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**Advanced Systems Analysis Program (ASA)**
**Acting Program Director: Elena Rovenskaya**

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**Mikko Dufva**

**Supervisor:** **Leena Ilmola-Sheppard**

**Research Project:** **Methods for analyzing and supporting the creation of a shared future direction for a socio-technical system**

**Abstract:** Responding to global challenges, such as climate change, resource scarcity, and clean and efficient energy production requires a radical transformation in existing socio-technical systems. However, creating this transformation is problematic due to, for example, the complexity of the situation, different perspectives on the right direction to take, external pressures, and surprising events. Thus, despite the clear need to radically transform many of our existing socio-technical systems, there is a lack of methodology to support such a transformation. While a socio-technical system cannot be controlled from the outside, it can be influenced if key leverage points are identified. This requires an understanding of both the characteristics and history of a system and its actors, and of possible future developments that are external to it.

My proposed research will focus on creating a shared and achievable direction for the system transition. Specifically, I will create a conceptual model of how the direction(s) of a socio-technical system is/are formed and also a participatory method on how to influence the direction(s). I will combine transition management, innovation system approach, foresight and agent-based modeling, leading to a novel and comprehensive approach to studying system transitions.

**Biographical Sketch:** Mikko Dufva completed his M.Sc. in systems analysis and operations research at the University of Helsinki (currently Aalto University) in 2008. He is currently a third-year Ph.D. student at the Systems Analysis Laboratory of Aalto University, and his thesis is about knowledge creation in foresight processes. His main fields of scientific interest include futures research, foresight, knowledge management, system transitions, and systemic change.

**Advanced Systems Analysis Program (ASA)**
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**Lukas Figge**

**Supervisor:** **Matthias Jonas**

**Co-Supervisor:** **Oskar Franklin**

**Research Project:** **Uncertain consequences of global ecological overshoot: "Adjusting" scenarios of global change and the ecological footprint until 2100**

**Abstract:** Humans have become the single dominating driving force for change in global social-ecological systems, transgressing planetary boundaries. According to ecological footprint (EF) data we have lived in the state of ecological overshoot since the 1970s. Consequences are climate change, a degrading resource base, loss of biodiversity, and soil erosion, among many others. While evidence for human pressures is mounting more and more, part of the problem is that some of the major impacts will materialize only in the future. Two key uncertainties of the future are about the sensitivity of global social and ecological systems, and how ecological overshoot may negatively feed-back into socioeconomic systems. Unknown critical transitions in nature and society may lie ahead.
Mainstream global environmental assessment and ecological footprint scenarios which employ modeling and quantitative scenarios consistently fail to incorporate dynamic feedbacks from (degrading) ecosystems to human/socioeconomic systems. There are various explanations for this oversight. First, those studies are often subject to governmental review, and extreme scenarios of potential collapse seem to be undesirable for a number of reasons. Further, uncertainty and non-linearity are difficult and controversial to include in (rather linear) models from a conceptual and methodological perspective. The objectives for my research at IIASA are: i) to conceptualize and formulate a system dynamics model to draw three standard scenarios of the ecological footprint and underlying socioeconomic drivers (continued growth, contraction, and a middle scenarios; and ii) to adjust the three standard scenarios by including feedbacks of three different strengths from ecological to human systems, based on different assumptions on the resilience and sensitivity of social-ecological systems (severe, moderate, no. This will yield nine scenarios in total. The goal for my YSSP stay is to identify and quantify the "right" model, including relevant feedbacks, as a basis for subsequent scenario development

**Biographical sketch:** Lukas Figge started working at the International Centre for Integrated assessment and Sustainable development (ICIS) at Maastricht University on the Ph.D. project "Globalization, Complexity and Sustainability" in December 2011. He holds a bachelor's degree in Economics from the Maastricht School of Business and Economics and a master's degree in public policy with a specialization in sustainable development at the Maastricht Graduate School of Governance.

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**Danielle Haak**

**Supervisor:** **Brian Fath**

**Research Project:** **Using ecological network analysis to assess habitat suitability of an invasive freshwater snail, *Bellamya chinensis***

**Abstract:** The field of ecology is shifting from population- and community-based research to social-ecological research at a systems scale. Successful natural resource management relies on understanding how the components within a system fit together, and the sub-fields of resilience and adaptive management aim to sculpt natural resource management to the systems approach, allowing management to be more proactive than reactive.

To apply this shift to aquatic invasive species management, I proposed a YSSP project that will combine current existing modeling methods with a new approach of applying these models to habitat suitability research. Current habitat suitability models are over-simplified and fail to account for all interactions within an ecosystem. Additionally, humans are often excluded from the analysis, nullifying the social-ecological approach proposed by resilience and adaptive management. From this approach, two main research objectives emerge: i) to identify how the social component of ecosystems can be integrated into ecological network analysis; and ii) to apply and adapt the current ecological network analysis approach to predict movement, likelihood of introduction, and establishment of aquatic invasive species. Results will provide managers with a completed, novel model specific to reservoirs in southeastern Nebraska, USA, as well as a model framework that can be applied to predict movements and suitable range of a variety of aquatic invasive species.

**Biographical Sketch:** Danielle Haak is currently a third-year Ph.D. candidate in the Nebraska Cooperative Fish and Wildlife Research Unit and the School of Natural Resources at the University of Nebraska-Lincoln. She received a B.Sc. in Wildlife Ecology from the University of Wisconsin-Madison (2007) and an M.Sc. in Biological Sciences from Michigan Technological University (2011). Her current research focuses on investigating the ecology of the invasive freshwater Chinese mystery snail, determining how this species disrupts ecosystem functioning, and developing bioenergetics and habitat suitability models for this species. Additionally, as a National Science Foundation Integrative Graduate Education and Research Trainee (IGERT), she is researching how aquatic invasive species, such as the Chinese mystery snail, alter ecosystem resilience after invasion.

**Thi Luu**

**Supervisor:** **Stefan Thurner**

**Research Project:** **Dynamics of bank-firm interrelations**

**Abstract:** This research focuses on investigating the interconnections between the banking sector and the real sector. It i) investigates the evolutionary structure of bank-firm network, and ii) investigates and explains the interrelations between banking sector and real sector, based on the agent-based modeling approach. Results will complement and contribute to the expansion of knowledge of financial-real interrelations.

**Biographical Sketch:** Thi Luu is currently a Ph.D. candidate at University of Kiel. Prior to his doctoral studies, he completed his first master's degree in International Trade and Finance in 2010 (Leeds Metropolitan University) and his second master's degree in Economics in 2012 (International Christian University, Japan). He also participated in the Advanced Studies Program in International Economics at Kiel Institute for World Economy in 2013-2014. His research interests include financial macroeconomics, financial markets, econophysics, complex system, and agent-based modeling. His current research focuses on financial-real interrelations, with an emphasis on agent-based models.

**Sergey Orlov**

**Supervisor:** **Elena Rovenskaya**

**Co-Supervisor:** **Vegard Skirbekk**

**Research Project:** **Decisions on fertility and education of children under environmental and social constraints**

**Abstract:** We have been observing lower fertility for societies and for groups within societies with higher financial resources. The question, though, is whether the greater probability of survival of these groups in the wake of natural disasters implies a higher number of offspring. Will the lower fertility of the rich be enough to maximize their social status, where a climatic or other disaster implies high levels of mortality risk and where the survival gradient is positive for those with more resources? If catastrophic events occur with a given probability and such an event causes increased mortality (and perhaps reduced fertility), this would mean that only a certain proportion of the global population would survive. Further, the survival probability and the ability to reproduce could hinge on resource levels—where greater resources would imply greater survival probabilities. Hence, even if there were fewer children born from richer parents, they would have a higher probability of living—and having children of their own.

To investigate these questions we will develop a mathematical model. We will assume that resources are inherited by children from parents, but may to some extent be redistributed in society by means of certain fiscal policies. It is planned to use the approach of overlapping generations, in which the current generation makes decisions in order to achieve maximum possible social status for themselves and their children and also aim to give their children as good an opportunity as possible to achieve a high status. The overall goal of the modeling is to explore how high-mortality events, regulation, and evolution of the role of education and wealth in the social status impact decisions on how many children to have.

**Biographical Sketch:** Sergei Orlov graduated from Moscow State University, Russia in August 2012 with a specialist degree in Applied Mathematics and Computer Science. He is currently a second-year Ph.D. student at the Department of Optimal Control at Moscow State University. His major is the Optimal Control Theory and its Application to Economics and Epidemiology and minor is Applied Mathematics in Physics. His PhD Program research focuses on the solution of nonlinear optimal control problems with economic and biological applications. His main fields of scientific interest include optimal control theory, mathematical models in economics, biology, and epidemiology, and other branches of applied mathematics.

**Askhad Panesh**

**Supervisor:** **Alexey Davydov**

**Co-Supervisor:** **Anatoly Shvidenko**

**Research Project:** **Optimal exploitation of size-structured populations under the accounting of the competition**

**Abstract:** Sustainable exploitation of biological resources is one of the most important economic problems in the management of natural resources. To find a reasonable way to maximize profit and reduce the impact of the exploitation on the environment is one of the key questions here. Mathematical modeling of these types of process includes the selection of a model of population dynamics, an exploitation mode, and an objective functional to define the quality of this mode. Studies done in this field, show that all three have an important influence on the selection of an optimal mode.

The problem becomes complicated when a resource is distributed, the objective functional includes averaging, the optimization is on the infinite horizon, or one needs to account for intraspecific and interspecific competition. In previous studies in this area I proved the existence and uniqueness of the nontrivial stationary state for size-structured population with interacting species (in a team with Anton Platov). We also showed that there exists an exploitation intensity that maximizes the profit functional of exploitation. There are many open questions related the optimal exploitation of size-structured populations. During the YSSP period I plan to continue the studies, in particular, to find conditions for the uniqueness of the optimal solution, to analyze its local stability, and to develop software to accompany the model.

**Biographical Sketch:** Askhad Panesh graduated in 2011 from the faculty of Mathematics and Computer Science at Adyghe State University, Russia, where he is currently a third-year Ph.D. student. His main fields of scientific interests include optimal control theory and its applications. His Ph.D. thesis is devoted to the analysis of stationary solutions in dynamics of size-structured population with interacting species and the optimization of the exploitation of such solutions with respect to various criteria.

**Tao Wang**

**Supervisor:** **Arkady Kryazhimskiy**

**Research Project:** **A proportionality approach to analysis of a multi-sector optimal control model for resource productivity in China**

**Abstract:** Natural resources function as a material foundation for the world economy and have become a critical issue for sustainable development, especially for China, which is undergoing rapid industrial growth and demonstrating a steeply increasing demand for resources. China's Twelfth Five-Year Plan for National Economic and Social Development proposes a 15% improvement in resource productivity in the 2011-2015 period. Previous research has paid relatively little attention to the dynamic mechanism of resource productivity, which is the key indicator of the level of sustainable development. Making progress in resource productivity is critically important for accelerating the transformation of the economic growth pattern in China.

My YSSP research will focus on analysis of the evolution of resource productivity in China in a recent past and a mid-term future period. My study will include: i) construction and a theoretical exploration of a multi-sector optimal control model based on material flow analysis, optimal control theory, endogenous growth theory, and the proportional development approach; ii) calibration and a simulation-based analysis of the model using data from China; and iii) comparison of the obtained results with available expert estimates. The results are expected to provide suggestions regarding the China's optimal strategy for improving resource productivity and resource management practices.

