



BOOK OF ABSTRACTS

Conference at the Potsdam Institute for Climate Impact Research, Member of the Leibniz Association

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Climate impacts in one location that propagate to other locations through trade and value chains, development and security policies, and financial systems, may have disrupting effects similar to the COVID-19 pandemic and the war on Ukraine. These effects are not easily represented in traditional analysis frameworks and need to be embedded in the wider context of social vulnerability and climate change. The conference brought together scientists across disciplines that work on approaches to better understand and respond/adapt to cross-border climate impacts and risks. The conference also seeks to identify knowledge gaps and directions for future research. Research presented at the conference highlighted what needs arise from a consideration of cross-border climate impacts, how to design research that is actionable for decision-making or how to improve the monitoring of risks.

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Opening Session

Opening Keynote by Hans-Joachim Schnellhuber

Speaker: Hans-Joachim Schellnhuber, Potsdam Institute for Climate Impact Research (PIK), Germany

Topic: Thinking about Disruption

The world is complex, and so too must be the activities that we perform. But that doesn't mean that we must live in continual frustration. No. The whole point of human-centered design is to tame complexity, to turn what would appear to be a complicated tool into one that fits the task, that is understandable, usable, enjoyable." This quote by Donald A. Norman, established design researcher, gets to the point. The Earth and climate system are the most complex structures we know. Their inherent highly non-linear dynamics pose demanding questions to the research community, who seeks to comprehend and model them.

At this moment in time, the Paris Agreement from 2015 is not holding up to its promises and the development pathway we are on is very likely to overshoot the 2°C guardrail all the nations laboriously agreed upon. Major disruptions in the climate system are already playing out worldwide. And the research community is just starting to unpack the various teleconnections in the system. Disruptions propagate through the system, sometimes in directions we have never anticipated. Are we getting closer to exceeding tipping points in the system or, even worse, setting in motion tipping cascades? Definitely we are getting closer, but we do not know when we will reach irreversible tipping points. This global systemic risk calls urgently for climate restoration to avoid leaving the Holocene state of the Earth and entering a hothouse state.

Luckily, there is one scalable nature-based solution doing the job that needs so badly to be done: wood! Evolution gifted us with an outstanding material which through its generation cleans up our atmosphere from CO₂ emissions. This nature based solution to achieve even negative emissions in the foreseeable future without the need to develop and fund unpredictable geo-engineering infrastructure, is as elegant as it is simple. Paired with the long-term use of wooden products and especially construction timber, whole buildings and cities can turn into artificial carbon sinks, restoring the global climate beam by beam.

1st Keynote Speech by Nicola Ranger

Speaker: Nicola Ranger, University of Oxford, UK

Topic: Protecting people and planet through embedding systemic resilience at the core of global finance and policy: a manifesto for science and policy

The world has changed into an increasingly complex web of interconnected systems and at the same time, we are eroding the natural capital upon which people, planet and prosperity depend. Recent work from the Stockholm Resilience Centre shows we have crossed six of nine planetary boundaries and the world is on track to exceed our climate goals. The consequences are evident in the growing risks of complex, cascading and compounding shocks that we have seen in recent years, which fall particularly heavily on developing countries. This presentation lays out a manifesto for how we can build systemic resilience and demonstrates the role of science, analytics and modelling in advancing this, drawing upon recent research at the Environmental Change Institute and beyond. It highlights the failures of our current international systems to address systemic challenges and identifies the distortions in our economics and policies that underpin this. It then focuses on the role of global finance in systemic resilience specifically, both as an enabler of resilience and as a source of risk in itself, drawing upon research with Central Banks, financial institutions and governments, and lays a roadmap for science and policy to integrate resilience at the core of global finance and the wider international system.

2nd Keynote Speech by Gabriel Felbermayr

Speaker: Gabriel Felbermayr, Austrian Institute of Economic Research (WIFO), Austria

Topic: Spatial Connectivity and Coping with Climate Change

Climate change will affect sectoral productivity at the local level. This will affect the patterns of comparative advantage. Moreover, more frequent but temporary shocks will increase the need for risk-sharing within and between countries. This presentation offers a discussion of the mechanisms at play. It shows evidence from empirical international trade studies that show that weather shocks lower affected countries' exports but increase their imports, with the magnitude of these effects strongly depending on countries' connectedness to international financial markets. Not allowing or hindering such adjustments would increase the costs of climate change. At the more granular level, the presentation shows some econometric evidence at the grid-cell level on the spatial diffusion of disaster-related events and how this diffusion is shaped by connectivity, especially through roads. It ends with model-based evidence on the role of connectivity for coping with climate change stressing the time dimension as well as trade policy.

Parallel Session 1: Conceptual frameworks of cross-border and cascading climate impacts/risks

A framework for understanding and responding to cross-border climate change impacts (Timothy Carter)

Speaker: Timothy Carter, Finnish Environment Institute (Syke), Finland

Topic: A framework for understanding and responding to cross-border climate change impacts

In responding to the risks of anthropogenic climate change it has been common to regard effects of mitigation as global and effects of adaptation as local. However, it is becoming increasingly clear that adaptation to climate change can also require a global lens, as numerous channels exist (e.g. trade, finance, people, psychological, geopolitical, biophysical and infrastructure) through which climate change impacts occurring in one region can propagate to others that are remote from the location of the initial impacts.

Here we report ongoing work to develop and apply a conceptual framework for describing, classifying and analysing cross-border climate change impacts. We also consider recent developments of the framework to address some of the adaptation policy challenges presented for regional actors who are at risk from such cross-border impacts.

The framework distinguishes a climate trigger with an initial impact in one region, which propagates across one or more borders via an impact transmission system towards actors at risk in another region. Options are available to risk-recipients for responding to these potential impacts via a response transmission system. This may be directed at the initial impact, at the impact transmission system, indirectly via an external system component, or at the region of recipient risk to reduce exposure and vulnerability. We demonstrate how the framework can be used as an organising device for comprehending the often complex routeways of impact propagation. We also examine how adaptation responses can be interpreted from the perspectives of policy coherence and integration.

The framework has been applied, operationalized and expanded in a diverse range of case studies, some co-developed with stakeholders. We will show examples of how it has been used to depict cross border impacts of historical short-period local climate triggers such as floods or droughts. By disrupting production of key commodities, impacts may be propagated via global supply chains to affect manufacturing, food security or supply of raw materials. Response measures implemented after such events can also be studied, to draw lessons for avoiding comparable disruption in the future.

Identifying, Assessing, and Governing Systemic Risks: Towards an Integrative Framework" **(Pia-Johanna Schweizer)**

Speaker: Pia-Johanna Schweizer, Research Institute for Sustainability – Helmholtz Centre Potsdam, Germany

Topic: Identifying, Assessing, and Governing Systemic Risks: Towards an Integrative Framework

Systemic risks appear on a systemic and structural level, produced and affected by complex endogenous and exogenous interdependencies. Systemic risks are unintended by-products of current transformation processes, such as the deployment and innovation of new technologies, infrastructural changes, or socio-political dynamics, for example. They originate and evolve in the nexus of tightly-coupled dynamic natural, societal, and often technological systems. In short, systemic risks are complex, transboundary, and nonlinear risk phenomena, which exhibit tipping points and cascading effects. However, so far they lack adequate assessment and evaluation approaches, which is a barrier toward developing effective policy measures for their governance. Inadequate governance of systemic risks, in turn, poses a major threat to modern societies, which are highly interdependent and technology-driven, and thus prone to vulnerabilities stemming from systemic risks. Consequently, systemic risks can lead to breakdowns in systems which provide vital functions for society. Systemic risks affect vital societal structures across borders and societal domains. Examples of this are the 2007/2008 financial crisis, the Covid-19 pandemic, or, less sudden but all the more impactful, the global ecological and environmental crisis.

In our presentation, we will propose an integrative framework for the identification, assessment, and governance of systemic risks. An integrative framework entails the qualitative identification and assessment of systemic risks, ethical and societal implications, as well as the quantitative analysis thereof. We suggest a two-step approach towards the assessment and governance of systemic risks.

First, a clear identification of the systemic risk in question. Analysis of systemic risks needs to pay attention to casual relations and feedback mechanisms between various system factors at the intra- and inter-system level, which result in transboundary cascading effects. Accordingly, delineating both the relevant systems and entangled risks requires an interdisciplinary approach, combining the quantification of risks alongside their qualitative assessment. This entails understanding, conceptualising, and modelling vulnerabilities, scenario development, as well as the integration of stakeholders to identify potential leverage points and enable the facilitation of transformative processes.

Second, the identified systemic risk requires adequate governance. Governance of systemic risks must be concerned with the analysis of embedded systems, procedural considerations of inclusion and deliberation, as well as closure. The salient features of reflection, iteration, inclusion, transparency, and accountability have been identified as guiding principles for governance processes concerned with systemic risk. The procedural governance approach also explicitly relies on ethical considerations, tied to recognition and procedural justice. The presentation proposes a framework to address the challenges of complexities, uncertainties, and ambiguities associated with systemic risks. The presentation draws on conceptual contributions as well as empirical evidence from transdisciplinary stakeholder and public engagement processes. The long-term goal is the development of an integrative framework, applying a variety of inter- and transdisciplinary methods to assess systemic risks and derive actionable knowledge for a transformation towards increased sustainability.

A multi-scale scenario approach to understand and respond to cascading climate risks to global food security (Magnus Benzie on behalf of Sara Talebian)

Speaker: Magnus Benzie on behalf of Sara Talebian, Stockholm Environment Institute - SEI, Sweden

Topic: A multi-scale scenario approach to understand and respond to cascading climate risks to global food security

Climate change increasingly impacts the production of agricultural commodities all around the world through increasing frequency and severity of natural hazards in the short-term and anthropogenic alterations in climatic patterns in the long-term. The distribution of these commodities via trade is also affected by climate change impacts and extreme weather events, posing risks to food security, not only at the site of production, but also along the supply chain and across national borders.

Cross-border climate impacts on agricultural supply chains pose one of the most globally significant cascading climate risks. The range of negative implications of such risks to global food security and social and geopolitical stability call for enhanced international cooperation for cross-scale adaptation and increased resilience of the global food system. However, there exists a knowledge gap in understanding how cross-border climate impacts manifest and interact with other socioeconomic drivers to exacerbate risks to food security in different localities, and how responses can be identified and implemented given different socioeconomic landscapes. This crucial gap in knowledge obscures key actors' understanding of risk and response options, and the necessary attribution of risk ownership. This impedes the effective governance of cascading climate risks.

Drawing on a project that is being developed during 2023, we will propose a multi-scale scenario approach for generating context specific and spatially explicit knowledge on cascading climate risks to food security and suitable adaptation responses in a number of different geographical and socioeconomic contexts. Scenario planning approaches are increasingly recognised as an appropriate tool for studying future climate impacts, since the type and severity of associated risks (and opportunities) could be different under alternative socioeconomic trajectories. Multi-scale scenario sets which are relevant to specific localities, and at the same time connected to the global context, provide a coherent baseline for analysing future cascading climate risks that propagate across space (e.g., via trade and supply chains).

To develop a set of multi-scale scenarios, we propose using a combination of global climate and socioeconomic scenarios – Shared Socioeconomic Pathways (SSP) and Representative Concentration Pathways (RCP) – and extend those to four clusters of countries, including: rich countries with low exposure, rich countries with high import dependence, least developed countries with “triple exposure”*, and developing countries with high exposure. Multi-scale scenarios could be used in a co-production process with stakeholders to make inquiries into future transboundary climate risks for two agricultural commodities (wheat and soy), focusing on the propagation of risk via trade, highlighting implications for food security and adaptation.

The main objectives of this study are: a) to explore how a set of globally significant cascading climate risks to agricultural commodity trade would unfold in different geographical and socioeconomic /contexts /or futures, and b) to identify the possible adaptation responses available to different localities, given their governance and coordination capacity, and political context. Such exploration presents an opportunity to understand the implications of future risks to trade and adaptation

responses for the geopolitics of food security, and to structure recommendations on no-regret responses – coherent across scales, and robust against a wide space of future possibilities.

*Countries are clustered based on Benzie and Lager (2022) approach, using three metrics, including exposure to transboundary climate risks, vulnerability to domestic climate risks, and gross domestic product per capita (GDP).

The transnational climate impacts index 2.0: a new, flow-based quantification" (Johanna Hedlund, virtual)

Speaker: Johanna Hedlund, Stanford University, United States

Topic: The transnational climate impacts index 2.0: a new, flow-based quantification

Countries' reliance on global food trade networks implies that regionally different climate change impacts on crop yields will be transmitted across borders. This redistribution constitutes a significant challenge for climate adaptation planning and may affect how countries engage in cooperative action.

We present a paper investigating the long-term (2070–2099) potential impacts of climate change on global food trade networks of three key crops: wheat, rice and maize. We propose a simple network model to project how climate change impacts on crop yields may be translated into changes in trade. Combining trade and climate impact data, our analysis proceeds in three steps. First, we use network community detection to analyse how the concentration of global production in present-day trade communities may become disrupted with climate change impacts. Second, we study how countries may change their network position following climate change impacts. Third, we study the total climate-induced change in production plus import within trade communities. Results indicate that the stability of food trade network structures compared to today differs between crops, and that countries' maize trade is least stable under climate change impacts. Results also project that threats to global food security may depend on production change in a few major global producers, and whether trade communities can balance production and import loss in some vulnerable countries.

Overall, our model contributes a baseline analysis of cross-border climate impacts on food trade networks. We end by describing new research aiming to extend the current analysis through the addition of extreme event data, giving a fuller picture of climate-induced triggers of global disruption.

Parallel Session 1: Participatory approaches towards cross-border risks

Policy simulations to co-create resilient futures in the context of cross-borders climate impacts" Demonstration session (Piotr Magnuszewski)

Speaker: Piotr Magnuszewski, Centre for Systems Solutions, Poland

Topic: Policy simulations to co-create resilient futures in the context of cross-borders climate impacts"

The Centre for Systems Solutions (CRS) is set to host an interactive demonstration of policy simulation, with a specific focus on the cross-border cascading climate impacts.

Policy simulations are interactive, participatory activities with the application of social simulations. They provide an opportunity to engage participants through challenges, immersion, emotions, and learning-by-doing in a safe environment. Within the duration of the CASCADES project, the Consortium organized three Core Workshops, bringing together policymakers and researchers from diverse fields. These stakeholders collaborated together within Policy Simulations and reacted to a plausible future crisis by developing policies in fictional roles of countries and organizations.

The CASCADES team has developed three policy simulations - namely the Arctic Future, the Raw Materials Challenge, and the Future of Food. In these simulations, stakeholders explored interactively the potential outcomes of cascading climate impacts for Europe. Furthermore, the CASCADES Consortium has designed a multiplayer game called the Cascades Game, which is an interactive educational tool that introduces the concept of cascading climate impacts and policy responses to mitigate these effects.

CRS will showcase the application of policy simulations in the series of CASCADES Core Workshops and highlight the simulation's value as an effective tool to communicate research findings. This session will be a unique opportunity to see and experience Policy Simulations and can be applied to broad research, by looking at examples of the Cascading Climate Impacts Policy Simulations.

Mapping the stakeholders to enhance co-creative approaches on climate change adaptation in two delta cities in the Greater Rotterdam Living Lab" (Theresa Audrey Oller Esteban)

Speaker: Theresa Audrey Oller Esteban, Delft University of Technology, Netherlands

Topic: Mapping the stakeholders to enhance co-creative approaches on climate change adaptation in two delta cities in the Greater Rotterdam Living Lab

Homes and communities are becoming more vulnerable to climate change. Particularly now, when the pace of climatic change is increasing, safety and livability concerns are of the utmost importance. The two coastal delta cities of Rotterdam and Dordrecht make up the Greater Rotterdam Living Lab (GRLL) for the RED & BLUE research project. Both cities have identified urban cases based on their present priorities for various climate issues. These urban cases are dealing with combined effects of climate change, including extreme rainfall, flooding, changes in groundwater levels, subsidence, heat, and drought, in various stages of development. In some cases, existing housing areas are to be retrofitted for climate-proofing, while others are to be designed as new (additional) housing stock, low density uses developments and future evacuation areas. Different stakeholders are involved in the process of creating and planning these integrated strategies as well as their actual implementation. It is challenging to identify all stakeholders; however, to have real integrated strategies, the less visible stakeholders, including those who will be most affected, need to be acknowledged, identified, and involved in creating solutions. The current study presents an approach for integrated stakeholder mapping. Through interviewing stakeholders currently involved in the urban use cases of the GRLL we (a) identified and categorised relevant stakeholders, (b) map their interests and resources, and (c) identified thematic areas of interests where the stakeholders are involved. The purpose of this research is to demonstrate that there are more stakeholders to be considered and to visualise how different interests are aligned. This in contrast to specifying who the important stakeholders are and how much power they have. By identifying the stakeholders presently involved and in which areas, we would like to contribute to enhancing the co-creation process for climate adaptive strategies that is inherent in a living laboratory.

The 2023 Global Transboundary Climate Risk Report”(Richard Klein on behalf of Katy Harris)

Speaker: Richard Klein on behalf of Katy Harris, Stockholm Environment Institute (SEI), Sweden

Topic: The 2023 Global Transboundary Climate Risk Report

The 2023 flagship report by Adaptation Without Borders is the first collection of evidence to assess the global implications of transboundary climate risks across 10 critical sectors and policy domains. Part I outlines the state of knowledge on transboundary climate risk. It provides an overview of their key characteristics and pathways, and identifies globally significant risks that are then assessed in subsequent chapters. It dives into the characteristics, variables and dynamics of these risks to understand how they propagate and their direct and indirect effects. Part II showcases the assessment of 10 globally significant transboundary climate risks led by experts from international organizations. These are transmitted through, and have implications for, the world’s ecosystems (terrestrial- and ocean-based shared natural resources), economies (agricultural commodities and trade, global industrial supply chains, energy networks and international finance) and globalized societies (human health, mobility, and livelihoods, peace and security). A cross-dimensional focus on wellbeing is also explored. For a given transboundary climate risk, each chapter explores its likelihood in a changing climate, its impacts across different distances and time scales, and its method of transmission, as well as an in-depth analysis of a representative real-world case study that demonstrates the severe consequences of these risks at multiple scales. Part III explores the space for solutions: the policy and governance opportunities to address transboundary climate risks at different scales, from global and multilateral to regional, national and subnational. Sections detail the multiple benefits of integrating cross-border and cascading climate risks to strengthen multilateral processes under the UNFCCC (global goal on adaptation and the global stocktake), the Sendai Framework (which explicitly calls for each State to ‘prevent and reduce disaster risk, including through international, regional, subregional, transboundary and bilateral cooperation’) and regional initiatives to address shared risks. Existing examples of cross-border cooperation are highlighted. This section also analyzes the current limitations of national adaptation planning that is often carried out in silos and that focuses on domestic issues, rather than contributing to regional or even global resilience and the development of shared benefits for all. The final sections of the report focus on knowledge gaps and areas for innovative research to better inform policy solutions and governance mechanisms. It outlines four areas for progress: opportunities for innovative research on transboundary climate risk; the design of indicators to track transboundary climate risks; research on the future of transboundary climate risks based on scenarios and foresight exercises; and the use of such exercises to characterise policy pathways to address transboundary climate risks. In conclusion, the report argues for a shift in the approach to adaptation from a local and domestic policy issue to an international concern that requires the involvement of new actors and new forms of coordinated action. Transboundary climate risks connect multiple countries, and this provides opportunities for more collaborative and cooperative action. This could, in turn, help to revive and expand ambitions to meet climate and sustainable development goals. A transboundary lens shows that climate risk is a shared reality and adaptation a collective responsibility.

