YSSP

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YSSP participants 2019

Biographical sketches and research project abstracts

Young Scientists Summer Program

International Institute for Applied Systems Analysis
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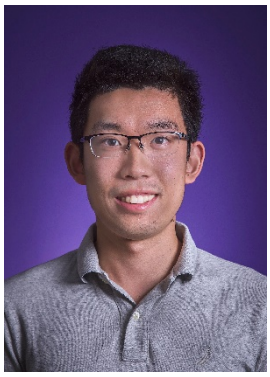


Minghao Qiu

Supervisor: **Jens Borken-Kleefeld**

Research project: **ANALYZING ON-ROAD VEHICLE EMISSIONS FROM REMOTE SENSING IN THE JING-JIN-JI (JJJ) REGION OF CHINA**

Abstract:
On-road vehicle emissions are a major contributor of air pollutant emissions in large cities all over the world. Prior studies showed that the on-road emissions can differ substantially from emissions measured at lab tests even under the same driving conditions, due to maintenance and deterioration of vehicles in the real traffic. Effective vehicle pollution policy requires understanding of the vehicle emissions under real driving conditions and the heterogeneity of on-road emissions, which is not possible from previous measurements (measured in labs or on test vehicles only) made in China.

On-road remote sensing provides an efficient method to measure emission factors of a large number of vehicles under real driving conditions. This project will analyze the data collected by the remote sensing programs launched by the Ministry of ecology and environment of China in 28 cities in the JJJ region. Using this data, we will be able to quantify the on-road vehicle emissions under real driving conditions for a relatively large sample in this region, and the differences between real emissions and the lab measurements. This project will develop statistical models to identify the high emitters with vehicle characteristics, and further quantify the heterogeneity of vehicle emissions across different brands, models and cities. Time and data permitting, we will also study the temporal trend and the spatial distribution of vehicle emissions in the JJJ region, which help us evaluating the effectiveness of China's recent pollution control program in this region. In the case we would not get access to Chinese data, we will do similar analysis for a big European on-road vehicle dataset that is at hand.

Biographical sketch:
Minghao Qiu is a third year PhD student at the Institute for Data, Systems, and Society at Massachusetts Institute of Technology. His main research interests are in the fields of environmental and energy policies and economics, with a focus on air pollution and climate change. His current research at MIT focuses on evaluating the causal effects of energy and environmental policy (including China's energy intensity policy and renewable policy in the US) on emissions, air quality and human health, using real-world data. Prior to coming to MIT, Minghao received his bachelor's degrees in environmental science and economics at Peking University in China.

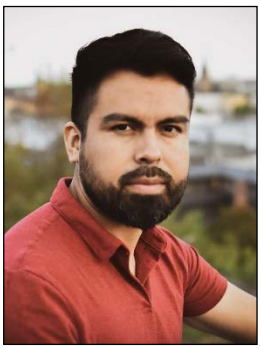
Muye Ru

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

Research project: **INTEGRATING THE MORBIDITY BURDEN AND ITS ECONOMIC IMPACTS INTO AIR QUALITY POLICIES**

Abstract:
Air pollution does not only shorten life, but also disables people with diseases, known as the morbidity burden. From an economic point of view, the morbidity burden reduces labor productivity and increases the social and household costs for care and medical expenses, all known as generating direct market impacts.
However, the importance of morbidity burden, and therefore the related economic costs, has not yet been well addressed. Based on the exposure estimates from the GAINS model, I will estimate cause-specific morbidity burdens, for a comprehensive set of diseases known to be associated with particulate matter (PM) pollution. Morbidity data for different countries will be combined. Statistical models will be developed to build concentration-response functions for the morbidity burdens. In practice, I will first focus on the morbidity burden of PM pollution in Asia, then update the global estimates using a similar approach.
Previous evaluations of the costs associated with morbidity burdens are limited in their coverage and level of details. For example, cost accounting is often based on evidence from Western countries. More cost data will be collected and imputed to complement the global estimate of the direct economic impacts induced by the morbidity burden related to air pollution. The expected output of my project will be a generalized set of functions linked to GAINS that estimate cause-specific morbidity burdens and the associated economic costs. As such, this output will be able to be applied to multiple air quality scenarios to produce policy-informing results on human health and the economy.

Biographical sketch:
Muye Ru is a PhD candidate in Earth and Ocean Science, Nicholas School of the Environment at Duke University. Her study focuses on the interactions among air quality, climate, and the economic system. She plans to study the morbidity burden and economic impacts associated with air pollution for the YSSP. In particular, she studies the mental health burden related to air pollution. Muye received a BS in Environmental Studies and a BA in Economics from Peking University. She also received a Master of Environmental Management from Duke university.



Jhonny Villarroel – Schneider

Supervisor: **Lena Höglund Isaksson**

Research project: **ANALYSIS OF SCENARIOS FOR GHG EMISSIONS REDUCTION THROUGH THE APPLICATION OF COMBINED ENERGY SYSTEMS IN THE LATIN AMERICAN DAIRY SECTOR**

Abstract:
GHG emitted by the Latin American (LA) dairy sector is increasing along with the consumption of dairy products of a growing population. In this sense, reducing these emissions using technological solutions such as combined energy systems are an interesting alternative. These combined solutions, such as cogeneration, trigeneration and polygeneration systems, are able to supply diverse energy demands simultaneously (electricity, heating and cooling services). Applying these solutions to the dairy sector will allow utilizing biogas produced with farm waste. Therefore, these systems can also supply biogas for cooking and provide fertilizers that is highly required in agriculture. Access to these services can be enhanced while mitigating the negative effects on the environment caused by an inadequate handling of dairy farm waste. In LA, the study of the emissions generated by this sector and the strategies for their reduction require greater efforts due to the diversity of geographical conditions, policies and regulations, and particularities of the dairy sector of each country. In these circumstances, studying future scenarios for GHG emissions (considering various technological solutions) is proposed to be carried out by first developing an extended version of the GAINS model, where existing technical measures to reduce methane emissions in the dairy sector are complemented with an analysis of co-benefits in the energy sector and associated carbon dioxide reductions. This will allow for exploring the boundaries for technical solutions to control GHG emissions in the LA dairy sector and to determine key variables that can help to determine cost-effective solutions while maximizing benefits in the line with the SDG's. The results of this analysis can serve as a reference when seeking strategies to reduce GHG emissions.

Biographical sketch:
Jhonny is a PhD candidate at the Royal Institute of Technology, KTH in Stockholm-Sweden. He is electromechanical engineer graduated from San Simon University in central Bolivia. Prior to start his PhD studies he worked in rural electrification programs and in Gas companies in his home country. The title of his PhD thesis is "Combined energy systems applied to productive sectors". His main fields of scientific interest include clean/sustainable energy technologies, decentralized/combined/hybrid energy solutions, circular economy and waste to energy solutions.

Xu Wang

Supervisor: **Pallav Purohit**
Co-supervisor **Shaohui Zhang**

Research project: **ASSESSING ENERGY EFFICIENCY CO-BENEFITS FOR AIR POLLUTION AND GREENHOUSE GAS ABATEMENT IN CHINA'S BUILDING SECTOR**

Abstract: The global energy consumption for space cooling and heating is growing faster than for any other end use in the building sector, due to the rapid urbanization and economic growth, particularly in developing countries. For example, the penetration of room air-conditioners in China has increased from 16.3% in 1997 to 128% in 2016 by urban residential buildings and from 0.4% in 1997 to 47.6% in 2016 by rural residential buildings. The usage of low-GWP refrigerants and enhanced energy efficiency of space cooling equipment for buildings have large potential for the mitigation of air pollution and greenhouse gas emissions. In addition, most of the cooling and heating technologies including solar thermal, combined heat and power (CHP), heat pumps and thermal energy storage are commercially available today. The large-scale penetration of energy efficient equipment via policy enforcement and technological improvement will maximize the co-benefits in air quality management, greenhouse gas mitigation and other policy priorities in the Chinese building sector.

In this study, we will model the penetration of cooling technologies and assess the energy use and associated greenhouse gas and air pollution emissions in China's building sector by 2050 at the provincial level. With consideration of the heterogeneities of urban-rural areas and building types, we will conduct a separate analysis of urban and rural areas as well as the residential and commercial building sector. Alternative scenarios will be analyzed to simulate different policy measures and technological improvements, as well as to predict energy saving and emission reduction potentials. We hope to provide a new perspective to track energy-efficiency opportunities by appropriate domestic policy measures along with accelerating the transition to low-GWP refrigerants in cooling technologies in the Chinese building sector.

Biographical sketch: Xu Wang is currently a second-year PhD candidate at the School of Economics and Management of the Beihang University, China. Her research interests include integrated assessment of air pollution and greenhouse gas emissions. Her doctoral research focuses on modelling co-benefits of cooling and heating in Chinese buildings (including residential and commercial building sector). The title of her Ph.D. dissertation is "Assessment of socio-economic and environmental synergies in Chinese building industry".

Nicolas Choquette-Levy

Supervisor: **Matthias Wildemeersch**
Co-supervisor: **Wolfgang Lutz (POP), Joanne Linnerooth-Bayer (RISK)**

Research project: **THE ROLE OF AGRICULTURAL NETWORKS AND CLIMATE ADAPTATION STRATEGIES IN RURAL-URBAN MIGRATION**

Abstract:
Recent literature has explored the effects of changing climatic conditions on both international and internal migration. While some disagreement exists, most empirical data points to a positive relationship between increases in mean temperature and increased migration, particularly in countries that are highly dependent on the agricultural sector. Yet, the mechanisms that shape farmers' decisions to migrate (or pursue other adaptation options) are still unclear. One particular question that has yet to be resolved is how farmers' social networks shape these decisions, and the implications this might hold for policies to support long-term climate resilience. This project will construct an agent-based model (ABM) to test theories of how different risk management strategies and social network effects interact with respect to agricultural climate adaptation and rural-urban migration. The ABM will model how agricultural households in developing countries choose between different adaptation strategies, e.g. continuing to farm cereal crops, diversifying to more climate-resistant crops, and/or sending a migrant to an urban setting. Specifically, it will explore how these decisions change under different climate risk scenarios, and how different social network effects (e.g., remittances between migrants and family members, the exchange of farm labor between neighboring households, and social ties between migrants and their home communities) impact the long-term evolution of these strategies. Time permitting, the model will also investigate the impact of formal vs. informal risk sharing schemes on the overall resilience of households under these climate risk and social network scenarios.

Biographical sketch:
Nicolas is a PhD student in the Science, Technology, and Environmental Policy program at Princeton University. His research focuses on how climate risks are influencing rural-urban migration, particularly among smallholder farmers in Nepal and China. He has a Master's degree in Chemical Engineering from the University of Calgary (Canada), and bachelor's degrees in Biomedical Engineering and International Relations from the University of Southern California. Prior to starting his PhD, Nic worked for six years on sustainability projects in Canada's energy sector.

Brent Eldridge

Supervisor: **Elena Rovenskaya**

Research project: **A LEARNING ALGORITHM TO ESTIMATE SELF-COMMITMENT INEFFICIENCIES IN ELECTRICITY MARKETS**

Abstract:
Over the past few decades, Independent System Operators (ISOs) have taken responsibility for determining wholesale prices and production schedules for the majority of the electricity produced in the United States. ISOs have proven to be largely effective at coordinating wholesale electricity markets, but debates have recently resurfaced about what constitutes an optimal pricing policy. These debates arise because standard marginal cost pricing rules cannot be guaranteed to clear the markets when power production costs and feasible regions are non-convex, e.g., due to lumpy start-up costs or binary on/off commitment decisions. This has stimulated many proposals that calculate uniform prices and various side-payments, but each pricing system has potential short-run inefficiencies, distorted investment incentives, magnitude of subsidies, instability, or other problems. My research attempts to measure the efficiency of these proposals so that relative benefits can be appropriately evaluated.
ISOs obtain schedules by solving the unit commitment (UC) problem, which is a non-convex, NP-hard mixed integer programming problem. Prices are subsequently determined using various modifications that convexify the UC problem. However, poor economic properties of the resulting prices could result in significant inefficiencies if market participants do not offer their true costs and capabilities. Standard analyses rely on modified forms of competitive equilibrium to prove the validity of a specific pricing model but offer no method to compare alternatives. This paper will evaluate alternative proposals using a learning algorithm for the Multi-Armed Bandit problem to estimate market participant behavior and measure the resulting market inefficiency.

