselves be transformed. Michel Serres' proposal for a new 'natural contract' (Serres 1995), which echoes 'the social contract' of Hobbes, Locke and Rousseau, constitutes a pathbreaking, new way to conceive of our relationship to the earth. In analogy to a social contract, which directs our attention to the possible consistency among the interests of diverse autonomous agents, a natural contract directs our attention toward consistency between human interests and ecosystemic integrity of the earth. It is argued that, at this point in the historical development of the Anthropocene Era, human interventions in the natural world have become so heavy-handed that 'the voice' responding from the natural world is becoming ever more audible and loquacious, manifested through rapid changes in the ecosphere. As a consequence, it will become evident that a contract between humanity and the natural world, as proposed by Serres, is increasingly reasonable. This perspective calls for an approach to sustainability that acknowledges earth as an active participant in governance processes affecting living conditions of human beings.

Achieving sustainability through epistemic framework changes: Redefining the place of humanity in nature. *By Ananka Loubser*

Presenter: Ananka Loubser, North-West University

Keywords: epistemic frameworks, dualism, sustainability, environment

Contemporary humanist conceptions of the relationship between humanity and nature seem to be influenced by a pre-theoretical epistemic framework, namely the nature-freedom ground motive. Transcendental criticism of this motive shows it to be dualistic: the freedom of the human personality is seen in opposition to a rather deterministic view of nature. The opposition becomes especially problematic when one pole of the duality is preferred over the other and, by implication humanity is either seen as part of nature (and at the mercy of natural processes) or as elevated above nature (through techno-scientific control of natural processes). Since the dialectic occurs on a foundational level, true synthesis of the two poles of the dualism cannot be achieved. The resulting conceptions of the relationship between humanity and nature are unsustainable. The aim of this article is to discern a sustainable conception of the place of humanity in nature. The article suggests a non-dualistic alternative. This position does not allow some aspects of reality to be absolutized, while others are simultaneously reduced and therefore promotes sustainable development of the human-earth system as a coherent whole. A few normative implications for human behavior towards nature conclude the article.

Why we need to rewrite the narrative of humanity: From conceptualizing the biosphere as resource to seeing it as the context of our being. *By Anders Frøslev Jensen*

Presenter: Anders Frøslev Jensen, Department of Nutrition Exercise and Sports, University of Copenhagen

Keywords: science, sustainability, eschatology, place, being

A model (EVSEN: the Existential search- Virtues of reason- and Secular Eschatologies-Nexus model) of the central formative and driving forces behind the development of modern science will be presented. According to the model modern scientific work was shaped by existential wondering on the world we inhabit, virtues of reason and secular eschatologies that envision how the fulfilment of history can be achieved by means of science. The secular eschatologies of the protestant reformation of knowledge by Francis Bacon and the enlightenment aim at I) recreating paradise by means of technology, and II) emancipating the spirits of citizens from designated illegitimate powers such as the church and the aristocracy, respectively. These visions has dominated the agenda of modern science ever since and designated future states of society as the times and places when/where we can realize our being. Until then we are on the route towards the right place. As a consequence our lives are routified: primarily, we submit ourselves to the rationality of economic growth and accept reducing our work efforts to this rationality. Accordingly, we conceptualize nature (including our own) as resources for the achievement of the mentioned goals. As a consequence the biosphere gets routified instead of being seen as the place where we can fulfil our being. These master plans of the western civilization has mainly been challenged by anti-modern radical conservatives such as Oswald Spengler, and Peter Sloterdijk, who designate past conditions as the true contexts or places of being. They oppose the routifcation of modern life, but they share the abovementioned problem of modernity. Hence, we need a new vision of history, which can replace the secular eschatologies as an agenda-setting narrative for a sustainable science and society: a vision where we insist that this earth - here and now - is our place.

Indigenous knowledge as local response to globalization and climate change in Africa. *By Geoffrey Nwaka*

Presenter: Geoffrey Nwaka, Abia State University, Uturu, Nigeria

Keywords: indigenous knowledge, climate adaptation, Africa

Africa contributes least to, but suffers the most from the worsening consequences of climate change. The industrialized and more affluent countries ought to assume greater responsibility for the current global environmental and economic crises; but Marshall Sahlins has emphasized the need for all people "to indigenize the forces of global modernity and turn them to their own ends" as the real impact of globalization and climate change depend largely on the responses developed at the local level. How can Africa engage with globalization and cope better with the growing threats of flooding, droughts and other emergencies that result from extreme weather conditions? African customs and traditions have for long been misconceived as irrational and incompatible with the conventional strategies of development. But the current global economic and ecological crises have exposed flaws in the Western, neo-liberal model of development. Indigenous knowledge may prove to be "the single largest knowledge resource not yet mobilized in the development enterprise". Poverty may sometimes force people to use resources unsustainably, but most traditional African societies have deeply entrenched ideas about environmental protection and sustainability because their livelihood depends largely on the land and on the stability of the ecosystem. They believe that land and other forms of nature are sacred, and are held in trust by present day users on behalf of dead ancestors and future generations. While Africa stands to benefit from modern science and international best practices, indigenous knowledge offers a model for rethinking and redirecting the development process. Development agents and researchers, who often assume a knowledge or capacity vacuum in Africa, should instead try to tap into the vast resource of indigenous knowledge for locally appropriate ways of forecasting weather systems, traditional techniques of soil management, pest and disease control, adopting suitable crop and animal varieties, and so on.

Applied evolutionary biology as a driver for integration of human-earth relationships in policy. *By Peter Søgaard Jørgensen*

Presenter: Peter Søgaard Jørgensen, Center for Macroecology, Evolution and Climate, University of Copenhagen

Co-author: Scott P. Carroll, Institute for Contemporary Evolution and UC Davis

Keywords: applied evolutionary biology, reconciliation, stewardship

Applied evolutionary biology is concerned with providing solutions to two widespread phenomena of the Anthropocene: The failure of many valued species to adapt to changing environments and the rapid adaptation of many pest species to human control efforts. These phenomena underlie current sustainability challenges in food production, natural resource use, health systems and biodiversity conservation. Both phenomena reinforce the perception of humans as drivers of change in the earth system and the need for earth system stewardship. Because of the diversity of issues addressed, solutions of applied evolutionary biology serve as an important example of how different views on human-earth relationships need to be taken into account early on in future management and policy initiatives. We review the role of human-earth relationships in policies applying three commonly used strategies of applied evolutionary biology. These serve as examples that current efforts to increase sustainability in biological systems challenge many widely held world views. These three strategies are genetic modification of crops, livestock, humans and wildlife; transfer of harvested crops and wildlife in anticipation of climate or other environmental change; and the use of non-eradication therapies in treatment of human pathogens and cancers, agricultural pests, or introduced invasive species. All three strategies emphasize humans as stewards of the earth system, but challenge existing world views that genetic modification is inherently dangerous, that native populations are often best adapted to future environmental conditions and that attempts of eradication are often the best treatment of organisms that may pose a threat to human well-being.

Bridging knowledge systems for sustainability – the case of the indigenous territory and biosphere reserve Pilón Lajas, Bolivia. *By Helen Gambon*

Presenter: Helen Gambon, Centre for Development and Environment CDE, University of Bern, Switzerland

Keywords: ontology, epistemology, Bolivia, human-earth relationship

There is growing consensus that ecosystems management and human well-being are too complex issues to be tackled by a single scientific discipline. Inter- and transdisciplinarity as well as including traditional ecological knowledge (TEK) in research settings are thus on the rise among scholars dealing with sustainability on the local to the global scale. Recognizing different values, practices, norms or institutions organizing and shaping human –earth system interaction as legitimate is the first step in bridging knowledge systems. But sustainability research has to go beyond the recognition of epistemological differences and take a closer look on questions regarding the underlying assumptions of knowledge – of what exists, of what can be known. This does not only apply to so-called traditional forms of knowledge, but also to natural sciences and the humanities. This paper's aim is to bring out the different ontologies underlying the management of the Indigenous Territory and Biosphere Reserve Pilón Lajas in the Bolivian Amazon region. The researcher argues that remaining challenges concerning the (unsustainable) use of natural resources in the area is mainly based on diverging perceptions on the human-earth relationship. While park authorities and NGO's represent a science-based worldview characterized by the dichotomy society-nature, the interaction of the Mosetene and Tsimane indigenous groups with their natural environment cannot be understood without the spiritual component that is shaping both the actions of individuals and communities, and the way nature presents itself to human beings. Different ontologies thus result in diverging ways of what is perceived by different actors as a "problem", of the underlying causes, and what possible solutions to it exist. The focus is put on an analysis of the concept of sustainability in the empirical case of the Indigenous Territory and Biosphere Reserve Pilón Lajas.

Poster presentation

Genesis of an indigenous social-ecological landscape in eastern Panama: History, tradition and gender. *By Divya Sharma*

Presenter: Divya Sharma, McGill University, Montréal

Co-authors: Gerardo Vergara-Asenjo, McGill University; Mitzy Cunampio; Raquel B. Cunampio; Mara B. Cunampio; Catherine Potvin, McGill University, Smithsonian Tropical Research Institute

Keywords: social-ecological, landscape, indigenous, tradition, gender

Despite awareness of the human dimension of land use change, there is still a paucity of knowledge on the interplay between social and ecological influences at the landscape level. Landscapes can be seen as an aggregate of small-scale land cover patches determined by household decisions. We conducted participatory mapping of land cover in an indigenous Emberá territory of eastern Panama to chart out the communal landscape. The resultant map illustrated a mosaic of land classes dominated by pasture. Given the cultural importance of the forest, forest loss has sparked the concern of community leaders. Therefore the goal of this study was to identify the factors that have influenced household decisions aggregating to low forest cover at the landscape level. We conducted 35 semi-structured interviews on socioeconomic characteristics, land use management and cultural changes. We interviewed women, landowners and youth in order to determine their perceptions of influences on land use decisions. Our multivariate analysis highlights the importance of family history and cultural norms on shaping the landscape. Timing of family settlement helped determine proportion of forest cover on family lands, and family's place of origin helped determine their proportion of short fallow for agriculture. Primary discourse on perceived influences on land use decisions was based on economic concerns like subsistence. However, social-cultural factors like reticence to abandon traditional agriculture and influence of Latino farmers' worldviews have also guided decisions. Furthermore, gendered social roles that are informed by both cultural norms and economic opportunities helped explain differences in perceived influences on the land; women had a greater interest in social-cultural issues while men were more aware of ecological influences. An aggregation of such studies to a larger scale could help inform social-ecological drivers of global deforestation.