Visualizing RECEIPT climate impact storylines in a web browser" (Gijs van den Oord, virtual)

Speaker: Gijs van den Oord, Netherlands eScience Center, the Netherlands

Topic: Visualizing RECEIPT climate impact storylines in a web browser

Explaining the effects and impacts of climate change to a broad audience is arguably one of the most important challenges of the climate impact and adaptation research community; finding the right balance between technical detail and convincingly simple reasoning is key to getting the message across to the intended audience. The methodology of physical climate storylines aims to make cascading impacts of global warming specific and tangible to potential stakeholders. This is done by constructing and studying plausible future events, often taking historical impactful phenomena as a starting point; one can then proceed by modelling the emerging causal chains under hypothetical future socio-economic conditions and compare for instance the effect of different policies in this particular context.

Within RECEIPT, the physical climate storyline concept is applied to remote climate events with impact transmission onto European citizens and socio-economic sectors. Part of the RECEIPT project has been devoted to the creation of a web-based interactive visualization tool for storylines. This storyline visualizer (<https://www.climateimpactstories.eu>) aims to facilitate the dissemination of the developed storylines to an audience of informed stakeholders. It guides the sectoral researchers in RECEIPT to structure their climate impact storyline into a logical progression of sections, and support each page with text, geospatial data and interactive charts.

In this session, we plan to discuss the capabilities of the storyline visualizer and elaborate upon the design choices made for this software. We will briefly showcase the various storylines that have been implemented in the visualizer. We review the lessons learned during the software development process and also the collaborative process of structuring and (re-)phrasing scientific storylines to be suitable for this platform. Finally, we intend to present ideas on possible applications of the visualizer beyond RECEIPT.

How to nurture cooperative behavior in ways that are useful for managing Transboundary Climate Risks in agriculture supply-chains" (Adis Dzebo)

Speaker: Adis Dzebo, Stockholm Environment Institute, Sweden

Topic: How to nurture cooperative behavior in ways that are useful for managing Transboundary Climate Risks in agriculture supply-chains

Transboundary Climate Risks (TCR) are risks that extend beyond national borders, triggered by climate hazards and adaptation responses. Their effects are felt in neighbouring countries, within regions, or even in countries far away from the initial trigger. Given their cross-border nature, TCR require substantial global governance. However, public willingness to support collective action internationally is limited, and the growing polarization of societies worldwide inhibits cooperation. While there is some progress being made on technical aspects related to TCR, such as in the ongoing climate negotiations, these are mainly taking place at a technical level and there is currently no political understanding nor agreement on how to manage TCR among and between citizens and decision-makers. This paper explores how we can understand and improve cooperative behaviour between citizens and decision-makers to better manage TCR by focusing on agriculture supply-chains. Its emphasis is on devising tools and methods related to deliberation and co-creation via participatory approaches. The paper explores how TCR linked to two agriculture products, coffee and beef, link producers to consumers in Tanzania, Brazil, Germany and Sweden. It investigates how deliberation via focus groups and stakeholder workshops can enhance the cooperative predisposition among citizens to contribute to or comply with policies on TCR. It then draws on these insights to explore how increased understanding among citizens can lead to better TCR management along the whole supply-chain as well as improved national and global governance of TCR under social and political polarization.

Parallel Session 1: Climate physical risks and the financial system

Asset-level climate physical risk assessment is key for adaptation finance”(Giacomo Bressan on behalf of Irene Monasterolo)

Speaker: Giacomo Bressan on behalf of Irene Monasterolo, WU Wien, Austria

Topic: Asset-level climate physical risk assessment is key for adaptation finance

Climate physical risk assessment is crucial to inform adaptation policies and finance. However, science-based and transparent solutions to assess climate physical risks are still missing. This is a main limitation to fill the adaptation gap. We provide a methodology that quantifies physical risks on geolocalized productive assets, considering their exposure to both chronic and acute impacts (hurricanes) across IPCC scenarios. Then, we translate asset-level shocks into economic and financial losses. We illustrate the methodology in an application to Mexico, a country that is highly exposed to physical risks, attracts adaptation finance and foreign investments. We find that investor losses are underestimated up to 70% when neglecting asset-level information, and up to 82% when neglecting acute risks. Therefore, neglecting the asset-level and acute dimensions of physical risks can lead to large errors in the identification of the relevant adaptation policy response and finance tools aimed to build resilience to climate change.

An integrated ABM approach to understanding the impact of pandemics and fiscal stimuli on the economy and climate" (Paola D'Orazio)

Speaker: Paola D'Orazio, Technische Universität Chemnitz, Germany

Topic: An integrated ABM approach to understanding the impact of pandemics and fiscal stimuli on the economy and climate

Infectious diseases significantly impact public health, healthcare, macroeconomics, and society. Although COVID-19 has received significant attention for its epidemiology, immunisation, and economic effects, research on the connected risks of climate change and the spread of pandemic diseases has been limited. To generate research useful for decision-making, it is necessary to integrate research on the spread and effects of pandemics into a broader framework encompassing major concerns related to the macro-financial impacts of climate-related risks.

To enhance risk monitoring, this paper proposes the CliMaPanLab, a modelling framework incorporating macroeconomic and financial dynamics and a climate module that accounts for the endogenous emergence of infectious diseases such as COVID-19. Using an agent-based computational approach, the CliMaPanLab facilitates investigating the complex interactions among agents and sectors.

The proposed framework is intended to analyze the trade-offs among virus containment policies, economic performance, financial stability, and the joint impacts of climate risks and the virus on the economy and the financial sector. It assesses the importance of fiscal policies in rebuilding economies following the impact of a pandemic and devising green recovery policies to establish a sustainable economy. This paper, in particular, employs the CliMaPanLab to examine how short-term economic recovery can be attained while promoting long-term sustainability.

Integrating pandemic and climate risks into policy planning is critical to ensuring sustainable economic recovery and mitigating future crises. The simulation results obtained through the CliMaPanLab may aid policymakers in formulating their response to future pandemics by taking into account the effects on the macro-economy and climate, contributing to post-pandemic policy planning for achieving green recovery.

Multilateral adaptation finance for systemic resilience: Addressing cross-border climate risks" (Katherine Browne)

Speaker: Katherine Browne, Stockholm Environment Institute, Sweden

Topic: Multilateral adaptation finance for systemic resilience: Addressing cross-border climate risks"

Research increasingly highlights cross-border climate risks but multilateral adaptation finance continues to treat climate risk largely as a local phenomenon. We analyzed adaptation projects funded by three major multilateral climate funds and examined the extent to which they support projects addressing climate risks in more than one country. We found that most funding is directed to countries on an individual basis for specific national or local projects. Funding for regional and multi-country projects tends to address common risks (e.g., drought or cyclones) rather than risks that cross national borders (e.g., climate driven migration). We argue that multilateral adaptation finance can and should do more to address these cross-border climate risks. Interventions that focus on the whole system rather than individual countries can deliver shared benefits for both recipients and contributors. We foresee two ways to operationalize systemic resilience in adaptation finance. First, current funding models can effectively address certain types of cross-border climate risk, at lower levels of complexity, by supporting regional cooperation and dialogue and enhancing local resilience. Second, other types of cross-border climate risks, including those that are more complex, will require established actors to adopt paradigm-shifting approaches, and to involve actors new to adaptation finance. Such approaches would shift focus from short-term projects in individual countries to long-term cooperation between countries. Multilateral actors seeking to build systemic resilience face significant obstacles, but recipient and contributor countries each have incentives to invest in management of shared climate risks.

Sensitivity analysis of the indirect cost model ARIO based on the 2021 July flood in Germany” (Samuel Juhel)

Speaker: Samuel Juhel, CIRED, France

Topic: Sensitivity analysis of the indirect cost model ARIO based on the 2021 July flood in Germany

Natural disasters have historically had significant economic consequences, but the increasing frequency and severity of these events due to climate change have brought this issue to the forefront. Given the interconnectedness of economies and the prevalence of just-in-time production processes, there is growing concern that even small interruptions to production caused by natural disasters could lead to greater indirect economic impacts. A substantial body of literature on this subject exists, notably with the help of input-output analysis, CGE and agent-based models. However, such models rely on parameters and data which are often either unobservable empirically or estimated with wide margins of uncertainty, and which heavily influence simulation results. Different parameter values and data sources are typically used throughout the literature to study similar disasters, which makes it difficult to compare the results across different papers and assess their reliability. Here, taking the example of July 2021 floods in Germany, we systematically analyze to what extent the simulation results of the ARIO model are robust when taking into account the uncertainty on input data. ARIO model is one of the most widely used models to simulate the indirect economic impact of natural disasters, and its mechanisms have been used as theoretical foundations for several other models. We conduct an extensive sensitivity analysis of the model's results by varying its key parameters, as well as by varying the multi-regional input output tables which it uses as its main input data. This analysis was made possible by the development of a new resource-efficient Python implementation of the ARIO model, which enables a large number of simulations to be run. We define the set of input parameters under the double constraint of being close to values used in the literature and preventing the model from leading to manifestly unrealistic simulation outputs. Our results show that the choice of the data source indeed heavily influences the outputs of the model, but that several key messages remain true across the range of possible input data.

Climate transition spillovers and sovereign risk: evidence from Indonesia" (Régis Gourdel)

Speaker: Régis Gourdel, WU Vienna, Austria

Topic: Climate transition spillovers and sovereign risk: evidence from Indonesia

We study the macro-financial relevance of climate transition risks for sovereigns that can materialize as a result of the introduction of low-carbon policies in a trading partner country. We define this notion as climate transition spillover risk, and we apply it to the analysis of the introduction of carbon pricing in China on Indonesia, a major coal producer and exporter to China. By tailoring the EIRIN Stock-Flow Consistent model, we quantify the impact of a shock on Chinese demand for Indonesian coal, consistently with the scenarios of the Network for Greening the Financial System, on the Indonesian economic performance, fiscal and financial risk. We find that transition spillover risk directly weakens the Indonesian balance of payment, which decreases by 4.4 percent of GDP, leading to indirect and cascading effects on public finance and public debt, which increases up to 9.6 percent of GDP. Further, we find a trade-off between trade decarbonization and sovereign financial stability for Indonesia, resulting in carbon-stranded assets. Our results highlight the importance for supervisory institutions, such as the International Monetary Fund, to integrate climate spillover transition risk in their debt sustainability analyses and financial stability assessment programs.

Parallel Session 1: Trade, Supply and Value Chains

Food-system consequences and responses associated with future trade-linked cross-border climate-border impacts: Insights from quantitative and qualitative research methodologies" (Chris West)

Speaker: Chris West, Stockholm Environment Institute, York

Topic: Food-system consequences and responses associated with future trade-linked cross-border climate-border impacts: Insights from quantitative and qualitative research methodologies.

Given heavy dependencies on overseas material and the fundamental importance of a secure supply chain to the EU economy and to livelihoods, the food system is likely to be one of the most relevant when considering the effect of climate- and trade-related impacts to Europe. Here, we undertake a synthesis of findings from across a combination of quantitative modelling (computable general equilibrium and partial-equilibrium based scenario analysis considering trade chokepoints, climate-yield driven changes, and the impacts of the Ukraine war as a 'shock' to the European food system), literature review and analysis of historical shocks, and stakeholder interviews (across a cohort of research, policy, and industry stakeholders) conducted within the CASCADES project, aimed at understanding: the key sources of impact, Europe's potential vulnerabilities to those impacts, and its ability to effectively respond to ensure a food system that remains sustainable and resilient in future. We will provide an overview of results from across the methods utilised, which provide insight into the complex nature of how impacts and risks might manifest themselves, and how they may (or may not) lead to discrete harms to the EU economy and to food supply. In addition, we will present recommendations for enhancing the quality of the research base for future assessments and - importantly - for building the EU's (and international) resilience to future climate shocks.

Impacts of compound natural hazards on supply chains" (Zélie Stalhandske)

Speaker: Zélie Stalhandske, ETH Zurich

Topic: Impacts of compound natural hazards on supply chains

In an increasingly interconnected global trade environment, both private and public organizations are facing heightened exposure to worldwide hazards. Seemingly unrelated events can intertwine through supply chains, leading to significant economic implications. This study investigates the impacts of worldwide natural hazards on European countries via supply chains, with a particular focus on compound events. To this end, we incorporate BoARIO, a Python-based implementation of the Adaptive Regional Input-Output (ARIO) model, into the CLIMADA modeling platform. CLIMADA enables the estimation of direct impacts, while BoARIO simulates how these impacts cascade through the supply chain. Focusing on historical tropical cyclone events on a global scale, we compare the aggregated indirect impacts of individual events with the cumulative impact of all events. In doing so, we examine how direct impacts can compound both spatially and temporally, potentially leading to either increased or decreased supply chain impacts. Finally, we discuss how this modeling chain can provide insights into the interactions between multiple events and their associated cross-border impacts.

Cross-border impacts of worldwide climate effects on effective labour for Finland"
(Johanna Pohjola, virtual)

Speaker: Johanna Pohjola, Finnish Environment Institute (Syke), Finland

Topic: Cross-border impacts of worldwide climate effects on effective labour for Finland

Climate change has already had negative impacts on the labour force in most parts of the world, with a possible exception being Scandinavian countries. Previous analysis has found that climate effects on labour are among the most important drivers of total economic costs of climate change. The most exposed regions are those near the equator while the most exposed sectors are those with outdoor workers like agriculture, construction and forestry. We analyse how productivity impacts are transmitted to other countries directly and indirectly via trade and allocation of international investments. Estimates of climate-induced changes in labour productivity on a regular grid with global coverage were taken from Dasgupta et al. (2021) who expanded previous analysis by including the impact on labour supply in addition to labour productivity and combine them to compute total impacts in the form of effective labour. Productivity changes are fed into the GTAP (Global Trade Analysis Project) model to obtain the cross-border impacts on trade patterns, sectoral changes and welfare. We focus on Finland and its trading partners in our analysis. The GTAP model is well suited for cross-border analysis as it is multi-region and multi-sector model.

Preliminary results suggest that the cross-border impact is slightly positive for Finland. We found that the sign of the welfare impact is sensitive to the mechanism of allocating international investments. Our results suggest that most of the cross-border impact on Finnish welfare is due to the reduction of labour productivity in indoor work outside the EU, although productivity is less affected for indoor work than outdoor work in sunlight. In addition to high-exposed sectors, labour-intensive sectors, like textiles, are most vulnerable. Our analysis reveals how trade chains are impacted due to both competitiveness and income effects. We demonstrate that market adjustments are essential to include in the analysis to capture indirect impacts through trade chains. We also show that losses are partly compensated through market adjustment. Enhancing market adjustments could therefore reduce negative impacts or take advantage of potential benefits from indirect impacts of climate change.

Uncertainty in land-use adaptation persists despite crop model projections showing lower impacts under high warming” (Edna Molina Bacca)

Speaker : Edna Molina Bacca, Potsdam Institute of Climate Impact Research Centre

Topic: Uncertainty in land-use adaptation persists despite crop model projections showing lower impacts under high warming

Climate change will likely impact crop yields and alter agricultural resource availability. Since climate impacts are expected to be heterogeneously distributed, local and specific adaptation would be critical to face climate change. Here, we used a land-use model (MAGPIE) to estimate the contribution of different climate change adaptation mechanisms (relocation of cropping areas, irrigation, cropland expansion, land use intensification, and shifts in grown crop mixes) under a set of the newest generation of crop yield simulations with CO₂ fertilization effects. Under strong climate change, the simulated global average crop yields decline in 2100 by a median of -5.6% ([-42%,+12%]) compared to the values in the year 2020, while for a low-impact scenario, yields only slightly decrease (0.5%, [-11%,+4%]). For the high emissions scenario, the land system responds to these impacts primarily by expanding cropland and shifting the types of crops produced in existing cropping areas compared to a case without climate effects. The impacts uncertainty leads to average adaptation costs between -1.5 and +19 US\$05 per ton of dry matter per year. Land-use adaptation can dampen adverse effects and take advantage of possible benefits, like local gains in crop yields. However, variance among impact projections creates challenges for effective adaptation planning.

Poster Session 1

“Culture, climate change, and water conservation: Water ecosystems and culture-based adaptation practice in Developing Countries” (Shahid Mallick)

Poster presenter: Shahid Mallick, Eastern Finland University, Finland

Topic: Culture, climate change, and water conservation: Water ecosystems and culture-based adaptation practice in Developing Countries

The research focuses on climate change, water conservation, and community development in Bangladesh. Bangladesh is one of the most climate-vulnerable countries in the world and water challenges, especially in the coastal areas are severe and significant. The aim is to determine the socio-ecological effects of water-related climate change in coastal communities in Bangladesh, with a specific focus on the potential of traditional knowledge (TK) and local, culture-based adaptation strategies to enhance resilience to water challenges in some of the poorest and most biodiverse regions on the planet. Until now, most climate change water adaptation practices are based on grey infrastructure (e.g. dams). Their functionality and effectiveness in storage, purification, and supply of water are not at the intended level and create obstacles to the natural flow. TK-based solutions, on the other hand, are culturally appropriate, focus on biodiversity and ecosystem restoration, and are easy to maintain as well as low cost. There is growing interest in nature-based and TK-based solutions at different scales. However, ecosystems are vulnerable to climate change and as TK is often based on historical knowledge of ecosystems, the question arises to what extent it can be helpful during radical change. Crucially, the research asks how the potential of traditional knowledge can be harnessed to strengthen resilience. Using a mixed method approach grounded in ethnographic methodologies, the project will help to guide greater community-level adaptation and biodiversity and ecosystem conservation and also influence future policy and planning in this field.