Biographical sketch:
Brent Eldridge is a fourth-year PhD student at Johns Hopkins University in Baltimore, Maryland, USA. His research uses techniques from operations research to improve the economic efficiency of electricity markets in the areas of optimal power flow and nonconvex pricing. He previously received a B.S. in Industrial Engineering from Texas A&M in College Station, Texas, and an M.S. in Industrial Engineering and Operations Research from the University of California in Berkeley, California, USA. He currently works in the Office of Energy Policy and Innovation at the Federal Energy Regulatory Commission in Washington, DC, USA.

Chenling Fu

Supervisor: **Brian Fath**

Research project: **MATERIAL FLOW-STOCK NETWORK MODEL OF URBAN METABOLISM—AN APPLICATION IN THE GLOBAL MEGACITY BEIJING**

Abstract:
Cities consume most of the world's natural resources, of which over one-half is stock materials, which are processed and manufactured to provide services for human benefits. Existing research on flow-stock metabolism is rough and not detailed to the sector, while the network research on a sector scale often focuses on flows and ignores the important role of stocks. In this study, a Material Flow-Stock Network (MFSN) model based on an urban metabolic perspective will be established and applied to Beijing, a global mega-city. First, we divide the urban system into 7 sectors, including agriculture, industry, domestic industry, transportation, construction, recycling industry and environment. We use bottom-up material flow analysis to calculate the flow and stock of each sector and their transformation among different sectors. The methods allow one to identify exactly how much flow translates into stocks accumulated in urban systems, and how they flow and accumulate among sectors. Then, we use Ecological Network Analysis to investigate the characteristics of the urban network system and evaluate it. The Flow Analysis and Storage Analysis are used for accounting the integrated flows and stocks. Based on them, we use System Robustness and Finn's Cycling Index to evaluate the cycling rate and stability of the system, thus identifying the critical material and sector that affects the metabolic process of Beijing. The results can provide scientific support for resource extraction, stock management, and recycling of urban resources towards a goal of increasing resilience and promoting a circular economy.

Biographical sketch:
Chenling Fu graduated (June 2017) from Northwest Normal University. She is currently a 2nd-year PhD candidate at School of the Environment, Beijing Normal University since 2017. Her current research focuses on the material stock and flow issues at an urban level using a systems perspective. Her main fields of scientific interest include: system dynamics, material flow analysis, ecological network analysis, input-output analysis, and resource management policy-making processes for socio-economic systems.

Roope Kaaronen

Supervisor: **Nikita Strelkovskii**

Research project: **THE CULTURAL EVOLUTION OF SUSTAINABLE BEHAVIOUR: AN AGENT-BASED MODELLING APPROACH**

Abstract:
Environments cause behaviors, behaviors cause attitude change, attitude change causes behaviors and behaviors change environments. This much is known from decades of research in psychology, cognitive science, ecology and theories of (cultural) evolution. It is also widely understood that human behavior, in particular, is a major driver for most of the ongoing ecological crises. Widespread behavior change is required for sustainable socio-ecological transitions. We need to consciously instigate the cultural evolution of sustainable societies. What is less well understood is how this should be done most efficiently: Do we require individual-level change in environmentally significant behaviors or a top-down approach? By adopting a pattern-oriented agent-based modelling approach, this research project will model the loopy, nonlinear emergence of behavioral cultures to help identify how they are most efficiently changed. The model will illustrate how we can leverage the feedback-loops of behavioral systems towards a more sustainable trajectory. The model design is based on Kurt Lewin's simple equation: $B = f(P, E)$. Simply, behavior (B) is a function (f) of the person (P) and their environment (E). The model will illustrate how environmental action-opportunities (affordances) affect our behavior, how we take part in designing the affordances within our everyday environments (niche construction) and how these influence the ways in which we think and act. The model also includes elements of networks and social learning. This research will, among other things, help us understand the self-reinforcing nature of cultures and behavior patterns, and has policy implications for environmental policy and design.

Biographical sketch:
Roope is an ecologically minded multidisciplinary researcher at the Helsinki Institute of Sustainability Science, University of Helsinki. He graduated with a Master's degree in Environmental Policy from the University of Helsinki in 2016 and is currently a 3rd year PhD student. His research interests include environmental behavior and cognition, socio-cognitive aspects of ecological crises, ecological and environmental psychology, complex systems and philosophy of science. His thesis is titled Steps to a Sustainable Mind. Roope also enjoys writing popular science and writes regularly for independent magazines. In his free time, Roope is an amateur musician who loves nature, hiking and coffee.

Christopher Krapu

Supervisor: **Matthias Wildemeersch**

Research project: **ASSESSMENT AND PROBABILISTIC FORECASTS OF CROPLAND LOSS DUE TO LAKE EXPANSION IN THE NORTH AMERICAN INTERIOR**

Abstract:
Geographically isolated or upland wetlands in terminal basins act as integrators of hydrological inputs over both space and time. Consequently, extended dry and wet periods can lead to dramatic contraction or expansion in the area inundated by shallow water bodies. In this work, we will conduct an analysis of the impact of this phenomenon induced by millions of isolated wetlands on agriculture in central North America's Prairie Pothole Region and attempt to attribute any salient trends to either anthropogenic or natural causes. We will integrate over thirty years of Landsat-derived observations of ponded water extent and US land use data to quantify the impact of hydroclimatic variability on the value of the region's cropland and its agricultural production. In order to both account for uncertainty in our observations and take advantage of prior knowledge regarding wetland processes, we will utilize a novel hybrid statistical-mechanistic model of wetland dynamics and estimate its parameters with variants of Markov chain Monte Carlo designed for high-dimensional problems. By using these newly developed Bayesian models of spatiotemporal processes, we will attempt to forecast trends in availability of arable land under varying future climate scenarios derived from CMIP5 projections within a framework that allows for holistic uncertainty quantification. This work will help expand our understanding of terminal wetlands from small scale studies over 10^2 basins to 10^5-10^6 sites across a range of land use types.

Biographical sketch:
Chris is a 5th year PhD student in civil and environmental engineering and is also pursuing a concurrent MS in statistics at Duke University. His research focuses on Bayesian modelling of large spatiotemporal datasets and hybrid stochastic-physical models. Prior to graduate school, Chris received a bachelor's degree in physics at Macalester College and worked as a database engineer.

Hanspeter Wieland

Supervisor: **Brian Fath**

Research project: **ASSESSING THE ROBUSTNESS OF GLOBAL IRON & STEEL SUPPLY CHAINS OVER TIME (1995-2015) TO IDENTIFY VULNERABILITY HOTSPOTS IN TRADE NETWORKS**

Abstract:
Iron is a strategically important resource for industrialized and industrializing economies. Trade plays a crucial role in securing the supply of those countries in which ores are not extracted. In 2015, only five countries (BRIC + Australia) accounted for 85% of global iron ore extraction. The intensifying spatial disconnect (between extractors-processors-users), unprecedented growth rates of global extraction (ca. 9% p.a.) and the threefold increase of trade volumes since 1995, signify a highly dynamic global iron-steel (I-S) supply chain network that is going through profound structural change. Growing fragmentation and complexity of internationally spread I-S supply chains increase the vulnerability of the network to supply chain disruptions where an actor is affected by a political intervention or some other unanticipated events like natural disasters. The overarching goal of my project is to elucidate vulnerability hotspots within global I-S supply chains by assessing internal structure and robustness of the network. This work is based on a global physical input-output (IO) model for I-S, currently developed in the FINEPRINT project (www.fineprint.global). I will apply ecological network analysis (ENA) to identify key actors and assess different network properties and their development over time (1995-2015). Using information-based ENA, I will analyse the robustness of the network, i.e., the balance between efficiency (specialisation) and redundancy (diversity) in the system. Particular attention will be paid to geographical patterns and the role of 'global players' like China, Japan, United States and Germany. Additionally, I will compare various ENA metrics with selected material flow indicators, e.g., the material footprint, to discuss the different viewpoints of the methodologies.

Biographical sketch:
Hanspeter Wieland is a first-year PhD candidate at the Institute of Social Ecology (SEC) at the University of Natural Resources and Life Sciences, Vienna. He has an educational background in Electrical Engineering. Hanspeter received a Bachelor's degree in Sociology from the University of Vienna, and a Master's degree in Social Ecology from SEC. Since 2014, Hanspeter is associated with the Institute for Ecological Economics at the Vienna University of Economics and Business. His research focuses on the role of international trade in the social metabolism. He combines multi-regional input-output modeling and material flow analysis to investigate global displacements of environmental pressures associated with economic activities, e.g. greenhouse gas emissions or the use of energy and metallic minerals.

Talita Cruz

Supervisor: **Shonali Pachauri**

Research project: **MODELLING SOCIAL HETEROGENEITY IN INTEGRATED ASSESSMENT MODELS (IAMS): HOW A BETTER REPRESENTATION OF INCOME INEQUALITY AFFECTS MITIGATION POTENTIALS IN BRAZIL**

Abstract:
Despite the importance of social heterogeneity in household energy consumption patterns affecting greenhouse gas emissions, most Integrated Assessment Models (IAMs) used to explore climate mitigation scenarios are limited in the way they represent income distribution and poverty. This research has the objective of analyzing how introducing social stratification in IAMs might affect the analysis of mitigation scenarios. It will assess this by exploring a pilot case for the residential sector in Brazil. For this purpose, a residential energy model will be developed employing a structural model of household energy choice calibrated using micro-datasets from Brazil's nationally representative household surveys. Demands for fuels and electricity in this model will be estimated at a household level to distinguish populations by income and rural and urban location. The residential energy model will be developed as a standalone satellite model to be soft linked with an IAM, so that macro-economic feedbacks from a larger energy system on residential energy use – particularly via energy prices – can be captured. The chosen IAM in this case is the Brazilian Land Use and Energy System – BLUES model, developed at COPPE-UFRJ/Brazil. BLUES is the result of concentrated efforts to update the MESSAGE model platform structured for Brazil (MESSAGE-Brazil). The BLUES model will be provided with estimates of the residential sector energy demand that it will need to supply at a minimum cost.

Biographical sketch:
Talita Cruz graduated in 2013 with a bachelor's degree in Economics from UFF and has a master's degree in Energy Planning from COPPE. She is currently a third year Ph.D. candidate with the Energy Planning Program at COPPE/UFRJ in Rio de Janeiro. Her research focuses on incorporating social heterogeneity in Integrated Assessment Models (IAMs). She is also a member of the research group at the "Center of Energy and Environmental Economics (CENERGIA)" Laboratory and a research collaborator at Euro-Mediterranean Centre on Climate Change (CMCC). Her main fields of scientific interest include income inequality, household energy use and climate change mitigation.

Matthew Gibson

Supervisor: **Narasimha Rao**
Co-supervisor: **Arnulf Grübler (TNT)**

Research project: **FOOD-ENERGY NEXUS OF GRAIN SUPPLY CHAINS IN INDIA: MODELLING THE ROLE OF ENERGY IN REDUCING FOOD LOSS**

Abstract:
The UN's Sustainable Development Goals (SDGs) are intrinsically interlinked, and effective policy intervention rests on understanding their synergies and trade-offs. Food systems are at the confluence of many SDGs, and research has typically looked at yield and production, with less understanding of the losses in these systems. Literature is clear that energy input plays a key role in enabling control of temperature and moisture to reduce food loss. However, the trade-off between food loss profiles against the useful energy demands required to deliver these improvements is not well characterised. This study looks at this trade-off from the perspective of India. The key objectives are: 1) to utilise grain loss survey data from the Indian Council of Agricultural Research, grain production data, and IPCC emission factors to generate annual cereal tonnage loss and GHGs for each of India's 14 mainland agro-climatic zones; 2) using sensible and latent heat considerations, model the useful energy removal demands to minimise losses from poor temperature and moisture conditions. Modelling work will be undertaken in Python, with the major parameters of interest resolved and mapped at regional and national scale. Outputs from this study will give an assessment of the magnitude of GHG emissions from current rates of cereal storage loss in India and the useful energy required to control temperature and moisture to reduce these losses. Bottom-up data and modelling of sustainable food systems in India will complement existing top-down approaches. Finally, it will offer an analytical framework with a view to extending the methodology to other South Asian and sub-Saharan African countries.