Nutrient management – Sustainable nutrient management in the Anthropocene

The session put the global cycles of nutrient elements in the spot-light, highlighting challenges and opportunities for sustainable management of phosphorus and nitrogen.

Session 1: What is the Nutrient Challenge?

Session 2: Towards a safe operating space for N and P use

Meeting multiple environmental targets for nitrogen with implications for global crop production. *By Sybil Seitzinger*

Presenter: Sybil Seitzinger, International Geosphere-Biosphere Program, IGBP

Co-authors: Carolien Kroeze, Wageningen University; Wim de Vries, Wageningen University

Keywords: food security, aquatic ecosystems, nitrogen

A sustainable planet requires integrated approaches to address the multiple environmental and societal pressures of the Anthropocene. A key question is: Can we double global food production to meet society's increasing needs and at the same time protect land, freshwater, and coastal ecosystems? To answer this question, multiple scenarios of nitrogen (N) use in agriculture were explored in >5000 watersheds globally using a spatially explicit global watershed modeling approach (Global NEWS). In all scenarios no change was allowed in the current area or location of agricultural land, thus minimizing additional land degradation and biodiversity loss. Meeting concurrent environmental targets for total nitrogen (TN) input to existing agriculture land (<200 kg/ha/yr) and river TN concentrations (<2.5 mg/l) suggests that global synthetic N fertilizer use could increase by 6.5 fold with a 3.2 fold increase in crop production relative to contemporary conditions. However, this would not meet a coastal eutrophication target in many coastal systems. If a coastal eutrophication target is added, that of keeping N:Si ratios favorable for diatoms, global synthetic N fertilizer use could still increase by approximately 3 fold with a 2 fold increase in global crop production and essentially no increase in global river TN load to coastal systems. These scenarios however imply substantial changes in the spatial distribution of fertilizer use and crop production in the world. They indicate that a doubling of global crop production is possible while not expanding agricultural area locally or exceeding local environmental nutrient targets for freshwater and coastal ecosystems. However, this is only possible after a reallocation of our crop production and related fertilizer use.

Coupling habitat exposure to nitrogen and species sensitivity to hypoxia – LCIA methodology applied to marine eutrophication. *By Nuno Cosme*

Presenter: Nuno Cosme, Technical University of Denmark (DTU)

Co-author: Michael Z. Hauschild, Technical University of Denmark (DTU)

Keywords: nitrogen, exposure, effects, hypoxia, eutrophication

Characterisation modelling in Life Cycle Impact Assessment (LCIA) aims at developing sound methods and tools to estimate potential impacts to ecosystems and humans. Ecological and environmental impacts arising from marine eutrophication can be caused by excessive oxygen depletion as a result of anthropogenic emissions of nitrogen (N) from e.g. agriculture and industry. Characterisation Factors (CF) in LCIA are used to translate emissions into potential impacts, traditionally by modelling fate, exposure and effects of the emitted substances. The present work builds on ecological and biological processes and couples marine habitat exposure to N and marine species sensitivity to hypoxia. The habitat exposure model explains the incorporation of N into planktonic biomass and subsequent respiration of the organic carbon in bottom waters where dissolved oxygen (DO) is consumed, delivering an exposure factor (XF). The effect model quantifies the sensitivity of the ecosystems receiving the N emissions (and where the DO is depleted) based on the sensitivity of the resident marine benthic and demersal species to deliver the potential loss of species as an effect factor (EF). Coupling habitat exposure (XF) and effects on resident biota (EF) seems a useful contribution to the estimation of CFs in LCIA where the damage dimension of the impacts to the ecosystem is given by the potential loss of biodiversity per mass of substance emitted. The application of such impact methods in estimating Life Cycle Assessment (LCA) indicators ultimately helps to quantitatively assess the environmental sustainability of human-based product systems and services.

Nitrogen and phosphorus lock-in – a double-edged trap for future food security. *By Helena Kahiluoto*

Presenter: Helena Kahiluoto, Agrifood Research Finland

Co-authors: Anna Kuokkanen, Lappeenranta University of Technology; Lassi Linnanen, Lappeenranta University of Technology; Mirja Mikkilä, Lappeenranta University of Technology; Miia Kuisma, Agrifood Research Finland

Keywords: nitrogen, phosphorus, lock-in, food, transition

Global food system reinforces nitrogen and phosphorus lock-in, which can have detrimental effects on future food security and the operating space for humanity, as it perseveres unsustainable food systems through technological, institutional, and social path-dependencies. A sustainable system change is needed. We hypothesize and empirically test the difference of lock-in situations between two contrasting cases, Finland and Ethiopia. The former, developed country context is locked in by the rigidity, with low level of heterogeneity, and low capacity to explore and dissipate stress. Monocultures, maximization of efficiency and output, centralization, and standardization are characteristic. Whereas, the latter, developing country context, is constrained by the poverty, with low level of network connections, low capacity to focus and low average stress. There, diversity of small-scale farming thrives, yet food needs are not sufficiently met, due to the systemic failures to access fertilizers, technology, seeds, and other assets. Regarding N and P, the two edges of the lock-in situation are strikingly manifested in that over 50 % of fertilizers are used on only 10 % of arable land. In developed countries overuse of fertilizers and increasing runoff of nutrients creates problems of atmospheric, terrestrial and marine pollution. At the same time growing demand for animal produce is infused by further segregation of crop production. On the other hand, countries in the poverty lock-in suffer from inefficiencies and food insecurity due to the lack of access to fertilizers. The situation is exacerbated by the global market that disregards the non-substitutable and disparate nature of nutrients, long time-frame, and the lack of global governance of right to nutrients and food, and the right to consume and distort earth mechanisms. Escaping poverty and rigidity traps would require deviant strategies in terms of sustainability transitions, however, essentially they are inter-related in the global food system.

"Limits" are not the only constraints…. By Katherine Richardson

Presenter: Katherine Richardson, University of Copenhagen

Co-authors: Elena Bennett, McGill University, Stephen Carpenter, University of Wisconsin, Sarah Cornell, Stockholm Resilience Center, Wim de Vries, Waganingen University, Will Steffen, Australian National University

Keywords: nitrogen, phosphorous, planetary boundaries

There is increasing recognition that human perturbation of Earth System (ES) components (land, water, and living resources) can undermine the function of the ES as a whole and, therefore, that mechanisms for the management of these global resources in an ES context must be developed. The current approach to management of these ES components is, generally, to deal with them sectorially and, often, rather simplistically. As these ES components are linked in multiple ways, however, there is a need to develop more dynamic approaches to their management. One ES process that links through these components is global biogeochemical cycling. In the same manner as for the global carbon cycle (leading to climate change), human perturbation of the global nitrogen (N) and phosphorous (P) cycles has greatly increased the magnitude of reactive forms of these elements in the ES. Until now, the effects caused by this perturbation of the N and P cycles have been treated as local/regional environmental issues and managed within individual ES components (water, land, air). However, the combined effect of local perturbations of the N and P cycles creates feedbacks at the global level that include impacts on the climate system, water quality and biodiversity. Thus, some form of management of the human perturbation of these element cycles at the global level seems likely to be a prerequisite for continued societal development. Here, the current natural science understanding of the human perturbation of the global cycles of N and P and the interactions of this perturbation with the functioning of the ES are presented. In addition, the scientific basis for establishing "guardrails" for the magnitude of societal perturbation of these nutrient cycles is discussed through consideration of recent efforts to analyse the synergies and trade-offs among clusters of issues and framed in terms of planetary boundaries.

Assessing planetary and regional nitrogen boundaries related to food security and adverse environmental impacts. *By Wim de Vries*

Presenter: Wim de Vries, Alterra, Wageningen University and Research Centre

Co-authors: Hans Kros, Alterra, Wageningen University and Research Centre, Carolien Kroeze, Environmental Systems Analysis Group, Wageningen University, Sybil Seitzinger, International Geosphere-Biosphere Programme (IGBP) Secretariat, Royal Swedish Academy of Sciences

Keywords: planetary boundaries, nitrogen, food security

The aim of this presentation is to first describe the concept of -, governance interest in- and criticism on planetary boundaries, specifically with respect to the nitrogen (N) cycle. It then systematically evaluates the criticism and argues that planetary N boundaries need to include both the benefits and adverse impacts of reactive N (Nr) and the spatial variability of Nr impacts, in terms of shortage and surplus, being main arguments for not deriving such boundaries. We then suggest a holistic approach for an updated planetary N boundary by considering the need to: (i) avoid adverse impacts of elevated Nr emissions to water, air and soils, and (ii) feed the world population in an adequate way. The derivation of a planetary N boundary, in terms of anthropogenic fixation of di-nitrogen (N2), by growing legumes and production of N fertilizer, is illustrated by (i) identification of multiple threat N indicators and setting critical limits for them, (ii) back calculating critical N losses from critical limits for N indicators, while accounting for the spatial variability of indicators and their exceedance and (iii) back calculating critical N fixation rates from critical N losses. The derivation of the needed planetary N fixation is assessed from the global population, the recommended dietary N consumption per capita and the N use efficiency in the complete chain from N fixation to N consumption. Results of example applications show that the previously suggested planetary N boundary of 25% of the current value is too low in view of needed N fixation and also unnecessary in view of most environmental impacts. We also illustrate the impacts of changes in the N use efficiency on planetary boundaries in terms of critical N fixation rates

How large is the safe operating space? Comparison of five proposals for the N and P cycle planetary boundaries and implications for governance. *By Anders Bjørn*

Presenter: Anders Bjørn, Technical University of Denmark (DTU)

Co-authors: Michael Zwicky Hauschild, Technical University of Denmark (DTU), Katherine Richardson, Copenhagen University (KU)

Keywords: eutrophication, governance, boundaries, Baltic Sea

The planetary boundaries concept highlights the importance of staying within ecological limits, the relevance of taking an Earth system perspective and the interactions across spatial scales of different environmental problems. A planetary boundaries approach to governance must target all activities encroaching on the safe operating space at the global level or within specific regions when regional environmental effects aggregate to threaten the stability of the Earth system. Central to the concept is the choice of a control variable and quantification of planetary boundary, which taken together define the size of the safe operating space for each relevant environmental problem. But how certain is this quantification? This question has so far only been sporadically explored. We aimed for a systematic analysis on the boundaries for nitrogen and phosphorous flows focusing on five recent proposals of a control variable and a quantified boundary. The control variables differed amongst the proposals with respect to both the object of protection and the location in the eutrophication cause-effect chain. The variations in the planetary boundaries was caused by differences in reference conditions (e.g. definitions of a natural state), the ecological basis for thresholds and the choice of multimedia fate models - a combination of value based choices and uncertainty in system knowledge. To test the implications for governance of the different proposals, each boundary was compared to the current value of the relevant control variable in the data rich case of the Baltic Sea. All proposals were found to agree that the safe operating space is exceeded for this case, though they disagree on the extent of the excess. The case of the Baltic Sea was subsequently used to analyze interactions between an excess of the safe operating space at the regional scale and the situation at the global level with potential policy implications.

