



# 18<sup>th</sup> Symposium 2023

Advancing Frontiers in Disaster Risk Science,  
Technology and Policy

**29 - 30 November 2023**  
**Singapore**



**NANYANG  
TECHNOLOGICAL  
UNIVERSITY**  
SINGAPORE



EARTH  
OBSERVATORY  
OF SINGAPORE

**Programme  
Book**



# NOV 29 DAY 1

## REGISTRATION

8:30 AM - 9:00 AM  
Foyer

## OPENING CEREMONY

9:00 AM - 10:00 AM  
Auditorium

## KEYNOTE - Dr. Pamela Cajilig

10:00 AM - 10:30 AM  
Auditorium

## POSTER & NETWORKING SESSION / COFFEE BREAK

10:30 AM - 11:00 AM  
Public Concourse

## BREAKOUT SESSION 1

### CLIMATE HAZARDS

#### SESSION 1.A: OCEAN, CRYOSPHERE AND SEA LEVEL CHANGES

11:00 AM - 12:30 PM  
Functiona Hall 3

Conveners: *Dhrubajyoti  
Samanta, Wenshu Yap*

### TECTONIC HAZARDS

#### SESSION 1.B: REMOTE SENSING AND MODELLING

11:00 AM - 12:30 PM  
Functiona Hall 1

Conveners: *Yu Jiang, Sharadha  
Sathiakumar, Angsana Chaksan*

### PUBLIC HEALTH & ENVIRONMENTAL HAZARDS

#### SESSION 1.C: CLIMATE CHANGE AND PUBLIC HEALTH

11:00 AM - 12:30 PM  
Functiona Hall 3A

Conveners: *Steve Yim, Huang Tao*

## LUNCH

12:30 PM - 1:30 PM  
Outside Function Hall 3

## BREAKOUT SESSION 2

### CLIMATE HAZARDS

#### SESSION 2.A: TROPICAL CYCLONE AND RAINFALL CHANGES

1:30 PM - 3:00 PM  
Functiona Hall 3

Conveners: *Dhrubajyoti  
Samanta, Masashi Watanabe*

### TECTONIC HAZARDS

#### SESSION 2.B: EARLY WARNING SYSTEMS AND MONITORING

1:30 PM - 3:00 PM  
Functiona Hall 1

Conveners: *Yu Jiang, Andrian  
Simanjuntak, Shengji Wei*

### PUBLIC HEALTH & ENVIRONMENTAL HAZARDS

#### SESSION 2.C: ENVIRONMENTAL EXPOSURE AND PUBLIC HEALTH

1:30 PM - 3:00 PM  
Functiona Hall 3A

Conveners: *Sonu Kumar, Fang  
Tingting, Steve Yim*

## POSTER & NETWORKING SESSION / COFFEE BREAK

3:00 PM - 4:00 PM  
Public Concourse

## BREAKOUT SESSION 3

### CLIMATE HAZARDS

#### SESSION 3.A: MODERN CLIMATE HAZARDS IN ASIA

4:00 PM - 5:30 PM  
Functiona Hall 3

Conveners: *Raquel Felix,  
Wenshu Yap*

### TECTONIC HAZARDS

#### SESSION 3.B: UNDERSTANDING GEOHAZARDS AND RISKS

4:00 PM - 5:30 PM  
Functiona Hall 1

Conveners: *Andrea Verolino, Eleanor  
Tennant, Hengki Eko*

### PUBLIC HEALTH & ENVIRONMENTAL HAZARDS

#### SESSION 3.C: NOVEL METHODS FOR STUDYING ENVIRONMENTAL HAZARDS

4:00 PM - 5:30 PM  
Functiona Hall 3A

Conveners: *Sonu Kumar, Huang Tao,  
Steve Yim*



**REGISTRATION**  
8:30 AM - 9:30 AM  
Foyer

**EARLY CAREER RESEARCHER LIGHTNING TALK  
COMPETITION**  
8:30 AM - 9:30 AM  
Auditorium

**KEYNOTE - Mr. Peter Stones**  
9:30 AM - 10:00 AM  
Auditorium

**POSTER & NETWORKING SESSION / COFFEE BREAK**  
10:00 AM - 11:00 AM  
Public Concourse

#### BREAKOUT SESSION 4

**ECONOMIC RESILIENCE: FINANCE  
& RISK**  
**SESSION 4.A: MEASURING  
ECONOMIC LOSSES AND  
RESILIENCE**  
11:00 AM - 12:30 PM  
Functiona Hall 3  
Conveners: *Gizem Mestav Sarica,  
Dennis Wagenaar, Jeanette Choong*

**STRATEGIES FOR  
SOCIOECOLOGICAL RESILIENCE**  
**SESSION 4.B: NATURE-BASED  
SOLUTIONS FOR RISK  
MANAGEMENT**  
11:00 AM - 12:30 PM  
Functiona Hall 1  
Conveners: *Erich Wolff, Alina  
Bill-Weilandt*

**MANAGING RISK**  
**SESSION 4.C: DISASTER  
RESPONSE AND RISK REDUCTION**  
11:00 AM - 12:30 PM  
Functiona Hall 3A  
Conveners: *Raquel Felix, Indraneel  
Kasmalkar, Natt Leelawat*

**LUNCH**  
12:30 PM - 1:30 PM  
Outside Function Hall 3

**KEYNOTE - Dr. Olivia Jensen**  
1:30 PM - 2:00 PM  
Auditorium

#### BREAKOUT SESSION 5

**STRATEGIES FOR SOCIOECOLOGICAL RESILIENCE**  
**SESSION 5.B: DISASTER RECOVERY AND  
RESILIENCE**  
2:00 PM - 3:30 PM  
Functiona Hall 1  
Conveners: *Erich Wolff, Alina  
Bill-Weilandt, Jeanette Choong*

**MANAGING RISK**  
**SESSION 5.C: DISASTER POLICY  
AND COMMUNICATION**  
2:00 PM - 3:30 PM  
Functiona Hall 3A  
Conveners: *Raquel Felix, Indraneel  
Kasmalkar, Natt Leelawat*

