Report

21st Swiss Climate Summer School

(3-8 September, 2023)

(by Suvangi Rath, PhD Scholar, Dept. of Agricultural Economics, College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar)

1. Background

The 21st International Swiss Climate Summer School focuses on the theme "Climate-Water-Energy-Food-Nexus". The summer school was organized by ETH Zurich, Center for Climate Systems Modelling and Oeschger Centre for Climate Change Research. The Swiss Climate Summer School (www.climateresearch.ch) is a highly regarded and internationally renowned one-week educational program for national and international PhD students and Postdocs organized since more than 20 years.

2. Aim and Scope

The purpose of this highly interdisciplinary summer school is to bring early-stage researchers in touch with established scientists from different disciplines to bridge the topic of climate change with sustainable development goals strongly focusing on social, economic, and humanity aspects. The main questions to be addressed in the keynote lectures and discussed in smaller groups within the planned workshops are:

- What is the impact of the changing climate on the water, energy and food systems?
- What is the adaptation potential of the water, energy and food systems coping with climate stress?
- How can we create innovation across the climate, water, energy, and food systems for them to be co-beneficial for sustainable development goals and transformation towards a net zero society?
- How can achieving climate mitigation and adaptation goals have positive spillovers on the water, energy and food systems?
- What are the ethical and societal implications when we take the nexus approach seriously and consider the climate, water, energy, and food systems together?

Owing to the highly interdisciplinary nature of the topic, the proposed summer school addresses early-stage researchers from the climate and Earth system sciences to food, social, political, and economic sciences, as well as humanities.

3. Program Overview

The entire summer school was well structured and comprehensive covering 12 keynotes and 4 workshops along with multiple poster sessions by the participants. The workshop comprised lectures on various issues of the climate-food-water-energy nexus but was not limited to the same. Experts from the filed of agriculture, economics, climate science, political science, philosophy and other domains came under the single roof to deliberate on the pressing issue of climate sustainability. A total of 70 PhD and Post doc students from different arenas of research were selected to participate in the summer school. All the participants were required to present

their work in the form of posters that were thoroughly discussed in the 5 poster sessions scheduled in the summer school. The deliberations covered issues from different parts of the globe covering the scenarios from developed, developing as well as underdeveloped nations. The 4 workshops conducted during the school were typically aimed at nurturing the research and analytical skills of the participants. They aimed at understanding the roles of scientists, making policy coherence and addressing the issues of climate food water energy nexus, modelling the nexus and finally learning about the open-source Economics of Climate Adaptation (Climada).

The logic of the summer school followed the steps of a complete nexus approach: identifying trade-offs and conflicts among systems; outlining adaptation potentials in one system due to stresses stemming from another/the climate system; and finally elaborating innovation and transformation potentials. The close connection among the climate, water, energy, and food systems make the nexus approach especially relevant to implement the Paris Agreement, co-benefits across SDGs, and transformation goals such as the net zero society.

Some of the key points of the different topics of the summer school are given below:

3.1 Climate, Water, Energy, Food Nexus (by Karin Ingold, University of Bern, Switzerland)

Water, energy and food are indispensable for human well-being, poverty reduction, and sustainable development. Projections show that the demand for freshwater, food, and energy will increase, for instance, due to demographic changes, economic progress and international trade. Climate change puts an additional strain on water availability and quality and brings about extreme events (heatwaves/droughts/floods) which have severe socioeconomic and environmental consequences. Actions to mitigate climate change necessary to transition to a net zero emissions society, as well as measures to adapt to climate change can have strong implications for the surface and ground water system and its users. This calls for coherent, responsible and consultative planning, which is made possible using the so-called nexus approach. The nexus perspective emphasizes the interlinkages between the climate, water, food, and energy systems.

3.2 A changing climate: how is it modelled, and what are the impacts on the water, energy, and food systems (by Sonia I. Seneviratne, ETH Zurich, Switzerland)

The keynote particularly provided an overview of the main conclusions of the 6th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC; IPCC 2021, IPCC 2023). Particularly, the main impacts of human-induced climate change on water availability and droughts, energy production, and food systems were discussed. In addition, we were told about how projected climate change is simulated in state-of-the-art Earth System Models, and what are current challenges for deriving plausible low-emissions scenarios. Emissions scenarios assessed in the IPCC reports are derived with Integrated Assessment Models, which also need to derive plausible pathways for society development, considering changes in water use, energy demand and production, as well as food systems, together with changes in greenhouse gas emissions and forest coverage. Possible challenges resulting from potential feedbacks from climate were also highlighted.