**Biographical Sketch:** Tao Wang received his bachelor's degree in Chemical Engineering and Technology in July 2013 from East China University of Science and Technology. He is currently a first-year PhD student at the Department of Chemical Engineering at Tsinghua University. His scientific interests focus on material flow analysis and resource productivity.

**Hongmei Zheng**

**Supervisor:** **Brian Fath**

**Research Project:** **An urban metabolism and carbon footprint analysis of the Jing-Jin-Ji regional agglomeration.**

**Abstract:** The Jing-Jin-Ji region (including Beijing, Tianjin, and Hebei) is one of the three largest regional agglomerations in China (with about 90 million people) and has the fastest-growing economy of all regional agglomerations. Its integration program was already developing in 1978 when China introduced regional cooperation, and its most recent report, which will guide its future development, was issued in 2014. The three areas in this region enjoy geographical proximity, and frequently exchange resources. This provides a basis for integrated regional development. However, as these three areas have different industrial structures and energy metabolic processes, their pollution sources for carbon emissions are not the same. To quantify the role of each area in integrated development, we can first introduce multi-region input-output analysis to analyze regional resource exchanges and identify direct paths among sectors in the same and different areas. Combining this with ecological network analysis and based on the direct flows, we can then trace the product manufacturing processes backwards and account for the indirect flows. The sum of the direct and indirect energy consumption is the total (or embodied) consumption.

The purpose of this research is to analyze the energy metabolic processes and carbon emissions of the producer and consumer actors of the three areas to help to determine their responsibilities in transforming production methods or reducing energy consumption to save energy and reduce emissions. To be specific, we will consider six sectors using the multi-regional input-output tables for China from 2002 and 2007 and the China Energy Statistical Yearbook. We will then develop the energy metabolic process network for the Jing-Jin-Ji region to account for the direct, indirect, and embodied energy consumptions among sectors, and also their corresponding carbon emissions. Finally, the ecological actors of three areas can be judged, and some suggestions for energy and carbon reduction can be proposed.

**Biographical Sketch:** Hongmei Zheng received her bachelor's degree in Environmental Science from Dalian Nationalities University in 2011. In September 2011 she began her postgraduate career at the School of Environment, Beijing Normal University, where she is currently a first-year PhD student. Her main fields of scientific interest include metabolic process analysis of urban and industrial systems using methods of input-output analysis, and ecological network analysis.

**Evolution and Ecology Program (EEP)**
**Program Director: Ulf Dieckmann**

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**Gbenga Abiodun**

**Supervisor:** **Rupert Mazzucco**

**Research Project:** **Climate change and malaria incidence in South Africa**

**Abstract:** Over the next few decades, climatic changes will newly expose large areas around the globe to the threat of tropical malaria by reshaping the ranges of the mosquito species that transmit this parasitic disease and by facilitating transmission between mosquitoes and humans. This will particularly affect certain regions in sub-Saharan Africa, where sanitary conditions, diagnosis chances, and treatment options are not as good as in other parts of the world.

In this project, I will analyze the impacts of temperature, rainfall, and land-use changes on the distribution, activities, and life histories of the three *Anopheles* species that are mainly responsible for malaria transmission in Africa. On this basis, I will predict malaria incidence over the coming decades in three provinces of South Africa, possibly also taking into account demographic changes.

**Biographical Sketch:** Gbenga Abiodun is currently a second-year Ph.D. student at the University of the Western Cape (UWC) in South Africa, where he is studying, through mathematical modeling, the impacts of climate and ecological factors on malaria transmission in South Africa. He completed a master's degree in Applied Mathematics at UWC in 2012, and a bachelor's degree in Industrial Mathematics at the Federal University of Technology Akure (FUTA) in Nigeria in 2008. His scientific interests include applied mathematics, infectious disease epidemiology, and mathematical biology.

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**Jessica Gephart**

**Supervisor:** **Åke Brännström**

**Co-Supervisor:** **Elena Roveskaya**

**Research Project:** **Structure and resilience of the global seafood trade network**

**Abstract:** The growth of the human population, increasing per capita consumption of animal proteins, and the effects of climate change on food supplies challenge the ability to meet future human food demands. Global trade is often seen as an option for countries to meet local food demands and overcome detrimental regional effects of environmental impacts on food supply. Until now, however, these discussions have largely focused on agricultural products. Seafood, despite being the most highly traded food commodity and an important source of animal protein in developing countries, has only rarely been considered.

This project aims to contribute a seafood perspective on global trade and food security. First, the spatial and temporal structure of seafood trade networks will be characterized and compared with trade networks for capture fisheries and aquaculture. Second, network dynamics characterizing changes in seafood trade flows will be defined. Third, the resilience of seafood trade networks will be investigated from two angles: i) by studying how negative local impacts such as the collapse of a regional fishery cause contagious effects that spread through the trade network; and ii) by examining how changes in trade policies may reshape seafood trade flows and affect the network's resilience. These analyses are expected to reveal which countries are most vulnerable to environmental impacts on the seafood trade network and identify conditions under which environmental impacts that initially are regionally confined cause knock-on effects that propagate throughout the seafood trade network.

**Biographical Sketch:** Jessica Gephart graduated in 2011 from Miami University, USA, with a bachelor's degree in Zoology and Environmental Science. She is currently a third-year Ph.D. student at the University of Virginia, USA, where she is working on her dissertation entitled "Fisheries in the Context of Global Water and Global Trade Networks." Her main fields of scientific interest include social-ecological systems, network analysis, global water resources, and food security.

**Evolution and Ecology Program (EEP)**
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**Jesper Sörensson**

**Supervisor:** **Rupert Mazzucco**

**Research Project:** **Signatures of speciation: From theoretical mechanisms to observable patterns**

**Abstract:** Species formation has traditionally been thought of as requiring genetic divergence between geographically segregated populations over geological timescales. More recent research has highlighted that, in contrast, species formation may occur frequently, and much faster, through local competition. While this alternative speciation mechanism, called adaptive speciation, is theoretically plausible, empirical evidence for its prevalence in nature is yet scant. This is mostly because the resulting biogeographic patterns are very similar to those resulting after species that initially diverged in geographic isolation again come into contact at a later stage.

The aim of this project is to identify post-speciation patterns—in terms of ecological, spatial, and reproductive differentiation among the resultant species—that allow the underlying speciation processes to be inferred, and in particular, a distinction to be made between adaptive speciation caused by local competition and its traditional alternative caused by geographic isolation. Guided by empirical data from a system of Mid-Atlantic island finches, I will investigate such patterns in different settings and evaluate their imprint on emerging patterns of genetic differentiation. By fostering insights into the mechanisms of speciation, the plausibility and prevalence of different such mechanisms, and our ability to infer underlying past processes from observations of present patterns more generally, this project will shed light on conditions promoting the formation of biodiversity.

**Biographical Sketch:** Jesper Sörensson has four degrees: Master of Education for the Upper Secondary School, Lund University (1997); bachelor's degree in Journalism, Lund University (2001); M.Sc. in Theoretical Ecology, Lund University (2010); and MBA, Blekinge Institute of Technology, Karlskrona, Sweden (2011). He is currently a third-year Ph.D. student at Lund University, Sweden. His scientific interests include how spatial and temporal structures affect speciation processes and how different evolutionary patterns emerge as a result.

**Evolution and Ecology Program (EEP)**
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**Floor Soudijn**

**Supervisor:** **Ulf Dieckmann**

**Research Project:** **Ecosystem-based fisheries management of cod and sprat in the Baltic Sea**

**Abstract:** The majority of commercially exploited fish stocks suffer from overfishing. This has led to the collapse of several fish populations. To improve fisheries management, fish stocks must be considered as interrelated elements of the ecosystem they inhabit. The fishing industry preferentially targets large predatory fish, such as cod, as these are often most profitable. These predatory fish critically depend on prey fish, such as sprat, for their survival and growth. Typically, these prey fish are also subject to commercial fishing. Even though it has become widely recognized that fisheries management should account for trophic interactions and multiple impacts in fishery systems, it is proving difficult to operationalize this approach.

Classic fisheries models are missing some essential biological mechanisms and therefore lack the power to handle this kind of complexity. This hinders the reliability of predictions of the effects of fishing and the establishment of optimal exploitation targets in systems of interrelated stocks. First, in most fisheries models, growth and reproduction are considered independent of the available amount of prey fish and other resources: yet, to account for feedbacks between a predator and its prey, growth and reproduction need to be analyzed as the food-dependent processes that they are. Second, seasonal rhythms, especially in the reproductive outputs of fish stocks, need to be taken into account, as seasonal variation in prey availability strongly affects the predator, feeding back on the prey. The aim of this project is to develop and examine these two extensions in an improved fisheries model, to elucidate how the fishing of cod and sprat affects the Baltic Sea ecosystem.

**Biographical Sketch:** Floor Soudijn received her master's degree in Biological Sciences in December 2009 from the University of Amsterdam, Netherlands. She is currently a Ph.D. student in the Theoretical Ecology Group of the Institute of Biodiversity and Ecosystem Dynamics at the University of Amsterdam. Her Ph.D. project focuses on emergent effects in predator-prey communities. Her main research interests include population dynamics, food-web dynamics, life-history characteristics, and theoretical ecology.

**Evolution and Ecology Program (EEP)**
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**Zepeng Sun**

**Supervisor:** **Ulf Dieckmann**

**Research Project:** **Seasonal life histories in changing environments**

**Abstract:** Climate change has a strong influence on ecosystems, biodiversity, and ecosystem services. In particular, climate change is altering the seasonal dynamics of many species and the timing of their interactions with other species. For example, both mammals and birds are strongly affected by ambient temperature and resource availability, especially in their timing of life-history transitions such as growth, reproduction, maturation, migration, hibernation, and molting.

In this project, we will examine stage-structured consumer-resource interactions and the evolution of a consumer's seasonal reproduction schedule using the theory of function-valued adaptive dynamics. Considering how patterns of resource availability are influenced by seasons and altered by climate change, we will analyze the conditions under which individuals with alterative reproduction schedules can invade established populations. Studying the resultant eco-evolutionary processes will enable us to assess how populations in seasonal environments will need to adjust their life histories in order to cope with changing seasonal patterns in their environments.

**Biographical Sketch:** Zepeng Sun received his bachelor's degree in Computational Mathematics in 2008 and his master's degree in Mathematical Biology in 2011 from Nanchang University in China. Since September 2011, he has been a Ph.D. student in Theoretical Ecology at the Institute for Biodiversity and Ecosystem Dynamics of the University of Amsterdam, Netherlands. His research interests focus on eco-evolutionary dynamics and semi-discrete population models.

**Energy Program (ENE)**
**Program Director: Keywan Riahi**

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**Oreane Edelenbosch**

**Supervisor:** **David McCollum**

**Co-Supervisor:** **Keywan Riahi**

**Research Project:** **The influence of social heterogeneity on consumer choices in the transport sector.**

**Abstract:** Understanding consumer choice in the transport sector is critical for scenario modeling, given that the transport sector is growing fast, and mitigating transport emissions can be difficult to achieve. Both IIASA and my home institute PBL perform system-level assessments of climate mitigation strategies, using the integrated assessment models (IAMs), IMAGE and MESSAGE. The models have different modelling approaches: IIASA's MESSAGE model is an optimization model, and IMAGE is a simulation model. However, their transport models are comparable; they include travel time budget and travel money budget to determine travel demand, and a detailed description of transport technologies. In both models social heterogeneity, in terms of, for example, per capita income, urban/rural environment, and lifestyles with respect to consumer choice are poorly represented. These socioeconomic factors are important drivers of decision making, and are of key importance for understanding consumer choice in the transport sector, such as technology adoption.

