International Conference: Big Data for Disaster Response and Management in Asia and the Pacific

Sendai, Japan | 15–17 February 2024

DAY 1: 15 February 2024

AGENDA

Room:	**Main hall of the IRIDeS building (1F)**			
Emcee:	**Madhavi Pundit**			
9:30-10:00 AM	Opening session **Toshiya Ueki**, Vice President, Tohoku University **Albert Park**, Chief Economist, Asian Development Bank **Shinichi Kuriyama**, Director, International Research Institute of Disaster Science **Christina Schönleber**, Chief Strategy Officer, Association of Pacific Rim Universities			
10:00-10:20 AM	Coffee break and group photo			
10:20-11:00 AM	*Keynote Talk*: "Enabling Resilient Cyber-Human-Infrastructure: Emerging Technologies" by **Nalini Venkatasubramanian**, Professor, University of California, Irvine			
11:00-11:40 AM	*Keynote Talk*: "Beyond Volume: Refining Big Data for Disaster Resilience" by **David Lallemant**, Assistant Professor, Nanyang Technological University			
11:40-1:00 PM	Lunch Break			
1:00-2:30 PM	Room 1 **Chair: Christina Schönleber**	Room 2 **Chair: Belinda Hewitt**	Room 3 **Chair: Takako Izumi**	Room 4 **Chair: Edward Charles Anderson**
	Demand, impacts and the consequences of mis-designed crop insurance program: Evidence from administrative data of nationwide program in Thailand *Boontida Sa-ngimnet* *Discussant: Miloud Lacheheb*	Designing a nationwide crop insurance program in Thailand using big data and mobile technology *Jose Velarde Morales and Surasak Choedpasuporn* *Discussant: W B Roshen Piumal Sachindra Fernando*	A Model Analysis Approach for Reassessment of the Cyclone Shelter Plan Focusing both on Accessibility and Accommodation Capacity for Local Communities - Case Study of Khulna, Bangladesh *Mohammad Ismail Hossain and Md Jubaer Arefin* *Discussant: Tomoko Sugiura*	Leveraging Earth Observation Data and Products to create a Comprehensive Tsunami Loss Estimation Platform – Impacts in a Changing Climate *Ronald T. Eguchi* *Discussant: Pritha Ghosh*
	Impact of Tropical Cyclones on Fishing Activity in the Philippines *Miloud Lacheheb* *Discussant: Erwin Knippenber*	Global Economic Consequences of the Physical Climate Impacts on Agriculture and Energy *W B Roshen Piumal Sachindra Fernando* *Discussant: Md Nahid Ferdous*	Modelling geo-hydrological hazard scenarios for assessing suitability of evacuation shelter by proposing Bayesian Optimized CNN *Somnath Bera* *Discussant: Noriel Christopher C. Tiglao*	Modeling dynamics of landslide hazard and exposed population under climate change scenario using deep learning *Pritha Ghosh* *Discussant: Yifan Yang*
	Poverty Impacts of the Pakistan Flood 2022 *Erwin Knippenberg* *Discussant: Chonnakan Rittinon*	Rapid assessment of landslide induced vegetation damage using Disaster Vegetation Damage Index (DVDI) *Md Nahid Ferdous* *Discussant: Elodie Blanc*	Analyzing Poverty Incidence and Disaster Vulnerability of Informal Settlements in Baguio City, Philippines using Spatial Microsimulation Approach *Noriel Christopher C. Tiglao* *Discussant: Keiko Saito*	Small-Grid Urban Flood Prediction Model Using Twitter Data and Population GPS Data - An example of the 2019 Nagano City Flood *Yifan Yang* *Discussant: Ronald T. Eguchi*
2:30-3:00 PM	Coffee break			
3:00-4:30 PM	Room 1 **Chair: John Gibson**	Room 2 **Chair: Madhavi Pundit**	Room 3 **Chair: Ilan Noy**	Room 4 **Chair: Abdul Abiad**
	Machine-learning Approaches to Enhance Tsunami Damage Modeling for Coastal Roads: Lessons from the 2011 Great East Japan Event *Anna Rita Scorzini* *Discussant: Bhuwan Awasthi*	The Impact of Natural Disasters on Light-based Geospatial Income Inequality *Jaqueson K. Galimberti* *Discussant: J.C. Albert C Peralta I*	Quantifying Traffic Responses under the Highest-Level Warning and Extreme Rainstorm in Beijing *Ziying Zhou and Xiaoyan Liu* *Discussant: Jonas Gunkel*	Framing of Disasters in Digital Media using NLP: A Case Study on Flood Management *Hannah Bailon* *Discussant: Ivan Harris Tanyag*
	Predictive Analytics for Road Safety Enhancement on Mugling-Narayanghat Road Section *Bhuwan Awasthi* *Discussant: Nattapong Puttanapong*	The Project CCHAIN Dataset: Linking Village-Level Data on Climatic Impact-Drivers, Socioeconomic Vulnerability, and Environmental Conditions to Health Impacts across 12 Philippine Cities *J.C. Albert C Peralta I* *Discussant: Paul Jasper*	Machine Learning for Disaster Mobility Modeling: Methods and Data *Jonas Gunkel* *Discussant: Makoto Okumura*	Agent-Based Modelling of Systemic Risk in Disaster Response in the Philippines Using Emotional Contagion Analysis *Ivan Harris Tanyag* *Discussant: Qi Zhao*
	An Integrated Framework for Satellite-based Flood Mapping and Socioeconomic Risk Analysis: A Case of Thailand *Nattapong Puttanapong* *Discussant: Anna Rita Scorzini*	Temperature variability as a driver of poverty in low- and middle-income countries *Paul Jasper and Ida Brzezinska* *Discussant: Jaqueson K. Galimberti*	Quantification of urban mobility, based on big data of population locations *Makoto Okumura* *Discussant: Ziying Zho*	Factors determining risk perception among university students in the face of an infectious disease outbreak *Qi Zhao* *Discussant: Hannah Bailon*

Day 2 Agenda

International Conference: Big Data for Disaster Response and Management in Asia and the Pacific

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DAY 2: 16 February 2024

Room:	**Main hall of the IRIDeS building (1F)**			
Emcee:	**Madhavi Pundit**			
9:30-10:10 AM	*Keynote Talk*: "The outline of the national project 'SIP' to tackle with natural disasters" by **Koichi Kusunoki**, Professor, University of Tokyo			
10:10-10:30 AM	Coffee break			
10:30-11:30 AM	Panel Discussion: Big data and disasters: Linkages between research, practice and policy			
	Moderator: **Abdul Abiad**, Director, Asian Development Bank **Edward Charles Anderson**, Senior Technology and Resilience Specialist, World Bank **Belinda Hewitt**, Senior Disaster Risk Management Specialist, Asian Development Bank **Ilan Noy**, Chair in the Economics of Disasters and Climate Change, Victoria University of Wellington			
11:40-1:00 PM	Lunch break			
1:00-2:30 PM	Room 1 **Chair and Commentator: Christina Schönleber**	Room 2 **Chair and Commentator: Belinda Hewitt**	Room 3 **Chair: Abdul Abiad**	Room 4 **Chair: Shunichi Koshimura**
	Are disaster impact estimates distorted by errors in popular night-time lights data? *John Gibson* *Discussant:Renzo Roel Tan*	The Relation between Entrepreneur's Social Identity and Venture's Performance in Times of Adversity: A Twitter Analysis *Syrine Adala* *Discussant: Joshua Panganiban*	Modeling and Monitoring social media dynamics to predict short-term peak electricity demand *Isabella Nunes Grieser* *Discussant: Zhaowen Wang*	Leveraging Big Data for Enhanced Disaster Response and Management: A Case Study of BRAC's Initiatives in Bangladesh *Naimul Islam* *Discussant: Sahara Sedhain*
	Twitter-Derived Measures of Economy and Uncertainty for the Philippines Renzo Roel Tan and Benedict Ryan Tiu Discussant: Jun Rentschler	Towards High-resolution Simulation of Post-Disaster Economies Utilizing Firm-level Data *Joshua Panganiban* *Discussant: Yoshihisa Maruyama*	Navigating Drought: Analyzing Panama Canal Transit Disruptions Using AIS Big Data *Zhaowen Wang* *Discussant: Zhenyu Yang*	Explainable Impact-Based Forecasting for Tropical Cyclones *Sahara Sedhain* *Discussant: Yasemin Palta*
	Urbanization in a changing climate: Global evidence of rapid urban growth in flood zones since 1985 *Jun Rentschler* *Discussant: John Gibson*	Numerical simulation for leak detection based on water pressure observation by smart meters *Yoshihisa Maruyama* *Discussant: Syrine Adala*	Exploring the Relationship Between Snow Depth and Population Mobility Using Mobile GPS and Weather Data *Zhenyu Yang* *Discussant: Isabella Nunes Grieser*	Using AI to Collect Information on Disaster Resilience of Public Financial Management Systems *Yasemin Palta* *Discussant: Naimul Islam*
2:30-2:45 PM	Coffee break			
2:45-4:45 PM	Room 1 **Chair: Takako Izumi**	Room 2 **Chair: Albert Park**	Room 3 **Chair and Commentator: Esperanza Martinez**	Room 4 **Chair: Ilan Noy**
	Monitoring Post-Disaster Reconstruction to Support Evaluation of Early Recovery Frameworks *Sabine Chandradewi Loos* *Discussant: Hiroyuki Miura*	Disaster Digital Twin - A Mixed Initiative of Human and Machine for Resilience *Shunichi Koshimura* *Discussant: Eva Brucherseifer*	Spatial Analysis of Weather Shocks Vulnerability in Children's Nutrition: A Comparative Study of Three Ecological Regions in Nepal *Prakriti Shakya* *Discussant: Amanda Guimbeau*	From Aspiration to Relocation – Assessing the Impacts of Natural Disasters on Migration using Big Data *Lennart Reiners* *Discussant: Patricia Anne Delmendo*
	Remote sensing-based approach for estimating insured typhoon-induced economic losses from building damage *Hiroyuki Miura* *Discussant: Shimpei Nakano*	A Data Classification Towards the Applicability of the Digital Twin Conceptual Framework in Disaster Management *Eva Brucherseifer* *Discussant: Raymond Freth A. Lagria*	Ocean Salinity, Early-Life Health, and Adaptation *Amanda Guimbeau* *Discussant: Martino Pelli*	Using Big Data to Improve Prediction and Management of Climate Induced Migration and Displacement in Asia and the Pacific *Patricia Anne Delmendo and Bradley Mellicker* *Discussant: Md Sariful Islam*
	Inspection of Multi-scale Analysis for Building Damage Extraction by Tsunami *Shimpei Nakano* *Discussant: Md Jubaer Arefin*	The Development of CrisisPulse: Text-based Extraction System for Microblogs *Raymond Freth A. Lagria* *Discussant: Masayuki Okugawa*	Storms, Early Education and Human Capital *Martino Pelli* *Discussant: Prakriti Shakya*	Walking on the Edge: Bangladesh's Erosion Realities, Geophysical Vulnerabilities, and Disproportionate Impacts on Different Demographics and Socioeconomic Groups *Md Sariful Islam* *Discussant: Sabuj Kumar Mandal*
	Impacts of disasters in conflict settings: Top-down and bottom-up estimations *Elodie Blanc* *Discussant: Sabine Chandradewi Loos*	Plant Disaster Prevention Through the Fusion of Robot Technology and Digital Twin *Masayuki Okugawa* *Discussant: Shunichi Koshimura*		Data Driven Perspectives on Disaster Induced Migration - Social Network Nexus among Rural Agricultural Households in India *Sabuj Kumar Mandal* *Discussant: Lennart Reiners*

Demand, impacts and the consequences of mis-designed crop insurance: Evidence from administrative data of nationwide program in Thailand

Boontida Sa-ngimnet,[1] Chonnakan Rittinon, and Sommarat Chantarat

Abstract

This paper contributes to the on-going debates on the design and scale-up crop insurance in developing countries, where theoretically, crop insurance could be one of the important tools to ensure resilient agricultural growth amidst the rise of disaster shocks but transaction cost, information asymmetry and high government subsidies have been impeding sustainable development of crop insurance market. We use several administrative data of insured and uninsured farm households nationwide merged at household and plot levels to understand dynamics of insurance demand, the potential direct and indirect impacts of crop insurance and the consequences of delay in indemnity disbursement (mis-design), lack of risk-based pricing (mis-pricing) and high premium subsidies (mis-government) on insurance demand and impacts. Thailand's nationwide rice insurance program started since 2011 could serve as a nice representation of one of the world's largest and long-standing programs for this study. Our results could shed light towards rethinking and redesigning a more sustainable crop insurance program in developing countries.

