YSSP22

A new generation of scientists

Participants and calendar overview

Young Scientists Summer Program

IIASA 50
International Institute for Applied Systems Analysis

Biographical sketches & Abstracts

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

Pietro Andreoni

Mentor: **Nikolay Khabarov**
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Research Project: **EFFICIENCY AND EQUITY IMPLICATIONS OF TRADING CARBON REMOVAL IN A NET-NEGATIVE WORLD**

Abstract: Most model-based assessments suggest that stringent climate targets require the deployment of negative emissions technologies (NET), either to compensate for residual emissions from hard-to-abate sectors or to recover from a budget overshoot. In absence of well-regulated policy mechanisms, the financing of these technologies after net-zero emissions would result in potentially prohibitive increase in governments' budget deficit. In addition, finding a geographical distribution of the negative emission budget that is both efficient and equitable is complex because the potential for these technologies is not equally distributed across countries, but full trading of carbon debt could lead to large financial flows across countries, raising questions of equity and sovereignty. Finally, large scale carbon dioxide removal (CDR) may entail relevant distributional effects within countries, because the subsidies that sustain those technologies will be financed by carbon tax revenues, potentially generating de facto regressive transfers. Carbon Removal Obligations (CRO) have been proposed as an implementable, market-based solution to internalize in today's carbon markets the costs of financing future CDR, in particular referring to net-negative emissions. We propose to use the RICE50+ model, a highly regionalized integrated assessment model developed by CMCC, to explore the interaction among these three dimensions (international, intertemporal, distributional) in shaping optimal CDR deployment policy. To do so, we will model optimal intertemporal financing of CDR and international trading of permits, and we will assess the equity and efficiency of these policy arrangements in the context of 1.5°C scenarios.

Biographical sketch:
Pietro Andreoni is a PhD student in Management Engineering at Politecnico di Milano and an affiliated researcher for the European Institute for the Economics and the Environment (EIEE RFF-CMCC), with a Master in Energy Engineering from Politecnico di Milano. His research explores the energy-economy-climate nexus mainly using Integrated Assessment Models. He has contributed to the development and worked with the WITCH and RICE50+ models, both developed and maintained at EIEE. Pietro's current research focus is on distributional implication of climate change and climate policy, including the financing mechanisms of negative emissions technologies. Previously he has worked on the exploration of widespread fossil fuel extraction bans as climate policy.

Dipesh Chapagain

Mentor: **Reinhard Mechler**
Co-Mentor: **Samir KC (POPJUS)**

Research Project: **IS CLIMATE CHANGE TO BLAME FOR RISING CLIMATIC DISASTERS MORTALITY IN NEPAL?**

Abstract:
Human death and economic losses due to climatic disasters have been rising globally. Several studies argue that this upward trend is due to growth in the population and wealth exposed to disasters. Others argue that rising climate extremes due to climate change are responsible for the increase. Hence, the causes of the rise in disaster impacts remain elusive. Disaster impacts are higher in low-income countries, but existing studies are mostly from developed countries. This study will assess the attribution of rising climatic disaster mortality to indicators of hazards, exposure, and vulnerability at the subnational scale in Nepal. We will follow a regression-based approach to overcome the limitations of the commonly used loss normalization approach in studying disaster impacts attribution.

Landslides and floods account for more than two-thirds of the climatic disaster mortality in Nepal. Hence, we will use the past 30 years' landslides and floods mortality data from DesInventar and Nepal DRR portal as the dependent variable. As explanatory variables to represent climatic hazards, extreme precipitation indices based on observational data from the Department of Hydrology and Meteorology Nepal will be used. We will use population as a proxy of disaster exposure. Indicators such as per-capita income, access to mobile phones, and land cover distribution will be used to represent vulnerability. Such socio-economic data will be accessed from the Central Bureau of Statistics and other sources.

Biographical sketch:
Dipesh Chapagain is a PhD candidate at the Center for Development Research at the University of Bonn, Germany. In his PhD project, Dipesh has been studying climatic disaster impacts and its attribution in low-income countries. Previously, he has completed the Humboldt research fellowship in Climate Analytics in Berlin. Moreover, he holds several years of experience in managing research and advocacy projects in UNDP Nepal, Oxfam, and Clean Energy Nepal. He is also a lead author of the UNEP Adaptation Gap Report 2021. Dipesh graduated with a master’s degree in Environmental Science from Tribhuvan University, Nepal in 2014.

Swaptik Chowdhury

Mentor: **Piotr Żebrowski**
Co-Mentor: **Elina Brutschin (ECE)**

Research Project: **EXPLORING EQUITY IN MODEL-CENTRIC DECISION-MAKING PROCESS**

Abstract: Phasing-out fossil fuels in the energy sector and transition to clean energy sources is widely accepted as an indispensable element of any effective strategy to reduce greenhouse gas emissions in line with the targets of Paris Agreement. A rapid and poorly managed transition to clean energy may, however, entrench systemic inequities between the prosperous, and the disadvantaged and vulnerable communities. Thus, the concern for equity, both in the transition process and its outcome, is of key importance. The goal of this study is to develop a model-centric approach that allows to connect qualitative equity considerations with quantitative models used to design strategies for decarbonization of the energy sector. The study will use existing environmental justice and energy equity principles to identify the functional requirements for considering equity in a model-centric approach and then adapt the energy end-use model for residential and commercial sectors to create a model ensemble that evaluates in a disaggregated form differential impacts of different strategies of decarbonizing the energy sector. The model ensemble will also be used to conduct a robust decision-making (RDM) analysis and to extract policy-relevant insights. The study hopes to establish a method that is easy to apply in different context to aid model-centric and equitable management of various transition processes.

Bio sketch: Swaptik Chowdhury is a doctoral candidate at the Pardee RAND Graduate School and an assistant policy researcher at RAND Corporation. His research interests include science and technology policy, mitigation of and adaptation to climate change, and decision analysis. Prior to joining Pardee RAND Graduate School, he worked as a forensic structural engineer on public and private capital improvement projects in New York and Ohio. His research background includes the analysis of alternate cementitious materials and experimental and computational study on damage-sensing "smart" building materials. He earned the Leadership in Energy and Environmental Design (LEED) and the National Council of Examiners for Engineering and Surveying (NCEES) certifies. He has an M.S. in structural engineering from Arizona State University and a B.Tech. in civil engineering from VIT University, India.

Chayasmita Deka

Mentor: **Nadejda Komendantova**
Co-Mentor: **Masoud Yazdanpanah**

Research Project: **ADOPTION OF ELECTRIC VEHICLES BY MIDDLE-CLASS INDIAN POPULATION: A COMPARISON OF GAIN & NORM MOTIVATORS & OTHER FACTORS**

Abstract

The increasing frequency of extreme climatic events has necessitated climate change adaptation and mitigation efforts like never before. An understanding of the drivers of energy use behavior is hence deemed essential to change people's behavior. With the enhancement of lifestyles among the middle-income group in India, the number of personal vehicles on the road has also increased to a great extent. Unless the carbon emissions from this increased road congestion are minimized, we cannot expect to move closer to our target of net-zero emissions by 2070, as envisaged by the Government of India. Of the range of energy use behavior, this project focuses on mobility behavior, and especially the factors influencing the acceptance of Electric Vehicles (EVs) among the middle-income population in the towns and cities in India, in the near future. Based on the Theory of Planned Behavior and the Norm Activation Model (TPB+NAM), we will compare gain motivation and norm motivation as drivers of intention to adopt EV. The TPB+NAM framework will also be extended to incorporate a few items from the Protection Motivation Theory (PMT). The impact of herd behavior on intention will also be studied. In order to enhance the accuracy of predicting intention to adopt EVs, we also plan to extend the TPB+NAM model with the Decision-Theoretic Model (DTM) of Behavior Change, developed by Matsumori and colleagues in 2019, which is based on the expected utility theory (EUT). Structural equation modeling (SEM) will be used as the method of analysis. The differences in adoption intention will also be compared across several socio-economic characteristics like gender, lower and upper-middle-income groups, and among the residents of rural and urban areas. Given the increasing investments under the FAME (Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles) Scheme by the Government of India, a detailed understanding of the factors influencing people's intention to adopt EVs in the near future can go a long way, in complementing the national schemes facilitating mobility transitions.

Biographical sketch:

Chayasmita is a third-year Ph.D. student in the Department of Humanities and Social Sciences, at the Indian Institute of Technology (IIT), Guwahati, India. She has a Bachelor in Economics (Honours) from the University of Delhi and a Master in Applied Economics from Christ University, Bangalore, India. After her post-graduation, she has worked for a year at the Indian Institute of Management, Bangalore as a Research Assistant. The title of her Ph.D. thesis is 'Mitigating Climate Change by Nudging towards Low-Carbon Consumption Behavior'. Her broad research interest lies in the intersection of energy consumption behavior, energy use and transition, and management of natural resources.

Aniruddha Deshpande

Mentor: **Josephine Borghi**
Co-Mentors: **Finn Laurien, Georg Pflug**

Research Project: **QUANTIFYING THE HEALTH CO-BENEFITS OF IMPROVING FLOOD RESILIENCE IN LOW- AND MIDDLE-INCOME SETTINGS**

Abstract:
Flooding is one of the most common extreme weather events, posing severe health and economic risks disproportionately in vulnerable low- and middle-income communities. Flooding due to sea-level rise and extreme precipitation is poised to worsen in many areas of the world due to anthropogenic climate change. Community resilience to flooding is a composite of many different variables including physical infrastructure, economic capital, health, and other social factors. Resilience measures have been developed and implemented in many different settings. The economic impacts of these measures have been characterized, but the health benefits have not been explicitly linked at scale. The Flood Resilience Measurement for Communities (FRMC) study obtains assessments of flood resilience from local experts across low- and middle-income countries. We will pair the pre-flood and post-flood assessments with corresponding local metrics from censuses, national surveys, and the Global Burden of Disease study. In doing so, we can quantify location specific health benefits of improving flood resilience and study how variation in health resilience relates to the variation in flood resilience across communities. A specific area of focus will be on water and sanitation infrastructure (WASH). Utilizing, established health risk functions of WASH from the epidemiological literature, we can calculate the health co-benefits as DALYs averted from the improvement of WASH, and quantify resilience to health risks and assess their concurrence with flood resilience. In doing so, we hope to illustrate the concurrent relationships between development for health and climate resilience.

Biographical sketch:
Aniruddha (Ani) graduated from Emory University with a BS in Biology & Philosophy in 2008 and completed his MPH in Global Epidemiology in 2016. He is currently working towards completing his PhD in Epidemiology at Emory examining how climate migration could impact infectious disease dynamics in low-resource settings and quantifying the health costs of flooding in high-resource settings. His main interests are in water-related health & development issues, simulation modeling, statistical inference, and infectious disease dynamics. He has previous experience in global health working with the CDC and on the Global Burden of Disease Study at IHME, University of Washington

Sophie Erfurth

Mentor: **Matthias Wildemeersch**
Co-Mentor: **Taher Kahil (BNR)**

Research Project: **GOVERNING COMMON POOL RESOURCES IN FRAGILE POLITICAL SYSTEMS: MODELLING BEHAVIOUR, INSTITUTIONS, AND SOCIAL-ECOLOGICAL DYNAMICS**

Abstract:
By 2050, it is estimated that more than half of the world's population will live in water-stressed areas and about a billion or more will have insufficient water resources (Schlosser *et al.*, 2014). How can governments and institutions manage the growing pressure on dwindling water resources? The question at hand is imperative in protecting the livelihoods of future generations that depend so heavily on the preservation of collective ends. Based on and expanding on the theory of collective action and common pool resource governance, this research project ties institutional results to environmental outcomes and seeks to explore how water user behaviour and resulting agricultural livelihood opportunities are mediated by fragility and natural resource dynamics. How can water researchers and managers move beyond deterministic notions of an 'inevitable tragedy of the commons'? This research project proposes a qualitative engagement with institutional arrangements and social norms, zooming in on local patterns of decision-making to help gain insights on how actions on the part of individuals translate to collective results. How have local water user groups coped with broader contextual risks and disturbances? In what ways can local responses to disturbances, trust and leadership translate to different outcomes for collective action and the underlying resource itself? Using agent-based modelling, this project seeks the integration of social and hydrological data and models to allow for a systematic coupling of both human- and environment-driven processes. The project aims to provide a guideline for alternative modes of policy-making and implementation to address the main water governance challenge in Tunisia, i.e. groundwater overexploitation.