3.3 Water systems and climate: Major trade-offs between water-using sectors across borders and value of coordinated action (by Annukka Lipponen, Ministry of Agriculture and Forestry, Finland)

River basins and aquifers are established units of water management, but managing land, including, agricultural land and forests, as well as the energy systems, operate are different scales. State borders significantly add to the complexity of assessing the resource dynamics of a system but also of devising coherent responses in policy and in taking technical management measures. Where water is scarce, different sectoral demands may be competing, and climate change further aggravates the pressure on water resources, water allocation is commonly a source of political friction. Presently, possibilities beyond basin and borders through a cross-sectoral (nexus) cooperation to bring broader benefits is increasingly recognized, while not addressing trade-offs and externalities across all sectors within a transboundary setting can lead to tension between communities, sectors and countries. Coherence in different sectors' action and between countries in policy and technical measures would bring synergy for sustainable development across sectors. Extensive scientific systems analysis work on the water-food-energy nexus for more than a decade has brought valuable insights, but governance, processes and politics complicate operationalization of cross-sectoral management. Moreover, adjusting flow regulation regimes to better account for different water needs, including environmental flows, could bring diverse benefits, or coordinating releases between power plants could increase the amount of energy generated. At different levels, climate action could provide something of an umbrella for water management and energy as well as other sectors to act in a more coherent fashion, co-optimizing for mutual benefit.

3.4 Local land use decisions and their global impact (by Rachael Garrett, University of Cambridge, UK)

This lecture emphasised how local land use decisions impact water, climate, biodiversity, and human wellbeing. The lecture focussed on how food commodity expansion affects the climate, biodiversity, and indigenous communities through deforestation. The underlying drivers of agricultural expansion into forests, including changes in the global food system dynamics, state level development objectives, individual household capital and labour scarcities, and intra-household power dynamics and preferences were also discussed. We also came across the possible "solutions" - how changes in land management in already cleared areas can help address climate, biodiversity, and livelihood concerns. Nevertheless, the need for a new economic paradigm that brings value to the standing forests and other native ecosystems, otherwise known as developing the tropical bioeconomy was also discussed - how improved management practices and bioeconomic development could theoretically be combined to enable a forest transition. Also,the ecological challenges and equity tensions that emerge when trying to achieve these new systems through the lens of "Ten Facts about Land Systems" were also discussed.

3.5 Climate change, extreme weather events, and implications for agricultural and food systems (by Robert Finger, ETH Zurich, Switzerland)

The agriculture and food system is a major contributor to climate change but also is inherently sensitive to climatic conditions and thus is one of the sectors most affected by climate change. Climate change has major impacts on agriculture and food systems

globally. In recent years, droughts, heat waves, heavy precipitation and late frosts have impressively shown how vulnerable our agricultural production is to extreme weather and weather events. Large-scale crop and livestock failures threaten food security and are a major source of risk for farms. In addition, these yield fluctuations pose major challenges for upstream and downstream industries, and can lead to food price spikes. Agriculture and food systems need to reduce greenhouse gas emissions, but also need adapt to climate change. Without adaptation measures, climate change would often result in reduced and more volatile yields for many crops. While adaptation can be effective, adaptation to climate change often implies high costs. Thus, key questions emerging are who can afford this adaption, and who pays the price for this adaption. Moreover, adapting to certain aspects of climate change, such as warmer temperatures on average, is easier (e.g., through adapted variety selection) than adapting to greater uncertainties about the occurrence of extreme events (e.g., a greater likelihood of droughts and heavy precipitation). Effective and efficient planning of adaptation strategies at the farm, market, and policy levels requires knowledge about potential climate change impacts, opportunities for adaptation, and the effectiveness and efficiency (i.e. also costs and benefits) of these strategies. For example, the sizing of irrigation infrastructure, information for breeding, and the development of robust yield prediction systems and the development of new insurance products. This lecture introduced climate change implications and opportunities of regional and global agricultural and food systems. Taking an agricultural economics and policy perspective, especial emphasis is laid on the role of climatic extreme events and their implications and adaptation responses in the sector and beyond, linking to economic, social and environmental implications.

