

**Workshop on developing quantitative methodologies for
analyzing the distributional impacts of climate-related disasters**

International Institute for Applied Systems Analysis (IIASA)

Wodak room and Zoom

17 October 2023

Program

Time (CEST)

9:00 Opening remark: Thomas Schinko (IIASA, EQU)

Session 1 Chair: Michael Kuhn (IIASA, EF)

9:10 Asjad Naqvi (Austrian Institute of Economic Research / IIASA)

"BinD: A model of growth, climate change, and debt sustainability"

Ozlem Omer-Cender, Nepomuk Dunz, Asjad Naqvi

9:50 Michael Freiberger (IIASA, EF)

"Modelling exposure and vulnerability to disaster risk: A dynamic household level approach"

Michael Freiberger, Roman Hoffmann, Alexia Prskawetz

10:30 Coffee break

Session 2 Chair: Asjad Naqvi (WIFO / IIASA)

10:50 Alessandro Taberna (Delft University of Technology)

"Exploring distributional effects of climate change and of adaptation with agent-based models"

Tatiana Filatova, Alessandro Taberna, Ignasi Cortes Arbues, Brayton Noll

11:30 Gabriel Bachner (University of Graz)

"Revealing indirect risks in complex socioeconomic systems: A highly detailed multi-model analysis of flood events in Austria"

Gabriel Bachner, Nina Knittel, Sebastian Poledna, Stefan Hochrainer-Stigler, Karina Reiter

12:10 Lunch

Session 3 Chair: Gabriel Bachner (University of Graz)

13:30 Muneta Yokomatsu (IIASA, EQU/SYRR)

"Climate-related disaster impacts in the Global South: Heterogeneity and human capital investment"

Muneta Yokomatsu, Thomas Schinko, Junko Mochizuki, Armon Rezai

14:10 Oliver Rehbein (Vienna University of Economics and Business)

"Borrowers under water! Rare disasters, regional banks, and recovery lending"

Michael Koetterabc, Felix Nothab, Oliver Rehbein

14:50 Coffee break

Session 4 Chair: Thomas Schinko (IIASA, EQU)

15:10 Laurent Millischer (Joint Vienna Institute)

"Distributional effects of climate-related disasters: Policymakers' needs"

Laurent Millischer

15:50 Nepomuk Dunz (World Bank)

"Climate physical risk assessment in emerging market and developing economies: A policy-oriented research agenda"

Nepomuk Dunz

16:30 Synthesis and outlook

17:00 Closing: Muneta Yokomatsu (IIASA, EQU/SYRR)

BinD: A model of growth, climate change, and debt sustainability

Ozlem Omer-Cender^a, Nepomuk Dunz^b, Asjad Naqvi^{c,d}

^a Bucknell University, Pennsylvania, USA

^b World Bank, Washington, D.C., USA

^c Austrian Institute of Economic Research, Vienna, Austria

^d International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

Email: asjadnaqvi@gmail.com

ABSTRACT

Low- and middle-income countries (LMICs) are disproportionately impacted by climate change, and Limited fiscal space and high dependence on the import of capital goods curtail their ability to make climate-resilient investments. In this paper we present a demand-driven model that is supply-side constrained due to insufficient buildup of production capacity. Calibrating the model to Fiji, we evaluate growth pathways for three climate futures -- 2C, 3C, and 4C global warming by the end of the century. We evaluate the role of a public climate fund to enable partial recovery from climate damages financed through four different schemes - debt-led recovery, higher tax rate on households, and higher taxes on capitalists, and unconditional grants. While the scenarios show similar recovery trends, they have different socioeconomic implications and create trade-offs for economic growth, income distribution, external balances, and debt sustainability. In the 4C scenario, even the most generous unconditional grants fail to prevent the downward spiral hitting capacity constraints despite an initial boost to growth. These insights shed light on the need for effective and equitable domestic climate policies and affordable finance and compensation to support sustainable development in vulnerable countries.