[1] Puey Ungphakorn Institute for Economic Research, Bank of Thailand

Impact of Tropical Cyclones on Fishing Activity in the Philippines

Miloud Lacheheb,[1] Ilan Noy, and Madhavi Pundit

Abstract

In this paper, we identify the main fishing grounds in the Philippines' maritime Exclusive Economic Zone and track the response of fishing vessels' activity to tropical cyclones (TCs) during 2012. We use satellite imagery from the National Oceanic and Atmospheric Administration to locate fishing vessels and identify the main fishing grounds; in conjunction with data on TCs' speed and trajectory from the International Best Track Archive for Climate Stewardship database. We use kernel density functions to identify fishing grounds and Vector Generalized Linear Model and Bayesian Time-Varying Parameter to assess the impact of TC speed on the location of fishing vessels during and after the TC. Our quantifications reveal the overall negative impact of TCs on the number of active boats during and 2 days after the TC. The fishing grounds located within the Sibuyan Sea, Visayan Sea, and Panay Gulf are the most affected areas. Daily reduction in the commercial fishing production in Western Visayas alone for every day a TC passed through was estimated at 7,800 tons per day, affecting more than 188,000 families.

[1] PhD Candidate School of Economics and Finance, Victoria University of Wellington

Poverty Impacts of the Pakistan Flood 2022

Erwin Knippenberg,[1] Mattia Amadio, and Moritz Meyer

Abstract

In the summer of 2022, devastating floods hit Pakistan with a profound negative impact on lives and livelihoods. Apart from the irreconcilable loss of life, household welfare was negatively impacted through at least four channels: (i) loss of household income and employment/livelihood due to destroyed harvest, killed livestock, or inactivity of businesses; (ii) loss of assets, including homes, livestock, productive equipment, and household durables; (iii) rising food prices due to shortages of food arising from lost food stocks, and poor harvests; and (iv) loss of human capital, given significant threat of disease outbreaks and food shortages, and prolonged school closures, with attendant learning losses. Yet, in the absence of just-in-time information from households, it was a challenge to evaluate the welfare impact, particularly in terms of poverty. This paper demonstrates how real-time geospatial data, in combination with administrative data and historical household survey data, can be used to model the impact of floods on Pakistani households. Estimates showed that, as a direct consequence of the floods, the national poverty rate would increase by 3.7 to 4.0 percentage points, pushing between 8.4 and 9.1 million people into poverty. Moreover, a spatially disaggregated analysis showed that the size and duration of shocks varied across locations and households depending on the intensity of the flooding and household characteristics. These estimates, which informed the Post Disaster Needs Assessment and were later used to inform the Donor Conference for Pakistan, provide an example of rapid modeling in the absence of real-time household data.

[1] The World Bank, Poverty and Equity Global Practice

Designing a nationwide crop insurance program in Thailand using big data and mobile technology

Surasak Choedpasuporn,[1] Sommarat Chantarat, Pucktada Treeratpituk,
Jose Velarde Morales,[2] and Teerasit Kasetkasem

Abstract

This paper explores promises of big data, satellite technology and mobile technology in creating high-quality plot-level loss verification and risk information necessary for unlocking market inefficiencies that have precluded sustainable development of crop insurance markets and overall risk management in agricultural sector, where uninsured risk remains a leading impediment of economic development. We attempt to answer three research questions. How well can big data combined with satellite technology be used to provide more timely, more accurate and more transparent verification of crop losses at plot level? How might these data driven loss verification be used to create technology-based design and pricing of nationwide crop insurance program? And how do we evaluate performance and create a quality assurance framework for technology-based crop insurance design to justify suitability of moving from research to real policy implementation?

[1] Puey Ungphakorn Institute for Economic Research, Bank of Thailand
[2] PhD Candidate, University of Chicago, Booth School of Business

Global Economic Consequences of the Physical Climate Impacts on Agriculture And Energy

Roshen Fernando[1]

Abstract

Climate change continues to be an existential threat to humanity. With intrinsic linkages to the natural environment, food and energy supply chains are two fundamental channels via which climate risks could spill over into the economy. This paper explores the global economic consequences of the physical climate impacts on agriculture and energy. Firstly, we construct a range of chronic and extreme climate risk indicators. Secondly, we incorporate those climate risk indicators, alongside the historical data on global agriculture and energy, in machine learning algorithms to estimate the historical responsiveness of agriculture and energy to climate risks. Thirdly, we project agriculture and energy production changes under three Shared Socioeconomic Pathways (SSPs). Finally, the derived shocks are introduced as economic shocks to the global, multisectoral, intertemporal general equilibrium model: G-Cubed. We evaluate the G-Cubed simulation results for various economic variables, including real GDP, consumption, investment, exports and imports, real interest rates, and sectoral production. We observe substantial losses to all economies and adjustments to consumption and investment under the SSPs. The losses worsen with warming. Developing countries are disproportionately affected. However, we observe the potential for double dividends from transitioning to sustainable livestock production and renewable energy sources, preventing further warming and physical damages, and enhancing the resilience of food and energy supply chains to climate risks.

[1] Centre for Applied Macroeconomic Analysis, Crawford School of Public Policy, The Australian National University

Rapid assessment of landslide induced vegetation damage using Disaster Vegetation Damage Index (DVDI)

Md Nahid Ferdous[1] and Mohammad Ismail Hossain

Abstract

One of the most significant, destructive, and frequent natural disasters in Bangladesh's hilly regions is landslides. Devastating landslides have frequently occurred in the nation's hilly regions in recent decades. Climate change typically is the major contributor of these events along with other human-caused factors like widespread excavation of hills, unplanned land use, and dense population growth. Nevertheless, to my knowledge, there are no official databases to analyze the trend of vegetation loss caused by landslides in the hilly regions. Accurately measuring vegetation damage is crucial for improving vegetation preservation and restoration. In this study, a remote sensing method was used for assessing the degree of damage caused by landslides. Vegetation damage was estimated from MODIS data by using vegetation damage indices DVDI. This study aims to explore the spatial pattern of vegetation damage. The initial application of DVDI in landslide disasters has shown its effectiveness in determining the degree of vegetation damage resulting from natural disasters and 2922.25 sq. Km of the total vegetation damaged by landslide event. The NDVI profile curve was used to verify the damage assessment results, and the expected downward curve was found. Findings from this study help policymakers and decision-makers conduct more accurate vegetation damage monitoring after landslides and any future extreme weather and climatic events.

[1] Institute of Disaster Management, Khulna University of Engineering & Technology

A Model analysis approach for reassessment of the Cyclone Shelter plan focusing both on accessibility and accommodation capacity for local communities' case study of Khulna, Bangladesh

Mohammad Ismail Hossain,[1] and **Md Jubaer Arefin**[2]

Abstract

Bangladesh is one of the most disaster-prone countries in the world and is affected by frequent disasters such as floods, cyclones, tidal waves, riverbank erosion and earthquakes. Optimizing the location and allocation of cyclone shelters is critical to improving the resilience of local communities. However, the existing disaster-cyclone shelter (CS) site allocation optimization models usually select new shelters from candidate shelters, neglecting the existing or planned shelters. In this study, we address the need to re-evaluate and improve the implementation capacity of the cyclone protection plan prepared exclusively by some local government authorities based on area analysis. Using a case study in Khulna, Bangladesh, researchers propose a simulation and network analysis based on a Geographic Information System (GIS)-based modeling approach to re-evaluate the implementation capability by focusing on the community's accessibility to nearby CS and their Concentrate accommodation capacity. The results show that the current CS ordered by the local government is not easily accessible when a cyclone occurs in coastal areas. Approximately 60% of residents do not have enough time to evacuate to the CS as many shelters are located far from residential areas. Communities were also found to vary in terms of shelter capacity risk. The use of public buildings near residential areas for emergency shelters was suggested and policy implications were derived to identify suspect areas for further investigation and possible improvement, by encouraging local community agreement on their shelters and adding new designated shelters in appropriate locations become. The proposed model has proven useful for site optimization of cyclone shelters, and the results presented can be used as a reference for balancing the interests of government and residents in shelter reconstruction and expansion projects. The paper concludes with further research needed to integrate the proposed approach to implementing the cyclone shelter plan.

[1] Institute of Disaster Management, Khulna University of Engineering & Technology
[2] Palli Karma-Sahayak Foundation (PKSF), Dhaka, Bangladesh

Modelling geo-hydrological hazard scenarios for assessing suitability of evacuation shelter by proposing Bayesian Optimized CNN

Somnath Bera,[1] Swapan Talukdar, Balamurugan Guru, Ranit Chatterjee, and G V Ramana

Abstract

The Western Ghat region of India, characterised by its complex topography and climatic conditions, is prone to natural hazards such as floods and landslides, which pose a significant threat to the local population and infrastructure. The main objective of this study was to develop robust susceptibility models for floods and landslides and integrate them with an evacuation suitability model using the Fuzzy Analytic Hierarchy Process (Fuzzy-AHP). Variable Inflation Factor (VIF) analysis was used to analyse characteristics such as 'precipitation' and 'lithology' for landslides and 'slope' and 'land use land cover (LULC)' for floods. This showed minimal multicollinearity with VIF values well below the threshold of 9. Recursive feature elimination with Random Forest (RFE-RF) further refined the feature selection and emphasised the importance of 'slope', 'precipitation' and 'runoff_proximity' for predictive modelling. Bayesian optimised Convolutional Neural Networks (CNN) with an attention mechanism were optimized for landslide and flood susceptibility modeling. The result was highly accurate models with overall accuracies, precision and recall rates above 91% and ROC values around 0.98 for landslides and 0.97 for floods. By integrating these models with evaluative and constraining factors via a Fuzzy Analytic Hierarchy Process (Fuzzy AHP), the study produced a zonation map showing that 18% of the region is highly suitable for evacuation shelters, while 47% is unsuitable, with moderate and low suitability zones covering 14% and 21% of the area, respectively. The spatial analysis also revealed that suitability in the northern and western parts of the region is lower than in the southern and eastern areas due to environmental factors, emphasising the need for targeted evacuation strategies. This comprehensive approach emphasises the effectiveness of the model in delineating vulnerable areas and provides a solid framework for local authorities to improve emergency response mechanisms in the Western Ghat region.

[1] Department of Geography, Central University of South Bihar, Gaya, India

Analyzing Poverty Incidence and Disaster Vulnerability of Informal Settlements in Baguio City, Philippines using Spatial Microsimulation Approach

Noriel Christopher Tiglao,[1] Erris Sanciangco, Niki Jon Tolentino, and Mark De Guzman

Abstract

This study presents the use of a spatial microsimulation approach and the utilization of high-resolution satellite images and crowdsourced GPS data in combination with census-based data in investigating poverty incidence and disaster vulnerability. Spatial microsimulation is a technique for estimating the characteristics of a population. It allows us to combine traditional census-style aggregate statistics about an area with smaller scale and more specific surveys to generate a population that contains estimated characteristics from both. Spatial microsimulation approach provides a very powerful framework in overcoming the data and modeling problems in urban analysis. One main advantage of the spatial microsimulation approach is that it is capable of building reliable disaggregate data sets at fine geographic scales. It is able to utilize existing disparate data sets and is flexible enough to incorporate new available information. Household micro data can be developed, appropriate models can be calibrated and tested using the rich database. A spatial microsimulation model called InformalSim has been developed for Metro Manila. The microsimulation model uniquely provides detailed household microdata and allows the identification of the informal households. On the other hand, the development of integrated urban models has been prompted by the need for more responsive policy analysis.