Biographical sketch:
Matthew Gibson graduated with a BSc degree in Physics from Durham University, UK (2013) and completed his Master's degree in Sustainable Energy Futures from Imperial College London (2015). He is currently a first-year PhD student, continuing his research at Imperial College London, after a period in industry working in clean tech development. His main field of scientific interest lies in understanding the complexity of sustainable development systems, with a focus on the UN's Sustainable Development Goals. His research looks to develop methods, including computational tools, to understand some of the key dynamics of sustainable development to support effective evidence-based policy-making.

Christine Hung

Supervisor: **Paul Natsuo Kishimoto**
Co-supervisor: **Arnulf Grübler (TNT)**

Research project: **COUPLING LIFECYCLE ASSESSMENT, VINTAGE STOCK MODELS AND IAMS: PRESCRIBING POLICY FOR THE SUSTAINABLE TRANSPORT ELECTRIFICATION PATHWAYS**

Abstract:
Electrification of the transport sector has been hailed by politicians, vehicle manufacturers and citizenry alike as a key climate change mitigation measure. However, previous lifecycle assessment (LCA) studies have found that electric vehicles generally have higher production emissions than conventional vehicles, thereby placing constraints on the effectiveness of electrification as a mitigation measure. Combining LCA and integrated assessment models (IAMs) such as MESSAGE offers an opportunity to assess electrification pathways and their environmental/climate change impacts.
This work encompasses the soft-linking of a parameterized lifecycle assessment-dynamic stock model of the passenger vehicle fleet in Europe to the MESSAGE IAM. The proposed approach combines the high technological resolution provided by LCA and the modelling of the global economy from MESSAGE. By optimizing the stock model towards minimum climate emissions while satisfying projected transport demand and resource constraints, we map the characteristics of sustainable electrification pathways compatible with specific climate targets towards 2050. This work will quantify the influence of key attributes of the passenger vehicle fleet and vehicle technologies on the environmental impact of the fleet, while capturing the dynamic nature of technological inertia and development in the vehicle fleet. The results of this work can then be used to prescribe effective and sustainable transport electrification policy.

Biographical sketch:
Christine Hung is a second-year PhD candidate at the Industrial Ecology Programme at the Norwegian University of Science and Technology (NTNU). Her PhD work uses industrial ecology approaches to assess environmentally optimized electric vehicle uptake pathways in Europe. Her research interests include the environmental assessment of electric vehicles at product and fleet levels and of emerging technologies. She received her Bachelor's degree in Chemical and Process Engineering from the University of British Columbia, Canada in 2008 and her Master's in Industrial Ecology from NTNU in 2010.

Aishwarya Iyer

Supervisor: **Alessio Mastrucci**
Co-supervisor: **Narashima Rao**

Research project: **INDIAN RESIDENTIAL BUILDINGS: FUTURE GROWTH AND ENERGY IMPACTS**

Abstract:
India is a global hotspot for urban development. 75% of the Indian buildings projected to exist by 2030 are yet to be built, and the floor space is also expected to double by then. The energy demand and environmental impacts from this massive uptake of construction are expected to be significant. Mapping the growth of cities and analyzing material and energy needs of expansion is therefore paramount to identifying sustainable development pathways. This work will project possible growth patterns for five major Indian cities and analyze energy requirements of this growth.

Using existing urban residential housing data, this project will estimate expansion of cities by identifying influential parameters such as migration patterns and service intensity of residential buildings. A statistical model will then map out the growth through different possible development scenarios. The project also will use current and potential future residential building archetypes to model this growth in a detailed manner for the subsequent energy analysis. The energy usage of the archetypes will vary for the five cities due to regional climatic conditions and usage patterns. The energy analysis of these scenarios of urban growth will be performed using the widely used EnergyPlus.

Anticipated to be the most populated country by 2030, India emerges as an important area to focus climate change mitigation efforts. Understanding the growth of urban areas is key to these efforts as the urban population in India is growing rapidly and adopting low-emission practices in cities can help pave a cleaner path to development.

Biographical sketch:
Aishwarya Iyer graduated with a B.Tech in Energy Science and Engineering, and M.Tech in Energy Systems Engineering from the Indian Institute of Technology, Bombay in August 2018. She is now a first-year PhD student at the School of Forestry and Environmental Sciences at Yale University, and works with the Yale Center for Industrial Ecology. Her main fields of scientific interest include energy systems and transitions analyses using LCA and MFA, and economic tools.

Stefanie Klose

Supervisor: **Volker Krey**
Co-supervisor: **Jihoon Min**

Research project: **UNDERSTANDING THE IMPACTS OF BIOPHYSICAL CONSTRAINTS ON IAM RESULTS – LINKING A BOTTOM-UP DEMAND-SIDE MODEL AND THE MESSAGE MODEL: THE CASE OF COPPER**

Abstract:
Technology-rich and scenario-based integrated assessment models (IAMs) are essential to quantify the possible future effect of sustainable development strategies and to identify the most promising development pathways for climate change mitigation. While most of the published IAMs contain considerable detail for energy conversion technologies and greenhouse gas emissions, there is little progress regarding the inclusion of material cycles, vintage tracking, the level of detail, and the dynamics of sectors other than the energy sector. However, material cycles and their development over time are important linkages between the society's biophysical basis and sustainable development. In particular for the transition to a low-carbon future, the consideration of the availability of metals and the life cycle perspective on technology are crucial to allow a comprehensive assessment of emission mitigation strategies. Therefore, the objective of this study is to link a bottom-up, product specific demand-side model of the copper cycle to the MESSAGE model. A common scenario description will be developed to make an assessment of the most sustainable transition pathways and determine strategies best aligned with climate change objectives by minimizing greenhouse gas emissions from the copper cycle. This study will help to understand the relevance of in-use stocks and flows, vintage tracking and waste treatment for climate change mitigation pathways. Thus, it is an important step towards the integration of the IAM and IE perspectives on society's biophysical basis and will help to provide more profound political advice.

Biographical sketch:
Stefanie Klose graduated in 2013 from the University of Heidelberg in Physics. She is currently a third year PhD student at the University of Freiburg at the chair of Industrial Ecology. The title of her thesis is prospective analysis of sustainable metal cycles. Her main field of scientific interest includes modeling and scenarios of socio-economic metabolism as well as linking socio-economic metabolism with climate change.

Alexandra Nutkiewicz

Supervisor: **Alessio Mastrucci**

Research project: **CHARACTERIZATION OF URBAN INFORMAL SETTLEMENTS IN THE DEVELOPING WORLD: ASSESSING KEY DESIGN PARAMETERS TO IMPROVE THERMAL COMFORT AND BUILDING ENERGY CONSUMPTION**

Abstract:
By 2030, over 2 billion people will be living in informal settlements worldwide. Characterized by poor quality of life with regard to sufficient living area, thermal comfort, and energy access, there is a massive push for slum redevelopment, where subsequent design decisions will impact cities for 50+ years. However, most research related to exploring how design decisions affect energy use and ensuing cooling needs have been focused in developed countries, largely because built environments in the developing world lack data to describe them. Our research aims to establish a novel energy simulation-based methodology for developing archetypes to characterize low-income settlements across varying global and climatic contexts. Using these archetypes, we expect to learn the key building design parameters that most strongly affect their thermal and subsequent energy performances.
The methodology, which includes a sensitivity analysis of influential building design parameters and a parametric analysis of various retrofit options for existing settlements, will allow building designers to estimate the energy needs for maintaining adequate thermal comfort. Building designers and engineers can subsequently develop targeted solutions for improving occupant comfort without needing to introduce energy-intensive, widespread active cooling measures. This work can help inform policymakers on specific retrofit or redevelopment design guidelines that can subsequently reduce the required energy needed to achieve “decent” living conditions. As a result, this project has significant implications for how to inform informal settlement redevelopment in order to enhance occupant living conditions and set our cities on a pathway to a sustainable energy future.

Biographical sketch:
Alex Nutkiewicz is a PhD Candidate in the Department of Civil & Environmental Engineering and a member of the Urban Informatics Lab at Stanford University. Her research is focused on understanding how urban environments influence building energy consumption and how those insights can drive energy-efficient design and retrofits. Prior to starting her PhD, she completed her B.S. in Sustainable Engineering and M.S. in Sustainable Design & Construction also at Stanford.

Jun Ukita Shepard

Supervisor: **Bas van Rujven**

Research project: **A REPRESENTATION OF TRANSPORTATION AND TRADE NETWORKS IN GLOBAL ENERGY MODELS**

Abstract:
Complex networks of trade and transportation underlie the global energy economy. Yet current models do not typically address the dynamics of these networks. Given the path dependence of trade and shipping, historic trade relations could dictate whether and how two countries engage in trade in the future. This is particularly important to model in the context of energy transitions, as shifting demand will break existing trade linkages while forming new ones. My project will introduce the dynamic nature of such networks to the MESSAGE model.

The project will first use shortest path algorithms to map sea routes among countries represented in the MESSAGE model. In doing so, we can assign dynamic transportation costs for energy resources and material components. We will then link this shortest path algorithm to a large database of bilateral trade. This database allows us to observe key links between countries trading energy resources and technology components. We can use this historical data, in conjunction with the shortest paths, to illustrate stability and volatility in trade linkages.

We can use these underlying data on transportation and trade to recalibrate the regional system cost calculation in the MESSAGE model using dynamic shipping costs. The updated model would be able to simulate shifts in trade and transportation networks, thus allowing us to examine the effects of trade shocks, technological transitions, and their implications for international energy security.

Biographical sketch:
Jun is a PhD student in the Division of Earth and Ocean Sciences at Duke University's Nicholas School of the Environment. Her research focuses on global energy systems in the context of trade, with the goal of better understanding international energy security. Jun holds an A.B. in Environmental Science and Public Policy (Harvard University) and an MPhil in Environmental Policy (University of Cambridge). Prior to matriculating at Duke, she worked for two years as a research fellow in the Economics department at Brown University.

Manan Bhan

Supervisor: **Steffen Fritz**
Co-supervisor: **Inian Moorthy**

Research project: **DO MORE TREES MEAN MORE CARBON? A CHANGE DETECTION ANALYSIS OF ASIAN TROPICAL FORESTS**

Abstract:
The magnitude and extent of global tree cover and carbon stock change remains a key question of scientific enquiry, but the relationship between these changes have not been well-explored. Contrasting trends in direction and magnitude of change signal a deficit in our understanding of ecosystem change, with implications for climate change mitigation, demonstrated by the contradictory findings of tree cover change by Hansen (2013) and Song (2018). With tropical forests in Asia as my region of study, I aim to integrate estimates of changes in tree cover and carbon stocks to quantify the uncertainties in these estimates and evaluate the correlations existing within these directional changes at the start of the 21st century. Using a suite of geo-statistical approaches, I will outline the emerging trends that highlight the divergent estimates of tree cover and carbon stock at the country and pixel levels. By identifying 'hotspots' of change (sub-regions where change estimates particularly diverge), I will seek to explore the drivers and socio-ecological aspects of change. Finally, I will attempt to characterize these divergences based on different land management approaches in the region through Geo-Wiki's Human Impact on Tropical Forests initiative. The results are expected to provide insights on the characteristics of forest change in the region and uncover a land use signal in the identification of ecoregions with particularly divergent estimates in magnitude and direction. This assumes increased significance in the light of studies which attribute land management as a key activity in tropical Asia and dynamic socio-ecological shifts in the region.

Biographical sketch:
Manan Bhan is currently a PhD candidate at the Institute of Social Ecology, Universistät für Bodenkultur (BOKU), Vienna. Manan graduated with a Bachelors in Geology from the University of Delhi (India) and a Masters in Environmental Change and Management from the University of Oxford (United Kingdom), where he was supported by the Louis Dreyfus – Weidenfeld Scholarship Programme. Manan's research focusses on analyzing the socio-ecological transformations that have driven the changes in global vegetation carbon stocks over the 20th and 21st centuries.