New ways of organizing sustainable management of nitrogen in agriculture –an adaptive framework for stakeholder involvement. *By Morten Graversgaard*

Presenter: Morten Graversgaard, Department of Agroecology, Aarhus University

Co-authors: Tommy Dalgaard, Department of Agroecology, Aarhus University; Chris Kjeldsen, Department of Agroecology, Aarhus University; Irene Asta Wiborg, Knowledge Center for Agriculture; Jørgen E. Olesen, Department of Agroecology, Aarhus University

Keywords: nitrogen management, sustainability, stakeholder involvement

Solutions to complex environmental problems and the need for a sustainable management of nitrogen in regions with intensive agriculture are becoming increasingly important worldwide. In Europe efforts have been made during the last two decades to reduce nutrient inputs from wastewater discharge and agriculture, the reduced nutrient discharge has led to a decrease in the concentration of nitrogen in groundwater and surface waters, but diffuse pollution still remains a major threat for long-term sustainability of agricultural systems in Europe, USA and East Asia. Dealing with these challenges requires new measures and actions to be constructed in collaboration with stakeholders, and the actions must feed back into policy. However, differences in interests, incentives and perspectives among the different stakeholders add to the complexity of nitrogen management. In policy development it has been emphasized that change in nitrogen management calls for collaboration with stakeholders. One of the goals is to ensure effective dissemination of recommendations from the stakeholders to decision-makers. An example of the latter is the EU Water Framework Directive (WFD), in which stakeholder involvement for the establishment of River Basin Management Plans is required. This paper reviews the Danish implementation and interpretation of stakeholder involvement in the WFD, and through an integrated view on the past efforts we propose new ways of organizing management on catchment scale. Through case studies in 6 different pilot areas within the Danish www.dNmark.org research alliance the implementation of an improved involvement of stakeholders, which integrates across different scales and sectors, is explored. The Danish cases are compared with community-led catchment management in England. It will be elaborated how participatory modelling in catchment management can be a motivating force for a transition of today's agricultural production and be an important element in the development of sustainable approaches, which are based on interaction between stakeholders.

Governance of sustainability innovation through stakeholder platforms: Global initiatives for managing phosphorus within the planetary boundary. *By Masaru Yarime*

Presenter: Masaru Yarime, University of Tokyo

Keywords: innovation, phosphorus, governance, stakeholder platform

Among the major planetary systems, including climate change, stratospheric ozone depletion, and biodiversity loss, phosphorus is not yet addressed successfully through a policy framework, unlike the United Nations Framework Convention on Climate Change (UNFCCC), Montreal Protocol, or Convention on Biodiversity (CBD). That reflects the fact that various stakeholders having different views and interests are involved in the supply chain of phosphorus, ranging from exploration, mining, and transportation to use and recycling, which would make it very difficult to establish a system for collecting, sharing, and utilizing a large amount of knowledge concerning natural and social systems and coordinating behavior among the stakeholders. Although there is a large potential in recycling phosphorus from different sources, a significant amount of phosphorus dissipates to the environment globally, with only a small portion of secondary phosphorus resources utilized so far. A crucial challenge for the governance of sustainability innovation is how to establish effective mechanisms of promoting coordination and collaboration among the relevant stakeholders. In Japan the Phosphorus Recycling Promotion Council has been established recently with experts from academia, industry, and the government to design and implement national strategies for socially robust phosphorus recycling systems. In Europe, the Nutrient Platform has been initiated in the Netherlands, with private companies, knowledge institutes, government authorities, and non-governmental organizations agreeing to share and utilize relevant knowledge. Successful design and management of stakeholder platforms will be the key for co-creating knowledge, co-designing targets, and co-implementing processes for sustainability innovation. There still remain several challenges, including how to organize and implement serious engagement and fruitful collaboration among stakeholders, what types of joint initiatives and networking contribute to identifying desirable goals and targets and developing complementary skills and capacities, and what factors promote or obstruct their successful implementation. Policy and strategic implications are discussed for promoting global cooperation.

Social equity, development and global environment

The session illustrated how global and national economic inequities affect the global environment and looked ahead towards innovative, alternative solutions and reforms capable of tackling the ecological crises and world inequities at the same time.

Session 1: Economic Systems and Sustainable Prosperity

Session 2: Equity and Sustainability: Views from the Developing World

Posters:

Cancel the apocalypse – new pathways to prosperity. *By Andrew Simms*

Presenter: Andrew Simms, Global Witness, the New Economics Foundation Fellow, & the New Weather Institute

Keywords: paradigm, economics, environment, boundaries, transition

If you grudgingly accept that there is no fundamental alternative to how things are, a daily diet of hard times and difficult choices you might want to visit Goodland. Its President refuses the state mansion for a humble homestead. He gives away 90 percent of his pay, living on the national average wage so as to share in the struggles of people. Goodland has a new constitution, written by citizens. When its financial sector fell apart, speculators were made to take their losses and the guilty were taken to court, rather than walking free with a public bail-out. The country has a dynamic, largely mutually owned, local banking system that helps small businesses. In Goodland, human well-being is a more important statistic than economic growth. There is a national plan for good living, free health and education services, subsidised childcare allowing for a more equal workplace and better work-life balance, and there is proper support for the elderly. It has a law enshrining protection of its life-supporting ecosystems that stands above all other laws. Goodland's cities are green and grow healthy, organic food for the people who live there. Their streets are pleasant places to walk and cycle, cars are mere guests on the roads and mass, public transport is clean, cheap and convenient. Urban areas are less stressful and easier on the eye because the visual pollution of advertising in public places is restrained. Faced with systemic economic and environmental problems, we live in an age of undrawn conclusions about necessary change. This presentation explores how the answers may already be around us. Embracing change may transform our lives for the better. It will take boldness, but as the poet Seamus Heaney wrote in Elegy: 'The way we are living, Timorous or bold, Will have been our life.'

The inevitable collapse of the fossil fuel empire: and the rise of the new paradigm. *By Nafeez Ahmed*

Presenter: Nafeez Ahmed, Institute for Policy Research & Development, International Relations

Current approaches to addressing climate change, energy challenges, food crises, economic crises, and violent conflict tend to do so through the lens of 'security'. The solutions that then follow tend to exacerbate the crises and fail to solve them. A holistic and systemic approach, however, demonstrates that these crises are symptomatic of not just a failed global neoliberal paradigm, but that the 'securitisation' of global crises in the name of solving them is largely bound up with the same failed paradigm. In reality, these crises signify a civilisational transition in which the fossil-centred global imperial system is cannibalising itself through a protracted collapse process. Events such as the Arab Spring can be understood as manifestations of this process. As this process accelerates, it opens up the possibility of new emergent, post-capitalist, post-carbon, decentralised paradigms. This emergence itself, however, has generated a new battleground as agents of the old neoliberal, fossil fuel centred order struggle against emerging spaces of resistance around the world.

Can market-based instruments be ethically defended? *By Torsten Krause*

Presenter: Torsten Krause, Lund University Centre for Sustainability Studies

Co-authors: Eric Brandstedt, Lund University - Department of Philosophy; Lennart Olsson, Lund University Centre for Sustainability Studies

Keywords: incentives, REDD+, governance, conservation, justice

Global environmental challenges are increasingly at the forefront of political and social debates, but ideas for further stimulating economic development and growth continue to thrive. As a result, environmental governance increasingly focuses on mechanisms that apply an economic logic, which fosters utilitarian ideals that are often framed as win-win approaches and are now applied worldwide. Yet, trade-offs at different spatial and temporal scales are inherent and increasingly acknowledged. Unless mechanisms are devised that lay the foundation for long-term visions of sustainability, global climate change, biodiversity loss and deforestation, among others, will continue to exacerbate and affect human societies at all levels. The starting point for this paper is a synthesis of research on the application of financial incentives for conservation and development. Empirical findings from the Ecuadorian Socio Bosque conservation incentive program inform our broader debate on the use of market-based instruments for the conservation of tropical forests. In this paper we discuss the sustainability of the incentive approach in environmental conservation from an ethical perspective, particularly in light of intergenerational equity, achievement of poverty alleviation and social development, as well as long-term environmental benefits.

Governance, social equity and resilience in Asia's cities. *By James Jarvie*

Presenter: James Jarvie, Mercy Corps

Co-author: Richard Friend, Institute for Social and Environmental Transition

Keywords: urban climate resilience, equity, Asia

Asia is going through unprecedented urbanization. Secondary cities are seeing the most rapid changes in land-use and ownership, social structures, and values. At the same time climate change is making many urban centers even more vulnerable to the risks they face. A result is a cry among development policymakers to build urban "resilience." Effort focuses on technical and managerial aspects of planning, particularly policy strategies and documents. There is less consideration of the political dimensions behind urbanization, enhanced planning processes that could generate greater representation, accountability and transparency. Urbanization is largely driven by global capital flows. This causes tensions between the regulatory and entrepreneurial role of local government, between ecological constraints and investment imperatives, and between the needs and interests of different groups of urban actors. There is often an implicit assumption urban governance is representative and accountable. This is not true in many Asian cities, and intervening directly with government in the name of resilience has potential to do harm. Building urban resilience is essentially about building a long-term urban future – a future that will need to be different from current trajectories of urbanization. If the main challenge of urbanization is considered to be management of investment flows, adding new funding streams for infrastructure or expanding technical capacity of city government, we risk reinforcing undemocratic and inequitable processes, particularly in cities where the poor, unemployed and migrants make up significant proportions of the population. To do so risks deepening inequality and resentment. Neither resilience theory nor the current discourse and practice of urban climate resilience address issues of power and politics effectively. If we are to apply resilience thinking to the highly politicized and contested context of Asia's new urban areas, we need to redress this and make an explicit commitment to rights, social justice, and equity.