Biographical sketch:
Sophie Erfurth graduated with a BSc in Geography from University College London, UK and an MEM in Water Resources Management from Duke University, USA. She is currently a second year PhD candidate at the University of Oxford, UK. Her main fields of scientific interest include water science and governance, decision-making under uncertainty, collective action, and coupled systems thinking and modelling.

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

Gemma Gerber

Mentor: **Elena Rovenskaya**
Co-Mentors: **Brian Fath**

Research Project: **TOWARDS HARNESSING ECOLOGICAL NETWORK INDICATORS IN ECOSYSTEM MANAGEMENT UNDER MODEL UNCERTAINTY**

Abstract:
Estuaries provide goods and services based on the effective function of the ecosystem. To assess ecosystem structure and function, energy flows within food web models are estimated and analysed with Ecological Network Analysis (ENA) to quantify ecosystem-level properties. The ENA indicators are sensitive to changes in the underlying models, and therefore useful to characterize how real-world changes are reflected at the ecosystem level. The practical application of system-level information derived from ENA indicators in management remains a challenge. As ecosystem properties cannot be directly managed, ecosystem-level information can be integrated into management by connecting ENA descriptors to tangibly manageable system components, such as biomass. Given each system's unique spatial and temporal contexts, changes in component biomass may have ambiguous consequences on overall system properties. Further technical challenges arise from the impracticality of direct flow measurements. Instead, flow values can be estimated with linear inverse modelling (LIM) and extended to calculate ensembles of representative food webs. The ensembles estimate infinitely many plausible flow values and ecosystem states, better representing ecological variability than single network solutions. This research aims to investigate the above challenges in selected South African estuarine ecosystems by using food web ensembles and ENA indicators to explore the following objectives: 1) estimate system-specific drivers of biomass change and likelihood of resultant ecosystem states using the Driver-Pressure-State-Impact-Response framework, and 2) quantify uncertainty in ecosystem properties introduced by temporal variations in biomass. The research outcomes preface the development of an ENA indictor-informed management framework to further holistic estuarine management.

Biographical sketch:
Gemma is a 4th year PhD candidate at the School of Life Sciences, University of KwaZulu-Natal (UKZN), South Africa. Her PhD research focuses on investigating global change in estuaries through ecosystem models. Gemma's previous research for her MSc (cum laude) (2018), and BSc Hons (cum laude) (2015) focused on microplastic pollution biomonitoring. Currently, her main fields of scientific interest include systems modelling and analysis, global change ecology, and tool development for advancing integration of real-world variability into ecosystem models.

Laura Merz

Mentor: **Célian Colon**

Research Project: **ASSESSING MEASURES TO MITIGATE UNEQUAL EXCHANGE ALONG GLOBAL VALUE CHAINS – AN AGENT-BASED MODEL APPROACH**

Abstract:
In a highly fragmented world economy, economically leading societies typically located in the global North consume beyond planetary boundaries whilst associated environmental and social costs are borne by the producing countries, often located in the global South. The prevailing globalised economic order enables the implicitness of externalising environmental and social costs. Even though such an asymmetric and unsustainable interdependency is increasingly scrutinised, the type of measures which are most effective in addressing the issue is still debated: Can changes of individual consumption behaviour significantly decrease these unequal exchanges? Can so-called corporate social responsibility initiatives, led by individual firms, result in industry-wide effects? How feasible are effects of binding standards on a national level? And how effective are voluntary transnational governance initiatives in regulating unequal exchange of international trade? We tackle these questions using an established three-sector and two-region agent-based macroeconomic model, based on the principles of evolutionary economics. We utilise it as a 'virtual lab' to model different intervention scenarios. By comparing individual, firm-level, national, and transnational attempts, our project will contribute to a more informed discourse on how to combat unequal exchange along global value chains.

Biographical sketch:
Laura Merz graduated from Uppsala University (Sweden) in MSc Sustainable Development in 2019. She received her Bachelor's degree in 2016 from Reutlingen University (Germany) which combined economics, business, supply chain management, and textile technology. Currently, she is a first year PhD student at the Environment and Economics chair at ESCP Berlin. The title of her thesis is 'Unequal Exchange and Externalised Costs along Global Value Chains'. Her main fields of scientific interest include Ecological and Behavioural Economics, Systems Analysis, and Social-ecological Modelling.

Linda Ofori

Mentor:	**Nikita Strelkovskii**
Co-Mentors:	**Ulf Dieckmann, Mikko Heino**

Research Project: **HOW HETEROGENEITY INFLUENCES INSTITUTIONAL CHANGE: A CASE STUDY OF THE LOFOTEN FISHERY**

Abstract:
Fisheries are subject to a multitude of external shocks such as climate change or economic crises, affecting the livelihoods dependent on them and potentially forcing many to search for new means to sustain their livelihoods, elsewhere. As displaced resource users resort to the extraction of less affected resources, newly formed groups of resource users become more heterogeneous, potentially creating new challenges or opportunities for the management of such resources. Thus, effective governance which can ensure sustainable resource use, in face of external shocks such as climate change or economic crises, requires a better understanding of how diversity among resource users affects cooperation and compliance. Using an agent-based model, this study investigates how increased socio-cultural and economic diversity among resource users affects collective behaviour in fisheries and how it may give rise to potential tipping points at which an existing social norm erodes or a new one emerges. The agent-based model will be empirically tested with a historical case study of the Lofoten fishery to explore what implications increased heterogeneity may have for resource management in small-scale fisheries today. The economic crisis which hit the Lofoten fishery in the 1920s and 30s, by triggering an influx of a variety of individuals from all parts of Norway, provides an example which remains relevant for the challenges to which fisheries continue to be exposed to today.

Biographical sketch:
Linda Ofori is currently a 3rd year PhD student at Wageningen University and Research, in the Netherlands. In her research, she studies drivers and mechanisms underlying institutional dynamics in exploited fisheries using a historical perspective, in order to find solutions to overfishing. She graduated from Wageningen University and Research with a BSc in International Development Studies and a Master's in Environmental Sciences, specialising in environmental and natural resource economics. Her research dealt with the effect of environmental stochasticity on the social-ecological system of reindeer pastoralism in the northern Norway. Her main fields of scientific interest include sustainable resource use, institutional change, social norms and social-ecological systems.

Alessandro Taberna

Mentor:	**Stefan Hochrainer-Stigler**
Co-Mentors:	**Finn Laurien, Reinhard Mechler**

Research Project: **FROM COMMUNITY TO REGIONAL RESILIENCE: ASSESSING LONG-TERM INDIRECT EFFECTS OF CLIMATE CHANGE ADAPTATION USING AGENT-BASED MODELING**

Abstract:
Climate change accelerates the frequency of floods beyond what humanity has experienced for generations. The raising threat, coupled with increasing urbanization in vulnerable regions, makes the scholarly and policy debate on building climate-resilient communities more urgent than ever before. Yet, the question remains whether and how the recommendations for today hold for resilience development over the next few decades. Models that account for indirect effects of climate change adaptation (CCA) pursued by various actors are needed to address these challenges. To answer this question a two-pillar approach will be adapted. First, to combine the computational power of the CRAB model with the rich longitudinal dataset on resilience currently developed by the SYRR Group to simulate the evolution of community resilience under different CCA options. And second, to explore the indirect effects of CCA strategies, focusing on policy interventions that enhance communities' long-term resilience. This approach allows studying the implication of investment in risk reduction on both individual and systemic risks, direct and indirect. The results will focus on the implications of different CCA policies, stressing the mechanisms that facilitate or hinder resilience dividend formation.

Biographical sketch:
Alessandro Taberna graduated cum laude with a Master's degree in Economics awarded by the University of Torino (Italy). He worked as a financial analyst for the European Investment Bank in the Risk Management department. Currently, he is a PhD student at the Delft University of Technology within the Technology, Policy and Management department as well as part of the 'Center for Social Complexity of Climate Change'. Alessandro works with ABMs and model integration/cross-scale processes. In particular, his current research focuses on how the autonomous adaptation of interacting heterogeneous households and firms affects regional climate-induced damages and resilience.

Wei Xie

Mentor: **Brian Fath**
Co-Mentor: **Saige Wang**

Research Project: **ECOLOGICAL NETWORK ANALYSIS OF LAND RESOURCE USE WITHIN CHINA**

Abstract:
In the past decades, expansive and rapid land cover change for human uses has been a key driver of environmental and societal stresses. However, how land resources are used and allocated within the industrial and socio-economic amalgam is still unclear. A key point of sustainable land management is to identify, from a systems perspective, the dominant direct and indirect pathways, network resilience, and vulnerable nodes to manage short and long term internal and external shocks. Based on a pre-established multi-regional and multi-sectoral land use dataset, a hybrid network model will be applied to study the interwoven connections of built-up land use among sectors and regions in China. Environmentally extended input–output analysis will be incorporated to evaluate the land resource flow, and ecological network analysis will be adopted to evaluate the cycling and resilience of each region of China. System robustness (SR), Finn's cycling index (FCI), the control allocation coefficient (CA), and the dependence allocation coefficient (DA) will be used to quantify relationships among regions and sectors and to estimate the magnitude of cycling flows in regional systems. Scenarios considering the risk of future land disturbance due to climate change or regional policy regulation will be used to assess the resilience of the land system, understanding how the disturbances spread through the land system. Incorporating built-up land into the resource metabolism study will bring new insights into regional sustainable development and resource metabolism, promoting resilient cities and sustainable land management.

Biographical sketch:
Wei Xie graduated from Shandong University, China, in 2015 with a degree in Ecology. He completed his MS degree in Landscape Ecology at the Chinese Academy of Sciences (2018). He is currently a PhD candidate at Fudan University in Environmental Science. The title of his thesis is Environmental System Modeling in Chinese Sectoral Land Resource Use and Environmental Transfer Effects. His main fields of scientific interest include land management, land resource metabolism, and industrial system analysis. Specifically, he focuses on 1) the land resource use and virtual flows between industrial and socio-economic systems; and 2) the interactions between natural systems and human systems linked to land use.

Cindy Giselle Azuero Pedraza

Mentor: **Andrey Lessa**
Co-Mentor: **Pekka Lauri**

Research Project: **INTEGRATING BIODIVERSITY CONSERVATION IN LAND ALLOCATION AND FOREST MANAGEMENT DECISIONS**

Abstract:
Forests play a major role in two of the biggest challenges humans face today, climate change and biodiversity loss. Increased interest in nature-based solutions and negative emission technologies such as Bioenergy with Carbon Capture and Storage (BECCS), harmonized with biodiversity conservation goals, puts forest management and land use change decisions in the spotlight. Forest and land management decisions respond to economic incentives of landowners or forest managers, but frequently ignore the related biodiversity impacts. In the proposed study, I address this issue and include biodiversity impacts into the global forest sector model GLOBIOM-forest, in a spatially explicit manner. Management and land use decisions in the model endogenize the changes in species diversity via countryside species area relationship (SAR) models. In this way, we identify the trade-offs between the costs and biodiversity impacts of land use change and the future land allocation when considering biodiversity impacts in the decision making.

Biographical sketch:
Cindy Azuero is a 4th year PhD student at the H. Milton School of Industrial and Systems Engineering, with a minor in Environmental Economics, at the Georgia Institute of Technology in Atlanta, United States. Her bachelor's and master's degree are both from Universidad de los Andes in Bogotá, Colombia in Industrial Engineering focused on Operations Research and Statistics.
Her research interests are in applications of engineering and economic tools including optimization, Life Cycle Assessment (LCA), economic modeling and simulation to environmental problems, which include biodiversity conservation, forests and climate change.
Current research projects involve the inclusion of biodiversity impacts in climate change mitigation decision making and the incorporation of new bio-technologies into EEIO models to assess its environmental impact. The title of her thesis is Including biodiversity conservation in Climate Change decision making.

Olivia Becher

Mentor: **Sylvia Tramberend**
Co-Mentor **Mikhail Smilovic**

Research Project: **A GLOBAL MULTI-HAZARD RISK ANALYSIS OF WATER INFRASTRUCTURE, NOW AND IN THE FUTURE**

Abstract:
Water and wastewater treatment facilities are critical infrastructure for society and disruptions to critical water infrastructure can have long-lasting consequences on connected households and the environment. However, their location near, and dependencies on, water bodies and coastal areas make them directly vulnerable to the impacts of water variability (e.g., droughts, floods) and natural disasters (e.g., hurricanes). As floods are becoming more likely in the future, the flood exposure of water assets is likely to change accordingly. Moreover, both water and wastewater plants need sufficient and good quality water for operations. During drought events, the water available for treatment can decrease significantly, while discharge of polluted wastewater is hampered by the lower dilution potential and lower water quality of water courses. Apart from a handful of local or regional studies focusing on the exposure of water and wastewater treatment plants (hereafter water infrastructure), large-scale disaster risk analysis of water infrastructure is lacking. One reason for this is the lack of large asset databases of water infrastructure. For instance, while hazard risk analysis to road, rail and airport infrastructure is now feasible given the availability of large datasets such as OpenStreetMap (OSM), water infrastructure is not well covered in open-source datasets. Here, we propose to use data on the exact locations of (surface) water and wastewater treatment plants to perform global flood, hurricane and drought risk analysis.