Yuyoung Choi

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

Research project: **ASSESSING SYNERGIES AND TRADE-OFFS BETWEEN BIODIVERSITY CONSERVATION AND CARBON STOCK UNDER CLIMATE CHANGE IN SOUTH KOREA**

Abstract:
Forests play an important role in responding to climate change, and there is a diverse range of reasonable feedbacks of forest management such as maintaining biodiversity, increasing carbon sequestration and wood production, etc. Forest management measures to achieve each goal may have synergic effects when implemented together but there are also many conflicts among ecosystem services and corresponding measures. This research addresses the questions “Is it possible to achieve two different goals, enhancing biodiversity and forest carbon stock, to cope with climate change at the same time? Which regions and measures are the most appropriate for sustainable management of the forest?” The study aims to evaluate the national plans and strategies on forest management in response to climate change by considering diverse management impacts in South Korea’s forests. In order to achieve this, we will establish spatial scenarios of forest management strategies including afforestation, species selection, and thinning. Through building a spatially-explicit methodology that can apply scenarios into the spatial prediction models, we are going to derive the change in biodiversity, biomass and carbon sequestration by applying such tools as Generalized Dissimilarity Modelling (GDM) and Global Forest Model (G4M). As a result, multi-dimensional impact of each forest management scenario will be analyzed. Finally, we will present what kind of forest management should be prioritized in each region. It could support future policy making by presenting the synergies and trade-offs between biodiversity and carbon stock depending on various forest management plans.

Biographical sketch:
Yuyoung Choi holds a degree in Environmental Science and Ecological Engineering, Korea University. She is currently at the fourth year of an integrated Master and PhD course in Environmental Planning and Landscape Architecture at Korea University. Her main fields of scientific interest include climate change adaptation, environmental planning and policy, ecosystem services and biodiversity conservation. She is working on several research projects which assess national climate change adaptation policies, deriving priority risk of climate change and assessing forest health. She has published several journal articles on climate change responses based on ecological modelling using such tools as GIS, Remote Sensing, and R language.

Bertram de Boer

Supervisor: **Michael Obersteiner**
Co-supervisor: **Hugo Valin**

Research project: **RED II'S CONTRIBUTION TO JOB AND GDP GROWTH**

Abstract:
The European Union (EU) needs to drastically change its energy system to meet its climate goals. To enact this change, the EU follows a three-pronged approach, namely reducing greenhouse gas emissions, increasing energy efficiency and increasing the share of renewable fuels. This approach promises to create new opportunities for jobs and GDP growth. It is unclear however, what the contributions of each approach are to this promise. This study focuses on the latter approach, i.e. increasing the share of renewable fuels through the Renewable Energy Directive II (RED II). We implement the targets of RED II in GLOBIOM in connection with EXIOBASE to assess job and GDP growth caused by RED II. We find that while growth is expected to occur in sectors related to biomass, this comes at the cost of losses in other sectors. Finally, we offer a number of recommendations to account for these socio-economic changes caused by RED II.

Biographical sketch:
Bertram de Boer is a PhD candidate in the Industrial Ecology department of the Institute of Environmental Sciences at Leiden University in the Netherlands. He has a strong interest in quantitative policy-relevant research, and currently focuses on quantifying trade-offs in environmental policy using input-output analysis. Previously he worked on the PRINCE project which aimed to develop a platform to continuously monitor the environmental footprints of Swedish consumption, and on the JRC PYP-UPDATE project focused on estimating previous-year-prices supply-use and input-output tables. He holds a Master degree in Artificial Intelligence from the University of Amsterdam, and a bachelor degree in Electrical Engineering from The Hague University of Applied Sciences.

Carlos Andrés García Velásquez

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

Research project: **ENVIRONMENTAL CONCERNS OF THE USE OF BIOMASS FOR BIOPLASTICS PRODUCTION AND ITS CONSEQUENCES IN THE ECONOMIC PERFORMANCE**

Abstract:
Bio-based plastics arose as an alternative for the wholly or partly substitution of fossil-based plastics. Nevertheless, it is still unclear if the use of biomass for the production of bioplastics can mitigate the environmental impact due to fossil fuels due to concerns regarding the increased pressure for land and other natural resources (i.e., water). In this sense, the main goal of this proposal is to evaluate the environmental influence of the carbon emissions (land use and biomass value chain) in the economic performance of the bioplastics production. Carbon emissions from the land use and the biomass value chain are calculated based on the loss of carbon content due to land transformation and Life Cycle Assessment (LCA), respectively. On the other hand, the economic performance of the bioplastic production can be assessed through two approaches: i) monetization of carbon emissions, and ii) multi-criteria decision analysis. The first approach considers the implementation of a 'carbon cost' in the direct and indirect CO_2 emissions, whereas the second approach is considered as an interpretation-oriented tool that allows determining possible solutions (decision-making) based on different criteria (i.e., economic and environmental). The comparison between these two approaches will help to understand the proper way to analyze the biomass value chain, considering an extra cost due to CO_2 emissions or trade-offs between the economic and environmental criteria.

Biographical sketch:
Carlos Andrés is a PhD candidate in the Aachen-Maastricht Institute for Bio-based Materials (AMIBM) under the H2020-MSCA-ITN project "FibreNet". In 2016, Carlos Andrés obtained the Master degree in chemical engineering with his thesis entitled "Hydrogen production through gasification and dark fermentation", from which he also received a *magna cum laude* distinction. In the same year, he was awarded as "Green Talent" by the German Ministry of Education and Research for his contribution in the promotion of sustainable ideas for the valorization of biomass residues in Colombia. His main fields of scientific interest include the physicochemical characterization of Lignocellulosic biomass, Gasification of forest/agriculture biomass, Conceptual design of biorefineries, Techno-economic analysis (TEA) and Sustainability Assessment.

Rory Gibb

Supervisor: **Piero Visconti**
Co-supervisor: **Támas Krisztin**

Research project: **ACCOUNTING FOR LAND USE AND CLIMATE CHANGE UNCERTAINTY IN PROJECTIONS OF ZOONOTIC DISEASE UNDER GLOBAL CHANGE: A CASE STUDY OF LASSA FEVER IN WEST AFRICA**

Abstract:
Anthropogenic global changes (climate, land use, biodiversity loss, socioeconomic change) are predicted to cause changes in incidence of many zoonotic and vector-borne diseases (e.g. Zika, Ebola, malaria). Projections of zoonotic disease incidence and associated uncertainty under future scenarios are therefore needed to inform public health and environmental policy. Disease risk emerges from complex interactions between multiple drivers, but regional-scale predictive modelling has focused mainly on climate effects, with few attempts to account for interactions with other equally-important system processes. In particular, land use change is a key influence on disease transmission, but the effects of future land use change on zoonotic disease outcomes are neglected in assessments of human health and ecosystem services under global change. In this project, I will incorporate spatially-downscaled projections of future land use change (from IIASA's GLOBIOM model) and climate change (from an ensemble of GCMs) into a spatially-explicit systems model of zoonotic spillover at the human-reservoir host interface, to evaluate the effects of future socio-environmental scenarios (2-3 RCP-SSP combinations) on predicted human zoonotic disease incidence at three epochs (2030, 2050 and 2070). As a case study, this project will focus on Lassa fever (LF), an emerging rodent-borne viral hemorrhagic fever endemic to West Africa, and which is predicted to respond strongly to environmental change in upcoming decades. In particular, I will focus on evaluating how within-scenario uncertainty in the extent and spatial pattern of future land use (based on multiple realizations per-scenario) impacts both total predicted human LF cases and their geographical extent. This will allow for more robust identification of high-risk regions and agriculture-disease trade-offs under future conditions, and represent a step towards developing zoonotic disease models that could substantively inform spatial land use planning.

Biographical sketch:
Rory Gibb is a third-year doctoral candidate in disease ecology at the Centre for Biodiversity and Environment Research, University College London (UCL). Prior to this he graduated with an MRes in Biodiversity, Evolution and Conservation from UCL (2015), and BSc in Biology from University of Bristol (2008), and is involved in several ongoing biodiversity monitoring and modelling projects. His research focuses on effects of environmental change on ecosystems, biodiversity and human health, with a particular focus on zoonotic and vector-borne disease. For over a decade he has also worked professionally as a freelance writer, journalist and editor.

Daniel Johnson

Supervisor: **Linda See**
Co-supervisor: **Támas Krisztin**

Research project: **MITIGATION OF THE URBAN HEAT ISLAND EFFECT: AN ECONOMIC ASSESSMENT OF THE POTENTIAL OF GREEN INFRASTRUCTURE**

Abstract: With high rates of urbanization and elevated temperature levels as a result of climate change, cities are becoming increasingly stressed with the so-called urban heat island effect. This effect has been shown to have negative impacts on human health in urban areas. Increasing the amount of green in cities through green infrastructure is recognized as one method to combat heat-related mortality and hospital costs. Green infrastructure, such as urban trees, façade greening and green roofs provide numerous ecosystem services, including the reduction of the urban heat island effect as a result of additional shading and increased evapotranspiration.

This research project shall compare the reduction of the urban heat island effect using a building scale model and an urban climate model. Results of this analysis will be integrated in an economic analysis of green infrastructure for mitigating the urban heat island effect by assessing the reduction of the risk for heat-related mortality and morbidity. Therefore, this research project investigates the mitigation of the urban heat island effect through green infrastructure implementation as well as develops a methodology for estimating the economic value of this mitigation. The results of this project will benefit planners and decision makers to design optimal combinations of green infrastructure to achieve the greatest benefit to society.

Biographical sketch: Daniel Johnson is currently in his third year of his PhD and works as a research assistant and coordinator of the SustBusy Research Center at ESCP Europe Berlin. His focus lies in the field of environmental economics and has a keen interest in urban ecosystem services and green infrastructure. Using methods in environmental economics, Daniel pursues increasing the awareness and the value of ecosystem services. Daniel received his M.Sc. in Water and Environmental Management from Leibniz University of Hannover in 2016 and his B.Sc. in Environmental Management from the Brandenburg University of Technology in 2014.

Julian Joseph

Supervisor: **Tamás Krisztin**
Co-supervisor: **Michiel van Dijk**

Research project: **AGRICULTURAL PRODUCTIVITY AND FDI IN LAND IN SUB - SAHARAN AFRICA: A REGIONAL ECONOMETRIC APPROACH**

Abstract:
Foreign direct investments in developing countries especially those in land have drawn substantial media and academic attention in the last years. Farming is likely to be influenced and smallholder farmers might either be positively affected due to spillover and learning effects from big agricultural firms or adversely given the lowered supply of essential resources such as water and land. The vast majority of literature relies on country-level observations, due to the lack of reliable sub-national statistics in Sub-Saharan Africa. In order to assess regional spillovers of FDI in land, we rely on aggregate spatially explicit household level data. The combination of the Living Standards Measurement Study - Integrated Surveys on Agriculture (LSMS-ISA) household surveys as panel data (2011 and 2015/16) for Ethiopia, Uganda, Tanzania, and Malawi and the data available on foreign land acquisitions through the Land Matrix project allow for a comparison of control groups with treated farmers households within proximity to large land deals. Their yield gaps are analyzed in a regression framework incorporating their distance from the foreign investor and agronomic endowments which can be obtained from spatially explicit data within the LSMS-ISA. Average yield gaps as well as per crop gaps will be considered as indicators for productivity. The aim is to identify whether farmers close to FDI in land exhibit significantly lower or higher productivity.

Biographical sketch:
Julian graduated from the University of Economics and Business in Vienna in Economics in 2017 and started his PhD in Economics at the same university in early 2018. After a brief intermission used for working on the evaluation of a development programme in Malawi for half a year he is now back in Vienna to continue work on his thesis. The thesis and his main academic interests revolve around development economics, particularly in agriculture and foreign capital flows into developing countries' agricultural sectors.

Zitong Liu

Supervisor: **Rastislav Skalsky**
Co-supervisor: **Juraj Balkovic**

Research project: **MODEL BASED APPROACH FOR MANAGING NITROGEN FOR SUSTAINABLE WHEAT-MAIZE ROTATION**

Abstract:
Sustainable nitrogen (N) management in agriculturally intensive regions in China is critically important with respect to crop productivity, profitability, and ecological protection. In this study, we tested three widely used crop models (EPIC, APSIM, and DSSAT) to simulate wheat-maize yields, the long term economic optimum N rate (NPOR, e.g., in terms of the gross revenue from yield minus the costs of N fertilizer), the ecological optimum N rate (NEOR, e.g., in terms of the benefits of economical systems minus the costs of eutrophication, soil acidification, and global warming) based on a 10-year field experiment from the Quzhou (QZ) comprehensive Experimental Station (36.9°N, 115.0°E), China. The experiment included five N fertilizer rates in a winter wheat-summer maize rotation. The objectives were to: (a) calibrate and evaluate the three models for the wheat-maize production system, and quantify model prediction accuracy among the three models; (b) utilize the calibrated model to estimate the yield, NPOR and NEOR, and explain factors causing year to year variability in yield, NPOR, NEOR; and (c) use the models and simulated climate data from 2020-2050 to design the optimum management practices to achieve objectives for NPOR and NEOR. Current farmer practice in this region is to apply approximately 500 kg N ha^{-1}. It is expected that this research will lead to management strategies based on future weather that will optimize NPOR and NEOR, leading to increased farmer net return and reducing N losses. N management using the NPOR and NEOR provides a win-win opportunity and should be prioritized in agricultural research and practice. I have collected and collated the data needed for the three models, and already mastered their application. During the summer, I hope to learn the principle of crop modeling, then complete the objectives listed above.