In the coming summer at IIASA I plan to investigate how transport consumer choice depends on social heterogenic factors, by means of a literature research, and to implement the relations found in the two IAM transport models. Existing scenarios of both models will be run, and subsequently a comparative assessment of heterogeneity in transport consumer choice on the demand for transport technologies and for transport services will be conducted for both models. Using the integrated framework of IMAGE and MESSAGE provides an opportunity to assess both the direct and indirect effects of transport demand scenarios on long-term energy projections and emission mitigation possibilities.

**Biographical Sketch:** Oreane Edelenbosch completed her M.Sc. in Energy Science in 2012, with a thesis on luminescent solar concentrators at the Experimental Physics Department of Imperial College London and a thesis on the interaction between climate- and air-quality policy at the University of Utrecht. She is currently a second-year Ph.D. student at the PBL Netherlands Environmental Assessment Agency. She is working for the EU FP7 ADVANCE project, where her main topic of scientific interest is the representation of energy demand in Integrated Assessment Models.

**Energy Program (ENE)**
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**Miho Kamei**

**Supervisor:** **Manfred Strubegger**

**Co-Supervisor:** **Shonali Pachauri**

**Research Project:** **Urban Energy Systems and their Increasing Importance in Global Long-term Energy Strategies**

**Abstract:** The bulk of $CO_2$ emissions come from cities. In other words, by improving urban energy efficiency, cities could play a significant role in climate change mitigation. An in-depth analysis of urban energy systems could provide a systematic model for developing policies, plans, and implementation strategies in urban areas.

My research will attempt to analyze potential opportunities for improving urban metabolism and services, while ensuring energy security, sustainability, and resilience. Different energy and emission pathways in regions where data are available will be examined to try to describe the possible outlooks for emerging regions. Factors driving energy consumption and urban energy flows will be explored and then linked to location and the urban planning contexts. This quantitative analysis will use the assumption of pathways developed for the SSP scenarios to analyze how these more general pathways could coincide with the development of major cities in various world regions. The research work will also focus on identifying key driving forces influencing consecutive development time phases in different regional contexts.

**Biographical Sketch:** Miho Kamei received her M.Sc. in Sustainable Urbanism from Bartlett School of Planning, University College, London, in 2012. She is also an experienced architect and city planning practitioner. She is currently a first-year Ph.D. candidate at the Department of Urban Engineering of the University of Tokyo. Her research focuses on urban structure and asset management for aging society and shrinking cities. In parallel, she is involved in low carbon society research projects in the Asian region at the National Institute for Environmental Studies in Japan.

**Energy Program (ENE)**
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**William Lamb**

**Supervisor:** **Narashima Rao**

**Co-Supervisor:** **Nils Johnson**

**Research Project:** **Basic needs, development pathways and the global carbon budget: Articulating the links between climate change mitigation and human well-being**

**Abstract:** Human well-being, particularly "basic needs," share complex links with infrastructures of energy and resource use. In emphasizing equitable basic needs access, contemporary development pathways in the global South are complicated by a potential climate change mitigation regime—it may no longer be possible for Annex 1 countries alone to instigate rapid emissions reductions and avoid dangerous climate change. How will this affect the development aspirations of the global South?

Using quantitative methods, this research will attempt to establish a baseline level of energy use and emissions associated with basic needs access; a quantity of emissions that may remain exempt from mitigation obligations. Further, this quantity of emissions, the basic needs "development space," will reduce the available space for mitigation delay and the speed of low-carbon transitions among developed nations, perhaps substantially so. By linking cumulative emissions scenarios to development space and an emissions exemption, this research will quantify and demonstrate the speed and ambition of emissions reductions that must be achieved in the global North to preserve equitable access to human well-being.

**Biographical Sketch:** William Lamb is a graduate of Edinburgh University (M.A., Chinese Studies in 2010, and M.Sc. in Ecological Economics, 2011). He is currently a second-year Ph.D. student at the Tyndall Centre for Climate Change Research, University of Manchester. The title of his thesis is "Identifying and learning from low-carbon pathways of human development." His research focuses on the interaction between measures of development achievement and carbon emissions mitigation, with a particular interest in heterodox economics, statistical methods, and political ecology.

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**Madeleine McPherson**

**Supervisor:** **Nils Johnson**

**Co-Supervisor:** **Manfred Stubegger**

**Research Project:** **Development and application of an improved tool for renewable resource modeling within MESSAGE**

**Abstract:** As intermittent renewable sources of electricity continue to gain market share, their inherent variability becomes an increasingly palpable threat to the electricity system's reliability. There are limited tools for mitigating and planning for intermittency, making it one of the more daunting challenges associated with transitioning to an alternative energy future. To overcome this challenge and mitigate the threat it poses to electricity system reliability, system planners and operators must be equipped with accurate parameterizations of renewable resource characteristics and constraints within the context of an integrated system. This capability will enable optimization of generation capacity and supporting grid infrastructure that correlate with demand profiles, minimize aggregate variability, and maximize system reliability and resilience. One of the current weaknesses of IIASA's MESSAGE model is the limited temporal resolution and representation of renewable resources.
To overcome these limitations, two improvements of renewable electricity modeling are proposed. Firstly, a more granular temporal resolution will be introduced in a geographically constrained version of MESSAGE to account for the highly variable nature of wind and solar resources and electricity load curves. Secondly, improved renewable resource quality variables, including reserve margin and operating reserve constraints, will be developed and implemented. Finally, several country-level scenarios will explore the impact of varying renewable deployment on backup generation, transmission expansion, storage infrastructure, demand-side management capacity, and curtailment strategies. Leveraging the existing functionality of MESSAGE will enable cost and greenhouse gas quantifications of these scenarios, while accounting for realistic technology transfer diffusion rates. Ultimately, the aim of this work is to develop a greater capacity to quantify and mitigate one of the most cited technical barriers to renewable energy deployment within the systems-level context.

**Biographical Sketch:** Madeleine McPherson is currently in her second year of a Ph.D. program in the Department of Civil Engineering at the University of Toronto. Prior to her doctoral studies, she completed a master's degree in Clean Energy Engineering at the University of British Columbia and a bachelor's degree in Applied Science and Engineering, also at the University of Toronto. Her research focuses on integrating intermittent renewable energy sources, such as wind and solar, into the electricity grid. Currently, she is modeling temporally granular renewable energy resource characteristics to optimize the network of supporting grid infrastructure.

**Energy Program (ENE)**
**Program Director: Keywan Riahi**

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**Robert Barron**

**Supervisor:** **Volker Krey**

**Co-Supervisor:** **Arnulf Grübler**

**Research Project:** **Quantifying the impact of supply-side R&D investment on energy pathways for sustainable development**

**Abstract:** The future state of the energy sector (the "energy future") and the many uncertainties surrounding it is a key aspect of climate change policy research. Political, technological, and socioeconomic factors will all influence the energy future. Previous work done for Chapter 17 of the Global Energy Assessment (GEA) found that significant increases to energy-related investment are needed, and identified three "branching points" corresponding to key decisions that shape the energy future: i) the tradeoff between supply and demand side improvements; ii) the choice of demand-side improvements; and iii) the choice between a "conventional" and an "advanced" transportation system.

This work will explore the role that R&D into electricity supply technologies (supply-side R&D) plays in shaping the energy future. This work will go beyond sensitivity analysis over supply-side outcomes, and will instead build on information gathered in expert elicitations in order to apply probability distributions over the full range of outcomes. The probability distributions are based on the combined results of three large-scale elicitation studies on five categories of technology, including carbon capture and storage (CCS), nuclear, solar, biofuels, and electricity from biomass. This new data set will allow a number of new questions to be explored, such as: i) given a demand-side/transportation sector/R&D budget, what is the probability that the outcome will fulfill the GEA objectives? or ii) given a demand-side/transportation sector combination, what is the optimal R&D investment? This work will develop insights into the role of supply-side R&D investment within the larger context of energy system investment as a whole, as well a sensitivity analysis of the optimal supply-side R&D allocation to different demand-side and transportation system assumptions.

**Biographical Sketch:** Robert Barron received a Master's degree in Industrial Engineering and Operations Research from the University of Massachusetts Amherst, USA, in 2013, where he is currently a Ph.D. candidate. His main research interests are modeling technological change in integrated assessment models and the effect of uncertainty on energy technology policy.

**Ecosystems Services and Management Program (ESM)**
**Program Director: Michael Obersteiner**

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**Volodymyr Blyshchyk**

**Supervisor:** **Dmitry Shchepashchenko**

**Co-Supervisor:** **Anatoly Shvidenko**

**Research Project:** **Modelling of live biomass and net primary productivity of Northern Eurasian forests**

**Abstract:** The study of the biological productivity of forests is crucial for estimating the state of terrestrial ecosystems and their dynamics under global change. Models of biological productivity represent dynamics of live biomass and net primary productivity (NPP) of forest ecosystems. In this project, we will improve the models needed to estimate the carbon stock in live biomass and the carbon flux between the atmosphere and vegetation: NPP.

During YSSP I will focus analyzing and updating the existing database of sample plots, on developing models of forest live biomass and of the NPP of major forest-forming species of northern Eurasia with a special focus on Ukraine. For this I will use methodology developed at IIASA (Shvidenko et al., 2007). To develop the models of biological productivity, a special simulation algorithm will be used that combines growth models and tables, models of live biomass, and a number of parameters describing the biological production of forest ecosystem. The assessment of the dynamics of biological productivity is an important part of the verified Full Carbon Account of the forests. My research will help to reduce the uncertainties of greenhouse gas emissions in northern Eurasia, including Ukraine. Tables and models of biological productivity and NPP will contribute to the ecologization of forest management and to the creation of a solid background for sustainable forest management.

**Biographical Sketch:** Volodymyr Blyshchyk graduated in 2010 from the National University of Life and Environmental Sciences (NULES) of Ukraine in Forestry, where he also completed his Master's degrees in Finance and Credit in 2012. Currently, he is a third year Ph.D. student in the Forest Management Department at NULES, Ukraine. His thesis is on net primary production of black alder stands of the Ukrainian Polissya. His main areas of scientific interest are modeling of live biomass and NPP of softwood stands, estimating the carbon sequestration and oxygen-producing functions of forests.

**Ecosystems Services and Management Program (ESM)**
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**Pietro Elia Campana**

**Supervisor:** **Florian Kraxner**

**Co-Supervisor:** **Ian McCallum**

**Research Project:** **Potential Sustainable Locations for Photovoltaic (PV) Water Pumping Systems**

**Abstract:** Grassland degradation is considered one of the worst environmental and economic problems in China because of its negative impacts on water and food security. The application of photovoltaic water pumping (PVWP) technology for irrigation is an innovative and sustainable solution to curb the progress of grassland desertification and to promote the conservation of farmland in remote areas. Research has shown that a combination of PVWP with water-saving irrigation techniques and sustainable management of the water resources enhances grass productivity, enabling wind and rainfall erosion to be halted and this higher incomes and better living conditions for farmers. PVWP systems have been used for more than 40 years, especially for drinking water, livestock watering, and irrigation in off-grid applications. It has previously been demonstrated that a PVWP system can also be deployed in on-grid areas for irrigation of numerous crops with several economic and environmental benefits.