Women's lived experiences of the slow water crisis in Cape Town (South Africa)" (Ariadna Romans i Torrent)

Poster presenter : Ariadna Romans i Torrent, University of Amsterdam, The Netherlands

Topic: Women's lived experiences of the slow water crisis in Cape Town (South Africa)

Women are among the most impacted groups by water shortages, especially with regards to health, hygiene, sanitation and care tasks. This research aims to investigate the lived experiences of low-income women in Cape Town with regards to water and the city's most recent water crisis. To do so, this research will follow four stages. Firstly, there will be a review of literature on water and women, with a primary focus on Cape Town. Secondly, local water experts will be consulted about the impacts of the most recent water crisis and whether it can be conceptualised as a slow crisis or catastrophe. Thirdly, stories will be obtained from low-income women in the city regarding their personal daily experiences with water, including during the water crisis. Lastly, the city's local water policy will be reviewed in order to investigate the government response to women's access to clean water and the water crisis, if any, and to identify opportunities for and barriers to mainstreaming low-income women into local water policies.

The role of youth-based organizations in addressing cross-border and cascading climate impacts and risks” (Amara Kamara)

Poster presenter: Amara Kamara, African Leadership College, Mauritius

Topic: The role of youth-based organisations in addressing cross-border and cascading climate impacts and risks

Climate change is a global challenge that poses complex and interrelated risks and impacts that transcend borders and sectors. Addressing these risks requires coordinated and collaborative efforts from various stakeholders, including youth-based organisations. This research paper explores the role of youth-based organisations in addressing cross-border and cascading climate impacts and risks. Through a literature review, case studies, and data analysis, this paper identifies the potential of youth-led climate action in developing a common language and shared understanding of climate impacts, and in promoting effective collaboration and communication across borders and disciplines.

The literature review highlights the key role of youth-based organisations in climate action, and the challenges and opportunities posed by cross-border and cascading climate impacts. The review also emphasises the importance of collaboration and partnerships in addressing climate impacts, and the potential of youth-led climate action in influencing policy changes and promoting sustainable initiatives.

The case studies presented in this paper showcase examples of youth-based organisations addressing cross-border and cascading climate impacts, including the Fridays for Future movement, the Youth Climate Strike, and the Zero Hour movement. These case studies illustrate the diversity of youth-led climate action, and the range of strategies and tactics employed by these organisations to promote climate awareness, advocacy, and action. The data analysis also provides statistics on the impact of youth-led climate action, including the number of participants in youth-led climate strikes, the number of policy changes influenced by youth-led advocacy, and the number of sustainable initiatives led by youth-based organisations.

The findings of this research paper highlight the potential of youth-led climate action in addressing the systemic risks and cascading impacts of climate change. Specifically, youth-based organisations can contribute to the development of a common language and shared understanding of climate impacts, and can promote effective collaboration and communication across borders and disciplines. The paper also identifies best practices for effective youth-led climate action, such as promoting diversity and inclusivity, fostering partnerships and collaborations, and promoting youth empowerment and leadership.

In conclusion, this research paper provides insights into the potential of youth-based organisations in addressing cross-border and cascading climate impacts and risks. The paper emphasises the importance of collaboration and communication in addressing climate impacts, and the potential of youth-led climate action in promoting sustainable solutions and shaping the future of climate policy. The paper also identifies future research and practice opportunities, including the need for further collaboration and partnership-building among youth-based organisations and policymakers.

Uncovering the Nexus between Fossil-Based Energy Security, Financial Policies, and Climate and Energy Transition Risks: Insights from a German Economic Case Study”
(Franziska M. Hoffart)

Poster presenter: Franziska M. Hoffart, Institute for Macroeconomics | Ruhr-University Bochum, Germany

Topic: Uncovering the Nexus between Fossil-Based Energy Security, Financial Policies, and Climate and Energy Transition Risks: Insights from a German Economic Case Study

Numerous challenges, including geopolitical crises such as the Russian war against Ukraine and the global climate crisis, mark the transition towards renewable energy and net-zero. It is crucial to consider the intricate dynamics that arise from these crises to achieve a successful and sustainable transformation.

To achieve a net zero future, it is important to adopt a comprehensive and holistic approach that acknowledges and addresses the complex interplay of various factors such as climate change, financial (in)stability, geopolitical energy crises, and the energy transition. Against this backdrop, we propose an analytical framework to unravel the intricate dynamics between these factors, identify key transmission channels, and use Germany for an economic case study.

The study shows that current financial policies should better align with Paris Agreement goals, while energy security policies can impede the transition. On the one hand, several energy security policies implemented in Germany in 2022 pose a threat to the progress of the energy transition, as they entail the construction of new fossil infrastructure, including LNG terminals. On the other hand, the absence of adequate climate-related financial policies, coupled with uncertainty and instability caused by climate and geopolitical crises, exacerbate negative feedback loops. Cascading effects, such as carbon lock-ins, lack of green finance, and absence of climate-related financial policies, can impact the economy and potentially hinder the net-zero transition.

The implications of this economic study extend beyond Germany's borders, as the crises it addresses are global, necessitating policy responses from other nations. Notably, the policies implemented by Germany may have spillover effects on other countries, underscoring the need for coordinated action at the international level. Navigating multiple crises while ensuring a successful energy and zero-emission transition requires adequate policy responses. In conclusion, policymakers must prioritize long-term climate goals over short-term financial and energy policies, recognizing the critical role of climate mitigation in ensuring a smooth energy transition and securing financial stability.

Rebuild better for a sustainable future” (Ilona M. Otto)

Poster presenter: Ilona M. Otto, Wegener Center for Climate and Global Change, University of Graz, Austria

Topic: Rebuild better for a sustainable future

The presentation concern rebuilding post-war areas in Ukraine and taking into account the net-zero and climate resilience goals. Since the construction industry is one of the largest sources of greenhouse gas emissions (GHG), and the lifespan of buildings and infrastructure extends beyond 50 years, it is essential to include net-zero climate targets in the post-war reconstruction. One possible step that can be taken to meet the climate policy goals is to use construction materials, where the manufacturing and use have a balancing effect the GHG emissions. These construction materials store carbon, and their manufacturing is associated with low GHG emissions. To give an example, timber can be considered as an alternative material in place of traditionally used cement and steel. The total carbon stored in newly built urban infrastructures worldwide over the next 30 years would sum up to 2–20 Gt if 90% of these would be built with timber, to 1–11 Gt in the 50% timber scenario, and to 0.25–2.3 Gt in the 10% timber scenario. However, few Ukrainian city planners and decision-makers have knowledge of climate policy goals or possible climate mitigation and adaptation options. Ukrainian scientists currently living abroad can play important roles in the knowledge transfer.

Flammable Futures - Storylines of Indonesia's wildfires and palm oil industry in a changing climate.” (Shelby Corning)

Poster presenter: Shelby Corning, IIASA

Topic: Flammable Futures - Storylines of Indonesia's wildfires and palm oil industry in a changing climate.

Wildfire events are driven by complex interactions of the climate and anthropogenic interventions. Predictions of future wildfire events, their extremity, and their impact on the environment and economy must account for the interactions between these drivers, especially in the context of climate change. Economic policy and land use decisions influence the susceptibility of an area to climate extremes, the probability of burning, and future decision making. To better understand how climate-driven drought events and adaptation efforts affect burned areas, agricultural production losses, and land use decisions, we developed a storyline approach centered on Indonesia’s 2015 fire events, which saw significant (>5%) production losses of palm oil.

We explored analogous events under three warming conditions and two storylines (ensemble mean climate change and high aridity). We employed a model chain consisting of climate modeling to quantify climate change impacts, a wildfire climate impacts and adaptation model (FLAM) to predict burned areas, and a bio-economic model (GLOBIOM) to predict the resultant production losses and socio-economic consequences in the oil palm sector in Indonesia and, by extension, the EU.

We found that the total burned area and production losses can increase by up to 25% and lead to local price increases up to 70%, with only minor differences between storylines. The results highlight the importance of considering the interactions of future warming, drought conditions, and extreme weather events when modeling their impacts on oil palm losses and burned area. Similarly, the impacts of land management policies on local and international environments and economies cannot be overlooked in the context of global warming and when considering adaptation and mitigation efforts.

Keynotes

Keynote 3: Yasuko Kameyama

Speaker: Yasuko Kameyama, University of Tokyo, Japan

Topic: Systemic transformation must start now to avoid the worst case scenario

More than 40 years have passed since climate change became an urgent issue for the international community, but the situation continues to worsen. This year has seen a variety of extreme weather events around the world. Three types of cross-border climate change impacts and risks will be examined to explain compounding risks related to climate change. Depending on how countries respond to the problem, relationship between affected communities can either end up in a confrontation or nurture cooperation. It is also indispensable to continue utmost effort to reduce greenhouse gas emissions to limit future temperature rise, so as to minimize severe adverse impact of climate change.

Keynote 4: Dhanasree Jayaram

Speaker: Dhanasree Jayaram, Manipal Academy of Higher Education, India

Title: Transboundary physical and transition climate risks in the Indo-Pacific

The climate vulnerabilities of the Asia-Pacific/Indo-Pacific region have grown immensely with adverse consequences for regional, national, human, and ecological security. The systemic risks posed by climate change (as well as climate action) in the region have far-reaching transboundary implications as multiple crises (food, water, climate, energy, economic, geopolitical, etc.) interact with each other in increasingly uncertain ways. Climate change cooperation (or the lack of it) in the region is deeply entangled with its geopolitical scenario(s). Climate action has been prioritised by most countries, including by integrating it into their security strategies, prioritising energy transitions, and reiterating the need for cooperation among the region's countries. Yet there are several impediments to effective collaborative climate action such as the lack of climate finance and geopolitical tensions. The presentation will reflect upon these issues pertaining to the Indo-Pacific region, by also locating climate change within the Indo-Pacific strategies of countries in the region (such as Australia, New Zealand, the U.S., India, Japan, and South Korea) as well as regional organisations (ASEAN and the Pacific Islands Forum or PIF) besides the European Union (EU), an extra-regional player, and the Quad.

Parallel Session 2: Scenarios and Storylines to capture cross-border climate impacts

Characterising future international connectivity in the SSPs to assess cross-border climate risks" (Stefan Fronzek)

Speaker: Stefan Fronzek, Finnish Environment Institute (Syke), Finland

Topic: Characterising future international connectivity in the SSPs to assess cross-border climate risks

International connectivity refers to the level of interaction across borders between entities distributed geographically, such as individuals, companies, cities and countries, via social, biophysical or virtual processes. The degree of international connectivity is an important factor in the propagation of climate change impacts from one region across borders to other regions, as well as between different sectors of the economy. This connectivity is also an important determinant of international cooperation to respond to these impacts. International relations are intrinsically dynamic and hence are also expected to change in the future. The Shared Socioeconomic Pathways (SSPs) offer a wide range of socioeconomic developments through to 2100, but hitherto a comprehensive characterisation of how they differ with respect to different aspects of their international connectivity has been missing.

We present an approach for locating scenarios within an existing framework for cross-border climate change impacts, which distinguishes a climate trigger, initial impact in one region, impact transmission system, recipient risk in another region, and responses from actors affected by this risk. Taking the global SSP narratives and selected SSP literature, we characterise SSP-based futures of international connectivity for policy and conflict, trade, migration and finance, and discuss their potential use in cross-border climate change risk assessments.

The cross-border dimensions of the global SSPs can be characterised as follows:

- SSP1(sustainability) has a high level of international political integration, strong global institutions and a focus on sustainable development, free trade and free movement, but with little incentive for people to migrate
- SSP2 (middle-of-the-road) has moderate political connectivity with occasional conflicts between countries, moderate global trade integration with imperfectly functioning global markets and intermediate migration with spikes due to conflict
- SSP3 (regional rivalry) has low political connectivity between (though not necessarily within) regional blocs, low market integration with regional markets and low levels of international migration
- SSP4 (inequality) has moderate political connectivity with global institutions that only serve the elite, mixed levels of trade connectivity with a globalized high-tech economy and more insular basic commerce and varying levels of migration

- SSP5 (fossil-fuel development) has a high level of political connectivity with strong global institutions that have a focus on economic growth, a high degree of free trade and high migration with open labour markets.

Global financial markets are not directly described in the SSP narratives, but international connectivity in finance is related to global governance and trade. Similarly, several studies have explored international dimensions of the SSPs for armed conflict and increased risk of invasive species. Lower levels of connectivity in one or several aspects might imply a relatively lower proportion of cross-border compared to direct climate change risks; however, it also implies reduced international cooperation to address these risks.

The SSP framework allows for a consistent comparison across studies of different scopes. Our framework operationalises this potential, thereby providing planners with an aid for understanding the relevance of cross-border impacts in a changing context. Improving scenario descriptions will therefore have benefits for practitioners and policy-makers as well as for research.

A framework and typologies for responding to cross-border climate change impacts (Magnus Benzie on behalf of Sara Talebian)

Speaker: Magnus Benzie on behalf of Sara Talebian, Stockholm Environment Institute - SEI, Sweden

Topic: A framework and typologies for responding to cross-border climate change impacts

Climate change adaptation is most often defined as a local and national governance issue. While the scientific literature recognizes the potential significance of cross-border climate impacts and new methods are being developed for the assessment of risks and opportunities associated with them, adaptation planning approaches are mostly confined within tightly defined sectoral contexts or specific geographical regions. These approaches overlook transmission of impacts across sectors and borders and fail to lay the groundwork for systemic responses and cross-scale solutions for transnational adaptation governance.

We propose a conceptual framework for identifying and filtering different types of responses to cross-border climate impacts. The framework provides typologies of cross-border climate impacts and responses to them and defines actor constellations who may take ownership in addressing impacts. Exploring different plausible response types, a set of governance modalities are then proposed which may be appropriate to adequately address certain impact types. The appropriateness of different responses and governance approaches depends on a number of contextual factors including actor constellations, cross-scale coordination, and governance capacity. Key to developing suitable governance modalities is a recognition of response effects and undesirable consequences that may redistribute or exacerbate risks across scales.

The response framework presents a sequence of steps to investigate the suitability of historical responses to cross-border climate impacts and map policy gaps and under-represented response types. It also offers a structured architecture for identifying suitable responses and governance modalities for addressing future cascading climate risks and opportunities and also, potentially minimising undesirable side effects of adaptation actions. To illustrate potential uses, we apply the response framework to case studies on trade and food security.

The framework enhances the understanding of opportunities and challenges for global collaboration on adaptation. While the framework is research-oriented, conceptual, and descriptive at this stage, we believe with further applications it could inform and assist policymakers to identify suitable intervention points for adaptation responses. For instance, this could include anticipating whether: (a) collaboration with actors across scales and jurisdictions should be broad or targeted, (b) reliance on internal adaptation and domestic capacity would be sufficient to achieve the desired results, and (c) combining different modalities would be advisable to accommodate short-term adaptation and long-term resilience-building.

The storyline approach as a scientific methodology for risk assessment of remote climate impacts on Europe" (Suraje Dessai)

Speaker: Suraje Dessai, University of Leeds, England

Topic: The storyline approach as a scientific methodology for risk assessment of remote climate impacts on Europe

The RECEIPT project aims to quantify the risk of remote climate events on key European socio-economic sectors using a storyline approach. To develop physical climate storylines, work has been undertaken in five sectors - including agriculture, finance, international development, manufacturing chains and coastal infrastructure - in which scientists with different expertise collaborated amongst themselves and with societal partners. We, the authors of this study, have been participant observers of the development of physical climate storylines throughout the project. This study documents the effectiveness of the storyline approach as a scientific methodology for risk assessment with the aim of providing guidance on storyline development based on RECEIPT research and lessons learnt. In addition to drawing from the authors' participation in the project, this study draws from the deliverables and publications produced by RECEIPT members, as well as a series of interviews with a representative group of RECEIPT members. Interviewees have been chosen to represent members of RECEIPT in different roles (e.g. work-package leader, societal partner, etc.), at different career stages (e.g. PhD candidate, Post-Doctoral researcher, Professor, etc.) and with different expertise (academic, industry, etc.). The interviews explored the project context in which the storylines were developed, the methodologies implemented and key related assumptions and aims, the collaboration with project members with different expertise as well as with stakeholders, and the future of the storyline approach.

Even though a general recipe was co-developed by the project members at the beginning of the project and later synthesised in van den Hurk et al (2023), a first analysis of the publications, deliverables and interviews shows that the project members developed rather different technical methodologies to develop physical climate storylines. This diversity is seen both as a virtue—as it is adaptable to different problems—and a vice—as it does not follow a specific set of steps—of the storyline approach. Another source of diversity is the aim of storylines and its relation to methodology. While it is to be expected that a physical storyline can be used for different purposes (Shepherd et al 2018), these different views are related to different attitudes toward methodology. Some interviewees attributed this diversity of views to a lack of face-to-face interaction due to COVID, others to other individual and contextual factors such as lack of relevant expertise or sufficient time. However, there was consensus among the interviewees that one of the key benefits of this approach is the fact that it allows scientists to make their assumptions about the methodology explicit.

The heterogeneity of views amongst the interviewees raises several questions in addition to providing guidance on further storyline development. For example, one key question that can be raised is the following: what is the aim of physical climate storylines, and how can the relevant experts be recruited to achieve this aim? A key recommendation is that depending on the aim of the storyline (be it for communication or research purposes), the necessary resources need to be given to storyline developers, as well as ensuring continuity of collaboration across actors.

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Synthesis of storylines through common policy directions: a causal network approach"
(Taro Kunimitsu, virtual)

Speaker: Taro Kunimitsu, CICERO Center for International Climate Research, Norway

Topic: Synthesis of storylines through common policy directions: a causal network approach

The physical climate storylines developed in the RECEIPT project cover a wide range of sectors and are based on various assumptions, resulting in outcomes that are difficult to synthesize into one coherent message. While a framework to assess all the storylines into one outcome would be ideal, this does not align, and is possibly incompatible, with the storyline approach. Nonetheless, the overall policy directions of future pathways determine the background assumptions that enter the storylines, and the messages coming out from the set of storylines should be consistent given these underlying assumptions. We show how these requirements can be satisfied by framing storylines with causal networks, placing them under common assumptions that connect the individual storylines. We also explore the policy messages that can be obtained by considering multiple storylines from the RECEIPT project.