Biographical sketch:
Zitong Liu is a third-year Master - PhD combined program graduate student in the Plant Nutrition Department at China Agricultural University in China. In 2015, she received her Bachelor's degree at Sichuan Agricultural University in China. Her research interests include potential yield and yield gap analysis, Nitrogen Use Efficiency and Environmental Cost. The title of her PhD thesis is "Simulating Yield Gap, Nitrogen Use Efficiency and Environmental Cost of Wheat and Maize at County Level in China." From 2016 to 2017, Zitong Liu served as Minister of Environment Protection Alliance department in the students' union at China Agricultural University. From 2016 to 2019, Zitong Liu worked as a research assistant for the resource management group.

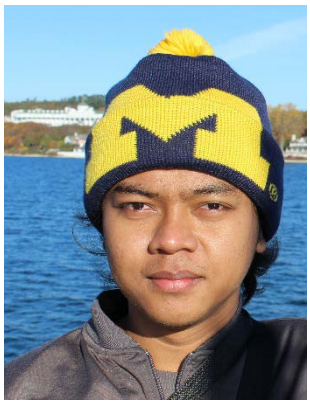
Lilit Ovsepyan

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

Research project: **ENVIRONMENTAL BENEFITS RELATED TO CARBONSEQUESTRATION AFTER LAND USE CHANGE**

Abstract:
Most land use changes (LUC) significantly affect the amount of carbon (C) sequestered in vegetation and soil, thereby, shifting the C balance of ecosystems. Ongoing on 220 million hectares worldwide, the abandonment of agricultural lands is an important phenomenon triggered by both ecological and socio-economic reasons. In the Russian Federation, a massive cropland abandonment was caused by the collapse of the Soviet farming system in early 1990s and now about 40 million ha (or ca. 50% of the currently cultivated area) is still remain unused. Abandonment of agricultural land leads to the substantial C sequestration in vegetation and soils and their self-restoration and development towards zonal natural ecosystems. Therefore, agricultural abandonment may be a significant and low cost strategy for carbon sequestration and mitigation of anthropogenic CO_2 emissions due to the vegetation recovery and increase in soil organic matter. The proposal is aimed to (i) provide geographically complete and spatially detailed analysis of C sequestration rate in abandoned lands and enhance the database of C sequestration after LUC in Russian Federation, (ii) estimate effect of croplands abandonment in Russia on national C budget, and (iii) develop the algorithms for implementation of croplands abandonments in the National Cadaster of Emissions and Removals of Greenhouse Gases and Russian national reporting to IPCC, as well as for economic valuation of ecosystem services of abandoned lands.

Biographical sketch:
Lilit Ovsepyan is a young researcher in the Dept. of Soil Cycles of Carbon and Nitrogen (Institute of Physicochemical and Biological Problems in Soil Science, Russian Academy of Sciences). In 2011, she graduated from Russian State Agricultural University in Moscow with a specialist degree in agricultural ecology. In May 2018, she successfully defended her PhD thesis at Moscow State University. Her main fields of research interests include environment changes after land-use change and environmental management.



Yoga Wienda Pratama

Supervisor: **Piera Patrizio**
Co-supervisor: **Ping Yowargana**

Research project: **ENERGY SYSTEM PLANNING WITH ENDOGENOUS FUEL PRICE: A BILEVEL GAME AFTER THE PARIS AGREEMENT**

Abstract:
Deep decarbonization of the energy system is critical to meeting the Paris agreement on global climate change mitigation. To achieve this, various policy supports, such as carbon pricing, have been introduced. Consequently, we might see a dramatic change in our energy systems and a rapidly diminishing demand for fossil fuel in the future. Numerous studies showed that zero emissions technologies will be economically favored by technology cost learning whilst the fuel price is fixed, ignoring the dynamic interaction between the energy system and the fossil fuel industry. The diminishing fossil fuel demand might threat the fossil fuel industry's assets become stranded. This will potentially push the industry to flood the market using their proven reserves to maximize their profit before the assets stranded. Hence, the fixed fuel price approach might underestimate the economy of carbon-emitting technologies that, even though suffering from carbon pricing, might be benefited from the declining price of fossil fuel due to oversupply. This research is aimed to fill this gap by considering technology cost and fuel price as endogenous variables in the energy system planning, using the UK power system as the case study. The role of negative emissions technology, i.e. BECCS, to offset residual emissions from carbon-emitting technologies will be evaluated. Bi-level game approach will be used to imitate the interactions between the power sector and fossil fuel and biomass industries. The results of this work are expected to contribute to the comprehension of their interactions that might significantly govern our pathway to cost-effectively decarbonize the energy system.

Biographical sketch:
Yoga Wienda Pratama is a Postgraduate Research Student in the Centre for Environmental Policy and the Centre for Process Systems Engineering at Imperial College London. His PhD research focuses on multi-scale modelling and optimization of energy systems, assessing the role and value of energy conversion and storage technologies in energy systems of different system characteristics. He earned his B.Eng. and M.Eng. in Chemical Engineering from Universitas Indonesia and an M.Eng. degree in Energy Systems Engineering from the University of Michigan-Ann Arbor. In the last 5 years, Yoga has been involved in many research and consulting projects works in collaboration with various institutions, mainly related to small-scale LNG supply and energy systems designs.

Katharina Schulze

Supervisor: **Dmitry Schepaschenko**
Co-supervisor: **Steffen Fritz**

Research project: **IMPROVING EVIDENCE-BASED MODELLING OF GLOBAL FOREST MANAGEMENT PATTERNS**

Abstract:
Forest can supply different ecosystem services such as the provisioning of resources, species habitats, carbon storage, or recreation space. The extent and quality of these services depends largely on the forest management type, including harvest regime, regeneration measures and species selection. Wood harvest and forest management are important land uses activities, substantially shaping our world and its future. They stand in competition with other land use types, such as crop production, livestock grazing or urban areas. Land use models, such as IIASA's GLOBIOM, are often applied, to inform policy and decision makers about the global issues of land use driven by human demand. To identify, where competing claims potentially occur now or in the future, these models often rely on spatial datasets. But knowledge gaps on the spatial patterns of forest harvest and management persist to exist, mostly due to poor quality in the underlying data. One way of creating spatial datasets is estimating statistical models based on predictor variables and location evidence. However, the latter is lacking in many regions of the world. IIASA's Geo-Wiki has been proven to be successful for mass data collection through crowdsourcing for numerous purposes, including validation points for land cover and land use, global field sizes, cropland percentage, and comparing different land cover products. Aim of this YSSP project is to improve current available spatial data on forest management by using evidence data, collected in previous Geo-Wiki campaigns. The project will include (1) the creation of a coherent dataset of documented locations of different forest management types, (2) analyzing, which spatial drivers are affecting the occurrence of different types and (3) to create an improved spatial dataset of forest management patterns.

Biographical sketch:
Katharina is a third year PhD candidate at the Environmental Geography Department, part of the Institute for Environmental Studies at the Vrije Universiteit Amsterdam, The Netherlands. Her PhD topic is the competing land claims for biodiversity conservation, climate change mitigation and resource production and how these will affect future land use. Her main research interests encompass the current and future state of forests, sustainable management of ecosystems and conservation of biodiversity. In 2015, Katharina graduated from the dual master's program "Environmental Science" at the University of Copenhagen, Denmark and the University of Natural Resources and Life Sciences (BoKu), Vienna, Austria.

Gabriel R. Smith

Supervisor: **Oskar Franklin**
Co-supervisor: **Florian Hofhansl**

Research project: **ECOSYSTEM EFFECTS OF BOREAL N FIXATION BY BRYOPHYTES**

Abstract:
Limitation of plant growth by nitrogen (N) availability is ubiquitous and may hamper the ability of the land carbon (C) sink to buffer increases in atmospheric C. Productivity in high-latitude boreal forests is especially N limited because a harsh climate slows decomposition and N release from organic matter. Though symbiotic N fixation should be very beneficial in these environments, trees with N fixing root microbes are far more common in tropical than boreal regions. A primary source of newly-fixed N in boreal forests could instead be understory mosses that host N-fixing cyanobacteria. In support, prior empirical research finds that moss N fixation can be significant in these environments. However, it is not yet known how these N inputs affect the total productivity of boreal forests, nor have the relative growth benefits of symbiotic N fixation vs. dependence on root-symbiotic mycorrhizal fungi to augment N nutrition been compared. At IIASA, I will work on building and parameterizing process-based ecosystems models that can address this knowledge gap and help us determine how this understudied element of the boreal N cycle may affect the response of northern forests to global change.

Biographical sketch:
Gabriel R. Smith is an American ecologist currently finishing the third year of his PhD He studies fungi, focusing especially on their role in terrestrial carbon and nitrogen cycles. Gabriel earned a B.S. in Conservation Biology from the SUNY College of Environmental Science & Forestry in 2015 and spent the following year as a Fulbright Fellow at the Swedish University of Agricultural Sciences in Uppsala, Sweden. He started his Ph.D. at Stanford University in 2016.

Hoang Anh Tran

Supervisor: **Piera Patrizio**
Co-supervisor: **Juraj Balkovic**

Research project: **POLICY-RELEVANT SIMULATIONS ON CO-FIRING BIOMASS FOR ELECTRICITY IN VIETNAM**

Abstract:
Vietnam is a country with high dependency on fossil fuels for power generation. Since 2015, the country was experimented as a coal importer, represented a net coal import of 12% in 2015. Consequently, the total greenhouse gases (GHG) emissions were estimated to increase nearly 1.73 times from 2000 to 2013. Therefore, the Vietnamese Government has promulgated numerous green policies related to renewable energy development strategy, green growth strategy to increase the share of renewable energy, especially in power sector. The co-firing is one technology to be implemented according to the revised National Power Development Plan 7.
The current BeWhere model configured for Vietnam explores the potential of co-firing technology at national scale. The study provided that co-firing rice residues on coal power plants can reduce CO_2 emissions. The cost of CO_2 emissions is a key parameter determining the deployed technology of the system. Key result of the study is 8% emission reduction could be achieved by retrofitting coal power plant for co-firing in 2030 with a carbon price at 8 $/tCO2eq.
This study proposes to extend further the current version of BeWhere Vietnam model to a larger variety of biomass feedstock (including agricultural residues, energy crops, forestry) with a fully inter-temporal dynamic approach. Additionally, it will compute to achieve the share of biomass for power generation of 6.3 % by 2030 according to the Renewable Energy Development Strategy (REDS) of Vietnam. A possibility to optimize the production/application of biochar could be considered as a third objective.

Biographical sketch:
Hoang Anh Tran received her Engineer and Research Master Diplomas in Process Engineering and Environment from the National Institute of Applied Science (INSA) of Toulouse, France in 2013. She is currently a first year PhD student at ABIES – Agro Paris Tech Doctoral School in France. Her research topic entitled “Clean energy, green growth and equity in Vietnam”, aims to understand how Vietnam could participate in the global effort to mitigate climate change and to achieve sustainable development and green growth. Her main fields of scientific interest include renewable energies, sustainable development, energy modelling, energy policies and policy implications in Vietnam.

Amr Abdelwahed

Supervisor: **Raya Muttarak**
Co-supervisor: **Anne Goujon**

Research project: **YOUTH DEVELOPMENT AND MIGRATION INTENTION IN EGYPT**

Abstract:
Youth constitutes one important engine of growth and development at the societal level. At the individual level, youth is when people's personal beliefs and attitudes are shaped, leading to important life choices. The project aims at calculating the Youth Development Index (YDI) in the case of Egypt and at examining the relationship between YDI and the migration intention among Egyptian youth. The data come from the panel data survey of young people in Egypt for two years: 2009 and 2014, which correspond, to periods before and after the Egyptian revolution in 2011. The survey is the first of its kind in Egypt, conducted on youth of ages between 10 and 29 years. It focuses on key aspects of their lives including education, employment, health, family formation, migration, reproductive health, social issues, and civic/political participation. Relying on spatial analysis, we will pay particular attention to sub-national differences at governorate (province) level and look at how the YDI has been affected by the development inequalities between governorates.