3.6 Water systems under stress; examples from sub-Saharan Africa (by Declan Conway, London School of Economics and Political Science, UK)

Climate change represents serious cross-cutting consequences for present and future ambitious development plans in many cities and river basins in Africa due to the strong interdependencies between the water-energy-food and environment sectors. However, climate impacts and their cross-sectoral transmission pathways are poorly quantified and rarely considered in development planning. This lecture profiled insights from detailed analysis of climate variability and change impacts in contrasting water systems: 1) three capital cities and; 2) the Rufiji River Basin in Tanzania. In all cases, the multi-sector and cascading nature of climate impacts underscores the need for greater horizontal governance and coordinated management structures which are nascent at present. Innovative modelling and visualisation techniques can provide opportunities to convey the complex outcomes of impacts and responses, capturing alternative perspectives and values and in so doing address some of the many barriers to enhanced coordination across sectors.

3.7 Can Fixing Dinner Fix the Planet? (by Jessica Fanzo, Johns Hopkins University, USA)

With climate change, the COVID-19 pandemic, and ongoing conflicts, food systems are facing increasing fragility. In a turbulent, hot world, threatened resiliency and sustainability of food systems could make it all the more complicated to nourish a population of 9.7 billion by 2050. Climate change is having adverse impacts across food systems with more frequent and intense extreme events that will challenge food production, storage, and

transport, potentially imperiling the global population's ability to access and afford healthy diets. At the same time, the way food is grown, processed, packaged, and transported is having adverse impacts on the environment and finite natural resources further accelerating climate change, tropical deforestation, and biodiversity loss. Food system policies and actions can contribute to climate adaptation and mitigation responses and, at the same time, improve human and planetary health, however multi-lateral cooperation, action and investments must be bold. While there is significant urgency in acting, it is also critical to move beyond the political inertia and bridge the separatism of food systems and climate change agendas that currently exists among governments and private sector actors.

3.8 Panarchy — Towards Transformational Resilience (by David Bresch, ETH Zurich, Switzerland)

The concept of risk allows for the evaluation of an uncertain outcome, in terms of probability and severity. Resilience describes the capacity to survive, successfully adapt and prosper in the face of change and uncertainty related to disturbances, whether they be caused by stresses and/or acute events. Therefore, resilience presents itself as a useful concept to frame pre-emptive approaches to deal with risk. A set of nine resilience lenses grouped in three dimensions or levels was proposed. Structural resilience encompasses redundancy, modularity and requisite diversity. Integrative resilience emphasises the complex interconnections between the primary system and its environment, where multi-scale interaction, thresholds and social capital are key elements of understanding. Finally, transformative resilience expands on the time scale with the aim to enhance transformability by exploring distributed governance, foresight capacity and innovation & experimentation as enablers. The talk linked these nine lenses to the (even) wider framework of Panarchy, charting out the intertwined path complex (eco)systems follow over time through the interplay between change and persistence, between the predictable and unpredictable.

3.9 Better safe than sorry about the nexus: The precautionary principle and its impact on the nexus approach (by Claus Beisbart, University of Bern, Switzerland)

Research on the climate, water, energy and food nexus is driven by practical goals. It is supposed to make a real difference to future planning and politics. But how can it do so despite the fact that the results are affected by uncertainties? The lecture answered this question with a special focus on the so-called precautionary principle. A fundamental distinction is that between statements about matters of facts, on the one hand, and evaluations or articulations of practical interests and goals, on the other. As a side effect, this distinction will help us to better understand the role of goals in nexus research and the meaning of tradeoffs. Standard decision theory then discriminates between three types of decisions: decisions under certainty, under risk and under ignorance. While there are universal and widely accepted rules for rational decisions under certainty and risk, things become more difficult under for decisions under ignorance. A prominent proposal is the precautionary approach. Its main thrust is often summarized using the slogan "better safe than sorry". In more detail, it is demanded that options which possibly lead to severe harms should not be chosen. One interesting thing to note about the principle is that mere possibilities make a difference on what we ought to choose rationally.

3.10 Low carbon energy innovation: drivers and potentials (by Tobias Schmidt, ETH Zurich, Switzerland)

Technological change, i.e., the invention, innovation, and diffusion of low carbon technologies (replacing polluting technologies) is arguably the most important lever to address climate change (of course other levers like behavioral change are also relevant). And tech innovation is also one of the few sources of good news in the climate-water-energy-food nexus: (most) technologies get cheaper the more we build and use them (in economics, this is called increasing returns to scale, which gives some mainstream environmental economists headaches). The lecture focused on why directing and accelerating technological change requires (strong) policy intervention beyond carbon pricing, e.g., in the form of "green industrial policy". Also, government failures that potentially undermine green industrial policies' successes and how we can make governments more "technology-smart" were also discussed.