In this project the feasibility areas for the implementation of PVWP systems both to combat grassland desertification and to promote the sustainable development of the agricultural and pastoral sector will be investigated. The main aim of this research project is to specify the potential locations for the implementation of PVWP systems taking into account different environmental constraints. Technical, economic, and environmental aspects for the implementation of PVWP will be considered in the project. The results of this research can be exploited both in developing and developed countries to enhance the use of solar energy in agriculture.

**Biographical Sketch:** Pietro Elia Campana graduated in 2011 from the University of Perugia, Italy, with an MSc in Environmental Engineering. Currently, he is a third-year Ph.D. student in energy and environmental technology at Mälardalen University, Sweden. The draft title of his Ph.D. thesis is “PV water pumping systems for grassland and farmland conservation.” His main fields of scientific interest include solar energy, in particular, integration of solar energy into agricultural and industrial processes.

**Ecosystems Services and Management Program (ESM)**
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**Moonil Kim**

**Supervisor:** **Nicklas Forsell**

**Co-Supervisor:** **Georg Kindermann**

**Research Project:** **Optimal forest management model for climate change**

**Abstract:** Forests are valuable resources in that they not only serve economic purposes by providing timber, but also provide a wide variety of common good services such as water storage, atmosphere purification, leisure, and tourism. Forests also have increasing value by reducing greenhouse gases and thereby mitigating climate change, which has caused catastrophic meteorological events across the world. According to 2010 statistics South Korea has an area of 10,014,822 ha, of which 6,433,667 ha or 64.2% is forests. In addition, South Korea is a peninsula and has a complex topography, which leads to spatial discrepancies in meteorological conditions. The IPCC has reported that climate change is occurring at a faster rate there than the global norm. Therefore, although it is crucial to consider the effects of climate change when forecasting changes in South Korea's forest resources, domestic research and model development is limited.

During the YSSP period, I am planning to improve two elements of the existing forest resource forecasting model. First, the capacity to make quantitative forecasts on how forest management affects forest resources; second, the capacity to make quantitative forecasts on how climate change affects forest growth among different tree species. I also plan to study the general algorithms of the G4M model, which was created by IIASA. This will complement South Korea's current forest management model and help manage local climate change trends. I also aim to run the G4M based on data collected from North and South Korea and use the results to establish South Korea's forest management plan and related policies.

**Biographical Sketch:** Moonil Kim received a B.Sc. in Environmental Science & Ecological Engineering in 2010, an M.Sc. with a major in Environmental Planning & Landscape Architecture in 2012, and is now a second-year Ph.D. student at Korea University of Life Science & Biotechnology in Seoul. His research focuses on modeling of forest growth and forest management optimization for carbon storage and sequestration under climate change, using GIS models to study spatial heterogeneity, and analysis of environment change using remotely sensed data.

**Ecosystems Services and Management Program (ESM)**
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**Kun Ma**

**Supervisor:** **Juraj Balkovic**

**Co-Supervisor:** **Rastislav Skalsky**

**Research Project:** **Application of EPIC Model to Explain Historic Change in Soil Organic Carbon Stock of Roige Wetland, China**

**Abstract:** Wetlands, as one of the most important ecosystems, cover 6% of the world's land surface and contain about 12% of the global carbon pool, playing an important role in the global carbon cycle. In a world of global climate change, wetlands are considered one of the biggest unknowns of the near future regarding element dynamics and matter fluxes. Accurate estimation of the size of wetland carbon pools is a prerequisite for management and protection of wetland resources and implementation of carbon sink enhancement plans, and the importance and urgency of this have been gradually recognized by scientists and politicians. Roige wetland, as an internationally important wetlans, is a typical peatland located in the northeast of Qing-Tibet plateau. Soil organic carbon storage is one of the most important ecosystem services here.

In this project, we chose Roige wetland as our study area. We will map the land use change in Roige wetland and collect data required for modeling. Using the EPIC model, we will then explain the historical change in soil organic carbon and its driving forces. The research outcomes will provide scientific information that will be useful for management and restoration of the Roige wetland.

**Biographical Sketch:** Kun Ma graduated from Beijing Forestry University in 2010 with a bachelor's degree in Management of Wildlife and Nature Reserves. He is currently a first-year Ph.D. student at Beijing Forestry University, majoring in Nature Reserve Science. His main interest is wetland ecosystem services, focusing on the relative research of carbon storage.

**Ecosystems Services and Management Program (ESM)**
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**Jon Nordling**

**Supervisor:** **Ian McCallum**

**Co-Supervisor:** **Steffen Fritz**

**Research Project:** **Global agricultural monitoring and mobile data collection**

**Abstract:** Today's environment is much different from that of about a century ago. A rapidly increasing population is bringing critical global stresses that range across all environmental systems in the world. Food security is one of the largest. Monitoring production of crops at a global scale will increase food security in today's global market. My research primarily consists of developing methods and architectures for global agricultural monitoring. Currently, my main focus is on developing an interface that utilizes F-VGI, remote sensing, and web mapping technology to visualize and interact with agriculture exports around the world to provide monthly crop-specific condition information. The inputs are then gathered for analysis and contributed to a global agriculture synthesis map that is released into the Agriculture Market Information System (AMIS). The Crop Monitor is being developed at the University of Maryland and was initiated by the Group on Earth Observation (GEO), to create transparency and synergy between agriculture agencies and global crop conditions.

My focus at IIASA will be on developing new methods and approaches for the crop monitoring. I will also explore mobile technologies for agricultural monitoring using the GeoODK mobile application and Geo-Wiki. Building an understanding of the capabilities, limitations, and future developments related to utilizing remote sensing coupled with ground observation data. I will also be exploring GeoTriggers, a geographic notification system for mobile applications that can be used for prompting data collectors when they are within a location that needs to be observed.

**Biographical Sketch:** Jon Nordling is a graduate student at the University of Maryland College Park. His background is in computer science and geographical information systems. Along with others he has been developing the GEOGLAM Crop Monitor. He is also the founder and lead developer of GeoODK, a mobile data collection tool kit. His research mainly focuses on interface architecture and application development for global agriculture monitoring.

**Ecosystems Services and Management Program (ESM)**
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**Amandine Pastor**

**Supervisor:** **Petr Havlik**

**Co-Supervisor:** **Amanda Palazzo**

**Research Project:** **How can irrigated land be expand while sustaining freshwater resources?**

**Abstract:** One of the major challenges of the 21st century is to manage the global water cycle in such a way that enough water will be available for both food production and the environment. The planetary boundary of human water consumption is likely to be reached in the near future. At the same time, there was, on average, a loss of 35% of freshwater ecosystem species between 1970 and 2000. Currently, by far the most water extracted by humans is used by the agricultural sector. A combination of dietary change, population growth, and climate change will have a large impact on water used for food production. There are, however, large uncertainties on how water demand and availability will change in the future.

We propose to develop an improved representation of water availability in the GLOBIOM model by including "environmental flows requirements." This will be done by including a water constraint to the model with the Variable Monthly Flow method developed by Pastor et al. (2013). The improved modeling framework will be used to test if both environmental needs and irrigation expansion can be met under a range of socioeconomic and climate change scenarios. Finally, we will evaluate different options for preventing unsustainable water use.

**Biographical Sketch:** Amandine Pastor has been a Ph.D. candidate at the Earth System Science group at Wageningen University, Netherlands, since 2011. The title of her thesis is "How to manage the global water system to sustain both food production and environmental needs under global change." Her research interests include environmental flows, hydrological modeling, sustainable food and agricultural production, climate change. She received a M.Sc. degree in Plant Science (organic plant production) in 2008 from Wageningen University and a M.Sc. degree in Agricultural Engineering from EIP, France, in 2008.

**Ecosystems Services and Management Program (ESM)**
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**Piera Patrizio**

**Supervisor:** **Sylvain Leduc**

**Co-Supervisor:** **Florian Kraxner**

**Research Project:** **Enhancing the optimization model BeWhere by including the generation of biogas and its use as a vehicle fuel**

**Abstract:** The BeWhere model developed by IIASA's Ecosystem Services and Management Program (ESM), currently works for wood waste, crop residues, lignocellulosic industrial waste, and three different biofuel production technologies. Nevertheless, the anaerobic digestion for biomethane production is not yet included in the model. Biogas production from cattle manure and waste flow residuals may provide multiple environmental benefits. Besides producing energy from renewable resources, anaerobic digestion can contribute to the recycling of nutrients and to reducing the environmental impacts of manure treatment; it is proving to be a very flexible technology, as a wide variety of organic materials can be used as raw materials. As part of my doctoral thesis, I am studying biogas utilization pathways in Italy with a special focus on the transportation sector. Relevant literature has shown that is more efficient in terms of CO2 emissions to use biogas for combined heat and power production than as a transport fuel. However, in almost all the biogas plants in the Italian countryside, the heat produced during gas burning process is lost; the heat used within the farm represents 10% of the total heat energy produced depending on the difficulty involved in developing heating infrastructures. Moreover, a Decree of the Ministry for Economic Development issued in December 201, introduced incentives for the production of biomethane as a transport fuel for the first time in Italy, confirming that biogas might play an important role in reaching the RES-T targets of 2020. During the past months, I have been developing a MILP model in GAMS, for the supply chain optimization of agricultural biogas as a vehicle fuel. The scope of this model, which is limited to the local level, is to find the optimal plant location to minimize supply chain costs.

My goal during YSSP is to enhance the powerful optimization model BeWhere by integrating its database with data on biogas technologies and supply chain structures. The final aim is to perform an economic and environmental analysis of the potentials of biogas as a vehicle fuel in northern Italy.

**Biographical Sketch:** Piera Patrizio completed her master's degree in Industrial Engineering at the University of Udine, Italy, in 2012, where she is currently a second-year Ph.D. student in Environmental and Energy Engineering Science. Her substantive research interest includes the use of alternative technologies in freight transport especially biofuels, and the improvement of environmental impact of logistic and supply chain optimization.

**Ecosystems Services and Management Program (ESM)**
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**Fabian Schipfer**

**Supervisor:** **Sylvain Leduc**

**Co-Supervisor:** **Florian Kraxner**

**Research Project:** **Biomass deployment strategies for the transition to a bio-based economy**

**Abstract:** Ensuring energy security while tackling climate change demands a broad portfolio of renewable energy technologies. The modern utilization of biomass will play a crucial role in heat and energy production as well as in transportation for decades to come. While many renewable energy technologies do not face competition from other economic sectors, biomass for energy competes directly and indirectly not only with food production but also with traditional and emerging material utilization.

With my research I wish to find and highlight cost-efficient and environmentally sound (non-food) biomass-to-end-use chains and address their potential to contribute to the transition toward a knowledge- and bio-based economy. A tool will be developed to illustrate and rank entire value chains, from the biomass production site to a possible preparation step, followed by a direct or cascaded consumption as biomaterials, biochemical, or bioenergy. Output from this tool, calculated by applying different framework conditions, will be used to generate scenarios, including considered value chains. Expected results are clear recommendations as to how corresponding bio-technologies can be used as pathways to a low-carbon Europe and what policy measures could optimally support them.

**Biographical Sketch:** Fabian Schipfer studied Physics at the University of Vienna, Austria, and the University of Seville, Spain. Since 2012 he has been working for the Institute of Energy Economics, Vienna University of Technology. His research interests are focused on the transition toward a bio-based economy with particular emphasis on bioenergy supply and utilization. He is contributing to several projects, for example, the EC FP7 SECTOR project which investigates the potential of secondary energy carriers by means of torrefaction, the ACRP CC2BBE project on the vulnerability of a bio-based economy to global climate change impacts, and the IEA Task 40 studies to bioenergy trade.