Biographical sketch:
Amr Abdelwahed is a second-year PhD student at the Asian Demographic Research Institute (ADRI) at Shanghai University in China. In 2016, he received his Master's degree in Demography at Cairo University in Egypt. Amr is working as a teaching assistant at Institute of Statistical Studies and Research (ISSR) - Cairo University since 2013. Prior to his joining the ISSR, he worked for two years as a researcher in the national statistical office "CAPMAS" in Egypt. His main fields of research interest include international migration, child labor & its impact, and youth development. The title of his PhD thesis is "A Socio-Demographic Appraisal of the Causes and Consequences of International Migration from Egypt Today."

Hélène Benveniste

Supervisor: **Raya Muttarak**
Co-supervisor: **Matthew Gidden (ENE)**

Research project: **UNPACKING REPERCUSSIONS OF INTERNATIONAL MIGRATION ASSUMPTIONS IN THE POPULATION COMPONENT OF SSP SCENARIOS ONTO THEIR GDP, INEQUALITY AND EMISSIONS COMPONENTS**

Abstract:
With climate change, migration patterns are expected to change, which might in turn significantly affect income levels and distributions, and to a certain extent, greenhouse gas emissions. The Shared Socioeconomic Pathways are scenarios representing five different narratives and combinations of challenges to mitigation and adaptation. They offer projections of populations, GDP, inequality and greenhouse gas emissions over the 21st century. The five SSP population components reflect various migration assumptions. Yet, those assumptions do not explicitly translate into other SSP components. For my YSSP project, I will unpack repercussions of six sets of international migration assumptions: one reflecting zero net migration, and the five reflecting the SSP narratives. Using an innovative combination of a simple gravity model with income distributions and remittances, I will transpose differentiated migration trajectories depending on income levels, into consistent sets of GDP, income inequalities and emissions components of the SSPs. As a result, I will provide a first stylized quantification of the effect of different migration scenarios on GDP and emissions levels.

Biographical sketch:
Hélène is a third year Ph.D. student in Environmental Policy at Princeton University. In her dissertation, she focuses on interactions between climate damages, international migration and inequality, using Integrated Assessment Models. She is also interested in international environmental agreements design, and in communication between science and policymaking on climate change. Hélène graduated in 2012 with a MSc in Science and Executive Engineering from Mines ParisTech. For her master thesis at Colorado-based NCAR, she developed a statistical tool for scoring extreme climate events forecasts. She then started her career as deputy attaché for energy at the French Embassy in Germany. During the Paris Agreement year, she worked as research scientist on an expertise mission for the French government aimed at assessing countries' Nationally Determined Contributions.

Asya Dimitrova

Supervisor: **Guillaume Marois**
Co-supervisor: **Gregor Kiesewetter (AIR)**

Research project: **THE FUTURE HEALTH IMPACTS OF AMBIENT AIR POLLUTION AND TEMPERATURE IN INDIA UNDER ALTERNATIVE CLIMATE CHANGE AND DEMOGRAPHIC SCENARIOS**

Abstract:
Rapid socio-economic development in India has been accompanied by gains in life expectancy and improvements in a range of health outcomes. However, it is uncertain how the fast pace of urbanization and climate change will alter this trend in the future. Some aspects of urban development can have detrimental impacts on human health, in particular through increases in ambient air pollution and temperature, and changes in lifestyles. Climate change is likely to add up to these multiple stressors by aggravating air quality and increasing the frequency and intensity of heat waves and other extreme events. Quantitative health impact assessments at subnational level are needed to estimate the scale of these challenges, identify the most vulnerable populations, and inform and contribute to the design of efficient and spatially explicit adaptation and mitigation strategies. This study aims to quantify the future mortality burden related to projected changes in ambient air pollution and surface temperature due to climate change for all states in India up to 2050. A multidimensional cohort-component projection model will be employed to explore the range of potential health impacts under three climate change scenarios and alternative demographic scenarios. Future ambient particulate matter ($PM_{2.5}$), ozone (O_3) and temperature exposure will be derived from global and regionally downscaled climate and air pollution models, driven by the Representative Concentration Pathways. Modeling the impacts of environmental exposures dynamically, by considering the change in the size and structure of the population, and spatially, will yield more realistic estimates and will enable us to map future vulnerabilities and reduce one of the main areas of uncertainty in projections of health impacts under climate change.

Biographical sketch:
Asya Dimitrova gained a M.A. in Economics and Mathematics at the University of Glasgow (First Class Honors). She graduated with a MSc. in Socio-ecological Economics and Policy, with specialization in demography and social policy, from the Vienna University of Business and Economics. She is currently pursuing a joint PhD programme in Global Health at the Barcelona Institute for Global Health and the University Pompeu Fabra. Prior to starting her PhD, Asya has been working for five years as a research fellow at the Vienna Institute for Managing Sustainability and she also completed a traineeship at the European Commission. She is particularly interested in incorporating the dynamics of global change, especially demographic and epidemiological change, as well as urbanization into estimations and projections of future health burdens related to climate change.

Moradhvaj

Supervisor: **Wolfgang Lutz**
Co-supervisor: **Nandita Saikia**

Research project: **EDUCATION OR ECONOMIC STATUS? COMPARING THEIR RELATIVE EFFECT ON ADULT HEALTH AND MORTALITY IN INDIA USING LONGITUDINAL SURVEY**

Abstract: Improvement in the health status of the population is closely related to its level of socio-economic development. Several studies on adult mortality emphasized on the relationship between adult mortality and socio-economic status measured through importance of occupation, income, wealth and education. During the last 20th education attainment and economic status contributed significantly to raise the survival chance in the adult age group. Only few studies have conducted in-depth assessment of the relative importance education and economic status associated with the risk of adult death among the developing countries. Without longitudinal data, it is difficult to study the effect of education and economic status on the changing adult mortality. Using the longitudinal macro and micro level data, this study aims conducting a thorough examination of the relative contribution of education and economic development on changing adult mortality in India. Macro level analysis will be performed to examine the relative effect of education and economic status on the adult mortality using Sample registration system data provides the age specific mortality and life expectancy for age groups. Micro level analysis will be done using data from a national sample of 132,116 Indian adults aged 15 years and above to examine their likelihood of death by their educational and economic status between wave 1 of the India Human Development Survey, conducted in 2004–05 and wave 2, conducted in 2011–12.

Biographical sketch: Moradhvaj is a third year PhD student at Centre for the Study of Regional Development at Jawaharlal Nehru University (JNU), New Delhi, India, Where he also completed his MPhil degree in population studies in 2016. Moradhvaj research interest includes mortality, morbidity, mathematical demography, health economics, gender and development. Prior to join JNU, Moradhvaj completed his Master degree in Population Studies form International Institute for Population Sciences, Mumbai, India. The title of his PhD thesis is “Changing Adult Mortality in India: Socio-Economic and Subnational Patterns”.

Paolo Miguel Manalang Vicerra

Supervisor: **Sergei Scherbov**
Co-supervisor: **Wolfgang Lutz**

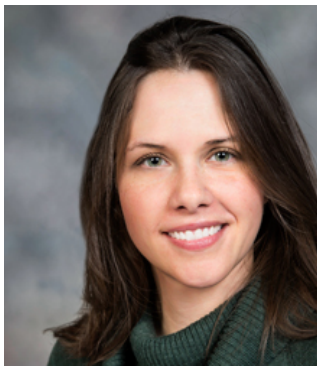
Research project: **COGNITIVE, PHYSICAL, AND MENTAL FUNCTIONING: A STRUCTURAL EQUATION APPROACH**

Abstract:
Studies on successful ageing usually involve dimensions of health. A number of these studies, particularly in Thailand, are on physical capacity and the presence of non-communicable diseases as the data is accessible from medical records, surveys, and clinical studies. Data, and therefore studies, tend to be limited for cognitive functioning and mental health. The literature that are present for those two health dimensions often involve clinical studies or community-based projects that have small samples. This study then aims to address this shortcoming in the literature by analysing cognitive health and its interaction with physical and mental health.

Physical, mental, and cognitive health are usually analysed individually. Understanding each health dimension exclusively is meaningful but much is absent if other health concerns among ageing persons are omitted. The simultaneity is important because it offers perspective in understanding the prevalence of health distresses and their mutual interactions for an ageing population.

For this study, the 2016 Population Change and Well-being in the Context of Aging Society (PCWAS) will be used. This is a representative survey of people aged 60 years and over in Thailand. Measures on the health dimensions will be created that are appropriate for the Thai context and the simultaneous equation modelling method (SEM) would be employed for the analysis to accommodate the complex relationship of the three health aspects.

Biographical sketch:
Paolo Vicerra is in the doctoral programme in demography at Chulalongkorn University, Thailand. He obtained his Master's from the same university. Part of his undergraduate studies was done at Nihon University, Japan and was completed at the University of the Philippines. His research interests are ageing, population health, and disaster risk reduction and management.



Regina Buono

Supervisor: **Joanne Linnerooth-Bayer**
Co-supervisor: **Wei Liu**

Research project: **STRUCTURING EMERGENCE: HOW DOES LAW IMPACT THE EMERGENCE FRONTIER FOR NATURE-BASED SOLUTIONS TO ENHANCE URBAN RESILIENCE?**

Abstract:
Legal systems are designed to enhance social stability and security and to facilitate change in a deliberative and orderly manner; they have long been anchored by the assumption that events in the human environment occur within certain parameters—in effect, that the world is stationary. These qualities, though desirable, may impede human adaptation in a world where climate change, demographic shifts, and economic and cultural integration are causing unpredictable shifts. To facilitate adaptation, law must allow—and even incentivize—societies to choose and bring to scale novel solutions. Some entities are experimenting with nature-based solutions (NbS) to address environmental challenges but have been stymied by uncertainty, including legal constraints and ambiguities. Drawing lessons from interviews with actors designing and implementing NbS in Valladolid, Spain, this study seeks to understand how law may shape, incentivize, slow, or impede adoption and implementation of these solutions and considers how changes in law or legal mechanisms may enhance the ability to reap the benefit of those solutions. It builds on prior research on NbS, adaptive governance, resilience, and law to generate knowledge about how innovative solutions can be more effectively implemented in practice, even as uncertainty increases due to climate change and other factors. The results will help actors working with NbS to assess and address legal components that guide, structure, or limit adaptation in their jurisdictions.

Biographical sketch:
Regina Buono holds a B.A. in international relations and political science and a B.A. in Spanish from the University of Arkansas, a J.D. from The University of Texas School of Law and an M.Sc. in water science and governance from King's College London. She is currently a doctoral student in public policy at the Lyndon B. Johnson School of Public Affairs at The University of Texas at Austin. Her research interests include water governance, urban resilience, and adaptive governance.

Nepomuk Dunz

Supervisor: **Thomas Schinko**
Co-supervisor: **Asjad Naqvi (ASA)**

Research project: **A STOCK-FLOW CONSISTENT (SFC) MODEL ASSESSMENT OF THE OPPORTUNITIES AND RISKS OF DEVELOPMENT BANKS' EFFORTS OF CLOSING THE CLIMATE-FINANCE GAP**

Abstract:
Development banks (DBs), such as the World Bank, Asian Development Bank, and the Inter-American Development Bank, have played a major role in mobilizing climate-finance flows to ensure global mean temperatures staying well below 2°C. Nevertheless, a significant climate-finance gap, particularly in developing countries prevails, constituting unexploited opportunities for sustainable investments and technology transfers. This calls for an even larger role of DBs. However, a larger involvement of DBs could also lead to systemic financial and economic risks for donor and recipient countries due to stranded assets, credit defaults and climate related extreme weather events. Hence, an in-depth assessment of the effectiveness and consequences of development banks' efforts in mobilizing climate-finance flows to close the prevailing climate-finance gap is needed. This requires a new wave of models, able to embrace a financial dimension, uncertainty and complexity that can capture systemic financial and economic risks associated with climate change and the low carbon transition. In this regard, Stock-Flow Consistent (SFC) models rooted in rigid accounting principles, can provide new insights for assessing and evaluating DBs' climate policy approaches. This research project aims to shed light on the opportunities and risks of DBs to close the climate finance gap by extending a North-South SFC model, and calibrating it to Austria and the Western Balkans, with international trade and financial capital flows. Thereby, distinct DBs' policies and strategies for closing the climate-finance gap can be assessed and comprehensively evaluated.