Parallel Session 2: Policy analysis methods for studying cross-border impacts and adaptation

Comprehensive security against climate change: Preparing for cascading and transition impacts" (Emma Hakala)

Speaker: Emma Hakala, Finnish Institute of International Affairs, Finland

Topic: Comprehensive security against climate change: Preparing for cascading and transition impacts

Climate change threatens people and societies around the world, and without rapid and decisive action its impacts will be aggravated in the future. Beyond direct impacts like extreme weather events, the climate crisis will also generate cascading impacts, where environmental changes are combined with socio-economic and geopolitical factors, and transition impacts associated with the unintended consequences of the mitigation of climate change. As a whole, climate impacts have the potential to endanger livelihoods, increase societal instability and conflict potential, disrupt global supply chains and escalate tensions in international relations.

Finland is a small country with an open economy, making it highly dependent on global networks and supply chains. This leaves it particularly vulnerable to disruptions through cascading and transition risks – as well as prone to contributing to similar impacts elsewhere. Although Finland is a high-income democracy with a stable societal structure and therefore comparatively well equipped to adapt to climate change, it has not necessarily prepared for the kinds of comprehensive implications that cascading and transition impacts are likely to have.

This presentation will examine preparedness for the cascading and transition impacts of climate change in Finland particularly from the point of view of the Finnish policy of comprehensive security. As a cross-sectoral cooperation model, comprehensive security aims to ensure the vital functions of society by bringing together authorities, the business community, organisations, and citizens. Although the premises of comprehensive security suggest it is also aimed to identify emerging threats, climate change has so far not extensively featured in its planning or implementation. Yet it could provide an effective framework for considering climate-related risks, also including cascading and transition impacts. The presentation will consider the potential of the comprehensive security model to integrate climate change and discuss possible new practices and measures that could be adopted. Through the Finnish example, it also aims to yield insights to climate security foresight and preparedness more broadly.

Consensus priorities on allocating forecast-based funding of humanitarian and disaster aid for climate change adaptation: A Delphi study" (Juha-Pekka Jäpölä)

Speaker: Juha-Pekka Jäpölä, University of Antwerp, Belgium

Topic: Consensus priorities on allocating forecast-based funding of humanitarian and disaster aid for climate change adaptation: A Delphi study

Around USD 19-26 billion has been allocated annually between 2020-2022 to humanitarian and disaster aid globally. Distributing the scarce public resources across borders impartially and equitably to people in need facing vastly different circumstances is a monumental task: In addition to working under time pressure, the prioritisation is influenced by various spatial and temporal variables as well as e.g., by political context, publicity, or scientific uncertainty.

According to IPCC AR6 WGII, "climate change is contributing to humanitarian crises where climate hazards interact with high vulnerability". The estimate of the joint INFORM Climate Change Risk report is that by 2050 "the number of people living in 'very high' crisis risk countries will roughly triple from 580 million to 1.5 billion" within the more pessimistic scenarios for greenhouse gas emissions and socio-economic development. In November 2022, the UN climate change conference COP27 reached an agreement on a new "Loss and Damage" fund for vulnerable countries.

Our study is examining the problem of distributing aid funding in advance of crises or disasters based on forecasting. The best solution would be to prevent them in the first place or adapt to become resilient enough to withstand their impact—which logically requires predictive information and modelling to fund such pre-emptive initiatives. To feed this forecast-based funding modelling, we use a novel combination of an iterative Delphi method to find economic preference from a thus far unused group of expertise.

Decision-making on according to which criteria and according to which forecasts should funding allotments be distributed is naturally already done routinely in different humanitarian and disaster aid offices (be they an international organisation, an NGO, a state, etc.) with implicit, discreet or internal rationales. The Delphi study therefore is intended to find a scientifically transparent consensus among an expert panel on:

- Q1. priority criteria in allocating humanitarian and disaster aid funding per future forecasts (based on the methodologies of INFORM Severity and INFORM Climate Change Risk); and
- Q2. priority options for which to allocate funding of humanitarian and disaster aid regarding adaptation to long-term risks of climate change (based on IPCC AR6 WGII findings).

Panellists invited to participate included humanitarian and disaster aid experts multinationally from different organisations, such as UN, EU, Red Cross/Red Crescent and World Bank, academic institutions and universities, governments, NGOs (e.g., ACAPS, REACH, VOICE), as well as private sector entities. Chosen first experts were requested to provide further experts suitable for the study ('snowballing technique').

Answers are gathered on an online survey platform allowing for numeric prioritisation and freeform commenting. The 1st round of the survey is about to end and we expect a 2nd round of the survey to be completed in June 2023—after which we will be able to analyse consensus via Pearson correlation coefficient.

The impacts of coastal flooding and sea level rise on critical infrastructure: a novel storyline approach" (Elco Koks)

Speaker: Elco Koks, Institute for Environmental Studies, Vrije Universiteit Amsterdam, Netherlands

Topic: The impacts of coastal flooding and sea level rise on critical infrastructure: a novel storyline approach

This study presents an event-based storyline framework to assess the influence of future climatic and socioeconomic conditions on coastal flood impacts to critical infrastructure. The framework combines well-established quantitative methods of sea level rise, coastal inundation, and critical infrastructure (CI) physical damage assessments into an integrated modelling approach. We apply our approach to re-imagine three historic events: storm Xaver, storm Xynthia, and a storm surge event along the coast of Emilia Romagna (Italy). Our results indicate that northern Germany would benefit mostly from coordinated adaptation action to reduce the flood impact, whereas the southwestern coast of France would find the highest damage reduction through asset-level 'autonomous' adaptation action. Our approach helps to improve the scientific understanding of how coastal flood risk are assessed and best managed, and forces a distillation of the science into an accessible narrative to support policymakers and asset owners to make progress towards more climate-resilient coastal communities.

Is the UNFCCC ready to handle the reality of cross-border climate risks? (Richard Klein)

Speaker: Richard Klein, Stockholm Environment Institute, Sweden

Topic: Is the UNFCCC ready to handle the reality of cross-border climate risks?

The negotiations under the United Nations Framework Convention on Climate Change (UNFCCC) have shaped countries' roles and responsibilities for planning, implementing and supporting adaptation action. In their adaptation planning and implementation, countries have prioritised addressing climate risks that arise within their borders. This focus on domestic adaptation is reflected in the financial, technological and capacity-building support that wealthy countries provide to poorer ones.

The Paris Agreement, adopted in 2015 under the UNFCCC, recognises that adaptation is a global challenge faced by all with local, subnational, national, regional and international dimensions. Transboundary climate risks are a clear illustration of the global nature of the adaptation challenge (Benzie et al., 2018). Climate impacts in one country can create risks and necessitate adaptation in other countries due to cross-border connectivity within regions and globally. Likewise, adaptation measures taken in one part of the world can alter transboundary links and flows, with consequences that ripple out far beyond their point of origin.

The Paris Agreement also sets a global goal on adaptation, which is to enhance adaptive capacity, strengthen resilience and reduce vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the agreement's temperature goal. For six years, this imprecise formulation presented "methodological, empirical, conceptual and political challenges", which the two-year Glasgow–Sharm el-Sheikh work programme on the global goal on adaptation seeks to address.

The formulation of the objectives of the work programme in 2021 could not benefit from the latest scientific insights on climate risks that were presented by the Intergovernmental Panel on Climate Change three months later (IPCC, 2022). The IPCC found that "climate change impacts and risks are becoming increasingly complex and more difficult to manage". This applies in particular to cross-border climate risks and the growing need for international collaboration.

A just transition for climate change adaptation: how do we build just resilience in an interconnected world" (Frida Lager)

Speaker: Frida Lager, Stockholm Environment Institute, Sweden

Topic: A just transition for climate change adaptation: how do we build just resilience in an interconnected world

In an interconnected world, the impacts of both climate change and adaptation measures are increasingly likely to be felt well beyond the places where they occur – across borders, sectors and continents. Research suggests that adaptation measures not only fail to target the most vulnerable, but often exacerbate, redistribute and create new risks for people and places most in need. Ensuring that adaptation is truly just and equitable requires recognising cascading and cross-border climate risk and building resilience on a global scale. This involves avoiding actions that simply shift risks to other actors or reinforce existing vulnerabilities, and better understanding the mechanisms through which risk is transferred, “owned” and managed in our global systems. It is a challenging and ambitious task, but one that is crucial for securing and safeguarding resources and societies in a globally interconnected world.

Injustice can also drive systemic risk. Climate-related hazards can indirectly fuel both greed and grievance-based conflicts at the community, national and regional levels. Reduced water availability, food scarcity and land degradation due to climate change may lead to increased poverty and hunger, especially in agricultural communities in developing countries. That, in turn, can escalate tensions, particularly in the absence of good governance. Adopting a just approach to adaptation is necessary to both safeguard human security and limit the subsequent negative effects on traditional national security and geopolitics.

In the past years, we have been working on better understanding the role of and implications for (in)justice of cascading and cross-border climate risk and adaptation. This has resulted in i) a conceptual framework for Globally Just Resilience inspired by just transition for mitigation (1), ii) a business brief on just transition for adaptation, based on interviews with multinational corporations (2), and iii) an EEA/ETC technical paper laying the groundwork for understanding how to measure just resilience for Europe (3). In addition, we are currently undertaking two case studies looking deeper into the role of connectedness to understand justice implications in global systems and supply chains looking into the dynamics of the i) cocoa and ii) lithium trade.

In this session we will share insights from this work focusing on methodological opportunities, challenges and blindspots, and invite to a reflection and discussion on how to incorporate and measure justice in adaptation to cascading and cross border climate risk to further advancing the research field.

1. <https://adaptationwithoutborders.org/knowledge-base/adaptation-without-borders/a-just-transition-for-climate-change-adaptation-towards-just-resilience-and-security-in-a-globalising-world>

2. <https://unglobalcompact.org/library/609>

3. Final report currently in print

Debate: Does the EU need a DG RESILIENCE? (Magnus Benzie)

Speakers: Magnus Benzie, Stockholm Environment Institute, Sweden and Ruth Townend, Chatham House, UK

Topic: Debate: Does the EU need a DG RESILIENCE?

Meanwhile, European society is increasingly exposed to a number of other cascading, interacting, systemic, even existential risks, including those driven by changes in cyber security, health pandemics, financial crises, biodiversity collapse, artificial intelligence and violent conflict. Many measures to build resilience to one of these risks will create resilience benefits in the face of other risks: they are related and in some ways similar.

Should the EU aim to build resilience by mainstreaming climate and other forms of resilience into existing policies and policy domains? Or does it require a new institution – a “DG RESILIENCE”, for example – to lead and coordinate such efforts?

This debate will present the cases for and against creating a DG RESILIENCE, drawing on perspectives that are emerging from the CASCADES project analysis of policy recommendations to build European resilience. After opening statements, each side of the debate will get the chance to respond to the arguments brought by his or her opponent.

Arguments will draw on conceptual/ theoretical and pragmatic/ political reasoning, reflecting not only the views of the debaters, but also stakeholders who have offered (often quite strong!) opinions on this question during consultations during the development of the CASCADES recommendations.

As is customary, the debate will be followed by an audience vote to determine who has won. The case “for” will be given by Magnus Benzie (SEI) and the case “against” by Ruth Townend (Chatham House).

Parallel Session 2: Climate-development-security nexus

Sustainable development, climate change and Mediterranean area: a nexus approach" **(Philippe Drobinski, virtual)**

Speaker: Philippe Drobinski, LMD-IPSL, Ecole polytechnique-IP Paris, ENS-PSL University, Sorbonne Université, CNRS, France

Topic: Sustainable development, climate change and Mediterranean area: a nexus approach

The Mediterranean is often referred as a “climate change hot spot”, as not only the regional projection of global climate change is exacerbated with pace of regional climate change larger than globally, but population growth, agricultural intensification, urbanisation, economic development and increasing resource demand increase the vulnerability of local communities and the level of insecurity of the the water, energy, food and ecosystem (WEFE) pillars. Resource overexploitation is contributing to their rapid depletion and consequent environmental degradation: it put at risk the Mediterranean countries in achieving the Sustainable Development Goals (SDGs) of the 2030 Agenda. The unsustainability in the WEFE pillars is not only characterised by insecurity but also by the large disparities across countries, and by the multiple interlinkages between the four pillars. An assessment of the WEFE nexus in the Mediterranean shows a strong correlation for water, food and ecosystem pillars, while little evidence is found for the energy pillar. So any deterioration of one of the correlated pillar, due to the climatic and non-climatic drivers of change impact, amplifies the degradation of the others in a cascading process. Two action pathways are reviewed: (1) implement innovative technological and nature based-solutions to loosen inter-dependency between the water, food and ecosystem pillars and (2) rely on renewable energy, enhanced efficiency in resource use and integrated technology assessments. However, research and policy initiatives on the WEFE nexus in the Mediterranean countries reveal a concept-to-operation gap due to (1) lack of accessible and reliable data, which inhibits wider adoption and application of the WEFE nexus in the Mediterranean region; (2) insufficient understanding of nexus trade-offs, insufficient incentives, limited vision, knowledge, development and investment, (3) absence of strong empirical evidence on the potential benefits of a WEFE nexus approach; (4) higher costs of nexus approaches as compared to silo approaches. Series of actions and interventions are needed to build institutional capacities, enhance finance mechanisms, support intra-regional dialogue, and pilot nexus approaches through modelling and assessment.

The effects of droughts on food (in)security in the context of climate change: a multifaceted relationship" (Domenico Bovienzo)

Speaker: Domenico Bovienzo, Euro-Mediterranean Centre on Climate Change(CMCC), Italy

Topic: The effects of droughts on food (in)security in the context of climate change: a multifaceted relationship

As the climate changes, droughts are increasing in intensity and frequency with escalating potential impacts on rural communities that are put at risk by escalating food insecurity, poverty, and inequality. The relationship between drought and food (in)security in developing countries is explored by combining information on more than 40 countries from 1990 to 2022 obtained by databases such as EMDAT and FAOSTAT. For our analysis, we define drought based on the Standardised Precipitation-Evapotranspiration Index (SPEI) which characterises the deficits in local water availability based on the precipitation and potential evapotranspiration. SPEI is computed using bias corrected Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) based on the Coupled Model Intercomparison Project Phase 6 (CMIP6). An econometric approach is applied to derive the relationship between food insecure people and drought by considering agricultural productivity and controlling for socioeconomic factors. As a case study, this approach is applied to Ethiopia, under current and future projected climate and socio-economic conditions, implementing a subnational composite indicator that combines vulnerability, hazard, and adaptive capacity information. The results are integrated into the INFORM Severity Index developed by the Joint Research Centre of the European Commission to support humanitarian crisis and disaster decision-making. The analysis shows that future drought will increase people in need of food assistance as well as forced displacement under future climate change and population projections. Humanitarian aid and assistance under these scenarios suggest large increases to compensate for the unmet additional requirements. The presented framework can be used as a tool to aid policy making on how to better prioritize future loss and damage funds and adaptation and mitigation investments to reduce exposure and vulnerability.

Average annual cost of internal displacement risk" (Mario Salgado-Gálvez)

Speaker: Mario Salgado-Gálvez, IIASA, Austria

Topic: Average annual cost of internal displacement risk

Disasters are the main trigger of internal displacement across the globe. Among the overall figures, climate related events have the largest share as the cause of internal displacement, which has been aggravated too by the effects of climate change. Because of its humanitarian and developmental roots, internal displacement risk has recently gained attention into different agendas although its formal assessment is still at its nascency. For something to be managed, it must first be measured and therefore, we propose a scalable and peril-agnostic methodology for the quantification of the average annual costs of internal displacement risk. It is based on three main components, namely the prospective quantification of internal displaced persons (IDPs) in terms of average annual figures, the estimation of the average annual displacement length, and the use of an empirical average annual cost of attending IDPs. Results are shown for flood-triggered internal displacement at global level, although the same methodology can be used for other sudden-onset hazards. The displacement length is estimated using as a proxy the physical damage at residential units, and the average annual cost of attending IDPs from the latest estimates by the Internal Displacement Monitoring Centre. This methodology can support different decision-making processes in the comprehensive management of displacement risk, ranging from the evaluation of mitigation and adaptation options to the design of financial protection instruments in the form of index-based payouts and forecast-based impact assessments.

Supporting Early Action with a flood Impact-based Forecasting: a case study of Tropical Cyclone Idai" (Margherita Sarcinella)

Speaker: Margherita Sarcinella, CMCC, Italy

Topic: Supporting Early Action with a flood Impact-based Forecasting: a case study of Tropical Cyclone Idai

Every day, in the Developed and Developing world, we witness the unfolding of extreme hydro-meteorological events that – most of the time - we are not prepared for. Weak or missing early action plans and protocols hamper an effective crisis response often leading to delayed humanitarian intervention and unplanned and scattered evacuations. Under the current lack of a widely adopted method to minimize the socio-economic impacts of weather-related hazards, channelling policy efforts towards preparedness and early action is vital. The resort to an Impact-based Forecasting (IBF) approach allows to take full advantage of the prediction window to pre-emptively act on-site to highly reduce the damage caused by the upcoming disaster. The goal of this research is to set-up a consistent, replicable and easily out-scalable methodology to forecast the impact of flooding on population, land and the built environment. The possibility to couple different approaches such as remote sensing and hydrological modelling to the IBF methods potentially allows for an unprecedented degree of accuracy in the ex-ante impact forecast. By resorting to this joint approach, the site-specific relationship between the likelihood of a given flood and its impact is established. This is done by combining a i) factual analysis to model flood extent and depth; ii) a probabilistic approach to associate a discharge value to each flood map and ultimately iii) linking those metrics with the relative physical and economic impact. A fully automated algorithm is developed and used in the first step to detect flood extent of past events from Sentinel-1 SAR imagery with a resolution of 10m. Such information is later matched with the output of LISFLOOD hydrological model to improve the forecasting capability beyond the limited record of historical events. Thus, each flood depth and extent map is linked to a given discharge and thresholds can be set to trigger early action. Lastly, the impact module produces maps of affected population, land cover classes and buildings as well as the estimate of economic damage caused to the built environment according to JRC's water stage-damage functions. The approach is applied to a number of case studies including the flooding generated by Tropical Cyclone Idai that hit the coast of Mozambique in March 2019, causing the death of over 1200 people. The impact of this event is computed with the proposed automated pipeline of codes and evaluated against available validation sources. Affected people estimates run as high as 1.87 M against the 1.85 returned by the aid agencies reports in the Sofala province alone while affected land reaches 3600 km². A more efficient intervention can be achieved by having access to this knowledge before the disaster hits. By wisely allocating resources and preparing evacuation plans within the lead time and locally improving disaster resilience where is most needed in the long term. Moreover, being able to compare the cost of intervention with the predicted economic loss of the upcoming flood can guide local stakeholders to optimize fund allocation by investing in preparedness rather than recovery.