Building just, inclusive and sustainable cities in Africa. *By Geoffrey Nwaka*

Presenter: Geoffrey Nwaka, Abia State University, Uturu, Nigeria

Keywords: cities, Africa, inclusiveness, social sustainability

As we consider the Post-2015 development agenda for Africa, many agree that the battle for sustainability in the continent will be won or lost in the cities, and that it is best to target the poverty problem where it is growing fastest - in the cities. The paper examines how poverty and widening inequalities in African cities can be addressed. UN-Habitat estimates that sub-Saharan African cities have over 166 million slum dwellers, most of who work in the informal sector where they simply do not earn enough to afford decent shelter and services. What does sustainability mean for such cities and townspeople? Agenda 21 of the Rio Summit emphasizes that sustainable development has to be socially just and ecologically stable. Some elite neighborhoods in African cities enjoy relatively high quality housing and residential environment, the bulk of the urban poor live in appalling and health-threatening conditions. The poor suffer disproportionately from the health effects of environmental problems and climate change. They are more vulnerable to increasing crime and violence in the cities. They have little or no social protection, and rely largely on their own means, and on traditional kin-based social security networks. The pattern of government spending on health and other social sectors tends to favor the well-off in society. Indeed government officials tend to see the urban poor and the informal sector as evidence of the failure of official policy, and therefore something to be removed through misguided policies of forced eviction and other form of repression. But current research suggests that the path to urban peace and sustainability lies in building more inclusive and socially equitable cities “where everyone, regardless of their economic means, gender, age, ethnic origin or religion are enabled and empowered to participate productively in the social, economic and political opportunities that cities offer”.

Homegrown solutions to natural resource conflict transformation: A case study of the community social peace and recovery model. *By Salome Zuriel*

Presenter: Salome Zuriel, Agency for Corporation on Research and Development

Co-author: Leonie Sendegeya, ACORD

Keywords: natural resources, community, conflict, sustainability

Peace and environmental protection are mutually dependent. The mis-management and scarcity of natural resources undermines livelihoods, increases vulnerability to disaster and puts human lives at risk. On the other, violent conflict, inappropriate or inadequate policy frameworks, greed and fragility lead to the mismanagement of natural resources and the erosion of local conflict management mechanisms. In Sub-Saharan Africa, conflicts are mainly internal, but often spill over national boundaries and affect neighbouring countries in terms of disruption of security and livelihoods, and increased pressure on services and natural resources. Further, Sub-Saharan Africa is arguably the region that is most at risk of instability as a result of climate change associated upheavals. This paper elucidates a homegrown methodology for building social peace amongst communities that are in tension over natural resources in several East, Central and West African countries. The Community Social Peace and Recovery model (CSPR) supports divided and affected communities to take leadership to dialogue and negotiate social peace and come up with agreed social contracts for sustainable peace and recovery. This is achieved through community dialogue and negotiation, the signing of social contracts for peace, joint design and implementation of peace and recovery projects and establishment of community watchdog mechanisms. Conflicts over control of land and water resources are common in Sub-Saharan Africa. Since 2009, in Chad, the CSPR model has been facilitating the brokering of peace between communities competing over scarce natural resources, in a context where there had been deadly clashes between farmers and nomadic pastoralists. Eight local conventions on the management of natural resources in four districts were signed and resulted in the ability of 10 rural communities to non-violently manage rangelands, agricultural, forest and water points. The signing of these agreements involved local communities, farmers and pastoralists, traditional authorities and religious leaders (Imams) and local authorities.

Caste as a driver of environmental change in India. *By Alfred Gathorne-Hardy*

Presenter: Alfred Gathorne-Hardy, University of Oxford

Keywords: caste, India, behavioural change, environment

Caste, a system of societal stratification largely based on occupation, remains highly influential in Indian society, especially in rural areas. While it is a key determinant of individual behaviour, its role as a driver for environmental impact has been ignored in the environmental literature. As human behaviour is the driver of anthropogenic impacts, mitigating environmental impacts is only possible if different behavioural drivers are clearly understood. This research for the first time maps behavioural aspects of caste and their environmental impacts. We identified three broad pathways through which caste could drive environmental change: 1. through prescriptions and proscriptions relating to specific caste groups. In Indian villages Dalits (formally known as untouchables) are still proscribed from actions that have immediate environmental impacts ranging from accessing water facilities to cycling on public roads (Shah, Mander et al. 2006). Additionally there has been a long history of compulsory service from dalits for specific occupations, often those associated with dirt and pollution. At the other extreme several high caste groups forbid themselves from eating meat, or living in certain areas, or having certain jobs. 2. individuals/groups may change behaviour to deliberately reject/associated certain caste-associated activities. Individuals at the bottom of the social and economic pyramid are prepare to pursue (un)-employment that is de-linked from caste to provide self-respect and dignity, even at the cost of material comfort (Gorringe 2010). Examples include the cessation of irrigation management or agriculture labour. Sansktritisation is a process that involves lower and middle castes taking on of rituals and habits of higher caste groups, for example the adoption of vegetarianism.. 3. the abuse by outside forces of local environments owned/managed by lower castes/tribal groups, exploiting these groups' lower socio-political status and economic power.

A social aspect to planetary boundaries: Equity in access to resources for food.

By Helena Kahiluoto

Presenter: Helena Kahiluoto

Co-authors: Miia Kuisma, MTT Agrifood Research Finland; Anna Kuokkanen, Lappeenranta Technological University; Mirja Mikkilä, Lappeenrantya Technological University; Lassi Linnanen, MTT Agrifood Research Finland

Keywords: nutrients, thresholds, food security, equity

Conversion of atmospheric nitrogen (N) into its reactive form and phosphorus (P) flows to water systems have been demonstrated to be among the three interlinked earth system processes which already transgressed the regulatory capacity of the earth (Rockström et al., 2009a,b; Carpenter and Bennett 2011). We assessed the reduction in N and P flows required to return to within the planetary nutrient boundaries and quantified the consequences to food supply. Agrifood systems account for 74% of N conversion and 80% of P flows which are important determinants of biomass production and food supply. P flows to freshwaters, representing the largest gap to bridge to return to within the planetary nutrient boundaries, and then N conversion, set the limits to food supply within the safe boundaries. We showed that the current gap to bridge for returning to within the boundaries is tremendous, while population growth and scarcity of P reserves are less important factors for food security. With current agriculture and diet, the required cut in P and N flows would reduce the present food supply to roughly a tenth and below a fourth, respectively. Such a gap cannot be bridged without a radical transformation of the global agrifood system. Further, the striking scarcity of nutrients and consequently in food within the safe boundaries will not allow the present disparities in food supply among individuals and countries. We exemplified the disparity in the current and accumulated access to N and P between Finland and Ethiopia. The historical nutrient flows which contribute to the soil nutrient stocks, if taken into account, limit the local nutrient flows within boundaries drastically more than the current spatial disparities do. We discuss a global institutional framework to induce a food system capable to supply food within the planetary boundaries and with equal access to resources.

Poster presentation

A critical review of tools for corporate impact assessment and management. *By Christine Meyer*

Presenter: Christine Meyer, Universität des Saarlandes, Center for Evaluation

Co-authors: Wolfgang Meyer, Universität des Saarlandes, Center for Evaluation; Jörg Rech, Universität des Saarlandes, Center for Evaluation

Keywords: impact assessment, responsible business practices

Realizing the vision of sustainable development has been a global challenge for the last decades. Multinational corporations (MNCs) are important actors to contribute to development goals, in particular by responsible business practices and integrating development issues into their management approaches. Measuring and managing their impacts on global development is of great relevance to many corporations. There is a great variety of tools and frameworks for corporate impact assessment and management, which provide a practical measurement methodology in order to assess or improve certain aspects of performance and impact of companies, strengthen managerial capacities or improve disclosure. Comprehensive frameworks that would help MNCs to better understand and manage their impacts both locally and along their international supply chains are still lacking. The GLOBAL VALUE project (www.global-value.eu) will deliver a comprehensive and tested framework for measuring and managing wider societal and development impacts. The presentation will provide a critical review and categorization of these tools, based on the research carried out for the GLOBAL VALUE project. It will also show the strengths and weaknesses of impact assessment methodologies, identify gaps, and demonstrate objectives of the application of these tools. Building on the GLOBAL VALUE project as well on the expertise in impact and programme evaluation of the Center for Evaluation (CEval) the presentation will give recommendations for corporate impact assessment for business including an understanding of “impact” and it´s pathways, the required data and how reliable and valuable impact assessment could be realized.

Urbanisation

The session explored the opportunities for efficient delivery of services, energy and material use, and fostering innovation and creativity through urbanisation.

Session 1: Challenges and opportunities of urbanization

Session 2: Innovation, Universities, and Urban Sustainability

Posters:

Urbanisation and air environmental impacts in China. *By Kebin He*

Presenter: Kebin He, School of Environment, Tsinghua University

Keywords: urbanization, motorization, air quality

The urbanization in China grew rapidly from 19% in 1980 to 53% in 2013. In the same period, China also experienced the rapid growth of industrialization and motorization. Consequently, Chinese cities have experienced a significant variety of urban air pollution problems during the past decades. In the 1970s and the 1980s, many cities, especially industrial cities, suffered severe coal smoke pollution, with high concentrations of total suspended particles (TSP) in the air. Since the 1990s, as a result of the dramatic growth in vehicle population and vehicle use, the air quality in large cities was deteriorated by nitrous oxides (NOx) and photochemical smog, which were typical of vehicle pollution. During recent years, under the influences of various pollution sources and complicated chemical reaction mechanisms, a large number of Chinese cities are facing the combined air pollution, which is characterized by high ambient concentrations of PM2.5. PM2.5 pollution can significantly affect the health of citizens and lowers the visibility, and it can impact a large area of regions. Now, PM2.5 pollution has become the major environmental concern of Chinese citizens.