[1] National College of Public Administration and Governance, University of the Philippines Diliman

Leveraging Earth Observation Data and Products to create a Comprehensive Tsunami Loss Estimation Platform – Impacts in a Changing Climate

Ronald T. Eguchi[1]

Abstract

This paper and presentation will summarize progress on a two-year grant recently awarded to the project team by the National Atmospheric and Space Administration (NASA) under its Disasters Program. This project has been designed to radically transform the way in which we characterize the impact of tsunamis over various timescales and for different emergency management operations. Assessing future risks from any natural catastrophe is complex and often involves the integration of physical and statistical models, accurate monitoring devices, and a clear connection to the decision-making needs of government agencies and other entities that must implement preemptive actions to mitigate the impacts of a disaster. Because tsunamis can impact extremely large stretches of coastlines, the use of robust data such as earth observation (EO) imagery are needed to fully characterize not only the physical features of a region that might lead to extensive tsunami inundation but also other factors that could exacerbate the impacts should the tsunami intersect human developments. EO information, along with space-geodetic techniques, like GNSS (Global Navigation Satellite Systems), has been shown to be essential in characterizing earthquake source properties that could lead to enhanced tsunami inundation. This same data has also been demonstrated to be an effective means of measuring and monitoring changes in the landscape and in human development, i.e., number, size and location of buildings and infrastructure. This project is novel and timely in that it connects all these concepts to produce a comprehensive and advanced tsunami loss estimation model.

The technical innovations of the platform are 1) a probabilistic framework for modeling future tsunami hazards and risks, 2) a comprehensive view of the financial and societal impacts of tsunamis, 3) data and models for exposure and climate change analysis using remote sensing technologies, 4) physics-based models of earthquake generation and tsunami inundation, and 5) a unified methodology using geodesy that can inform tsunami risk assessments in real-time.
This study also affords several opportunities to ensure its impact is far-reaching and sustainable. For example, the solutions that are envisioned in extending complex, simulation-based solutions to simplified and easily executed operations will ensure that robust assessments of risk can be performed using "event set" methodologies without massive computing resources. This type of solution can be applied to many other natural catastrophes, such as flooding and coastal storm surge, to help fully understand the potential for these events to cause significant losses over decades, and beyond.

Probabilistic tsunami risk modeling also plays a vital role in identifying areas of higher or lower risk, allowing for the efficient allocation of resources for mitigation and preparedness. By quantifying the probabilities associated with different levels of tsunami impacts, it enables policymakers, emergency planners, and coastal communities to make informed decisions. These decisions encompass various aspects, including land-use planning, evacuation strategies, infrastructure design, and early warning systems. Additionally, asset stakeholders can take appropriate measures, such as securing adequate financial protection through insurance, to mitigate potential financial losses in future tsunami disasters.

[1] ImageCat, Inc.

Modeling dynamics of landslide hazard and exposed population under climate change scenario using hybrid deep learning

Pritha Ghosh,[1] Swapan Talukdar, Shivam Priyadarshi, and Somnath Bera

Abstract

The mountainous region particularly South Asia is experiencing frequent disaster events that likely come out as a consequence of increasing landslides under the impact of climate change and rapid growth of human population. These problems are not only evident in the present but pose a serious threat to the future of the mountain. To overcome the problem, landslide risk assessment has been developed as a preliminary tool that is flourishing in the advent of spatial big data and Geo AI. Despite the progress, major studies on landslide risk have been looked at from a static approach. One of the limitations of this approach is that it ignores the dynamics of hazard and its interaction with the exposed population which shapes the future risk. Therefore, the static approach is not appealing for long-term risk mitigation planning. In the background, we propose a spatial framework for landslide hazards and exposed populations using a dynamic approach. The methodological framework constitutes three parts: (i) landslide hazard modeling using Geo AI, (ii) developing future landslide hazard scenarios considering climate change, and (iii) assessing population risk. We use novel deep learning and GIS for creating landslide hazard modeling. The hazard modeling includes the susceptibility index. At first, a detailed landslide inventory database (covering the year from 2001 to 2023) is generated using a GPS-based field survey, multitemporal Google Earth images (2001-2021), and high-resolution satellite images. The study incorporates geology, topographic factors, and some climatic variables as modeling input like total annual precipitation considered as dynamic triggering factors. After the database preparation, the deep learning algorithm is applied to predict the landslide susceptibility index considering inventory and geophysical factors as data input. Further, the hazard scenario is projected (the years 2040, and 2050) using rainfall in Representative Concentration Pathway (RCP) 2.6, 4.5, 6.0, and 8.5. In the second part, exposed population has been analyzed by integrating susceptibility scenarios. We apply the methodological framework in the Darjeeling Himalayas, India which is one of the hotspot regions of landslides. The finding of the study shows the hazard significantly changes under differential rainfall scenarios in the same spatial framework. The trend of population risk is overall increasing although not always in a linear way. The resulting diverse pattern of population risk indicates the possible impact of intra-migration that needs to be studied further. The study can help in policy-making and assessing the carrying capacity of the region.

[1] Department of Geography, Central University of South Bihar, Gaya, India

Small-Grid Urban Flood Prediction Model Using Twitter Data and Population GPS Data - An example of the 2019 Nagano City Flood

Yifan Yang,[1] Naoki Ohira, and Hideomi Gokon

Abstract

In this study, a small-grid urban flood prediction model integrating Twitter data and population GPS data was constructed using the 2019 Nagano City flood as an example, and the validity of these two data for the model was determined. Using natural language processing techniques, Twitter data is filtered to extract real-time information relevant to flooding. At the same time, geographic information processing techniques are applied to analyze the population's GPS data and obtain the distribution of the population's location. Based on these two types of data, combined with terrain, land use, traffic and infrastructure data related to flooding, a real-time flood prediction model is constructed using the random forest algorithm with a basic unit of a 70m x 70m grid. An analysis of the model accuracy shows that, the model that includes both GPS and Twitter data shows an improvement in prediction accuracy of about 0.08 compared to flood prediction models that do not have these data sources. This indicates that the integrated use of Twitter and GPS data allows for a more accurate representation of the dynamic characteristics of flood disasters, thereby improving the performance of real-time flood prediction models and increasing real-time awareness of flood events. This approach provides effective flood monitoring methods for disaster management authorities.

[1] School of Knowledge Science, Japan Advanced Institute of Science and Technology, Ishikawa, Japan

Machine-learning approaches to enhance tsunami damage modeling for coastal roads: lessons from the 2011 Great East Japan Event

Anna Rita Scorzini,[1] Mario Di Bacco, James H. Williams, Daisuke Sugawara

Abstract

In the context of disaster risk assessment, the accurate prediction of tsunami-induced damage to coastal road infrastructure remains a critical challenge. Conventional approaches often rely on fragility functions, which, while valuable, might not fully capture the intricate non-linear interactions among diverse variables influencing the damage mechanisms. This study aims at addressing this limitation by employing advanced multi-variable machine learning models, based on the road damage dataset compiled by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) of Japan after the 2011 Great East Japan Event in the Tōhoku region.

The dataset comprises a line shapefile that represents the actual length of each damaged road segment, with an associated damage level, distinguished into three classes, as minor, moderate or severe damage. To address the absence of information regarding undamaged assets into the original MLIT dataset, all roads within the inundated area are incorporated into it. This integration involves sourcing road data from OpenStreetMap or digitizing them from aerial imagery. As a result of this comprehensive data compilation effort, the dataset finally encompasses approximately 4300 km of inundated roads, with roughly 20% of them associated with a specific damage level. This empirical dataset is one of the few globally available for tsunami-damaged transportation infrastructure, making it a valuable asset to be used in data-intensive machine-learning approaches. Moreover, to obtain insights into the multi-variable nature of tsunami damage mechanisms on roads, the dataset has been enriched by associating additional potential explanatory variables to each segment. These are not limited to the hydraulic features of the inundation, but they also encompass morphological features at the road location as well as proxy variables for accounting for shielding effects and debris impacts exerted by nearby structures, all of which can be computed through straightforward geospatial analysis.

The utilization of this extended dataset within a machine-learning framework allows for an enhanced understanding of road damage dynamics during tsunami events, overcoming the limitations of conventional fragility functions. The insights generated by multi-variable models, such as the outcomes from the feature importance analysis, can empower stakeholders with the essential knowledge for more informed and efficient decision-making in disaster risk management. This encompasses targeted and optimized resource allocation, both in the ex-ante risk assessment phases and during the post-event emergency response. As a result, the improved model outcomes, along with the explicit treatment of modeling uncertainties and efficient input data retrieval and computation, would contribute to an enhanced overall effectiveness of risk management processes. The proposed modeling framework demonstrates significant potential for replication across diverse geographical regions. As new datasets emerge, this approach holds promise for widespread applicability, making it a versatile and adaptable tool for disaster risk assessment across various contexts.

[1] Department of Civil, Environmental and Architectural Engineering, University of L'Aquila

Predictive Analytics for Road Safety Enhancement on Mugling-Narayanghat Road Section, Nepal

Bhuwan Awasthi,[1] Swostika Goraju, Sulav Lohani, Sandesh Karki, Sanjaya Devkota, and Youb Raj Bhatta

Abstract

This study aims to build a relationship between environmental factors and road traffic accidents along the Mugling-Narayanghat road section. The complex topography, fragile geological conditions, adversarial weather conditions, and diverse traffic volume on this highway present a unique case for applying machine learning techniques to predict and mitigate hazard1-induced road accidents.

A combined dataset consisting of variables such as weather conditions, visibility, traffic volume, slope gradient, historical road landslides and accident data was prepared to create a predictive model. This dataset was assembled using remote sensing imageries, meteorological data, and on- ground traffic records to ensure competency and relevance to the analysis.

In the initial phase, the Factor of Safety (FoS) model was calibrated incorporating the terrain attributes such as infiltration rate and slope with various rainfall thresholds alongside other geotechnical parameters to measure the stability of the varied and complex terrains along the road section. Here, the rainfall data accompanied by the thresholds acted as a dynamic variable, offering insights into the transient and often volatile nature of the landscape's stability. Additionally, an empirical model developed at the University of Lausanne was used. The Flow-R (Flow path assessment of gravitational hazards at a regional scale) model was applied to delineate the propagation of flow, runout and susceptibility on the roadside terrain. A digital elevation model was used to derive the preconditioning factors contributing to the debris flow susceptibility map. Similarly, a visual depiction of geographical hotspots was depicted where landslides and accidents have previously occurred for assessing patterns, correlations and anomalies. Similarly, heat maps were produced portraying a historical chronology of slope movements alongside accident data. The challenges regarding data limitations in Nepal were thoroughly acknowledged. To address these issues, several external sources including newspapers, official reports, and academic research were assessed to enhance the compatibility of the datasets.

Subsequently, machine learning algorithms were applied to understand their predictive accuracy. The models were created using Artificial Neural Networks (ANN), Logistic Regression (LR), Decision Trees (DT), and Support Vector Machines (SVM). The independent variable of rainfall and morphometric parameters of the slope were critical to understanding their impact on road safety. Additionally, the application of OneHotEncoder and StandardScaler aided towards categorical and numerical data which were transformed and normalized, enhancing the model's predictive capability. The performance evaluation was conducted using metrics of precision, recall, and F1-score.

Our findings indicated a significant correlation between adverse weather conditions, increased traffic volume, and the propensity for landslide-induced road accidents (LIRA) along the Mugling-Narayanghat road section. The predictive models demonstrated promising potential to act as an instrumental tool for authorities and policymakers to develop informed, data-driven strategies to augment road safety.

This study applied a novel approach by utilizing machine learning to understand the dynamics of road safety to delineate patterns and correlations that traditional analytical methods might overlook on the Mugling-Narayanghat Road section. The insights gathered here have the potential to significantly reduce hazard-induced accidents, enhance traffic management, and foster a safer commuting environment, marking a significant stride towards the integration of machine learning techniques in urban planning and disaster management in the context of Nepal.