Biographical sketch:
Olivia is a second year PhD student at the University of Oxford. Her research is on quantifying the risks that climate extremes (drought, flood and hurricane) and change pose to water service providers, households, businesses and the wider economy to guide climate adaptation strategies. She did an undergraduate degree in Civil Engineering and completed an MSc in Water Science Policy and Management at Oxford. Olivia's professional experience includes engineering (Mott MacDonald) and international development consulting (World Bank and the University of Oxford). Her main research interests include climate risks to infrastructure, disaster risk financing and natural capital.

Wenjia Cai

Mentor: **Oskar Franklin**
Co-Mentor: **Jaideep Joshi**

Research Project: **LEAF AREA CONSTRAINED BY SOIL NUTRIENT STATUS WITH OPTIMALITY PRINCIPLES**

Abstract:
Leaf area index (LAI) is an important biophysical property of terrestrial vegetation. As the primary locus for mass and energy exchange, leaf area is directly linked to carbon assimilation, evapotranspiration, and the energy and carbon balances of terrestrial ecosystems. Predicting the response of terrestrial vegetation under climate change requires accurate characterization of plant biophysical and biochemical processes in which LAI is a key determinant. LAI depends on carbon allocation to foliage, which is subject to resource (energy, water, nutrient) availability. While plant responses to single resource and trade-off between energy and water limitation through transpiration has been well-studied, it remains largely overlooked how nutrient limitation interacts with energy and water availability, and how plants respond to concomitant variation in these environmental changes.

Here we apply the eco-evolutionary optimality principles, in which carbon investment on leaf and root maximize plants benefits while it minimizes resource acquisition costs, to explore the mechanistic links between leaf and root growth to predict leaf area index. The aboveground capacity to capture light for photosynthesis (LAI) should coordinate with belowground capacity to explore nutrients (root mass fraction, RMF). We hypothesize a trade-off between LAI and RMF under nutrient limitation and proportional to nutrient status. An adjusted IIASA-based soil nutrient metric will be tested on this trade-off pattern. Lastly, we will explore the interaction between nutrient and water limitation. The framework will thus provide a robust and reliable mechanistic understanding of plant responses to environmental changes and incorporating this framework into vegetation model would improve carbon cycle projection in a changing world.

Biographical sketch:
After acquiring a MRes degree in Ecosystem and Environmental Change at Imperial College London, Wenjia continued to do a PhD in Environmental Change and Ecosystems. She is currently a third year PhD candidate at Imperial College London and a member of the research group led by Prof. Iain Colin Prentice. Her research focuses on understanding vegetation responses to environmental change based on eco-evolutionary optimality (EEO) principles. Specifically, her research interests include modelling and analysis the trend and driver of plants production and coverage, as well as vegetation feedback on CO_2 seasonal cycle amplitude.

Biodiversity and Natural Resources Program (BNR)
Program Director: Yoshihide Wada

Melissa Chapman

Mentor:	**Piero Visconti**
Co-Mentor:	**Martin Jung**
Research Project:	**MULTISCALE PRIORITIZATION OF CONSERVATION AND RESTORATION MEASURES TO MEET POST-2020 BIODIVERSITY TARGETS IN THE EU**

Abstract:
In alignment with the global ambition to protect 30% of earth's land and sea over the next decade ("30x30"), the European Union has committed to expanding the scope of its protected area network by 2030. While nationally planned and implemented protected areas have been the cornerstone of area-based conservation both in the EU and globally, decentralized conservation planning has limited capacity to conserve large scale ecological processes, such as transboundary species migrations, and can lead to inefficient allocation of limited conservation resources. Systematic conservation planning at broader scales (e.g., continental) might address these shortfalls. However, broad conservation planning presents other risks such as overlooking relevant institutional structures through which environmental decisions are made and/or underemphasizing the importance of local ecosystem function.
This project will first explore the synergies and trade-offs between restoring and protecting habitats for carbon and biodiversity under land-use constraints in the EU. We will prioritize conservation and restoration measures at two scales, (1) continental and (2) biome/country, allowing for assessment of spatial mismatches and synergies not only across priorities (carbon and biodiversity) but also across scenarios of multilateral coordination. For each solution scale, we will estimate local functional diversity in the proposed protected area networks using data from vertebrate and plant trait databases. This will examine how the scale at which we prioritize land conservation measures impacts not only the contributions of protected areas to climate mitigation and species-level conservation targets, but also ecosystem function and services. Finally, to understand the broader implications of each prioritization strategy, we will feed the solutions into an integrated assessment model (GLOBIOM) to simulate future scenarios of land-use change.

Biographical sketch: Millie is a PhD candidate at University of California, Berkeley in the Department of Environmental Science, Policy, and Management. Her research interests are at the intersection of decision theory, ecology, and data science. Millie's dissertation seeks to understand how we can more effectively, and equitably, meet global conservation targets while considering uncertainty and environmental change. Prior to graduate school, Millie worked at a Woodwell Climate Research Center studying the drivers and dynamics of deforestation.

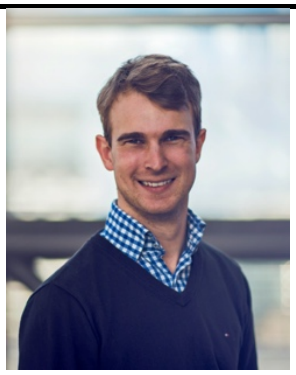
Dapeng Feng

Mentor: **Jens de Bruijn**
Co-Mentor: **Reetik Kumar Sahu**

Research Project: **APPLY DEEP LEARNING BASED HYDROLOGIC MODELS TO RUNOFF SIMULATION AT THE GLOBAL SCALE**

Abstract:
Recently, deep learning (DL) models have achieved outstanding performance in rainfall runoff modeling. Many studies provided strong evidence that DL models such as long short-term memory (LSTM) network can significantly outperform traditional process-based models. Furthermore, the physics-informed DL models were also developed to embrace good performance and physical constraints. However, among these studies, most were at continental or smaller scales, with models trained in a basin-lumped way. Distributed runoff modeling is necessary for accounting with regards to the heterogeneity within basins, but few DL studies have investigated this topic at a global scale. In this study, we plan to apply the DL-based models developed in our previous studies to the high-performance global runoff simulation on a meteorological forcing dataset with 0.1° resolution. Multiple experiments are designed to train and evaluate the models for global simulations. This global study leveraging DL regionalized models can help us better understand the hydrologic processes in those ungauged regions and we aim at providing a daily global runoff dataset with high resolution and accuracy to the hydrology community. This research is also a very important step towards building an efficient forecasting system for global rivers and assessing climate change impacts on the water cycle in the future.

Biographical sketch:
Dapeng Feng is a PhD candidate in the Department of Civil and Environmental Engineering at The Pennsylvania State University. He earned his Bachelor's degree in hydraulic engineering from Wuhan University and his Master's degree in hydrology and water resources from Peking University. His research interests focus on large scale hydrologic modeling with integrating physical and deep learning models, multi-source data integration for streamflow forecasting and climate change impacts on water resources. He is a member of the American Geophysical Union and his research has been published in scientific journals like *Nature Communications*, *Geophysical Research Letters*, *Water Resources Research*, etc.



Simon Happersberger

Mentor: **David Leclere**
Co-Mentor: **Nadejda Komendantova**

Research Project: **THE INTEGRATION OF BIODIVERSITY IN PREFERENTIAL TRADE AGREEMENTS. A TEXT-AS-DATA APPROACH TO THE ADAPTABILITY OF POLYCENTRIC TRADE GOVERNANCE**

Abstract:
International trade plays a critical role for planetary boundaries: As engine of the world economy, it embodies large amounts of environmental pressure, while it also enhances the resilience of the economic system to deal with crisis. Given the current standstill of the WTO, Preferential Trade Agreements (PTAs) remain the main tool in place to govern environmental externalities of trade. The relation between PTAs as polycentric system of governance and the ecological system, however, remains underspecified: How do PTAs integrate environmental concerns? Do textual changes emerge in response to changes in the ecological system? Focusing on the case of biodiversity, this study investigates the integration of environmental knowledge in trade agreements. Building on the theoretical foundations of socio-ecological systems and complex adaptive systems, it first analyzes textual data from the Trade and Environment Database with an automated Text-as-Data approach regarding the coverage and intensity of legal provisions on biodiversity and deforestation. In a second step, I exploit historical data of proxies of biodiversity to statistically examine the extent to which these trends relate to actual changes in biodiversity, with a particular focus on land use changes and biological invasions. Overall, this analysis contributes to a better understanding of the adaptability of the trade governance regime to the ecological transition in biodiversity.

Biographical sketch:
Simon Happersberger is a second year PhD student at the Vrije Universiteit Brussel and an associated PhD fellow at the United Nations University Institute on Comparative Regional Integration Studies. His research focuses on the comparative effectiveness of policy instruments fostering environmentally sustainable trade. Simon holds a master's degree in Political Science from Freie Universitaet Berlin and University of Cape Town and a Dual Bachelor's Degree in Political Science and German Philology from University of Goettingen and Universite Paris-Sorbonne. He collected first professional experiences at the Secretariat of the European Parliament, the German Institute for International and Security Affairs and the German Federal Foreign Office.

Xander Huggins

Mentor: **Taher Kahil**
Co-Mentor: **Amanda Palazzo**

Research Project: **GLOBAL SOCIAL-ECOLOGICAL SYSTEM ARCHETYPES OF GROUNDWATER-CONNECTED SYSTEMS**

Abstract: Groundwater is a resource deeply embedded in complex social-ecological systems, and groundwater resources are being depleted in over half of the major aquifers of the world. To mitigate impacts of groundwater misuse on social, ecological, and Earth systems, global action is needed to promote groundwater sustainability. Yet, the convention remains to study groundwater, and particularly the sustainability of groundwater resources, as an isolated resource and the social, ecological, and Earth system processes that drive groundwater used and determine the impacts of changes in groundwater are often omitted from analysis. Social-ecological system archetyping is a data-driven approach to identify recurring relationships between biophysical and social elements of a given human-environmental system and to classify these relationships into a finite set of archetypes. Archetypes generate awareness of place-based differences between systems and infer that responses to pressures or interventions will vary between archetypes. Social-ecological system archetyping is an emerging topic and it has yet to be applied to groundwater systems. In this work, global groundwater systems will be classified and mapped into social-ecological archetypes for the first time. The analysis will use an in-development global database for interdisciplinary groundwater sustainability assessments. Measures of the frequency and success rate of implemented groundwater sustainability solutions will be assessed across global groundwater archetypes to test the potential for such archetyping analysis to guide context-dependent solution implementation. The insights from this work can be useful both internally to groundwater researchers and practitioners: by identifying the macro-scale social and biophysical conditions that support sustainable groundwater outcomes; and externally to other sustainability scholars: by providing a template of global systems archetyping that can be adapted for other common-pool resources.

Biographical sketch: Xander is a PhD candidate in the Department of Civil Engineering at the University of Victoria (Victoria, Canada) and at the Global Institute for Water Security at the University of Saskatchewan (Saskatoon, Canada). He holds a B.Eng. degree in Water Resources Engineering from the University of Guelph (Guelph, Canada), and fast-tracked from MASc to PhD programs in May 2020. Xander's current research interests lie at the interface of groundwater hydrology and sustainability science, with a tendency to focus at the global scale.