3.11 Climate Policies for Net-Zero GHG-Emissions on a domestic and international level (by Ralph Winkler, University of Bern, Switzerland)

Due to the long-lasting temperature response of greenhouse gas emissions, global net zero carbon emissions are inevitable to stabilize the temperature anomaly of anthropogenic climate. This implies that the world economy, currently still dominated by carbon technologies, has to transition to carbon neutral technologies fast in order to stay below the 1.5–2° C target. To date the enaction of more stringent climate policies both on a domestic and international level has been undermined by concerns about their economic costs and their distributional consequences. This lecture discussed that these concerns are unjustified. First technological change and its dependence on the socioeconomic environment was discussed. It was discussed the replacement of old by new technologies follows highly non-linear transition paths, which systematically leads to an overestimation of both the timeframe and the costs of such a transition. Second, we derive policy implications towards fostering the transition towards carbon neutral technologies from both a domestic and international perspective. Although we are already within the transition towards a carbon neutral economy, the situation is very heterogeneous across sectors. As a consequence, an efficient domestic climate policy has to establish an encompassing and long-term vision of the transition path towards climate neutrality. While a carbon price is the single most important climate policy, it has to be accompanied by a bundle of other policies. The international dimension of carbon neutrality poses both threats and challenges: On the one hand, technological leadership in carbon neutral technologies offers lucrative export opportunities, as they have to be employed worldwide eventually. On the other hand, strict unilateral climate policies bear the risk of creating pollution havens abroad. Finally, the economic costs and distributional consequences of efficient climate policies were explored.

3.12 Linking the nexus approach with exploring co-benefits of SDGs (by Anders Branth Pedersen, Aarhus University, Denmark)

This was the final lecture of the summer school that investigated the politics of national SDG indicator systems through a comparison of how the global SDG framework (SDG 1-17) is implemented in four European countries, demonstrating considerable variation in the political dimensions of national SDG indicator systems. Implications for SDG implementation - barriers and enablers for fulfilling the SDGs at national level were

discussed. The second part of the lecture presented examples on concrete project implementation in energy transformations by analysing implementation of smart energy solutions in four European local communities contributing to sustainable energy transformation and climate change mitigation (SDG 7, 13). Finally, the third part focused on the introduction of a concrete policy instrument – the Danish pesticide tax which is the world's highest pesticide tax (SDG 2, 6). This evolved around political discussions, design of the tax, behavioural changes of farmers, and wrapped up with a more general discussion of enablers and barriers for introducing tough policy instruments and local initiatives in the climate-energy-water-food-nexus (SDG 2, 6, 7, 13).

Workshops

The entire summer school comprised 4 workshops. Each student had a chance to attend two workshops on the first cum first serve basis. All the workshops were both theory and practical oriented enabling the participants to develop suitable research and analytical skills. I had the opportunity to attend workshop 1 and 2 namely: Climate Communication as scientists - different roles and ways of communication and Climate-Food-Energy Nexus and how to make policy coherence happen.

In the first workshop, we were made to discuss various roles of a scientist viz, pure scientist, science arbiter, issue advocate and honest broker. It was important to see how different arenas were discussed as well viz scientific arena, media, etc and we were made to identify the challenges and solutions thereof in each of them. We learnt ***elevator pitch*** and practised communications in various situations.

In the second workshop, we learnt how different situations may be analysed and arguments may be made to convince the respondents for our research in order to get the correct data. Moreover, we also learnt how coherence is important from the point of data collection to policy implementations.

My Work- Poster Presentation

It was an honour for me to be selected to present my work in this international arena. The overview of my work is given below:

Title: Economic Valuation of Agro-Ecosystem Services in India: A Meta-analysis

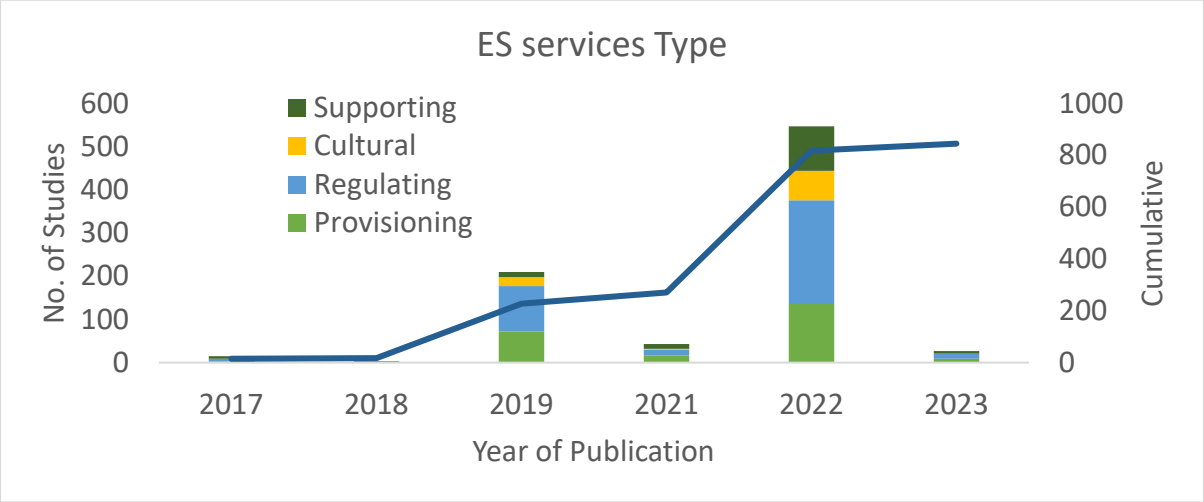
Introduction:

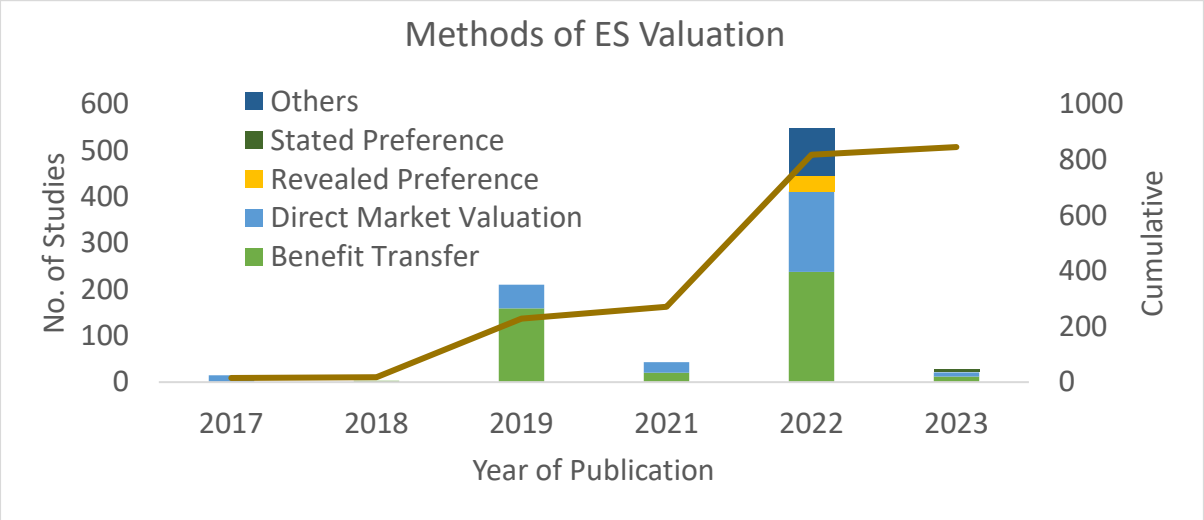
- Demographic, economic, social, and climatic changes- Increasing pressure on natural resources- Ever increasing global demand of energy, food, and water.
- The key to shift towards sustainable development lies in the strategic decisions that we shall take for natural resources, which need to be better valued and more responsibly managed.
- Ecosystem services for tackling climate change: mitigation and adaptation.
- Policies and local initiatives related to ecosystem management can integrate both climate change strategies and avoid trade-offs between them.
- The extent and conservation of Ecosystem Services (ES) in agriculture depends largely upon the farm management practices.

Methodology

1. Generalized Linear Mixed Effect model
2. Data- secondary
3. GIS-mapping

Graphs





Key Outcomes

1. Provisioning services contributed highest to ES.
2. Revealed preference, benefit transfer and stated preference methods produced lower ES than ecosystem modelling.
3. Diversification and land productivity have a positive and significant effect on ES while population density has a negative impact on them.
4. Recognize the multiple functions and services provided by ecosystems at multiple spatial scales.
5. Valuing the ES aims at developing schemes on PES that can lead to livelihood security of the rural masses in countries like India.

Appreciation letter

I am happy to inform that I have received an appreciation letter from the director of the summer school for my performance throughout the summer school.

Acknowledgments

I would extend my deepest gratitude to the Agriculture Economics Society, UK to provide me with the travel grant to attend the 21st Swiss Climate Summer School, 3-8 Sept, 2023 in Ascona, Switzerland. I also express my heartfelt gratitude to the organizing committee of the summer school to provide the grant for registration and full boarding.

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