The Urban Opportunity: Enabling Transformative & Sustainable Development in 21st century. *By Aromar Revi*

Presenter: Aromar Revi, the Indian Institute for Human Settlements (IIHS)

From now till 2050, the world urban population will grow from over 3.5 to 6.2 billion, by when two-thirds of the global population will live in cities. Of this, over half a billion are expected to live in extreme poverty. By 2025, the GDP of the 600 highest contributing cities will rise by over $ 30 trillion or 65% of global growth. Annual urban infrastructure and building investments are expected to rise from $10 trillion today to more than $20 trillion over this period, largely concentrated in emerging economies. Yet cities will concentrate much of emergent risks and urban consumption will drive over two-thirds of global carbon emissions.

Cities and regions that embed them offers unprecedented leverage to help operationalise the UNs prospective Sustainable Development Goals especially help end multidimensional poverty; dramatically improve life expectancy, health status and education; help diminish social stratification and inequality; enable greater economic and political participation; provide the ‘space’ to deepen the governance and conserve ecosystem services.

Governing cities for low carbon transitions? *By Harriet Bulkeley*

Presenter: Harriet Bulkeley, Durham University

Keywords: cities, governance, low carbon transition

While conventionally seen as a global problem requiring global solutions, it is increasingly evident that climate change is a critical urban issue. In response, municipal authorities, together with a wide range of public, private and civil society actors, now have their sights set on the city as a critical arena through which to respond to climate change. While research has examined the ways in which such responses are taking place through formal processes of planning and policy-making, this paper explores the alternative spaces and politics of climate governance in the city taking place through the emergence of new forms of intermediary organisation and forms of climate change experimentation as a host of projects and initiatives are deployed across the urban landscape. Rather than regarding these forms of climate governance as marginal or as exceptional curiosities, we find that they are central to the contested urban politics of low carbon transition. Drawing on a range of case-studies from the global North and global South, the paper explores how these forms of governance work in practice, their politics, and their implications for low carbon transitions.

Modeling Land Use in Coastal Urban Areas: Amenities, Risks, and Resilience. *By Margaret Walls*

Presenter: Margaret Walls, Resources for the Future

Keywords: resilience, hurricanes, land use, economics

Climate scientists predict extreme weather events to worsen in the future and coastal communities will be hit especially hard. Over 600 million people live in coastal areas around the world; in the United States, 39 percent of the population lives in counties directly on the shoreline. Furthermore, these areas are seeing the largest rates of population growth. These facts mean that planning and preparing for the risks from climate change in coastal urban areas is imperative. In order to plan and prepare, it is important to understand the factors that motivate people to live in coastal areas and appreciate how perceptions of risks affect their choices. We construct an economic agent-based model of housing and land markets in a coastal setting in the mid-Atlantic region of the United States. The model incorporates the behavior of three agents—farmer/landowners, developers, and consumers. The population grows over time; agent interactions in the marketplace generate spatial patterns of development over the landscape over time. In the model, consumers choose where to live, balancing the amenities of living near the coast with risks of incurring substantial damage due to storms and hurricanes. We show how land and housing prices vary spatially and over time. And we show how prices and the spatial patterns of development depend on storm risks and whether consumers' subjective risks match actual risks. Finally, we use the model to analyze policies that are designed to alter land use patterns. Elected officials in coastal urban areas need to understand how potential policies will work and how they will affect land and housing markets. In many countries, including the U.S., the financial costs of storms are significant but policymakers have had difficulty in moving people away from the coasts. Our model will highlight the tradeoffs in achieving such outcomes.

Future Cities Lab: Innovative research for sustainable cities. *By Peter Edwards*

Presenter: Peter Edwards, Singapore-ETH Centre

Established in 2010 as part of the Singapore-ETH Centre for Global Environmental Sustainability, the Future Cities Laboratory (FCL) is a cross-cultural, cross-disciplinary research platform producing knowledge and ideas that cities need to develop sustainably. The FCL programme is based on the concept of 'urban metabolism', which treats the city as a complex system characterized by stocks and flows of resources, such as energy, water, capital, people and information, and their relation to design. The individual FCL projects, led by professors at both ETH and Singapore, cover topics as diverse as new building materials, digital fabrication, mobility and transportation planning, urban simulation, urban design, urban sociology and territorial planning. An important part of the 'glue' holding these projects together are the superb facilities provided by the 'Value Lab Asia' for modelling and presenting 3-D and more-dimensional data. These facilities provide not only an essential research tool, but also a means for translating research into instruments that practitioners can use. In this lecture, we show how this innovative approach is being applied to the particular problems of one high density, tropical city, Singapore. For example, we describe the dramatic improvements that can be achieved in the efficiency of cooling systems, offering the prospect that future highrise buildings will not only consume less energy but also require less material to construct. And at a larger scale, we show some of the complex inter-dependencies between Singapore and its surroundings, which can be characterized by flows of natural resources, people and wealth, and also byless tangible things such as ideas and cultural influences. In conclusion, we argue that this kind of transdisciplinary approach, engaging strongly with stakeholders at all stages while seeking to understand a city in its full complexity, will be essential for a sustainable urban future.

Innovative Urban Sustainability: the Capacity of University-Municipality Alliances to Develop Durable Solutions. *By Melissa Goodall*

Presenter: Melissa Goodall

Keywords: university sustainability, urban university

There are over 22,000 universities in the world. Most of these are in in urban settings, and many are public institutions and therefore directly affiliated with various levels of government. These institutions house academic thought-leaders and emerging scholars. They frequently function as mini-cities, offering housing, transportation, food, workspace, and more to their community members. In terms of operations, they tend to be more agile than municipalities and less profit-driven than businesses. The standard mission statement of a university relates to teaching, research, and service, and therefore precludes advocacy and direct influence of politics. These factors add up to a set of institutions around the world that are ideally suited to develop and test innovative technologies and systems in the urban environment, and to cultivate strong sustainability values in the next generation of leaders. This last is a particularly important element. As President Abraham Lincoln once wrote, “The philosophy of the classroom today is the philosophy of the government tomorrow.”

This talk will offer a set of concrete examples where universities have partnered with cities to streamline systems and develop durable solutions to urban sustainability challenges. It will also offer a set of challenges and lessons learned in the context of both academia and local government. It will conclude with a basic set of core concepts for integrated sustainability planning between municipalities and higher education institutions.

Environmental impacts and quality of life in a compact city in the context of aged society. *By Keisuke Hanaki*

Presenter: Keisuke Hanaki, Integrated Research System for Sustainability Science, University of Tokyo

Keywords: QOL, transportation, building, energy saving

Lowering of vitality and decrease of the population is a challenge of aged society. The need for welfare services increases while the movement ability of people is smaller. However, current trend is to decrease service level, and to increase the travel distance of the residents due to the decrease of population density and shrink of the budget of local government. Another challenge is to realize low carbon society. Reduction of energy consumption and utilization of renewable energy in urban area are required. Compact city has the potential to lower the environmental impact, improve the quality of life of the people in this context. The compact city is expected to reduce energy consumption in the transport sector. Public transport system, especially railway system, of which energy consumption is low, becomes feasible at high population density. In the middle size city, new type of railway such as LRT (Light Rail Transit) is suitable. Energy consumption of the building itself is independent from the urban form. However, if renovation of building and shifting from detached house to apartment house is implemented together with formation of compact city, energy saving in the building sector is expected. By forming a compact city, accessibility to medical, cultural and commercial service is improved. Because such accessibility becomes critical in an aged society, this is a very important. Moving the people by bicycle or walking creates more opportunity of forming community of neighborhoods. Improvements of these aspects of quality of life are essential to realize the compact city. These advantages of the compact city are theoretically reasonable, but yet to be demonstrated in an actual city. Implementation of compact city is needed to go one step further.

Poster presentation

Green Transport Solutions for African Cities: A case study of Nairobi, Kenya. *By Benedict Muyale*

Presenter: Benedict Muyale, Vesta Networks

Keywords: cities, transport, Nairobi, green technologies

Cities have always been the loci for nationals as well as growth of cultural fusion and innovation. Over 50 per cent of global population dwells in cities and urban centers. This means that cities are prolific users of natural resources and generators of waste; hence they produce most of the greenhouse gases that are causing global climate change. The root cause of increase in transport sector carbon curve is mainly due to more numbers of individually owned cars. Development in these cities is geared towards economic progress while environmental sustainability is ignored. Infrastructure projects focus on road expansion, electrification and more parking spaces. These leads to more carbon emissions, traffic congestion and air pollution. Recent development plans for Nairobi city are now on road expansion with little priority on electric train solutions. The Vision 2030, Kenya's development guide, has shade some light in the city with numerous road expansion projects. This Paper seeks to realize the following objectives; a) to assess current transport situation of Nairobi; b) to review green transport solutions being undertaken in the City; c) to give overview of alternative green transportation solutions and d) to provide a green transportation framework matrix. This preliminary study will utilize primary and secondary data through mainly desktop research and analysis, literature, books, magazines and on-line information. This forms the basis for formulation of approaches for incorporation into the green transportation framework matrix of the main study report. The main goal is the achievement of a practical green transportation system for implementation by City County of Nairobi to reduce carbon emissions, congestion and promote environmental sustainability.

Poster presentation

Resettlement in the absence of resettlement policy: Lessons from urbanizing Dar Es Salaam. *By Dawah Magembe-Mushi*

Presenter: Dawah Magembe-Mushi, Ardhi University, Dar es Salaam

Co-authors: Nathalie Jean-Baptiste, UFZ; John Lupala, Ardhi University, Dar es Salaam

Keywords: displacement, resettlement, urbanization, mass-population risks

The paper intends to provide evidences on challenges faced by mass population displacement resulted from development. The displacement was done within an urban area and the resettlement was organized in a peri-urban area. The key issue that is embedded in this paper lies on the changes occur during such displacement. Impacts such as loss of livelihood, conflict and hostility were experienced by both the displaced and the receiving communities. The empirical evidences of this paper were obtained from household, in-depth, key informant and official interviews as well as non-participant observation of the processes associated to the evacuation of more than 10,000 inhabitants between 1997 and 2010. Findings from the fields indicate that resettlement of the mass displaced population was particularly lengthy, to the detriment of the displaced and receiving communities. It also revealed that the displaced population were adversely affected in terms of their livelihoods, more specifically through loss of income-generating opportunities, household assets and access to services and facilities due to change of habitations. The field findings have further highlighted how the urban displaced population affected the displacement of farm owners in the receiving peri-urban communities. The latter were dependent on farming and related activities, which were disturbed by the incoming urban population. Recommendations drawn from this particular case address the need for securing livelihood opportunities which could ensure some sort of life improvement after displacement. It is further recommended that any resettlement policy should consider location of resettlements to reflect previous livelihood strategies; in order to ensure a more equitable management of displaced people and more specifically poor urban settlers.