[1] Forum for Energy and Environment Development (P) Ltd, Lalitpur, Nepal

An Integrated Framework for Satellite-based Flood Mapping and Socioeconomic Risk Analysis: A Case of Thailand

Nattapong Puttanapong[1] and Nutchapon Prasertsoong

Abstract

This study introduces a novel approach to monitoring floods and estimating socioeconomic impacts in Thailand. The approach leverages advancements in geospatial data, employing two web-based applications developed on the Google Earth Engine platform. These tools provide user-friendly access to a vast array of satellite data at the provincial level, including flooded areas, nighttime-light density, drought index, rainfall, cropland, and urban areas. The study also merges these satellite-based indices with official provincial GDP data from 2018 to 2022 to empirically analyze socioeconomic impacts using spatial panel regression techniques and machine learning algorithms. The result obtained from random-effect panel regression shows that a one percent increase in one-week flooded land can reduce GDP by 0.025 percent with an r-squared value of 0.702. Alternatively, four machine learning algorithms were applied, with Random Forest (RF) demonstrating the highest predictive power for GDP forecasting (r-squared value of 0.912). Feature analysis methods identified the proportion of flooded urban areas as a significant variable in predicting provincial GDP. The RF prediction model was also employed to conduct counterfactual simulations for the period 2018-2022, hypothesizing a scenario devoid of flood events. This approach facilitated the determination of a theoretical GDP value in the absence of floods, thereby enabling the calculation of flood-related economic losses, which averaged 0.945 percent of GDP. The study's analytical framework, notable for its cost-effectiveness, leverages openly accessible data and open-source software packages, making it highly applicable to various developing countries.

[1] Faculty of Economics, Thammasat University

The Impact of Natural Disasters on Light-based Geospatial Income Inequality

Jaqueson K. Galimberti,[1] Stefan Pichler, and Regina Pleninger

Abstract

We evaluate the impact of natural disasters on inequality, taking advantage of a newly constructed and here extended database of light-based geospatial income inequality (LGII) measures. Our new database provides Gini-coefficients for 233 countries and territories over the period from 1992 to 2019. The LGII is based on geo-located data of nighttime lights matched with gridded population counts, and is constructed to approximate income inequality from a benchmark measure that is not available for many countries affected by disasters. We estimate the impacts of disasters on inequality using panel regressions and a synthetic control group method (SCGM). The impact of natural disasters is hard to disentangle due to heterogeneity across disasters and the slowly moving nature of inequality. The panel regressions indicate that climatological disasters tend to decrease inequality, while meteorological disasters increase it. The SCGM analysis further illustrates the high variation of impacts across a selection of severe disasters. The magnitudes of the effects tend to decrease when looking at countries with multiple disasters, which suggests some degree of preparedness may condition the impacts of disasters on inequality.

[1] Asian Development Bank

The Project CCHAIN Dataset: Linking Village-Level Data on Climatic Impact-Drivers, Socioeconomic Vulnerability, and Environmental Conditions to Health Impacts across 12 Philippine Cities

John Wong, Pia Faustino, Faye Abigail Cruz, Ericka Lynne Nava, **J.C. Albert C Peralta I,**[1] Veronica Marie Araneta, Dafrose Camile Bajaro, Abigail Moreno, Kathlyn Baladad, Mathew Limlengco, Luis Desquitado, Ma. Angelica Daza, Julie Mae Dado, and Leia Pauline Tonga

Abstract

The Philippines is among the world's most vulnerable countries to climate change – simultaneously exposed to typhoons, sea level rise, and extreme heat, while striving to address income inequality and rising disease burdens. While there is growing interest in modeling the health impacts of climate change in the country, this has proven to be difficult because data is fragmented across different sources. Significant data workflow logistics and multi-disciplinary expertise is required to assemble and process health, climate, and socioeconomic data from diverse sources, formats, geographic coverage and resolutions. The Project Climate Change, Health, and Artificial Intelligence (Project CCHAIN) dataset: a validated, open-sourced linked dataset measuring 20 years (2003-2022) of climate, environmental, socioeconomic, and health dimensions at the barangay (village) level across 12 Philippine cities. The dataset will be used to build a baseline village-level outbreak prediction machine learning model which simulates potential impacts of communicable diseases like dengue. In addition to the linked dataset, a dataset of building outlines containing roof attributes based on satellite imagery is also provided to aid in generating more detailed data at the community level. Data is sourced from local and national health facilities, climate and weather institutions, open-source geospatial platforms, and previously conducted household surveys to ensure that the dataset represents the variety of socioeconomic, climatological, and geographic conditions across the Philippines. The resulting open-source datasets will provide policy-makes, civil society, enterprises, academe, and the communities themselves with a baseline picture of the historical and spatial connection between climate and health in the Philippines and can promote investments in the creation of more open and analysis-ready datasets.

[1] Thinking Machines Data Science, Inc.

Temperature variability as a driver of poverty in low- and middle-income countries

Paul Jasper[1] and **Ida Brzezinska**[1]

Abstract

Climate change distributes its negative impacts on societies unequally. Low- and middle-income countries (LMICs) are disproportionately affected by climate change, which threatens to undo global progress in poverty reduction. Temperature variability has been shown to reduce macro-economic growth and to negatively affect household wealth. Climate models predict that LMICs are located in 'hotspot' areas that will experience the largest increases in temperature variability. Understanding the effects of an increasingly variable climate on social and economic outcomes is thus of key importance. Yet current literature on the link between temperature variability and poverty has limited geographical coverage, with evidence from many LMICs still missing. In addition, the poverty data used in studies to date have tended to be at a low level of spatial disaggregation, obscuring the spatial distribution of poverty at small areas. This paper combines remote sensing temperature data from the Reanalysis Fifth Generation (ERA5) global climate dataset for 2018 and micro-estimates of relative household wealth at a 2.4km spatial resolution predicted by machine learning (ML) algorithms from Chi et al. (2022) in a Spatial First Differences (SFD) research design. We find a robust negative effect of increases in day-to-day temperature variability on household wealth across 89 LMICs. Our heterogeneity analysis shows that certain regions will be more affected than others. The magnitude of negative effects of day-to-day temperature variability on poverty is largest in Sub-Saharan Africa, followed by Middle East & North Africa, East Asia & Pacific, and South Asia – when compared to Europe & Central Asia. Altogether our findings highlight the need to build climate resilience across LMICs, for instance through climate-responsive social protection programmes – particularly in the most affected geographies.

[1] Oxford Policy Management

Quantifying Traffic Responses under the Highest-Level Warning and Extreme Rainstorm in Beijing

Ziying Zhou[1] and **Xiaoyan Liu**[1]

Abstract

Climate change leads to frequent and intense extreme weather, posing threats to densely populated urban areas. The disaster warning system is an effective adaptation method, but research in high-density areas of developing countries remains limited. In this context, our study focuses on Beijing, the capital of China, examining a case of the highest-level rainstorm warning issued in late July 2023. Using 30-minute interval traffic congestion data, the study conducts a quantitative analysis of the urban operational rhythms. We found that citizens actively responded to the disaster warning, reducing road traffic pressure on rainy days. Specifically, when the warning was issued, traffic congestion experienced a slight increase, with an earlier occurrence of the evening rush hour, reflecting the preparatory actions before the rainstorm. In the following three days, road congestion was below normal levels, indicating the cancellation of numerous activities during the rainstorm. The complex congestion conditions can be categorized into three modes: the intensely changing evening peak, the locally changing off peak, and the relatively stable morning peak. The study clusters the city's internal spaces based on typical modes and classifies them using multi-source variates. It was found that population characteristics, location accessibility, and built facilities can effectively explain the changes in road congestion during disasters. Based on these findings, suggestions for future extreme disaster response are proposed.

[1] Beijing Normal University

Machine Learning for Disaster Mobility Modeling: Methods and Data

Jonas Gunkel,[1] Andrea Tundis, and Max Mühlhäuser

Abstract

In the field of disaster management, understanding the dynamics of urban mobility during extreme situations plays a pivotal role. In order to forecast future mobility and comprehend its complex relationships and interdependencies, according data must be available. Within the last years, Machine Learning models have been increasingly applied to model and predict the dynamics of mobility. However, existing work mostly addresses mobility in regular situations and neglect extreme events and disasters. To accelerate research on approaches that center on such events, we present a structured literature review on machine learning methods for disaster mobility. The purpose of this review is to provide a foundation of knowledge for other researcher and synthesize novel approaches. We identify the existing approaches and analyse them with a focus on the proposed methods and used data. Our review shows a limited but heterogeneous body of literature that comprises diverse approaches, tasks and disaster context.

[1] Institute for the Protection of Terrestrial Infrastructures, German Aerospace Center (DLR)

Quantification of urban mobility, based on big data of population locations

Makoto Okumura[1] and Yuri Sawamura

Abstract

In this study, we propose a general method for quantitatively capturing urban daily mobility based on the Mobile Spatial Statistics data including residential location information by Docomo Insight Marketing Co. Ltd. We propose a method for setting up aggregation zones that can ensure calculation accuracy while aggregating a large amount of the hourly population data by mesh and residential municipalities. In the proposed method, the distance traveled can be easily calculated based on the zone index number by defining aggregation zones classified by distance and direction from a representative origin in the city center, and by taking into account the location relationship with the residential area. We applied the method to the Sapporo Metropolitan area and showed stable fluctuations under normal conditions and to quantify the impact of the heavy snowfall disaster in Sapporo in early February 2022.

[1] International Research Institute of Disaster Science, Tohoku University

Framing of Disasters in Digital Media using NLP: A Case Study on Flood Risk Management

Hannah Bailon,[1] Claudia Orellana-Rodriguez, Marc Van Den Homberg, and Kees Boersma

Abstract

High-quality impact data is essential for several applications in disaster risk management such as Early Warning Systems. However, currently, most impact data has spatial and temporal gaps, especially in data-poor contexts. Local news media reporting on disasters can contain information to bridge these gaps, whereby each news media outlet frames disasters differently, especially since disasters diffuse in time and space. This study addresses these challenges by interrogating the implications of varying depictions of disasters in media reporting and their added value for impact databases. Our case study focuses on Malawi given that it is a relatively data-poor country and very prone to flooding.

Our dataset is based on the Emergency Events Database (EM-DAT) and the damage data from the Department of Disaster Management Affairs (DoDMA) in Malawi. These are official sources that record the types and effects of the disasters in Malawi. Hereby, DoDMA relies only the data they collect themselves via Damage and Needs Assessments, whereas EM-DAT also include damage data from other sources. As for the news articles, four quality national newspapers of leading news outlets were identified through a basic web search and an electronic database search of Malawian news outlets.

To comprehensively investigate our dataset, we applied natural language processing (NLP) techniques and content analysis to break down and interpret the news article text and narratives, such as the sentences, and even parts-of-speech. To get insights into the articles' grammatical structure, we worked with three linguistic annotations: part-of-speech tagging, named entity recognition, and sentiment analysis.

The main conclusions from the framing are that: (1) online media has a human-focus framing when reporting on the dramatic events in Malawi, emphasizing the role of crucial persons and actors; and (2) online media frame impact at a more granular level. A better understanding of the framing of disasters in newspapers can be used to extract impact data and enrich institutional impact databases in a more insightful way.

While our study focuses on Malawi, an African country which is out of scope of this conference, we argue that our study has many valuable applications also in other disaster-prone countries in the Asia Pacific, given the high penetration of online news and social media. Our study serves as a first step into better understanding the framing of disasters in newspapers to extract impact data and enrich institutional impact databases used in various countries. This study can help actors in disaster risk management to focus on official information from local news media to enrich existing impact data and to better define triggers for disaster risk management.

[1] Vrije Universiteit Amsterdam

Agent-Based Modelling of Systemic Risk in Disaster Response in the Philippines Using Emotional Contagion Analysis

Ivan Harris Tanyag[1]

Abstract

Emotional contagion, a process where one person's emotions and behaviors can influence and trigger similar emotions and behaviors in others within a social network, holds the key to unraveling its intricate relationship with systemic risk, which have traditionally relied on multi-hazard risk assessments and physical vulnerability analyses. Previous research has only looked into the outward expressions of emotion after disasters. Nowcasting emotional contagion however offers a more novel and promising approach to comprehending the dynamics of systemic risk more comprehensively. The presence of social media platforms and the unprecedented volume of data generated by its users during disaster events provide an opportunity to delve into the phenomenon further. Big data analytics, coupled with multi-hazard risk assessments and rapid-mapping approaches, allow policymakers in the field to explore how emotions propagate through affected populations in real-time by identifying key emotional drivers and influencers within these networks.

