IIASA

a new generation of scientists

YSSP

40th Anniversary

Young Scientists Summer Program

YSSP participants 2017

Biographical sketches and research project abstracts

Table of Contents

Arctic Futures Initiative

Maisa Nevalainen

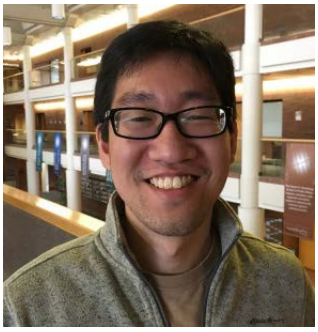
Supervisor: **Brian Fath**
Co-Supervisors: **Mia Landauer, Wei Liu**

Research Project: **Assessing the risk posed by oil spills to Arctic marine areas—Index-based approach for estimating vulnerability and sensitivity of Arctic biota**

Abstract: Climate change in the Arctic region has led to the opening of shipping routes, increasing Arctic maritime traffic and thus increasing the risk of an oil spill. Nevertheless, there are hardly any quantitative risk analyses of such occurrences, and there is insufficient understanding of the uncertainties related to both accidents and their consequences. There is an obvious need for analytical tools to quantitatively and systematically assess the impacts of Arctic oil spills on Arctic biota so that the risks of spills can be taken into account, in particular in terms of new sea routes and unexploited oil reserves. Through the development of literature-based indices, I will study the vulnerabilities (probability of oiling) and sensitivities (probability of dying because of oiling) of key Arctic functional groups in the face of an oil spill. The results are expected to comprise: i) a conceptual framework of the procedure involved in assessing the vulnerability and sensitivity of Arctic functional groups; and ii) quantitative assessments of vulnerability and sensitivity of selected key Arctic functional groups. The results will indicate the most vulnerable and sensitive functional groups in the Arctic (and whether this varies seasonally) and will also highlight the greatest knowledge gaps in order to guide future research. The results can be combined with oil spill models and species distribution models, hence enabling spatial Arctic risk analyses. Such analyses could concretely benefit the conservation of Arctic, as shipping routes could be designed based on the spatially and temporally varying risk and, in case of an accident, possible oil-combating resources could be allocated to areas with the highest ecological risk.

Biographical sketch: Maisa Nevalainen is a third-year PhD student at University of Helsinki, Finland. Her PhD is conducted under the Centre of Excellence for Arctic Shipping and Operations, which aims to ensure safe Arctic operations and transport. Her main focus is on environmental impacts caused by Arctic oil spills, while her main research interests include marine environment, environmental impacts of oil spills, and the use of Bayesian reasoning, especially when empirical data are limited or lacking altogether. Prior to starting her PhD, she received a BSc and MSc in Environmental Science from the University of Helsinki.

Air Quality and Greenhouse Gases Program (AIR)
Program Director: Markus Amann



Andrew Fang

Supervisor: **Fabian Wagner**
Co-Supervisor: **Gregor Kiesewetter**

Research Project: **Comparing new bottom-up city carbon footprinting plus PM2.5 dispersion model using the GAINS Model to assess carbon, air pollution, and health co-benefits in Chinese cities**

Abstract: Few models address carbon, air pollution, and health (CAH) co-benefits at the subnational scale. Cities—where there are large populations directly exposed to air pollution—are taking the lead in carbon mitigation at subnational scales. The goal of this proposed collaboration is to compare the GAINS approach with a new bottom-up city carbon footprinting plus air pollution dispersion (CFAD) model, developed by our team for Chinese cities. Comparing CFAD to the GAINS downscaling approach will enhance scientific understanding of how spatial scale and boundaries shape the quantification and uncertainty of CAH co-benefits. A hybrid approach may also be taken to more effectively represent the science behind the uniquely urban-scale infrastructure transitions to reducing carbon and air pollution emissions in Chinese cities. The new city CFAD model is novel in connecting city bottom-up transboundary GHG footprints of community-wide infrastructure provisioning across the 600+ urban areas in China, while quantifying the local air pollution and health benefits of reduced PM2.5 emissions through an air pollution dispersion model (AERMOD). The city CFAD approach allows for evaluation of cross-sectoral urban emission mitigation (urban-industrial symbiosis) strategies dependent on the co-location of residential, commercial, and industrial producers and consumers, such as industrial-waste heat reutilization through district heating systems. As it utilizes bottom-up data and models of energy-use activities occurring in individual cities, it addresses a finer-grained scale for cities in China.

Biographical sketch: Andrew Fang is a PhD student at the Center for Science, Technology and Environmental Policy (CSTEP) of the University of Minnesota Humphrey School of Public Affairs in. He expects to graduate in May 2018. His research focuses on the connection between greenhouse gas emissions and local air pollution in cities. Most recently, he has been estimating community-wide greenhouse gas emissions using various methodologies in US and Chinese cities, including Denver, Colorado, and will be working with IIASA this summer to compare methods for modeling PM2.5 concentrations in cities.

Air Quality and Greenhouse Gases Program (AIR)
Program Director: Markus Amann

Leila Niamir

Supervisor: **Gregor Kiesewetter**
Co-Supervisor: **Wolfgang Schöpp**

Research Project: **Assessing the macroeconomic impact of heterogeneous households' energy-saving behavior on air quality**

Abstract: There are several ways to achieve a transition to low-carbon economy, such as technological energy-efficiency solutions, switching to low-carbon energy sources, and behavioral change. While the impacts of the first two are readily traceable with the help of numerous macroeconomic, integrated assessment and technological models, quantifying the macro impacts and drivers of energy-related behavioral changes remains a challenge. It is also essential to consider any feedbacks between diffusion of energy-efficient technologies or low-carbon energy sources and behavioral responses in order to avoid any unforeseen and undesirable consequences (e.g., rebound effect). The transition to a low-carbon society is a complex process: economic, climatic, demographic, behavioral, and social factors all significantly impact on individual energy decision-making. Within YSSP, I aim to combine my ongoing research with IIASA's GAINS model to explore the effects of consumers' (heterogeneous households') energy choices and behaviors, such as installing solar panels, on reducing greenhouse gas (GHG) emissions. In this research, I intend to investigate the impact of feedbacks between the diffusion of new technologies such as solar panels, and households' behavior in energy consumption (electricity and heating), and consequently its impact on avoiding GHG emissions. In general, my work can be broken down into two stages: i) to develop a modeling framework that comprises several methods and tools within the same platform (namely, BENCH agent-based and GAINS models); and ii) to estimate the impacts of potential climate change mitigation strategies and energy policy scenarios, considering consumer behavior, within Integrated System of Models (ISM).

Biographical sketch: Leila Niamir received her MSc in Information Science and Knowledge Management from the University of Tehran in 2012. In 2013 she received an Erasmus Mundus scholarship for a post-graduate program in Geo-informatics, ITC, University of Twente in the Netherlands. She is currently a PhD student at the Department of Governance and Technology for Sustainability, University of Twente. From February 2014, she joined an EU FP7 project "COMPLEX" focusing on design and implementation of agent-based models for energy market in the context of low-carbon strategy. Her main scientific interests include agent-based modeling, economics of energy, economics of climate change, and modeling regime shifts.

Air Quality and Greenhouse Gases Program (AIR)
Program Director: Markus Amann

Karl Seltzer

Supervisor: **Jens Borken-Kleefeld**

Research Project: **Air quality and near-term climate impacts of equivalent climate policies**

Abstract: The co-benefits to air quality associated with climate policy are well documented. In such studies, a climate scenario is simulated and co-benefits from this climate trajectory are quantified. Subsequently, the coincidental co-emitted air pollutant reductions are quantified. This project proposes to evaluate how various climate policies with equivalent emissions of long-lived climate pollutants can yield varying impacts to air quality and near-term climate. This allows efforts to maximize benefits and/or to minimize costs to be explored by policy makers.

To accomplish this task, we start by analyzing one important sector in a major country, evaluating a set of low carbon transportation policies with equivalent CO_2. Since current battery technology for vehicles is already capable of meeting the demands for ~87% of vehicles in the USA and an increase in the overall demand for electricity can substantially help the continued expansion of renewable sources of energy, the foundation of the project is widespread electric vehicle dispatch. The low carbon transportation policies analyzed for this task and for the USA are increased fuel efficiency standards, an increased dispatch of electric vehicles charged by generators proportional to current energy portfolios, and a larger dispatch of electric vehicles charged exclusively by renewable energy sources. To quantify the air quality impacts of such policy in more polluted regions, this scenario will also be evaluated for China. Tools involved in this analysis will include the GAINS model, to convert policy to emissions, and chemical transport models (GEOS-Chem and GISS modelE2), to convert emissions to concentrations/impact metrics.

Biographical sketch: Karl Seltzer is currently a third-year PhD student in the Earth and Oceans Sciences Department at Duke University in Durham, North Carolina (USA). His research interests are atmospheric chemistry, climate change, and numerical modeling; his thesis focuses on the impacts of climate policy on air quality and near-term climate forcers. Prior to his arrival at Duke, he attended the University of Florida in Gainesville, Florida (USA).

Air Quality and Greenhouse Gases Program (AIR)
Program Director: Markus Amann

Nannan Zhang

Supervisors:	**Wilfried Winiwarter**
Co-supervisor:	**Zbigniew Klimont**
Research Project:	**Analyzing costs and benefits of options to reduce NH_3 emission from dairy production in China**

Abstract: Ammonia (NH_3) in the atmosphere is an important precursor of inorganic aerosols, and its deposition can cause adverse effects on ecosystems. Ammonia emissions over China are particularly large due to intensive agriculture activities. Dairy production in China has significantly increased following the "open policy" instigated during the 1980s. The dairy industry contributes a large proportion of ammonia emissions. However, current dairy production structures are still complicated with large differences in the feed regimes and manure management. Moreover, most of the previous estimations of ammonia emissions were based on parameters from developed countries rather than locally measured data. In the next few decades, China will require more milk to meet the growing demands of an increasing population and higher incomes. The challenge here is to produce enough milk to meet the additional milk demand without further increasing NH_3 emissions and to identify the cost and benefits of mitigation options. The main objectives of the proposed study are to assess the potential of options for reducing ammonia emissions from dairy production in China, as well as assess their related environmental benefits and economic costs. Local information about abatement options available specifically for the Chinese farming systems will be collected and updated to the GAINS and NUFER models to evaluate the impacts of these abatement options on NH_3 emissions, as well as on N_2O and CH_4 emissions at regional levels under different scenarios. Further pathways for the abatement options will be discussed based on their economic costs.

Biographical sketch: Nannan Zhang graduated from the University of Chinese Academy of Sciences, China in 2012 with a Master's degree in Biotechnology Engineering. Her third-year project was related to soil carbon emissions and characteristics of soil organic carbon in the 38^o N Ecological Transect of Hebei Province. She is currently a second-year PhD candidate at the Center for Agricultural Resources Research, Institute of Genetics and Developmental Biology, Chinese Academy of Sciences. Her PhD study is associated with GHG and NH_3 emissions and mitigation from dairy production in China.

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

Vanessa Haller

Supervisor: **Elena Rovenskaya**

Research Project: **Optimizing the functional grouping of species in ecosystem models**

Abstract: Coral reefs are complex ecosystems that are exposed to multiple interacting threats (e.g., sedimentation, bleaching, and fishing). However, these threats are usually managed individually, without consideration for any interactions between these threats that may change their ecological impact. My PhD aims to investigate threat interactions and prioritizing their management using a coral reef ecosystem model. Specifically, it will develop a new ecosystem model based on the mechanistic description of functional group interactions. While functional groups in ecological theory are still debated and the variability within functional groups is unknown, they are essential for this analysis, as species-level networks are too complex to track uncertainties. My YSSP project aims to optimize the functional grouping of species (i.e., number of nodes) within the energy-flow network to overcome the challenges of species-level networks. This optimization will attempt to merge species into groups while keeping predictions about the interactions of these threats stable, thereby negating sole reliance on ecological theory. This will create a less complex model while simultaneously validating functional groups from the literature and giving estimates of variability within each functional group. Overall, by validating the functional groups and the variability within these groups, the project will enable better uncertainty analysis in the remainder of my PhD.