Poster presentation

Dynamic changes of urban ecosystem's carbon balance and its influential factors: a case study in Xiamen, China. *By Ge Rubing*

Presenter: Ge Rubing, Institute of Urban Environment (IUE), Chinese Academy of Science

Keywords: carbon balance index, influential factors

Due to fast-paced urbanization and energy consumption, human society has been posing increasing pressure on the environment which we depend on for existence. "Natural ecosystem left in the urban ecosystem" or "Human urban ecosystem nested in natural ecosystem", which seems like a simple play on words, however represent two entirely different positions and attitudes. Therefore the application of the concept of city compound ecosystem in the evaluation of city development is necessary. This study attempts to seek quantitative indictors to evaluate the effects of human society on environment in the view of carbon balance. Based on Xiamen city, a typical example of rapid urbanization in China, we built an urban ecosystem carbon emissions and carbon sinks model based on social and economic development data and Land-Use and Land-Cover Change (LUCC) in long time series, and estimated carbon source, carbon sequestration and carbon balance index (CBI) which can be used as a quantitative indicator to reflect the regional ecological balance level along with city's development. Further, we explored potential influential factors of carbon emission and CBI among economic and social factors, aiming at supplying some beneficial decision support for government policy makers.

Poster presentation

Linked Responses - An analysis of transnational municipal climate networks in Germany. *By Henner Busch*

Presenter: Henner Busch, Lund University Centre for Sustainability Studies

Keywords: transnational municipal networks, local climate-governance

In times of ongoing urbanisation and unabated climate change, cities have to meet an increased demand for urban climate change governance. This paper investigates the activities of Transnational Municipal Networks (TMNs) that were set up in response to climate change and analyses their potential to influence local climate governance. On the basis of a conceptualisation of Transnational Municipal Climate Networks (TMCNs), quantitative data on memberships in Germany was compiled and complemented with an analysis of scientific, grey literature and interviews. German municipalities represent several hundred memberships in TMCNs. The cities and municipalities organised in these networks account for more than half of the German population. The networks find wide proliferation amongst German bigger cities (>100.000 inhabitants). Nearly all bigger cities are a member in at least one of the networks. Furthermore, it was found that two meta-networks – one focussing on adaptation and one focussing on mitigation - emerged through links between the different networks. TMCNs have different profiles and provide different functions. For this paper four different functions have been identified. All findings point at the important role TMCNs play in the context of urban climate governance.

Poster presentation

Energy efficient urban planning in three Nordic medium-sized cities. *By Juliane Grosse*

Presenter: Juliane Grosse, University of Copenhagen

Co-authors: Christian Fertner, University of Copenhagen; Niels Boje Groth, University of Copenhagen

Keywords: energy efficiency, urban planning

Transforming cities' energy use to address the threats of climate change and resource scarcity is one of the main future challenges in urban development. Striving towards regional energy cycles, energy efficient retrofitting of the built environment as well as decoupling of urban development and energy use are crucial for a city's future development. The EU-FP7 project PLEEC – "Planning for Energy Efficient Cities" – uses an integrative approach to achieve the sustainable, energy-efficient, smart city. By coordinating strategies and combining best practices of six participating medium-sized cities of the EU, PLEEC will elaborate pathways, considering diverse challenges and requirements, for energy efficient and sustainable urban planning. The paper focuses on structure-driven energy efficiency potentials within urban planning, regarding the institutional and planning dimension as well as the spatial dimension, in three PLEEC cases: Turku (FI), Tartu (EE) and Eskilstuna (SE). The questions how national and local energy policy evolved and how it frames urban energy planning are examined. As the study focuses on medium-sized cities the cases are exemplary for the challenges a high share of European cities is facing currently. Different from growing metropolises, medium-sized cities mainly have to deal with their existing building stock, with complex and advanced urban energy systems, and at the same time process the required transformation. Further, from an energy perspective ongoing regional enlargement and increased commuting is challenging many medium-sized cities. The cities go in some ways ahead their national climate and energy policy and aim to establish urban planning as an instrument to regulate and influence the city's transformation process in a sustainable way. Considering the revealed present urban structures and frameworks the study aims to figure out ideas and suggestions to improve the integration of energy considerations into the established planning processes to meet the needs of the city's specific challenges.

Poster presentation

Scandinavian Eco-cities: Urban experiments & new imaginaries from sustainability to climate change. *By Marcella Samuels*

Presenter: Marcella Samuels, Lund University Centre for Sustainability Studies, Lund University

Keywords: urbanization, cities, climate change, sustainability

Inter-governmental climate talks have had little success in implementing measures to mitigate human-induced climate change. Their fundamental perspective, economic rationality, has not provided a compelling or effective basis for achieving their desired goals. At the local scale, various constituencies have come together to address climate change by developing communities that allow their residents to live a lifestyle that includes concrete adaptation and mitigation measures that do deal with the problems of climate change. By taking a perspective that emphasises ecological rationality, these eco-communities and eco-villages are challenging the status quo.

This study examines four Scandinavian eco-city case sites using a mixed-methods approach that combined site visits including narrative walking interviews and a critical literature review examining how the sites are characterised in the English digital media. A comparative analysis then applies the theoretical frameworks of Critical Institutional Theory and Strategic, Values-based Planning Theory to examine how it is that these efforts have succeeded, to determine who were the key decision makers and who benefited from these projects, and to see what lessons about equity can be drawn from these local actions.

The study found that neither emission targets, nor market mechanisms are required as pre-requisites to catalyse change at the subnational level. What motivates multi-stakeholder action is committing to action around specific values and priorities set by the communities themselves. The more resident involvement during planning and decision making before construction, the more socio-ecological elements were implemented in each of the four Scandinavian eco-communities and eco-cities.

Poster presentation

Remote sensing estimates of impervious surfaces for hydrological modelling of changes in flood risk from high-intensity rainfall events. *By Per Skougaard Kaspersen*

Presenter: Per Skougaard Kaspersen, Technical University of Denmark

Keywords: remote-sensing, impervious-surfaces, pluvial-flood-modelling, urban-land-cover-change, NDVI

In recent years it has been widely demonstrated that cities globally have become increasingly exposed to the impacts of pluvial flooding (Field et al., 2012). There is evidence that the observed change in risk may have been caused by a combination of large increases in the extent of urban cover, which is primarily driven by general population growth and 20th and 21th century urbanization trends, and climate change (Field et al., 2012) (Angel et al., 2011). Urban environments are dominated by impervious surfaces (IS), which are sealed areas through which water cannot penetrate, as road infrastructure, buildings and other paved areas occupy a large share of the urban land area (Weng, 2012). Changes in the quantity and location of IS have important implications for the hydrological response of a catchment. Water moves faster over sealed surfaces, than over natural surfaces, and replacing natural land cover with artificial surfaces subsequently increases run-off volumes, peak flows and flood frequency. In addition the location of IS is important for estimating run-off volumes during high intensity rainfall events, and is an important input in urban flood models (Butler, 2011) (Parkinson and Mark, 2005). This research investigates the accuracy of Landsat 8 maximum value composite (MVC) NDVI in quantifying sub-pixel impervious surface fractions for eight cities in Europe. The objectives are: (i) to show that NDVI is an equally accurate measure of small scale impervious surface fractions for cities with very different climatic and vegetative conditions across Europe, and (ii) to explore the potential for using Landsat based estimates of IS and changes herein in pluvial flood modelling. This will enable accurate and systematic quantification of the influence of the past 30-40 years of urban development on the changes in risk towards the occurrence and impacts of high-intensity rainfall events.

Poster presentation

Phosphorus sustainability of food consumption in China's urbanization. *By Su Xu*

Presenter: Su Xu, Institute of Urban Environment, Chinese Academy of Sciences

Co-authors: Wei Huang, Institute of Urban Environment, Chinese Academy of Sciences; Shenghui Cui, Institute of Urban Environment, Chinese Academy of Sciences

Keywords: phosphorus footprint, food consumption, China

China's unprecedented urbanization greatly influences the quantity and structure of Chinese food consumption, causing food security challenge and calling for sustainable phosphorus management. We quantified Chinese phosphorus footprint (PF) through food consumption during 1990 - 2009 and predicted PF in 2020 and 2030 based on scenario analysis. The results showed that PF increased from 4.74 kg P capita-1 yr-1 (1990) to 5.40 kg P capita-1 yr-1 (2009) and will grow to 5.79 kg P capita-1 yr-1 (2020) and 6.20 kg P capita-1 yr-1 (2030). The increase (amount and proportion) of animal food consumption was the key reason for PF growth. However, the scenario analysis based on income implied that PF inflection point will appear between 2020 and 2030, which means that PF will decrease by 2030. We also estimated that the total amount of phosphorus ore used for producing food would be no less than 9.30 Tg in 2030. These results demonstrate that a balanced diet is an important component of the phosphorus sustainability in China's urbanization. A dynamic view on the demand of phosphorus ore resource should be approached both on short-term environmental management and long-term resource availability in the process of urbanization.

Poster presentation

Advancing Urban Innovation: Living Labs for Sustainable Building and Planning.