KEYWORDS

Climate change; Economic growth; Low- and middle-income countries; Sustainable economic development; Climate financial resilience

Modelling exposure and vulnerability to disaster risk: A dynamic household level approach

Michael Freiberger^a, Roman Hoffmann^b, Alexia Prskawetz^{a,c,d}

a Economic Frontiers Program, International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

b Population and Just Societies Program, International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

c Institute of Statistics and Mathematical Methods in Economics, TU Wien, Vienna, Austria.

d Wittgenstein Centre for Demography and Global Human Capital (IIASA, OeAW, University of Vienna), Vienna Institute of Demography, Vienna, Austria

Email: freiberger@iiasa.ac.at

ABSTRACT

Various empirical studies have identified key factors of exposure and vulnerability of households to disaster risk. However, we still lack a conceptual understanding of how these forces interact and how they impact household decision making. This study develops a dynamic household model, in which households face stochastic environmental hazards, which can lead to a loss of their wealth. To respond to the risk, households can either relocate to a safer area or undertake preventive measures to protect their physical assets. Both actions require material and immaterial resources, which constrain the household's decision. Households are assumed to be heterogeneous with respect to key empirically identified factors for individual disaster risk: education, income, risk awareness, time preference and their access to preventive measures. Theoretical insights on the optimal household strategies are derived from the first order conditions of the households problem. A numerical solution for the optimal policy functions is presented and calibrated to data from Thailand. We evaluate multiple different policy interventions with respect to their cost-benefit efficiencies and compare their differential impact on the heterogeneous population.

KEYWORDS

Natural hazards; Exposure and Vulnerability; Household behaviour; Policy evaluation; Heterogeneity; Dynamic Programming; Relocation and Prevention

Exploring distributional effects of climate change and of adaptation with agent-based models

Tatiana Filatova^a, Alessandro Taberna^a, Ignasi Cortes Arbues^a, Brayton Noll

^a Department of Multi Actor Systems, Faculty of Technology, Policy and Management, Delft University of Technology, Jaffalaan 5, 2628 BX Delft, The Netherlands
Email: t.filatova@tudelft.nl

ABSTRACT

The overlapping of global urbanization trends and climate change poses a significant challenge to human societies. The impacts of extreme rainfall, river and coastal floods and rising sea levels already result in severe economic losses and affect billions of people worldwide. Furthermore, with UN projections indicating that approximately 70% of the global population will reside in urban areas by 2050, coastal economies situated in flood-prone regions face heightened vulnerability. This study explores how rapidly urbanizing economies populated with heterogeneous boundedly-rational households and firms could adapt to these escalating climate-related challenges.

Our approach revolves around innovative simulation tools that incorporate autonomous climate change adaptation (CCA) strategies of various actors within a regional economic framework. We commence by examining current advancements and gaps in the utilization of Agent-Based Models (ABMs) to assess climate-induced flood risk and adaptation. Emphasizing the pivotal role of human actions in shaping risks and resilience in flood-prone urban settings - via their location and adaptation choices - we introduce the Climate-Economy Regional Agent-Based (CRAB) model. This model employs an evolutionary perspective to provide a comprehensive view of the interplay between economic agglomeration and climate hazards. Depending on the trade-offs between agglomeration forces and increasing hazard probability and severity, the distribution of risks between regions is shifting, as does the performance of the overall economy.

Furthermore, we enrich this regional economy model with diverse autonomous CCA actions, ranging from protective behavior to insurance, using different behavioral heuristics. The CRAB model allows for quantitatively estimating the distributional impacts of individual actions on both direct and indirect damages and traces the distributional impacts of private adaptation. Moreover, we show how ABMs could be coupled with macroeconomic climate policy models to incorporate micro-funded CCA into the broader global policy frameworks.