The impact of disasters on EU humanitarian aid allocations: a storyline approach to Tropical Cyclone Idai” (Letizia Monteleone)

Speaker: Letizia Monteleone, Euro-Mediterranean Center on Climate Change, Italy

Topic: The impact of disasters on EU humanitarian aid allocations: a storyline approach to Tropical Cyclone Idai

The flooding caused by Tropical Cyclone Idai’s (TC Idai’s) landfall in 2019 caused severe physical damage, displaced hundreds of thousands of people, and resulted in thousands dead and missing. A storyline approach is applied to this event to investigate the impacts of climate and population change, humanitarian access constraints due to local armed conflict, and COVID-19 on humanitarian aid policy. To do so, relationships between flood and storm intensities and displacement risk, direct damages, and humanitarian aid requirements are developed and applied. It is found that with additional global warming and increased population, a disaster like TC Idai would have been more devastating, leading to considerably more displacements and higher incurred damages and costs than those in the storyline factual, even under an ambitious mitigation and low population growth scenarios. Direct damages to buildings using JRC flood stage-damage functions indicate substantial increases from 128 million USD in the factual up to 257 million depending on the climate and population scenario. Humanitarian aid costs are estimated using hazard, exposure, and fatality data from the EM-DAT database matched with humanitarian aid flows requested in Humanitarian Flash Appeals from UNOCHA’s Financing Tracking System database following disasters for 14 African countries. The resulting average aid per capita, computed under the climate and population scenarios, shows that humanitarian aid costs to the EU increased from 95 million USD in the factual event to up to 128 million USD. As a final step, the storyline is applied to the INFORM Severity Index, which is a composite indicator designed to aid the decision-making process for crisis resource allocation and coordination of humanitarian action. Under the variety of counterfactuals including climate and population scenarios, and humanitarian access constraints, and COVID-19, INFORM crisis severity ranges from medium to high. The results from the explored storyline suggest that projected climate and population changes and socioeconomic instabilities could inhibit the development, competitiveness, stability, and resilience of many low-income countries. The consequences could have severe cascading and knock-on effects for the EU including to its emergency/relief operation budgeting; development cooperation project planning and implementation; development-oriented approaches to forced displacement; restoration plans following emergency situations; and anticipatory climate change mitigation and adaptation investments to reduce population vulnerability and exposure.

Parallel Session 2: Trade, supply and value chains

Estimating the Impact of Physical Climate Risks on Firm Defaults: A Supply-Chain Perspective" (Ruben Kerkhofs)

Speaker: Ruben Kerkhofs, KU Leuven, Belgium

Topic: Estimating the Impact of Physical Climate Risks on Firm Defaults: A Supply-Chain Perspective

In this research, an agent-based model was developed to study the propagation of physical climate shocks through supply chain networks. By combining supply chain and financial models, the study examines the effects of climate shocks on firms' production capacities and their subsequent impacts on firm default risk. A comprehensive mathematical framework is presented for the simulation of physical risks, their subsequent up- and downstream impacts along the supply chain, and the translation of physical impacts into an increased level of default risk. The results highlight the importance of supply chains as a transmission channel for physical climate risks and emphasize the effectiveness of implementing adaptation measures. Practical examples demonstrate the model's behavior under hypothetical climate scenarios and identify the sectors most vulnerable to increases in the frequency and intensity of climate events. Overall, this study provides insights into the transmission dynamics of climate shocks and emphasizes the need for resilience against climate events in supply chain networks.

Stressed economies respond more strongly to climate extremes" (Robin Middelanis)

Speaker: Robin Middelanis, Potsdam Institute for Climate Impact Research, Germany

Topic: Stressed economies respond more strongly to climate extremes

Economies experience stress for various reasons such as the global Covid-19 pandemic beginning in 2020. The associated lock-downs caused local economic losses and the disruption of international supply chains. In addition, such stress alters the effects of short-term shocks as caused by climate extremes, especially their propagation through the economic network and the resulting repercussions. Here we show that adverse indirect impacts of tropical cyclones, river floods, and heat stress on global consumption are strongly enhanced when the economy is under stress. This compound effect results from aggravated scarcity causing higher consumer prices. Modeling climate impacts during Covid-19, we find that in a stressed economy with the current network structure, consumption losses due to climate extremes double in the USA and triple in China. The simulated effects intensify when climate shocks grow stronger. Our results emphasize the amplifying role of the interaction between climate change and its socioeconomic backdrop.

Risks to global food security triggered by the Russian invasion of Ukraine" (Kilian Kuhla)

Speaker: Kilian Kuhla, Potsdam Institute for Climate Impact Research, Germany

Topic: Risks to global food security triggered by the Russian invasion of Ukraine

The concentration of production in a few breadbasket regions and the resulting import dependencies of many developing countries render the global food web fragile to systemic shocks induced by (multi-)breadbasket failures, export restrictions or conflicts. Resulting supply failures and price spikes may put tens of millions of additional people at risk of food insecurity, especially in import-dependent low-income countries in Africa and Asia. Recently, the Russian invasion of Ukraine caused world wheat price spikes in spring 2022, and food shortages in countries that are strongly dependent upon Ukrainian wheat imports. Better than normal harvests in other main wheat producing regions and strong international cooperation helped to avert a much larger food crisis. We employ the storyline approach to map out threats to global food security that could have aggravated the crisis triggered by the Russian invasion of Ukraine. To this end we combine an analysis of the global supply network for wheat with an agricultural commodity price model accounting for storage and compute two key metrics for food security risks: impaired national crop supply and world market crop price hikes. We show that the lifting of export restrictions from the beginning of 2022 as well as the establishment of the Solidarity Line and Black Sea Grain Initiative reduced the annual world market price for the trading year 2022 by 13%. Further, we find that world market prices for wheat could have exceeded the price spikes of the world food price crisis in 2007/08 if national policymakers responded uncoordinatedly or there would be a multi-breadbasket harvest failure as in trade year 2007. In a worst case scenario where multi-breadbasket harvest failures, escalating export restrictions, and missing international agreements to transport Ukrainian grain via rail, road, and ship, the annual wheat price could increase by 90% compared to the average world market price between 2000 and 2020. Short-term coping strategies – such as food-secure countries dispersing stocks, reducing wheat as feed, or boosting wheat production – are effective at mitigating the price spike in simplified scenarios. Our findings emphasize the importance of internationally coordinated response measures in averting larger food crises.

Representation of Indirect and Interregional Effects in Modelling Approaches in the MYRIAD-EU Project" (Benjamin Blanz)

Speaker: Benjamin Blanz, Universität Hamburg, Germany

Topic: Representation of Indirect and Interregional Effects in Modelling Approaches in the MYRIAD-EU Project

The total impact of hazards can only be understood if their indirect effects are taken into account. This concerns both propagation of an impact within a system or economy, but also the regional propagation of impacts to connected systems or economies. Within the MYRIAD-EU project multiple modelling approaches (DAPP-IAMM, CGE, descriptive, empiric, ABM) are applied to investigate the impacts of multi hazard events in five different regions (North Sea, Scandinavia, Canary Islands, Veneto, and Danube), including their intersectoral and interregional indirect effects. Each of the approaches used has different strengths in the representation of indirect effects. While computational general equilibrium (CGE) models excel at large scale interregional and intersectoral effects, the underlying assumptions prevent the use of these models on smaller scales. The agent-based models (ABM) on the other hand allow investigating effects on the household and firm scale but are not suited for global international trade effects. The analysis of dynamic adaptive policy pathways (DAPP) in combination with integrated impact assessment meta models (IAMM) allows for an in depth multi-dimensional policy evaluation including some indirect effects, at the cost of regional representation. The descriptive methods used detail the interrelationships that cause indirect effects and how they propagate within a system, but do not offer quantification. The empirical methods allow the quantification of indirect effects in past observations of hazard events, shedding light on the strength of interrelationships, but do not explain their cause. Hence, in the context of systemic risks, it is important for model developers, users, and recipients of model results to understand how indirect effects are represented in the modelling approaches and in derived management recommendations.

Parallel Session 3: Scenarios and Storylines to capture cross-border climate impacts

Integrated climate, environmental and socio-economic storylines to support adaptation in the Euphrates-Tigris Basin (Elena Saggioro)

Speaker: Elena Saggioro, Walker Institute, University of Reading, England

Topic: Integrated climate, environmental and socio-economic storylines to support adaptation in the Euphrates-Tigris Basin

Despite being crossed by two of the historically most important rivers in southwest Asia, the Euphrates-Tigris Basin (ETB) is affected by a worsening water security crisis. Recent prolonged droughts, old water infrastructure damaged by conflict, ineffective agricultural practices, and the uncoordinated operation of several large dams across Türkiye, Iraq, Syria and Iran, has led to critically low levels of river flows, especially in the Syrian and southern Iraqi areas on the basin. Climate projections worryingly show declining precipitation in the ETB, although large uncertainty in the magnitude of these changes remain. If left unaddressed, water scarcity compounded with environmental and socio-economic vulnerabilities may impact development and security across the region.

As part of a project to support climate adaptation and peace and security in the region, a set of storylines of integrated climate, environmental and socio-economic risk for the ETB was developed. The storylines summarise climate uncertainty and, paired with current vulnerabilities, are translated into environmental and socio-economic impacts for two specific livelihood zones (LZs) in north-west Iraq, following the Driver-Pressure-State-Impact-Response (DPSIR) framework. Household Economy Approach data for the LZs is used to assess impacts at a granular level that can be used by local decision-makers. The integrated storylines are expressed via an infographic, a narrative in the present tense, and a summary table of impacts across six sectors (land and water resources, agriculture, health, livelihoods and energy).

Our analysis showed that, despite scenario and model uncertainty, increased temperatures, a consistent negative precipitation trend in ETB headwaters (which is the main source of rivers' recharge), and land degradation will worsen climate risk under any future storyline. The extent of precipitation decline in the headwaters largely depends on model uncertainty, highlighting the need to prepare for the worst even under low emission scenarios; while no model agreement is found for changes further downstream for which different storylines are needed. As a consequence, both rainfed and irrigated agricultural areas in north-west Iraq LZs will be strongly affected by decreasing precipitation and permanently lower river levels, even before accounting for changes in dams' operations upstream. If unmitigated, the already pervasive socio-economic vulnerabilities stressed by worsening climate factors will result in widespread impacts, especially for women, children and internally displaced people. Crucially, competition for water between countries will increase, highlighting the pressing need for multilateral water management agreements. However, locally much can be achieved by improving water use efficiency especially for agriculture which consumes about 80% of total water, with adaptation measures that may result also in improved production and livelihoods.

The ETB storylines developed are providing the basis for supporting adaptation planning on the ground. They will be used in forthcoming stakeholder consultations at national and subnational levels, for communicating climate risk locally (see My Climate Risk; <https://www.wcrp-climate.org/my-climate-risk>), and assessing adaptation strategies accordingly.

A Framework for Multi- and Systemic-Risk Analysis: Focusing on Indirect Risks Based on Dependencies (Stefan Hochrainer-Stigler)

Speaker: Stefan Hochrainer-Stigler, IIASA-International Institute for Applied Systems Analysis, Austria

Topic: A Framework for Multi- and Systemic-Risk Analysis: Focusing on Indirect Risks Based on Dependencies

Despite the rising importance of both systemic and multi-risks caused by interrelated natural hazards (e.g., compound, cascading, consecutive), there is still an apparent lack of unifying frameworks that allow for harmonized assessment and management of these risks. This paper presents a six-step framework developed as part of the HORIZON 2020 MYRIAD-EU project, with the framework flexible enough to cover single, multi- and systemic risk analysis, including measurement, modelling and management dimensions. The six steps are: i) finding a system's definition, ii) characterization of direct risk, iii) characterization of indirect risk, iv) evaluation of direct and indirect risk, v) defining risk management options, and vi) accounting for future systems state. The framework is developed based on systemic risk ideas, drawing a need to delineate clear system boundaries and identify interdependencies of system elements, ultimately enabling system of systems approach that can incorporate complexities in a manageable level for a diverse set of risk bearers. As done traditionally, in the process of risk assessment, we first propose an assessment of direct risks, emerging due to direct contact of system elements with a hazard(s). However, we suggest to move forward and then focus on indirect risks emerging due to interdependencies in the system and in response to direct risk realization, especially within a co-produced selection of indirect risk metrics with relevant stakeholders. Risk management options, including indirect risk management, are then considered, with a special emphasis on synergies and asynergies of risk management options between hazards, sectors, and impact types and between top down and bottom-up related risk management instruments. While the paper is focused on a detailed presentation and discussion of the conceptual framework, given that the framework is currently applied in five pilots across Europe (Danube, Canary Islands, Scandinavia, North Sea, and Veneto Region), it also brings initial results from practical implementation, including initial tools and methods, challenges, and opportunities.

How resolving ocean eddies can strengthen storylines of a warmer future climate." (Gerrit Versteeg, virtual)

Speaker: Gerrit Versteeg Barcelona Supercomputing Center, Spain

Topic: How resolving ocean eddies can strengthen storylines of a warmer future climate

A noticeable increase in the uptake of the term ‘physical climate storylines’, hereafter referred to as PCS, has been observed in the climate science community. As an informative tool to generate conditional hypotheses of future plausible climate trajectories, PCS trades probabilities for plausible explanations of how the physical aspects of the climate system could evolve. Conditional statements can be integrated into a causal network to represent highly complex and deeply uncertain local weather phenomena. However, for active uptake in risk assessments and adaptation strategies, non-climatic drivers of the causal network should be adequately represented to inform policy about the vulnerabilities of the human-climate system. The co-development of PCS with stakeholders can illustrate the societal response to climate and stress test how hazards are translated to impacts.

Applied in a case-study manner, PCS is anchored in physical aspects and should be injected with local knowledge to be more meaningful to policy and society. The physical characteristics of the current climate models are refined by resolving ocean eddies -the weather of the ocean- and studying how the ocean mesoscale influences atmospheric processes. With the new generation of models, specific climatological systems that drive atmospheric circulation are investigated and adjusted to represent the impacts of climate variability on regional scales, allowing for exploration of the deep uncertainty of dynamic climate processes. The dynamic changes are conditioned on future carbon emissions of a warmer earth. Additional socioeconomic data further fills the causal network. The informativeness of PCS in representing future tipping points or plausible climate pathways can complement traditional scientific approaches. When further applied to impact models, the policy domain is entered, giving more room to study the cross-border implications and responses to a changing climate. Following continuous stakeholder involvement during the co-developmental approach of PCS, their input is extremely beneficial to understand system vulnerabilities. Furthermore, assuming multiple credible perspectives enables a value-rich environment that fits the specific scales and decision contexts a changing climate affects. Storylines supported by a legitimate narrative and physical elements are a potentially insightful tool for multiscale risk assessments.

Storylines of future changes in precipitation regimes across the RECEIPT hotspots of remote agricultural risk affecting Europe" (Rohit Ghosh)

Speaker: Rohit Ghosh, Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Germany

Topic: Storylines of future changes in precipitation regimes across the RECEIPT hotspots of remote agricultural risk affecting Europe

The European agro-economy heavily relies on remote regions for essential agricultural products including Soybeans, Cacao, and Palm Oil, which are predominantly sourced from South America, West Africa, and Indonesia respectively. These RECEIPT hotspot regions are located in tropical to sub-tropical climates and are susceptible to changes in precipitation regimes from climate change. However, uncertainty regarding the spatial patterns of such changes poses significant challenges for adaptation planning. In particular, the uncertainty includes systematic aspects which introduce an element of correlated risk across the different remote hotspots, beyond the obvious dependence on global warming level. The spatial patterns of tropical Pacific Ocean sea-surface temperature anomalies are known to drive year-to-year rainfall changes in these hotspots, and thus represent an obvious candidate for correlated aspects of long-term change. In this study, we use data from the Coupled Model Intercomparison Project phase 6 (CMIP6) and a dynamical storyline approach to represent this systematic uncertainty and provide insights into potential future precipitation regimes in these key hotspots, based on different scenarios for the tropical Pacific Ocean temperature. Additionally, we consider local oceanic drivers that may contribute to rainfall uncertainty in specific hotspots, providing a more comprehensive picture of potential future risks to the aspects of Europe's agro-economy considered in RECEIPT. Our model findings are further validated by comparing the observed changes in relation to these oceanic drivers, enhancing the fidelity of our climate model results.

Building storylines of high impact storms under global warming and sea level rise"
(Henrique M. D. Goulart, virtual)

Speaker: Henrique M. D. Goulart, Deltares, Netherlands

Topic: Building storylines of high impact storms under global warming and sea level rise

Coastal regions are particularly vulnerable to the impacts of storms due to their complex and compound nature, involving both storm surges and extreme precipitation. The influence of global warming on storms in general is not particularly clear, with many components to analyse. In addition, individual storms might respond differently to global warming. This study aims to investigate the potential impact of global warming on an individual storm and its resulting flooding in coastal areas. For this, we use spectrally nudged data to simulate historical events under certain global warming levels (changing sea surface temperature and co2 emissions), and combine these scenarios with different sea level rise levels. A framework that included two hydrodynamic models was used to convert the simulated storm into actual coastal compound flooding. Furthermore, the results of inland precipitation and storm surges were separately modeled to distinguish the effects of each factor. Our initial findings reveal the complexity of modeling the influence of global warming on dynamic and compound events such as storms. While simulating both storm surges and precipitation is essential for accurate coastal flooding predictions, the impact of global warming on actual coastal flooding is not a linear relationship, and internal variability dominates the global warming signal.

Parallel Session 3: Modelling complex dynamics in social/ economic systems

Cascading climate tipping events and how they may be prevented by society" (Nico Wunderling)

Speaker: Nico Wunderling, Potsdam Institute for Climate Impact Research, Germany

Topic: Cascading climate tipping events and how they may be prevented by society

Several climate tipping elements such as the Amazon rainforest or the large ice sheets on Greenland and Antarctica are showing increasing signs of dramatic change in response to human-made global warming. While dangerous tipping risks can be reduced by keeping strict temperature guardrails set by international agreements, so far, such agreements have prompted only moderate emission cuts due to socio-political challenges. Here, we couple a conceptual model of interacting climate tipping elements to a simplified social model outlining an energy-production transition toward clean energy. Using this coupled model, we find that three ingredients are required for a fast sustainability transition, achieving a safe sustainability transition without triggering tipping events or cascades: (i) Strong political incentives to invest in clean energies, (ii) high societal pressure to avoid crossing climate tipping thresholds, and (iii) scientific guidance leading to sufficiently small uncertainties in tipping points. If these conditions are met, we reveal that tipping risks can be reduced by a factor of up to 20, in particular when uncertainties in tipping element thresholds are reduced significantly.