**POSTER & NETWORKING SESSION / COFFEE BREAK**  
3:30 PM - 4:00 PM  
Public Concourse

#### BREAKOUT SESSION 6

**STRATEGIES FOR SOCIOECOLOGICAL RESILIENCE**  
**SESSION 6.B: EDUCATION, AWARENESS  
AND PREPAREDNESS**  
4:00 PM - 5:30 PM  
Functiona Hall 1  
Conveners: *Pamela Devan, Eleanor  
Tennant*

**MANAGING RISK**  
**SESSION 6.C: VULNERABILITY AND  
RISK ASSESSMENT**  
4:00 PM - 5:30 PM  
Functiona Hall 3A  
Conveners: *Elinor Meredith, Raquel  
Felix, Pamela Cajilig*

**LIGHTNING TALK AWARD + CLOSING CEREMONY**  
5:30 PM - 6:00 PM  
Auditorium

**SYMPOSIUM RECEPTION**  
7:00 PM - 8:30 PM  
Pen&Inc, One - North

**NOV**  
**30**  
**DAY 2**



# DEC 01

DAY 3

FIELD TRIPS: EOS/NTU, SUNGEI BULOH NATURE RESERVE,  
ADAPTING WATERFRONTS INSTALLATION, MARINA BARRAGE  
9:00 AM - 12:30 PM

Topic: CLIMATE HAZARDS  
1.a. Ocean, cryosphere and sea level changes

#### **Probabilistic risk assessment of tropical cyclone-induced storm surges around the coast in Singapore**

Masashi Watanabe <sup>1</sup>, Adam D. Switzer <sup>1,2</sup>, Constance Ting Chua <sup>1</sup>, Jun Yu Pua <sup>2</sup>, Elaine Tan <sup>2</sup>, Timothy Shaw <sup>2</sup>, David Lallemand <sup>2</sup>

<sup>1</sup> Earth Observatory of Singapore, Nanyang Technological University

<sup>2</sup> Asian School of the Environment, Nanyang Technological University

The location of Singapore along the equator means that the risk of tropical cyclones and, hence, storm surge in Singapore is likely to be negligible. It was generally believed that tropical cyclones are unlikely to form near the equator because the Coriolis effect is minimal. However, on 27 December 2001, a tropical cyclone - Typhoon Vamei, classified as a category 1 typhoon- formed southeast of Singapore, demonstrating a potential localised risk of cyclone-induced storm surges in Singapore. We investigated the risk of the storm surge around Singapore based on numerical simulations. We used Delft-3D/SWAN to calculate both potential storm surge and waves induced by typhoons. We reproduced the storm surge caused by typhoon Vamei through numerical simulation, and found that storm surge in Singapore came up to about 5 cm. We then moved the path of Vamei southward while the size remains constant, and calculated the maximum water level in the northern part of Singapore. We further conducted the storm surge simulations by assuming the 500 and 1000-year probability size of the typhoon based on generalised Pareto distribution and changing the typhoon's path. When the probability size of the typhoon was 1000-year, and the typhoon path was shifted  $-0.8^\circ$  southward from the path of typhoon Vamei, the maximum water level on the coastline in Singapore became most significant. This analysis provides policymakers and urban planners baseline insights to enhance coastal defence preparedness and formulate effective mitigation strategies.

#### **Drivers of Extreme Coastal Currents in Singapore**

Pua Jun Yu <sup>1</sup>, David Lallemand <sup>1</sup>, Ivan D. Haigh <sup>2</sup>, Kyle M. Morgan <sup>1</sup>, Adam D. Switzer <sup>1</sup>

<sup>1</sup> Nanyang Technological University, Singapore, Singapore

<sup>2</sup> University of Southampton, Southampton, UK

Coastal currents pose a risk to ship navigation and public safety. A notable example is the 1983 Sentosa cable car crash in Singapore, when two cabins plunged into the sea and got swept away by strong currents, resulting in seven deaths. As such, there is a clear need to quantify the contributions of the various mechanisms that drive coastal currents in the strongly tidal coastal system of Singapore. We installed four tilt current meters each in Pulau Hantu and Kusu Island, in the southern of Singapore. We provide an analysis of the temporal variability of coastal currents in the frequency domain from March 2018 to March 2019 using power

Tidal motions are one of the dominant drivers of currents, being responsible for about 14-45% of total variance across all sites, with diurnal currents generally having more energy than semidiurnal currents. The wind stress oscillating at the diurnal frequency is characteristic of the land-sea breeze and strengthens during the monsoons. We then investigate its effect on currents using wavelet coherence. Our study shows that currents and wind stress are highly correlated at the diurnal and subtidal frequencies during the monsoons with varying time lag from 0 to 18 hours. We speculate that wind forcing modifies the diurnal K1 tidal constituent, whose amplitude we extracted from short-term harmonic analysis and that this is evidently affected seasonally in tandem with the monsoon regime. Given the importance of wind, for future work we would require longer datasets to examine how atmospheric phenomena such as ENSO influence currents at longer time scales to make more accurate predictions.

#### **Climate Risks and Mitigation Strategies for the Coastal Communities in San Francisco, Quezon, Philippines**

Almira Geles L. de Mesa\*, Nina Camille Cornista, Elizabeth Bandojo

*Department of Community and Environmental Resource Planning, College of Human Ecology, University of the Philippines Los Banos, Philippines*

Coastal communities are prone to direct impacts of climate change. San Francisco is a coastal municipality in the Philippines covering municipal waters more than twice of its land area. An analysis known as climate and disaster risk assessment was conducted to determine the impacts and risks of climate hazards in the municipality. Results showed that San Francisco is vulnerable to the impacts of climate change especially if emissions were not reduced in the next years. Areas near tributaries and coasts as well as at the low-lying parts or catch basins in the municipality were calculated to have high risk to flooding. Storm surge, on the other hand, affected all five coastal villages particular the coastal areas where isolation may occur. Given the municipality's risk to storm surge and flooding, measures to address these hazards should be considered in local development planning. The study suggests risk mitigation interventions through infrastructure, policy and ecosystem-based approaches. Specifically, construction of seawall to prevent coastal flooding, monitoring and announcements of the status of tropical cyclones and sea level using innovative and reliable equipment, allocating protection buffer for coastline and mangrove areas, and investment in mangrove reforestation initiatives to maintain its function as natural wave breaker and protection buffer from typhoons and storm surge are recommended for the coastal areas.