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**Olga Turkovska**

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| **Supervisor:** | **Nicklas Forsell** |
| **Co-Supervisor:** | **Mykola Gusti** |
| **Research Project:** | **Forest management in recursive dynamic global partial equilibrium model** |

**Abstract:** Large-scale partial equilibrium models have a problem with respect to numerical description of forest age class dynamics and representation of forest management in global (partial) equilibrium models. We are going to use existing age class models for forests with different age structures as well as different approaches to calculating optimal rotation time, in particular Faustmann and Hartman models, to find an optimal solution to this problem.

We propose to use predefined forest management options (e.g., a set of rotation times maximizing total wood production or specific components like sawlogs, or maximizing carbon stock; different thinning intensities, etc.) and respective net present values of forest use and allow GLOBIOM to choose optimal forest management in each optimization period. Forest age structure and biomass must be updated using a forest growth function according to the chosen forest management option and passed to the next optimization period. In fact, these forest management options are modeled in the dynamic global forest model G4M therefore G4M input data and modeling results, in particular, can be used for parameterization of the FM module.

**Biographical Sketch:** Olga Turkovska graduated from Lviv Polytechnic National University, Ukraine, in 2011, where she is currently a third-year Ph.D. student in the Department of International Information. The title of her thesis is “Information technologies for analysis of CO2 emissions from forestry and land use change in Ukraine for support of international negotiations.” Her main fields of scientific interest include forestry modeling and analysis of international climate agreements.

**Ecosystems Services and Management Program (ESM)**
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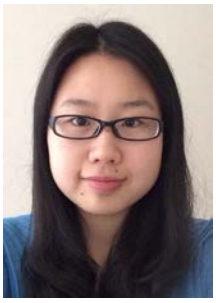

**Jie Zhang**

**Supervisor:** **Linda See**

**Co-Supervisors:** **Steffen Fritz**

**Research Project:** **Assess the capabilities of remotely sensed indicators for agricultural drought monitoring**

**Abstract:** Within the context of climate change and the frequent occurrence of extreme weather events, the issue of global drought is becoming more and more pronounced, attracting increasing attention from governments, scientists, and the public. Currently, more than half Earth's land surface is susceptible to drought, and the world loses a total of about US$6-8 billion each year due to drought. Agriculture is the main sector to be affected by drought. Although agricultural production has been rising in recent years, agricultural drought is the primary causes of crop loss, often leading to global food price instability and threatening global food security. Satellite-based Earth observation has proven its potential for near real-time drought monitoring and early warning, and many remotely sensed indicators have been developed for drought monitoring based on vegetation conditions, surface temperature, and soil moisture. However, most current drought monitoring methods are generic and not agriculture-specific. Agriculture is different from other ecosystems in that it has a relatively shorter and more quickly changing phenology and undergoes intensive human management. Thus, the performance of these indicators in terms of both their responsiveness and their effectiveness, specifically for agricultural drought monitoring is still not clear during the growing season.

The proposed research is intended to examine the response of different remotely sensed indicators to agricultural drought, investigate the effectiveness of these indicators for agricultural drought monitoring during the growing season, and evaluate the coarse resolution ASCAT soil moisture dataset for agricultural drought monitoring.

**Biographical Sketch:** Jie Zhang received a bachelor's degree in Remote Sensing from Nanjing University of Information Science & Technology, China, in 2008 and a master's degree in Natural Disasters from Beijing Normal University, China, in 2011. Currently, she is a Ph.D. candidate at the Department of Geographical Sciences at the University of Maryland, College Park, USA. Her dissertation topic focuses on global agricultural drought monitoring from satellite observations. Her main fields of scientific interest include satellite-based agriculture and agricultural drought monitoring, vegetation response to drought, as well as drought impacts on agricultural production.

**Ecosystems Services and Management Program (ESM)**
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**Nur Aulia Bt Rosni**

**Supervisor:** **Linda See**

**Research Project:** **Determining urban sprawl geospatial indices using remote sensing and GIS**

**Abstract:** The term urban sprawl has a decades-long history within the academic discourse; yet there is no commonly agreed-upon definition of what, exactly, it constitutes. Researchers all over the world have used various techniques and methods to determine urban sprawl; one of these methods is spatial factor measurement. Characterizing urban sprawl using spatial measures requires a concise definition of its spatial patterns. This research attempts to study the urban sprawl measurement using different spatial factor indexes, namely, Urban Density, Leapfrog Development, and Highway Strip through remote sensing and GIS. SPOT-5 satellite imagery with a 2.5 meter resolution was used and combined with a GIS database to analyze the geospatial indicators using these indexes. The city of Kuala Lumpur was designated as a study area based on land use patterns for the year 2012. Kuala Lumpur was divided into six districts; the study areas selected are new township residential areas, approximately 60 acres in area, namely, Taman Melati, Bandar Tun Razak, Bangsar Baru, Sentul Raya, Bukit Jalil, and Kampung Baru. The findings show that the city of Kuala Lumpur has been subject to urban sprawl based on the indexes calculated. These measurements of Urban Density, Leapfrog Development, and Highway Strip also show that the gap between sprawl and non-sprawl indexes is very low, which indicates that the city is facing issues of urbanization, especially in handling and planning the rapid development of land.

The YSSP study on urban sprawl growth will give an opportunity for stakeholders to determine what measures should be taken to solve issues related to big cities. In the present research on spatial measurement, GIS and remote sensing technology has helped provide a new direction in urban sprawl studies that address the finding of sprawl and presents a robust analytic approach for characterizing urban development at a city scale.

**Biographical Sketch:** Nur Aulia Rosni completed her bachelor's degree in Urban and Regional Planning from the International Islamic University Malaysia in 2011, where she is a final-year Master's student of Science and Built Environment. Her main fields of scientific interest include the application of GIS and remote sensing to the town planning process.

**Mitigation of Air Pollution and Greenhouse Gases Program (MAG)**
**Program Director: Markus Amann**

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**Jun Liu**

**Supervisor:** **Zbigniew Klimont**

**Co-Supervisor:** **Chris Heyes**

**Research Project:** **Co-benefits from air quality management and climate change mitigation strategies in Beijing-Tianjin-Hebei region in China**

**Abstract:** With their higher population density and energy consumption rate, megacities are most sensitive to air pollution and climate change. Undertaking mitigation measures in megacities will hopefully help achieve large human health co-benefits.

In the study, potential air quality, human health and climate co-benefits from air quality management and climate change mitigation strategies in Beijing-Tianjin-Hebei city clusters will be assessed using an interdisciplinary method. The city-scale integrated assessment model (GAINS-City) will be used for emission estimation in response to air quality and climate policies that will be taken in future transport, power generation, industry, and domestic sectors in Beijing. The air quality under different policy scenarios will be simulated with the regional air quality model, which will be used for subsequent exposure and health impact assessment. Co-benefits of different strategy options will be quantified for aspects of air quality, human health, and climate, and these will be utilized to help the government establish appropriate environmental policies that maximize environmental benefits.

**Biographical Sketch:** Jun Liu graduated from the College of Urban and Environmental Sciences, Peking University in July 2010. She is a fourth-year Ph.D. student at the College of Environmental Sciences and Engineering at Peking University, majoring in Environmental Sciences. Her main fields of scientific interest include source of air pollution, regional air quality modeling, mitigation policy, and health effects of atmospheric air pollutants.

**Mitigation of Air Pollution and Greenhouse Gases Program (MAG)**
**Program Director: Markus Amann**

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**Thanicha Ruangmas**

**Supervisor:** **Lena Höglund Isaksson**

**Co-Supervisor:** **Wolfgang Schöpp**

**Research Project:** **The pollution haven hypothesis: What are the embedded costs in Chinese exports to the EU?**

**Abstract:** The goal of this research is to show that Europe's remarkable pollution reduction achievements have been partially due to the relocation of polluting industries to China, and to suggest how China should adjust its long-term trade policy theory to combat its pollution problem. The research would use both theory and empirics to show that the pollution haven hypothesis applies to the China-EU trade scenario. A trade model applied to pollution intensity data of The World Bank as well to the GAINS-China model will be used to calculate the damage from emissions of SO2, NOx, and PM2.5 in current exports to the EU. Using the GAINS-China model, a forecast of China's pollution damage cost can be produced once China expands its manufacturing industry exports in relation to less polluting industries. The result of this research can be used to address China's trade policy as a viable option in combating its pollution problem.

**Biographical sketch:** Thanicha Ruangmas received her undergraduate degree in Quantitative Economics from Chulalongkorn University in Bangkok, Thailand, in 2012. Currently, she is a Ph.D. student in the Department of Agricultural and Applied Economics at the University of Wisconsin-Madison. Her research concentration is in resource and environmental economics, specifically in air pollution regulations and fisheries. She is currently working on environmental federalism and the optimization methods in air pollution monitoring. She is at the end of the second year of her Ph.D. studies.

**Mitigation of Air Pollution and Greenhouse Gases Program (MAG)**
**Program Director: Markus Amann**

**Younha Kim**

**Supervisor:** **Young-Hwan Ahn**

**Research Project:** **Assessment of special measures for Seoul Metropolitan Area program using GAINS-Korea Framework**

**Abstract:** Korea has ambitiously set the second phase of its capital air quality improvement program, called the Special Rule for Air Quality Improvement over the Seoul Metropolitan Area (SRAQI-SMA), targeting the year 2024. The air quality improvement targets for the year 2024 are 30 ug/m3 and 20 ug/m3 for PM10 and PM2.5, respectively. Emissions of PM10 and PM2.5 are required to be decreased by up to 35% and 45%, respectively, from their future baseline level. Various special measures, such as cap-and-trade, LEV program, will be implemented to control emissions over the Seoul, Incheon, and Gyeonggi-do area. In the meantime, Korea has set its national and sectoral GHG mitigation targets for the year 2020. There should therefore be synergies between GHG mitigations and air quality improvement measures. The GAINS-Korea Model, which is being jointly developed by Konkuk University and IIASA, should play an important role in understanding the impact of air quality improvements across the regions in Korea.

The main purpose of my research is to assess the impact of air quality improvements, from the baseline level, that are due to those special air pollution control measures and GHG mitigation policies. The tasks are: i) to implement control technologies and costs for GHGs and air pollutants in GAINS-Korea; ii) to develop baseline and control scenarios; iii) to assess the local air quality improvements by control policy pathway.

**Biographical Sketch:** Younha Kim is currently a first-year Ph.D. student in the Department of Advanced Technology Fusion at Konkuk University in Korea and received her M.Sc. in the same field. She holds a bachelor’s degree in Journalism and Communications. Her main fields of research interest include integrated air quality management, emission inventories, and control scenarios.

**World Population Program (POP)**
**Program Director: Wolfgang Lutz**

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**Abhishek Kumar**

**Supervisor:** **Valeria Bordone**

**Co-Supervisor:** **Raya Muttarak**

**Research Project:** **Intergenerational Influence on Fertility Behaviour of Young Women in Rural Bihar, India**

**Abstract:** Bihar is the third most populous state of India. According to the 2011 census, in the past decade, the state has the highest population growth rate of the major states of India due to lagging behind both socioeconomically and demographically. Women in Bihar, on average, still bear around four children in their reproductive lifetime because of the interplay of a complex set of individual, household and community socioeconomic (micro and macro) and cultural factors. While the study of the role of socioeconomic factors on fertility is well established, little is known about the influence of the fertility and family size preferences of older generations (mothers-in-law and mothers) on the fertility behavior of younger generations (daughters-in-law) in India in general and Bihar in particular. Understanding the generational influence on fertility behavior and its underlying mechanisms may be crucial from a policy perspective.