Multi-hazard risk assessment of critical infrastructure at the global scale" (Sadhana Nirandjan)

Speaker: Sadhana Nirandjan, Institute for Environmental Studies (IVM), Netherlands

Topic: Physical Vulnerability Database for Critical Infrastructure Multi-Hazard Risk Assessments

Critical infrastructures (CI) play an essential role in the day-to-day functioning of societies and economies. They refer to the array of physical assets required for the operation of the complex infrastructure network, which include energy grids, waste systems, and transportation networks. At the same time, impacts of natural hazards highlight the importance of improving our understanding on the natural hazard risk to these infrastructures. CI have evolved in large interconnected networks, whereby disruption of one asset may quickly propagate into widespread consequences – even outside an exposed area. The disruption of the services provided by CI have large potential to seriously hamper the daily activities of societies and economies that depend on them, as well as the recovery in the aftermath of a disruptive event. This can be exemplified by the many natural hazards that occurred this year alone, such as Hurricane Otis in Mexico, the Libya floods, and the Moroccan earthquake that severely damaged the infrastructure network, leaving numerous people without the reliable provision of services.

Sound risk assessments are urgently required to support risk mitigation efforts, and to prioritize where investments in CIs are most crucial. However, assessing the infrastructure risk at detailed level has proven challenging. One of the challenges is that the level of vulnerability of CIs is an unknown, while this is a key determinant to reduce natural hazard-induced risks. To date, quantitative vulnerability data is distributed across scientific articles, technical reports, manuals, rather than being accessible in a centralized dataset. Also, data is often presented in an incomplete way restricting researchers from directly using them.

We present a unique multiple hazard physical vulnerability database for CIs that can instantly be used for hazard risk assessments, including flooding, earthquakes, windstorms and landslides, which evaluate the potential damages to infrastructure assets. Through our systematic literature review that involves both peer-reviewed articles and grey literature, we have collected over 1,250 fragility and vulnerability curves from 93 sources for CI assets of energy, transportation, water, waste, telecommunication, health and education. Moreover, we systematically assess the literature on hazard, exposure and vulnerability characteristics and indicate a number of details regarding reliability and reference purposes. Complementary to the curve database, we also provide cost numbers that can be used in combination with the curves.

Our literature review has highlighted that there are substantial differences in availability of curves across hazards and CI systems as well as at geographical scale. Vulnerability development has mainly focused on earthquake curves for a wide range of infrastructure types. Windstorms have the second largest share in the database, but are especially limited to energy curves. While all CI systems require more vulnerability research, additional efforts are needed for telecommunication that is largely underrepresented across the different hazards and CI systems. Furthermore, our database has a below median coverage for South America, Central America and, in particular, Africa.

Towards a better understanding of the economic cost of compound events" (Lin Ma, virtual)

Speaker: Lin Ma, CICERO, Norway

Topic: Towards a better understanding of the economic cost of compound events

This work is part of the EU project MYRIAD-EU which aims at catalyzing a paradigm shift in how risks are currently assessed and managed. Instead of addressing risks and hazards one by one, MYRIAD-EU is working on multi-hazard, multi-sector, and systemic risk management. This project is built around 5 pilots: in the North Sea, on the Canary Islands, in Scandinavia, the Danube region, and in Italy's Veneto region. These pilots are central to MYRIAD-EU as they serve as laboratories for systemic multi-hazard risk assessment and management. Each pilot focuses on the connections between different risks and at least 3 economic sectors.

In this presentation, we focus on the Scandinavian pilot study, where we analyze the interlinkages between compound events including heat stress, droughts, and wildfires for 3 sectors: agriculture, forestry, and energy. We take the example of an existing compound event, which happened in 2018 and had major impacts in Scandinavia. The goal is to better understand the economic cost of such an event, as well as the direct and indirect risks for each sector.

In this analysis, we utilize empirical data on climate and sectoral outputs to investigate the relationship between compound events and physical impacts in the agriculture, forestry, and energy sectors. Additionally, a global computable general equilibrium (CGE) model, GRACE (Global Responses to Anthropogenic Changes in the Environment), is used to assess the economic impact of multi-hazards. The GRACE model not only describes the interactions among producers and between producers and consumers in the domestic region but also considers the interactions between local and global economies through international trade.

Our analysis evaluates the direct and indirect economic impacts of compound events in the spring and summer of 2018 and finds that the agriculture, forestry, and electricity sectors experienced negative implications due to the direct effects of heat. We also show that these events had a moderate impact on GDP, but with a considerable indirect negative impact on the domestic refined oil sector because of the disturbances in energy inputs in the production process.

Last but not least, our results indicate considerable cross-border effects on the trade pattern of forestry goods, as the Scandinavian region plays a vital role in the global trade of forestry goods. This result emphasizes the importance of including the ripple impacts of cross-border trade when analyzing the impacts of compound events in the Scandinavia region.

Tessellated border-independent exposure analysis for operational climate and disaster risk preparedness applications" (Piero Campalani)

Speaker: Piero Campalani, Eurac Research - Center for Climate Change and Transformation, Italy

Topic: Tessellated border-independent exposure analysis for operational climate and disaster risk preparedness applications

Currently available risk preparedness and prevention tools are increasingly lagging behind the growing threat of climate change, with multiple hazards often compounded causing cascaded and intertwined damages to society and the environment. Transborder mountainous areas are especially vulnerable to such threats, given the susceptibility to natural hazards as well as remoteness of some settlements and the related importance of connectivity and accessibility. At the same time mountains have experienced above average warming (Adler et al., 2022) and potentially more climate extremes than other areas. An effective risk management requires transnational collaborative efforts. We hereby propose an integrated approach to risk assessment, based on a homogeneous planar tessellation of hexagonal cells and an innovative dual graph-based simplification, where multiple spatial datasets, such as climate and natural hazard forecasts, exposure datasets and projections, impacts and vulnerability indicators converge. Cell- and edge-based data aggregations at user-defined spatial scales allows to find a balance between the complexity of the model and its computational efficiency for risk-related applications. By keeping a maximum resolution of 250m we ensure a sufficient degree of anonymity of potentially sensitive data at a scale still useful for civil protection risk management purposes.

For an effective assessment of risk, dynamic multi-temporal modelling is critical, in particular for the most volatile exposure component of all: the population. Rooted in the mentioned tessellated spatial support, we propose a border-independent population flow model that estimates dynamic intra-day concentrations of residents, where cell-based attraction coefficients allow for incremental refinements depending on the availability of auxiliary datasets. What-if scenarios for the simulation of changes in the underlying topology (e.g., roads interruptions due to landslides or floods) can be efficiently explored to provide decision support to local authorities. With the aim of fostering the discussion on exposure modelling for complex climate-related events, the hereby proposed system modelling approach can be viewed as an open and flexible platform on top of which additional data sets and processes can be superimposed and plugged-in, enabling higher level applications including quantitative risk analysis and numeric simulations, probabilistic risk assessment, impact forecasting and early warning.

As a preliminary testbed of this platform, in the frame of the EU-co-funded TransAlp project, we generated an exposure model addressing the trans-national area that comprises South Tyrol in Italy, East Tyrol in Austria and the mountain community of Agordino in the Italian Veneto region. Overall the ca. 10'000 [km]² study area was covered with a total of 165'000 hexagons at 250m horizontal spatial resolution. Exposure information covering the cross-border area under consideration sourced from authoritative sources as well as global datasets when necessary were harmonised onto the common tessellation and successfully used to showcase the potential impact of the presented system multi-temporal modelling to the local stakeholders.

Parallel Session 3: Coherence of policy responses to systemic risks

An assessment of the suitability of EU food and trade policy in the context of cross-border climate risks and geopolitical instability" (Joe Simpson)

Speaker: Joe Simpson, SEI-York, England

Topic: An assessment of the suitability of EU food and trade policy in the context of cross-border climate risks and geopolitical instability.

Maintaining secure food supply chains is a high-priority policy goal of the EU. Increasing climate-driven cross border shocks and geopolitical disruptions have created new challenges for the EU. Supply chain disruptions caused by the COVID-19 pandemic and the Russo-Ukrainian war prompted many to reexamine the resilience of their supply chains to shock events occurring outside their national borders. The role of climate change in triggering these shock events is likely to increase in the coming decades.

Additionally, the re-emergence of competition between global powers has catalysed a trend of deglobalisation, or at least stalled globalisation. Nation-states and regional blocs' policy making has pivoted towards increasing domestic production and mapping their import dependencies in strategically important areas, including the food system.

A multitude of public and private supply chain actors operate within the European food system, each with their own interests, vulnerabilities, and desired public policy outcomes. EU food policy must cohere with these supply chain actors, whilst simultaneously promoting the transition towards an environmentally sustainable resilient food system and guaranteeing a supply of affordable food.

This paper combines insights from semi-structured interviews with EU food system stakeholders and an in-depth policy analysis across food, trade, and sustainability policy domains to assess the capacity of current EU policy to respond to climate-driven cross border shocks in this new geopolitical context. Findings indicate that climate-driven cross border shocks are yet to be thoroughly, or adequately, integrated into relevant EU food policy, representing a gap - and potential lack of preparedness - for future cascading climate impacts.

Spanish responses to cross-border climate security risks in the agricultural sector" (Hector Morales Munoz, virtual)

Speaker: Hector Morales Munoz, adelphi, Germany

Topic: Spanish responses to cross-border climate security risks in the agricultural sector

Climate impacts on local farming and food systems are often an inflexion point before subsequent risks materialise that can cascade across sectors (locally) and borders (internationally). The paper discusses the Spanish government's efforts to support climate adaptation at the origin of agri-food systems in countries outside of Europe considered critical to Spanish foreign policy and development cooperation and the resources it has mobilised to achieve this goal. It examines Spain's challenges in balancing its objectives in other outward-facing sectors with its support for climate adaptation. The research draws on various sources, including strategy documents from relevant Spanish ministries and the Spanish Agency for International Cooperation, OECD data on Spanish ODA commitments, secondary literature, and semi-structured interviews with stakeholders from government, civil society, and academia. Overall, the paper highlights the need for Spain to enhance its capacities within AECID and other institutions to understand the cross-border impacts of climate change better and build effective climate adaptation responses in collaboration with stakeholders and sectors. The analysis reveals that while Spain's development cooperation strategy prioritises the coordination of sectors and the mainstreaming of climate change, its climate change strategy documents are outdated, and it has yet to develop a specific ODA strategy that integrates system-wide climate adaptation to the cross-border impacts of climate change on agri-food systems. Nonetheless, lessons from Spanish development cooperation experiences in Latin America can inform a coherent strategy to support the domestic adaptation of actors in the MENA

Evaluation of EU policy responses to cross-border impacts originating in the Arctic, towards advancing adaptation to climate change. (Claire Mosoni, virtual)

Speaker: Claire Mosoni, Finnish Environment Institute (Syke), Finland

Topic: Evaluation of EU policy responses to cross-border impacts originating in the Arctic, towards advancing adaptation to climate change

Climate change is increasingly affecting the Arctic with observed warming rates nearly four times as fast as the global average. Impacts include increasing loss of sea-ice, higher risks of wildfires, changes in fauna and flora, permafrost thaw and melting of glacial ice, the Greenland ice sheet in particular.

The biophysical impacts have societal consequences. Locally, changes in the Arctic environment threaten traditional livelihoods. Permafrost thaw and extreme weather events create risks for infrastructure and transport. Elsewhere in the world, including the European Union (EU), sea level rise affects many coastal cities and communities. Finally, melting of ice and the opening of formerly frozen sea areas create economic opportunities in the Arctic, that raise international interest while posing new risks for the fragile Arctic environment.

An important feature of climate change impacts in the Arctic is their likelihood to cascade and cross borders, creating risks and opportunities for countries and actors outside the initial region of impact. Therefore, adaptation responses become a challenge for policies, with interactions at local, national, and international level and across different policy domains. Moreover, policy responses confront a trade-off between a politically expressed wish to protect the Arctic, and a desire to take advantage of the new economic opportunities.

No multilateral agreement exists on common policies between the many states governing the Arctic. However, the Arctic Council provides a forum for cooperation between Arctic states, indigenous peoples, non-Arctic states, intergovernmental, Parliamentary, and non-governmental organisations. Despite being an important funder of Arctic research and innovation activities, the EU lacks a formal observer status in the Council though representatives of the European Commission may participate in meetings. The EU has an interest in Arctic affairs, as shown by several policy initiatives, and the EU is also a recipient region of climate change impacts that originate in the Arctic.

The aim of this paper is to evaluate EU policy responses to cross-border climate impacts originating in the Arctic. This requires an analysis of interactions, synergies, trade-offs and potential conflicts between policy domains and relevant actors. Our analysis is based on examining policy integration and coherence to address the following questions: how is integration and coherence reflected in the EU's efforts to respond to cross-border impacts originating in the Arctic? What is the influence of non-climatic events in responding to risks from the Arctic and what could be done to improve adaptation policy in the future?

We draw upon data from a thorough policy document analysis, and expert interviews with Arctic officials, representatives of different communities, ministries and the EU conducted in 2022-2023. Preliminary results show EU policies to be relatively coherent with one another, but challenges arising from the economic opportunities provided by climate change have largely been neglected in EU adaptation policy. This contributes to tensions between the EU's objectives for the Arctic and local needs in the face of climate change. The Russian illegal invasion of Ukraine has furthermore shown that non-climatic events outside the Arctic can change conditions for overall policy coherence in Arctic policies.

Analysing coherence and integration in policies for adapting to cross-border impacts of climate change" (Paula Kivimaa and Mikael Hilden)

Speaker: Paula Kivimaa, Finnish Environment Institute, Finland & Mikael Hilden, Finnish Environment Institute, Finland

Topic: Analysing coherence and integration in policies for adapting to cross-border impacts of climate change

The impacts of climate change materialise in different ways and are of varying magnitudes at different locations around the world. Adaptation is increasingly a global policy challenge because impacts of climate change can also propagate across borders. The presence of borders influences the policy responses that may aim at preventing, alleviating, or exploiting the impacts. Yet the dynamics of response to cross-border impacts have not been explored in research on policy coherence. Here we extend the analysis of climate policy coherence and integration to cover adaptation policies that are enacted at different but interacting geographical locations – proposing a conceptual approach of how to do this. We illustrate our approach with examples of European Union (EU) policies and the cross-border impacts of climate change in the Arctic. Our example highlights interconnections between climate change adaptation policy with foreign, security and trade policies. When climate change impacts are transmitted through systems that cross borders, it is important to recognise the links between policy domains with potential significance in responding to these cascading impacts. Borders create constraints on the policy responses that a recipient region at risk of such impacts can undertake. By explicitly recognising elements of integration and coherence, more effective policy actions can be developed. Seeking coherence between climate and other policies between different regions, intertwined together via global networks of trade and other relations, should

Integration and coherence of climate change adaptation policy with EU finance and trade policies" (Samuli Pitzén and Mikael Hilden)

Speaker: Samuli Pitzén, Finnish Environment Institute SYKE, Finland & Mikael Hilden, Finnish Environment Institute SYKE, Finland

Topic: Integration and coherence of climate change adaptation policy with EU finance and trade policies

The need to adapt to the effects of climate change has been recognised for decades. However, research has pinpointed challenges in its implementation. One of these are the various cascading effects of climate change that may travel across geographical regions via, for example, the domains of international trade and finance. In this article, we apply a cross-border perspective to the assessment of adaptation policy integration and coherence to gain an understanding how policy actors of trade and finance domains identify adaptation needs. Our findings suggest there has been progress at the general policy level and informal coordination between domains, whereas formalised measures promoting integration and coherence are yet emerging. Moreover, we find that managing the cross-border impacts of climate change and adapting to them is demanding for at least the following reasons: 1) The relevant impact transmission systems are wide and interconnected and, thereby, often extend beyond the mandate and field of competence that any single organisation has, 2) the impacts of climate change are varied and complex, 3) the policy responses need to be adaptive, multifaceted, and tailored, which requires a detailed understanding of the impact transmission system and also of the interconnectedness of the response system, and 4) climate change adaptation policy is not yet fully established as a visible recognised policy element within trade and finance policies, which means that resources and knowledge for developing skills and practices are insufficient. Given that these challenges are likely too difficult for many actors to respond to, and the rapid advancement of climate change, there is a need for quick progress that is supported by high-level political commitment.

Coherence of climate change policy" (Sayouba Ouedraogo)

Speaker: Sayouba Ouedraogo, University Thomas SANKARA, Burkina Faso

Topic: Coherence of climate change policy

Adaptation to climate change is no longer a choice, but a compulsory and unavoidable option in the quest for sustainable development. This is why a national climate change adaptation plan is being implemented. The process requires the inclusive and effective involvement of all relevant actors to address the root causes of climate change. It is better to take into account the "side effects" of internal and external, non-development assistance policies in climate change. Climate change policy is coherent its was not contradictory with international development and national goals. The coherence may also mean the presence of synergies between these policies and the economic growth/transformation and poverty reduction strategies of developing countries and security. However, governments have encountered political, institutional, and also technical difficulties in implementing climate change. Because of the lack of empirical knowledge about the collateral impacts of policies on economies and societies, in specific contexts and for specific dimensions of economic and human development, and security. So far, most studies on policy coherence for development approaches have generally been confined to institutional arrangements, policy measures, or the effects of sectorial policies individually at more or less aggregate levels. In the area of security, little information is available on the actual effects of policies on households. Besides the technical aspect, an important characteristic is the participation of multiple stakeholders, from both Burkina Faso and partner countries. The assessments for the methodology of climate change policy coherence for development will provide guidance for interested stakeholders in other developing countries/regions. The objective is to outline a methodology for assessing policy coherence for climate change and, more generally, for development, and to promote multi-stakeholder dialogue on this issue with different types of actors, from the public and private sectors, from developed like OCDE and developing countries.

Through a documentary, analytical and pragmatic review, it emerges that the climate change adaptation policy coherence provides knowledge to national governments, regional institutions, and other stakeholders to help them formulate policies better adapted to the constraints of the international context.

Parallel Session 3: Trade, supply and value chains

Stakeholder perspectives on cross-border climate risks in the Brazil-Europe soy supply chain" (Emilie Stokeld)

Speaker: Emilie Stokeld, Stockholm Environment Institute York, England

Topic: Stakeholder perspectives on cross-border climate risks in the Brazil-Europe soy supply chain

In a case study of the Brazil-Europe soy supply chain, our paper aims to explore how stakeholders perceive past and future shocks, how climate change impacts may affect stakeholders differently, and how they might respond. Soy is a key internationally traded commodity and Europe relies on imports for the majority of its soy consumption, used widely in livestock feed. Via 96 semi-structured expert interviews, we found different stakeholder groups are vulnerable to different types of weather shocks, experience different price and supply consequences, and have different capacities to respond. While some responses can reduce risk of impacts across the supply chain (e.g. new soy cultivars, improving transport infrastructure), we also identified examples where responses exacerbate risk for other stakeholders (e.g. export bans, changing demand). A holistic cross-border approach to analysing risk in the soy supply chain can help avoid maladaptation and offer opportunities for more collaborative adaptation.