**DAY 1 - 29 November 2023**

**Oral Presentations**

**Breakout Session 1: 11 AM - 12:30 PM**

Topic: **TECTONIC HAZARDS**  
1.b. Remote Sensing and Modelling

**Mantle convection patterns explain active tectonics and seismicity in the Middle East.**

Mikhail K Kaban\*, Alexey G Petrunin

*Helmholtz Centre Potsdam - GFZ German Research Centre for Geosciences, Potsdam, Germany*

The Middle East is characterized by active tectonics. Interaction of different tectonic processes results in a very complex structure, a high level of seismicity and continuous earthquake activity. Mantle convection is one of the main driving forces that control plate tectonics at all levels. Therefore, modelling of the mantle convection can aid in understanding the origin and development of the tectonic processes and seismicity. The main difficulty in such modelling in the Middle East is that there exists a strong interplay of regional and global factors. Even recently, dynamic models for this region were based on low-resolution global models. We present a novel dynamic model, which includes high-resolution density and viscosity distributions as well as weak plate boundaries. The final model of mantle flow takes into consideration both the traction forces at the base of the lithosphere induced by the global mantle convection and the regional forces caused by local heterogeneity of the lithosphere and upper mantle. Mantle flow velocities and principal stress directions were thus estimated for the lithosphere and upper mantle in the region. The resulting mantle flow patterns show a clear distinction in tectonics and explain the distribution of seismicity. Furthermore, the stress orientations explain the active fault structures in the region.

**Mapping and Quantifying the Current Trends of Land Subsidence in Metro Manila, Bulacan, and Pampanga, Philippines Using Historical ALOS-2, Sentinel-1, and Cosmos SkyMed SAR Images**

John Bart Lovern C. Dumalag\*, Neyzielle Ronnicque R. Cadiz, Karl Louie S. Mariano

*DOST-Advanced Science and Technology Institute, Quezon City, Philippines*

Land subsidence in Metro Manila and in the nearby provinces of Bulacan and Pampanga has already been documented in several studies, some of which utilized SAR images that were captured between the years 2003 to 2011. Same studies attribute this subsidence primarily to excessive ground water extraction that are being done in the affected areas. DOST-ASTI, through its partnership with JAXA, conducted a study to determine the current ground deformation dynamics in these areas using ALOS-2 L-Band SAR images, which JAXA provided to DOST-ASTI and were captured between the years 2015-2022, were processed. Using PSInSAR method, the ground deformation rates and cumulative ground displacement in the areas covered by these images were estimated.

Results show that several cities and municipalities in Bulacan and Metro Manila, generally the same areas that were identified as subsidence hotspots in the earlier studies, still have ongoing land subsidence. Inspection of several random persistent scatterer points reveals that the trends of their cumulative ground deformation generally do not suggest any apparent decrease over time. Historical Sentinel-1 C-Band and Cosmos SkyMed X-Band SAR images acquired between 2017-2019 were also processed to help validate the outputs from ALOS-2 datasets. The results from these datasets also show similar observations. The output of this study implies the need for urgent and stricter implementation of existing policies that can address the occurrence and effects of land subsidence. Moreover, the same can also be used for more informed planning and construction of future vital infrastructure in the area.

**Slow Slip Events and Coupling along the Middle American Trench in Southern Costa Rica**

Mason Perry <sup>1</sup>, Cyril Muller <sup>2</sup>, Marino Protti <sup>2</sup>, Lujia Feng <sup>1</sup> Emma M. Hill <sup>1,3</sup>

<sup>1</sup> *Earth Observatory of Singapore, Nanyang Technological University, Singapore.*

<sup>2</sup> *Observatorio Vulcanológico y Sismológico de Costa Rica, Universidad Nacional, Heredia, Costa Rica.*

<sup>3</sup> *Asian School of the Environment, Nanyang Technological University, Singapore*

At the Osa peninsula in Southern Costa Rica, at least three large (magnitude > 7) earthquakes have occurred in 1904, 1941, and most recently in 1983. While the timing of these events supports a recurrence of approximately 40 years, the state of coupling in the region is poorly constrained. Older studies of the megathrust variously ascribe intermediate to full coupling along the Middle American trench, but the recent discovery of recurring shallow slow slip events (SSEs) in the region indicate that these previous coupling ratios may be inaccurate as they are based on campaign GNSS measurements with poor temporal and spatial resolution. By leveraging the unique geography of the region, with the Osa peninsula located within ~20 km of the offshore trace of the Middle America Trench, we can gain valuable insight into shallow subduction zone processes that in most places require seafloor observations. Using data from a newly updated and densified continuous GNSS network on and around the Osa peninsula, we derive inter-SSE rates of deformation and calculate slip distributions of recent SSEs. We then use these to invert for inter-SSE kinematic coupling under the backslip assumption with and without accounting for stress shadows. Our results indicate that the region of recurring SSEs is located within a zone that is otherwise kinematically coupled, with elevated coupling ratios in the inter-SSE models in comparison to the interseismic models. Additionally, while estimated cumulative slip from the SSEs is sufficient to close the slip deficit from tectonic loading over the SSE recurrence interval and potentially limit the size of future ruptures, large portions of the megathrust remain coupled and liable to rupture in the future.