In this paper, we use agent-based computational model to simulate the spread of emotions and opinions in online social networks. We focus on posts, comments, and interactions related to pre-identified recent disaster events in the Philippines, namely the (1) Super Typhoon Noru, and (2) 2022 Northern Luzon Earthquake. A virtual environment was created to represent the online social networks of affected individuals. Each user is modeled as an agent with attributes related exclusively to their demographics, social connections, and emotional states. These emotions are represented on a scale, and agents can transition between emotional states based on their interactions and exposure to emotional content. Each post or comment will be classified into emotional categories, such as positive, negative, neutral, or specific emotions like fear or hope. We also tracked how the sentiment in social media data evolved over time during and after a disaster. This temporal analysis helps us understand how emotions change as the crisis unfolds.

Our initial findings suggest that emotional contagion plays a significant role in shaping public sentiments during disaster events in the Philippines. Users oftentimes use specific keywords or hashtags to call out for help, express dismay or anxiety, and seek emotional support on social media platforms. Moreover, it is noticed that users with a high number of followers tend to have a more substantial influence on emotional contagion within the network. As such, there is a risk of amplifying "negative" emotions and misinformation during critical phases of disaster response and recovery. These findings underscore the need for a more integrated approach that incorporates emotional contagion dynamics into systemic risk assessments. One practical step would involve the integration of sentiment analysis tools in early-warning SMS alert system to better gauge and respond to the emotional state of affected populations in real-time. Post-disaster mapping can also prove invaluable as well by overlaying emotional contagion dynamics onto existing geographical data. These forms of disaster impact assessment will help policymakers better identify the socioeconomic distress and status of affected individuals using disaggregated data.

[1] School of Urban and Regional Planning, University of the Philippines-Diliman

Factors determining risk perception among university students in the face of an infectious disease outbreak

Jiasheng Xiong, Genming Zhao, Biao Xu, and **Qi Zhao**[1]

Abstract

Background: Risk perception, which mainly includes risk susceptibility and risk severity, refers to an individual's understanding of various objective dangers in the external world, and excessive risk perception tends to be psychologically stressful, which further contributes to the occurrence of psychiatric disorders. Understanding the determinants of individual risk perception in infectious diseases may help to provide efficient health promotion and interventions to reduce the occurrence of mental illness.

Objectives: To investigate the level of risk perception among university students experiencing the COVID-19 pandemic and to explore the relevant factors that determine risk perception in the face of a public health emergency.

Methods: An anonymous questionnaire including demographic, socioeconomic characteristics, risk perception of COVID-19 and relevant determinants was conducted through an online survey system from April 19 to April 30, 2020. According to the number of confirmed COVID-19 cases at the time of the survey, the locations of university students were classified into three groups, named as high, median and low disease burden areas. Risk perception scores ranged from 1 to 4. Each relevant determinant was scored on a scale of 0 to 10, with a higher scores reflecting a greater influence on a person's risk perception, and a score of 0 indicating no association between the indicator and risk perception. Descriptive analysis and chi-squared test were used to identify differences in respondents' risk perceptions, while Factor Analysis and Multinational Logistic Regression were used to analyze common factors associated with risk perceptions.

Conclusions: More attention should be paid to female students and those living in areas with high disease burden. Efficient health education on infectious diseases should be developed based on the student's risk perception and understanding of the determinants. More information on the curability of infectious diseases and the availability of medical resources should be provided to students in high-risk areas, while for those in low-risk areas, vigilance against public opinion should be emphasized.

[1] Fudan University

Are disaster impact estimates distorted by errors in popular night-time lights data?

John Gibson,[1] Yi Jiang, Xiaoxuan Zhang, and Geua Boe-Gibson

Abstract

Practitioners and researchers can now rapidly assess economic and social impacts of disasters and monitor recovery by using satellite-detected earth observation data. Readily accessible night-time lights (NTL) data have especially enabled this research on disasters (Feeny et al, 2022; Nguyen and Noy, 2020). Yet even as this literature expands, questions are raised elsewhere about NTL data as a proxy for changes in local economic activity. These data seem to only weakly relate to changes in traditional measures of local activity, such as commune-level employment and household expenditures (Goldblatt et al, 2020) or county-level GDP (Zhang and Gibson, 2022) even in countries where more spatially aggregated data give closer activity-luminosity relationships. It is especially low density rural areas of developing countries where relationships between NTL data and local economic activity are weak (Gibson et al, 2021). In such places, alternative data for evaluating disaster impacts are scarce. Some researchers therefore suggest that NTL data may only be suitable for studying disasters that mainly affect urban areas (Akter, 2023).

One issue with NTL proxies for local economic impacts is that the most popular data are from the Defense Meteorological Satellite Program (DMSP), which first launched in the 1960s for cloud observation by the US Department of Defense. These low resolution data have ground footprint of 25 km2 at best while newer research-oriented satellites provide data that are at least 45 times more spatially precise (Elvidge et al, 2013). The DMSP data are also temporally inconsistent, and top- and bottom-coded. The combined effects of various DMSP errors create biases in impact evaluations of local shocks (Kim et al, 2023).

It might be expected that disasters research would naturally transition to the higher resolution VIIRS data available since 2012 but two factors cause features of DMSP data to still matter. First, some recent influential papers on disasters have continued to rely on these DMSP data (Elliott et al, 2015; Strobl, 2019). Second, DMSP data have been given a new lease of life by 'harmonized' data that link VIIRS and DMSP (e.g. Li et al, 2020) which have proved popular with economists because of the long time-series. Harmonization requires downgrading VIIRS products to be like the low-resolution DMSP data (Nechaev et al, 2021) and so the properties of DMSP data are still relevant for disasters in the VIIRS era (2012 onwards).

We examine whether the use of DMSP data distorts disaster evaluations, using typhoon damages in the Philippines from 2012-19 as our case study. With the DMSP data, municipal level negative impacts on economic activity always appear at least 50% larger than when the more accurate VIIRS data are used. This potential overstatement of the economic shocks is apparent especially when using spatial models that allow for spillovers. A likely cause is the far larger DMSP ground footprint which induces much more apparent spatial autocorrelation. Harmonized data that degrade VIIRS data to be like DMSP likely also have this spurious autocorrelation so researchers should be cautious in using these data for disaster assessments.

[1] University of Waikato

Twitter-Derived Measures of Economy and Uncertainty for the Philippines

Daniel Boller, Kazushi Ikeda, Madhavi Pundit, **Renzo Tan,**[1] **Benedict Tiu,**[2]
Priscille Villanueva, and Zihao Yu

Abstract

Economic planners need to closely monitor the state of the economy to make timely policy decisions, especially in times of uncertainty. However, they are constrained by a lack of near real-time information because traditional data such as the gross domestic product, activity indicators, and business surveys usually come with a considerable time lag. With this, the quest for timely indicators for macroeconomic monitoring is gaining importance, particularly during event like COVID-19 pandemic, disasters and economic shocks.

High-frequency data, such as social media posts, offer near-real-time insight into public sentiment but are often considered too unstructured and noisy for effective modeling. This study proposes a novel set of Twitter-based (now called X) economic and uncertainty indicators, with the Philippines as a case study. The research employs search strategies and text mining techniques to convert social media-based text into usable data for macroeconomic nowcasting. The resulting indicators enable a data-driven approach to identifying and monitoring significant events across various sectors, with themes customizable to highlight domains of interest.

In establishing predictive power, traditional economic variables are set as benchmark input. A mixed-data sampling framework is adopted for the nowcasting models, with the quarterly gross domestic product growth and other main indicators as targets. The new tweet-based metrics demonstrate significantly lower errors, both with machine learning and factor modeling, and may be utilized by policymakers to assess the impact of significant events such as disasters on the economy. The measures are grounded on a balance of interpretability and accuracy, following a data-driven approach from indicator construction to predictive modeling.

[1] Asian Development Bank, Nara Institute of Science and Technology, Kyoto University, Ateneo de Manila University
[2] Nara Institute of Science and Technology

Urbanization in a changing climate: Global evidence of rapid urban growth in flood zones since 1985

Jun Rentschler,[1] Paolo Avner, Mattia Marconcini, Rui Su, Emanuele Strano, Louise Bernard, Capucine Riom, and Stephane Hallegatte

Abstract

As countries rapidly urbanize, settlements are expanding into hazardous flood zones. This study provides a global analysis of spatial urbanization patterns and the evolution of flood exposure between 1985 and 2015. Using high-resolution annual data, it shows that settlements across the world grew by 85 percent to over 1.28 million square kilometers. In the same period, settlements exposed to the highest flood hazard level increased by 122 percent. In many regions, risky growth is outpacing safe growth, particularly in East Asia, where high-risk settlements have expanded 60 percent faster than safe ones. Developing countries are driving the recent growth of flood exposure: 36,500 square kilometers of settlements were built in the world's highest-risk zones since 1985 – 82 percent of which are in low- and middle-income countries. In comparison, recent growth in high-income countries has been relatively slow and safe. These results document a divergence in countries' exposure to flood hazards. Rather than adapting their exposure to climatic hazards, many countries are actively increasing their exposure.

A part of this ongoing work was recently published.[2] *Ongoing work aims at adapting this method for continuous "real time" monitoring of high-risk urbanization.*

[1] The World Bank

[2] Rentschler, J., Avner, P., Marconcini, M. et al. Global evidence of rapid urban growth in flood zones since 1985. Nature 622, 87–92 (2023).

The Relation between Entrepreneurs' Social Identity and Venture Success in Times of Crisis

Syrine Adala[1]

Abstract

The meanings entrepreneurs associate with their ventures shape their behavior and actions, particularly in the face of extreme challenges. These meanings, closely tied to entrepreneurial endeavours, are in turn an expression of entrepreneurs' social identity. Building on the typology of entrepreneurs' social identity orientations developed by Fauchart and Gruber (2011), this study investigates whether and to what extent entrepreneurs' social identity influences their ability to successfully navigate their ventures through times of crisis (i.e., the COVID-19 pandemic). The authors build a unique longitudinal dataset comprising 5,749 entrepreneurs, their associated ventures, and their tweets. This dataset combines venture-level data from Crunchbase with fine-grained Twitter data, covering both pre- and during the COVID-19 pandemic periods. Social identity orientations are measured via a computerized textual analysis of the digital footprints of entrepreneurs on Twitter. The results show that a darwinian social identity orientation positively influences venture success during times of crisis, while a communitarian and missionary social identity orientation positively impacts venture success in stable times.

[1] Technische Universität Darmstadt

Towards High resolution Simulation of Post Disaster Economies Utilizing Firm level Data

Joshua Panganiban,[1] Amit Gill, Lalith Maddegedara, Yoshiki Ogawa, Muneo Hori, Tsuyoshi Ichimura, and Kohei Fujita

Abstract

Major disasters affect economies in highly complex ways due to the strong interrelationship of economic entities to each other and their heavy dependence on infrastructures. As an example, damages to the lifeline and transportation networks, accessed by firms and their suppliers and consumers, brought upon by disasters are highly heterogeneous, causing extremely varied impacts on different firms even if they are located within the same geographical region. Moreover, the interdependence of economic entities makes these disaster impacts ripple through the regional and national economies in another highly complex manner. For this reason, accurate assessment of the short-term and long-term economic impacts of disasters and the economic performance of their corresponding candidate recovery plans calls for an approach that considers individual economic entities, their complex interdependence, and other real-world constraints such as access to lifelines, transportation, and changes in the government policies during the post-disaster recovery period. Achieving this level of analysis requires high-resolution modeling of the economy and the infrastructure as an integrated system. Going towards this objective, we developed a high-performance computing (HPC) extension for an agent-based economic model that is capable of efficiently simulating large economies with hundreds of millions of economic entities at a 1:1 scale. In our most recent works, we further advanced this model by integrating it with the historical business data of around 1.4 million firms provided by Teikoku Databank, Ltd., such that the firm agents in the model are initialized with the data of their real-world counterparts. Validation tests show that the model is capable of reproducing the past observed indices of the Japanese economy at three levels of resolution: national (e.g., national GDP), industrial (e.g., sectoral production) and firm-level (e.g., sales records of major firms). To demonstrate the application of the developed system in a disaster case and policy use, we estimated the economic impacts of a hypothetical disaster scenario and simulated a simple recovery plan. This research contributes to the understanding of disaster consequences and highlights the use of firm-level data in the field of disaster risk analysis and management.