Using cross-generational data (collected from two generations) of 450 pairs of co-residing mothers-in-law and daughters-in-law, the present study focuses on investigating the influence of older generations' fertility and fertility preferences on the family size preferences of younger generations. This study also attempts to examine the influence of older generations' and familial fertility on the transmission of age at first birth, second birth, and third birth among the younger generation. Coombs scale, ordinary least square, and event history analysis are used to examine the intergenerational influence. The study will also discuss the potential policy-relevant issues and the wider implications emerging from this research.

**Biographical Sketch:** Abhishek Kumar graduated in Geography from Banaras Hindu University (BHU) in 2007, thereafter doing an M.Phil. in Population Studies at the International Institute for Population Sciences (IIPS), Mumbai, in 2009. He is now working on his Ph.D., entitled "Intergenerational transmission of fertility behaviour in rural Bihar." His research interests include socioeconomic inequality in maternal and child health status, and use of maternal and child healthcare services. In 2013-2014 he was a Policy Communication Fellow of the Population Reference Bureau (PRB), Washington DC, USA.

**World Population Program (POP)**
**Program Director: Wolfgang Lutz**

**Adriana Reyes**

**Supervisor:** **Vegard Skirbekk**

**Co-Supervisor:** **Marcin Stonawski**

**Research Project:** **Explaining population movements by variation in past growth rates of nations**

**Abstract:** The world has seen unprecedented demographic changes taking place over the last half century. Overall, the population size has increased and aged. Globally, immigration has continued to grow, increasing by 65% since 1990 to a stock of about 232 million immigrants in 2013 (United Nations, 2013). In large part, immigrants are concentrated in more developed nations, which also happen to have lower fertility rates than many developing nations. For instance, Europe has seen its fertility rate fall from above reproduction levels in the 1960s to currently below replacement fertility, causing a population decline in several countries.

My research project will attempt to explain population movements between countries by fertility characteristics of host and sender nations, for instance, do migrants move toward areas where there has been lower population growth. This study will utilize a new global database on gross national origin-destination flows for 196 countries between 1990 and 2010 (Abel and Sander 2014, *Science*) allowing detailed estimates to be made on migration. This is important, as it relates to whether migration flows go from countries that experience high population increase toward nations with slow or negative growth. It is also important in terms of global and regional TFR—if migrants adjust their TFR to the host country, will high migration imply lower regional and global fertility over time, and what would global fertility be without migration?

**Biographical Sketch:** Adriana Reyes graduated in 2010 from the University of Arizona with a bachelor's degree in Sociology and in 2012 with a master's degree in Sociology and Demography from Pennsylvania State University. The title of her thesis was "Left Out of the Equation: Older Immigrants and Health Insurance Coverage." She is currently a fourth-year Ph.D. candidate at Pennsylvania State University. Her main areas interests include social demography, immigration, population aging, life course, and inequality.

**World Population Program (POP)**
**Program Director: Wolfgang Lutz**

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**Niharika Tripathi**

**Supervisor:** **Vegard Skirbekk**

**Co-Supervisor:** **Marcin Stonawski**

**Research Project:** **Preferred life expectancy and its correlates among elderly women in rural Uttar Pradesh, India**

**Abstract:** Population aging poses diverse socioeconomic, demographic, and health-related challenges across nations. Recent research indicates that feminization of aging is under way as women constitute a sizable proportion of the elderly population. Older women are more likely to be poorer in old age, more likely to face discrimination, and can be subjected to abuse and violence. Women in rural areas are frequently responsible for caring for grandchildren, as their own children migrate to cities in search of opportunities for a better livelihood. Due to the gender-specific division of labor, women often have to care for older relatives, and then also for husbands throughout their life cycle. Finally, when these older women themselves need help after a life full of hard work, there is no one left to care for them (UN 2002). This research examines the association between the preferred life expectancy and its selected socioeconomic and demographic correlates. Given the several multiple socioeconomic and health deprivations they face, elderly women may not desire to live many more years into the future, particularly in the rural areas. Findings will contribute to the debate on whether ongoing efforts to improve life expectancy are really warranted. Results may help to address emerging issues in the field of active and healthy aging of population, and to understand the circumstances that shaped these notions and the expectations of elderly women. Data for the study have been drawn from primary survey of 300 elderly women from four villages of Deoria district in the eastern parts of Uttar Pradesh in India. Both quantitative and qualitative information were collected to explore the gender dimensions of aging, such as inheritance and property rights, role in decision-making, female autonomy, financial dependency, perceived health status, preferred life expectancy, economic and social support networks, involvement in community life, social well-being, and life satisfaction.

**Biographical Sketch:** Niharika Tripathi is a fourth-year doctoral candidate at the International Institute for Population Sciences, Mumbai, India, under the University Grants Commission (UGC), New Delhi, Senior Research Fellowship Program. Her thesis is entitled “Gender and Elderly: Inheritance rights, family support, autonomy and well-being of elderly women in rural Uttar Pradesh, India.” Her main research interests encompass issues on gender and population aging, inheritance rights and women’s health, social capital and well-being of the elderly, family life education, and adolescent health. She earned a master’s degree in Population Studies from the International Institute for Population Sciences, Mumbai, India, in 2010 and a B.A. and M.A. in Sociology from Banaras Hindu University, Varanasi, India, in 2006 and 2008 respectively.

**World Population Program (POP)**
**Program Director: Wolfgang Lutz**

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**Haochen Wang**

**Supervisor:** **Anne Goujon**

**Co-Supervisor:** **Samir K.C., Gui-Ying Cao**

**Research Project:** **A projection of human capital in Beijing—Education and health perspectives**

**Abstract:** In the case of China, rapid economic growth in some areas is leading to regional disparity with a large floating population, particularly of the well-educated. It is important to study the educational composition of present migration flows in order to better project future population growth and education in regional China. The methodology available for such projections is that of multi-state population projection, developed at IIASA. Next to improvements in education levels, health can also be considered as a way of improving human capital. Currently, with rapid economic development, many people live in Beijing and other developed cities in China. The concentration of people leads to more vehicles which is a possible source of haze, resulting in adverse health effects. Studies show that Beijing has a higher mortality rate from lung cancer than other big cities. Poor health weakens human capital and may cause migration from Beijing. Some people choose to live in a Beijing suburb or Hebei Province (especially in the northern part which has a better environment). Meanwhile, some students from the southern provinces return home after their graduation for better environment. So health may affect migration, especially among well-educated people. Therefore, the effect of health on migration can be utilized in the projection model.

My proposal is to take Beijing as the research object and to supplement the effect of health on migration in the PDE projection model. The first step is to analyze the association between health, migration, and life expectancy. People with poorer health may emigrate. The second step is to integrate the effects into the projection model to discover the extent of the effects among people with different education levels. In this model, the impact of changes in the one-child policy on the fertility rate is also considered, which can help identify the extent to which the change will influence the number and structure of a population in a city. This should make the simulation more comprehensive.

**Biographical Sketch:** Haochen Wang graduated in 2010 from Rensselaer Polytechnic Institute, Troy, NY, USA. He is currently a third-year Ph.D. student at Peking University. His thesis is entitled: “A projection of human capital in Beijing—Education and health perspectives.” His main fields of scientific interest include population health, environment and health, and forecasting techniques.

**Risk, Policy and Vulnerability Program (RPV)**
**Program Director: Joanne Bayer**

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**Edoardo Borgomeo**

**Supervisor:** **Georg Pflug**

**Co-Supervisor:** **Stefan Hochrainer-Stigler**

**Research Project:** **Analysis of water resources system vulnerability to changes in inter-annual hydrological variability**

**Abstract:** The performance of water systems is influenced by the hydrological flow regime. Understanding the vulnerability of water systems to inherent natural hydrological variability and future changes related to climate change is essential for water planning and to quantification of the system's response to change. Hydrological variability has also been shown to have a profound impact on a nation's wealth and development; thus, analyses of the water system's vulnerability to hydrological variability and change can also provide insights into the economic consequences of hydrological complexity.

This research seeks to explore the robustness of a water system under plausible assumptions about natural hydrological variability and climate change variability. Variability in stream flow is represented using two characteristics: inter-monthly autocorrelation and winter flow volumes. Large ensembles of stream flow time series will be developed using a novel technique based on simulated annealing and run through a water system model to identify under what present (i.e., normal hydrological variability) and future hydrological conditions (future climate projections) the system fails. The vulnerability analysis will also be informed by climate model projections, which will be mapped on to the vulnerability space. The methodology will be applied to the Thames river basin in southern England to assess the system's vulnerability to hydrological variability and future climate change.

**Biographical Sketch:** Edoardo Borgomeo is a second-year Ph.D. student at the Environmental Change Institute, University of Oxford. He is interested in water resources planning and management and analysis of water-related risks. His research explores a range of decision-making approaches to help water managers in the London area identify the impacts of climate change on water supply and make sustainable and robust climate change adaptation decisions. His doctoral research is jointly funded by the UK Environment Agency and by Thames Water utilities. His background is in environmental and Earth sciences.

**Risk, Policy and Vulnerability Program (RPV)**
**Program Director: Joanne Bayer**

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**Apolonia Diana Sherly da Costa**

**Supervisor:** **Junko Mochizuki**

**Co-Supervisor:** **Adriana Keating**

**Research project:** **Community resilience due to river flooding in Belu Regency, East Nusa Tenggara Province, Indonesia**

**Abstract:** Community perception contributes to the flood disaster management process and has been highlighted as the strength of the community to face, overcome, and minimize the risk of flood, greatly supporting local decision making and behavioral choice.

This YSSP research will analyze the community perception of flood risk and key sources of community flood resilience, asking the following questions: i) What is meant by community resilience? ii) Is there a relationship between flood severity and community resilience? iii) How can community resilience be quantified? and iv) what is the relationship between flood severity and community resilience? The selected case study areas are three of the most flood-prone villages of Belu Regency, East Nusa Tenggara Province, Indonesia. The data regarding community disaster resilience, in particular, on community capitals or assets, i.e. (human, natural, social, economic, physical, legal, political, and cultural) were obtained through in-depth, semi-structured interviews with 60 respondents, focus group discussions (FGD), and participatory mapping using Geographic Information Systems (pGIS). This project will analyze community self-perception of capitals, river flooding, and resiliency, considering damage to community life (e.g., loss of life or injury, damage to houses, public facilities, loss of cultural heritage sites, damage to the environment, etc.), together with livelihood impacts (e.g., loss of agricultural production and cultivation lands, livestock and fisheries, etc.). The results of the case study will be paired with analysis of wider institutional factors to develop recommendations for improving community flood resilience in the region. Experience in the area to date indicates that issues of accessibility and access to information may be critical, and political capital may be an important source of resilience.

**Biographical Sketch:** Apolonia Diana Sherly da Costa is a Ph.D student (Dr.rer.nat) at the Institute for Social-Human Geography at Faculty of Chemistry and Earth Science, Friedrich Schiller University of Jena, Germany. She holds a M.Sc. from Graduate School of Environmental Science (Multidisciplinary Studies) concentrating on geo-information for spatial planning and disaster risk management. Her Ph.D. research project is entitled "Building Resilience for the Flood Event based on Community Perception, A Case Study in Belu Regency, East Nusa Tenggara Province, Indonesia."