A novel methodology to assess crop-specific climate risks: A cross-border case study of agri-food trade between Turkey and the EU" (Tijmen Schults)

Speaker: Tijmen Schults, FutureWater, Netherlands

Topic: A novel methodology to assess crop-specific climate risks: A cross-border case study of agri-food trade between Turkey and the EU

Climate change-induced extreme weather events adversely impact agriculture and food production worldwide. Historically, climate risk and impact assessments of food systems have mostly focused on production within a specific geographic location. However, food systems and agricultural value chains extend beyond country borders as regions of imports and exports are connected through international trade. This study presents a novel methodology to enhance climate change risk studies for food systems, by focusing on crop-specific climate hazards and connecting derived climate risks to cross-border trade implications. The climate risk assessment takes into account crop-specific climate hazards, by incorporating stress thresholds and growing requirements that affect the agricultural productivity of the crop of interest. Spatially explicit climate hazard indicators were produced from the global daily downscaled climate projections of the NEX-GDDP-CMIP6 dataset of NASA. The relative change in the frequency of climatic stresses (e.g., heat stress, cold stress, and humidity stress) was assessed between a historical reference period (1990-2020) and two Shared Socioeconomic Pathways (SSP2-4.5 and SSP5-8.5) for the 2030-2060 time horizon. Furthermore, datasets related to climate change vulnerability and exposure, both socio-economic and physical-geographical, were integrated to derive crop-specific climate risks for each district of Turkey for the two considered climate change scenarios.

This methodology was applied to agri-food trade between Turkey and the EU, focusing on the key crop value chains of apricots, figs, grapes, and hazelnuts. The results of the climate risk assessment of these crops were connected to current trade and policies in place between the EU and Turkey. The climate risk approach presented in this study highlights the spatial distribution of crop-specific climate risks for production within Turkey and provides insights into the implications of climate change on agri-food trade in the aforementioned crops. The outcomes of this study will be used to increase awareness of the risks posed by climate change to the agri-food trade and the broader economy. Enhanced risk information may enrich existing and recommend new policies to reduce climate risk for food value chains.

Cascading impacts in the Russia- Ukraine war" (Cornelia Auer)

Speaker: Cornelia Auer, PIK Potsdam, Germany

Topic: Cascading impacts in the Russia- Ukraine war

Conflict among major economic players can lead to heavy disruptions of global trade and supply cascading into vital systems like economy, finance and food. In our presentation we take the crisis between Russia and Ukraine as basis of potential scenarios that can emerge due to their position as main exporters of global energy and food trade. Based on the scenarios this setup allows to assess extremes and quantify potential risks from a macroeconomic, financial but also household perspective. The unprecedented approach of connecting a macro-economic Computable General Equilibrium model named ICES with a financial overreaction model overcomes the limitations of prior approaches and allows to assess the short term macroeconomic shocks and compare them to the effect of instantaneous shocks on daily market fluctuations. The ICES model analyses as a general equilibrium model the impact of potential trade and supply disruptions on macroeconomic quantities (e.g. GDP, prices, sector output), whereas the financial overreaction model provides insight on the effect of changes in market expectations on future and spot markets, on prices and consequently on financial portfolio performance. The general equilibrium model reflects effects over a one year time horizon where supply adjustments and abatement (e.g. through negotiations) can take place. The excess reaction model allows it to capture to the potential extent of an instantaneous shock without abatement. For the two types of shock - short term and instantaneous - both models provide insight into sectoral or regional effects in their respective quantities. Especially interesting is the dimension of the effect on food price inflation in the two respective shocks, which we apply to a food affordability model that shows how strong the impact of the two diverges for private households. We deduce the inflation effects on food prices from both shocks and assess the affordability of two types of diets, a calorie sufficient diet and a healthy diet, with respect to different income levels of individual households.

Climate storyline approach for cross-border climate change risks in agri-food trade: case study of cacao" (Ertug Ercin)

Speaker: Ertug Ercin, R2Water Research and Consultancy, Netherlands

Topic: Climate storyline approach for cross-border climate change risks in agri-food trade: case study of cacao

The European Union (EU) is the global leader in chocolate production, consumption, and export, heavily relying on cacao supplies from Ivory Coast and Ghana, the two largest cocoa producers in the world, which supply over 60% of EU imports. Climate change is expected to have negative impacts on cacao production in these West African countries, which could lead to significant economic consequences for the EU. To model these impacts, this study used a storyline approach that analyzed changes to trade volume and cocoa prices under different climate change scenarios. This approach aims to simplify and communicate the complex and interconnected issues related to climate change, inspiring a deeper understanding of the need for action. The approach focuses on a coherent narrative about past or potential future climate-related events that are consistent with the realities of climate change.

The analysis considered two climate change scenarios, two EU import policies, and the possibility of sourcing cacao from other regions in the event of climate shocks in the main production areas. The results showed that cacao supply to the EU would decrease due to climate change, resulting in higher commodity prices. The study estimated that cacao supply would decrease by an average of 8% in the future and up to 26% in an extreme year under both RCP2.6 and RCP8.5 scenarios. By 2050, the EU is expected to pay an additional 2.5 billion euros per year for cacao, and up to 16 billion euros in an extreme year under RCP8.5.

The study also found that EU policies, such as the prohibition of cacao imports produced on deforested land, could impact the price and availability of cacao supply in the future. If the EU implements such a policy, it would pay an additional three billion euros per year by 2050, on top of the costs incurred due to climate impacts, and this additional cost could rise to 4.5 billion euros in an extreme drought year. Moreover, such a policy could lead to sudden shortages of up to 20% in the EU's cacao supply by 2050 in an extreme year.

Impacts of climate change on global food trade networks" (Johanna Hedlund, virtual)

Speaker: Johanna Hedlund, Stanford University, United States

Topic: Impacts of climate change on global food trade networks

Countries' reliance on global food trade networks implies that regionally different climate change impacts on crop yields will be transmitted across borders. This redistribution constitutes a significant challenge for climate adaptation planning and may affect how countries engage in cooperative action.

We present a paper investigating the long-term (2070–2099) potential impacts of climate change on global food trade networks of three key crops: wheat, rice and maize. We propose a simple network model to project how climate change impacts on crop yields may be translated into changes in trade. Combining trade and climate impact data, our analysis proceeds in three steps. First, we use network community detection to analyse how the concentration of global production in present-day trade communities may become disrupted with climate change impacts. Second, we study how countries may change their network position following climate change impacts. Third, we study the total climate-induced change in production plus import within trade communities. Results indicate that the stability of food trade network structures compared to today differs between crops, and that countries' maize trade is least stable under climate change impacts. Results also project that threats to global food security may depend on production change in a few major global producers, and whether trade communities can balance production and import loss in some vulnerable countries.

Overall, our model contributes a baseline analysis of cross-border climate impacts on food trade networks. We end by describing new research aiming to extend the current analysis through the addition of extreme event data, giving a fuller picture of climate-induced triggers of global disruption.

Poster Session 2

Framework of climate risks in the context of business activities” (Monika Sadkowska)

Poster presenter: Monika Sadkowska, Deloitte CE, Poland

Topic: Framework of climate risks in the context of business activities

Companies are facing increasing pressure to report on ESG (environmental, social and governance) matters and climate risks driven by strong pressure from regulators, financial institutions with a public mandate, banks, insurance companies, rating agencies and shareholder activism. Voluntary disclosure recommendations like the Task Force for Climate-Related Financial Disclosures (TCFD) underpinned the new mandatory disclosure standards worldwide. The examination carried out on 134 companies listed on the Polish Warsaw Stock Exchange studied the way the process of analysing and assessing climate risks is reported, as well as the transparency of the process description. There were noticeable gaps between reporting practices and the risk assessment process carried out and between the degree of disclosure of climate risks in the financial sector and the real economy, indicating the difficulties companies face in identifying and assessing climate risks.

Destination Earth Digital Twins as tools for adapting to climate change” (Jörn Hoffmann)

Poster presenter: Jörn Hoffmann, European Centre for Medium-Range Weather Forecast (ECMWF), Germany

Topic: Destination Earth Digital Twins as tools for adapting to climate change

With its Destination Earth initiative (DestinE) the European Commission aims developing a digital model of the Earth System that will simulate and predict the interaction between natural phenomena and human activities. Development has started with setting up Earth System Digital Twins on Climate Change Adaptation and weather-induced extremes, investing into improving the realism and accuracy of physical models and setting up an infrastructure to run coupled Earth System and impact sector models. These Digital Twins can be viewed as tools to understand implications of different adaptation choices and thus support corresponding decisions to minimize risks and/or cost.

An initial set of use cases is being implemented to demonstrate how DestinE can create value for selected applications and users, including in domains of energy systems, urban heat/health, flood risk, and others. Use cases form a principle way of co-designing DestinE as a system that can support decision-making at local level.

The representation of climate change social impacts in Integrated Assessment Models: a systematic literature review” (Paola López-Muñoz)

Poster presenter: Paola López-Muñoz, University of Valladolid, Spain

Topic: The representation of climate change social impacts in Integrated Assessment Models: a systematic literature review

Integrated Assessment Models (IAMs) are typically used to evaluate and guide sustainability policy action, but they usually focus on greenhouse gases mitigation policies rather than quantifying climate change impacts. Among those IAMs that include climate change socioeconomic damages, there are some names that always stand out, such as DICE, FUND or PAGE. These cost-benefit IAMs have been widely criticized for the lack of theoretical and empirical foundations in the development of the damage functions, as well as for focusing on aggregated economic production losses by leaving out other market and non-market impacts. In this study, we conduct a systematic literature review and meta-analysis on the representation of climate change social impacts in integrated assessment models. To conceptualise what we mean with climate change social impacts, we carry out a narrative review of conceptual frameworks of wellbeing, social impact assessments and human needs. After, based on the previous frameworks and classifications identified, we conduct a systematic search on the representation of climate change social impacts, with a focus on human health (mortality and morbidity) and place (migrations and culture) in IAMs. We then generate a database of 37 integrated models and characterise them by methods, categories, hazards, affected variables and regional scale used. We also assess how they represent inequality if they do. We finish our study with key recommendations to enhance the representation of climate change social impacts and we conclude the importance of embracing novel integrated modelling approaches that represent human dimensions of climate change in a more realistic manner.

Transnational adaptation governance: A global lens for coherent approaches to formal and informal adaptation“ (Adis Dzebo)

Poster presenter: Adis Dzebo, SEI, Sweden

Topic: Transnational adaptation governance: A global lens for coherent approaches to formal and informal adaptation

In front of these challenges, the international community, led by the UN System and the European Union as the largest donor of the region, proposes the implementation of the Humanitarian-Development-Peace (HDP) nexus. At the centre of strengthening the coherence between HDP efforts, is the aim of effectively reducing people’s needs, risks and vulnerabilities, supporting prevention efforts and thus, shifting from delivering humanitarian assistance to ending need. (OECD/LEGAL/5019). Therefore, this nexus approach is meant to build adaptation options for long-term resilience in these strategic countries.

Do you know what I know?: Understanding risk through collective introspection” (Theresa Audrey Esteban)

Poster presenter: Theresa Audrey Esteban, TU Delft, Netherlands

Topic: Do you know what I know?: Understanding risk through collective introspection

Risk perception research has been used in flood risk management, environmental policies and programs, and the assessment of environmental attitudes and biases. Survey methods are frequently used in risk perception studies to assess a large population's perception of specific risks such as natural hazards. Others prefer focus group discussions and key informant interviews to target the study's specific risks. While these methods have yielded significant results in understanding a population's perception of the existence or non-existence of risks, as well as the personal effect or lack thereof on the target participants, these targeted risk perception studies have pre-determined risks outlined at their disposal that may condition the participants' thinking. In the City of Rotterdam, The Netherlands, six climate-related threats have been identified by the city that affects the current and future infrastructure and housing development in the city. This include extreme rainfall, flooding, soil subsidence, groundwater level decrease/increase, heat and drought, which affect many of the old houses built on poles because any drop in groundwater and increase in heat and drought weaken these wooden poles. In addition to these threats, the national government is under pressure to build at least 850,000 housing units by 2030 in order to meet current housing demand. Using a speculative design method that allows community participants to think of their own situations the study will explore what for them are existing and future risks, how they cope, and what they aspire to address the perceived existing and future risks. In this way, we will be able to identify interconnections or gaps in a community's risk perception in relation to government policy documents that have identified risks in the communities where participants live. In this study, I hope to find answers to the following questions: What are the current and perceived risks in communities both outside and inside the dike? What environmental and infrastructure changes are taking place in their communities? What effects do these changes have on the participants? And how do they intend to address perceived current and future risks?

Parallel Session 4: Modelling complex dynamics in social/ economic systems

Modelling uncertain economic impacts of climate change under a multi-regional and multi-sectoral bottom-up perspective" (Paola López-Muñoz)

Speaker: Paola López-Muñoz, University of Valladolid, Spain

Topic: Modelling uncertain economic impacts of climate change under a multi-regional and multi-sectoral bottom-up perspective

Integrated Assessment Models (IAMs) have been widely criticized for their failure to provide a solid representation of climate change economic damage with which to evaluate mitigation and adaptation policies. Here, we develop a novel stochastic methodology to estimate multi-regional and multi-sectoral monetary impacts from heat-related extreme weather events (heatwaves, droughts, and wildfires) on capital stock and test it in the under-development Integrated Assessment Model WILIAM. The economic module of WILIAM is characterized by many feedback loops and interrelationships. It is based on system dynamics and has an Input-Output table at its core, allowing to account for direct and indirect economic impacts of climate change. The damage functions estimated have been programmed through an algorithm that allows to select the functional form that better fits the data, considering different lineal and quadratic functions for each hazard-sector-region-uncertainty scenario combination. Preliminary results show that the model captures the complex causal economic chain of damages: just accounting for capital stock damages can already have substantial macroeconomic impacts. Under a business-as-usual scenario, the model shows high heterogeneities between sectors and regions as well as spreading of the impacts to regions that initially suffered little damage. Also, we obtain high heterogeneities depending on the uncertainty scenario, which reinforce the importance of considering non-deterministic impacts when analysing climate damages. We conclude that improvements in the representation of economic damages in IAMs is urgent, since even although our research only considers some impacts on capital and not all the possible effects on the economy, the most pessimistic scenario reports much more GDP loss than other widely used IAMs.

Understanding the dynamics of recurrent floods in the Philippines" (Inga Sauer)

Speaker: Inga Sauer, Potsdam Institute for Climate Impact Research, Germany

Topic: Understanding the dynamics of recurrent floods in the Philippines

Extreme weather events cause both short- and long-term impacts. Therefore, direct damages are only the tip of the iceberg since the adverse long-term impacts on the well-being of affected people may be much larger. Successful recoveries in the aftermath of extreme weather events are critical to avoid long-term poverty implications. However, in disaster prone areas there may not always be enough time to recover in-between recurrent extreme events, so households are likely to be affected again within their recovery period. On the one hand, there is a common narrative that incomplete recoveries caused by recurrent extremes aggravate socio-economic impacts. On the other hand, there may also be counteracting mechanisms where a cluster of events leads to less destruction than a series of well-separated events because assets that were already destroyed by a first event, cannot be destroyed again by a second event following shortly afterwards. To develop a systematic quantitative understanding for the interplay of these different mechanisms, we extend an agent-based household model to recurrent floods. We calibrate the model to the Philippines and drive it with a novel data-set of flooded areas based on satellite imagery to assess the poverty implications of recurrent floods for different income groups of households, nationally and regionally. We find that incomplete recoveries increase cumulative consumption and well-being losses across the study period 2000-2018 by 50%. While low-income households suffer the highest absolute well-being losses independent of the event frequency, lower-middle income households experience the largest additional increase in well-being (240%) and consumption losses (120%) due to incomplete recoveries. Our results underline that the impacts of recurrent extreme weather events on households are not additive as disaster resilience of households decreases under recurrent events. In consequence, the well-being and consumption losses can be critically underestimated when concluding from the poverty implications of an individual event on the implications of recurrent events, as usually done in conventional disaster risk management. Thus, to better prepare societies for an intensification of recurrent weather events under global warming, incomplete recoveries need to be considered in risk management strategies.

Archetypes of cascading climate change impacts" (Cornelia Auer)

Speaker: Cornelia Auer, PIK Potsdam, Germany

Topic: Archetypes of cascading climate change impacts

Conflict among major economic players can lead to heavy disruptions of global trade and supply cascading into vital systems like economy, finance and food. In our presentation we take the crisis between Russia and Ukraine as the basis of potential scenarios that can emerge due to their position as main exporters of global energy and food trade. Based on the scenarios this setup allows to assess extremes and quantify potential risks from a macroeconomic, financial but also household perspective. The unprecedented approach of connecting a macro-economic Computable General Equilibrium model named ICES with a financial overreaction model overcomes the limitations of prior approaches and allows to assess the short term macroeconomic shocks and compare them to the effect of instantaneous shocks on daily market fluctuations. The ICES model analyses as a general equilibrium model the impact of potential trade and supply disruptions on macroeconomic quantities (e.g. GDP, prices, sector output), whereas the financial overreaction model provides insight on the effect of changes in market expectations on future and spot markets, on prices and consequently on financial portfolio performance. The general equilibrium model reflects effects over a one year time horizon where supply adjustments and abatement (e.g. through negotiations) can take place. The excess reaction model allows it to capture to the potential extent of an instantaneous shock without abatement. For the two types of shock - short term and instantaneous - both models provide insight into sectoral or regional effects in their respective quantities. Especially interesting is the dimension of the effect on food price inflation in the two respective shocks, which we apply to a food affordability model that shows how strong the impact of the two diverges for private households. We deduce the inflation effects on food prices from both shocks and assess the affordability of two types of diets, a calorie sufficient diet and a healthy diet, with respect to different income levels of individual households.