Tara Ippolito

Mentor:	**Juraj Balkovic**
Co-Mentor:	**Tamas Krisztin**
Research Project:	**SPATIO-TEMPORAL MODEL RESPONSE CHARACTERISTICS OF THE EPIC MODEL**

Abstract:
The EPIC model can provide valuable insights regarding the response of crops to climatic changes, textural differences, and amendments such as fertilizer or manure without needing extensive work carrying out site level model parameterization and testing. The mechanistic information which underpins models such as EPIC provides very useful information which may inform agricultural decision making. Much of the current literature surrounding crop models centers on the accurate prediction of yield and the data required to achieve this. While yield is a critical metric for understanding agricultural production and constraints, the mechanistic knowledge underpinning the EPIC model could also be used to predict response curves to amendments or decision-related parameters such as added Nitrogen. Our goal is to use a hypercube approach to EPIC to generate response curves to key predictive variables and test whether these can be used in real world field setting to predict yield responses to management or physical factors without the use of site specific model runs. Furthermore, we aim to provide a better understanding of the nuanced effects climate change may have on European agriculture depending on management and biophysical properties.

Biographical sketch:
Tara Ippolito graduated in 2019 from University of Redlands, a small liberal arts college in California, with a Bachelors of Science in Mathematics. She is a third year Environmental Studies PhD student at University of Colorado, Boulder advised by Dr. Jason Neff in the Sustainability Innovation Lab at Colorado. Her thesis is titled “The Spatio-Temporal Dynamics of Biophysical Drought Risk in Agricultural and Grazing Systems”. Her main fields of scientific interest include agricultural drought risk, smallholder agriculture, machine learning, and large-scale data analytics. In her free time, Tara enjoys skiing, making homemade pasta, and taking her rescue dog Corra on hikes.

Hyun-Woo Jo

Mentor: **Andrey Krasovskiy**
Co-Mentor: **Florian Kraxner**

Research Project: **IDENTIFYING OPTIONS FOR ADAPTING TO FOREST FIRE IN SOUTH KOREA USING IIASA'S FLAM MODEL**

Abstract:
As a part of international efforts towards net zero emissions, the need of maintaining forest services – particularly carbon sequestration – has become greater than ever before. The risk of forest fires has been amplified by climate change-driven droughts and heat waves. These lead to higher fire frequency, but also to larger and more intensive biomass burning and associated emissions, which create a vicious cycle by accelerating climate change. Despite evidence of growing risk of forest fires, a response system in South Korea, where more than 60% of land is forest, is still focusing on posterior measures, rather than preventive in terms of lowering the fire risk. To improve preventive measures, forest fire models need to be developed for the assessment of future fire risk and projected burned areas. In that context, this study aims at applying IIASA's FLAM model to South Korea. The following model developments are planned: 1) development of a soil moisture module for improved representation of weather impacts on wildfire probability in FLAM; and 2) optimization of probability functions in FLAM using national GIS data representing biophysical and social impact features. These developments will result in projections for both long- and short-term forest fire risk at a 4 km resolution using data from the Korean weather station network. Also, the proposed developments will support the assessment of detailed spatial synergies and trade-offs among environmental and anthropologic conditions across the country. Finally, the results will build the basis to establish novel adaptation and emergency planning leading to a reduced risk of forest fires in South Korea.

Biographical sketch:
Hyun-Woo Jo received a BSc degree in environmental science and ecological engineering from Korea University, Republic of Korea, in 2018, where he is currently pursuing the MSc/PhD integrated degree in environmental planning and landscape architecture. His research interests include processing remote sensing data with deep-learning techniques in the field of agro-forestry and integrating data science concepts with field-specific domain knowledge. During his degree course, he was involved in the Horizon 2020-EOPEN project and developed a deep-learning-based rice paddy detection model which has been integrated to the project platform. He is also involved in the Horizon 2020-CALLISTO project where he is doing research on deep-learning-based agricultural monitoring to support decision making.

Marlene Palka

Mentor: **Rastislav Skalský**
Co-Mentor: **Juan Carlos Laso Bayas**

Research Project: **SOIL DATA REQUIREMENTS TO IMPROVE LOCAL FERTILIZATION STRATEGIES**

Abstract:
Crop growth and yield vary as a function of complex crop-environment-management interactions. With climate change, these complexities become even more challenging to capture. To be economically and ecologically successful, farmers need to account for these variations in their management, however. Current practices largely rely on empirical approaches, afflicted with uncertainty due to incomplete knowledge of these crop-environment-management complexities, e.g., inadequate nitrogen fertilization practices, causing some of the most severe environmental stresses from cropping systems worldwide.
Attempts to support agricultural management often build upon extensive field trials over a long period of time. At this point, process-based crop models come in handy. They are capable of representing fundamental crop-environment-management processes for a multitude of scenarios, e.g. fertilizer applications, in a resource-efficient manner, and can therefore be considered as an integral component to improve fertilization strategies. Nevertheless, providing individual, localized support based on these models remains difficult, largely stemming from inhomogeneous soil properties at small spatial scales that influence site-specific growing conditions and decrease model accuracy. By the example of the 'East-Austrian breadbasket' area, this study seeks to answer the question "How coarse can soil data be vs. how specific does soil data need to be to support practical fertilization strategies of individual farmers through crop modelling?". Results from this study are intended to feed into existing user applications such as digital portals (e.g., Sentinel Hub EO Browser), crop maps or mobile apps. Farmer feedback obtained from these platforms could in turn help to improve individual applicability of this model-based management support.

Biographical sketch:
Marlene is currently a third-year PhD student at the Institute of Agronomy, University of Natural Resources and Life Sciences (BOKU), Vienna-Austria, where she focuses on the development and evaluation of decision support tools for adapting crop management to a changing climate in Austria. She received a Bachelor's degree in "Agricultural sciences" from BOKU in 2014 and completed her Master studies in "Environmental protection and agricultural food production" at the University of Hohenheim, Stuttgart-Germany in 2016. Marlene's main research interests are remote sensing and crop modelling tools, tailored for applied agricultural management.

Irlan Rum

Mentor: **David Leclere**
Co-Mentor: **Ester Boere**

Research Project: **GLOBAL TRADE AND BIODIVERSITY THREATS IN INDONESIA'S REGIONS**

Abstract:
As global trade increases, the economy and environmental problems in distant places are connected to one another in a complex way. Global domestic consumption has driven one-fourth of global foreign production. However, this global domestic consumption has created environmental pressures on production countries. Previous studies have shown how international trade may have social and economic gains but also drives deforestation and biodiversity loss in developing countries. Indonesia has become the highest net exporter of biodiversity threats embodied in trade. This study will analyze the impact of future international trade on deforestation and biodiversity loss in Indonesia. A linkage between the global-subnational MRIO model of Indonesia and GLOBIOM will be developed to i) expand GLOBIOM indicators with employment and value-added indicators and ii) to improve at province level the representation in GLOBIOM of the palm oil sector and its link to international trade flows. A baseline scenario of increasing world demand for Indonesian agriculture commodities without biodiversity conservation efforts will be used and compare it with additional scenarios on land protection and sustainable agricultural intensification in Indonesia, as well as global demand and trade policy scenarios. This study will contribute to understanding the impact of global trade on the palm oil sector, land use, deforestation, biodiversity loss and employment across Indonesia's regions and which interventions can allow reaching a sustainable future.

Biographical sketch:
Irlan Rum obtained his Bachelor's degree in Mathematics in 2005 from Institut Teknologi Bandung. In 2009, Irlan started studying at Clemson University and obtained his Master's degree in Economics in 2011. His thesis focused on the impact of trade cost on Indonesian agri-food sectors using Computable General Equilibrium model. In 2011, he joined Department of Economics, Universitas Padjadjaran as lecture in Econometrics. In September 2019, Irlan started his PhD trajectory on Indonesia's development in Asian and Global context, supervised by Prof. Arnold Tukker and Prof. Arief Yusuf. In his project, he specifically focused on the social, economic and environmental impact of global trade and policy on Indonesian regions.

Zhimin Shi

Mentor: **Marta Kozicka**
Co-Mentor: **Michael Kuhn (EF)**

Research Project: **OBESITY/OVERWEIGHT AND ENVIRONMENTAL IMPACTS: ASSESSMENT OF EXCESSIVE FOOD INTAKE IN CHINA**

Abstract:
Rapidly rising incomes and increased urbanization are driving global dietary transition in which traditional diets are replaced by diets higher in refined sugars, refined fats, oils and, meat. This is closely related to environmental and human health. Considering the large urban population, distinctive urbanization processes, preference for refined foods, and serious environmental challenges, such trends are particularly important for China. Currently, 6.4% of Chinese adults are obese and 34.3% are overweight, which means China became a country with the highest number of obese and overweight people in the world. Excess food intake is considered the fundamental cause of obesity and overweight. At the same time, excessive food intake and unsustainable diet structure will expand the burden on the natural environment and climate change, as well as threaten food security. The environmental impacts of diet patterns and the health consequences of unsustainable diets are recognized as global issues, yet the environmental implications of excess food intake have been less well studied. In such cases, this study aims to 1) identify the crucial factors and demographic characteristics of excessive food intake and resulting obesity/overweight based on the appropriate statistical methods. 2) investigate the impact of excessive food intake on national sustainability, including population health and environmental impact based on the theory of human metabolism and life cycle assessment (LCA) method. 3) explore the impact of excessive food intake on food security and develop future food demand scenarios and analyze them with GLOBIOM. This study is expected to provide a comprehensive estimation of obesity and environmental impact resulting from excessive food intake in China. Results of this study would provide theoretical support to achieve sustainable diet adjustment and ultimately sustainable development goals.

Biographical sketch:
Zhimin is currently a third-year PhD candidate in the School of Environment at Beijing Normal University (BNU), China. She holds a BSc in Environmental Science from Jilin University (2019). Zhimin's dissertation research at BNU focuses on investigating the how excessive food intake impacts national sustainability. Her broader research interest lies in contributing towards effective diet adjustment strategy and sustainable food consumption management.

Biodiversity and Natural Resources Program (BNR)
Program Director: Yoshihide Wada

Christopher Wade

Mentor:	**Tamas Krisztin**
Co-Mentor:	**Stefan Frank**
Research Project:	**FROM GLOBAL TO LOCAL: DOWNSCALING GLOBAL LAND USE MODELS TO ADDRESS FINE SCALE SPATIAL AND TEMPORAL CONFLICTS WITHIN THE LAND USE SECTOR**

Abstract:
As countries continue to develop and implement policy changes aimed at reducing GHG emissions from the agricultural sector, decarbonizing the energy sector, and increasing terrestrial carbon sequestration, global models which represent the interconnected nature of energy, food, water, and land use sectors are needed to assess the impacts on land use, land use change, and forestry of disparate policy goals. However, global modeling frameworks do not always accurately represent the spatial heterogeneity that is needed to assess the impacts of these policies at subnational scales. For this work, we aim to create alternative future land use projections for the Central Valley of California using a highly spatially heterogeneous optimization modelling framework that represents the current crop mix, irrigation water availability, and land use competition from alternative uses such as expanded renewable energy. Alternative future scenarios modeled will account for potential changes in U.S. diets with representation of high-value agricultural commodities such as vegetables, fruits, and nuts; renewable energy expansion, and irrigation water availability, as outlined by the recently enacted, California Sustainable Groundwater Management Act. These land use scenarios will then be linked with the US GLOBIOM model developed under the FABLE project using an iterative multi-model approach.

Biographical sketch:
Chris Wade is a second year PhD student in the College of Natural Resources at North Carolina State University. He has previously received a master's degree in forestry and natural resource economics from Virginia Tech. He currently works as an applied natural resource economist at RTI international while pursuing his doctoral degree. His research focuses on applying dynamic, spatially explicit modeling frameworks to assess tradeoffs in coupled human-environmental systems. His research covers an array of topics including forestry, land use, climate change mitigation, groundwater management, and coastal resources.

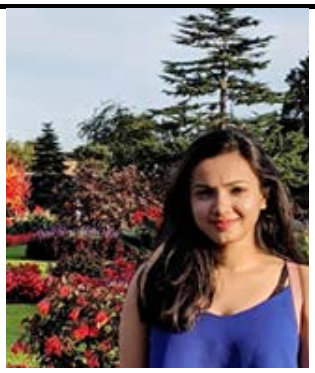
Dan Wang

Mentor: **Taher Kahil**
Co-Mentor: **Reetik Kumar Sahu**

Research Project: **A NEW AND INTEGRATED HYDRO-ECONOMIC MODEL BASED ON THE SOCIETAL WATER CYCLE FRAMEWORK: APPLICATION TO WATER STRESS EVALUATION IN CHINA**

Abstract:
To better understand how human activities interact with water resources is an important research question. In this study, we propose a research question "In the societal water cycle, which impacts do economic activities have on water resources and what is their respective contribution to water quantity and quality stress?" to investigate the impacts of economic activities on the hydrological system based on a provincial-level case study in China. Previous studies mainly focus on the impacts of water withdrawal, water consumption or virtual water import and export on water resources. In this research, we map physical and virtual water flows based on the framework of societal water cycle, which contains interaction processes of water withdrawal, water consumption, industrial water recycling, return flows, wastewater treatment, wastewater reclamation, and virtual water import and export. We link all direct interaction processes to a Multi-Regional Input-Output (MRIO) model to build an extended hydro-economic MRIO model to study impacts of economic activities on the hydrological system, especially direct and indirect impacts of water quantity and quality stress. Finally, we identify key processes and drivers that affect the hydrological system in the societal water cycle to propose ways to reduce water quantity and quality stress.