Biographical sketch: Vanessa Haller graduated from James Cook University, Queensland, Australia, with a Bachelor of Science with Honours in Marine Biology in 2014. She is currently in the second year of a four-year PhD program at James Cook University working with the Centre of Excellence for Coral Reef Studies and the Australian Institute of Marine Science. Her academic interests are based on population or ecosystem models and specifically the uncertainty encompassed within these models. Her PhD thesis is utilizing an ecosystem model for coral reefs to evaluate the potential impacts and management of multiple threats.

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

Lavinia Perumal

Supervisor:	**Matthias Jonas**
Co-Supervisor:	**Wei Liu**
Research Project:	**Assessing the impact of transport infrastructure on natural capital**

Abstract: Infrastructure development such as transport corridors is important for meeting the UN 2030 Sustainable Development Goals. However, development approaches, if conducted without careful mitigation of ecological impacts, may also be the greatest threat to the ecosystems on which all of humanity relies. Globally, more than 25 million kilometres of new transport developments are expected by 2050, but the majority of construction will take place in developing countries and will include many ecologically important and sensitive areas. Transport infrastructure extending into ecologically sensitive areas is a major driver of habitat destruction and loss of ecosystem degradation. My research aims to understand the complex interactions that exist between and within social-ecological systems with a particular focus on the impact of extensive transport infrastructure development. We will adopt a systems approach to investigate the natural capital impact of major road and railway development projects in selected African regions. This will be conducted through the development and application of a composite natural capital impact index to estimate the effects of proposed development projects. This work will make a significant contribution to understanding the complex relationships that exist between transport infrastructure development, land cover change, and concomitant changes and loss of biodiversity, ecosystem functions, and services across various spatial scales.

Biographical sketch: Lavinia Perumal received a BSc Honours in Environmental Science from the University of KwaZulu-Natal in 2013 and an MSc in ecology from Rhodes University, both in South Africa, in 2016. She is currently a first-year PhD candidate at the University of Cape Town in South Africa. Her PhD work focuses on assessing the ecological impacts of road and railway infrastructure in selected African regions. Her main research interests are assessing and understanding global change biology and climate change adaptation in African regions.

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

Ming Ren

Supervisor:	**Yurii Yermoliev**
Co-Supervisor:	**Tatiana Ermolieva**
Research Project:	**Research on technology development paths of the iron and steel industry in the Beijing-Tianjin-Hebei Region of China under resource and environmental constraints**

Abstract: China is the world's largest iron and steel producer, with the Beijing-Tianjin-Hebei region accounting for nearly one-third of China's iron and steel production. Rapid production has been driven by the growth of the economy, construction, infrastructure and manufacturing industries. However, iron and steel production consumes large quantities of energy primarily from coal resources, which leads to extensive greenhouse emissions, emission of air pollutants, and water consumption. The central government has introduced powerful policies to support the introduction of advanced steel production technologies, in particular, those with lower energy and water consumption, in order to reduce over-reliance on coal in this area. Against this background, technologies using natural gas can considerably or even completely substitute for coal, increasing productivity and decreasing production costs. Among the gas suppliers is the project, "Power of Siberia": liquefied natural gas (LNG) can be considered as an essential energy resource option to enable gas transportation and gas storage. The Yamal LNG project of Russia can be a LNG supplier. Storage of LNG enables gas to be preserved and delivered when most needed, for example, hedging market risks. The aim of the model is to explore the optimal and robust technological development path of the iron and steel industry to 2050 in the Beijing-Tianjin-Hebei region, identifying the advantages of the "with natural gas" and "without natural gas" technological options.

Biographical sketch: Ming Ren graduated from China University of Mining and Technology, Beijing (2014) from the Master's program. She is a third-year PhD student at the School of Management of the same university and is majoring in Management Science and Engineering. Her research focus is on resources and environment, industrial energy saving, and emissions reduction. She is also interested in uncertainty analysis stochastic optimization.

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

Nemi Vora

Supervisor: **Brian Fath**

Research Project: **Understanding the US Food-Energy-Water nexus through quantifying opportunities and interventions in food trade networks**

Abstract: Integrated management of food, energy, and water (FEW) resources has been globally advocated to mitigate unintended consequences of favoring one resource over another. FEW systems are highly interdependent, interconnected, and exhibit numerous interactions at distinctive spatial scales. This analysis will address FEW systems through the food production perspective for the United States (USA). Food trade is an integral component of food supply and security. Food trade also presents pathways for transferring vast quantities of embodied resources and emissions associated with food production. Irrigation adds significant value to food and feed production in the USA and provides a crucial link to study the domestic FEW systems. Food trade and associated virtual trade of impacts can be evaluated through network analysis so that the structure of these interconnected systems can be understood under series of interventions. To this end, I will use publicly available datasets to develop weighted and directed networks of interstate food trade and associated environmental impacts within the USA. The topology, robustness, and implication for cascading impacts will be characterized through applying relevant network measures and matrices from diverse network disciplines. Furthermore, a range of possible technology and policy interventions, including changes in irrigation practices, energy mixes, and spatial changes in food production patterns, will be explored to understand the effects of interconnected systems and their implications for systemic risks. This work will facilitate understanding of the benefits and limitations involved in evaluating the resilience of FEW systems through a nexus perspective.

Biographical sketch: Nemi Vora is a second-year PhD candidate at the Department of Civil and Environmental Engineering at University of Pittsburgh, USA. Her research interest areas include sustainable engineering and life cycle assessment, industrial ecology, network science, and statistical analysis. She is specifically interested in using open data to understand environmental impacts of food production systems. She received her MS in Environmental Engineering from Carnegie Mellon University, USA (2014) and BE in Environmental Engineering from Gujarat Technological University, India (2013).

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

Saige Wang

Supervisor: **Brian Fath**

Research Project: **Regional Energy–Water Nexus within China**

Abstract: Water and energy are recognized as indispensable inputs to economic activities and highly interwoven with regional development. A large amount of energy and water flows embodied in economic activities are transferred via the trade of products and services, and these shape the intrinsic connection between energy and water. The geographic distribution of China's water resources is uneven, which affects energy development choices. Tracking energy and water flows among regions and quantifying their interdependencies are fundamental for coordinative management of these two essential resources. In this project, we build an accounting framework to assess the impact and system properties of the energy–water nexus networks within China. We inventory the water consumption for different energy types, and energy consumption for all stages of water use for different regions. The direct and indirect energy and water embodied in monetary flows among 30 regions in China for 2012 are then calculated via multiregional input–output analysis to build the following combinations: i) embodied energy network; ii) embodied water–related energy network; iii) embodied water network; and iv) embodied energy–related water network. Finally, a set of ecological network analysis indices are used to analyze the properties and connection of these four networks to explore the properties of the nexus networks and sectoral nexus impacts. The regulating pathways for each region to integrate their nexus management will also be identified. The proposed nexus network approach may help bridge the gap between nexus modeling and regional resource management.

Biographical sketch: Saige Wang has been a PhD candidate majoring ecological modeling at the School of the Environment, Beijing Normal University since 2015. Her current research focuses on the energy–water nexus issues at the city, metropolitan, and national levels using a systems perspective. Her research interests include: system dynamic analysis, input-output analysis, ecological network analysis, energy analysis, footprint analysis, and life cycle analysis for economic-ecological systems. She is also interested in China's energy-water coordinative management policy-making processes.

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

Perla Catalina Chaparro Pedraza

Supervisor:	**Ulf Dieckmann**
Co-Supervisor:	**Mikko Heino**
Research Project:	**Fisheries-induced life-history evolution in anadromous stocks**

Abstract: Atlantic salmon and other salmonid species are threatened by anthropogenic disruptions, including overfishing, habitat degradation and fragmentation, and global shifts in climate. Given the economic and cultural importance of these species, different policy measures have been taken to accomplish their conservation and sustainable exploitation. In particular, high-seas salmon fisheries were prohibited in the 1990s, with catches thenceforth allowed only during the spawning migration. The resultant shifts in mortality regimes have likely impacted the evolution of life-history traits in Atlantic salmon. For instance, the timing of the habitat switch from the early juvenile habitat in rivers to the pre-maturation years in the ocean is subject to natural selection. In the ocean, salmonids experience increased food availability that elevates the energy they can allocate to growth and energy reserves. An early habitat switch thus enables high energy reserves and consequently raises fecundity. However, small-sized salmon face elevated mortality from predation in the ocean. Conversely, a late habitat switch increases body size and consequently reduces predation risk after migrating to the ocean. I will investigate the effects of fishing on this fecundity-survival tradeoff, to predict fisheries-induced life-history evolution under different mortality regimes, including those before and after the prohibition of high-seas salmon fisheries. For this purpose, I will use an adaptive-dynamics approach in conjunction with physiologically structured population models. The results of this research will contribute to understanding the effects of fishing mortality and conservation policy on the evolution of anadromous species such as Atlantic salmon, which is key for their conservation and sustainable exploitation.

Biographical sketch: Catalina Chaparro graduated in 2012 and 2013 with Bachelor's degrees in Biology and Environmental Engineering from the Universidad de los Andes in Bogotá, Colombia. She then obtained her MSc degree in Biology from the same university, working in the Mathematical and Computational Biology Research Group. She is currently a third-year PhD student in the Theoretical Ecology Group at the Institute of Biodiversity and Ecosystem Dynamics of the University of Amsterdam, the Netherlands, where she investigates the ecology and evolution of migration of physiologically structured populations.

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

Daniel Cooney

Supervisor:	**Ulf Dieckmann**
Co-Supervisor:	**Karl Sigmund**
Research Project:	**Emergence of efficient extraction in social-ecological models for common-pool resources**

Abstract: With a majority of the world's fisheries either exhausted or diminished due to overfishing, the problem of designing mechanisms for managing common-pool resources has gained important practical relevance. While the ecological theory for harvesting renewable resources demonstrates the existence of a socially optimal level of resource extraction, individual fishers have an incentive to extract at a faster rate in order to sell more fish. This is an example of the 'tragedy of the commons,' through which a group of rationally acting individuals overexploit a resource and consequently are worse off than a group that extracts at the socially optimal level. One way to resolve this social dilemma is the establishment of a social norm by which extractors punish those who overexploit. Recent work has shown that such a social norm makes socially optimal extraction an evolutionarily stable strategy, meaning that an established group of socially optimal extractors cannot be invaded by overexploiters. However, a relevant question to ask is whether socially optimal extraction can emerge in a group that starts out with different extraction levels. To explore this question, we will consider a general framework for describing the distribution of extraction levels in a group of fishers and investigate how they adjust their extraction levels in response to the competing incentives of catching fish and avoiding punishment for overfishing. We will employ a range of analytical approaches, including adaptive dynamics, mean-field games, and landscape gradient dynamics, to examine whether groups of fishers can achieve socially optimal resource extraction in the long-run.

Biographical sketch: Daniel is a second-year PhD student in the Program for Applied and Computational Mathematics at Princeton University, USA. He received a Bachelor of Arts in Mathematics with a Secondary Field in Economics. Daniel works with Professor Simon Levin and is interested in using probability theory and partial differential equations to explore the evolution of cooperation and emergent phenomena in biological systems with competition at multiple scales.