Biographical sketch:
Nepomuk Dunz is a second year PhD student at the Institute for Ecological Economics at Vienna University of Economics and Business (WU). He holds a Master's degree in Socio-Ecological Economics and Policy from WU and a Bachelor's degree in International Economics from the University of Tübingen, Germany. His research interests cover the field of ecological macroeconomics and sustainable finance. By applying a stock-flow consistent modelling approach, Nepomuk investigates the roles of technological change, international trade, income distribution and financial flows for achieving a socio-ecological low-carbon transition. Further, he focuses on the integration of natural disaster risks into structural macroeconomic models of development to understand socio-economic challenges for developing countries in the realm of ongoing climate change.

Safa Fanaian

Supervisor: **Wei Liu**
Co-supervisor: **Mikhail Smilovic (WAT)**

Research project: **RIVERS AND CITIES: EXPLORING THEIR COMPLEX WATER-RISK AND ITS GOVERNANCE**

Abstract:
Current systems of water-risk governance for riverine cities are a product of past decisions carried out through networks of actors. There is a need to understand these past processes, to know the limitations and path dependencies that lead to lock-in decisions of current actors. In a federal system such as India, management, investment, and infrastructure development decisions on water-related risks in riverine cities are complex. Not only local (urban), but national governments and a host of interest groups are involved in decision-making, as the river often flows beyond city jurisdictions. The evolution of water-risks and its governance for a riverine city in India is therefore explored through combined insights from Historical Institutionalism and Multi-Level Perspective. Mapping the networks of actors involved in governance processes will be carried out through Social Network Analysis. Guwahati city is the case explored as it is an emblem of urbanization on the Brahmaputra River. The water-risks explored include urban floods, inadequate domestic water supply, and wastewater released into rivers. This research provides a context-specific approach that can be applied to improve the resilience of riverine cities in India and the Global South.

Biographical sketch:
Safa Fanaian is a second-year doctoral student at the School of Geography and the Environment, University of Oxford and an Oxford-Indira Gandhi Scholar at the Oxford-India Centre for Sustainable Development. She has an MSc. in Water Management from IHE-Delft, Institute for Water Education, Netherlands and an MSc. in Ecology and Environmental Science from Pondicherry University, India. Her Ph.D. thesis utilizes complexity theory to explore and advance the governance of water-risks for riverine cities in the global south. She has more than seven years of experience working on collaborative research projects to improve water security in South Asia.

Huan Liu

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

Research project: **ESTIMATION OF BUSINESS LIFELINE RESILIENCE FACTORS TO DISASTER: A MARKOV MODEL ANALYSIS OF MULTIPLE LIFELINE DISRUPTIONS**

Abstract:
This research aims at empirically estimating the lifeline resilience factors under multiple lifeline disruptions after a disaster. Restore of lifeline factors are highly related to the recovery speed of business. Thus, measuring the resilience factors of lifeline to reduce the business losses from disaster is an important priority for business recovery. Recent studies have provided reference results related to the lifeline resilience factors of industrial sectors. However, those results are derived from business surveys on a hypothetical disaster or experts-opinion-based estimation due to lack of data from businesses which experienced the lifeline disruptions after disaster. In this research, the Markov model is developed based on the assumption of multiple lifeline disruptions, and lifeline resilience factors are estimated to explain the impact of lifeline disruptions on the production capacity recovery by using the survey data obtained after the 2011 Great East Japan Earthquake. A comparative study between manufacturing and non-manufacturing sectors is conducted to understand the resiliency and vulnerability characteristics in these sectors. The results may contribute to providing references to the priority of the lifeline factors recovery after a disaster in different industries and formulating an improved lifeline factors restoration pattern to achieve a quick recovery.

Biographical sketch:
Huan Liu is a second-year PhD student of Graduate School of Informatics at Kyoto University, and belongs to the Disaster Prevention Research Institute (DPRI), Kyoto University. She holds a Master's degree in Regional Economics. Her research interests are disaster risk reduction and governance, especially on the business resilience towards disaster and business post-disaster recovery. Specifically, her current research focuses on the estimation of lifeline resilience factors with the 2011 Great East Japan Earthquake as a case study.

Bruno Meirelles de Oliveira

Supervisor: **Wei Liu**
Co-supervisor: **Brian Fath (ASA)**

Research project: **PROTOTYPE OF SOCIAL-ECOLOGICAL SYSTEMS RESILIENCE USING SYSTEM DYNAMICS MODELLING**

Abstract:
Modern resilience thinking started with Holling (1973) and has an important message: socio-ecological systems (SES) have limits that, if crossed, may cause the system to be operating with increasing uncertainties and the possibility to flip to a new regime entirely. Considering that SESs at different regimes produce different sets of ecosystem services (Biggs et al., 2015), the reliability of delivering a particular set of ecosystem services, is facing risks. Modelling SES with complexity and adaptiveness (i.e., dynamic and full of feedbacks) becomes a crucial tool to decision makers in order to build governance behavior that tackles ES management under uncertainty.
This work intends to build a prototype SES resilience model for Ubatuba, Brazil that embraces causalities and formalizes them in a rather simple structure. The objectives are 1) to understand to which extent the operationalization of the certain principles associated with resilience (e.g., polycentricity, connectivity, etc.) could benefit from the formalization of their dependences and dynamics; 2) to discuss the necessity and the benefits of making quantitative assessments of social principles; and, 3) to list methods to measure those principles, including discussions of their limitations and caveats. This model will be developed in a system dynamics class model called MIMES (Multiscale Integrated Model of Ecosystem Services) (Boumans et al., 2015).
Expected results will address several methodological questions: 1) is it necessary to assess quantitative anthroposphere resilience principles in order to model them? If so, which method will properly address them numerically? 2) Is it better to assess them qualitatively, in order to be used in a systems dynamic model? 3) How general must the protocols be for measuring the governance principles in order to make the prototype replicable?

Biographical sketch:
Bruno is currently a PhD candidate (2016–2020) in Energy and Environment Institute at University of São Paulo (USP), Brazil. He holds a Masters in Environmental Sciences from the same school and an MBA in Environment Management from the Polytechnic School of USP. His professional background is in biology, education, rural development, and environmental consulting. His scientific interests include ecosystem services modeling, social ecological system dynamics, governance, resilience, and application of system dynamics modeling.

Simone Pretorius

Supervisor: **Stefan Hochrainer - Stigler**
Co-supervisor: **Sylvia Tramberend (WAT)**

Research project: **EXAMINING THE LESSONS LEARNT FROM THE 2015-2018 DROUGHT ON LARGE-SCALE COMMERCIAL FARMERS, IN THE WINTER RAINFALL REGION OF THE WESTERN CAPE, SOUTH AFRICA**

Abstract:
The Western Cape Province in South Africa, suffered a multi-year severe drought from 2015-2018, which negatively affected both rain-fed and irrigated agriculture. Climate change projections for the province indicate that the region is likely to become hotter and drier, with drought becoming more frequent. Analysis of weather data for the study regions show rainfall dropped as much as 60% during the drought period. For the Western Cape agricultural sector to adapt to climate change with minimal adverse impacts, effective adaptation strategies need to be adopted. Responses taken by farmers to the current drought can be investigated and adaptation strategies which will increase the sector's resilience can then be identified. The study will analyze the response (preparedness, responses and lessons learnt) of rain-fed (represented by wheat) and irrigated (represented by apples) agriculture to the 2015–2018 drought and seek to understand producer's perspectives on climate change and adaptation. This will be achieved through structured interview questionnaires along with supplementary data (crop yield, quality of yield, pack out, profit, exports) provided by industry bodies. Approximately 180 questionnaires across the various sectors will be distributed and the results will be analyzed statistically in R. The interviews will make use of a Likert-type questionnaire in order to evaluate the agreement levels of farmers' perceptions on statements regarding drought, adaptation and climate change. Questions surrounding perceived change in climate in terms of both temperature and rainfall, as well as their choice of adaptation methods and their perceived barriers to adaptation will also be gauged.

Biographical sketch:
Simone Pretorius graduated with a master's degree in Environmental Science from the University of Pretoria in 2017. She is currently enrolled as a second year PhD student, in Sustainable Agriculture at Stellenbosch University. The title of her thesis is Improving Resilience in Rain-fed and Irrigated Agriculture in the Winter Rainfall Region of the Western Cape: Lessons from the 2015–2018 Drought. She is on the professional development program at the South African Agricultural Research Council in Stellenbosch. Her main fields of scientific interest include water resources, climate change adaptation and agriculture with the use of remote sensing and modelling tools.

Wu Chen

Supervisor: **Arnulf Grübler**
Co-supervisor: **Volker Krey (ENE)**

Research project: **UNLOCKING THE TRANSPORTATION-ENERGY NEXUS: CASE STUDY FOR CHINA'S PASSENGER VEHICLES TRANSITION**

Abstract:
A transition toward sustainable transportation can help address climate change and environmental issues. Delivering a sustainable transportation system requires a full understanding of its developmental trajectories and its interplay with other systems (e.g., upstream material production systems and energy systems) To decode transportation-energy nexus, we will conceptualize a system framework to characterize how these systems (e.g., transportation systems, energy systems, material systems, and transportation service systems) are coupled and to demonstrate how the transition in one system would interact with other systems, using China's passenger vehicles (PVs) transition as an example. China has been both the biggest producer and consumer of motor vehicles since 2008. However, China's PVs ownership per is far less than developed countries. To avoid lock-ins or problem shifting, a sustainable transition in China's PVs system should build on an in-depth understanding of transportation-energy nexus. This project will: (a) Retrospect the historical development of passenger vehicle stocks from various dimensions (e.g., quantity, electrification rate, category, and size); (b) Delineate the energy systems (e.g., power plant, transmission line, and transformer substation) that are closely linked to the passenger vehicle stocks; (c) Explore a variety of PVs stock deployment pathways (e.g., vehicle ownership and penetration of electric vehicles) and examine related environmental impacts, considering clean energy transition, socioeconomic transition (e.g., peoples' lifestyle), and material production transition (e.g., material efficiency). This project could deliver a message to the on-going debates on sustainable transportation transition. The system framework could be applied to other transportation systems.

Biographical sketch:
Wu Chen is currently a second-year PhD student at Center for Life Cycle Engineering, University of Southern Denmark (SDU), Denmark. Her PhD project is exploring the evolution of transportation systems and unlocking the service-material-energy nexus in sustainable transportation systems. She holds a Master's degree (2017) and a Bachelor's degree (2014) in Industrial Engineering and Business Administration from Chengdu University of Technology, China. Her research mainly focuses on material flow analysis, social-economical metabolism, sustainable transportation, and material-energy nexus.

Jakob Knauf

Supervisor: **Arnulf Grübler**

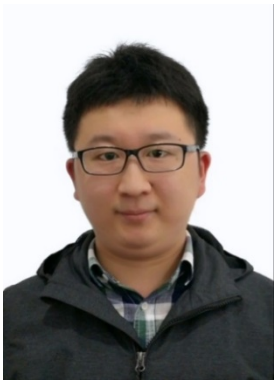
Research project: **CLUSTERING EFFECTS AND THE DIFFUSION OF INNOVATIVE DOMESTIC ELECTRICITY AND HEATING TECHNOLOGIES- A COMPARATIVE STUDY**

Abstract: The transformation of the energy system is considered as one key challenge in order to achieve climate protection goals. However, the slow transformation rate, especially in the heating sector, is a challenge for governments. One main reason for this gradual pace is that transforming the energy system involves multiple technologies and infrastructures as well as organizational and institutional changes. Such high degree of complexity generally causes slow technological diffusion.

Insights on mechanisms that determine transformation rates can be gained from former transitions and their long-term patterns of technological change. Clustering, spillover, learning and other effects belong to the "grand patterns" according to which the energy system evolves. These factors are not constant and equally important over time and scale for different energy technologies and application contexts.