Biographical sketch:
Dan is a 3rd year PhD student at University of Groningen. She holds a BSc and a MSc degree in Environmental Engineering. Her PhD research interests are impacts of human activities on water resources. The main research questions she wants to answer are how to link societal water cycle to natural water cycle, and what are impacts of economic activities on water stress. She is trying to combine economic models with hydrological models and her engineering background to address the research problems.



Prerita Agarwal

Mentor: **Pallav Purohit**
Co-Mentor: **Zbigniew Klimont**

Research Project: **ACHIEVING CO-BENEFITS FROM BLACK CARBON EMISSIONS REDUCTIONS FOR NORTH INDIAN CITIES USING GAINS AND WRF – CHEM MODEL**

Abstract:
Ambient air pollution is now recognised as the highest health risk factor in India, with 100% of the population living in areas where $PM_{2.5}$ (particulate matter having an aerodynamic diameter smaller than 2.5 microns) levels exceed the latest WHO Air Quality Guidelines (HEI, 2022). A strong light-absorbing component of $PM_{2.5}$ is Black Carbon (BC) particles, released into the atmosphere from incomplete combustion. They can perturb the Earth's energy balance by absorbing solar radiation and modifying cloud microphysics, thereby contributing to climate warming. BC emissions from India are among the highest globally, impacting the Indian summer monsoon, regional climate, and human health. From an economical and strategic policy intervention standpoint, BC particles are well suited for achieving co-benefits for both climate and public health. Apart from adverse climatic effects, BC emissions reductions could potentially prevent occurrences of frequent severe haze episodes over the Northern Indian region. Therefore, it is crucial to assess the implications and cost-effectiveness of future emission reductions and policy interventions for short-lived species such as BC. This study looks at future BC emission reduction scenarios, focusing on shifts to cleaner domestic fuels for energy in India. Utilising the emissions results from the GAINS model, this study will also look at the effects of BC particle interaction with meteorology and other pollutants. The role of BC in the formation of new particles and promoting severe haze episodes has not been quantified in the Indian context so far. Combined with WRF-chem model results, this study aims to quantify the role of BC in the previous haze episodes and attempts to explore the least cost intensive pathways to reduce such events in the future.

Biographical sketch:
Prerita is a 3rd year PhD student at the School of Geosciences, University of Edinburgh, UK. Her research focuses on modelling and understanding the interactions between meteorology and absorbing aerosols during extreme air pollution events. She received her MPhil in Environment Science and Sustainable Development from Banaras Hindu University and MSc in Environment Management from GGS Indraprastha University, India. Before starting her PhD, she was a Junior Research Fellow at the National Physical Laboratory, India, where she looked at the variation of criteria air pollutants during the winter season in New Delhi.

Sebastian Franz

Mentor: **Paul Kishimoto**

Research Project: **GREEN TRANSITION PATHWAYS FOR THE MARITIME INDUSTRY – MODELING INTERACTIONS OF BEHAVIORAL AND SOCIOECONOMIC ASPECTS OF DEMAND WITH ALTERNATIVE FUELING OPTIONS**

Abstract:
Reducing emissions from the maritime sector is crucial to lowering challenges towards climate mitigation and meeting the Paris Agreement targets. Therefore it is essential to identify an efficient and feasible decarbonization pathway to avoid carbon-intensive lock-in for the maritime industry. To study the interaction of demand and SSP narratives, I will use an open-source least-cost optimization model (SEAMAPS) with a detailed representation of alternative fueling options for the maritime industry, coupled with SSP-specific demand projections and the IAM MESSAGEix-GLOBIOM. The demand projections will be derived via an open-source gravity model, which strictly implements the underlying SSP-specific narratives beyond GDP and population projections by including SSP-specific socio- and techno-economic parameters in the modeling approach. The coupling of the three described models will allow a novel outlook on future decarbonization pathways for the maritime industry that combines these demand- and supply-side aspects. We utilize the strength of a global IAM to analyze the intersectoral competition for available biomass and electricity generation, both of which are essential for future fuel supply in international shipping. The strict implementation of SSP-narratives will allow me to develop insights into challenges and opportunities for the maritime industry to come. Furthermore, we will show implications of possible market-based measures and the impacts towards challenges for climate mitigation and the overall design of policy measures.

Biographical sketch:
Sebastian has a background in energy economics and is a PhD student at Denmark Technical University in the Sustainability, Society and Economics Division. His research focuses on identifying defossilization pathways for the maritime industry covering a technological, economical and policy related dimension. Prior to his position at DTU he was a research assistant at Potsdam Institute for Climate Impact Research in the energy systems group, where he developed aviation demand projections for different Shared-Socioeconomic Pathways.

Nora Krenmayr

Mentor: **Adriana Gomez Sanabria**
Co-Mentor: **Pallav Purohit**

Research Project: **FROM WASTE TO RESOURCE? OBSTACLES AND LEVERAGE POINTS FOR A MORE SUSTAINABLE E-WASTE MANAGEMENT IN THE EU**

Abstract:
Waste from electrical and electronic equipment is one of the fastest-growing waste streams and a major environmental polluter, that has been widely overlooked in debates about sustainability, digitalization and circular economy. E-waste contains both toxic chemicals and hazardous pollutants as well as precious metals like gold, silver, iron, aluminum, and copper. Therefore, e-waste recycling poses a unique conundrum of economic incentives and environmental and health hazards. Europe has a high per capita production of e-waste, but also shows the highest formal collection and recycling rate globally. This can be attributed to EU policies, pursuing a doubling of the current reusing and recycling rate to 85%, as part of efforts towards building a circular economy through higher resource efficiency. The implementation of up to 85% e-waste recycling is however generating conflicts between several actors with different power resources involved in the e-waste management. This calls for research, which seeks to contribute to a more complex understanding of power and politics in the e-waste sector. By developing a conceptual framework grounded in political ecology and cultural political economy I want to identify visions and strategies by actors and reflect on their power resources. Following a qualitative research design, I conduct a literature review, a document analysis of important EU policies and strategy papers as well as expert interviews. My guiding research questions are: Who are important stakeholders and what are their power resources? How are collection and recycling structures, recycling work and e-waste flows changing because of new regulations and recycling techniques? What are the technical and regulatory constraints of better e-waste management?

Biographical sketch:
Nora holds a BA in International Development form the University of Vienna and obtained her MSc in Social and Human Ecology from Alpen-Adria University in 2020. Currently she is a first year PhD student in the Doctoral School Social Ecology at the University of Natural Resources and Life Sciences, Vienna (BOKU). She carries out her PhD research under the supervision of Prof. Christoph Görg in the project “Challenges for Social-Ecological Transformations – Addressing institutional dimensions of long-term and global resource use” funded by the Austrian Science Funds (FWF).

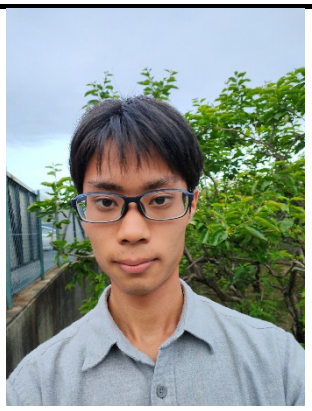
Tianyang Lei

Mentor: **Lena Höglund-Isaksson**
Co-Mentor: **Parul Srivastava**

Research Project: **ASSESSING OIL AND GAS SECTOR METHANE EMISSIONS AND MITIGATION POTENTIALS AT THE FACILITY LEVEL**

Abstract:
The oil and gas extraction industry plays a crucial role in energy transition and greenhouse gas (GHG) emissions today, facing the new challenges of meeting the energy supply while also reducing GHG emissions. Continuous dynamics of resource-type-/geolocation/decision-makers-specific GHG emissions within the oil and gas extraction industry worldwide remains poorly understood, but is vital to explore the mitigation potential of critical GHG emitters and supporting the targeted emission reductions. By coupling bottom-up field-based information with top-down satellite imageries and published information on region-specific management practices, this research aims to establish a time-series, field-level GHG emissions inventory for global oil and gas fields, explore the near-real-time (day by day and month by month) GHG emission monitoring and accounting, and assess the scope for reduced emissions. Based on the proposed inventory, this research will try to distinguish the major GHG emitters at the field-/company-/country- level in the oil and gas extraction industry worldwide, to clarify the responsibilities of these major emitters and give a baseline for their GHG budget against the backdrop of carbon mitigation worldwide. The proposed near-real-time GHG emission dataset will provide rapid feedback on the effectiveness of abatement technologies and related policies in reducing emissions. This research has the potential to significantly improve the accuracy of GHG emission inventories of oil and gas fields worldwide, support targeted emission reductions, and benefit global carbon neutrality.

Biographical sketch:
Tianyang Lei graduated from the East China Normal University in 2019 with a Science Bachelor's in geographic information science. She is now a third-year PhD candidate in the Department of Earth System Science at Tsinghua University. Her current research focuses on the development of global key infrastructure greenhouses gas emissions datasets, such as oil and gas facilities, iron and steel plants, and so on.



Osamu Nishiura

Mentor: **Volker Krey**
Co-Mentors: **Oliver Fricko, Bas van Ruijven**

Research Project: **MACROECONOMIC AND HOUSEHOLD IMPACTS OF ENERGY TRANSFORMATION PATHWAYS FOR PARIS AGREEMENT TEMPERATURE GOALS**

Abstract:
Various kinds of Integrated Assessment Models (IAMs) have been developed for specific targets, such as analyzing economic impacts or the energy system transition due to the reduction of emission. To enable policymakers to decide on emission reduction strategies based on different perspectives, it is necessary to develop an IAM that has multiple features simultaneously. In this research proposal, I plan to develop an IAM by combining MESSAGEix, a perfect foresight energy system model, with AIM/Hub, a computable general equilibrium (CGE) model. This coupled model will allow us to estimate emission reduction scenarios considering long-term investment and large-scale change in the energy system, and to provide detailed economic implications. I will explore assessing ways of reducing household consumption loss as a results of emission reduction.
In the emission reduction scenario, large-scale changes in the energy system and long-term investment tend to reduce gross domestic product (GDP) and increase the burden of energy-related expenditure. In contrast, early and widespread adoption of biomass energy is expected to lead to higher food prices, increasing the burden of household food expenditures. Based on these price changes and the economic impact of each sector, I will discuss the factors of household consumption loss and the measures to moderate the impact of emission reductions.

Biographical sketch:
Osamu Nishiura is a 2nd year PhD candidate in The Department of Environmental Engineering of the Graduate School of Engineering, Kyoto University (Kyoto, Japan). He received a master's degree of Environmental Engineering from Kyoto University in 2021, and a bachelor's degree in Engineering from Kyoto University in 2019. His current research focuses on modeling computable general equilibrium model regarding new technologies to achieve net-zero goal. His main fields of scientific interest include computable general equilibrium modeling and energy-system modeling.

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Minwoo Park

Mentor: **Younha Kim**
Co-Mentor: **Zbigniew Klimont**

Research Project: **THE SPECIATED NMVOC EMISSIONS CHANGE DUE TO EMISSIONS CONTROL POLICY AND ITS IMPACTS ON AIR QUALITY**

Abstract:
VOC(volatile organic compounds) is one of the important pollutant of air pollution reduction policies to improve the air quality. This study aims to achieve a better understanding of the impacts to the air quality from VOC emissions change by climate change and air quality management policy.
Volatile organic compounds (VOCs) play an important role in the formation of PM2.5 and O3. Therefore it's critical for understanding the mechanism of formation of secondary pollutions and devising effective control policies. But VOCs include a large number of chemical species which differ significantly in their chemical characteristics and thus in their impacts on ozone and secondary organic aerosol formation.
I propose to develop a policy-technology-based VOC speciation profile that can support air quality modeling to understand future specified VOCs emissions.
I intend to develop policy-technology pathways for reducing greenhouse gas-air pollutants in Northeast Asian countries and estimate the speciated VOC emission by applying the chemical speciation profiles to each emission scenarios. In addition, the speciated future VOC emission will be used in the air quality model to forecast and evaluate emission under the reduction policy scenarios in East Asia.