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

Sara Loo

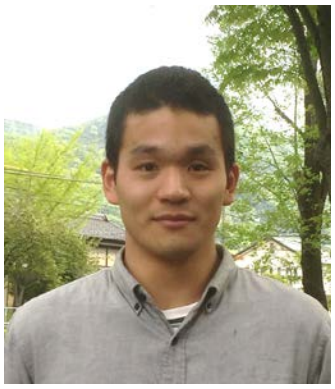
Supervisor: **Karl Sigmund**
Co-Supervisor: **Ulf Dieckmann**

Research Project: **Cultural evolution of low fertility at high socioeconomic status**

Abstract: The cultural evolution of fertility from high to low, in response to improvements in socio-economic status, has been of increasing interest to evolutionary biologists. It seems intuitive to assume that greater wealth enables a large amount of wealth to be endowed to offspring, which would imply high fertility at high socio-economic status. In many developed countries, however, the converse is true, with negative correlations being observed between socio-economic status and fertility. Investigations into the mechanisms underlying this cultural evolution need to consider not only trade-offs between the quantity and quality of offspring, but also the effects of status-seeking and social learning on the fertility decisions of parents. We aim to build on previous work in the EEP Program by refining and analyzing a cultural-evolution model for understanding conditions under which low fertility emerges at high socio-economic status. In particular, we will investigate three extensions through which (i) the disposable wealth of parents depends on their own socio-economic status and on their parent generation's endowment to offspring, (ii) parents base their fertility decisions on decisions of other parents with similar socio-economic status, and (iii) role models for fertility decisions are chosen probabilistically across the whole range of socio-economic status with a gradual preference for imitating parents with high-socio economic status. We hope these extensions will provide a richer understanding of the mechanisms that drive the cultural evolution of low fertility at high socio-economic status.

Biographical sketch: Sara Loo graduated from the University of Wollongong, Australia, in 2014, with a Bachelor of Medical Mathematics Advanced Honours. She is currently a third-year PhD candidate at the University of Sydney, Australia, where her research focuses on the evolution of uniquely human behaviors. Her main scientific interests lie at the intersection of mathematics and dynamical systems, considering different hypotheses about human evolution embedded within anthropology. She has investigated the evolution of pair-bonding in humans, and in choices of food acquisition and sharing within hunter-gatherer populations as driven by status tradeoffs. She remains invested in the exploration of patterns of behavioral evolution as pertains to male strategic choice.

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



Takuji Oba

Supervisor:	**Åke Brännström**
Co-Supervisor:	**Hans Metz**

Research Project: **Towards enhanced realism in models of biodiversity evolution**

Abstract: Human activities are increasingly affecting ecosystems and the services that they provide. Mathematical modeling helps to understand and predict the dynamics of ecosystems and the evolution of biodiversity. Many of the commonly used models descend from traditional predator-prey models, in which interactions with other species are represented as a weighted sum over species abundances. While these models are used to study the evolutionary emergence and maintenance of ecosystems, it remains unknown how the simplified representation of interaction intensities as weighted sums affects the results. The aim of this project is to investigate how this assumption influences the ecological and evolutionary dynamics in models of biodiversity evolution. I will approach this aim from two complementary directions: i) by investigating analytically how the weighted-sum assumption affects key properties of the dynamics for a general class of models; and ii) by investigating numerically how this assumption influences the dynamics in one or more prominent models of biodiversity evolution. The former approach promises to give insights that allow us to assess the plausibility of any given model, while the latter will reveal how the weighted-sum assumption affects biodiversity evolution in specific models.

Biographical sketch: Takuji Oba is currently a second-year PhD student in the Graduate School of Informatics at the Kyoto University, Japan, where he also completed his Bachelor's degree at the Science Faculty and his Master's degree at the Graduate School of Informatics. His doctoral research focuses on revealing and constructing mathematical foundations of evolutionary dynamics. His main fields of interest are adaptive dynamics, eco-evolutionary dynamics, and mathematical and statistical analysis.

Energy Program (ENE)
Program Director: Keywan Riahi

Karl-Kiên Cao

Supervisor:	**Volker Krey**
Co-Supervisor:	**Daniel Huppmann**

Research Project: **A novel method for incorporating power exchange limitations into energy system models and the impact of spatial aggregation**

Abstract: Energy system models need to be simplified so that their complexity does not scale with the complexity of the system being analyzed. One of these simplifications is the aggregation of spatial data; however, this goes hand in hand with overlooking possible transmission grid congestion. For energy systems that rely on high shares of renewable energy sources, electricity transmission can also become crucial between small regions, especially if it is limited. I thus develop a methodology that estimates network congestion by evaluating nodal price differences of a spatially highly resolved energy system model. The objective of the research project is to deliberately define spatial aggregations while maintaining information regarding limited electricity transmission capabilities.

Biographical sketch. Karl-Kiên Cao graduated as Bachelor in Electrical Power Engineering at the Baden-Wuerttemberg Cooperative State University, Mannheim, Germany, in 2010. He received his MSc in Electrical Engineering and Information Technologies at the Karlsruhe Institute of Technology. Since 2013 he has been working at the German Aerospace Center, Institute of Engineering Thermodynamics, in Stuttgart. The working title of his PhD thesis is “Analysis of long-term scenarios for transmission grid expansion in the German and European power system.” His main fields of scientific interest include power system optimization, transmission grid modeling, and speed-up approaches for large linear optimization models.

Energy Program (ENE)
Program Director: Keywan Riahi

Esperanza González

Supervisor:	**Alessio Mastrucci**
Co-Supervisor:	**Narasimha Rao**
Research Project:	**Assessment of technical and economic feasibility of nearly Zero Energy Buildings in the Brazilian buildings sector**

Abstract: Brazil will face challenges in the coming years with respect to both the current household deficit (around 6 million units in 2014) and the expectation of about 24 million new households by 2022. This means that the Brazilian energy supply system must meet a substantial and growing demand for energy. The energy supply system will have its own problems in terms of its future higher dependence on hydroelectric plants and the lower remaining hydroelectric-generation potential. Some findings from energy supply optimization models show a higher penetration of fossil fuels in the next few years. Energy planning in Brazil should not only take into account the expansion of the supply sector but also consider a holistic planning approach, which includes interventions at the end-use level. The main objective of this proposal is to investigate relevant pathways for provision of nearly Zero Energy Buildings (nZEB) and renewable energy integration in the residential sector until 2050 to cover both the household deficit and the growing energy demand. The research will use a quantitative method involving interactions of micro and macro approaches. The micro approach considers a model in GAMS (BL-GAMS), which allows the optimal capacity and operation of on-site generation technology configuration to be obtained in a nZEB, as well as its costs. The macro approach uses the MESSAGE model, which will be useful to determine the penetration of nZEB per Brazilian region, under different scenarios.

Biographical sketch: Esperanza González is a fourth-year PhD student and researcher at the Energy Planning Program of the Federal University of Rio de Janeiro in Brazil. She holds a Master's degree in Energy Planning, a Bachelor's degree in Economy and a Postgraduate Diploma in Statistics from the National University of Colombia from the same University. She has worked in the energy consulting and regulatory field in institutions such as the Regulatory Agency for Water and Sanitation (CRA), Planning Unit Mining and Energy of Colombia, Ecopetrol S.A., and the Colombian Energy Observatory. Her research topics focus on energy optimization modeling, renewable energy, integrated assessment modeling, and climate change.

Energy Program (ENE)
Program Director: Keywan Riahi

Ryan Hanna

Supervisor:	**Daniel Huppmann**
Co-Supervisor:	**Shinichiro Fujimori**

Research Project: **The impact of microgrid adoption on greenhouse gas emissions from the electric power sector**

Abstract: Technology, policy, and market forces are combining to make microgrids economically viable within some modern electric grids. As industry forecasts point to significant future growth, and with some calling for decentralized grids, it is critical to understand the potential impacts of these systems—in particular on patterns of electricity provision and consumption and on greenhouse gas emissions. The latter may have profound implications for deep decarbonization efforts.

In my work, I am studying the impact of distributed microgrid systems—implemented by private adopters who seek private benefits like better service reliability—on marginal greenhouse gas emissions from the electric power sector. Further, I am looking at how various policy levers, such as a carbon tax or special tariffs designed for distributed energy systems, might alter emissions and economics. These studies use a new bi-level optimization model that provides least-cost investment and operation of distributed energy resources in microgrids and, importantly, includes value streams from providing energy locally and increasing reliability. A large part of my doctoral work to date has been creating that model. I am exploring the market conditions under which microgrid adoption is economical, the impact of adoption on emissions, and how policy levers might affect outcomes for technology diffusion, economics, and emissions.

Biographical sketch: Ryan Hanna is a Ph.D. candidate at the University of California, San Diego (UCSD) in mechanical engineering (expected graduation spring 2018). He is affiliated with the Center for Energy Research and Deep Decarbonization Initiative at UCSD. His research interests include modeling, optimization, and simulation of distributed energy systems—in particular, microgrids. Much of his research has focused on how to quantify and value reliability in microgrids. He is interested, in particular, in how engineering, economics, and policy interact in the electric power industry as the grid decarbonizes and decentralizes.

Energy Program (ENE)
Program Director: Keywan Riahi

Gibran Vita

Supervisor:	**Narasimha Rao**
Co-Supervisor:	**Jihoon Min**

Research Project: **The dynamics of stocks or flows for environmental impact and human development**

Abstract: Stocks, flows, and services are all interrelated and co-evolve throughout socioeconomic transitions. For example, stocks of capital (durable goods), such as vehicles and buildings, require flows (consumable goods) such as energy and other services (e.g., human labor) in order to be operational. The evolution of these variables has different environmental consequences, implications for natural resources, and contributions to human well-being that are not fully understood. In this research we use a model for the global economy and resources from a supply chain and life cycle perspective (EXIOBASE, an Environmentally Extended Multi Regional Input-Output model). The purpose is to study the economic and material transitions in developing countries to understand how households change through time in their use of capital (e.g., appliances), their need for consumables (electricity) and services (child care, health care), and the implications for the quality of life of citizens. Understanding societal change from a systems perspective that combines economic growth, human development, and the environment has implications for the pathways we choose to achieve the sustainable development goals.

Biographical sketch: Gibran Vita holds and engineering degree in Bioengineering from the Monterrey Institute of Technology and Higher Education (ITESM) in Mexico. In 2013 he completed the Erasmus Mundus MSc in Industrial Ecology and received a joint degree from Chalmers University of Technology in Sweden and the University of Graz in Austria. He is currently a PhD candidate at the Norwegian University of Technology (NTNU) where he works for European projects based on interdisciplinary research to understand the global relations between consumption lifestyles, natural resources, and well-being.

Energy Program (ENE)
Program Director: Keywan Riahi

Yaoping Wang

Supervisor:	**Edward Byers**
Co-Supervisor:	**Simon Parkinson**
Research Project:	**Investigation of the water use of power plants under changes in water temperature and availability**

Abstract: The electricity generation sector faces the challenge of meeting increasing electricity demand under changing hydrometeorological conditions. One step toward planning under this challenge is to better understand the water use of power plants. This project will model the evolution of water use by power plants under different Shared Socioeconomic Pathways (SSPs), considering the potential effects of water temperature, technological change, and leapfrogging in developing countries. We will use a process-based model for water use by power plants that is part of the MESSAGE Integrated Assessment Model at IIASA, in conjunction with data acquired and processed by Ms. Wang that show an improvement in water-use intensity over time. The effect of water temperature will be examined by using a gridded temperature dataset. The leapfrogging investigation will investigate if the water-use intensity in developing regions: i) gradually improves along the same trajectory as in the United States; or (ii) improves more rapidly on the "learning curve." The results of this research will contribute to the ability to more accurately model water use by power plants and also to integration of water resources and energy planning, especially under changing technological and climatic conditions.