[1] The University of Tokyo

Numerical Simulation for Leak Detection based on Water Pressure Observation by Smart Meters

Yoshihisa Maruyama[1] and Takashi Yasue

Abstract

Currently, more than 20,000 water leakage and pipe breakage incidents occur annually in Japan's water supply system. Leaks in water pipes can be roughly classified into two types: aboveground leaks that flow out above the ground and underground leaks that do not flow out above the ground but flow underground. While aboveground leaks are easy to detect because they are visible, under-ground leaks cannot be directly confirmed visually. Therefore, development for early detection method is required. In this study, the authors tried to detect leakage location based on water pressure observation, assuming the monitoring of pipelines using smart meters, which are currently in widespread use. Six models with different explanatory variables and machine learning methods were constructed, and their prediction accuracy was compared. The leakage prediction model based on LightGBM, which uses the rate of water pressure change, amount of water pressure change, and pipe type information as explanatory variables, showed the best results.

[1] Chiba University

Modeling and Monitoring social media dynamics to predict short-term peak electricity demand

Isabella Nunes Grieser,[1] Tobias Gebhard, Andrea Tundis, Jens Kersten, Tobias Elßner, and Florian Steinke

Abstract

During the COVID-19 pandemic, the world witnessed the phenomenon of panic buying, with consumers stockpiling essentials. Such unexpected consumer behavior is often influenced by social media in the form of rumors or fake news and can lead to sudden, synchronized actions. Currently, these events have primarily impacted supply chains. However, synchronized consumer behavior poses a substantial threat to critical infrastructure services, such as energy supply, and excessive power consumption can cause blackouts. Therefore, to understand the relationship between social dynamics and energy usage and to detect such trends can play a crucial role in disaster response and crisis management. This paper proposes a novel data-driven modeling approach to monitor critical social media dynamics that impact power infrastructure. We present a framework designed to model information propagation, simulate changes and estimate peaks in electricity demand. An epidemiological model, the Susceptible-Infectious-Recovered (SIR) model, is used to simulate information propagation processes. Households who disseminate false information can be viewed as "infected". The model calculates the aggregated electricity consumption for a scenario in which households receive misinformation about reduced electricity prices for a limited time. We utilize social media data from past disaster events from X (formerly Twitter) to estimate the specific model parameters of our framework. To overcome the sparsity of incidents where social media actually influenced the use of energy, we used social media data from other critical events to fine-tune the parameters of the SIR model. Using unrelated but similar data to develop the core of the model is crucial for its ability to generalize to unknown future scenarios.

[1] Energy Information Networks and Systems Lab, Technical University of Darmstadt

Navigating Drought: Analyzing Panama Canal Transit Disruptions Using AIS Big Data

Zhaowen Wang,[1] Mahinthan J. Mariasingham, Cherryl Chico, and Ed Kieran C. Reyes

Abstract

The Panama Canal experienced historically low water levels due to a severe drought in 2023. In response, the Panama Canal Authority has imposed restrictions on daily transits since July 2023, causing significant backlogs of vessels awaiting passage. This study leverages big data from the Automatic Identification System (AIS) to comprehensively analyze the impact of the drought on transit activities through the Panama Canal. By examining AIS indicators such as count of transits before and during the drought, this study conducts a statistical analysis to recognize the evolving trend in the time series to quantify the drought's impact on transit activities. The Mann-Kendall and Sen's Slope Estimator are applied to identify and determine the magnitude of the trend. Furthermore, as a critical conduit connecting the Atlantic and Pacific Oceans, the Panama Canal holds immense importance in regional and global trade. By utilizing AIS data, this study identifies the top 10 country pairs that transit through the Panama Canal and investigates the monthly counts of transit activities between these countries, shedding light on how the drought in Panama has impacted maritime transportation and the global supply chain. The ongoing water scarcity crisis in Panama serves as a reminder that climate change is fundamentally reshaping economic and trade landscapes, posing a significant threat to future growth and prosperity. Harnessing the potential of AIS data provides a profound and immediate understanding of the drought's impact on the Panama Canal, empowering stakeholders to effectively mitigate economic vulnerabilities and ensure sustainable development amidst evolving climate patterns.

[1] Asian Development Bank

Exploring the Relationship Between Snow Depth and Population Mobility Using Mobile GPS and Weather Data

Zhenyu Yang,[1] Hideomi Gokon, and Ziheng Liu

Abstract

Snow disasters significantly impact people's mobility, leading to traffic congestion and economic losses. This study explores the relationship between weather factors, road density, and population distribution during snow disasters. By employing Pearson correlation coefficients and Bayesian Structural Time Series Models, this paper identifies the correlation and causality between weather variables and population distribution. Additionally, the study utilizes polynomial regression analysis to define the specific mathematical relationship between the rate of snow depth change and population change rate. Furthermore, through spatial clustering and propensity score matching methods, this paper also investigates the impact of road density on the resistance to snow disasters. The results indicate that changes in snow depth have a significant causal effect on population distribution. Overall, snow disasters negatively affect people's mobility. Additionally, areas with higher road density exhibit stronger resistance to snow disasters.

[1] School of Knowledge Science, Japan Advanced Institute of Science and Technology

Leveraging Big Data for Enhanced Disaster Response and Management: A Case Study of BRAC's Initiatives in Bangladesh

Naimul Islam[1] and Saiyeed Mashkur Al - Hakim

Abstract

Bangladesh faces recurrent natural disasters, such as cyclones and floods, challenging the resilience of its population. BRAC, the world's largest NGO, plays a pivotal role in emergency health support. BRAC's health program, including the innovative mHealth system launched in 2020, has digitized health services and improved data capabilities. The paper explores the impact of mHealth's big data in disaster response, focusing on the 2022 floods in Sylhet regions of Bangladesh.

In response to the severe 2022 floods in Bangladesh, BRAC efficiently used its mHealth database to adaptively respond to evolving immediate community needs across Sylhet regions. By rapidly analyzing data, BRAC targeted vulnerable groups, providing timely aid like high-energy biscuits. The organization's comprehensive approach extended beyond food provision to address diverse needs, supported by post-response assessments for continuous improvement.

BRAC's use of big data during the 2022 floods in Bangladesh proved crucial, aiding 316,002 beneficiaries, with a focused approach benefiting 24,519 pregnant women, 34,104 lactating mothers, and 257,379 children under five. The extensive outreach demonstrated the significant impact of leveraging big data in disaster response, enabling swift, informed decisions to ensure aid reached those in need.

BRAC's success in disaster response in 2022 reflects a broader pattern of effective and adaptive crisis management, extending beyond floods to addressing the COVID-19 pandemic and a diarrhea outbreak. Looking ahead, BRAC aims to expand its data-driven initiatives, emphasizing the transformative potential of big data in creating resilient and responsive global disaster management systems.

[1] BRAC Health Programme

Explainable Impact-Based Forecasting for Tropical Cyclones

Sahara Sedhain,[1] Marc van den Homberg, Aklilu Teklesadik, Maarten van Aalst, and Norman Kerle

Abstract

With an increase in the number of disasters due to rising climate hazards and vulnerabilities, the investment and focus of disaster practitioners has shifted from conventional response-driven approaches to anticipatory actions (AA). To support this process, humanitarian organizations have been developing trigger mechanisms to automatically release funding and initiate early actions once the agreed threshold in terms of hazard or impact-based warning is reached. Technical advances in hazard forecasting and increased use and access to big and small data have accelerated this process of trigger model development to scale up AA. However, this also means increased complexity in the modelling algorithms, making interpreting the trigger model and results difficult for decision-makers. This gap between developers and users limits the adoption of these models. Therefore, a framework for evaluating and interpreting these trigger models is essential for humanitarian decision-makers, one that remains relatively unexplored. We adapted the concept of explainability from the Artificial Intelligence domain for impact-based forecasting (IBF) models used for triggering actions before a tropical cyclone. This concept was applied to two contrasting approaches to IBF. One approach uses a machine learning algorithm with several predictors, which 510-the Netherlands Red Cross developed for the Philippines. A second approach uses a damage curve for impact prediction and combines it with composite vulnerability ranking and was adapted for the same study area during this research. We developed indicators of explainability, both post-hoc and intrinsic, that can be used for characterizing IBF models, by showing which elements influence the result and how, through a model card. Additionally, through a case study of typhoon Kammuri (2019) in the Philippines, we demonstrate how the two models would have performed in hindsight, based on their accuracy of impact prediction and ability to trigger action on time. The sensitivity of the result was also tested for variation in parameters such as forecast lead time uncertainty and trigger thresholds. The results suggest that complex models are not necessarily an obvious choice for making better predictions, as the elementary model performed relatively better for this case study. The model card provides a good indication of the working principle of the models, highlighting the similarities and differences between the two. To effectively communicate the comparison, we developed an interactive decision-support tool prototype that allows dynamic testing of the variations in input parameters, enabling decision-makers to understand the models better and enables them to assess how each model meets their requirements. However, only a comparison between the two approaches over a sufficiently large set of historical events and socio-economic contexts can be used to evaluate the performance. Hereby it is important to mention that an impact-based forecasting model can never be better than the hazard forecast that goes into the model due to the uncertainties in hazard forecasting. The model card and decision portal template have the potential to facilitate AA, not only in making a more informed selection of IBF models, but also to communicate the uncertainties and choices involved in the process to all relevant stakeholders.

[1] University of Twente, Faculty of Geo-information Science and Earth Observation (ITC), Netherlands

Using AI to Collect Information on Disaster Resilience of Public Financial Management Systems

Yasemin Palta[1]

Abstract

Disasters pose extraordinary challenges for public financial management (PFM) systems because they place urgent demands on governments for relief and recovery while simultaneously disrupting economic activity and the normal operations of governments. PFM practices of preparing, executing, reporting, and scrutinizing the budget that is appropriate during normal operations may be ill-suited for disaster response. Resources may need to be shifted to disaster response without going through the usual approval process. Budget execution and public procurement procedures may need to be expedited to ensure the timely delivery of disaster relief. However, this needs to be done in an accountable and transparent manner.

To understand how countries can better prepare for, respond to, and recover from disasters, the World Bank team identified the eight aspects of PFM in a Disaster Resilient and Responsive PFM Assessment Tool (DRR-PFM; http://hdl.handle.net/10986/37033) to help improve the government's capacity to manage disaster-related risks and sustain PFM after a disaster. The DRR-PFM Assessment covers five key areas of the PFM system: planning and budgeting, public investment and asset management, budget execution and control, public procurement, audit and oversight, as well as the three cross-cutting themes of institutional arrangements, IT systems and records, and social inclusion. The Assessment encompasses the central finance agencies (CFAs) as they regulate and manage core PFM functions, spending or line agencies, and oversight institutions. The Assessment acknowledges the need for close collaboration between central finance and national disaster management agencies to ensure adequate, effective, and inclusive preparation for, response to, and recovery from disasters.

To help governments and development partners collect data on the extent to which PFM systems are designed to support disaster risk management and how they can improve, the team developed a prototype for an online and streamlined data collection, analysis, and reporting tool. The prototype solution helps stakeholders to collect the data using a user-friendly questionnaire, automates the creation of a final report from the questionnaire, and efficiently reviews and analyzes the evidence provided by stakeholders in response to the questions to streamline the assessment process and improve the accuracy of assessments, and extracts valuable insights from questionnaires, visualizes the assessment results; track a country's disaster resilience progress over time, while also allowing for easy comparison with other countries.