**DAY 1 - 29 November 2023**

**Oral Presentations**

**Breakout Session 1: 11 AM - 12:30 PM**

**Topic: PUBLIC HEALTH & ENVIRONMENTAL HAZARDS**  
1.c. Climate change and public health

### **Humid heat an underestimated challenge in urban informal settlements**

Emma E. Ramsay<sup>1,2</sup>, Perrine Hamel<sup>2\*</sup>, Steven L. Chown<sup>1</sup> and Grant A. Duffy<sup>1,3</sup>

<sup>1</sup> School of Biological Sciences, Monash University, Clayton, Victoria 3800, Australia

<sup>2</sup> Asian School of the Environment, Nanyang Technological University, Singapore 639798, Singapore

<sup>3</sup> Department of Marine Science, University of Otago, Dunedin 9016, New Zealand

Humid heat threatens the liveability of tropical cities, home to the largest proportion of informal settlement communities. Extreme wet-bulb temperatures surpassing the 35 °C theoretical limit of human survival have already been reported, and the negative health and economic impacts of heat stress occur at much lower levels. Yet, the low density of meteorological stations across the tropics fails to capture heat extremes in dense urban settlements. In situ climate monitoring from informal settlements across Asia and Africa show that humid heat exposure is severely underestimated by station data. Wet-bulb temperatures measured in houses and outdoors consistently exceed corresponding measurements from the nearest meteorological station, sometimes by up to several degrees. Houses provide little protection, especially overnight, likely increasing exposure for the most vulnerable such as the elderly and very young. Under a warming climate and ongoing urbanisation, heat adaptation in informal settlements must be prioritised alongside ongoing efforts to improve water and sanitation through upgrading programs. Nature-based solutions have the potential to address these challenges by integrating the cooling benefits of green and blue space with other needs like storm and grey water management.

### **Global health impacts of ambient fine particulate pollution associated with climatic variability**

S.H.L. Yim<sup>1,2,3,\*</sup>, Y. Li<sup>4</sup>, T. Huang<sup>4</sup>, J.T. Lim<sup>2</sup>, H.F. Lee<sup>4</sup>, S. Chotirmall<sup>2</sup>, G.H. Dong<sup>5</sup>, J. Abisheganaden<sup>2</sup>, J.A. Wedzicha<sup>6</sup>, S.C. Schuster<sup>7</sup>, B. Horton<sup>3</sup>, J.J.Y. Sung<sup>2</sup>

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<sup>3</sup> Earth Observatory of Singapore, Nanyang Technological University, Singapore 639798, Singapore;

<sup>4</sup> Department of Geography and Resource Management, The Chinese University of Hong Kong, Sha Tin 999077, Hong Kong, China;

<sup>5</sup> Guangdong Provincial Engineering Technology Research Center of Environmental Pollution and Health Risk Assessment, Guangzhou Key Laboratory of Environmental Pollution and Health Risk Assessment, Department of Preventive Medicine, School of Public Health, Sun Yat-sen University, Guangzhou 510080, China;

<sup>6</sup> Airways Disease Section, National Heart and Lung Institute, Imperial College London, London, UK;

<sup>7</sup> Singapore Centre For Environmental Life Sciences Engineering (SCELSSE), Nanyang Technological University, Singapore, Singapore

Air pollution is a key global environmental problem raising human health concern. It is essential to comprehensively assess the long-term characteristics of air pollution and the resultant health impacts.

We first assessed the global trends of fine particulate matter (PM<sub>2.5</sub>) during 1980-2020 using monthly global PM<sub>2.5</sub> reanalysis, and evaluated their association with climate variability. We then estimated the PM<sub>2.5</sub>-attributable premature deaths using integrated exposure-response functions. Results show a significant positive increasing trend of ambient PM<sub>2.5</sub> in the four decades due to increases in anthropogenic emissions. Ambient PM<sub>2.5</sub> caused a total of ~135 million premature deaths globally during the four decades. Occurrence of air pollution episodes was strongly associated with climate variability which are associated with up to 14% increase in annual global PM<sub>2.5</sub>-attributable premature deaths.

### **Urbanization and infectious disease: the potential of Nature-based solutions**

Chloe Pottinger-Glass\*

Stockholm Environment Institute, Bangkok, Thailand

A major challenge for the achievement of Sustainable Development Goal 3 which calls for health and wellbeing for all including ending epidemics and communicable diseases by 2030, will be rapidly growing cities of the Global South where critical infrastructure, and services such as sanitation and waste management can struggle to keep pace. Meanwhile, climate change is changing patterns of disease in new and unexpected ways. The World Health Organization states that “continued urbanization is expected to lead to cities becoming epicenters of disease transmission, including vector-borne disease”.

To investigate this topic, we focus on the city of Bharatpur, Nepal as a case study, highlighting a knowledge gap on the application of Nature-Based Solutions for biological hazard – hazard from disease producing organisms. In Bharatpur, the continued construction of open sewage canals, unofficial waste dumping along the river, and annual monsoon flooding exacerbated by climate change, causes shortage of safe drinking water and outbreaks of water-borne diseases such as cholera, diarrhea, dysentery, and typhoid. A particular and worsening public health hazard has been increasing exponential increase in cases of dengue fever over the past five years, which have been associated with warming temperatures which create more suitable breeding habitats.

This presentation will describe some preliminary results from the ongoing research project, including the complex ways that deficiencies in urban planning and service delivery exacerbate biological hazards, strategies that municipalities and communities have been taking to tackle them, and some potential nature-based and “nature-positive” responses which can create synergies between urban public health, healthy ecosystems and urban livability, while offering most cost-effective and flexible solutions compared to grey infrastructure alone.

**DAY 1 - 29 November 2023**

**Oral Presentations**

**Breakout Session 2: 1:30 PM - 3 PM**

Topic: **CLIMATE HAZARDS**  
2.a. Tropical cyclone and rainfall changes

**Development of Severe Wind Damage Database in the Philippines for Empirical Vulnerability Analysis Using Surface Data Evaluation of Historical Typhoons**

Joshua C. Agar\*, Manuel Miguel Lenin C. Muhi, Diocel Harold M. Aquino

*Institute of Civil Engineering, University of the Philippines, Diliman, Quezon City, Philippines*

Typhoons reveal the vulnerability of the structures in the Philippines against severe wind hazards. To better understand and reduce severe wind vulnerability, a compilation of building damage data is needed to comprise the severe wind damage database to which the computational methods of building vulnerability analysis can refer. To determine the local magnitude of the typhoon winds that resulted in building damage, analytical models of typhoons are derived from surface data. Damaged buildings are documented from field surveys, news reports, and online surveys where the building damage ratios are quantified. Building damage data is collected from 10 recent significant typhoons in the Philippines. Insights to enhance coastal defence preparedness and formulate effective mitigation strategies.