Biographical sketch: Yaoping Wang graduated from Beijing Normal University, China, in July 2012 with a Bachelor's degree in Environmental Science. She is a fifth-year PhD candidate in the Environmental Sciences Graduate Program at The Ohio State University, where she is advised by Prof. Jeffrey M. Bielicki (YSSP '06). Her main scientific interests include the post-processing of climate model outputs, modeling the linkage between hydrometeorological variables and the demands on resources in the electricity system, and understanding the implications of the evolution of demands on future planning. Her main non-scientific interests include all things related to "Middle Earth."

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

Hadi

Supervisor:	**Andrey Krasovskii**
Co-Supervisor:	**Ping Yowargana**
Research Project:	**Generating and analyzing three decades of gradual changes in high-resolution forest cover in the humid tropics of Indonesia**

Abstract: In 2015 a historical international climate agreement was reached in Paris, and forests are central to the climate solutions prescribed. A standalone article of the agreement urges countries to support activities relating to reducing emissions from deforestation and forest degradation (REDD+), the second largest source of global CO_2 emissions. Much of the forest destruction occurs in the tropical region; it has been estimated that tropical forest conservation and restoration could provide half of the target net emission reductions. One enabling technology in urgently combating tropical forest deforestation is remote sensing, by mapping and monitoring the vast forest area using satellite images taken periodically by the Earth observation (EO) satellites. EO data, particularly from the Landsat mission, have been used to map stand-replacing forest cover change (i.e., deforestation) at high spatial resolution globally. The approaches typically looked at changes at two points in time (bi-temporal change) based on annual or epochal (multi-year) composites of single-best cloud-free observations. These approaches are, however, not able to detect: i) transient changes between the composite periods such as plantation establishment; and ii) gradual changes (i.e., forest degradation—the other "D" in REDD+), and regrowth. Within the REDD+ context, there remains a significant uncertainty in carbon accounting concerning these undetected processes. This research aims to test the possibility of utilizing the full temporal resolution of the Landsat data archive to monitor gradual dynamics in the humid tropical forest of Indonesia.

Biographical sketch: Hadi completed an Erasmus Joint Master's degree with an EU scholarship in geoinformation science and Earth observation for environmental modeling and management at Lund University, Sweden, and University of Twente, the Netherlands, in 2015. He is currently a second-year PhD student in geoinformatics at Aalto University, Finland, and aims to graduate in late 2018. The title of his thesis is "remote sensing of canopy structure in boreal and tropical forests." His main fields of scientific interest include remote sensing (optical, radar, lidar) of the biophysical and biochemical properties of vegetation using statistical and physically based models in different biomes, with a special interest in the humid tropical forests of Southeast Asia, where he is from.

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

Milton A. Uba de Andrade Junior

Supervisor:	**Hugo Valin**
Co-Supervisor:	**Aline Soterroni**
Research Project:	**Exploring future land-use change impacts of the ethanol sector development in Brazil**

Abstract: Brazil is the world's largest sugar producer and exporter and the second-largest ethanol producer. In 2014-15 Brazil's sugarcane plantations occupied a total area of 9.13 million hectares, a growth of 3.6% compared to the previous year. According to the UN Conference on Trade and Commerce (UNCTAD) Brazil has the potential to produce 10 billion liters of second-generation (2G) ethanol by 2025.The future expansion of ethanol production in Brazil has the potential to cause both direct and indirect land-use changes (iLUC). In this research, we assess and analyze the complete future impacts of land-use change resulting from the production of ethanol in Brazil. To this end, we spatially project Brazil's land-use change and agricultural outputs through 2050, taking into account national policies for biofuel production as well as external trade and exogenous drivers such as gross domestic product (GDP) growth, population growth, and dietary trends. Our approach is based on the GLOBIOM-Brazil, a bottom-up global economic partial equilibrium model of the agriculture, forestry, and bioenergy sectors. Results are expected to suggest possible mitigation strategies in terms of deforestation and carbon emissions. We also aim to quantify the relative impacts of 1G and 2G ethanol production. Possible links and synergies between the cattle ranching and ethanol sectors will also be explored.

Biographical sketch: Milton Uba de Andrade is a second-year PhD student at The University of Queensland, Australia. His research project aims to analyze strategies to reduce land-use change impacts and the influences on food security of meeting sugarcane ethanol demand in Brazil, considering supply-side and demand-side measures. He has a MSc in Environmental Engineering from the Federal University of Santa Catarina, Brazil, focused on life-cycle assessment of waste management systems. Since 2009 he has been a technical analyst of the State Department of Sustainable Economic Development in Santa Catarina, Brazil, supporting governmental policy, schemes, and decision making in the areas of sanitation and the environment.

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

Cécile Godde

Supervisor:	**Petr Havlík**
Co-supervisor:	**David Leclère**

Research Project: **Intensification of grazing systems: Challenges and opportunities**

Abstract: Sustainable grazing-system intensification consists of increasing grazing livestock production without increasing land area or creating unmanageable social, economic, and environmental trade-offs. This approach is hypothesized to be a key solution in terms of continuing to provide livestock products to a growing human population while decreasing the environmental impact of our societies and sparing land for other uses. However, grazing systems around the world are diverse and complex, each with a unique agro-ecological, geographical, historical, political, social, and cultural context. Consequently, the feasibility and the socioeconomic and environmental impacts of grazing-system intensification need to be assessed in these complex contexts. This project, using grassland and grazing models including the Global Biosphere Management Model (GLOBIOM), aims to estimate the potential for grazing-system intensification and to understand the environmental, economic, and social trade-offs of the intensification processes. We also aim to identify optimal policy interventions for climate change mitigation within the larger Agriculture, Forestry, and Other Land Use (AFOLU) framework. The overall objective of this study which focuses on both global and regional contexts, is to target policy interventions that move us closer to achieving sustainable grazing systems.

Biographical sketch: Cécile Godde graduated in 2014 from AgroParisTech (France) with a Master's in Agricultural and Environmental Sciences. She is currently a second-year PhD candidate at CSIRO and The University of Queensland in Brisbane. She is passionate about the challenges relating to agriculture, food security and global change, at the farm level and in a national and global context. Through her work, she wishes to have a concrete impact on decision making to feed the world more sustainably and equitably, now and in the future. Her main scientific interests include: agricultural intensification, yield gap analyses, grazing systems dynamics, drivers and trade-offs (social, economic, biodiversity, soil carbon, greenhouse gas emissions), land-use dynamics, climate change and climate variability (impacts, adaptation and mitigation). Prior to starting her PhD, she gained other international experiences working for CSIRO and Greening Australia (Australia), the International Livestock Research Institute (Costa-Rica), MARS Inc. (Brazil), and the French governmental agency for organic agriculture-Agence BIO (France).

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

Örjan Grönlund

Supervisor:	**Fulvio Di Fulvio**
Co-Supervisor:	**Nicklas Forsell**

Research Project: **Spatially explicit assessment of management strategies in forest areas suitable for nature conservation in Sweden**

Abstract: The dominant use of Swedish forest land is highly efficient forestry based on clearcutting and replanting of a few tree species. However, a significant share of Swedish forest land is intended for natural conservation. From a forest management perspective, there are two main conservation approaches—forest stands left to free development and stands in need of active management to maintain their value. Even though the latter alone probably amount to more than 0.5 million hectares, there are no comprehensive national data on these areas, on applied management strategies, standing biomass volumes, conservational values, or need for management of these stands. The aim of this project is to combine the Global Forest Model (G4M) and qualitative descriptions of stands suitable for nature conservation in order to identify different stand types in Sweden, including their locations, management options, carbon stocking, biological richness, and the potential removal of woody biomass. Data on management of nature conservation areas from a sample of Swedish forest companies and spatially explicit information on biophysics, biodiversity, and socioeconomics will be combined in a Multi-Criteria Analysis performed in a Geographic Information System. The project is expected to create a high-resolution map of current nature conservation forests in Sweden, as well as indicate potential areas and needs for management in the existing and potential conservation areas. The aim is to increase knowledge and to define the value of nature conservation areas in Swedish forestry and also to improve the downscaling of the G4M for mapping nature conservation forests.

Biographical sketch: Örjan Grönlund has a forestry MSc from the Swedish University of Agricultural Sciences. He spent two years studying political science, sociology, and rhetoric. He has been employed at the Forestry Research Institute of Sweden since 2012 involved in several projects concerning forest bioenergy. He is a forestry PhD student enrolled at the Department of Forest Biomaterials and Technology at the Swedish University of Agricultural Sciences. His PhD project aims at increasing efficiency in the mechanized thinning of forests where aims other than economical create the need for policy.

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

Cornelius Hirsch

Supervisor:	**Tamás Krisztin**
Co-Supervisor:	**Linda See**
Research Project:	**Analysing the rush for foreign land (FLA-deals) by the means of an extended gravity-model analysis**

Abstract: What drives the rush for foreign land? Large-scale foreign land acquisition (FLA) has become an intensively studied issue in the scientific literature after the surge in investment deals covering vast hectares of land in the global south. However, empirical work in this area is rare, to a large extent due to data issues. My motivation is to contribute to this crucial and sensitive debate about land investments by offering a sound and comprehensive empirical analysis. By means of a gravity model, based on a newly available, larger dataset of land deals, in combination with resource and soil quality data from the Environmental Policy Integrated Model (EPIC) of IIASA's Ecosystems Services and Management Program, a significant research gap can be filled. The topic of foreign direct investments in land is particularly relevant for tropical areas, which represent hotspot regions for land investments and are often related to deforestation to grow cash crops. A typical example is palm oil plantations in Papua New Guinea, the country that, according to the new dataset, is the largest provider of land to foreign investors.

Biographical sketch: Cornelius Hirsch is a Research Associate at the Austrian Institute of Economic Research (WIFO). He currently holds a pre-doctorate position in the "Research Centre for International Economics" (FIW), which is a collaborative project between three economic research and statistical institutes located in Vienna, among others, WIFO, and three Austrian universities. He has been enrolled at the Vienna University of Economics and Business (WU Wien) as a PhD candidate (PhD Program in Economics and Social Sciences) since 2016. He holds a Master of Science degree in agricultural economics from Humboldt-University Berlin and a Bachelor's degree in economics from the Free University, Berlin. His PhD thesis focuses on international trade, globalization, and its interrelation with rural areas.

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

Malan Huang

Supervisor: **Steffen Fritz**
Co-supervisor: **Juraj Balkovic**

Research Project: **Rural labor and evolution of cropping systems in China**

Abstract: Cropping systems in China have changed greatly over the past few decades, mainly due to demographic evolution, agricultural technology innovation, and market reform. The production of rice, wheat, and corn accounted for 90.3% of national grain production in 2014. While China has a considerable effect on the international food market, it will exert strong negative externalities on the entire food security of the world if it cannot achieve food security mainly from domestic production. Rural labor is one of the essential elements of production and an important factor affecting grain yield. With the rapid economic growth of the 1990s, nonagricultural sectors have increased their demand for rural labor. The higher urban wages have stimulated a large transfer of rural labor toward off-farm employment in urban areas, which has brought about a rapid increase in rural wages and opportunity costs of farm labor. "Aging farmers, agricultural sidelines, ghost villages" summarizes what is happening in rural China. This project aims to map the spatial distribution and changes in the patterns of cropping systems and to determine the impact of potential drivers on cropping systems in China. First, the spatial autocorrelation Moran's *I* measure will be used to investigate overall differentiation characteristics and the spatial correlation of cropping systems. Meanwhile, combined with the process of industrialization and rural labor transfer characteristics, the evolution of rural labor will be analyzed, followed by the use of local Moran's *I* to map clusters of cropping systems of 31 provinces in China. Finally, the selected spatial regression-based model will be used to explore the relationship between cropping systems and potential drivers. As a result, a better understanding of rural labor and cropping system relationships and their policy implications in China will be gained, which could potentially be extended to other developing countries.