By Yuliya Voytenko

Presenter: Yuliya Voytenko, Lund University

Co-author: James Evans, Manchester University

Keywords: living labs, building, planning, innovation

The immense urban and societal challenges facing humanity, including climate change, environmental pressures, demographic shifts, and infrastructural problems, demand concerted collaborative efforts across sectors as well as interactions and combinations of disciplines. Urban living labs offer a platform for advancing sustainable building and planning in response to these challenges through collaboration, experiments and innovation that integrate users as co-creators. Urban living labs are relevant to new buildings and construction as well as retrofitting existing buildings, different scales from buildings to districts to cities, and sustainability in all its dimensions. The literature has established the potential importance of urban living labs as sources of innovation in the field of urban sustainability. However, there is limited understanding of how and why urban living labs are established, develop and impact urban sustainability. The purpose of this paper is to discuss critical knowledge gaps on urban living labs drawing on examples from sustainable building and planning in the UK and Sweden. This paper will address three key research areas or questions. First, it will investigate user-driven sustainable urban development, looking at places that have engaged communities and achieved transformative change rather than simply dropping in technology. User-driven projects or engaging users as co-creators is a central element of urban living labs. Second, cross-sector partnerships (including universities and municipalities) have gained serious traction as drivers of innovative urban development. A significant research question relating to these collaborations is how knowledge production can drive urban transitions. Third, it is important to improve understanding of how experiments or tests in specific places through urban living labs can contribute to broader regulatory change and feed into sustainable building and planning.

Water for all

The session addressed how to meet direct human needs for water while preserving ecosystem function. It examined this in local or regional contexts with the goal of identifying transferable solutions and concepts.

Session 1:

Session 2:

Posters:

Risk management framework of global changes on water for human well-beings. *By Taikan Oki*

Presenter: Taikan Oki, Institute of Industrial Science, the University of Tokyo

Keywords: hydrological cycles, climate change, management

The real hydrological cycles on the Earth are not natural anymore. Humans are now driving changes in atmospheric processes through emission of green-house gases and land cover changes directly and indirectly. Global mean temperature is projected to rise approximately proportional to the cumulative total anthropogenic CO2 emissions from 1870 (AR5, IPCC WGI). Temperature rise itself will have direct impacts on the availability of water resources through changing flow regimes in snow-dominant or glacier-effluent river basins, and it will also be associated with sea level rise because thermal expansion is one of the major causes of observed and projected sea level rises. Further, climate change is projected to alter hydrological cycles: changing temporal and geographical patterns of hydrological components, such as precipitation, evapotranspiration, runoff, and ground water recharge, and particularly in their extremes. Consequently, the frequency of floods and/or droughts is projected to increase some parts of the world. However, as articulated in the AR5 of IPCC WGII, “Risk of climate-related impacts results from the interaction of climate-related hazards (including hazardous events and trends) with the vulnerability and exposure of human and natural systems”, increasing frequency of natural hazards, such as torrential rainfall or long-lasting heat wave, alone will not cause damages on human and natural systems, and both climate and social changes are relevant for planning sustainable development in the future. AR5 (WGII) also says “Significant co-benefits, synergies, and tradeoffs exist between mitigation and adaptation and among different adaptation responses; interactions occur both within and across regions”. Mitigation and/or adaptation actions should not be planned in an isolated manner, but should be integrated into wider frameworks, such as integrated water resources management and sustainable development. It would preferably be integrated into a risk management framework assessing and managing possible global risks, and ultimately pursue increasing human well-beings.

California dreaming: natural systems as urban water infrastructure. *By David Sedlak*

Presenter: David Sedlak, University of California, Berkeley

Keywords: managed natural systems, water quality

The vitality of California's economy is intimately linked to an abundant and stable water supply. Over the past two decades, an increasing recognition of the need to restore aquatic ecosystems coupled with continued population growth and severe droughts have led to a re-examination of the wisdom of continued reliance on imported water. In response, California's cities have begun to diversify their water supply portfolio with large investments in water recycling, stormwater harvesting and restoration of contaminated aquifers. A key component of this strategy is the active management of natural systems. For example, a new type of engineered treatment wetland, built on a section of the Santa Ana River where most of the flow consists of wastewater effluent, removes nitrate, waterborne pathogens and trace organic compounds. The wetland is also valued for its recreational attributes and its role in supporting endangered species. In the near future, urban runoff, a nuisance that often contaminates rivers and beaches, will be captured in former gravel quarries. The captured water will be used to create parks where treatment wetlands will be employed to remove contaminants before the water is recharged. The integration of managed natural systems into urban water infrastructure is also occurring in coastal areas, where municipal wastewater effluent is being used to create wetlands that will provide critical habitat as sea-level rise reduces the area of the existing system. Lessons from California may be instructive in regions struggling to find a balance between the needs of people and ecosystems in the face of diminishing water sources.

First steps in an assessment to meet the global water quality challenge. *By Ilona Bärlund*

Presenter: Ilona Bärlund, Helmholtz Centre for Environmental Research-UFZ

Co-authors: Dietrich Borchardt, Helmholtz Centre for Environmental Research-UFZ; Jeanette Völker, Helmholtz Centre for Environmental Research-UFZ; Martina Flörke, Center for Environmental Systems Research (CESR), University of Kassel; Joseph Alcamo, Center for Environmental Systems Research (CESR), University of Kassel

Keywords: water quality, data analysis, modelling

Major socio-economic developments and measures for achieving the Millennium Development Goals are triggering a new "global water quality challenge" affecting developing and transition countries in particular. It can be seen that water pollution is increasing because of the progress being made in expanding public water supplies, but failing to adequately treat the wastewater flows now entering the surface waters. This development poses a risk to public health, food security, and the economy. What is needed is knowledge to better understand the global state of water quality problems and the best way to solve them. In response to this need, UN-Water Group has launched the first preliminary phase of a World Water Quality Assessment (WWQA), led by the United Nations Environment Programme (UNEP). The main goal of this first phase (2013-2015) is to review the state of water quality in rivers and lakes of developing countries and to identify areas currently most under threat, especially with respect to organic and nutrient loading, and risks to human health and freshwater fisheries. The analysis has two main tracks: a data-driven approach based on observed data publicly available, and a model-driven approach to simulate in-stream concentrations based on computed sectoral wastewater volumes. The Assessment is soliciting data from researchers and water managers, and offering assistance to analyse these data as well as transfer of knowledge from other river and lake basins. The modelling approach has been applied to Africa, where first outputs include a mapping of the location and stretches of rivers most likely to be affected by organic pollution and bacterial contamination as indicated by levels of BOD and coliform bacteria. Currently the data-driven and model-driven approaches are being combined in representative river and lake basins. It is expected that the analysis will yield transferable lessons for other river basins in the world.

Building sustainability by combining and sharing knowledge in the water domain. *By Jafet C. M. Andersson*

Presenter: Jafet C. M. Andersson, SMHI - Swedish Meteorological and Hydrological Institute

Co-authors: Berit Arheimer, SMHI - Swedish Meteorological and Hydrological Institute; Niclas Hjerdt, SMHI - Swedish Meteorological and Hydrological Institute; Yeshewatesfa Hundecha, SMHI - Swedish Meteorological and Hydrological Institute; Lena Strömbäck, SMHI - Swedish Meteorological and Hydrological Institute

Keywords: water, knowledge sharing, knowledge integration

We present examples at national, regional, and continental scales where iterative integration and open sharing of knowledge has been instrumental in improving tools for comprehending and responding to sustainability challenges in the water domain. In Sweden, hydrologists and water managers have collaborated for a number of years. Recently, we have combined the expertise of hydrological forecasters and aquatic ecologists in an open tool that informs managers in advance about relative river discharge at 36 693 catchments across the country (http://vattenwebb.smhi.se/hydronu/). This assists in timing ecosystem monitoring to ecologically critical flow conditions, thereby enabling the monitoring campaigns to be more informative for assessing ecological status and prioritizing interventions. In West Africa, we have adapted a hydrological model to simulate floodplain dynamics in the Inland Niger Delta (a key ecosystem in the region) by combining the process understanding of West African scientists with the computational expertise of Swedish scientists. This has been synthesized into a new joint open-source model of the entire catchment, which is being used to jointly analyze potential impacts of climate change on water resources and associated consequences for societies and ecosystems in the region. In Europe, we combine open data, open code, and standardized methods developed by hydrologists across the continent, and conduct comparative hydrological experiments across catchment boundaries (e.g. on water withdrawals). The large team of experts has identified inaccuracies in the drainage delineation – fundamental for estimating water fluxes – which were not discernible to the team initially developing the dataset. These errors were corrected and a refined dataset was made publicly available, which is likely to improve the accuracy of the continental-scale experiments. These examples illustrate the value of combining and sharing knowledge to address the sustainability challenges in the water domain.

Facing a global boom in hydropower dam building. *By Christiane Zarfl*

Presenter: Christiane Zarfl, Leibniz-Institute of Freshwater Ecology and Inland Fisheries Berlin

Co-authors: Alexander E. Lumsdon, Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin; Department of Biology, Chemistry and Pharmacy, Freie Universität Berlin; Jürgen Berlekamp, Institute of Environmental Systems Research, University of Osnabrück; Laura Tydecks, Leibniz-Institute of Freshwater Ecology and Inland Fisheries Berlin; Klement Tockner, Leibniz-Institute of Freshwater Ecology and Inland Fisheries; Department of Biology, Chemistry and Pharmacy, Freie Universität Berlin

Keywords: rivers, fragmentation, biodiversity, developing countries

Global population growth, economic development and the intent to close the electricity gap lead to an increasing demand for energy. At the same time, coping with climate change intensifies the demand for electricity production from renewable sources, with hydropower as one of the most approved techniques. Following a period of a flattening trend an unprecedented boom in hydropower dam construction is underway globally. Here, we provide a global, comprehensive analysis of hydropower dams that are either under construction or planned. Information on 3,700 hydropower projects over 1 MW capacity was derived from more than 360 sources including scientific publications, public databases, and grey reports, but also data directly received from government departments and non-governmental organizations. These dams may almost double the total electricity production from hydropower to about 1,700 GW within the next decades. The future boom in hydropower dam construction primarily occurs in developing countries and emerging economies in South America, SE Asia and Africa. Furthermore, there is a shift for future hydropower dams to lower discharge segments, which goes along with the expected high global share of small and medium sized dams (<100 MW). Dam construction will lead to a further fragmentation (22%) of the remaining large free-flowing river systems globally. Our database on future hydropower dams and the corresponding information on freshwater biodiversity (www.freshwaterbiodiversity.eu) form a key foundation for evaluating where to build future hydropower schemes and how to improve the dam building management. This will serve to develop hydropower as a more sustainable mode of electricity production.