**Intensification of ENSO-induced rainfall variability across South-East Asia under global warming**

Chen Chen\*, Sandeep Sahany, Aurel F. Moise, Xin Rong Chua, Muhammad E. Hassim, Gerald Lim, Venkatraman Prasanna

*Centre for Climate Research Singapore*

The El Niño–Southern Oscillation (ENSO) phenomenon in the tropical Pacific exerts far-reaching impacts on rainfall variations worldwide. South-East Asia (SEA), located in the Indo-Pacific warm pool, experiences strong ENSO influences. During El Niño (positive phase of ENSO), the SEA becomes drier than normal and prolonged dry periods cause a heightened threat of wildfires and transboundary haze. Conversely, La Niña (negative phase of ENSO) brings intensified rainfall across the SEA, leading to wetter-than-normal conditions and an escalated risk of floods. The ongoing development of another El Niño in 2023 magnifies concerns regarding climate hazards. Looking into the future, potential changes in this crucial climate driver and its impacts are critical for climate adaptation and strategic planning in SEA. Our study utilizes state-of-the-art CMIP6 global climate models aligned with the IPCC AR6 to unveil future projections. Robust model projections indicate that, for both land and sea rainfall over SEA, the negative rainfall variability during El Niño will enhance significantly under warming. The SEA may experience much drier conditions than the present climate during El Niño, which may lead to enhanced droughts and water scarcity. These projections are robustly supported by the model agreement and scale up with different warming levels. By identifying potential changes in the SEA region and their connections to large-scale physical drivers, our findings reveal an alarming trend that underscores the urgency of region-specific climate resilience strategies and proactive measures to mitigate adverse impacts of ENSO in a warmer world.

**Evolving tropical cyclone characteristics over Southeast Asia in a changing climate**

Dhrubajyoti Samanta<sup>1\*</sup>, Andra J. Garner<sup>2</sup>, Mackenzie M. Weaver<sup>2,3</sup>, Benjamin P. Horton<sup>1,4</sup>

<sup>1</sup> *Earth Observatory of Singapore, Nanyang Technological University, Singapore*

<sup>2</sup> *Department of Environmental Science, Rowan University, USA*

<sup>3</sup> *Department of Earth & Environmental Science, University of Pennsylvania, USA*

<sup>4</sup> *Asian School of the Environment, Nanyang Technological University, Singapore*

Tropical cyclones (TCs) are a damaging natural hazard to coastal communities, particularly in Southeast Asia where densely populated cities are situated in low-lying areas. The evolving behaviour of TCs and their accompanying rainfall patterns in a changing climate has substantial uncertainties. Here, we utilize TCs downscaled from nine global climate models using a statistical/deterministic model. Our investigation spans historical (1881-1900), modern (1981-2000), and future (2081-2100) eras, encompassing over 64,000 synthetic TCs traversing Southeast Asia. A comparison of moderate (SSP2-4.5) and high (SSP5-8.5) emission scenarios for the future compared to historical and modern eras reveal the following over mainland Southeast Asia: (1) TCs exhibit tendencies toward rapid intensification, farther inland termination, and reduced translational speed; (2) pronounced northward shift of TC tracks; (3) projected increase in TC activity during post-summer monsoon; and (4) increase in total accumulated TC-induced rainfall. There is an increased risk of strong and prolonged TC impacts on important coastal cities like Dan Nang, Bangkok, and Yangon by the end of the 21st century. Furthermore, more frequent TC-induced extreme rainfall poses additional flood risks in the region. Our results emphasize the evolving TC risk which necessitates meticulous planning within vulnerable communities to mitigate future damage in Southeast Asia. Initiatives to maintain its function as natural wave breaker and protection buffer from typhoons and storm surge are recommended for the coastal areas.

**Projected Changes in Extreme Rainfall under Stratospheric Aerosol Injection and Cirrus Cloud Thinning Scenarios over the National Capital Region, Philippines**

Keane Carlo G. Lomibao<sup>1\*</sup>, Patricia Ann J. Sanchez<sup>1</sup>, Hannah W. Jose<sup>1</sup>, Emmanuel Zeus S. Gapan<sup>1</sup>, Catherine B. Gigantone<sup>1</sup>, Jessa O. Aquino<sup>1</sup>, Allan T. Tejada Jr.<sup>1,2</sup>, and Rodel D. Lasco<sup>3</sup>

<sup>1</sup> *UPLB Interdisciplinary Studies Center for Water, University of the Philippines Los Baños, Los Baños, Philippines*

<sup>2</sup> *Department of Science and Technology – Science Education Institute, Taguig, Philippines*

<sup>3</sup> *Oscar M. Lopez Center, Pasig, Philippines*

To offset global warming, solar radiation management (SRM) techniques known as Stratospheric Aerosol Injection (SAI) and Cirrus Cloud Thinning (CCT) were proposed.



SAI involves introducing particles in the stratosphere to reflect incoming sunlight back into space while CCT aims to reduce the optical thickness of cirrus clouds through seeding which allows more longwave radiation to escape to space, thus cooling the Earth's surface. In the Philippines, the National Capital Region (NCR) is one of the areas that is highly vulnerable to climate change impacts, especially, cyclones and floods.

This study aims to determine the possible effects of SAI and CCT to extreme rainfall events over NCR for the years 2041-2060 relative to the 1981-2000 baseline period and the Scenario Model Intercomparison Project high forcing scenario (SSP5-8.5). Global climate models performing SAI (G6Sulfur) and CCT (G7Cirrus) under the Geoengineering Model Intercomparison Project were utilized, and the 3-step statistical bias correction was used to improve the local rainfall estimates of the models.

Bias correction on precipitation shows a drastic increase in frequency under SSP5-8.5 and a potential reduction in frequency of extreme rainfall events over NCR under G6Sulfur and G7Cirrus. Particularly, a historical extreme rainfall event with 25-year (50-year) return period will likely have a 7-year (15-year), 26-year (72-year), and a 44-year (100-year) return period under high forcing scenario, SAI, and CCT, respectively. While the return period findings under SRM look promising, this mitigation technique must be studied further, and the reduction of greenhouse gases shall remain the global priority."recommended for the coastal areas.