Biographical sketch: Malan Huang is currently a five-year combined master-doctoral candidate in the Faculty of Agricultural Economics at the Huazhong Agricultural University, China, from where she received her Bachelor's degree (2013) in Agricultural Economics Management. Her PhD thesis focuses on rural labor change and the evolution of cropping systems in China. Her main fields of scientific interest are the evolution of cropping systems, rural labor price change, rural labor migration, resources and environmental economics, and food security.

Ecosystem Services and Management Program (ESM)
Program Director: Michael Obersteiner

Bernd Lenzner

Supervisor:	**David Leclere**
Co-Supervisor:	**Oskar Franklin**
Research Project:	**Developing the first global scenarios for biological invasions in the 21st century**

Abstract: During the last centuries, human action has fundamentally altered the biotic and abiotic properties of the Earth, resulting in the emergence of a human-dominated era, the Anthropocene. Anthropogenic behavior has affected many features of the biophysical environment, and the rates of change have intensified in the last decades, unrivalled by any changes seen in the past. To assess the consequences of our impact on the environment, we need to better understand the implications of human action, its potential future trajectories, and the impacts it may cause. Consequently, scenario techniques to assess plausible future socioeconomic developments have been developed and widely applied to project long-term environmental changes (e.g., changes in climate, land-use, vegetation). Such scenarios are crucial for policy and decision making. Among the most prominent are the IPCC climate change reports, the Millennium Ecosystem Assessment, and the IPBES working group on biodiversity and ecosystem services. At a global scale, invasive species are among the main drivers of biodiversity loss. Their importance is recognized, for example, by the Convention on Biological Diversity, Aichi Target 9, which stresses the need to identify invasive alien species, their impact, and preferential introduction pathways. Nevertheless, until now the impact and development of alien species numbers under plausible future scenarios has not been directly quantified. Based on already defined qualitative scenarios, this project aims to develop a first global quantification of relevant drivers for the development of alien species richness and relate them in the Global Biosphere Management Model (GLOBIOM).

Biographical sketch: Bernd Lenzner works as a PhD student at the Division of Conservation Biology, Vegetation and Landscape Ecology at the University of Vienna. He graduated from the University of Bayreuth, Germany, in 2015, where he worked mainly on island biogeographic and macroecological patterns in terrestrial snails and vascular plants. His current research focuses on understanding spatial and temporal patterns and processes of global naturalized alien plant species richness. Here his work encompasses classic macroecological analysis of ecological and socioeconomic drivers of alien species richness in continental and island settings, as well as the effect of evolutionary history on invasion success.

Ecosystem Services and Management Program (ESM)
Program Director: Michael Obersteiner

Hana Mandová

Supervisor: **Sylvain Leduc**
Co-Supervisor: **Florian Kraxner**

Research Project: **The potential for meeting emission reduction targets of iron and steel industry using biomass**

Abstract: To keep the global temperature rise below 2°C, all sectors, especially industry, have to increase their efforts to move away from the use of fossil fuels. Iron and steel making is the greatest contributor to global industrial emissions, with on average 800 kg of coal being needed for the production of every tonne of crude steel from raw materials. As most of this coal is actually used as a carbon source for the iron ore reduction process, its substitution by alternative fuels is an essential step for decarbonizing this important industry. To this end, blending together coal with sustainably sourced biomass offers a significant opportunity, particularly for on-site emission reduction. However, even though the technical limitations of biomass use are reasonably well understood, the economic feasibility, emission-reduction potential, and resource availability concerns currently limit its deployment. This project will use and extend the BeWhere model to optimize the biomass supply chain for the existing iron and steel plants in Europe. As there are multiple ways of using biomass within the process, and also for generating electricity used at the plant, the aim is to identify the most strategic way of using the limited biomass resources for this industry. The results obtained will be used to assess the opportunities for biomass usage in other energy and emission-intensive industries, such as cement. The findings will provide answers to how—and even whether—biomass can be used as an emission reduction strategy in the iron and steel industry.

Biographical sketch: Hana Mandová is a second-year PhD student at the University of Leeds, UK. She is part of the EPSRC-funded Centre for Doctoral Training (CDT) in Bioenergy within the School of Chemical and Process Engineering, which she joined after finishing a four-year integrated Master's degree in Mathematics. Her research focuses on identifying opportunities and overcoming barriers related to the use of renewable energy in the iron and steel industry to define a plausible strategy to move the industry away from the use of fossil fuels.

Ecosystem Services and Management Program (ESM)
Program Director: Michael Obersteiner

Cholho Song

Supervisor: **Dmitry Shchepashchenko**
Co-Supervisors: **Anatoly Shvidenko**

Research Project: **Enhanced approach to assessing forest ecosystem functions and ecosystem services under land cover changes in South Korea**

Abstract: To carry out economic valuations for decision-making purposes, the use of ecosystem services matrices is suggested. However, directly interpreting ecosystem functions as ecosystem services through the elaboration of economic values could lead to confusion in spatial analysis and in the decision-making process. To enhance the approach, we need to clarify the distinctions between ecosystem functions and ecosystem services, by examining these processes in dynamical terms. In the forest sector, forest growth and climate change can be classified as drivers that affect the supply of ecosystem functions. On the other hand, land cover change and population change can be classified as drivers that relate to the demand for ecosystem services. In South Korea, time series data of forest stock and regional climate models have been developed that allow the future dynamics of forests and their functional assessment to be measured based on the Representative Concentration Pathways (RCP) scenarios in the context of future ecosystem functions. However, if there is a demand for future land cover and population change, such processes can be challenged under the Shared Socioeconomic Pathways (SSPs), particularly in assessments of future ecosystem services based on their status. Although national institutes have their own future projections, there are differences in the narratives of national and global pathways. The proposal thus aims to improve the national description of SSPs by applying the appropriate IIASA ESM models and to grasp the effect of SSP results on ecosystem services in terms of forest changes. The project aims to downscale the resolution to the national scale; and to produce an integrated assessment framework of ecosystem service management at the national level.

Biographical sketch: Cholho Song is PhD student at Graduate School of Department of Environmental Science and Ecological Engineering, Korea University, Republic of Korea where he has received his master of science degree. He was also a scholarship student of Korea National Research Foundation (NRF) and Deutscher Akademischer Austauschdienst (DAAD) at Mercator Research Institute on Global Commons and Climate Change (MCC). As a member of Korea University Environmental GIS/RS Lab, he has participated in research projects related to ecosystem services, land change monitoring, and spatial modeling.

Ecosystem Services and Management Program (ESM)
Program Director: Michael Obersteiner

Kasparas Spokas

Supervisor:	**Florian Kraxner**
Co-Supervisor:	**Sylvain Leduc**
Research Project:	**Incorporating geological constraints and risk in spatially explicit optimizations of carbon capture and sequestration projects**

Abstract: Creating a low-carbon energy system relies heavily on countries' abilities to transition away from fossil fuel energy generation and/or to sequester its resultant emissions. However, given a reluctance to incorporate nuclear energy generation into national energy portfolios, electricity generation remains dominated by fossil fuel plants with a growing renewable energy capacity. Moreover, renewable energy sources remain variable and intermittent in the absence of large-scale energy storage, placing a heavy reliance on fossil fuel power plants to maintain electricity grid stability. To mitigate the environmental impact from fossil energy, carbon capture and sequestration (CCS) has been proposed as a potential technical solution that can lead to neutral or even negative emissions. To develop cost-efficient CCS projects, the location of CO_2 transport pipelines and injection facilities will need to be determined given a suite of site-specific factors such as the location of fossil-generated CO_2 sources, geological target formations, and populations. This project aims to incorporate geological constraints and population risks into the CCS-version of the optimization model BeWhere, while considering an extended time framework. In fact, future CCS systems will need to account for several technical issues such as changes in the storage potential of candidate injection sites as well as in energy demands levels. Incorporating future energy systems could enable the design of more cost-effective CCS systems and inform policies aimed at developing CCS in the future. The methodology will be applied to the US power sector, which is characterized by high reliance on fossil fuels for power generation and a high availability of suitable geological formations for CO_2 sequestration.

Biographical sketch: Kasparas Spokas is a third-year PhD. student at Princeton University studying geochemical and geomechanical processes that affect the leakage of subsurface reactive fluids through rock fractures. His interests also extend to energy and climate policy aimed at developing a low-emissions electricity sector. He completed his undergraduate education at McGill University, Canada, where he studied Earth Sciences.

Ecosystem Services and Management Program (ESM)
Program Director: Michael Obersteiner

Radost Stanimirova

Supervisor:	**Myroslava Lesiv**
Co-Supervisor:	**Victor Maus**
Research Project:	**Dynamics of global rangelands: Modeling vulnerabilities and monitoring impacts from humans and climate variability**

Abstract: Rangelands are an important and understudied part of the global agricultural system. While many studies have focused on the productivity and resiliency of croplands, there is an urgent need to improve our understanding of how global rangelands will be affected under the combined pressures of a changing climate and increasing population in the coming decades. To address this knowledge gap, this project aims to develop an observation and modeling framework that exploits remote sensing, meteorological datasets, and land cover information to improve our capability to both monitor and manage the long-term sustainability of this globally extensive and societally critical land use. The core hypothesis is that current and future changes in climate, in combination with increased demand for meat and dairy products, will affect the geographic distribution, productivity, and vulnerability of global rangelands. To evaluate this hypothesis, I will develop a database of climate, land cover, and rangeland productivity information and create an empirical model that quantifies the spatially explicit sensitivity of global rangelands to both short- and long-term climate variations. The model I propose to develop will be estimated using an enhanced vegetation index calculated from time series of reflectance from the MODIS satellite sensor, in association with global gridded time series of precipitation and air temperature.

Biographical sketch: Radost Stanimirova received a Bachelor's degree in Environmental Science from Barnard College of Columbia University in New York in 2012. She is currently a third-year doctoral student in the Department of Earth and Environment at Boston University, USA, where she is also pursuing a certificate in Biogeoscience. Her research and academic interests include climate variability and human transformation of the landscape, especially through agriculture. Before starting her PhD, she was a research staff assistant at the International Research Institute for Climate and Society where she developed capacity-building materials, facilitated climate risk management workshops in rural agricultural communities, and contributed to remote sensing and index insurance research projects.

Ecosystem Services and Management Program (ESM)
Program Director: Michael Obersteiner

Shaohui Tang

Supervisor:	**Michael Obersteiner**
Co-Supervisor:	**Juraj Balkovic**
Research Project:	**Cost-benefit analysis of controlling phosphorus emissions from agricultural fields—A dynamic modeling approach**

Abstract: Effectively controlling phosphorus (P) emission from agricultural fields is a critical step toward decreasing harmful algal blooms (HABs) in the Western Lake Erie Basin (WLEB). Despite a significant investment in conservation programs in past decades, the nutrient problem in Lake Erie appears to be getting worse. In general, this project will focus on assessing the benefits and costs of phosphorus control strategies for farming in the WLEB and will have four main parts. First, we will develop a generic integrated dynamic model of agricultural phosphorus management by soft coupling the EPIC/APEX model and a dynamic economic optimization model, treating soil P and lake P as stock resources. The model will account for detailed biological and hydrologic processes, the impacts of landowner decisions on environmental quality (and vice versa), and the social benefits and costs of different best management practices (BMPs). Second, the model will be applied to the WLEB with bioeconomic components of the model specifically calibrated for this region. With the model, we will derive an optimal path for adoption of BMPs by farmers and recover the social cost of phosphorus. Third, system uncertainties will be incorporated into the model. The stochastic model will examine how uncertainties in the economic and soil-lake system affect optimal choices of BMPs over adaptation and the social cost of P. Finally, an empirical analysis on the implications of market incentives on the severity of HABs in WLEB will be conducted.