KEYWORDS

Agent-based models; Agglomeration forces; Climate shocks; Distributional impacts; Behavioral theories

Revealing indirect risks in complex socioeconomic systems: A highly detailed multi-model analysis of flood events in Austria

Gabriel Bachner^a, Nina Knittel^a, Sebastian Poledna^b, Stefan Hochrainer-Stigler^b,
Karina Reiter^b

^a Wegener Center for Climate and Global Change, University of Graz, Graz, Austria

^b Advancing Systems Analysis Program, Systemic Risk and Resilience Research Group,
International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

Email: gabriel.bachner@uni-graz.at

ABSTRACT

Cascading risks that can spread through complex systems have recently gained attention. As it is crucial for decision-makers to put figures on such risks and their interactions, models that explicitly capture such interactions in a realistic manner are needed. Climate related hazards often cascade through different systems, from physical to economic and social systems, causing direct but also indirect risks and losses. Despite their growing importance in the light of ongoing climate change and increasing global connections, such indirect risks are not well understood. Applying two fundamentally different economic models—a computable general equilibrium model and an agent-based model—we reveal indirect risks of flood events. The models are fed with sector-specific capital stock damages, which constitutes a major methodological improvement. We apply these models for Austria, a highly flood exposed country with strong economic linkages. A key finding is that flood damages pose very different indirect risks to different sectors and household groups (distributional effects) in the short and long-term. Our results imply that risk management should focus on specific societal subgroups and sectors. We provide a simple metric for indirect risk, showing how direct and indirect losses are related. This can provide new ways forward in risk management, for example, focusing on interconnectedness of sectors and agents within different risk-layers of indirect risk. Although we offer highly relevant leverage points for indirect risk management in Austria, the methodology of analyzing indirect risks can be transferred to other regions.

KEYWORDS

Agent-based modeling; Austria; Computable general equilibrium; Food risk; Indirect risk; Macroeconomic modeling

Climate-related disaster impacts in the Global South: heterogeneity and human capital investment

Muneta Yokomatsu^a, Thomas Schinko^a, Junko Mochizuki^b, Armon Rezai^{c,a}

^a Population and Just Societies Program, International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

^b Biodiversity and Natural Resources Program, International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

^c Institute for Political Economy of Public Policy, Vienna University of Economics and Business (WU), Vienna, Austria.

Email: yoko@iiasa.ac.at

ABSTRACT

This study develops a dynamic model of climate-related disaster impacts, considering multidimensional household heterogeneity, for analyzing changes in growth and inequality in low-income countries. Focusing on human capital development, the study demonstrates the multiple impacts of disaster risk reduction (DRR) policies on human capital investment, including the effect of schooling opportunities for households constrained by the subsistence consumption constraint. Through numerical simulations performed for two economies that differ in terms of human capital, modeled after Madagascar and Fiji, it is illustrated that the possibilities of involuntary unemployment and the work-learning choice drive the diversity in macroeconomic impacts of a disaster. In an economy characterized by low levels of human capital, a disaster could cause an increase in labor supply in the immediate aftermath, but interrupt human capital formation, impeding long-term growth and human capital formation. Such a result contradicts prevailing intuition by demonstrating that a disaster occurring in an economy under recession may not result in a large adverse GDP impact in the short run but may negatively impact growth in the long run. On such a path, a policy of development in DRR infrastructure with appropriate taxation could reduce human-capital gaps in the long run by supporting continued post-disaster human-capital investment opportunities for the poor.

KEYWORDS

Natural hazards; Economic growth; Household heterogeneity; Human capital investment; Low-income countries

Borrowers under water! Rare disasters, regional banks, and recovery lending

Michael Koetter^{a,b,c}, Felix Noth^{a,b}, Oliver Rehbein^d

a Halle Institute for Economic Research (IWH), P.O. Box 110361, Halle (Saale) 06017, Germany

b Otto-von-Guericke University, Universitätsplatz 2, P.O. Box 4120, Magdeburg 39114, Germany

c Deutsche Bundesbank, P.O. Box 10 06 02, Frankfurt 60006, Germany

d Vienna University of Economics and Business, Welthandelsplatz1, 1020 Vienna

Email: Oliver.Rehbein@wu.ac.at

ABSTRACT

We show that local banks provide corporate recovery lending to firms affected by adverse regional macro shocks. Banks that reside in counties unaffected by the natural disaster that we specify as macro shock increase lending to firms inside affected counties by 3%. Firms domiciled in flooded counties, in turn, increase corporate borrowing by 16% if they are connected to banks in unaffected counties. We find no indication that recovery lending entails excessive risk-taking or rent-seeking. However, within the group of shock-exposed banks, those without access to geographically more diversified interbank markets exhibit more credit risk and less equity capital.