Biographical sketch:
Minwoo Park is currently a 5th year integrated PhD program student in Informative Environmental Technology, Konkuk University. He received his BSc degree in Department of Advanced Technology Fusion, Konkuk University(2018). His research mainly focuses on emission processing and evaluating the effect of policies by each source's characteristics. He has been working on the development of the emissions estimation model for road transportation, and emissions processing to support CTM(Chemical Transport Model) to evaluate the policy effectiveness.

Pooja Ramamurthi

Mentor: **Narasimha Rao**
Co-Mentor: **Shonali Pachauri**

Research Project: **QUANTIFYING THE RELATIONSHIP BETWEEN PSYCHOLOGICAL FACTORS AND ENERGY EFFICIENT BEHAVIOUR ACROSS CULTURES: A STUDY OF THE U.S AND INDIA**

Abstract:
Typically, empirical models to determine energy consumption use economic and demographic assumptions. However, it has been established that consumer behaviour and preferences are often determined by non-monetary cognitive factors such as motivations, beliefs, and norms. Even within a single socio-economic demographic, there can be heterogeneity in consumption based on cognitive motivations. Further, literature on how differences in cultural and country contexts impact non-monetary motivations of sustainable lifestyles is scarce, with a dearth of studies on efficient lifestyle choices in emerging economies. Therefore, gaps remain in understanding the 'behavioural realism' of energy consumption in models at aggregated levels. At IIASA, I will address these gaps and study determinants that lead to choices around household energy efficient electrical appliances. Using existing datasets, I will parameterise the non-monetary factors of personal norms and beliefs as well as norm and belief perceptions on the willingness to pay for efficient appliances in the U.S. and India. In an industrialised economy (U.S) this may signal a lifestyle ‘shift’ towards energy efficiency, whereas in emerging economies (India), it may signal a lifestyle where energy intensive technology is ‘avoided’. Results from the study can provide a framework on whether, which, and how realistic cognitive non-monetary factors can be incorporated into sectoral and regional models of IAMs such as MESSAGE at IIASA.

Biographical sketch:
I am a PhD student in the Science, Technology and Environmental Policy (STEP) program at Princeton University. My research interests lie in the areas of energy transitions, climate change and sustainability. My work has always been multidisciplinary, where I look at technical, socio-economic, political and developmental aspects of energy. Within STEP, I am interested in understanding the relationship between human decisions and their impacts on climate change and energy. In order to hasten the shift to renewable energies, I want to study how environmental and energy based choices/behaviours are made in emerging economies.

Jan Streeck

Mentor: **Volker Krey**
Co-Mentor: **Gamze Ünlü**

Research Project: **TRIANGULATION OF STOCK-FLOW INDICATORS OF MATERIAL CYCLES FROM MESSAGEix AND INDUSTRIAL ECOLOGY**

Abstract:
Climate change mitigation requires radical reductions of GHG emissions. The potential of different strategies to reduce GHGs is subject to fierce debate and investigation, the assessment of strategies requiring a technology-rich scenario approach. Technology-rich Integrated Assessment Models (IAMs) contribute to prominent science-policy interfaces such as the IPCC but have an important shortcoming: although material production accounts for ~1/4th of global GHG emissions, many IAMs ignore potential interventions in material life cycles as a GHG mitigation option, which makes these assessments incomplete and neglects the contribution materials can make to reduce impacts.
Recent advances in integrating major material flows into IAMs try to tackle this gap. However, the accurate quantification of material cycles is a challenge even in the scientific field primarily occupied with this task, Industrial Ecology, which merits the validation of indicators across methods.
The proposed research will compare the stock-flow indicators used in the IAM MESSAGEix, with recent results from Industrial Ecology. For comparison we will obtain independent data from (a) top-down, economy-wide Material Flow Analysis, as well as bottom-up data from (b) spatially explicit material stock, and (c) sectoral stock-flow modelling. The comparison will elaborate on the qualitative and quantitative representation of stocks and flows and attempt to explain emerging differences among models. The target scope for an initial prototype with good data availability is the MESSAGEix region North America (USA & Canada) for the base year 2015 and the sectors buildings, power, transportation and (residual) infrastructure. Results are expected to contribute to validating the representation of material production and consumption in MESSAGEix, to subsequently enable improved representation of the GHG mitigation potential of material efficiency measures.

Biographical sketch:
Jan is a 4th year PhD student at the Institute of Social Ecology, University of Natural Resources and Life Sciences, Vienna. His thesis is investigating the connection of economy-wide material flows and stocks to the services that humans derive from using materials and energy for their well-being. Jan's additional scientific interests and activities include climate change mitigation through material efficiency and demand-side measures, input-output analysis, integrated assessment, and ecological macroeconomics. In 2017, Jan graduated with a master's degree in Environmental Governance from Freiburg University.

Mel George

Mentor:	**Jihoon Min**
Co-Mentor:	**Shonali Pachauri, Narasimha Rao**

Research Project: **ATTAINING UN SDG-7 FOR VULNERABLE HOUSEHOLDS IN 1.5 DEG C PATHWAYS**

Abstract:
Even while targeting similar climate outcomes, transition risks depend on mitigation pathway, implying dissimilar outcomes for different households. Analyzing such distributional effects on vulnerable sections is important for enhancing national mitigation ambitions by supporting social objectives & going beyond co-benefits. There is limited research exploring distributional consequences of diverse pathways to the same climate outcome and underestimation of the skew in investments for SDG attainment without accounting for additional tradeoffs for vulnerable households. My work is driven by the question of how alternate mitigation pathways can best deliver on climate & social goals.
Using a global Integrated Assessment Model (IAM), I will compare different 1.5C pathways on their relative spatial & temporal effects on household energy burdens & linkages within SDG7 dimensions (access, affordability, clean energy & energy security). I shall study 12 pathways varying by pace of transition, technology choices, and socioeconomics to identify regions which might benefit in each case and pathways that better address SDG7 tradeoffs. Applying a recent framework by Pachauri & Rao (2020) that distinguishes condition and cause of energy deprivation, I will also examine the effect of mitigation pathways on households, going beyond regions, with contrasting cases of USA & India. I will overlay IAM results with household survey data and income distribution projections to map the effects by income deciles. Lastly, I intend to explore how redistribution policies could mitigate these effects and achieve decent living standards in residential energy use, using a compensating variation approach.
My work will demonstrate how well-designed mitigation pathways can limit transition risks to vulnerable sections.

Biographical sketch: Mel George graduated with a Master's degree in Energy Science & Engineering from the Indian Institute of Technology – Bombay in 2009. He is currently a fourth year PhD student at the University of Maryland – College Park, USA, after a decade in the public sector and energy industry. His dissertation explores justice and equity implications of climate change mitigation pathways.
An electrical engineer by training, Mel's research interests are at the intersection of technology & policy, and their implications for sustainable development and broader societal needs. He enjoys working on interdisciplinary problems at all scales, spanning the gamut from grid integration of renewable energy to political economy aspects of the energy transition.

Hui Yang

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

Research Project: **DISTRIBUTION AND IMPLICATIONS OF FUTURE GLOBAL AIR POLLUTION RELATED HEALTH CO-BENEFITS UNDER DIFFERENT CLIMATE MITIGATION STRATEGIES**

Abstract:
To combat climate change, countries have agreed to undertake ambitious efforts to reduce greenhouse gas emissions and limit global warming to below 2 °C. Even if a globally uniform carbon price is the most cost-efficient way for climate mitigation, in the real world, the climate policy is regionally varying due to political feasibility and equity considerations. In addition, socio-demographic factors such as population, income and technology assumptions affect the multi-sector dynamics between socioeconomics and biophysics, driving the global and regional changes of energy use, hence the changes in air pollutant emissions. As air pollution exposure and socio-demography of population differ across temporal and spatial horizons, the associated health burden is distributed unequally among different population groups. With the same climate target, policies with different allocations of mitigation efforts will lead to different distributions of mitigation costs and health co-benefits. Previous studies mostly focus on either the upstream analysis (socio-demographic factors – energy future) or the downstream implications (emissions – health burden). Yet, it is less explored how the upstream and downstream drivers will interact together in the course of time.
This study aims to investigate how the distribution of mitigation costs and health co-benefits will differ between optimal (globally uniform carbon pricing) and second-best (regional varying carbon pricing reflecting the allocation of mitigation efforts) climate policy scenarios. Using IPCC carbon budget and basic elements projections (e.g., population, age structure, income) from the Share Socioeconomic Pathways dataset, we plan to run the GCAM model for emissions outputs under various 2-degree scenarios, the GAINS model for calibration of exposure estimates and for conducting health impact assessment. We will further quantify the future global total health benefits and mitigation costs along with their distributions across regions and population groups. Through this, the heterogeneity in the socio-economy that drives emissions is made consistent with the socio-economy heterogeneity that underlies the health benefit assessment. Our work will demonstrate the roles that socio-demographic factors play in future global health burden and the equity outcomes shaped by different shares of mitigation efforts and provide an innovative and self-consistent methodology for integrated assessment modeling.

Biographical sketch:
Hui is a third-year PhD candidate in Environmental Engineering at The Pennsylvania State University. She holds a MSc in Civil & Environmental Engineering (2018) from Carnegie Mellon University and a BSc in Civil Engineering (2017) at University of Macau. Hui's research lies at the nexus of climate change, air quality and human health. She is a pet mom of two, a buff/white tabby cat and a golden retriever pup.

Gesangyangji ("Ge-sang")

Mentor: **Mastrucci Alessio**
Co-Mentor: **Edward Byers**

Research Project: **CHANGES IN DIURNAL COOLING ENERGY DEMAND IN THE UNITED STATES**

Abstract:

Electricity demand and associated emissions to meet cooling needs are one of the fastest-growing components of demand that create additional stress on electricity systems. Understanding hourly variation in cooling demand is essential to finding potential solutions to curb associated emissions. However, studies on hourly cooling demand at a national or global level are lacking due to limitations in climate projections. The primary objective of this work is to study future changes in the diurnal cycle of buildings cooling demand with a focus on the U.S. residential sector, accounting for the impacts of climate and socio-economic changes. To undertake this research, a rescaling method will be used to produce future hourly data from projected daily maximum and minimum temperatures and historical diurnal fractions. Then, this future hourly data, along with other socio-economic factors will be used to calculate cooling energy demand employing an existing model developed at IIASA. This combination of climate data rescaling with IIASA's residential thermal energy demand model, will allow for a comprehensive analysis of future changes in the diurnal cooling demand for the U.S. residential sector. The analysis will deliver helpful information to support sectors like electric utilities and air-conditioning companies, as well as cooling-related policymaking in the U.S. The methods developed can be applied to other countries to improve our knowledge of future cooling demand at a global scale and explore potentials for energy conservation, pollution control and climate change mitigation.

Biographical sketch:

Gesang is a PhD candidate in the Nelson Institute Environment and Resources Program at the University of Wisconsin-Madison (UW-Madison). She holds an MS in Atmospheric and Oceanic Sciences and a Certificate in Energy Analysis and Policy from UW-Madison. She is broadly interested in topics related to climate change and energy conservation. Her research at UW-Madison has focused on the impacts of climate change on building design and indoor heating and cooling energy use in the U.S. She also minors in science communication and cares about issues related to interdisciplinary collaboration and research-practice partnerships. Outside of research, she enjoys dancing, reading, hiking, and traveling around the world.

Zixuan Zhang

Mentor: **Marek Makowski**
Co-Mentor: **Julian Hunt**

Research Project: **HARMONIZING DIFFERENT TIME-SCALE DECISIONS IN RENEWABLE ENERGY GENERATION PLANTS**

Abstract:
Decisions on the development and operation of Renewable Energy Generation plants (REGs) concerning different time scales, ranging from decades to hours. Moreover, the decisions are made for highly uncertain and variable external conditions, in particular determining energy generation by solar photovoltaic devices and wind turbines, as well as for uncertain demand and prices for the produced energy. The widely known approaches focus on planning either the development (for long periods) or shorter-period operations of plants with given technologies and production capacity.
I will develop a model for supporting harmonized decision-making in long-term planning (capacities and technologies) and the short-term operation of REGs. The model will build on integrating the available knowledge on generating renewable energy as well as diverse methodologies and technologies for dealing with variability and uncertainty. I will exploit the structured modeling paradigm, which will enable the modular structure of the whole modeling process (composed of the symbolic specification model, generation of model instances using diverse data for model indexing structures and parameters, and various methods of model analysis). Such a modeling paradigm will enable model reuse, e.g., for diverse energy generation and storage technologies. Multiple-Criteria Model Analysis (MCMA) will be used to support interactive analysis of various trade-offs between reachable goals for conflicting objectives, such as diverse costs (investment, operation, and maintenance, total annual), the energy efficiency of the storage technologies, and income from selling products.
In YSSP this summer, I plan to establish the first stage of the model, which focuses on the operation of given REGs (with wind turbines), i.e., capacities of the REGs elements are assumed, components shall be fixed. The planning decisions such as the capacity of the type of the storage devices and the operation decisions such as the energy flows will be the outcomes of the model.