Topic: **TECTONIC HAZARDS**  
2.b. Early Warning Systems and Monitoring

#### **A very first step for developing Early Warning System in Nepal**

Shiba Subedi\*, Bishal Nath Upreti

*Nepal Academy of Science and Technology, Lalitpur, Nepal*

Nepal lies in the heart of the most active continental seismic zone, the Himalaya. Due to the collision of India and Eurasia, a large number of earthquakes occur in this area. Nepal has experienced devastating earthquakes throughout history, claiming large number of lives and causing significant damages. The 2015 Gorkha earthquake, the latest major earthquake event, killed nearly 9,000 people and injured over 22,000. It was the worst natural disaster to strike Nepal since the 1934 earthquake. Still, these casualties and damage were far under the expectation. After the Gorkha earthquake, Nepali people are eager to learn more about earthquakes and highly concern about their safety. Proper education reaching to a wide group of the population early in their life is strongly needed. Scientific education of local communities is key in helping to reduce the risk associated with natural disasters such as earthquakes. Nepal is highly prone to further earthquakes in future; however, the majority of the population is not aware about or prepared for them. No earthquake prediction is possible till date, nevertheless, using the modern communication techniques, Early Warning system (EEW) is saving people in many countries from earthquakes. To increase earthquake awareness and improve preparedness, and to reduce seismic risk, we are aiming at (i) preparing the community for EEW including Seismology at School program, (ii) developing a module for earthquake preparedness: earthquake evacuation protocols and drills, (iii) background noise analysis of seismic sites for EEW purposes. Carrying out educational activities by teaching earthquake-related topics in classrooms, conducting earthquake evacuation drills in schools in a regular manner, offering training to teachers supports raising earthquake awareness and lesson learned are crucial for the successful implementation of EEW. More essentially, we will study background noise of 15 sites for future installation of seismic sensors with early warning purposes.

#### **The Matano fault poses a significant seismic hazard as revealed by a comprehensive interdisciplinary approach**

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The Matano fault in Indonesia facilitates the rapid motion between the Pacific and Australian plates. However, its seismic behavior remains enigmatic due to lack of comprehensive studies. Since 2021, we have been investigating the fault through an interdisciplinary approach encompassing geologic, geophysics, and geodetic methods.

Detailed fault mapping, based on elevation and bathymetry data from various sources, unveiled the highly segmented nature of the fault with a total length of ~290 km. Shallow geophysical surveys provided insights into the geometry, vertical motion, and Quaternary activity of the fault and also helped in identifying potential locations for paleoseismic trenches which unearthed history of surface-rupturing earthquakes on the fault. A seismic barrier emerges at Lake Matano which is relevant to the b-value distribution. InSAR modeling resulted in a slip rate of ~30 mm/yr, aligning with our geologic estimation. Correlating paleo-earthquakes documented at the trenches reveal the potential for earthquake ruptures to extend from Lake Matano to the eastern end of the fault for ~180 km. Remarkably, this eastern fault portion has unruptured for at least two centuries, forming a seismic gap, and has accumulated ~6 m of slip for the next surface-faulting event. Similarly, the western portion of the Matano fault may form a seismic gap with a comparable potential hazard. Given the significant seismic hazard it poses, this information must be factored into mitigation strategies, particularly due to the presence of nickel-related industries along the Matano fault, which could be severely affected by the large earthquakes. cumulative ground displacement in the areas covered by these images were estimated.

#### **The critical role of path calibration in Earthquake Early Warning (EEW)**

Shengji Wei\*

*Earth Observatory of Singapore/ Asian School of the Environment, Nanyang Technological University*

Earthquake early warning relies heavily on fast and accurate determination of earthquake source parameters. Besides real time data transmission, it is crucial to stream proper seismic waveform data into a well-designed program for source parameter inversion. However, the velocity structure of the earth is in general very complex, which produces difficulties to conduct robust waveform inversions and derive precise source location with travel time. Here we emphasize that it is possible to use historical earthquake waveform records to identify clean paths and make travel time calibrations. The effectiveness of such path calibration is shown using the 2016 Kumamoto, 2018 Palu and 2021 Maduo earthquake sequences. For waveform inversion, we conduct focal mechanism inversions using M5-6 earthquakes with regional to teleseismic stations. Through comparing the synthetic and observed waveforms, we identify station, velocity model and frequency ranges that are associated with high cross-correlation between data and synthetics. These parameters/information should be given with significantly large weights in the early warning system. Back-projection of regional and teleseismic array waveform data is another important method that can quickly determine the rupture directivity and dimension of large earthquakes, hence could be an important component of early warning system.

Travel time path calibration from smaller earthquakes in the source region of future large earthquakes is critical to reduce the location uncertainty of back-projection methods. Here we show that the uncertainty of high frequency radiator from back-projection could be narrowed down to as small as 10 km.

Topic: PUBLIC HEALTH & ENVIRONMENTAL HAZARDS  
2.c. Environmental exposure and public health

#### **Environmental health risk assessment of NO<sub>2</sub> (Nitrogen Dioksida) exposure to street vendors at Gajah Mada Street Padang**

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Gajah Mada street is one of the main road with dense activity of transportation and causes pollution, for example is NO<sub>2</sub>. Beside that, there are many activity of human everyday. The purpose of this study was to analyze the level of a Health risk Exposure to NO<sub>2</sub> (Nitrogen Dioxide) on Street Vendors at Gajah Mada Street Padang. This study uses the method of environmental health risks assessment (EHRA). EHRA is a method for calculating the level of health risk from exposure to agents of pollutants. The population is the street vendors who work at Gajah Mada Street. Sample was taken by accidental sampling technique as much as 50 vendors. Ambient air samples taken as many as four points in settlements using Impinger. The concentration of NO<sub>2</sub> at Gajah Mada Street is 0,00547 mg/m<sup>3</sup>. The average lifespan of street vendors at Gajah Mada Street is 32 years old, with a median time of exposure of worker to 8 hours/day, frequency of exposure to a mean of 324,18 days/ year, with a median duration of exposure was three years and average weight was 58,10 Kg. Non carcinogenic intake value obtained for the intake NO<sub>2</sub> lifetime is 0,000554 mg/m<sup>3</sup> and intake NO<sub>2</sub> realtime is 0,000555 mg/m<sup>3</sup>. Wich means no risk that can cause health problems. The concentration of NO<sub>2</sub> at Gajah Mada Street Padang doesn't cause bad effect on health to street vendors. Expected to the government can conduct further studies and routine monitoring of the concentration of NO<sub>2</sub> in order not to jeopardize the street vendors.