Biographical sketch: Shaohui Tang is a PhD candidate in the Department of Agricultural, Environmental and Development Economics at The Ohio State University. She received her Bachelor's degree in Agricultural and Forestry Economics and Management from Northwest A&F University in China. Her research interests span a broad range of topics in environmental and resource economics and integrated dynamic modeling. In particular, she focuses on understanding human-nature interactions and how policies can be used to address market failures that do not internalize the environmental damages from human activities.

Ecosystem Services and Management Program (ESM)
Program Director: Michael Obersteiner

An Ha Truong

Supervisor: **Piera Patrizio**
Co-Supervisor: **Sylvain Leduc**

Research Project: **Co-firing biomass with coal for electricity in Vietnam: Where, when, and how much?**

Abstract: As a renewable fuel, biomass emits less carbon dioxide than coal over its life cycle. Thus, co-firing biomass with coal has long been recognized as a way to reduce the greenhouse gas emissions from coal-burning power plants. This is an attractive option in Vietnam where coal-based electricity generation is expanding rapidly, as is agricultural productivity, which makes a larger biomass resource base available. Today, twenty coal power plants are in operation in Vietnam. Together they provide 43% of total electricity supply. By 2030 the current Power Development Plan proposes to add 43 GW of coal-based generation capacity. Concurrently, the Vietnam government aims to increase the share of biomass in power generation from nearly nothing at the moment to 2.1% of total electricity produced by 2030. How might Vietnam use co-firing, a well-known technology, to increase the share of biomass in electricity generation? In this study, we will assess the economic feasibility of implementing co-firing in Vietnam at national scale. IIASA's BeWhere model will be used to determine a technically optimal scenario for Vietnam, based on the biomass availability in the country and different development trajectories of the electricity sector. The scenario obtained will answer the following questions: which coal plants should do co-firing, how much biomass is needed, and what biomass source should be used. We will further develop the model to compute different aspects of socioeconomic and environmental consequences of the proposed development plan: greenhouse gas emission reduction, air quality, job creation, and effects on the agriculture market.

Biographical sketch: An Ha Truong is a second-year PhD student at University of Science and Technology of Hanoi, Vietnam Academy of Science and Technology. She obtained a joint Master of Energy from the University of Toulouse III-Paul Sabatier (France) and University of Science and Technology of Hanoi (Vietnam) in 2015, graduating valedictorian of her intake. Her PhD thesis focuses on the costs and benefits of co-firing biomass with coal in Vietnamese power plants. Her research interests include energy and climate policy

Meng Jiang

Supervisor: **Gui-Ying Cao**
Co-Supervisor: **Wenji Zhou**

Research Project: **Assessing energy and natural resource footprints under China's sustainable economic transformation**

Abstract: China is one of the world's major energy and resource consumers. Globally, China's energy consumption accounted for 23% in 2014 (BP, 2016) and natural resource use to almost one-third in 2008 (UNEP, 2013). However, the efficiency of energy and natural resource use in China is still lower than many developed countries. The project deals with three questions: i) Assessing sustainable pathways within a more comprehensive nexus by extending the scope of natural resources studied (not just energy). ii) Determining the driving forces of resource use and how these factors impact energy and raw material footprints in line with the economic transition and consumption changes; iii) assessing the synergies and balancing the trade-offs of various dimensions with respect to energy, natural resource consumption, and environmental pressure in the short and medium terms. By utilizing an environmentally extended input output analysis (EE-IOA) model, the footprint of critical energy (oil-gas and coal) and natural resources (iron ore, nonferrous metals, limestone, biomass and etc.) can be calculated. The socioeconomic drivers of crucial natural resources and of energy will be explored by structural decomposition analysis (SDA) in association with changes in industrial structure. The scenario analysis will be conducted to assess the co-benefits and trade-offs and will aim for policy-relevant outcomes. The study will enrich the database of energy and resource utilization and change of consumption, and will help to better understand the nexus of energy, natural resources, and changes in consumption patterns and urbanization.

Biographical sketch: Meng Jiang is a first-year PhD student at the Center for Industrial Ecology, Department of Chemical Engineering, Tsinghua University, China. His main interests lie in the areas of energy efficiency and resource efficiency. His research focus on using Environmentally-Extended Input-Output Analysis (EE-IOA) and Material Flow Analysis (MFA) to account for resource and energy footprints. His research aims to develop a better understanding of energy and resource efficiency issues in the context of sustainable production and consumption in SDGs (Sustainable Development Goals) in emerging economies.

World Population Program (POP)
Program Director: Wolfgang Lutz

Jeofrey Abalos

Supervisor: **Daniela Weber**
Co-Supervisor: **Anne Goujon**

Research Project: **Adult children's education and parents' health status in the Philippines**

Abstract: This research examines the influence of children's education on the health status of their parents. There are various mechanisms by which children's education influences parental health, including provision of better instrumental support, and transfer of both material and non-material resources. For example, well-educated children are more likely to give better care to their parents because they themselves are healthier, have more resources, and have more flexible jobs that enable them to provide practical assistance to their parents. They are also more knowledgeable about health-related information and more comfortable in navigating the health care system, which comes into play when children give health-related advice to their parents or decide how to address the health problems of their parents. Highly educated children also tend to adopt healthier behavior and lifestyle, which in turn, can influence the health behaviors of their parents. Using the 2007 Philippine Study on Ageing (PSA) data, this study extends earlier research by investigating how Filipino children's education influences their parents' health status. The Philippines provides a different context from previous studies mostly conducted in developed countries: it is a developing country, characterized by large family size, strong norms of intergenerational support, and the presence of a significant generational divide in terms of educational attainment. In this context, we would expect the impact of children's education to be much stronger than that found in other settings. Given the high prevalence of overseas labor migration in the country, this study also explores whether the association between children's education and their parents' health status transcends geographical boundaries.

Biographical sketch: Jeofrey Abalos is a PhD candidate at the School of Demography in the Australian National University. He completed his Master in Population Studies degree at the University of the Philippines Population Institute. His research interests include population ageing, population health, union formation and union dissolution.

World Population Program (POP)
Program Director: Wolfgang Lutz

Olugbemisola Samuel

Supervisor: **Samir K.C.**
Co-supervisor: **Markus Wurzer**

Research Project: **Effects of air pollution on life expectancy outcomes of male and female adults population in selected West African countries**

Abstract: Life expectancy is a statistical measure of the average number of years a person is expected to live, based on the year of their birth, their current age, and other demographic factors including their sex. However, life expectancy for a particular group of persons or population depends on several variables such as their lifestyle, access to healthcare, diet, working conditions, natural disaster prevalence, and the relevant mortality and morbidity data. Most West African countries are victims of air pollutions that has shortened the life expectancies of the population. The average number of years lived by persons in most African countries is on the decline, due to some of the factors mentioned above. This study thus seeks to identify those air pollutants affecting life expectancies in selected countries: Nigeria, Ghana, Liberia, and Burkina Faso. These countries were selected because of the availability of IPUMS data. This study will also explain the pattern of relationship that exists between each of the pollutants identified and the life expectancy outcomes of male and female population in these countries. The extent to which these pollutants have affected life expectancies among adult populations in these countries will also be examined and lastly, the differences in the effects of these pollutants on the male and female population. The findings from this study will help to improve life expectancies in the selected countries and also help identify those air pollutants affecting life expectancies so that policy makers can find ways of mitigating them.

Biographical sketch: Gbemisola Samuel received her first and second degrees in Demography and Social Statistics from Covenant University, Ota, Nigeria. She is a third-year PhD student of Demography and Social Statistics, Covenant University, and will graduate in August 2017. Her thesis is titled, “Proximate Determinants: The Pathways of Influence of Underlying Factors on Under-five Mortality in Nigeria”. Her research interests are in the areas of mortality, reproductive health, and population development.

World Population Program (POP)
Program Director: Wolfgang Lutz

Karen Umansky

Supervisor: **Wolfgang Lutz**

Research Project: **The Impact of Immigration Education and Skill Levels on Europe's Labor Force Participation and the Political Discourse about this Topic**

Abstract: Migration is an inherent part of contemporary Western societies. However, globalization and technological advances pose challenges not only to migrating populations, but also to hosting countries. Numerous claims suggesting a correlation between immigration, economic development, and unemployment are being made by the re-emerging populist radical right in contemporary European countries. This project aims to evaluate the current state of affairs and enrich the research in the field by combining qualitative and quantitative approaches. Recent studies have shown that education level affects the global labor force participation rate or the productivity of the labor force and, ultimately, the economic growth rate. Therefore, our objective is to assess education and skill levels and labor force participation rates of immigrants to European countries. Building on the multi-state and micro-simulation models developed at IIASA to make population projections and a qualitative analysis of the political discourse in Europe, the goal of this project is to generate science-based policy options for policy makers in regard to immigration policy, education, economic situation, labor market changes, as well as to attempt to provide myth-busting tools to combat the current radicalization of the political discourse.

Biographical sketch: Karen Umansky received her M.A. in Political Science from Tel Aviv University in 2014. Her thesis "The Quest for a "Legitimate" Enemy: Electoral Behavior of Populist Parties in Europe" provided empirical evidence from Austria, the Netherlands and the UK. Umansky is currently a third-year PhD candidate at the department of Public Policy at Tel Aviv University. The major scope of her research lies in the impact of immigration on European population, politics, and policies, focusing on the recent electoral success of populist radical parties in Europe in particular.

Risk and Resilience Program (RISK)
Acting Program Director: Joanne Bayer

Mahban Arghavani

Supervisor:	**Nadejda Komendantova Aman**
Co-Supervisor:	**Stefan Hochrainer-Stigler**
Research Project:	**Resilience assessment of Tehran electricity transmission grid against earthquakes**

Abstract: Electric power is essential to the continued functionality of critical infrastructure, lifelines, and the economic vitality of every industrialized community. Several natural and man-made hazards affect electricity grids and could lead to power outages or even blackouts with serious effects beyond the losses suffered directly. In general, indirect costs can be up to five times higher than the direct costs. Cascading failure as a sequence of dependent failures can lead to damage spreading and thus exacerbates both direct and indirect losses. To reduce the losses and restore the stricken region, rapid recovery of electric power is critical. Iran is one of the most seismic countries in the world, with the electricity network performing poorly even against not very big earthquakes and in not very populated cities; the country thus has potentially high vulnerability. While the Iranian power grid's resiliency against earthquakes has not been investigated to date, the majority of power outages in Iran happen because of electricity transmission and distribution faults rather than electricity generation. Thus, the objective of this research is to develop a comprehensive model for integrated vulnerability assessment, as well as a framework for risk and resilience analysis of power transmission grids due to earthquakes. The study will focus on modeling the power grids, performance analysis, fault propagation, and network restoration in earthquake-prone areas, with a case study of Tehran.

Biographical sketch: Mahban Arghavani graduated in 2011 from International Institute of Earthquake Engineering and Seismology (IIEES) and received a Master's degree in structural earthquake engineering. She also got a bachelor's degree in civil engineering from Arak University in 2007. She is currently a third-year PhD student at IIEES. The title of her thesis is resilience assessment of Tehran electricity transmission grid against earthquakes. Her main fields of scientific interest include vulnerability, risk and resilience infrastructure assessment, mathematical modeling of resilience and the recovery process, network analysis and decision-making problems.