Biographical sketch:
Zixuan Zhang is currently a fourth-year PhD student at the center of energy economics and environmental management at East China University of Science and Technology. Her current research focus is harmonizing different time-scale decisions in energy system analysis. She has experience with Input-Output analysis, and her main interests are energy system modeling, energy storage, energy system resilience, and environmental economics.

Andreas Lichtenberger

Mentor: **Michael Kuhn**
Co-Mentor: **Miguel Sanchez Romero, Fabian Wagner (ECE)**

Research Project: **ANALYZING THE REDISTRIBUTIVE AND MITIGATION EFFECTS OF DIFFERENT CARBON TAX POLICIES**

Abstract:
Carbon taxes (CT) can be implemented in a progressive manner (Morris & Munnings 2013) and research showed the positive social and environmental aspects of a CT with recycled revenues (Budolfson et al. 2021). The landscape of micro-data studies is still scarce (Ott & Weber 2022) and so far, no study has analyzed the redistributive character of different CT implementations for observed consumer expenditure data and looked into their implications on welfare and future mitigation. This research will fill that gap. Firstly, I will systematically compare countries that implemented CT policies in the past years and study the redistributive character for country cases with different CT scenarios. I.e., I will look at countries that introduced (i) CT with no earmarking of the revenues (Ireland 2010, UK 2013), (ii) CT with environmental spending (France 2014, Portugal 2015), and (iii) CT with revenue recycling (British Columbia 2008, Switzerland 2008). I will compute consumption pattern changes before and after the introduction of the CT, the associated tax burdens (and re-transfers) for different household income groups, and the respective impact on the income distribution. Secondly, I am using the information on the changes on different income groups for a forward-looking perspective on mitigation. Via a quadratic almost ideal demand system model (QUAIDS; Bjelle et al. 2021) I analyze how much the changed income patterns reduce/increase consumption and thereby induce further carbon dioxide changes. Changes in affluence are used to compute consumption-based emission dynamics for a few years into the future. The hypothesis is that carbon taxation reduces the consumption of higher carbon intensive goods and that in cases with revenue recycling CT schemes lower income households are less impacted by the price shifts.

Biographical sketch:
Andreas is currently a third year PhD student at the Economics department at The New School for Social Research (US). His dissertation focusses on *Fiscal policies for an ecologically sustainable and socially equitable* and his main fields of scientific interest include economics of inequality, ecological macroeconomics, and public policy analysis. In September 2022 he will join the wiiw (Vienna Institute for International Economic Studies) as Economist for Macroeconomics and Fiscal Policies. Before coming to the US he did his bachelor studies at the University of Vienna (Philosophy, Sociology, Economics) and his master studies at the Vienna University of Economics and Business (Socio-Ecological Economics and Policies). Besides academia he enjoys playing instruments (guitar, piano, percussion, singing), dancing Salsa & Samba, international cuisine (especially Persian food), and combining Western psychoanalytic and Eastern Buddhist meditation techniques as sources for personal development.

Maddalena Muttoni

Mentor: **Stefan Wrzaczek**

Research Project: **MULTI-STAGE OPTIMAL CONTROL PROBLEMS WITH RANDOM SWITCHING TIMES**

Abstract: Society faces threats of catastrophic events from a variety of sources, some critical examples being environmental disasters, pandemic outbursts, socioeconomic/sociopolitical crises, etc. Alternatively, an unpredictable event may bring about an equally abrupt but beneficial change, as is the case with technological breakthrough. Either way, in a dynamic system, this uncertainty raises questions about optimal resource management over time, under the expectation of one or more disruptive events which may change abruptly the nature of the system.
The objects of this study are dynamic models that change disruptively at stochastic points in time. In contrast to established analysis, in the most relevant scenarios the hazard rate may depend on the agent's past and instantaneous behavior. The decision maker, who aims to optimize the expectation of the total objective value (either maximizing payoff or minimizing costs) over all possible realizations of the regime switches, may be interested not only in reducing the risk of regime shifts that have harmful impacts (or encouraging shifts with beneficial impacts), but also in adapting to such regime shifts when they occur.
From the analytical point of view, the problem is reformulated as a deterministic heterogeneous optimal control problem and is solved through a suitable adaptation of Pontryagin's Maximum Principle.
This theoretical framework finds applications in areas such as environmental economics, health economics, epidemiology, etc. The chosen area of application of this study is environmental economics, specifically the analysis and solution of a Dynamic Integrated model of Climate and the Economy (DICE) in continuous time featuring a *tipping point* (i.e., an environmental catastrophe induced by greenhouse gas emission).

Biographical sketch: Maddalena Muttoni is a second year PhD student at the Department of Mathematics "Tullio Levi-Civita" of the University of Padova, the title of her thesis being *Multi-stage optimal control problems with random switching times*. She is passionate about mathematical models that aid the decision-making process in complex situations. Her main scientific interests are Optimal Control and Differential Games under the threat of one or more regime shifts, with applications to epidemiology, climate change, and economics. Prior to her doctoral studies, she obtained a MSc in Mathematics in 2019 from the University of Milano-Bicocca, with a thesis on the topological approach to the Social Choice problem.

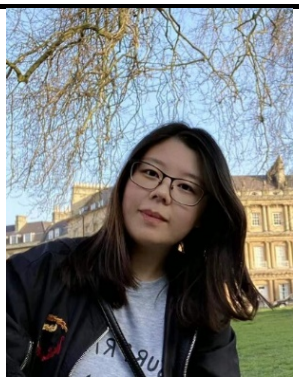
Mathilde de Goër de Herve

Mentor: **Thomas Schinko**
Co-Mentor: **John Handmer**

Research Project: **BOOSTING RESILIENT AND SUSTAINABLE DEVELOPMENT BY EMPLOYING A RISK JUSTICE FRAMEWORK: ILLUSTRATION WITH THE EUROPEAN RISK GOVERNANCE**

Abstract:
Societal risks are uncertain and unwanted events that threaten a certain number of people so they are at least partially tackled at the collective level. Society needs to manage them to become more resilient and boost sustainable development. We hypothesize that including fairness considerations allows to contribute to this aim. A theoretical and analytical framework, called risk justice, is crafted which consolidates important aspects of justice that must be considered in risk management for it to contribute to sustainable development. Risk justice includes distributive and procedural justice aspects under four dimensions that overlap: social, ecological, spatial, and temporal. Social justice is the fairness between different groups of people, while ecological justice is the fairness between humans and non-humans, as well as between different non-human entities. Spatial justice is the fairness between living entities situated in different geographical areas and temporal justice between the ones living at different points in time. These dimensions reflect several appropriate justice concepts such as inter-, intra-generational, and multispecies justice, which are relevant to address the main elements described in most sustainable development's definitions: targets, territories, and time. To illustrate the potential of risk justice as an analytical tool, European guidelines of risk governance are analyzed in light of the framework, starting with the flood directive, as the recent events in Western Europe during the summer 2021 witness this increasing threat due, at least partially, to climate change.

Biographical sketch:
Mathilde graduated in 2018 with an international master degree in Sustainable and Territorial Development, jointly delivered by the Universities of Padua (Italy), KU Leuven (Belgium), and Paris I Panthéon Sorbonne (France). She is currently in her third year PhD student in risk and environmental studies at Karlstad University (Sweden), her thesis is about justice and temporal issues in disaster risk management. She is affiliated to the Centre for Societal Risk Research and the research school on Sustainable Societal Transformation. Her main fields of scientific interest include sustainable development, long-term effects, and evaluation.



Xinyi Kou

Mentor: **Guillaume Marois**
Co-Mentor: **Dilek Yildiz**

Research Project: **BILATERAL INTERNATIONAL MIGRATION MEASUREMENT AND FORECAST: AN AGENT-BASED MODEL**

Abstract:
As the most challenging demographic component, international migration studies suffer from the uncertainty at both macro and micro levels. The uncertainty at macro level is rooted in the difference on defining a migrant, and stems from the imperfect measurement of migration and data deficiency, this is so-called epistemic uncertainty. The aleatory uncertainty, that is defined as the inherent uncertainty due to the probabilistic variability or other types of randomness, stems from the individual migration decisions in migration studies. This study is aiming to address uncertainties at micro level and generate a real-world quantity of interest, such as the 'true' bilateral international migration flow and the migration age profile. Specifically, a 'bottom-up' modelling approach, agent-based modelling (ABM), is proposed for this research. The model simulates the complex individual migration decision-making process by modelling the micro-level theoretical framework. This theoretical framework addresses the bilateral migration driven by job opportunities, wage differentials and origin-country-based migration networks. The proposed research provides a better insight of the underlying mechanism of migration behaviours. And it has the ability to provide a consistent and reliable set of bilateral international migration data and generate various 'what if' scenarios based on the Shared Socioeconomic Pathways (SSP) population parameter values for future bilateral migration flows until 2030. The ABM's initial conditions are based on the empirical estimates from IPUMS-I 2001 data. Considering of the computational ability, the output will be a set of predicted bilateral migration flows and the accordingly age distributions of migrants between Poland, Germany and the United Kingdom from 2001 to 2030.

Biographical sketch:
Xinyi Kou holds a BSc in Applied Mathematics, jointly awarded by Ningbo University (China) and Middle Tennessee State University (USA). She continued her study with a MSc in Statistics at the University of Manchester. She is currently a 3rd year PhD student in the Department of Social Statistics at the University of Manchester. Her main research focuses on the measurement of migration uncertainty and harmonization of data inadequacies on biliteral international migrations. She has a specific interest on the individual-level modelling techniques, such as agent-based modelling and microsimulation.

Population and Just Societies Program (POPJUS)
Program Director: Anne Goujon

Thomas Leffler

Mentor: **Roman Hoffmann**

Research Project: **SPATIAL-TEMPORAL ASSOCIATIONS BETWEEN FOREST COVER CHANGE AND PEDIATRIC HEALTH INDICATORS IN SELECTED SUB-SAHARAN AFRICAN COUNTRIES**

Abstract:
The relationship between forest cover loss and infectious disease risk is in need of further investigation, particularly in impacts to vulnerable populations (children). The proposed research investigates the linkages between forest cover change and selected pediatric health outcomes. We propose various regression analyses to investigate forest cover data from NOAA and pediatric health data from USAID's Demographic and Health Survey to assess these associations. The research will use DHS "cluster sites" along the human-wildlife interface in Senegal, Kenya, and Tanzania as appropriate geographic variables. Anticipated outcomes would demonstrate the positive or negative relationship between forest cover change and certain diagnoses, while allowing for further mechanistic investigation.

Biographical sketch:
Thomas is currently a second year PhD student at the Nelson Institute for Environmental Studies at the University of Wisconsin-Madison. His research focuses on the nexus of land-use change and health, specifically looking at deforestation and associated infectious disease emergence risk. Thomas also holds an MPH in International Development from the University of Sheffield, and worked thereafter in clinical oncology research before going back for his PhD following the COVID-19 pandemic. Inspired by the pandemic to investigate disease emergence issues further, Thomas is hoping to apply his previous research skills to health and disease with a OneHealth perspective. Outside of academics, Thomas has been a lifelong environmentalist and is an avid hiker, cyclist, guitar player, chef, and sunset enthusiast!