KEYWORDS

Disaster risk; Credit demand; Natural disaster; Relationship lenders

Distributional effects of climate-related disasters: policymakers' needs

Laurent Millischer^a

a Joint Vienna Institute (JVI), Vienna, Austria
Email: lmillischer@jvi.org

ABSTRACT

This analysis presents the results of a survey among former participants in Joint Vienna Institute (JVI) courses covering climate or inequality topics. Respondents were public sector officials from Central, Eastern and Southeastern Europe, the Caucasus, Central Asia, Turkey and Iran – central bankers and finance ministry employees for the most part. They responded to categorical and open-ended questions concerning their interests in the topic of distributional impacts of climate-related disasters as well as the policy applications of their work and their modeling and data requirements. While not a representative survey, the response dataset shines light on policymakers' needs and can serve to connect state-of-the-art research with potential users in central banks and ministries.

KEYWORDS

Natural hazards; Economic growth; Inequality; Economic modeling

Climate physical risk assessment in Emerging market and developing economies: A policy-oriented research agenda

Nepomuk Dunz^a

a The World Bank, Washington DC, USA
Email: ndunz@worldbank.org

ABSTRACT

Emerging market and developing economies (EMDEs) are particularly vulnerable to growing climate change, and assessing and managing climate economic and financial risks in these countries requires tailored approaches due to the diverse context. To achieve this, methodological approaches used for climate risk assessment can range from simple exposure assessments to complex stress tests, which involve connecting various models and data sources to identify potential risks and vulnerabilities in the economy and financial sector. The World Bank has conducted exposure analysis for its client countries, which can identify data and capacity gaps and focus areas for more in-depth risk assessment. For more in-depth climate stress testing exercises, severe but plausible scenarios are developed, and standard stress testing is applied to assess risks and impacts on the financial sector. However, there are substantial challenges and shortcomings that remain, particularly for EMDEs, relating to the availability, granularity, and quality of data for risk assessment, the scope of the risks considered, the methodologies and assumptions used for risk assessment, and the capacity requirements to perform analysis. This presentation will provide an overview of the World Bank's approach to climate risk assessment, including its climate change and development reports (CCDRs). It will also highlight the persisting challenges and indicate relevant next steps for policy-oriented research.

KEYWORDS

Climate physical risks; Sustainable development; Emerging markets and developing economies, Climate stress testing

Participants

As of October 14, 2023

<i>Name</i>	<i>Affiliation</i>	<i>Email</i>
Abraham Yosipof	IIASA, CAT	avi.yosipof@gmail.com
Adriana Gomez Sanabria	IIASA, PM	gomezs@iiasa.ac.at
Adriano Vinca	IIASA, IACC, TISS	vinca@iiasa.ac.at
Alberto Fresolone	IIASA, EQU	fresolone@iiasa.ac.at
Alessandro Taberna	Delft University of Technology	A.Taberna@tudelft.nl
Ali Kharrazi	IIASA, SYRR	kharrazi@iiasa.ac.at
Amit Ashkenzy	Delft University of Technology	amit@sustainabilityforesight.com
Andre Deppermann	IIASA, IBF	depperma@iiasa.ac.at
Aneeque Javaid	IIASA, IACC, S3	javaid@iiasa.ac.at
Armon Rezai	Vienna University of Economics and Business / IIASA	Armon.Rezai@wu.ac.at
Asjad Naqvi	Austrian Institute of Economic Research / IIASA	naqvi@iiasa.ac.at
Darina Zlatanova	IIASA, EM, CAT	zlatanova@iiasa.ac.at
David Leclere	IIASA, IBF	leclere@iiasa.ac.at
Denise Watzenig	IIASA, EQU	watzenig@iiasa.ac.at
Dipesh Chapagain	IIASA, SYRR	chapagain@iiasa.ac.at
Eva Preinfalk	IIASA, EQU	preinfalk@iiasa.ac.at
Fei Guo	IIASA, IACC, S3	guof@iiasa.ac.at
Gabriel Bachner	University of Graz	gabriel.bachner@uni-graz.at
Gaurav Shrivastav	IIASA, EM, ECE	shrivastav@iiasa.ac.at
Gladys Shamirian	IIASA, EQU	shamirian@iiasa.ac.at
Gregor Zens	IIASA, MIG	zens@iiasa.ac.at
Hossein Hassani	IIASA, CAT	hassani@iiasa.ac.at
Jarmo Kikstra	IACC, S3, TISS	kikstra@iiasa.ac.at
Jihoon Min	IIASA, S3, TISS	min@iiasa.ac.at
Jingwei Xie	IIASA, TISS	xiejingwei@iiasa.ac.at
Johanna San Pedro	IIASA, AFE	sanpedro@iiasa.ac.at
Jonas Peisker	IIASA, EQU	peisker@iiasa.ac.at
Julian Joseph	IIASA, WAT	joseph@iiasa.ac.at