**Risk, Policy and Vulnerability Program (RPV)**
**Program Director: Joanne Bayer**

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**Margaret Garcia**

**Supervisor:** **Wei Liu**

**Co-Supervisor:** **Brian Fath**

**Research Project:** **Development of a coupled socio-hydrological model to evaluate flexible strategies for reliable water supply**

**Abstract:** Climate change is a significant planning challenge for water supply management. New methods developed to address this challenge have significantly advanced the assessment of strategies to adapt water infrastructure to climate change, but they still have a critical limitation: they fail to account for intelligent management of systems in response to biophysical conditions.

In response to this gap, I will develop a coupled socio-hydrological model to evaluate flexible strategies for reliable water supply while considering both biophysical and institutional dynamics. I will use a revised version of Ostrom's Institutional Analysis and Development (IAD) framework to structure the analysis. This framework seeks to understand behavior within the institutional arrangements and integrates feedbacks between the dynamic biophysical system and the evolving policy context. Based on this framework, I will create a system dynamics model, using historical data on water management in the Las Vegas area to develop and parameterize the model. The key limitation of this approach is the paucity of data available to parameterize a model with such high dimensionality. I will mitigate this limitation by taking a comparative socio-hydrology approach. Drawing upon comparative hydrology, this approach analyzes multiple socio-hydrologic systems and looks at the influence of institutional and biophysical characteristics in order to identify properties generalizable to systems with shared characteristics. Operationalizing the comparative socio-hydrology approach is a long-term goal; however, the plan of work described here is an important first step that will test the feasibility of the approach and lay the groundwork for future study.

**Biographical Sketch:** Margaret Garcia is a second-year Ph.D. student in Civil & Environmental Engineering at Tufts University and a fellow in the Tufts' Water Diplomacy IGERT program. Her research focuses on socio-hydrologic modeling to understand the impact of water resources management policies and infrastructure on structuring the feedbacks between social and hydrologic systems. She earned bachelor's and master's degrees in Civil Engineering from Lafayette College in 2007 and UCLA in 2012, respectively. Prior to returning to school, she worked for four years as a Civil Engineer in Arup's New York office, where she worked on the design of drainage systems, stormwater treatment, erosion controls, and utilities.

**Risk, Policy and Vulnerability Program (RPV)**
**Program Director: Joanne Bayer**

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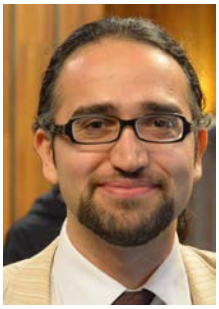

**Faridoddin Karimi**

**Supervisor:** **Nadejda Komendantova-Amann**

**Co-Supervisor:** **Michael Thompson**

**Research Project:** **The role of socio-cultural factors in risk perceptions concerning carbon capture and storage**

**Abstract**: In this research, the developing Carbon Capture and Storage (CCS) technology is scrutinized from the social and cultural structures perspective. Although the technical aspects of CCS are substantially researched, the social aspects of the technology remain noticeably under-researched. The public perception of risk is an important issue that has to be carefully considered not only in the risk governance of CCS but also for every new climate-change-related technology. Although the lack of knowledge is an important factor in the risk perception, many studies hypothesize that an increase in knowledge will not result in reduced aversion to risks. Thus, we draw upon cultural theory in order to understand these issues in more detail. The argument is that the public acceptance of novel technologies is not a simple case of information and knowledge dissemination. Instead, it is a more complex process, incorporating cultural factors.

In this research, we will argue that it is crucial to have a richer understanding of where the public opinion on the technology comes from, and we develop a model that helps in this understanding. This research contributes to the risk governance of CCS by developing a new framework that can be used as a tool by policymakers and authorities to consider the unheeded issue of culture in their planning.
In this study we will address these questions: i) How do cultural structures of a society affect the risk perception of CCS? ii) How would the experts' mental models shape the future of the technology in each cultural context? This research is principally based on the interviews with experts from different stakeholders and Cultural Theory. We aim to analyze the experts' perception and reaction to CCS by using group and grid Cultural Theory. In this research, case studies from CCS development in some countries will be investigated to scrutinize the results of the study for those case studies, to test if our interpretation and analysis are valid.

**Biographical Sketch:** Farid Karimi has an M.Sc. in Sustainable Energy Technology (Energy and Society track) and graduated in 2011 from Delft University of Technology, the Netherlands. He is currently a researcher and second-year Ph.D. student in Environmental Policy at University of Helsinki. His doctoral dissertation focuses on the socio-cultural aspects of environmental risk governance in Carbon Capture and Storage (CCS).

**Risk, Policy and Vulnerability Program (RPV)**
**Program Director: Joanne Bayer**

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**Minella A. Martins**

**Supervisor:** **Stefan Hochrainer-Stigler**

**Co-Supervisor:** **Georg Pflug**

**Research Project:** **Vulnerability risk index of agricultural production in the Brazilian Semi-Arid**

**Abstract:** According to the latest census, the population of the Semi-Arid region of Brazil is more than 22.5 million. With a demographic density of 23.1 inhabitants/km², it is considered one the world's most populated semi-arid regions. The rural population is almost 40% of the total population, who depend on rainfed agriculture for their subsistence. Intraseasonal and interannual variability of rainfall have a major influence on crop yield. Severe droughts cause crop failure and food insecurity in rural areas. As well as vulnerability to droughts, several climate change scenarios suggest that large areas of the Brazilian Semi-Arid could become unfeasible for rainfed subsistence agriculture, making poor populations more vulnerable because of a reduced food supply. Although rainfed agriculture in the Semi-Arid has low economic relevance for the Brazilian economy, it is very important from a social point of view because of the large low-income population living in rural areas.

To measure how vulnerable the agriculture is in each city in the Semi-Arid region of Brazil, this research project proposes the creation of the Vulnerability Risk Index of Agricultural Production which consists of Partial Indexes (Economic Impact – PIEC; Social Impact – PISO, and Environmental Impact – PIEN). Each Partial index is composed of the main variables which represent the social, environmental,and economic characteristics of the region. Through the Vulnerability Risk Index of Agricultural Production, this project intends to evaluate the vulnerability of agricultural production in each city from a risk based and interdependent sub-groups dynamics perspective and suggest priority sectors (Economic, Social and/or Environmental) for investments and improvements.

**Biographical Sketch:** Minella Martins graduated in Agricultural Engineering from the Federal University of Lavras (UFLA), Brazil, in 2010, and received her master's degree in Meteorology from National Institute for Space Research (INPE), in 2012. She is currently a third-year Ph.D. student in Earth System Science at INPE. The title of her thesis is "Seasonal Forecasts of Agriculture Yield from AquaCrop Model using climate forecast for the Semi-Arid of Brazil." Her main fields of scientific interest include crop models, rainfed agriculture, crop failure, water use, vulnerability of agriculture and households, climatology, meteorology, hydrology, and water balance.

**Risk, Policy and Vulnerability Program (RPV)**
**Program Director: Joanne Bayer**

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**Thomas Schinko**

**Supervisor:** **Nadejda Komendantova-Amann**

**Co-Supervisor:** **Fabian Wagner**

**Research Project:** **Governance of risks in financing renewable energy investments in North and South Africa**

**Abstract:** Tackling the threats posed by climate change requires a fundamental reconfiguration of the global energy system on the basis of renewable and low-carbon energy technologies. To advance this endeavor, substantial investments will be necessary over the next decades. However, the competitiveness of renewable electricity generation, and hence its attractiveness as an investment option, crucially depends on financing costs. Possible risks from the point of view of investors have to be identified and carefully managed in order to reduce the cost of finance. Therefore, I will set out to answer the following research questions: i) How do perceived risks of investors associated with renewable energy projects influence the cost of capital and hence the levelized cost of renewable electricity? ii) How can these risks be governed in order to establish a sound environment for investments in low-carbon energy technologies? iii) What are the macroeconomic effects of a de-risking strategy? In my analysis I will concentrate on investments in wind energy and PV projects in two concrete case study regions, the North African region and South Africa. Methodologically, a literature review will be carried out to illustrate the status quo of financing costs for renewable energy investments in the case study regions and to identify a matrix of specific elements of investors' perceived risk as well as the respective contribution of single elements to higher financing costs. This analysis will point out crucial leverage points for the governance of financing risks. Building upon this risk analysis, I will quantify the macroeconomic effects of a de-risking approach to renewable energy investments using a computable general equilibrium (CGE) framework. In addition to the direct economic benefits of a reduction in investors' risk perceptions, the CGE analysis allows macroeconomic feedback and spillover effects via international trade and energy markets to be taken into account.

**Biographical Sketch:** Thomas Schinko studied environmental system sciences with a major in economics at the University of Graz, Austria, and Uppsala University, Sweden. He received his master's degree in 2010. He is currently a third-year Ph.D. student in the economics Ph.D. program at the University of Graz and a researcher at the Wegener Center for Climate and Global Change. His main fields of scientific interest include the economics, ethics, and risks of international energy and climate change policies, the economics of human development, and international trade.

**Risk, Policy and Vulnerability Program (RPV)**
**Program Director: Joanne Bayer**

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**Daniel Suarez**

**Supervisor:** **Joanne Bayer**

**Co-Supervisor:** **Wei Liu**

**Research Project:** **The institutionalization of ecosystem services in transnational policy networks**

**Abstract:** The concept of ecosystem services has been used increasingly in global and regional environment governance since at least the late 1990s. Currently, several ecosystem services discourses exist and are beginning to institutionalize. The objective of this research is to explore the variety and scope of the ways in which ecosystem services discourse institutionalize with two main components. First, I will examine environmental finance flows directed explicitly towards returns-generating, "for-profit" biodiversity conservation. Intense controversy continues to surround debates over the implications of ecosystem services as a vehicle for commodification, neoliberalization, and an array of market mechanisms. However, these debates are often framed in potential terms (whether auspicious or ominous) rather than around systematically gathered, comprehensive empirical evidence indicating the scale and scope of global environmental finance, which has actually and already been brought into being for these purposes. The second component, building on ongoing research, will be a typology of the different "forms" in which ecosystem services concepts have institutionalized. Each of these forms in which ecosystem services is being discussed and manifested rest on different conceptualizations of ecosystem services, and often distinct communities of practitioners developing and promoting (or critiquing) that conceptualization and the kinds of policy prescriptions, institutional arrangements, and kinds of actions that conceptualization presupposes. This project component will systematically parse "ecosystem services" discourse into its distinct claims, and the ways in which it is talked about, proposed, and actually instituted. This research will provide important insights on how ecosystem services get translated from a discourse into actual institutional structures, policies, and practices.

**Biographical Sketch:** Daniel Suarez graduated from the University of British Columbia in 2008 with a B.Sc. in Environmental Science and Anthropology. He completed his M.A. at the University of Toronto in Geography and Environmental Studies in 2011. He is currently a doctoral candidate at the University of California, Berkeley, in the Department of Environmental Science, Policy and Management. The title of his dissertation is: "The Institutionalization of Ecosystem Services in Transnational Policy Networks." The project uses mixed social research methods to examine the spread and uptake of ecosystem services approaches across different institutions of environmental governance.