In addition to traditional technologies, groundbreaking AI capabilities are leveraged to propose a way to bring efficiency into the DRR-PFM assessment process. The proposed solution uses Generative LLMs (Large Language Models) such as OpenAI GPT-4 32k model, Azure Semantic Cognitive Search, and Azure Form Recognizer to automatically retrieve evidence for eligible questions from selected pdf documents, generate element-level summaries that reflect a concise overview of all the answers related to these elements, and provides key findings of the entire assessment, ultimately supporting the evaluation process for the country's disaster management practices.

This approach allows for an efficient and streamlined process in creating reports, enabling decision-makers to quickly assess and act upon the crucial aspects of disaster management for the respective country.

[1] The World Bank

Monitoring Post-Disaster Reconstruction to Support Evaluation of Early Recovery Frameworks

Sabine Loos,[1] Paula Bürgi, and Kanako Iuchi

Abstract

In the first year after a major international disaster, early recovery frameworks are developed by the National Government of the affected country with support from multilateral agencies. These early recovery frameworks are important since they shape the recovery from the disaster for years after the event, though evaluating the effectiveness of these frameworks is challenging because conducting longitudinal household-level assessments of recovery is time and resource-intensive. This project leverages earth observation data to develop a method to monitor recovery remotely, which can complement a small sample of field surveys of recovery to inform recovery policy evaluation. Specifically, we develop a times series change detection technique leveraging InSAR (Interferometric Synthetic Aperture Radar) coherence data. We compare the recovery monitoring assessment from the InSAR data to a subset of a longitudinal survey of recovery conducted between 2015 and 2019 for a range of n = 2,980 (2015) to n = 5,857 (2019) respondents. Preliminary results show that it may be possible to leverage InSAR data to obtain large-scale differences in reconstruction between communities that were prioritized in the recovery framework and those that were not. With additional development, this method can prove useful as an evaluation tool for early recovery frameworks to evaluate whether change is occurring due to a recovery policy intervention.

[1] Civil and Environmental Engineering, University of Michigan

Remote sensing-based approach for estimating insured typhoon-induced economic losses from building damage

Hiroyuki Miura,[1] Yusuke Murata Hiroyuki Wakasa, and Tomotaka Takara

Abstract

Rapid and cost-effective economic loss estimation for buildings in non-life insurance is an important issue for insurance industries in order to provide immediate financial supports to residents affected by natural disasters. This study introduces an empirical approach for economic loss estimation of typhoon-induced building damage from post-disaster remote sensing (RS) images based on insurance records obtained in Osaka and Chiba, Japan affected by the 2018 Typhoon Jebi and the 2019 Typhoon Faxai, respectively. From the insurance records and the analysis of the RS images, we found that area-based loss rates (ALRs) defined as ratio of amount of loss to amount of insured values within a mesh were proportional to building damage ratios (BDRs) identified from number of damaged buildings in the RS images and existing building inventory data, whereas it was still challenging to accurately estimate loss rate for building-by-building even from very high-resolution images. A linear regression function was developed from the relationship between the ALRs and BDRs obtained in this study. We confirmed that the regression function provided a good approximation of the insured losses from the typhoon disasters. Furthermore, we also demonstrated applications of deep learning (DL) model for automatic building damage identifications from aerial images to quickly evaluate BDRs. This method consists of building area detection based on building footprints, DL-based classification of building damage for detected image patches, and visualization of building damage distribution. We confirmed that the BDRs estimated by the DL model agree with the BDRs from visual inspections. These results indicate that typhoon-induced insured losses can be rapidly estimated from the insurance inventory and the analysis of post-disaster RS images without field investigations.

[1] Graduate School of Advanced Science and Engineering, Hiroshima University

Inspection of Multi-scale Analysis for Building Damage Extraction by Tsunami

Shimpei Nakano[1] and Gokon Hideomi

Abstract

Disaster response and resource allocation are critical to minimize the impact of a significant disaster and prevent secondary disasters, which require rapid assessment of the damage. Remote sensing techniques using synthetic aperture radar (SAR) installed in satellites have been proposed to assess the extent of damage across large areas quickly. However, accurately assessing damage, especially in cases of inundation such as tsunamis and floods, involves considering multiple scales of damage, from the urban-wide scale to individual buildings. While previous studies have hinted at the benefits of considering multiple scales for improving the accuracy of building damage extraction compared to methods that rely solely on local changes in backscatter coefficients, there has been a lack of comprehensive research on determining which scale parameters are most suitable for different phenomena.

This study addresses this gap by aiming to develop a more accurate building damage extraction method. Our approach involves incorporating multiple scale parameters into the SAR image analysis algorithm. To achieve this, we surveyed to identify which scale parameters could enhance accuracy and improve our ability to capture various phenomena. The primary focus of our research was the machine-learning-based binary classification of buildings affected by a tsunami in the 2011 off the Pacific coast of Tohoku Earthquake. We utilized SAR data from TerraSAR-X backscatter coefficient images taken before and after the disaster. Our classification targets consisted of house polygons generated through field surveys. To distinguish the degree of damage, we introduced a 10-meter buffer zone around each building polygon, termed "Small Scale Segments." These segments were categorized as either residuals or runoff based on post-tsunami field surveys, serving as our primary objective variable.

Preprocessing techniques were applied to the SAR images, including calculating the difference in backscatter coefficients before and after the earthquake, cross-correlation, standard deviation of the backscatter coefficient difference image, and the difference of standard deviation. In addition, image segmentation was performed on these images using the Region Growing method to create a "Large Scale Segment."

For the explanatory variables, we computed zone statistics for each preprocessed image in both the Small Scale and Large Scale Segments. We then employed five machine learning algorithms—Logistic Regression, Support Vector Machine, Decision Tree, Random Forest, and AdaBoost—to perform binary classification using objective and explanatory variables. Our findings revealed that the Random Forest algorithm achieved the highest classification accuracy, achieving 77.4% accuracy when using Small-scale parameters and an impressive 88.4% when utilizing Small+Large scale parameters. Notably, this improvement in accuracy was consistent across all the algorithms we employed. In response to these results, we conducted a detailed analysis of the distribution and characteristics of buildings whose classification results differed between the Small-scale and Multi-scale cases. This investigation allowed us to identify and discuss the challenges associated with this methodology.

[1] Japan Advanced Institute of Science and Technology

Impacts of disasters in conflict settings: Top-down and bottom-up estimations

Elodie Blanc,[1] Karima Ben Bih, Chloé Desjonquères, Bramka Arga Jafino, Adeline Guasch, and Katie Ann Harris Peters

Abstract

We estimate the differentiated economic impact of natural hazard-related disasters (the specific disasters studied here being floods) when they occur in conflict- versus non-conflict-affected areas. While the literature shows that disasters can cause significant distress to countries and people, assumptions are made that their economic impact tends to be larger in conflict-affected areas. However, little evidence is available on the differentiated extent of these damages. This paper investigates whether, how, and to what extent, the presence of conflicts has amplified the impacts of floods on economic activity and people, and hampered recovery. In this draft paper we apply a "top-down" approach to estimating the differential impacts of natural disasters between conflict and non-conflict affected areas using satellite-derived imagery of nightlight radiance as proxy for economic activity, along with geospatial footprints of floods. A second, subsequent analysis will complement these findings using household survey panel data ("bottom-up"). The analysis is based on the study of tropical cyclones Idai and Kenneth and subsequent floods in Mozambique in 2019. Using difference-in-difference estimations, we find that there are significant differences in disaster impacts and recovery between conflict- and non-conflict-affected areas: we observe a greater decline in economic activities and longer recovery time in conflict affected areas.

[1] The World Bank; Motu Economic and Public Policy Research

Disaster Digital Twin - A Mixed Initiative of Human and Machine for Resilience

Shunichi Koshimura,[1] Erick Mas, Yusaku Ohta, Naomichi Kuwahara, and Shinji Kataya

Abstract

Digital twin is now recognized as digital copies of the physical world's objects stored in digital space and utilized to simulate the sequences and consequences of target phenomena. By incorporating the physical world's data into the digital twin, developers and users can fully view the target through real-time feedback. Recent advances in high-performance computing and large-scale data fusion of sensing and observations of both natural and social phenomena are enhancing the applicability of the digital twin paradigm to natural disaster research. Artificial intelligence (AI) and machine learning are also being applied more widely and contributing as essential elements of digital twin. Those have significant implications for disaster response and recovery to hold out the promise of dramatically improving our understanding of disaster-affected areas and responses in real-time.

A project is underway to enhance the resilience of disaster response systems by constructing "Disaster Digital Twin" to support the disaster response team in the anticipated tsunami disaster. "Disaster Digital Twin" platform consists of a fusion of real-time hazard simulation, e.g. tsunami inundation forecast, social sensing to identify the dynamic exposed population, and multi-agent simulation of disaster response activities to find optimal allocation or strategy of response efforts, and achieve the enhancement of disaster resilience.

[1] International Research Institute of Disaster Science, Tohoku University

A Data Classification Towards the Applicability of the Digital Twin Conceptual Framework in Disaster Management

Eva Brucherseifer,[1] Marco Marquard, Andrea Tundis

Abstract

The Digital Twin (DT) concept has gained attention within the last years and offers monitoring as well as simulation features. It provides a new perspective for supporting the management of critical infrastructures, such as energy, water, traffic or communication, and their related services. Such networked infrastructures are nowadays the backbone of our societies with increasingly complex and interconnected characteristics and high availability demands. As such DT also provides new opportunities to improve implementation of disaster Response and Management within urban areas. Starting from our previous contribution related to the conceptualization of a Digital Twin Framework to improve critical infrastructure resilience, in this work we deal with its applicability with reference to disaster response and crisis management so as to show the suitability of the paradigm of digital twins to handle big data. To allow the DT to effectively support the management process of crisis situations, it is important to enable the DT to handle variable kinds of data input. This is because the failure of critical infrastructures or part of them due to the occurrence of crises and disaster can strongly influence the availability of data sources. As a consequence, to reduce the negative impact of missing sources, it is fundamental to gain a global understanding of multiple and alternative sources which can be used as alternative or complementary information to be processed. Therefore, we investigate (i) different types of potential sources by highlighting their distinguishing features on the one hand, and (ii) the relationships between them by distinguishing, for example, between non-substitutable, complementary and alternative sources on the other hand. Thus, we obtain a classification of data that can be integrated into the DT framework to enable the automatic handling of data shortages in crisis situations in different application contexts. The evaluation of the proposal is conducted by considering different application scenarios that are part of ongoing DLR projects as well as by also considering the already existing research contribution in the literature.

[1] Institute for the Protection of Terrestrial Infrastructures (PI), German Aerospace Center (DLR)

The Development of CrisisPulse: A Text-based Extraction System for Microblogs

Raymond Freth A. Lagria,[1] Malvin Domingo, and Kimberly Tiamzon

Abstract

The Philippines consistently ranks among the top 10 countries most severely impacted by disasters caused by natural phenomena. In response to this ongoing vulnerability, this paper introduces CrisisPulse, a text-based extraction system designed to leverage microblogs as a valuable resource for disaster risk reduction and management. The utilization of social media data, particularly microblogs, offers a vast repository of information that can be harnessed for various applications, including data visualization, social sensing, and advanced analytics, with a particular focus on disaster scenarios. CrisisPulse operates through a server interface that connects to a microblog API, enabling the retrieval of real-time data containing predefined keywords associated with disasters. The extracted text data is then transformed from JSON format to structured format and are stored in a relational database, specifically PostgreSQL. Subsequently, these data are processed to generate informative data visualization plots, which are presented through a custom-built webpage employing ChartJS. Beyond visualization, the framework can support advanced analytics applications, such as classification and time series analysis, to provide deeper insights into the data. To illustrate the system's efficacy, this paper utilizes earthquake-related text data during significant seismic events as a case study. The validation process underscores the proposed framework's efficiency in capturing earthquake events of a certain magnitude through social sensing. These findings underscore the potential of CrisisPulse as a valuable tool in enhancing disaster response and risk mitigation efforts, particularly in regions prone to natural disasters like the Philippines.