The resource (in)sufficiency of the Caribbean: Analyzing Socio-metabolic Risks (SMR) of Water, Energy, and Food" (Francisco Xavier Felix Martin del Campo, virtual)

Speaker: Francisco Xavier Felix Martin del Campo, École Polytechnique Fédérale de Lausanne (EPFL), Laboratory for Human-Environment Relations in Urban Systems (HERUS), Switzerland

Topic: The resource (in)sufficiency of the Caribbean: Analysing Socio-metabolic Risks (SMR) of Water, Energy, and Food

Socio-metabolic risks (SMRs) are systemic risks associated with the availability of critical resources, the integrity of material circulation, and the distribution of their costs and benefits in a socio-ecological system. For resource-stressed systems like small island nations, understanding trade-offs and synergies between critical resources is not only crucial, but urgent. Climate change is already putting small islands at high risk through more frequent and intense extreme weather events, changing precipitation patterns, and threats of inundation with future sea-level rise. This study compares the shifting resource-baseline for 14 Caribbean island nations for the year 2000 and 2017. We analyse water, energy, and food (WEF) and their nexus through the lens of SMRs, using indicators related to their availability, access, consumption, and self-sufficiency. Our findings point to the decreasing availability of all three resources within the Caribbean region. Meanwhile, between 2000 and 2017, consumption levels have increased by 20% with respect to water (from 230 to 275 m³/cap/yr) and primary energy (from 89 to 110 GJ/cap/yr), and 5% for food (from 2,570 to 2,700 kcal/cap/day). While universal access to these resources increased in the population, food and energy self-sufficiency of the region has declined. Current patterns of resource-use, combined with maladaptive practices, and climate insensitive development – such as coastal squeeze, centralised energy systems, and trade policies - magnify islands' vulnerability. Disturbances, such as climate-induced extreme events, environmental changes, financial crises, or overexploitation of local resources, could lead to cascading dysfunction and eventual breakdown of the biophysical basis of island systems. This research is a first attempt at operationalizing the concept of SMRs, and offers a deeper understanding of risk-related resource dynamics on small islands, and highlights the urgency for policy response.

Parallel Session 4: Climate physical risks and the financial system

Increasing countries' financial resilience through global catastrophe risk pooling" (Alessio Ciullo, virtual)

Speaker: Alessio Ciullo, ETH Zürich, Switzerland

Topic: Increasing countries' financial resilience through global catastrophe risk pooling

Extreme weather events can severely impact national economies, leading the recovery of low- to middle-income countries to become reliant on foreign financial aid, which is however slow and uncertain. Therefore, the Sendai Framework and the Paris Agreement advocate for more resilient financial instruments like sovereign catastrophe risk pools. These are financial instruments that exploit risk diversification to provide more affordable insurance policies and thus increase the financial resilience of the pools' members. Existing sovereign catastrophe risk pools – however - might not fully use their financial resilience potential because they were not designed to maximise risk diversification and because they pool risk only regionally. In this talk, we will first introduce a method to find the optimal sovereign risk pool, namely the smallest subgroup of countries - within a given group - having the group's highest achievable risk diversification. Then, we will apply the method to assess the benefits of global pooling compared to regional pooling. It is found that - in general - global pooling 1) always provides a higher risk diversification, 2) better distributes countries' risk shares in the pool's risk and 3) increases the number of countries profiting from risk pooling. Furthermore, optimal global pooling could provide a diversification increase to existing pools of up to 65 %.

Differential Fiscal Performances of Plausible Disaster Events: A storyline approach for the Central American and Caribbean Governments under CCRIF" (Stefan Hochrainer-Stigler)

Speaker: Stefan Hochrainer-Stigler, IIASA-International Institute for Applied Systems Analysis, Austria

Topic: Differential Fiscal Performances of Plausible Disaster Events: A storyline approach for the Central American and Caribbean Governments under CCRIF

While considerable attention has been given in the past to the direct damages caused by natural hazards, indirect impacts, i.e., losses that occur due to direct damages, and the management of it, are gaining increasing attention. Going from direct risk management of natural disaster events to the management of indirect risks also enables an analysis of disaster events from a development perspective. Focusing on the Caribbean region and on the fiscal performance of governments after disaster events, we empirically analyse the effectiveness of the Caribbean Catastrophe Risk Insurance Facility (CCRIF) regarding the reduction of indirect fiscal effects. We embed this analysis within a novel climate impact storyline approach where we produce past plausible events and investigate the usefulness of insurance under such events. Changes in risk due to global and climate changes were looked at for addressing the issue of whether the CCRIF is fit for purpose under changing conditions. We found that both hurricane strikes and the CCRIF affect fiscal outcomes of Caribbean countries. Furthermore, CCRIF can significantly counteract the negative fiscal consequences induced by the disaster. Our analysis sheds some light on the current discussions on how development related assistance can be structured to enhance climate resilience in highly exposed countries for both direct and indirect impacts of disasters.

Smart-Support Governments in Global South to Address Physical and Financial Risks of Infrastructure induced by Climate Change" (Qinhan Zhu)

Speaker: Qinhan Zhu, IIASA, Austria

Topic: Smart-Support Governments in the Global South to Address Physical and Financial Risks of Infrastructure induced by Climate Change.

Fiscal stress induced by climate hazards is vital for governments of the Global South. In the aftermath of disaster, the loss of revenues, higher demand of expenditure, and the potential rise in debt are among the undesirable fiscal impacts on these governments. Furthermore, these shocks impose more pressure on the debt sustainability of the government, which would result in degraded credit rating and hence constrained access to the international capital market. The failure to address these impacts are concluded as two major action gaps: the adaptation gap to reduce physical damages, and the protection gap for transferring climate risk with the assistance of financial tools.

To assess and respond to these gaps, we take Madagascar as the case study. Three questions are answered in the project: what is the direct physical risk of climate hazards in Madagascar, the fiscal stresses of these hazards, and the multi-benefit of introducing integratively the Climate Disaster Reduction Measures (CDRM) and Climate Disaster Risk Finance and Insurances (CDRFI) tools, which we call Smart Support.

Two hazards were examined in the project: tropical cyclones and coastal flood. We used the catastrophe model CLIMADA to study these two disaster risks under current and future climate scenarios in Madagascar. Both general and public assets were looked at. We then feed the calculated exceedance frequency curve into the fiscal model we developed. The model simulates the governmental decision process, where policy makers maximise GDP growth and limit volatility of growth rate while subjected to an upper bound of debt to GDP ratio. Throughout this process, we examined different policy combinations of various CDRM and CDRFI options. The investment cost on these measures are reflected in the governmental expenditure terms, while the benefits could be observed as either averted damages, or extra revenue gains in the time of disaster.

The project illuminates the significance of Smart Support in enhancing fiscal resilience in the Global South. It suggests that higher fiscal resilience not only benefits the debt sustainability, but also facilitates the governments of the Global South with lower interest rates and larger access to the international capital market. This enables them to further invest in more extensive CDRM and CDRFI measures.

Exploring the efficient frontier in physical risk reporting" (David N. Bresch)

Speaker: David N. Bresch, ETH Zurich, Switzerland

Topic: Exploring the efficient frontier in physical risk reporting

An increasing number of countries request large companies to disclose their physical climate-related risks based on regulations inspired by work of the Task Force for Climate-related Financial Disclosure (TCFD). Current reports do not lend themselves to direct comparison of physical risks across companies and by no means allow investors to build a portfolio optimised with respect to physical risks. Methods such as event-based probabilistic natural catastrophe risk assessment exist and would allow for aggregation of pertinent information, taking into account global diversification of risk. Convergence of TCFD-reporting towards such methods would enable investors and financial intermediaries to construct portfolios with respect to an efficient frontier in terms of physical risks. In the true spirit of TCFD, this would allocate capital towards companies best positioned to cope with the impacts of climate change and hence incentivise economic actors to strategically embrace climate adaptation. We present a fully transparent and easily replicable open-source and -access approach to construct such an efficient frontier and will discuss resulting risk-reward profiles and implications for corporate strategy development in the context of climate change.

How vulnerable is Europe to severe climate-related disasters abroad? Integrating CGE and natural disaster models” (Jan Brusselaers)

Speaker: Jan Brusselaers, Vrije Universiteit, Amsterdam, Netherlands

Topic: How vulnerable is Europe to severe climate-related disasters abroad? Integrating CGE and disaster models

The European economy and financial markets are closely connected to the rest of the world through trade and investment flows. These linkages allow severe disasters abroad to generate spill-over effects on Europe, especially under the increasing climate risks. This paper contributes to the thin literature on the cross-border financial and economic impacts of disasters by presenting an innovative methodology which links disaster models – calculating the direct losses from disasters – to CGE models – calculating the financial and economic spillover of the disasters. This combination of models assesses different scenarios, developed by applying the recently introduced climate storyline approach. Specifically, we estimate the economic damages of downward counterfactuals of tropical cyclones in the United States, China, and Japan in 2017 to 2019. In the storyline approach, downward counterfactuals are plausible alternative realisations of historic events that are much more impactful than the actual event. These downward counterfactuals are then projected to the future under two alternative scenarios: one with moderate climate change and meeting the Paris Agreement targets, and the other with no acceleration of current mitigation policies. The results show material effects on the European economy, with marked differences between economic sectors, scenarios, and the short and long run. In addition, the net impact on the European financial market is the result of the positive impact arising from higher valuation of remaining capital goods and investment opportunities on the one hand and the negative impact from destroyed capital goods and capital drainage towards the reconstruction of affected regions on the other hand. These effects are related to the initial physical damages as well as to the economic responses that are likely to follow the disaster.

Keynote & Closing Session

Keynote 5: Marc Zebisch

Speaker: Marc Zebisch, Eurac Research, Italy

Topic: Climate Risk Assessment in a complex reality – challenges and solutions

Climate-related hazards often lead to cascading risks, triggering compounding impacts and leading to complex and interconnected adverse consequences for various ecological and human systems. At the same time, other underlying risk drivers such as poverty, demographic development or land degradation are aggravating exposure and vulnerability to climate-related hazards. Due to this complex and partly systemic nature of climate-related risks, risk assessments and management, in the context of climate change, require a more comprehensive, systemic perspective on risk and its underlying drivers.

The first requirement is that a climate risk assessment (CRA) is not just seen as a scientific exercise but a targeted and solution-oriented approach with the goal to support risk management in reducing climate-related risks. Key questions for a CRA are: how could climate change lead to severe consequences on what you want to protect or develop? Where are key vulnerabilities? How can these vulnerabilities be reduced through adaptation?

The talk will give an overview over requirements for and challenges of a comprehensive risk assessment and present two concepts that have been developed to address these challenges.

a) Climate risk assessment with impact chains.

The method follows a general assessment framework consistent with the IPCC AR5 and AR6 concept on climate risk. This framework has been developed by Eurac Research within the context of various projects with the German Environment Agency and the German Gesellschaft für Internationale Zusammenarbeit (German Corporation for International Cooperation)—GIZ. It has been applied in almost twenty national climate risk assessments worldwide (e.g., Burundi, Bangladesh, Thailand, Vietnam, Madagascar) and has been perceived as (1) an appropriate means for risk analysis, (2) a useful tool for communication of complex cause-effect relationships in climate change impacts and risks, and (3) a great approach to identify entry points for adaptation measures. For an operational risk assessment, impact chains serve as a basis for the selection of appropriate models, indicators or guide more qualitative, expert-based assessment.

b) The European Risk Assessment – EUCRA

EUCRA is implemented by the European Environment Agency (EEA) jointly with the European Commission (EC). The first EUCRA is a fast-track assessment that aims to support the identification of needs and priorities for managing climate-related risks in Europe during the next EU policy cycle. EUCRA includes several innovations over existing information sources on climate impacts and risks for Europe, such as the IPCC Sixth Assessment Report or model-based climate impact assessments. These innovations include a combination of various quantitative and qualitative lines of evidence; strong interaction with relevant stakeholders, in particular from the EC, throughout the assessment process; and a strong emphasis on complex and cascading climate-related risks through various risk storylines. Find more information on the EUCRA page of the European Climate Adaptation Platform, Climate-ADAPT.

Closing Session : Unfiltered Mentimeter outcomes:

What has excited, inspired, motivated (or frustrated) you about the topics of discussion in the past few days?

- The role of economics and its potential (or liability) in dealing with the climate crisis and extreme events
- The keynote speeches on day one were very inspiring.
- The interrelations of climate related impacts
- Exciting to see the emerging body of work on cascading cross-border impacts, but I feel we are still only scratching the surface!
- "Exiting: people talking about mitigation. Irritating: keynote and panellist asking for an economist and presenting economics as exact Science with comparison to natural sciences."
- The width of the topics in the talks and discussions demonstrated how many angles are relevant in exploring cross-border impacts. Many inspiring thoughts!
- Some presenters were so eager to present all details in their own work that they forgot to allow time for the discussions and reflections from the floor. Some training is needed :-)
- "Excited by the breadth of topics and depth.
- Frustrated by little discussion of how to translate this science into adaptation on the ground."
- The spirit, the seriousness, the willingness to engage and have an impact, the ability to think complexity,
- The breath of topics, the openness and engagement of colleagues
- learning about available models
- Frustrated by the ever-growing awareness of how close we are to break the equilibrium loops.
- Methods to deal with complexity
- Really exciting to meet and get in touch with fellow modellers.
- Frustrated by the similarity and lack of breakthrough in modelling methods.
- A lot of new ideas, especially on economic assessment of real world spatially explicit impacts rather than aggregate impacts that are too generalised to be of use in practical adaptation
- The topic of cascading climate risk has matured! It has reached the point where no single person has read all of the published work: this is beautiful! The Cascadian Explosion!
- "Motivating: Curiosity and eagerness of colleagues to collaborate
- Frustrating: Societal fatigue and reluctance to change"
- Motivated by the realisation that there is so much knowledge and insights from smart people that could be even better used to promote policy changes
- Excited and inspired: nice people and interesting talks -very good discussion depth. All in one a good place to forging a community
- Excited that we have embarked on changing the narrative of climate adaptation, from a local issue to one that reflects a global policy and geopolitical challenge.
- I'm concerned that we frame potential impacts only in terms of hazards and vulnerability. Climate is not only a hazard - it is fundamentally a resource. Failing to realise opportunities is also a risk
- Virtually the attendance opportunity is very valuable as it connects like-minded people. Frustrating: Very Important and complex topics do not reach bottom-up social tipping points.
- I would disagree with the view cc is a resource - it is threat to resources and their equitable use
- CC can indeed be a threat, but climate itself is a resource - we couldn't survive without it!
- The road of understanding complexity is bumpy. It helps when fellow scientists work towards similar goals, share difficulties and challenges. And then the results are quite interesting.
- We frame the risk as critical, even existential, but we propose risk management solutions that are incremental.
- We are great at defining the "problem" of climate change, but for policy to change and our work to be adopted, we need to be better at researching the solutions
- Militarization of the policy process has integrated climate into all policy areas, effectively managing cascading risks. But fortress Europe is so solid that only certain elites have freedom to move.
- The relevance of policies

Imagine it's ten years from now: What new cascading climate risks will emerge? Which existing risks will become severe?

- Will AI be making decisions that would otherwise have been left to policy makers or people in business? Is this a good or a bad thing?
- I believe socio-economic components are the ones with the highest potential and uncertainty for risk in the future. Migration, supply chain and financial system seem to be main topics of concern
- Migration, geopolitical tensions linked to mitigation.
- Coupling of effects of degradation of natural capital with climate impacts to exacerbate overall risk.
- Acceleration of the impacts of sea level rise, including on critical infrastructure. Spread of disease into new regions driven by climatic change and migration.
- The movement of people representing an impact and mediating other impacts will create new demands on adaptation as well as new opportunities.
- The interaction between climate risks and other risks will create new challenges that demand adaptation also beyond the 'traditional' adaptation actions and policies
- The severity is likely to arise by interacting climate and other risks, not by any single trigger
- New diseases due to climate change spreading across the world and antibiotic resistance. Poverty and migration increased by climate change leading to loss of livelihoods and water security.
- shifts in species distributions (also humans)
- Forced migrations taking importance because of some places turn inhabitable
- More resource shortages imposed on the population.
- Retrenchment from globalisation, weakness of the UN system
- Transboundary misinformation leading to widespread polarisation and reluctance to address climate risks.
- There may also be positive surprises, but public rigidity seems to kick off an entire landslide of cascades - uncertainty, the unknown unknown.
- Challenge of climate displacement and increasing political pushback against immigration
- Riots, civil disruption and political violence in European capitals, triggered (partly) by cascading climate risks
- Summers will be warmer, storms will be stronger, but cities will become greener, technology will evolve to catch pluvial water
- I am a member of a new transnational religious tribe, which also provides my internet connection, branded clothing and supply chains: I buy fruit and rare earth metals from my tribe in other countries.
- Militarization of the policy process has effectively integrated climate into all policy areas, including cascading risks. But fortress Europe only allows certain elites the global freedom of movement.
- New infectious disease

In 10 years, what progress will have been made to advance the science behind cascading, cross-border, climate impacts and effective responses to risk?

- Better integration of 'irrational' and non-linear effects into assessment models.
- Better modelling. Online interactive tools
- I'd like to see more models combining climate and other sectors, also the accessibility of those models and tools to general public
- A better understanding of what information policy makers actually need from scientists to help them navigate the complexity.
- More research on 'solutions' to cascading risk in addition to identification of threats.
- The main progress will be in research serving policy domains and actors who today have only now begun to realise the significance of cross-border risks and who have started to search for responses
- The really important work is strengthening the base for effective responses. This research will need to combine many areas of investigation, from technical to legal
- Clear processes to assign risk ownership across EU DGs and national ministries on cascading risks
- increased transparency of asset level vulnerabilities
- better mapping of connectedness of hazards and impacts
- More international coordination for action
- Informed dialogue underpinned by stories, qualitative and quantitative data (in this order)
- Transition to Post-normal science and calibration.
- Better models , but without impact on adaptation

In 10 years, what new policies have been developed to deal with the impacts and risks? Are there any new modes of science-policy collaboration?

- "More responsive fund. Better economic monitoring."
- Need policy to integrate siloes of decision making across government departments. At the moment there is too limited exchange between e.g. treasury, development, environment and trade departments.
- Policies will have been modified, perhaps not that many 'new' policies. Co-creation will be a key approach
- counterproductive barriers to trade and human mobility
- More cultural-shift/transformational policies
- Distributed governance with strong ties to levels above, below and around (cf integrative towards transformational resilience)
- More policy-oriented science, data is all there, we just have to act sharp regardless of uncertainty of projection ensembles
- AGI may be near Singularity.
- More liability rules

(Inspired by the future trip) what personal commitments regarding science or policy of cascading climate impacts are you ready to take?

- Talk to people
- Willing to keep the debate alive!
- Include the cascading and transboundary lens to my work on climate risk assessment and adaptation research and policy advise.
- invest taking climate risks into account
- Any
- Help and support to explore the (adaptation and risk management) solution space, through teaching, research (incl provision of open-source and -access models and data) and engagement on various levels
- Lifestyle adaptation. Food Systems, Circularity, Decluttering, etc.
- Take responsibility to interpret



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