**Transitions to New Technologies Program (TNT)**
**Acting Program Director: Arnulf Grubler**

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**Guilherme De Paula**

**Supervisor:** **Arnulf Grübler**

**Research Project:** **Analysis of Historical Cost Reductions in Brazilian Ethanol Production**

**Abstract:** Biofuel is a very important technology for its potential to substitute gasoline and diesel and mitigate emissions of greenhouse gases. Sugarcane ethanol is considered more sustainable than alternatives such as corn ethanol and Brazil has become the largest producer of sugarcane, sugar, and sugarcane ethanol in the world after decades of government incentives in combination with favorable climate. The sustainability and expansion of the Brazilian ethanol program depends on continuous improvements in efficiencies and reductions in production costs as ethanol competes directly with gasoline. Recent increases in ethanol production costs have raised questions about the ability of this industry to fulfill its potential without additional government subsidies.

The proposed research project contributes to the important analysis and debate about the potential of sugarcane ethanol through a quantitative assessment of historical drivers of ethanol cost reductions. The objective of this project is to explain the significant cost reductions in sugarcane ethanol production in Brazil since 1975. The proposed approach for this analysis is to integrate an engineering model of ethanol production with an economic analysis of the determinants of ethanol production costs. Preliminary work suggests that there is large uncertainty about the time series of production cost for sugarcane ethanol in Brazil and the actual cost reductions could be a fraction of the numbers accepted in the literature. The proposed analysis will investigate alternative explanations for the historical efficiency improvements on ethanol production in Brazil.

**Biographical Sketch:** Guilherme DePaula earned his Bachelor of Engineering degree in Electrical Engineering from the Pontifical Catholic University of Rio de Janeiro. He worked for several years as management consultant in Brazil and as operations manager for an Electrical Utility in the United States. Guilherme received his M.Sc. degree in Environmental Economics in 2011 from Yale University and is currently a third year Ph.D. student at Yale. The title of his dissertation is “Modeling Agriculture Supply and Biofuel Expansion in Brazil.” His main fields of interest are environmental and energy economics.

**Transitions to New Technologies Program (TNT)**
**Acting Program Director: Arnulf Grübler**

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**Hana Nielsen**

**Supervisor:** **Arnulf Grübler**

**Co-Supervisor:** **Simon de Stercke**

**Research Project:** **Scaling dynamics and the role of institutions: new evidence on technology diffusion and scaling under changing political regimes**

**Abstract:** The relationship between technology and energy use, and consequently environmental impact, is important in the modeling of energy futures; and studies of the actual drivers and patterns of technological change in historical perspective represent an exciting research area. According to the evidence available, the process of transition to new technologies spans several decades and there is a strong relationship between the duration and extent of capacity expansion. Moreover, previous research has found that "technologies with a more pervasive effect in the market take more time to diffuse" (Bento, 2013). This is an important consideration given the current debates about the need for the next energy transition and the new post-fossil energy technologies.

The aim of my research at IIASA is to expand our knowledge in this field by investigating the scaling dynamics in a number of process industries and how unit capacity increased over time and with experience. By using time series data for a number of process industries (food, steel, cement, ammonia production, petrochemical industry, etc.) I will provide more historical evidence of the scaling patterns of technologies and what can be done to speed up adoption of new technologies. Apart from a wider perspective, to the extent possible the research will focus on the areas of former Czechoslovakia. By incorporating a comparative perspective with Western Europe it will be interesting to observe any potential impact of central planning on the adoption of innovation and on technology diffusion and scaling. In particular, the case of Czechoslovakia represents an interesting empirical study, as it offers a study of paths of technological change under two major economic systems—market-driven (until 1945) and centrally planned (1948-1989), followed by a rapid return to a market economy. Consequently, this case study can be seen as an example of institutional impact on the pattern of technology diffusion in a historical context and could potentially be used as a reference for technology policymakers.

**Biographical Sketch:** Hana Nielsen graduated from the Lund University where she received an M.Sc. in Economic Growth, Innovation and Spatial Dynamics. In 2012 she started her Ph.D. studies in Economic History at Lund with a focus on the role of energy in economic growth in a long-run perspective.

**Water (WAT)**
**Acting Program Director: David Wiberg**

**Qiuying Ding**

**Supervisor:** **Günther Fischer**

**Co-Supervisor:** **Laixang Sun**

**Research Project:** **Soybean production in China under climate change: Analysis of the effect of adaptive techniques based on DSSAT and AEZ-China model fusion**

**Abstract:** Soybean production is one of the main sources of edible vegetable oil and feed protein in China. In recent years the demand for soybean products has been increasing much faster than its domestic production, which has resulted in massive imports and reduced self-reliance, from about 60% in 1999-2001 down to just over 25% in 2008-2009. Soybean cultivation faces a wide range of production conditions in China and is rather sensitive to climate change. Understanding the impacts of climate change on soybean production potential has received much attention and has been studied by many researchers. However, what is currently lacking is the coupling of models across different spatial scales and the multi-scale evaluation of adaptive technologies both locally and across different cropping regions and the country.

The research will proceed in five steps: i) Establish a model coupling procedure between Decision Support System for Agro-technology Transfer (DSSAT) and the China Agro-ecological zone model (AEZ-China); ii) Calibrate DSSAT based on available research data covering 31 years (1981-2011) of site-specific observations of soybean growth and development; iii) Simulate soybean production with DSSAT and generate additional information for parameterization and verification of AEZ land utilization types; iv) Estimate soybean potential production, suitable planting area and other relevant agro-ecological information with the updated dataset and models for current (period 1981-2010) and future climates; and v) Analyze the effectiveness of possible adaptive measures to climate change such as using irrigation, adjusting planting dates or changing to new cultivars. This study will produce refined estimates of soybean production potential in China under future climate change, based on the latest available soybean research data and using a range of regional climate model projections. It will also give practical advice on strategies for adaption of soybean planting to future opportunities and risks of climate change.

**Biographical Sketch:** Qiuying Ding received her bachelor's degree in Geographic Information Systems (GIS) from LuDong University, 2012. She is currently a second-year master’s student at Shanghai Institute of Technology and Shanghai Climate Center. Her main scientific interests focus on the impacts of climate change on agriculture, especially on oil crops.

**Water (WAT)**
**Acting Program Director: David Wiberg**

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**Etienne Fluet-Chouinard**

**Supervisor:** **David Wiberg**

**Co-Supervisor:** **Sylvia Tramberend**

**Research Project:** **Global Assessment of Future Human- and Climate-induced Stressors of Wetlands**

**Abstract:** Wetlands are critical components of the global freshwater system, playing an important role both in biodiversity and human society. Wetland landscapes are being degraded at an alarming rate globally, with anthropogenic activities acting as the main driver of degradation. Proper assessment of present and future wetland habitat degradation is crucial for management and conservation actions to effectively preserve biodiversity and ecosystem services. However, no formal assessments of the contribution of climatic factors as future drivers of wetland degradation are currently available. The ongoing effort with respect to future stressors of riverine ecosystems provides an excellent opportunity to conduct parallel analyses specific to wetland habitats at the global scale.

My work at IIASA will be devoted to assessing scenarios of wetland condition and loss over the next 50 to 100 years. The assessment will be conducted through a spatial analysis of global datasets on wetlands combined with river discharge and human stressors under a range of scenarios. Future wetland extent will be predicted in response to change in river flow due to water consumption and climate change, and then overlaid with non-hydrological human induced stressors maps to identify areas of stressor co-occurrence. This project will yield a family of wetland extent and stressor maps generated from combining future maps of wetland extent and multiple classes of anthropogenic and climatic stressors. By identifying vulnerable regions of future wetland loss and stressor co-occurrence, the results from this analysis will provide critical input towards prioritizing wetland management efforts across the globe.

**Biographical Sketch:** Etienne Fluet-Chouinard received a B.Sc. in Environmental Geosciences from Université de Sherbrooke in 2009 and a M.Sc. degree in Geography from McGill University in 2012. He is now a second-year Ph.D. student of the Center for Limnology at University of Wisconsin-Madison. His research interests are centered on better understanding human-natural interactions in the global water system, particularly in large river basins. His doctoral dissertation focuses on the interactions between hydropower, riparian areas, and inland fisheries.

**Water (WAT)**
**Acting Program Director: David Wiberg**

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**Irene Nilsen**

**Supervisor:** **David Wiberg**

**Co-Supervisor:** **Michelle Van Vliet**

**Research Project:** **Assessing spatial and temporal patterns in energy fluxes during wet and dry extreme months using the NOAH land surface modelling scheme**

**Abstract:** As the climate and land surface in certain regions of Europe is drying or becoming wetter, certain feedback mechanisms may contribute to enhancing or reducing the effects on climate. For instance, soil moisture–precipitation feedbacks may act as a driving force to dry southern parts of Europe and to moisten northern parts. Understanding the partitioning of net radiation into turbulent sensible and latent heat fluxes is important in representing these processes.

In this project, NOAH will be run, using ERA-Interim forcing data for four years covering both extremely wet and dry periods for regions in southern as well as northern Europe. In the first part, maps of the Bowen ratio will be plotted to establish the distribution of turbulent fluxes for wet and dry conditions. Second, the results will be compared with precipitation and temperature trends found in my Ph.D. study to identify if possible concurrent changes in heat fluxes can explain the trends. The project contributes to understanding the driving forces controlling water availability which is important for water shortage mitigation.

**Biographical Sketch:** Irene Brox Nilsen is a second-year Ph.D. student in Hydrology at the Department of Geosciences, University of Oslo (UiO), Norway. Her Ph.D. project focuses on trends in the water balance and feedbacks between land and atmosphere under a changed climate. She received her master's degree from UiO on a project within stochastic hydrology. Before graduating in 2011, she worked on a project in Germany studying water infiltration in soils covered by different types of vegetation.

**Water (WAT)**
**Acting Program Director: David Wiberg**

**Shengfa Li**

**Supervisor:** **Laixang Sun**

**Co-Supervisor:** **Günther Fischer**

**Research Project:** **An estimation of the area of abandoned croplands in the mountainous regions of China**

**Abstract:** With the wages for migrant workers having increased dramatically (10-20% per annum) in China since 2003, more and more poor farmers have abandoned farmland and found jobs in urban areas. As a result in plain areas, agricultural machinery is being used intensively to replace the lost farm labor forces. However, this is not the case for croplands in the mountainous regions of China where mechanization is difficult due to the rough terrain; this has led to the abandonment of marginal croplands. According to our rural household survey data in Chongqing, a mountainous city located in southwest China, 15%-30% of croplands have been abandoned by farmers owing to the shortage of farm labor forces, not including the area reduced by the Chinese government's Grain to Green Project. The China Statistical Yearbook records that the gap in per capita incomes between urban and rural household increased in the last decades, which may lead to the continuing drain of farm labor forces in the future. Considering that mountainous croplands account for about 25% of total croplands in China, food security in China may be affected in the near future due to the reduction in grain areas as a consequence of the expected massive migration and loss of farm labor.

My research at IIASA aims to estimate the amount of abandoned croplands and how this will change in the future by applying a regression model based on panel data and IIASA's PDE model for counties in China's mountainous areas. The result will contribute to designing better informed agricultural policy in response to the ongoing processes of migration and aging in the mountainous rural regions of China.

**Biographical Sketch:** Shengfa Li received his Master's degree from Sun Yat-sen University, Guangzhou, China, in 2011. He is currently a first year Ph.D. student at Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences. The title of his thesis is "An Estimation of the Area of Abandoned Croplands in Chinese Mountainous Regions and its Influence on Food Security of China." His main fields of scientific interest include land use changes, land resource assessment, and land use policy.