Leap-frogging towards water resilience in Dar es Salaam and Addis Ababa. *By Lise Herslund*

Presenter: Lise Herslund, Institute for geosciences and natural resource management, University of Copenhagen

Co-authors: Antje Backhaus, IGN; Ole Fryd, University of Melbourne; Marina Bergen Jensen, IGN; Li Liu, IGN

Keywords: Africa, water resilience, green infrastructure, leap-frogging

Urban flooding and water scarcity are major climate change hazards affecting African cities. Dar es Salaam and Addis Ababa are growing rapidly and suffer from lack of urban water services. The project 'Water Resilient Green Cities in Africa' explores how to improve water resilience in Dar es Salaam and Addis Ababa by establishing a strong green infrastructure that can reduce the impact of floods and simultaneously provide day to day services to the citizens like e.g. water supply and areas for food production. Using the landscape may 'leap-frog' development of urban water services by means of eco-technologies which seems to be a cheaper, more flexible and adaptable option in contrast to conventional 'grey' technologies that developing world cities are now trying to rectify. It is hypothesized that an integrated approach to urban water management in Addis Ababa and Dar es Salaam can be achieved by: 1. facilitating a rapid mind-set change towards landscape based water management by identifying and engaging potential champions among relevant city officials and in flood prone communities in a knowledge sharing and vision building process, 2. utilizing the pace of urbanization to introduce sustainable and resilient construction practices by drafting exemplary water catchment plans in collaboration with communities and city level champions based on physical analyses, existing water coping practices and interactive design charrettes, and 3. adopting 'smart' dissemination technologies and practices for knowledge sharing with different members of society. The paper presents the first results of challenges and main opportunities for 'leap frogging' towards water resilience in Dar es Salaam and Addis Ababa. Challenges are a fragmented institutional set up and lack of collective and coordinated practices to prevent floods and drought. Opportunities are identified powerful champions and awareness of the problems with floods and drought at both city and local level.

Sustainability assessment of water policy: Methodology to prioritize actions on a national irrigation strategy. *By Alex Godoy-Faundez*

Presenter: Alex Godoy-Faundez, Facultad de Ingenieria, Universidad del Desarrollo

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Keywords: irrigation, water policy, sustainability assessment

Chilean industrial activities based on the exploitation of natural resources –agriculture, hydropower, mining, tourism- depend heavily on surface and groundwater supply in the Andes. Conflicts arise when these industries share the same watershed. As water demand is increasing, it is needed to increase the infrastructure for water supply –storage and distribution- as country-level strategy. If we add projected impacts of climate change, the set of strategies to improve water availability must include a continuous improvement in water efficiency and water allocation. In 2011, the National Commission for Irrigation issued the National Irrigation Strategy (NIS) as a blueprint of set of actions necessary to deploy a national irrigation policy. Here, we analyzed the NIS by a sustainability assessment approach that prioritizes and defines the scope to ensure the sustainability of water resources. A sustainability assessment goes beyond policy analysis – ex ante - or policy evaluation –ex post -; this recognizes that the policy-making process has influence on how the policy and its contents is implemented; thereby indicating the likelihood of policy success. We set the water resources as the keystone for the new irrigation policy. According to new policy, three main scopes were proposed: Increase of availability of water resources, Improvement of water efficiency and improvement of allocation based on information systems and water markets. All actions are based on (1) the relationship between increasing water availability and its efficient use to alleviate water scarcity and food security, (2) environmental sustainability, (3) the role of users to promote a proper distribution of resource into water markets. Finally, the impact assessment and prioritization of actions based on expert knowledge and stakeholders participation, shows that the investment on distribution and infiltration systems are better options than the construction of large dams or reservoirs against of perception that big dams are big solutions.

Water security indicators and the 'InCoDys' water security model. *By Bruce Lankford*

Presenter: Bruce Lankford, University of East Anglia

Keywords: water security, SDGs indicators, insecurity

A significant challenge in the governance of water (reflected for example in the debate about the sustainable development indicators; SDGs) is how to arrive at a set of measurable meaningful water indicators that reflect water security. In an attempt to answer this, I propose that water security and insecurity are not necessarily polar opposites; that water security need not be the opposite or "converse" (Grey and Garrick, 2012) of water insecurity. Rather, by establishing two gauges or axes of water security (sufficiency of water security and equity of water security) four conditions of water security are proposed, hinted at in the title of this paper ('InCoDys'). First 'in' is shorthand for 'insecurity; second 'co' is short for 'collective security' and third 'dys', implying inequitable security, is short for 'dys-security'. The fourth condition is 'co-insecurity' but this is not repeated in the title. The paper explores a number of indicators that sit within each of these axes also recognising that commensurability should be addressed. Implications of the InCoDys framework are then explored.

Trending now: A nexus and convergence in water security. *By Christina Cook*

Presenter: Christina Cook, the University of British Columbia

Co-author: Karen Bakker, the University of British Columbia

Keywords: water security, water governance, nexus

Since its use at the World Water Forum in 2000, the concept of water security has been increasingly adopted across a range of academic disciplines and policy forums. Our analysis reviews the water security literature across all disciplines. Using a dataset which tracks the evolution of academic debates over water security across time, we compare definitions of, and analytical approaches to, water security across the natural and social sciences. We find that distinct, and at times incommensurable, methods and scales of analysis are being used. Our analysis indicates that diverse framings of water security are mobilized across and within disciplines and applied to different types and scales of studies. We discuss the implications of geography for definitions of water security, the militarization of the term, and the implementation of water security in relation to IWRM. We also explore the emerging convergence in themes of water security in light of a growing focus on the water-food-energy security nexus. Finally, we suggest future research agendas for water security, both with respect to well-known issues (such as sanitation), and in relation to new research agendas (e.g. socio-eco-hydrology, and Urban Political Ecology).

Poster presentation

Increasing water availability in New South Wales, Australia: Why do some utilities recycle more water than others? *By Janet G. Hering*

Presenter: Janet G. Hering, Swiss Federal Institute of Aquatic Science & Technology (Eawag)

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Keywords: water reuse, water recycling, QCA

Supplying water at an adequate quantity and quality to support human welfare while preserving ecosystem function poses a challenge in many parts of the world. In Australia, the recycling of municipal wastewater for productive uses is recognised as part of the solution for reducing pressure on natural systems and increasing overall water availability. However water recycling rates vary across the country, including at the level of individual water utilities. Understanding the factors that explain these differences is a necessary step to meet policy goals that seek to promote recycling. However the literature lacks a systematic analysis that examines which factors are individually or jointly associated with high rates of water recycling at the level of water utilities. We present the results from a comparative analysis of 26 water utilities within New South Wales, which drew upon publically available data. The analysis sought to identify factors that influence the percentage of water recycled for either agricultural or commercial/industrial/municipal use. From a review of grey and academic literature, we theorised that six factors would be most influential: two contextual (rainfall and population density), two regarding proximity (distance to the coast; and to large water users); one utility-specific (size of the utility); and one economic (revenue for water supply services). We used Qualitative Comparative Analysis (QCA) to determine the combinations of factors associated with high recycling rates for either type of use. Results show that the utilities with high recycling rates for either agricultural or commercial/municipal/industrial recycling share two common attributes – they receive low rainfall and are small in size. We provide evidence from specific cases on why these factors influence recycling rates. This analysis has provided a foundation for ongoing research to explore the reasons why some water utilities recycle more water than others.

Poster presentation

Surface water quality of Wadi El Bey-Tunisia: Spatial and temporal monitoring using multivariate statistical approaches. *By Gasmi Taoufik*

Presenter: Gasmi Taoufik, Water Researches and Technologies Center, Technopark of Borj Cedria-Tunisia

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Keywords: water, pollution, Wadi El Bey

The monitoring of pollutants concentration along rivers affords the opportunity to examine the persistence of contaminants in the fluvial environment. During this study, physicochemical and bacteriological parameters of surface water of Wadi El Bey, located in the North-East of Tunisia, were assessed for the first time. Chemical oxygen demand, biochemical oxygen demand, Phosphorus, nitrate, ammonia, faecal coliforms (FC), faecal streptococci (FS), Escherichia coli, enterococci and other pathogens such as Salmonella, Staphylococcus and Pseudomonas were monitored over a two-year period. Thirteen samples were collected seasonally at different sampling points along the wadi from 2012 to 2013. High values of the chemical and bacteriological parameters were recorded (COD: 1100 mg/L; Nitrate: 41mg/L; Phosphorus 47.68 mg/L and Ammonia: 112.77 mg/L). The effluent bacterial concentrations were dependent on the season. The highest feacal coliform and E.coli concentrations were measured in summer and were respectively (132 × 103 CFU/100 mL), (125.4 X 103 CFU/100 mL).While the highest concentrations of feacal streptococci (188 x 103 CFU/100 mL) and Enterococcus (304 x 103 CFU/100 mL) were recorded in autumn. Salmonella concentrations were high in winter (327 x103 CFU/100 mL); high levels of Pseudomonas (185 x 103 CFU/ 100 mL) and Staphylococcus (233 x 103 CFU/ 100 mL) were also found in winter. To elucidate factors affecting the water composition, Multivariate statistical analysis was used to extract the factors associated with these parameters and to obtain the spatial and temporal changes in the water quality. The results show that there are a great number of bacteriological and physicochemical pollutant sources in the areas of Wadi El Bey and thus, in order to implement strategies to improve water quality in this wadi, its monitoring should continue.

Posters from Copenhagen Competition

The Copenhagen Competition is an interdisciplinary international negotiation competition for students at master level. This year's topic on the Sustainable Energy Trade Agreement (SETA) was inspired by the efforts made in concluding the "real" SETA amongst States. The Competition assumed a fictional case scenario wherein a group of States have agreed to conclude the SETA and the final negotiation session takes place in Copenhagen. The students on each team represented a fictional State in the SETA negotiations and each State proposed one item of particular importance to that State to be placed on the final negotiating list for the SETA.

The posters displayed a visual presentation of the product chosen by the 7 competing teams:

- Australian National University (Solar fuel)
- Haramaya University (Coffee)
- Hebrew University of Jerusalem (Dye solar cells)
- National University of Singapore (BM1 enzymes)
- University of Barcelona (Wind turbines)
- University of Cape Town (Three-way catalytic converters)
- University of Copenhagen (Wind turbines)

More info

More information and webcasts of all plenary sessions are available at
www.sustainability.ku.dk/iarucongress2014/

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