#### **Unexpected associations of long-term and excessive exposure to trivalent chromium with hypertension and glycosuria in male tannery workers**

Tomoyuki Tsuchiyama <sup>1,2</sup>, Dijie Chen <sup>1,2</sup>, M.M. Aeorangajeb Al Hossain <sup>2,3\*</sup>, Akira Tazaki <sup>1,2</sup>, Takumi Kagawa <sup>1,2</sup>, Yishuo Gu <sup>1,2</sup>, Yanjun Gao <sup>1,2</sup>, Fitri Kurniasari <sup>1,2</sup>, Nazmul Ahsan <sup>1,2</sup>, Anwarul A. Akhand <sup>2,4</sup>, Masashi Kato <sup>1,2,5</sup>

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Serious health hazards including renal, skin and hearing disorders have been reported in Bangladeshi tannery workers (TWs) who were chronically exposed to a large amount of trivalent chromium [Cr (III)].

However, the effects of Cr (III) exposure on the prevalence of hypertension and the prevalence of glycosuria in TWs remain unknown. Since the Cr level in toenails is an established marker reflecting long-term exposure to Cr (III) in humans, the associations of Cr levels in toenails with the prevalence of hypertension and the prevalence of glycosuria in male tannery and non-tannery office workers (non-TWs) in Bangladesh were investigated in this study. The mean toenail Cr level in non-TWs (0.5 µg/g, n = 49) was comparable to that in the general population reported previously. Mean Cr levels in TWs with a low toenail Cr level (5.7 µg/g, n = 39) and those with a high toenail Cr level (298.8 µg/g, n = 61) were >10-fold and >500-fold higher, respectively, than that in non-TWs. Our univariate and multivariate analyses indicated that the prevalence of hypertension and the prevalence of glycosuria in TWs with a high toenail Cr level, but not in TWs with a low toenail Cr level, were significantly lower than those in non-TWs. This study showed for the first time that long-term and excessive exposure to Cr (III) that is more than >500-fold but not >10-fold higher than the usual exposure level could decrease the prevalence of hypertension and the prevalence of glycosuria in TWs. Thus, this study revealed unexpected effects of exposure to Cr (III) on health.

#### **Decreased hearing levels at frequencies for understanding speech in tannery workers exposed to a high level of trivalent chromium in Bangladesh**

Yishuo Gu <sup>1,2</sup>, Nobutaka Ohgami <sup>1,2,5</sup>, M.M. Aeorangajeb Al Hossain <sup>2,3\*</sup>, Akira Tazaki <sup>1,2</sup>, Tomoyuki Tsuchiyama <sup>1,2</sup>, Tingchao He <sup>1,2</sup>, Masayo Aoki <sup>1,2</sup>, Nazmul Ahsan <sup>2,4</sup>, Anwarul Azim Akhand <sup>2,4</sup>, Masashi Kato <sup>1,2,5</sup>

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Hexavalent chromium [Cr(VI)], which has a strong corrosive effect, has been reported to cause perforation of the eardrum. Trivalent chromium [Cr(III)] also has a weak corrosive effect. However, there has been no study on the effects of exposure to Cr, either Cr(VI) or Cr(III), on hearing levels in animals or humans. In this study, the effect of Cr(III) exposure on hearing levels was determined in a human study. Then the reproducibility of the results obtained in the human study and the etiology were investigated in an animal study. The mean levels of total chromium (t-Cr) in hair and toenails from 100 Bangladeshi tannery workers were >20-fold and >360-fold higher, respectively, than those in hair and toenails from 49 Bangladeshi non-tannery workers (office workers). Multivariate analysis revealed decreases of hearing levels (DHLs) at 1 k and 4 k Hz, frequencies that are crucial for understanding language, but not at 8 k and 12 k Hz, in the tannery workers.

Since >99.99% of t-Cr in the wastewater that the workers were in direct contact with in the tanneries was Cr(III), the epidemiological results suggest Cr(III)-mediated DHLs in the tannery workers. The results of animal experiments in this study further showed that treatment with eardrops but not intraperitoneal injection with the same amount of Cr(III) that tannery workers might be exposed to resulted in DHL with a damaged eardrum in mice. Previous studies suggested that Cr(III) can directly reach the eardrums of tannery workers via droplets in the air. Cr(III) could also reach the eardrum via picking an ear canal with a finger contaminated with tannery wastewater including Cr(III). Taken together, the results of both human and animal studies suggest the risk of DHLs caused by damage of the eardrum through external exposure to Cr(III) via the ear canal.

Topic: CLIMATE HAZARDS  
3.a. Modern climate hazards in Asia

#### **Gap Analysis of Flood Mitigation Infrastructure Programs in Pampanga River Basin Based on Real-time Inundation Models of Selected Typhoons in the Philippines**

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The Philippines is frequently affected by typhoons, and more than half of the Pampanga River Basin (PRB) area in Central Luzon has been identified as susceptible to flooding brought about by such natural disaster. This study analyzed the gaps in the existing, proposed, and ongoing flood mitigation infrastructure programs and the lack thereof in Pampanga River Basin as one of the primary measures to minimize flood disaster impacts within the area. Real-time flood inundation by selected typhoons—Typhoon Pedring (Nesat) in 2011, Typhoon Ulysses (Vamco) in 2020, and Typhoon Karding (Noru) in 2022, simulated using the Water and Energy Budget-based Rainfall-Runoff-Inundation (WEB-RRI) model were the basis for gap identification. The flood inundation models showed that low-lying areas within the PRB area, especially in the Candaba Swamp, Pampanga Delta, and along the Pampanga River and its tributaries, have been highly susceptible to flooding. There were proposed and already ongoing programs and projects in some of these areas to attempt to address the vulnerability of PRB to climate risks, as well as in areas where flood risk susceptibility is still relatively high. The necessity, appropriateness, and effectiveness of these infrastructure programs were subjected to further qualitative analysis. The absence of flood mitigation infrastructures in other flood risk-susceptible areas was also discussed in the study.