Leonard Kwhang-Gil Lemke

Mentor: **Susanne Hanger-Kopp**

Research Project: **A QUALITATIVE SYSTEM MAPPING APPROACH TO AUSTRIAN AGRITOURISM DEVELOPMENT**

Abstract: Covid-19 had numerous consequences for the Austrian tourism sector, but the spatially diverse and socially uneven effects of the pandemic remain yet to be discovered. Whilst preliminary findings indicate the paralyzing economic effects in terms of rapidly declining revenues and international visitor numbers on a global scale, very little remains known about mountainous regions and the nature and intensity of the pandemic experienced in rural areas. In this context, tourism and agriculture not only make a significant source of income, but play an important role for sustainable development, climate change adaptation and biodiversity conservation as well. Perspectives from Human Geography have long emphasized how systems thinking can help to comprehend socio-environmental change in space and time. During the YSSP, I therefore aim to integrate knowledge from primary and secondary sources to look into rural agritourism in Tyrol that was affected by – or changing in response to – Covid-19. The research is thereby situated within a larger methodological framework of qualitative system mapping (QSM) and aims to visualize a number of rural system elements and their causal relationships via kumu.io. Correspondingly, I will couple iterative desk-based research, covering Austrian policy documents, academic literature and expert interviews, with continuous relationship mapping and visualization. My entry point are actors and stakeholders related to agritourism and surrounding governance structures. Throughout the three months, I will specify actor profiles, roles and connections to generate a baseline of the human dimensions of rural agritourism systems in Austria.

Biographical sketch: After receiving his BA in International Relations at Birmingham University in the UK, Leonard Kwhang-Gil Lemke obtained his MSc in Environmental Sciences from Wageningen University, where he focused on climate adaptation and water systems. Currently, he is in the second year of his Ph.D at the Institute for Regional Research and Geography at the University of Vienna. The working title of his thesis is “Transformative Regional Economic Resilience: A comparative investigation into Covid-19 and Agritourism in Thailand and Austria.” His main fields of scientific interest include critical theory, human geography and sustainable development.

Xueting Li

Mentor: **Raya Muttarak**
Co-Mentor: **Roman Hoffmann**

Research Project: **MEASURING GLOBAL SOCIAL VULNERABILITY TO NATURAL DISASTERS AT THE SUB-NATIONAL LEVEL**

Abstract:
Identifying and addressing social vulnerability is an integral element of disaster risk reduction efforts. A range of quantitative approaches have been proposed to measure vulnerability in different contexts, guiding the scale of research and the selection of indicators. Validating the approach of social vulnerability measurement with the actual impacts of natural hazards is necessary for comprehensively understanding the interplay between hazard, exposure and vulnerability. Here, highly localized studies face difficulties in capturing the common characteristics of societies and comparable factors shaping social vulnerability at a larger scale, challenging comparisons at the global level. This study will investigate global social vulnerability to natural disasters using sub-national data for a large number of countries. Various sources of demographic and socio-economic data will be employed to construct a social vulnerability index (SVI). Principle Component Analysis and modelling approaches will be adopted to develop the SVI and to determine the contributions of different factors.

Biographical sketch:
After graduating in 2020, Xueting Li continues her PhD study in Asian Demographic Research Institute, Shanghai University. Now, she is a 2nd year PhD student majoring in Demography. Title of her thesis is “Multi-scale Assessment of Social Vulnerability under Global Environmental and Climate Changes”. Her main fields of scientific interest include quantitative research on demographic dynamics and climate change risks, vulnerability, resilience, and mitigation.

Lilipramawanty Kewok Liwin

Mentor: **Daniela Weber**
Co-Mentor: **Sonja Spitzer**

Research Project: **THE CAUSAL EFFECT OF SCHOOLING ON OVERWEIGHT/OBESITY IN LOW- AND MIDDLE INCOME SETTINGS**

Abstract:
Average educational attainment is strongly associated with the long-term decline in morbidity and mortality of a population. In particular, studies on obesity show a consistent relationship between education level and the risk of obesity. Evidence from low- and middle-income countries is, however, scarce. Moreover, studies rarely establish a causal relationship between educational attainment and health outcomes at the individual level.
My previous study on the link between education and obesity in Indonesia has identified the shifting in association and direction of educational levels to the risk of overweight/obesity over time. Changes in access to education and the ongoing nutritional transition in Indonesia may lead to the shifting of educational gradients in overweight/obesity over time.
Hence, this study aims to conduct an in-depth analysis of the phenomena by investigating the causal effect of schooling on being overweight/obese in Indonesia. My project evaluates the link between educational policies on population health outcomes using a difference-in-differences approach that exploits variations in education policies. This study will examine data from Indonesia Family Life Survey, Indonesia Nasional Basic Health Survey (Riskesdas), and National Socioeconomic Survey (SUSENAS).

Biographical sketch:
Lili is currently a third-year PhD student at the School of Demography, the Australian National University. Her thesis is Adult Morbidity and Mortality Related to Type 2 Diabetes in Indonesia: Understanding the Role of Demographic Changes. She receives a Bachelor in Statistics from Bina Nusantara University in Indonesia and a Master of Social Research from The Australian National University in Australia. Her main fields of scientific interest include assessing the interplay between demographic changes and population health in particular obesity, diabetes, mortality, and the impact of the population's education level on population health.

Camila Ferreira Soares

Mentor: **Michaela Potančoková**

Research Project: **COHORT FERTILITY DIFFERENTIALS FROM RURAL/URBAN MIGRATION IN BRAZIL**

Abstract:
Compared to developed regions of the world, the demographic transition in Brazil occurred rapidly, first characterized by the decline of the mortality rate, followed by the reduction of fertility. Despite being well documented, one of the gaps that remain to be explored concerning this fertility decline is the relationship between internal migration and fertility. Numerous studies have demonstrated that urban women tend to have lower fertility. Therefore, we can expect that the urbanization process has been an important driver of fertility decline in Northeast and Southeast Brazil. We analyze cohort fertility differentials according to the migration status of women. Using unique detailed microdata from Brazilian censuses from 1970, 1980, 1991, 2000, and 2010, it is possible to analyze the completed fertility of women (age 35 and over) concerning their migration history, i.e., differentiating between those who migration between urban/rural regions, those who moved within urban or rural areas and those who did not. Preliminary results indicate substantial cohort fertility differentials among migrant categories, indicating that the country`s internal migration process was important in determining past fertility levels. The methodology will also include Kitagawa's decomposition method to decompose fertility differences between migrant categories. The aim is to compare more and less urbanized areas, and we will also add educational attainment to the analysis, an important driver of internal migration and fertility. Based on the fact that rapid urbanization in Brazil, especially in the Southeast, possibly, migration may have accelerated the process of fertility decline.

Biographical sketch:
Camila received a Master`s degree in Demography from the University of Campinas, Brazil, in 2019, where she studied the relationship between a conditional income transfer program and cohort fertility measures. She is currently a 4th-year PhD student at the University of Campinas, Brazil. Her main scientific interests include fertility and migration. Her thesis mainly focuses on using methods to estimate the internal migration impacts on Brazil's fertility decline.

Junhua Zhu

Mentor: **Michael Thompson**
Co-Mentor: **Dipak Gyawali**

Research Project: **AI FAIRNESS WITH CHINESE CHARACTERISTICS? MAPPING THE MICRO, MESO, AND MACRO INSTITUTIONS IN THE CHINESE AI ECOSYSTEM**

Abstract:
We oftentimes see unethical scandals about AI appearing in the headlines, such as tech giants' exploitation-like collection of personal data and big-data based discriminatory pricing algorithms. Indeed, as regulatory mechanisms always lag behind the technology innovation, AI ethics did not become a fashion term until the third wave of AI started in 2010s. Among the existing AI ethical guidelines, fairness is one of the most frequently advocated principles and has been a popular research subject in academia as well. However, among the English literature, systematic research on AI fairness in the Chinese context is still yet to come. What kinds of unfairness are expected to occur in AI application scenes in China? How do the Chinese AI practitioners address those unfairnesses? Particularly, this research project is proposed to locate the micro-, meso-, and macro-institutions that shape those decision-making processes. This will provide a deeper understanding of the Chinese AI ecosystem in terms of stakeholders, networks, and their preferred considerations in AI fairness. Methodologically, this project employs qualitative semi-structured interviews as the main method for first-hand data collection, targeting AI practitioners as the interview participants via snowball sampling. The interviews will be analyzed with grounded theory in an inductive manner. The outputs of this project include a systematic institutional mapping of the Chinese AI ecosystem and an elaborated analysis on the patterns of how different institutions interact with each other. They are expected to contribute to the literature on the Chinese innovation mode that is rooted in its own social-cultural-political context and have great global implications.

Biographical sketch:
Junhua Zhu graduated from Lund University and obtained his Master of Science degree in Asian Studies. He is currently a second year PhD student at Centre for East Asian Studies, University of Turku. His research focuses on AI ethics specifically in the China context. Other fields of scientific interest include technology governance, innovation ecosystem, human-machine interactions, and also linguistics.

Strategic Initiatives Program (SI)
Program Director: Steffen Fritz

Romain Clercq-Roques

Mentor: **Katya Perez-Guzman**
Co-Mentor: **Marta Kozicka (BNR)**

Research Project: **MODELLING THE SOCIAL-ECOLOGICAL DYNAMICS OF BIODIVERSITY LOSS AND UNDERNUTRITION OF SMALL-HOLDER FARMERS IN EASTERN MADAGASCAR USING PARTICIPATORY AGENT-BASED MODELLING**

Abstract:
Madagascar is a low-income tropical country with one of the highest rates of undernutrition as well as being one of the 'hottest' biodiversity hotspots. The population is mostly composed of smallholder farmers dependent on natural resources in their landscape. Forests in particular provide important sources of wild foods, natural remedies, construction material and fuelwood. Agricultural production also benefits from ecosystem services provided by biodiversity in forests and farms. However, Madagascar is facing widespread deforestation for agricultural expansion, overharvesting of wild species, and soil degradation caused by unsustainable agricultural practices, which cause important biodiversity loss, notably in eastern Madagascar's forested landscapes. Studies in other contexts have found that losses of wild foods, soil biodiversity and associated agrobiodiversity impacted smallholder farmers production and diets. Many studies have also shown wildlife hunting and agriculture to cause biodiversity loss in tropical landscapes. The dynamics connecting biodiversity loss to undernutrition of smallholder farmers remain poorly understood, however. This study will explore whether a social-ecological trap maintains smallholder farmers locked in a dynamic of increasing biodiversity loss and undernutrition. Specifically, the study will firstly aim to assess whether external pressures (population growth and climate change) and an internal reinforcing feedback loop between biodiversity loss and worsening nutrition outcomes could explain the observed patterns of deforestation, soil degradation and undernutrition in eastern Madagascar. Secondly, the study will aim to identify agroecological and sustainable resources management interventions that could provide the greatest co-benefit for biodiversity and nutrition in eastern Madagascar. A participatory modelling approach will be used to develop an agent-based model of a forested landscape of eastern Madagascar. Focus-group discussions, a role playing game and participatory workshops will be conducted with local stakeholders to design, develop and validate the model. This study will provide a greater understanding of the interdependencies between biodiversity in the landscape and nutrition of smallholder farmers and of interventions that could benefit both.

Biographical sketch:
Romain Clercq-Roques is currently a 2nd year PhD student in public health and policy at the London School of Hygiene and Tropical Medicine, exploring the social-ecological dynamics linking biodiversity loss and undernutrition for smallholder farmers of rural eastern Madagascar. He obtained a Master of public health at King's College London and a Master of international law at Pantheon-Assas University.

Summer Calendar – Important Dates

June 2022

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1 YSSP Opening Day 1	2 YSSP Opening Day 2	3 HR Briefings and Tickshots	4
5	6 Vienna Tour (Holiday - IIASA closed)	7	8	9 YSSP Introduction Workshop	10	11 YSSP hike
12	13	14 Science & Diplomacy Event	15 Mulitlateralism Session with Paul Meerts	16 Holiday IIASA closed	17	18
19	20 2nd Tick Shot	21	22	23	24	25
26	27 SA Reading Group	28 Showcase Poster Session	29 R course with JC Laso-Bayas	30		

July 2022

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1	2
3	4	5	6 YSSP Award Winners talk	7	8	9
10	11 SA Reading Group	12	13 Climate Migration Workshop	14	15	16 YSSP hike
17	18 YSSP visit to AEMS in Vienna	19	20 Manuscript Writing Workshop	21 AEMS visit to IIASA	22	23
24	25	26	27	28	29	30
31						

August 2022

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1	2	3 An Editor's Guide to Writing Reviews Workshop	4	5	6
7	8 SA Reading Group	9	10	11	12	13
14	15 Holiday IIASA closed	16	17	18	19	20
21	22	23	24	25 YSSP Final Colloqium Day 1	26 YSSP Final Colloqium Day 2	27
28	29 Farewell Banquet	30	31			