<i>Name</i>	<i>Affiliation</i>	<i>Email</i>
Jung-Hee Hyun	IIASA, SYRR	hyun@iiasa.ac.at
Junko Mochizuki	IIASA, WAT	mochizuk@iiasa.ac.at
Laurent Millischer	Joint Vienna Institute	lmillischer@jvi.org
Lorenza Campagnolo	Centro Euro-Mediterraneo sui Cambiamenti Climatici	lorenza.campagnolo@cmcc.it
Luca Fierro	IIASA, EM	fierro@iiasa.ac.at
Marina Andrijevic	IIASA, IACC, TISS	andrijevic@iiasa.ac.at
Michael Freiburger	IIASA, EF	freiburger@iiasa.ac.at
Michael Kuhn	IIASA, EF	kuhn@iiasa.ac.at
Mohammad-Reza Yeganegi	IIASA, CAT	yeganegi@iiasa.ac.at
Moradhvaj Moradhvaj	IIASA, MDM	moradhvaj@iiasa.ac.at
Muneta Yokomatsu	IIASA, EQU, SYRR	yoko@iiasa.ac.at
Mykola Gusti	IIASA, IBF	gusti@iiasa.ac.at
Nepomuk Dunz	World Bank	ndunz@worldbank.org
Nikita Strelkovskii	IIASA, EM, CAT	strelkon@iiasa.ac.at
Oliver Rehbein	Vienna University of Economics and Business	Oliver.Rehbein@wu.ac.at
Omkar Patange	IIASA, EF	patange@iiasa.ac.at
Ornit Avidar	IIASA, WAT	avidar@iiasa.ac.at
Oscar Higuera-Roa	IIASA, SYRR	higueraroa@iiasa.ac.at
Ozlem Omer-Cender	Bucknell University	omero679@newschool.edu
Pratik Patil	IIASA, CAT	patil@iiasa.ac.at
Qinhan Zhu	IIASA, SYRR	zhuqinhan@iiasa.ac.at
Robert Sakic Troglic	IIASA, SYRR	troglic@iiasa.ac.at
Setu Pelz	IIASA, TISS	pelz@iiasa.ac.at
Shasha Xu	IIASA, IBF	xus@iiasa.ac.at
Shubhi Misra	IIASA, SYRR	misra@iiasa.ac.at
Stefan Velez	IIASA, SYRR	velev@iiasa.ac.at
Tatiana Filatova	Delft University of Technology	T.Filatova@tudelft.nl
Thiago Brito	IIASA, PM	brito@iiasa.ac.at
Thomas Schinko	IIASA, EQU	schinko@iiasa.ac.at
Timothy Foreman	IIASA, EQU	foreman@iiasa.ac.at
Tzach Harari	Tel Aviv University	tzach.harari@gmail.com
Valeria Javalera Rincón	IIASA, EM	javalera@iiasa.ac.at

<i>Name</i>	<i>Affiliation</i>	<i>Email</i>
Xiaoyang Zhong	IIASA, IACC, S3	zhongx@iiasa.ac.at
Xuxia Li	IIASA, SYRR	lixuxia@iiasa.ac.at
Yazhen Wu	IIASA, IBF	wuyazhen@iiasa.ac.at
Yuliya Kulikova	IIASA, EF	kulikova@iiasa.ac.at
Zuelclady Araujo Gutierrez	IIASA, IBF	zmfaraujo@iiasa.ac.at