Risk and Resilience Program (RISK)
Acting Program Director: Joanne Bayer

Claudia Canedo

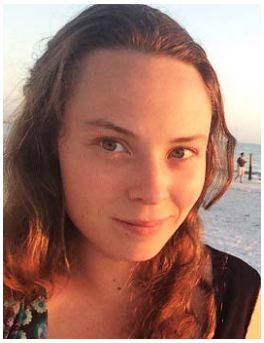
Supervisor: **Stefan Hochrainer-Stigler**
Co-Supervisor: **Georg Pflug**

Research Project: **Drought impacts and risks on agricultural production in the Bolivian Altiplano**

Abstract: Bolivia declared a state of water emergency in 2016 several months after Lake Poopo, which is the second largest lake in the country, completely dried out. Droughts in Bolivia are important setbacks to the national economy which, to a large extent, depends on water resources—in particular the agricultural sector. This is the case for the Bolivian Altiplano, where more than half the population relies on agricultural activities. The Bolivian Altiplano is a semiarid plateau located 3000 m above sea level in the mid-part of the Andes, between the east and west branch of the Cordillera. This region presents a greatly heterogeneous topography that drives a north–south gradient of annual precipitation decreasing from 1100 mm to 200 mm. Droughts over the region have been studied by researchers in the past. However, there is a lack of understanding of the vegetation and soil coverage changes under local climate conditions and their relationship with atmospheric flow variability. In this research, an analysis of the droughts´ impact on and risk for agricultural production in the Bolivian Altiplano is developed using statistical and remote sensing analysis. Vegetation maps will be analyzed and related to climate conditions. Important climate phenomena, such as the El Niño–Southern Oscillation (ENSO), will also be related to the local climate. Finally, drought impacts on agricultural production will be analyzed and compared with normal climatic conditions. Expected results, which include the quantification of local and regional drought impacts on agricultural production, should further contribute to the development of prediction tools for drought impacts.

Biographical sketch: Claudia Canedo completed her Master's degree in irrigation engineering in 2013 at the Mayor University of San Andres, Bolivia. She is currently in the Doctoral Program in water resources engineering at Lund University, Sweden. She is interested in studying the hydrological and climatological conditions over small basins in the South American highlands. The aim of her research is to define water resources availability and find strategies for a sustainable water management in the semiarid region. Recently, she has studied and published on the precipitation variability and its relation with climate phenomena in the Bolivian Altiplano.

Risk and Resilience Program (RISK)
Acting Program Director: Joanne Bayer



Liv Lundberg

Supervisor: **Junko Mochizuki**
Co-Supervisors: **Nikita Strelkovskiy**

Research Project: **Economic policies for the transition to a renewable electricity system—Modeling the risks**

Abstract: Transforming the electricity sector into a sustainable system based on renewable energy is a crucial part of mitigating climate change. In governing this transition, economic policies will most likely be an important factor, catalyzing change but also forming the future electricity system. A transition to a system with high shares of solar and wind power will most likely change the electricity market dynamics, as they have characteristics that are significantly different from fossil fuels. An important aspect is that solar and wind power are intermittent, have very low marginal costs and (at this point) relatively high investment costs; they can be built decentralized and they can be owned by small-scale consumers. These new characteristics could mean that actors and markets in the electricity sector will behave differently in the future. To promote a successful transition, it is important to develop economic policies that can deal with these new challenges. The aim of this project is to study how the interactions and decision-making of actors in electricity markets affect the outcomes of economic policies (such as subsidies and CO_2-taxes) and shape the electricity system transition. It will build on an agent-based model for power system transition developed at Chalmers University of Technology in Sweden and social simulation ("serious game") with the goal of using empirical observations from the serious game to inform decision processes in the model.

Biographical sketch: Liv Lundberg graduated in 2012 from Chalmers University of Technology in Sweden with a BSs in Engineering Physics and a MSs in Industrial Ecology. She is currently a fourth-year PhD student at the division of Physical Resource Theory at Chalmers. Her main research focus is on modeling economic dynamics and decision making in land-use, forestry, and electricity systems. She primarily works with agent-based modelling, using it as a tool to study how heterogeneity, interaction and learning among actors affects price formation and the efficiency of economic policies.

Risk and Resilience Program (RISK)
Acting Program Director: Joanne Bayer

Tobias Sieg

Supervisor: **Reinhard Mechler**
Co-Supervisor: **Thomas Schinko**

Research Project: **Assessment of the costs and the duration of business interruptions after flood events in Germany**

Abstract: The total economic damage caused by a flood event in Germany in 2013 is estimated at €6.67 billion, of which €1.32 billion impacted the business sector. This share of about one-fifth of the total damage reveals companies' large potential for damage. Thus, appropriate adaptation strategies and disaster risk assessments are becoming increasingly important to reduce this damage. Assessing business interruptions as being part of overall flood damage has been mostly overlooked by damage modeling and risk assessments to date. Hence, this study focus on two main aims: i) the development of an appropriate model to estimate the costs and the duration of business interruptions; and ii) identification of the main drivers of business interruptions after floods to deepen the understanding of the underlying mechanisms of, and the vulnerability to, flood events. An ensemble of tree-based classifiers, called Random Forests, is used for the identification of the main drivers of business interruptions as well as for estimating costs and duration. An additional objective is to transfer these findings for single companies to a regional scale using agent-based models. This enables an assessment of systemic risks triggered by flood events. The data sets used are taken from two surveys conducted after the floods in the Elbe and Danube catchments in 2002 and 2013 in Germany. The expected results could provide valuable insights into the vulnerability of societies to floods and therefore lead to an enhancement of adaptation strategies in the near future.

Biographical sketch: Tobias Sieg holds a Bachelor's and Master's degree in Geography and Global Change Ecology from the Friedrich-Schiller-University Jena and the University of Bayreuth, Germany. Currently, he is a second-year PhD student at the University of Potsdam and the Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences. His PhD project "Analysing changes in micro-scale flood-related vulnerability of companies" is part of the research training group "NatRiskChange." The project focuses on flood damage modeling and the quantitative assessment of aspects influencing the vulnerability of companies to flood events.

Risk and Resilience Program (RISK)
Acting Program Director: Joanne Bayer

Jillian Student

Supervisor:	**Wei Liu**
Co-Supervisor:	**Asjad Naqvi**
Research Project:	**Vulnerability is dynamic: Approaching the emerging challenges of coastal tourism**

Abstract: Tourism is one of the largest sectors in the world, contributing to 10% of global GDP and one in eleven jobs. While an important contributor to economic prosperity, tourism is both a driver and a risk of global (environmental) change. Caribbean coastal tourism specifically depends on the natural resources of "sun, sand, and sea" to attract tourists. However, these resources are susceptible to climate change and locally induced environmental change (e.g., pollution). Socio-ecological vulnerabilities to global (environmental) change are understood to be dynamic phenomena affecting different parts of a system and even altering interactions within it. However, tourism researchers have faced difficulty in operationalizing a dynamic vulnerability assessment. My research operationalizes a dynamic approach to understanding coastal (tourism) resilience, exposure to new hazards, and the emergence of vulnerabilities through exploring the socio-ecological interactions and feedbacks. This innovative approach includes stakeholder engagement, companion modeling, social simulations, and agent-based modeling. Literature review and empirical work on two case studies in the Caribbean, Barbados and Curaçao, inform this approach. During YSSP in the RISK program, I will organize and assess the findings from my recently completed fieldwork. I have two main goals: to draft a methodological paper and to develop an agent-based model stemming from the proposed framework. The expertise at RISK will also help improve and operationalize the conceptual framework and aid in translating fieldwork and scientific scenarios into an agent-based model.

Biographical sketch: Jillian Student completed her undergraduate studies in Canada before moving to the Netherlands, where she completed her first Master's degree at the Vrije Universiteit and a second Environmental Sciences Master's degree at Wageningen University. She is currently a third-year PhD student at Wageningen University in the Environmental Policy and Environmental Systems Analysis groups. The title of her thesis is "Vulnerability is dynamic: Enhancing adaptive governance to climate change for Caribbean tourism through interactive modelling." Her main fields of research interest are human-environmental dynamics, interactive (companion) modeling, tourism, environmental change, and participatory research.

Risk and Resilience Program (RISK)
Acting Program Director: Joanne Bayer

Dmitrii Iakubovskii

Supervisor: **Nadejda Komendantova**
Co-Supervisor: **Elena Rovenskaya**

Research Project: **Reliability of electric power systems of the Eurasian Economic Union: Assessing impact of risks on interconnections**

Abstract: To guarantee power supply to the Eurasian Economic Union, including such countries as Russia, Uzbekistan, Kirgizstan, and other countries of Central Asia, electric power systems (EPS) need to be reliable. A timely assessment of impacts of risks and their probability is thus required to ensure that risk mitigation and resilience actions are followed up through, for example, installation of control equipment. This research work is based on the mathematical model for risk assessment of EPSs, which is a non-linear programming problem. It includes various scenarios of hazards and threats in EPSs (for example, natural, technogenic, social, financial), which will be simulated with the help of the model. The simulations will help to identify bottlenecks and possible power shortages. All investigation will be provided by real-world information about EPSs that have been investigated, taken from the public record. For example, the Schemes and Programs of Development, Russian EPSs (2016-2022) will be used to collect information about Russian EPSs. The research will be compiled using high-speed optimization methods. To research the resilience of the electricity system, we will first use the penalty method combined with the nonlinear conjugate gradient method, and then the differential evolution method. Using the penalty method, the problem will be changed from one with constraints to one that includes constraints as objective functions. The changed problem will also be solved by the conjugate gradient method, which include the one-dimensional optimization method. The results of this analysis will allow identification of the vulnerabilities of EPSs. Based on the results, we will develop recommendations about the reliability of the current Eurasian Economic Union EPSs and probabilities of possible risks.

Biographical sketch: Dmitrii Iakubovskii holds a Master of Computer Science degree in Automated Systems of Information Processing and Management from the Irkutsk National Research Technical University, Russia. Since 2015 he has worked on his PhD at the same university. He is also employed as a research engineer at the Melentiev Energy Systems Institute of the Siberian Branch of the Russian Academy of Sciences. His PhD thesis focuses on the problem of applying optimization methods while ensuring the reliability of electric power systems. His main fields of scientific interest include nonlinear programming, genetic algorithms, machine learning, and parallel programming.

Risk and Resilience Program (RISK)
Acting Program Director: Joanne Bayer

Ziyun Zhu

Supervisor: **Susanne Hanger**
Co-Supervisors: **Wei Liu, Oskar Franklin**

Research Project: **A global analysis of wildlife damage insurance**

Abstract: Maintaining a functioning diversity of the biosphere is critical for ensuring the sustainable provision of ecosystem services. Large mammals play a pivotal role in regulating the population of other species and strongly influence ecosystem functioning. As humans continue encroaching on wilderness areas, human-wildlife conflict (HWC) becomes common and intensive. Worldwide, HWC causes billions of dollars of economic losses and substantial casualties annually. It often leads to retaliatory killing of animals and is an underestimated driver of biodiversity loss and ecosystem degradation. HWC mitigation sometimes involves financial instruments, usually direct compensation, which often fails. Insurance has recently emerged as a new financial tool to mitigate HWC, but the key factors and necessary enabling environment for an effective wildlife damage insurance scheme are unclear. In this study, I propose to conceptualize HWC using state-of-art risk-assessment and risk-layering approaches, based on evidence from a global pool of HWC cases. This will help to clarify the suitable tools of HWC mitigation for different scenarios. I will then focus on HWC insurance. I will use the Ostrom analytical framework and Qualitative Comparative Analysis to identify the key characteristics and enablers of effective wildlife insurance schemes. The results will serve several purposes: First, to produce actionable knowledge that can be used by practitioners to mitigate the negative impacts of HWCs. Second, to enhance co-adaptation between community and wildlife and promote sustainable co-existence Third, to support sustainable development of communities in some of the most biodiversity-rich regions around the world.