[1] University of the Philippines Diliman

Plant Disaster Prevention Through the Fusion of Robot Technology and Digital Twin

Masayuki Okugawa,[1] Yoshikazu Othsubo, Shotaro Kojima, Tetsuya Kimura, Shizuka Ikawa, Tatsuya Sato, Ranajit Chatterjee, Fumitoshi Matsuno, and Satoshi Tadokoro

Abstract

A mobile robot that can patrol the plant under autonomous control or remote control performs visual inspections of various gauges and operates valves, sequentially reporting inspection and work results to the digital twin. The digital twin will be updated on plant operating status and will record history by digitally archiving. The digital twin will be updated on plant operating status and will record history by digitally archiving. Utilizing big data obtained using robot technology is expected to not only understand the operating status of the plant but also enable avoiding accidents, equipment health evaluation, early detection of abnormal conditions/deformations, fitness for service, accident/disaster risk prediction with simulation, and optimization of plant operating status. In addition, robots can replace inspectors in dangerous locations or bad environments, which helps ensure the safety of inspectors. Furthermore, learning the know-how of experts using AI is also expected to solve the problem of technology inheritance. This paper describes problems during plant operation, outlines the competition concept and rules for the WRS plant disaster prevention challenge, and describes the benefits of fusion digital twin and robot technology, as well as presents a future image of next-generation plants.

[1] Aichi Institute of Technology

Spatial Analysis of Weather Shocks Vulnerability in Children's Nutrition: A Comparative Study of Three Ecological Regions in Nepal

Prakriti Shakya[1]

Abstract

Nutrition obtained during the growth period of childhood significantly influences long-term well-being and overall productivity, ultimately contributing to the economy of a society. However, sudden extreme weather events such as droughts, floods, typhoons, can wreak havoc by damaging crops and disrupting market access, which directly impacts the food intake of both adults and children. When these adverse events occur during childhood, short term and long term inadequacy in nutrition can cause malnutrition leading to stunted growth and cognitive impairment that may persist into adulthood, affecting the labor market and increasing health expenditure. To address this issue, we develop a novel Food Insecurity Index using Random Forest model with r-square of 0.86 that uses satellite data of temperature and precipitation to measure the vulnerability of children's nutrition to these environmental fluctuations across three ecological regions of Nepal.

[1] Master's Student, Department of Economics, University of San Francisco

Ocean Salinity, Early-Life Health, and Adaptation

Amanda Guimbeau,[1] Xinde James Ji, Zi Long, and Nidhiya Menon

Abstract

We study the effects of in utero exposure to climate change induced high ocean salinity levels on children's anthropometric outcomes. Leveraging six geo-referenced waves of the Bangladesh Demographic and Health Surveys merged with gridded data on ocean salinity, ocean chemistry and weather indicators (temperature, rainfall and humidity) from 1993 to 2018, we find that a one standard deviation increase in in utero salinity exposure leads to a 0.11 standard deviation decline in height-for-age. Effects on weight-for-height and weight-for-age for a similar magnitude increase in salinity are 0.13 and 0.15 standard deviations, respectively. Analyses of parental investments and health-seeking behaviors demonstrate that compensating actions along these dimensions to attenuate the detrimental effects of salinity are few and restricted to poorer households. Using satellite-sourced datasets on agriculture and land-use, we find that increasing salinity constrains farmers' land use choices, leading to lower agricultural profitability. In particular, the effects of salinity on child health originate in areas with lower agricultural intensity caused by the progressive salinization of productive lands. These results highlight highlight the costs of environmental insults on early-life health outcomes in vulnerable populations.

[1] Université de Sherbrooke

Storms, Early Education and Human Capital

Martino Pelli[1] and Jeanne Tschopp

Abstract

This paper explores how school-age exposure to storms impacts the education and primary activity status of young adults in India. Using a cross-sectional cohort study based on wind exposure histories, we find evidence of a significant deskilling of areas vulnerable to climate change-related risks. Specifically, our results show a 2.4 percentage point increase in the probability of accruing educational delays, a 2 percentage point decline in post-secondary education achievement, and a 1.6 percentage point reduction in obtaining regular salaried jobs. Additionally, our study provides evidence that degraded school infrastructure and declining household income contribute to these findings.

[1] Asian Development Bank; University of Sherbrooke; CIREQ; and CIRANO

From Aspiration to Relocation – Assessing the Impacts of Natural Disasters on Migration using Big Data

Madhavi Pundit, **Lennart Reiners,**[1] and Lukas Wellner

Abstract

Climate change will increase both the frequency and intensity of extreme weather events such as floods, droughts, and heat waves. As policymakers commit to net-zero emissions targets, people in the Global South are already experiencing the impacts of climate change. Coping mechanisms in developing countries are often weak at best. In this context, migration is becoming an increasingly important coping strategy, and climate change-induced migration is estimated to reach 143 million people by 2050 (IPCC 2022). This will further exacerbate global migration pressures, making understanding natural disaster-induced migration a key policy concern.

However, there is a notable gap in the existing literature regarding precise causal estimates of how climate change affects migration decisions. Due to data limitations, analyses often rely on either aggregated (e.g., Beine and Parsons 2015) or individual-level survey sources with limited scope and external validity (e.g., Bekeart et al. 2020, Bertoli et al. 2020). Big data, therefore, offers a unique opportunity to improve our understanding of disaster-induced migration in Asia and the Pacific and beyond. To this end, our project aims to extend the literature by i) exploiting previously untapped big data sources related to migration, ii) combining them with novel econometric methods, thereby iii) allowing us to estimate both disaster-induced migration aspirations and actual decisions, while iv) investigating the underlying mechanisms of this risk coping behavior.

We employ two strategies: First, we use data from the Gallup World Poll (Gallup 2021) on individual-level migration aspirations in the Global South between 2008 and 2020, combine them with CRED's Emergency Events Database, and integrate them into a survey time-based discontinuity estimation framework (Wellner et. al. 2022). This approach can provide arguably causal estimates of disaster-induced migration decisions on a global scale for over a decade, which would be a significant contribution to the literature. Our second strategy recognizes that while migration aspirations have been shown to translate into actual migration (Docquier et. al. 2014), estimating disaster-induced migration flows will provide even more policy relevance. Therefore, we complement our analysis with a set of case studies in Indonesia and analyze whether the same set of disasters induced actual migration in the medium term. In this context, we integrate another novel big data source - individual movements from mobile phone networks - into a difference-in-difference framework. Such data have been shown to be suitable proxies for migration flows (e.g., Lai et al. 2019), but have not been fully exploited in the context of natural disasters.

Our study can significantly contribute to the knowledge of how natural disasters will affect migration patterns in the 21st century. Not only does it combine novel data sources with innovative causal inference methods, but it is also easily scalable. While our estimates of aspirations will already provide estimates for the Global South, our case studies can also be extended because they use data that are in principle available globally. We thus lay the groundwork for future research at the intersection of big data, natural disasters, and migration.

[1] Asian Development Bank

Using Big Data to Improve Prediction and Management of Climate Induced Migration and Displacement in Asia and the Pacific

Bradley Mellicker,[1] Neelay Srivastava, Jerico E. Mendoza, Joy T. Santiago, **Patricia Anne S. Delmendo,**[2]
Arge Louise Joy S. Esquivel, April Dawn F. Tegelan, John Kenneth B. Suarez, and Alfredo Mahar Francisco A. Lagmay

Abstract

In the past decade, disasters in Asia and the Pacific have caused 225 million internal displacements, accounting for 78% of the global total. The 2023 Global Report on Internal Displacement shows that disasters caused by natural hazards led to 22.6 million new displacements in 2022 alone, nearly 70% of the global total. Meanwhile, climate-induced displacements from slow-onset events are on the rise, potentially displacing up to 88.9 million people across the region by 2050 in the worst-case scenario. In response to these trends, the United Nations Migration Agency (IOM) launched an initiative to improve understanding of the future impacts of climate change on migration and displacement in Asia and the Pacific. Collaborating with partners such as the University of the Philippines (UP) Resilience Institute (UPRI) Nationwide Operational Assessment of Hazards (NOAH) Center, the initiative aims to increase resilience against climate-induced displacement and proactively manage associated loss and damage.

The initiative revolves around four objectives: prevent and manage future displacement, address integration challenges for already displaced, create receptive 'in-migration' areas in case of future population influxes, and improve management of climate security risks. These objectives are realized, first, through the development of a predictive model that will help in anticipating future displacement risk. This includes channeling multiple data sources to underpin informed decision-making. Second, the initiative aims to utilise this data to serve as a strong basis for action to address gaps, increase preparedness and prevent future displacement identified by the model.

This research aims to present the Climate Displacement Risk Index (CDRI), offering an overview of its current progress and development. CDRI is built on a framework which considers not only hazards, but also other environmental factors as well as economic, political, social, and demographic 'drivers' of displacement. The model involves a two-stage process: first a country level macro analysis which can identify potential hotspots for future displacement. Then, in high-risk locations, partners will conduct a micro-level analysis which aims to provide critical information on future displacement risk, allowing for this information to be integrated into local or national contingency plans, utilised to support both shorter-term preparedness as well as long-term prevention and resilience building. The model incorporates both spatial and non-spatial data, and aims to leverage big data and advanced analysis techniques, such as machine learning algorithms.
UPRI has led preliminary work to support model development in the Philippines. Examining flood exposure, the pilot study calculates the number of individuals potentially affected by floods by intersecting simulated flood hazard data with the high-resolution settlement layer. A regression analysis reveals a moderately strong correlation between calculated exposed individuals and internally displaced persons in areas affected by tropical cyclone Kai-Tak. This suggests the potential use of exposure values in predicting future displacement. Future research aims to integrate additional datasets including those related to vulnerability and adaptive capacity, which will help in integrating additional drivers of displacement which will make for a more comprehensive analysis.

[1] Regional Office for Asia and the Pacific, International Organisation for Migration (IOM)
[2] University of the Philippines Resilience Institute

Walking on the Edge: Bangladesh's Erosion Realities, Geophysical Vulnerabilities, and Disproportionate Impacts on Different Demographics and Socioeconomic Groups

Md Sariful Islam,[1] Thomas W. Crawford, and Danielle Wood

Abstract

Coastal Bangladesh is prone to extreme shoreline erosion, resulting in challenges like population displacement and the loss of properties, fertile lands, infrastructure, and livelihoods. The anticipated exacerbation of coastal erosion due to climate change and rising sea levels poses a heightened threat to economically vulnerable populations. Focused on the lower Meghna estuary region, this study aims to enhance our understanding of the magnitude and severity of coastal shoreline movement and its impacts on coastal populations. Employing Landsat satellite imagery and a random survey along the Meghna River's eastern bank, the research assesses trends in shoreline movement and investigates disproportionate impacts on various demographic and socioeconomic groups. Utilizing time series Landsat data from 1988 to 2022, the study evaluates erosion trends at the transect level. Survey responses aid in assessing the impacts of shoreline movement on the coastal population. The results indicate an increasing trend of erosion in most areas (70%). These findings underscore the severe consequences for areas lacking revetment protection, emphasizing that marginalized communities bear a heavier burden of erosion, exacerbating existing inequalities. Integrating remote sensing and social science, this study informs more effective planning and management of coastal areas, providing crucial insights for developing mitigation and adaptation strategies that consider community perspectives on coastal erosion risk.

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Data Driven Perspectives on Disaster Induced Migration - Social Network Nexus among Rural Agricultural Households in India

Gauri Sreekumar and **Sabuj Kumar Mandal**[1]

Abstract

While the impact of natural disasters like flood on migration is well documented in the literature, very little is known about the role of social network on this flood induced migration. Our study aims to feel this gap in the literature. We use a nationally representative large household level panel data from the two rounds (2004-05 and 2011-12) of India Human Development Survey (IHDS) to construct our two main variables of interest – perception based flood impact and social network. A difference – indifference-in-difference (DDD) methodology is used for empirical analysis. Our empirical results show that even though flood intensity reduces the number migrants from the flood affected households, social network moderates such negative impact of flood on migration. Our results confirm that households with social network send more migrants in the post flooding period compared to the households with no such connections. Therefore, social network provides a community feeling and encourages households to take migration as an adaptation strategy in the aftermath of flooding. Policy implications of our results are also discussed.

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