For example, until recently the costs of photovoltaics and wind energy were the main barrier for their utilization. In order to transform the whole electricity system further to a very high share of renewable energies, additional measures like demand response and adaptions to the T&D infrastructure will become increasingly important. Therefore, the co-dependence on transformations of related infrastructures will grow. In contrary, costs of innovative heating technologies might not be the single most important barrier because some technology switches, e.g. from gas boilers to heat pumps in old houses, need immediate further expensive adaptions on house infrastructures (e.g., insulation). The proposed research aims at determining the technological co-dependence of energy technologies on related infrastructures for different building types from a private investment perspective.

Biographical sketch: Jakob Knauf is a second-year PhD student in Economics at the Institute for Strategic Innovation and Technology Management at Konstanz University of Applied Sciences. His research focuses on analyzing techno-economic characteristics of innovative heating technologies connected to the grand patterns of technological diffusion (e.g., technological learning, economies of scale, clustering and spillover effects). Before coming to Konstanz, he studied at Karlsruhe Institute of Technology, National Taiwan University, University of Oldenburg and University of Groningen.



Xingrong Zhao

Supervisor: **Tieju Ma**
Co-supervisor: **Arnulf Grübler**

Research project: **ANALYSIS OF ELECTRIC VEHICLE ADOPTION IN SHANGHAI: BASED ON EMPIRICAL DATA AND AGENT-BASED SIMULATION**

Abstract:
Adopting electric vehicles (EVs) is considered as an important solution to reduce fossil fuel dependency in transportation section. China has become the world's largest market for EVs with strong support from the Chinese government. This study proposes an EV adoption model which takes into account demographic characteristics and peer effect among consumers, with Shanghai as a case study of the model. Based on the survey conducted in Shanghai, this study will first use Discrete Choice Model (DCM) to investigate the influence of demographic characteristics (including age, gender, education, occupation, income, family size, number of children and administrative regions) on EV adoption and develop consumers' EV-purchasing utility function. After that, an Agent-Based Model (ABM) will be developed by introducing peer-effect into the DCM. With agent-based simulation and the empirical survey data, this study will investigate the impact of peer-effects on EV adoption and predicts the future dynamic market shares of battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) in Shanghai under different scenarios. This study is expected to help government to design better policies to sustain the adoption of EVs in Shanghai, and inform industries how to prepare for the dynamics of EV market.

Biographical sketch:
Xingrong Zhao is currently a second-year PhD student in the School of Business, East China University of Science and Technology (ECUST). In 2015, he graduated from China University of Petroleum with a master's degree in chemical engineering. Before he enrolled in ECUST, Xingrong worked as a technical assistant in Zhejiang Energy Group in 2016-2017. Now, his main research topic is the diffusion of electric vehicles from the perspective of consumers.

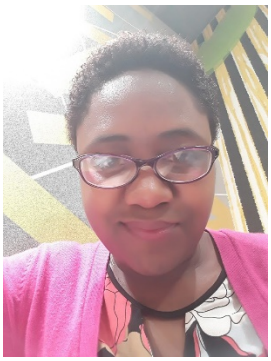
Felicia Chiang

Supervisor: **Peter Greve**
Co-supervisor: **Ted Veldkamp**

Research project: **CONCURRENT TEMPERATURE AND PRECIPITATION SHIFTS IN HISTORICAL AND HISTORICAL NATURAL-ONLY MODEL SIMULATIONS**

Abstract:
Droughts have been observed to warm at a faster rate than the average climate in southern and northeastern United States between the early and late 20th century (Chiang et al., 2018). CMIP5 projections also show this amplified warming pattern in southern states between the late 20th and 21st centuries (Chiang et al., 2018). I propose to explore the use of copula theory to observe how temperature and precipitation concurrences are shifting in historical and historical natural-only model simulations to quantify human impacts on the underlying processes. I plan to quantify the joint probability of low precipitation (drought) and high temperature (warm spell) concurrences in historical and historical natural-only simulations. From these results, we can gain a better understanding of the impact of climate change on concurrent drought and warm spells. I also propose to calculate the conditional probability of exceeding a high-temperature threshold during meteorological droughts for both historical and historical natural-only simulations. This will allow us to evaluate how climate change has impacted the occurrence of high temperatures given specified drought intensities. Through this conditional framework, we can provide a measure of conditional risks and attribute these risks to climate change.

Biographical sketch:
Felicia Chiang graduated in 2013 from the University of California, Berkeley with a degree in Environmental Sciences and a minor in Energy and Resources Group. She is currently in her fourth year of a joint M.S.-PhD program in the Civil Engineering department at University of California, Irvine. The title of her dissertation is “Understanding the Physical Underpinnings of the Observed Amplified Warming of Droughts”. Her main fields of scientific interest include hydroclimate extremes, concurrent and compounding extremes, detection and attribution research, and climate change impacts and projections.



Fortune Gomo

Supervisor: **Barbara Willarts**
Co-supervisor: **Michiel van Dijk (ESM)**

Research project: **DEVELOPING A BASIN-LEVEL SYSTEM DYNAMICS MODEL TO SUPPORT INTEGRATED DECISIONS ACROSS WATER, ENERGY AND FOOD (WEF) SECTORS**

Abstract:
The water, energy, and food (WEF) sectors can be viewed as socio-ecological systems (SES), intricately linked with and affected by one another. The Zambezi river basin is a large transboundary SES, with strong interactions between WEF sectors across the basin. It is vital to its eight riparian countries for water resources, energy and food production. However, the development goals of the basin countries are geared towards sectoral expansion for all three sectors, with some conflicting goals and a limited and unequal distribution of resources across the basin. Understanding WEF nexus dynamics will help aid integrated decision making for a sustainable future that considers synergies and trade-offs between sectors for the basin. Therefore, the main aim of the proposed research is to understand the current dynamics of the WEF systems and support stakeholders in integrated policy and decision making across water, energy and food sectors. I will develop a Zambezi basin level DPSIR (drivers, pressures, states, impacts, responses) analysis and system dynamics model with water at the center of the nexus. The system dynamic model will then be used to identify leverage points for policy action that address key WEF challenges, as well as alternative development pathways for a sustainable future.

Biographical sketch:
Fortune Gomo is a fourth year PhD Geography student at the University of Dundee in Scotland. Her thesis title is: ‘Supporting better decisions across water, energy and food challenges in the Zambezi River basin’. Fortune has an MSc in Water Management (specialization Water Resources Management) from IHE Delft, Institute for Water Education (formerly UNESCO-IHE, Institute for Water Education) in the Netherlands; and a BSc (Honors) in Environmental Science from the National University of Science and Technology (NUST) in Zimbabwe. Her main field of scientific interests is the study of water resources systems, with a focus on sustainable water resources management for economic development and human welfare.

Paul Joseph Ruess

Supervisor: **Taher Kahil**
Co-supervisor: **Günther Fischer**

Research project: **IMPACT OF TRADE ON GROUNDWATER USE AND DEPLETION**

Abstract:
Water and food are both critical to human health and well-being, necessitating efficient and equitable management of these resources on a global scale. This is especially important as local water resources are often insufficient to meet agricultural water demands in many parts of the world, resulting in nonrenewable groundwater use and subsequent aquifer depletion. While this may temporarily increase agricultural productivity, reliance on unsustainable water resources cannot be a long-term solution. Trade may offer an opportunity to better balance local water and food supplies with global demands, enabling water intensive food production to be moved away from water scarce regions. It is therefore important to understand how global trade influences these resources as we strive for future global water and food security. To this end, this study proposes to address the following scientific question: What is the impact of global trade on groundwater use and depletion? Answering this question requires two activities: 1) annual irrigation-based groundwater use and associated depletion will be calculated for all crops and countries worldwide, and 2) the impact of trade on groundwater use and depletion will be modeled. Overall, the study hypothesizes that trade will reduce global groundwater use and depletion. This research could help improve our understanding of the complex global water-food-trade system and may have policy implications as countries balance water, food, and trade priorities.

Biographical sketch:
Paul Ruess is a second-year PhD candidate at the University of Illinois at Urbana-Champaign studying Civil and Environmental Engineering. He holds an MS in Environmental and Water Resources Engineering from the University of Texas at Austin (2017), and a BS in Civil and Environmental Engineering from the University of Virginia (2014). Paul also worked as an Environmental Engineer designing and commissioning wastewater treatment plants with CDM Smith from 2014-2016. Paul's dissertation research focuses on understanding how global trade impacts local water and food resources using hydrologic modeling and econometrics. His research interests include the food-energy-water nexus, water and food policy, econometrics, integrated water resources management, and socio-hydrology.

Fabian Stenzel

Supervisor: **Sylvia Tramberend**
Co-supervisor: **Günther Fischer**

Research project: **DO IRRIGATED BIOENERGY PLANTATIONS HAVE A LARGER EFFECT ON WATER STRESS THAN THE AVOIDED CLIMATE CHANGE?**

Abstract:
Bioenergy with carbon capture and storage (BECCS) is a terrestrial negative emission technology widely used in climate scenarios for the 21st century. Hejazi et al. showed in 2015 for the United States, that contrary to the general perception that climate change mitigation improves water conditions, irrigated bioenergy could increase water stress more than the avoided climate change effect would be. We take this climate-water-energy setup to the global scale and compare water stress in two worlds: One with active climate engineering through BECCS resulting in only moderate global warming of end-of-century temperatures well below 2°C and one without BECCS in a warmer climate. For water stress, we use an indicator, which includes not only the natural water availability and the water demand for irrigated agriculture, but also projections of the future water demand for households, industry and livestock. We use plantation areas for bioenergy from available land-use scenarios for the Shared Socioeconomic Pathways (SSPs) and employ irrigation and management parameters from recent BECCS literature. Additionally, we analyze how strict compliance to the regional planetary boundary of freshwater by respecting environmental flow requirements would influence water stress. Simulations are performed with the dynamic global vegetation model LPJmL.

Biographical sketch:
Fabian holds a Master's degree in Geophysics from Ludwig-Maximilians-Universität (LMU), Munich (2015). Since September 2016, Fabian is part of the priority program 'Climate Engineering: Risks, Challenges, Opportunities' of the DFG and conducts his doctoral research at PIK Potsdam and Humboldt-University Berlin. He is also a member of the IRI THESys graduate program. Prior to his PhD, he worked as a research assistant for the Department of Geophysics at LMU and conducted research at the University of Sydney and Simula Research Laboratories in Norway. In his PhD, Fabian investigates potentials and potential side effects of terrestrial negative emission technologies, with a focus on the water demand of bioenergy plantations.

Wenting Yang

Supervisor: **Peter Burek**
Co-supervisor: **Yoshihide Wada**

Research project: **EVALUATION OF GROUNDWATER RECOVERY IN THE NORTH CHINA PLAIN USING THE HIGH-RESOLUTION COMMUNITY WATER MODEL**

Abstract: The Groundwater level of the North China Plain (NCP) has declined significantly during the past decades due to severe overexploitation and low efficiency of agricultural irrigation, resulting in land subsidence, drying-up of streams and wetlands, and seawater intrusion. In order to ease the water crisis and ensure food security in North China, the South-to-North Water Diversion (SNWD) project was developed. During the Young Scientists Summer Program, I will first attempt to set up the Community Water Model (CWatM) of IIASA at a high spatial resolution of up to 30 arcsec (~1 km at the equator), and simulate total water storage and groundwater storage (GWS) changes of the NCP. Second, I will improve modules of the high-resolution CWatM model to better depict the hydrological processes in the NCP. Third, I will evaluate contributions of the central SNWD route, suppression of agricultural use, and precipitation variability to groundwater recovery of the NCP. This study aims at developing a high-resolution version of CWatM with a spatial resolution of 30 arcsec for better representing spatial heterogeneity, and provides an understanding of the mechanisms of groundwater recovery across the NCP under the impacts of human interventions and climate. It will also be valuable for predicting GWS changes under different climate and socioeconomic scenarios, benefiting the successive construction of the central SNWD route and water and food security here in the future.

Biographical sketch: Wenting Yang is currently a third-year PhD candidate at the Department of Hydraulic Engineering, Tsinghua University. Her dissertation research is primarily focused on examining effects of human interventions and climate change on historical, at-present, and future water availability at regional and country scales at large. Her main fields of scientific interest include hydrological modelling, groundwater (e.g., groundwater recharge and groundwater storage change), irrigation schemes of the North China Plain, and climate change.