Biographical sketch: Ziyun Zhu is a PhD candidate of Peking University, China. He started his conservation biology research in the Tibetan Plateau in 2014. He focuses on the Tibetan traditional ecological culture, and tries to discover how the special culture can contribute to biodiversity conservation there. He is also interested in the solution of human-wildlife conflict, and the institution, system, and culture that can contribute to human-wildlife co-existence.

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

Yaru Zhang

Supervisor: **Tieju Ma**
Co-Supervisor: **Fei Guo**

Research Project: **A multi-regional energy transportation strategy for China's electricity system using the MESSAGE model**

Abstract: The distribution of, and the demand for, electricity are in serious imbalance in China's electricity system. Energy transportation has always been an important issue in meeting China's regional electricity demand. Because of China's energy resource endowment, nearly 75% of China's electricity generation still relies on coal power plants. The traditional energy transportation network transports coal from coal reserve sites to electricity demand sites where there are established power plants. However, the environmental capacity in some regions is relatively small due to the high population density, which makes it no longer suitable to build new large-scale coal power plants. To solve the long-distance energy transportation problem, another way of transporting energy called "Ultra High Voltage (UHV) transmission," has begun to attract extensive attention in recent years. First, coal is used to produce electricity at a power plant located at the coal reserve site; then the electricity is transmitted by UHV to the demand site. UHV as a new technology in China may solve the problem of high capacity electricity transmission between regions. In this proposed research, a multi-regional MESSAGE model that reflects an actual electricity system with two pathways of energy transportation will be proposed. Different scenarios will be provided to illustrate what kinds of energy transportation strategies will work best (or be satisfactory) in a multi-regional electricity system from the medium- to long-term perspective.

Biographical sketch: Yaru Zhang received her Master's degree in Management Science and Engineering in 2012 from Harbin University of Commerce, China. She is currently a fourth-year PhD student at the East China University of Science and Technology, China. Her dissertation topic is "A multi-regional energy transportation model and spatial configuration of UHV in China's electricity system." Her research focuses on energy transformation processes and adoption of new technology in the electricity system.

Water (WAT)
Program Director: Simon Langan

Xiaogang He

Supervisor:	**Yoshihide Wada**
Co-Supervisor:	**Sebastian Poledna**
Research Project:	**Investigation of drought adaptation options using an integrated hydrological and agent-based model**

Abstract: Human water management practices can exacerbate drought conditions, exemplified in the recent drought in California, and this underscores the importance of human water management in effective drought adaptation and mitigation. The state-of-the-art hydrological and water resources model (e.g., PCR-GLOBWB) can quantify human impacts, but does not consider the dynamics between human behaviors/decisions and water availability. It is therefore necessary to integrate social and behavioral dimensions into the current hydrological model framework. The proposed study aims to apply the agent-based modeling (ABM) approach and couple it with a hydrological model (e.g., PCR-GLOBWB). The proposed framework will have a balanced representation of social, environmental, and economic factors by including individual behaviors/decisions through the highly "disaggregated" process-based model. ABM also has the advantage of being able to mimic the human-natural system in a probabilistic way by performing different sets of scenarios. The integrated framework will be applied to explore the effectiveness of different water management strategies for drought mitigation and adaptation.

Biographical sketch: Xiaogang He is a third-year PhD candidate in the Department of Civil and Environmental Engineering at Princeton University. His research interest focuses on the fundamental understanding of how climate change and climate variability affect the global flood and drought risk and how we can improve the predictability of these extreme events to reduce their potential impact. He received his M.E. in Civil Engineering from the University of Tokyo in 2013; B. Eng (Major) in Hydraulic Engineering, and BSc (Dual) in School of Economics and Management from Tsinghua University, China, in 2011.

Water (WAT)
Program Director: Simon Langan

Jing Li

Supervisor:	**Peter Burek**
Co-Supervisor:	**Yoshihide Wada**
Research Project:	**Modeling framework setup for studying impact of Nutrients (Nitrogen and Phosphorus) on Cyanobacteria/Cyanotoxins Dynamics in Lake Vomb, Sweden**

Abstract: Where surface water resources are used as a drinking water supply, harmful cyanobacteria have become a major critical concern. Future climate change with a higher temperature and an increase in humic substances from intensive rainfall runoff can accelerate algal blooms in lakes. We need to understand the growing mechanisms of algal blooms as well as how activities in the catchment area influence their growth in a lake. This requires an integrated approach on a basin scale taking into consideration hydrological condition, land use, wastewater treatment, and fertilizer usage together with possible climate change impacts. This project aims to set up a preliminary modeling framework for understanding the interaction between nutrients loads (Phosphorus and Nitrogen) from the catchment area and the cyanobacteria blooms and potential cyanotoxin formation in Lake Vomb, Sweden, through: i) collecting available data and studying the possible correlations and drivers; and ii) exploring current catchment-scale modeling approaches and identifying the suitable models for Lake Vomb. The approach will cover hydrological/hydrodynamic modeling, nutrient load assessment, and water quality modeling for studying algal bloom dynamics in the lake. This will be the first step toward building an integrated catchment-scale algal bloom water quality model for Lake Vomb, able to help decision makers achieve a sound management of freshwater resources.

Biographical sketch: Jing Li is an industrial PhD student at Water Resources Engineering, Lund University, financed by Sweden Water Research, a joint research company comprising three major water and wastewater service companies in south and west Skåne. Her topic is Removing Canotoxin from the Drinking Water Supply System. She received her Master of Water Resources Engineering at Lund University in 2011. She worked at a Swedish company as a consultant to optimize a machine for monitoring microbial water pollutants before beginning her job at Lund University as project coordinator and part time PhD student in 2014.

Water (WAT)
Program Director: Simon Langan

José Pablo Ortiz Partida

Supervisor:	**Taher Kahil**
Co-Supervisor:	**Yurii Yermoliev**

Research Project: **Multi-objective Optimization for Human and Environmental Water Resources Management**

Abstract: Water supply for human and environmental objectives have been at odds under current water management strategies; this research illustrates that reservoir releases may benefit both society and the environment. Multi-objective evolutionary algorithms (MOEAs), an optimization technique, are applied to a water allocation simulation model to optimize a reservoir operational policy to maximize agriculture water supply reliability, maximize environmental flow reliability, and minimize flood risk. The overall hypothesis is that simulation and optimization models can be combined into a "state-of-the-art" tool to i) design water management strategies for sustainable water resources systems that improve systems operations to meet both societal and environmental water requirements; and ii) evaluate trade-offs across the border. The research findings may contribute to shifting the current thinking of water management, where water allocation to agriculture and the environment are mutually exclusive. The area of application is the Big Bend Reach of the Rio Grande/Bravo, a transboundary river basin that while increasing the problematics of this research and the tools to be developed, does not limit their application in other non-shared basins.

Biographical sketch: José Pablo Ortiz Partida is an Environmental Engineer graduated from ITESO University, Mexico, in 2012. He is a PhD candidate in Hydrologic Sciences at the University of California, Davis, under a scholarship from CONACYT (Mexico's Science and Technology Ministry). His research focuses on designing strategies for improving the environment health of aquatic and riparian ecosystems without negatively affecting human water management objectives, such as agriculture water supply and flood management.

Water (WAT)
Program Director: Simon Langan

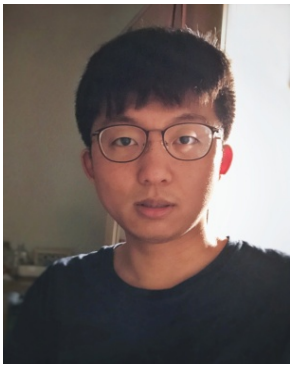
Francine van Brandeler

Supervisor:	**Sylvia Tramberend**
Co-Supervisor:	**Simon Langan**
Research Project:	**Can a water crisis be averted in Mexico City? The effectiveness of water use rights in promoting sustainable water use and reducing groundwater over-exploitation**

Abstract: The world is urbanizing rapidly and megacities are multiplying, with heavy impacts on natural resources. A business-as-usual scenario is unsustainable and we need to rethink how cities use and share common goods such as water. Mexico City is struggling to provide water to its growing population and expanding economy. Local aquifers have been over-exploited, so water is imported from distant sources, with high economic, social and environmental costs. Climate change and variability will likely further aggravate water challenges. In addition, Mexico City is characterized by a highly unequal water distribution throughout its territory. Water use rights and related water use policy instruments have gone through several reforms in recent decades in order to limit water extractions and promote more efficient and sustainable water use behavior. This research will use data collected during fieldwork in Mexico City in 2016 through document analysis and semi-structured interviews to assess how water use rights and their related instruments have been implemented and how effective they have been at fostering sustainable water use. Early inferences indicate that progress has been limited for a number of reasons, particularly related to the water governance regime in place. Water use policy is influenced by actors at multiple levels of government and at the river basin and aquifer level, leading to potential mismatches between institutional and biophysical scales. Performance of water use rights is evaluated in relation to the perceived ability of this instrument to achieve its mandated policy goal. The coherence of this instrument at urban and river basin scales, as well as across multiple levels of governance will also be examined. Expected results on challenges for and characteristics of effective water use rights will be used to formulate policy recommendations in support of the Sustainable Development Goals.

Biographical sketch: Francine van den Brandeler is a third-year PhD candidate working under the supervision of Prof. Joyeeta Gupta and Dr. Michaela Hordijk, with the Amsterdam Institute for Social Sciences Research (AISSR) at the University of Amsterdam and the Center for Latin American Research and Documentation (CEDLA). Francine received a Research Master degree in International Development Studies from the University of Amsterdam (2013).

Water (WAT)
Program Director: Simon Langan



Hanqing Xu

Supervisor:	**Günther Fischer**
Co-Supervisor:	**Laixiang Sun**
Research Project:	**Drought risk, irrigation demand, and maize yield under climate change in the northeast farming region of China**

Abstract: Maize is the number one cereal crop in China and has played the leading role in guaranteeing the food and feed security in the country. Drought risk has been one of the main limiting factors for maize production in the Northeast Farming Region of China (NFR). Previous studies on assessments of the impact of drought on maize yield are based on field experiments or over the whole growing season in the NFR, ignoring the fact that maize growth is affected differently by the same extent of drought risk in different growth phases. Given the importance of the NFR in China's food security, it is crucial to understand how drought risk potentially affects maize yield in different growth phases and how to develop a suitable irrigation schedule to mitigate the negative effects of drought on maize yield in NFR under climate change. This research will analyze the spatial and temporal variation of climatic factors in different maize growth phases and their influences on maize yield based on the records of 36 agro-meteorological observation stations in the NFR. It will develop a probabilistic estimation of the yield-reducing effects of drought risk in specific growth phases under climate change by making use of multi-model ensemble output. It will investigate the spatial and temporal variation of drought risk impacts on maize yield based on crop-growth model DSSAT simulations. Finally, it will estimate the spatial and temporal variation of irrigation water demand in each key growth phase under different climate projections.

Biographical sketch: Hanqing Xu received his Bachelor's degree in Geographic Information Science (GIS) from Shanxi Normal University in 2015. He is currently a second-year Master's student at Shanghai Institute of Technology and Climate Change Center. His main scientific interests center on the impacts of climate change on agriculture. His dissertation focuses on drought risk, irrigation, and maize yield under climate change.