#### **The BOOG-FAG Web App – A Decision - Support Tool for Soil Erosion Risk Assessment and Mitigation after Wildfires in Case Study of Khao Laem, Thailand**

Pongpun Juntakut <sup>1</sup>, Yaowaret Jantakat <sup>2</sup>, Ann Kambhu <sup>3</sup>, Chomphak Jantakat <sup>4</sup>, and Parskorn Yasawute <sup>5</sup>

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Wildfires are known to be one of the main causes of soil erosion and land degradation. Due to changes in climate, non-controlled large-scale wildfires are becoming more frequent and dangerous for human lives and ecosystem. A quantitative assessment of soil erosion is needed to outline an evaluation on the extent and magnitude of post-fire soil erosion potential and to develop the effectiveness of the mitigation actions.

Thus, this study establishes the BOOG-FAG web app for estimating soil erosion rate by using the coupling of the Revised Universal Soil Loss Equation (RUSLE) and the Geographical Information Systems (GIS) through the Google Earth Engine (GEE) platform. On 22-26 February 2020, a large wildfire occurred in Khao Laem, near the Chulachomklao Royal Military Academy, Nakhonnayok in Thailand. After the wildfire, the Forest Services applied a hillslope rehabilitation treatment of the vetiver system in order to protect the soil against erosion. In this study, the soil erosion rates of pre-fire, post-fire, and after rehabilitation treatment in Khao Laem are estimated to be 330 t/ha/year, 459 t/ha/year, and 424 t/ha/year, respectively. As a result, the vetiver system can be used to successfully protect the soil erosion in the study area after wildfires. Therefore, the BOOG-FAG web app can be a decision-support tool to contribute in assessing and planning of the wildfire mitigation actions and to achieve the water and soil conservation of the Sustainable Development Goals (SDGs).

#### **Development and validation of a global tropical cyclone wind model**

Dennis Wagenaar\*

*Earth Observatory of Singapore/ Asian School of the Environment, Nanyang Technological University*

Tropical cyclones rank among the most catastrophic natural phenomena, necessitating precise modeling for effective risk assessment and mitigation. Traditional modeling efforts, primarily serving the insurance industry, often exhibit high-quality outcomes but are limited geographically to regions with established insurance markets. Conversely, existing global models, while broader in scope, suffer from limitations such as coarse resolution and a lack of consideration for local land-use factors critical in accurately simulating wind speeds. In response to these challenges, we introduce an innovative global tropical cyclone wind model that integrates detailed local land-use parameters to refine wind speed predictions, including peak gusts. To compute the friction and gust, the model includes eight distinct wind directions and for friction it also takes into account the measurement height. This enhances its applicability and precision. The validation of our model is extensive, leveraging the Ibracs historical track data alongside precise wind speed measurements from weather stations during various typhoons in Japan. This comprehensive approach goes beyond aggregated metrics that are normally used to validate global tropical cyclone wind models, focusing instead on local accuracy and reliability to assess the model's local performance. The outcomes of this research demonstrate the feasibility of achieving localized wind speed modelling with a globally applicable model. This advancement holds significant potential for improving tropical cyclone risk assessment and informing targeted adaptation strategies, ultimately contributing to more resilient communities in the face of escalating climate hazards.

**DAY 1 - 29 November 2023**

**Oral Presentations**

**Breakout Session 3: 4 PM - 5:30 PM**

Topic: **TECTONIC HAZARDS**  
3.b. Understanding Geohazards and Risks

**Implementing a strategic plan for multi-hazards issues:  
A political action and concept for international research  
collaboration in Indonesia**

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Indonesia is a country that has multiple hazards because it is located in an active tectonic region and is surrounded by active volcanoes and dynamic climate change. One example of a damaging disaster is the earthquake that occurred in the western part of Sumatra in February 2022 with an Mw 6.4, which was felt as far as Singapore and Malaysia. Furthermore, the Mw 5.5 earthquake in the Cianjur area, which is close to the Gede volcano, resulted in hundreds of casualties and damage to the capital city of Jakarta. Both earthquakes occur on unknown active faults. An international collaboration between the Indonesian Agency for Meteorology, Climatology, and Geophysics (BMKG) and the Earth Observatory of Singapore (EOS) successfully describes in detail the tectonic structure of the area. In addition, seismic monitoring also captures several eruption activities that are too late to be monitored, such as Mount Agung, Mount Merapi, Mount Sinabung, and so on. Thus, international cooperation is needed to complement each other and examine seismic and volcanic activity. In addition, dynamic changes in weather and climate will produce droughts throughout 2023, which are characterized by low rainfall <100mm and high surface temperatures > 35C caused by the El Nino phenomenon. It is enough to be a disaster in the agricultural and plantation sectors and health in the lower middle class. The Indonesian government is politically very supportive of environmental research that is sustainable and effective in economic improvement. The Indonesian government is also an essential part of environmental issues which supports afforestation and forest restoration in the tropics. Therefore, potential environmental disasters must be anticipated early to support sustainable development. Strategic studies within the international collaboration for proper disaster mitigation are urgently needed for future risk management to support environmental and socio-ecological resilience in the Indonesian region and Southeast Asia."and effective in economic improvement. The Indonesian government is also an essential part of environmental issues which supports afforestation and forest restoration in the tropics.

Therefore, potential environmental disasters must be anticipated early to support sustainable development. Strategic studies within the international collaboration for proper disaster mitigation are urgently needed for future risk management to support environmental and socio-ecological resilience in the Indonesian region and Southeast Asia."To increase earthquake awareness and improve preparedness, and to reduce seismic risk, we are aiming at (i) preparing the community for EEW including Seismology at School program, (ii) developing a module for earthquake preparedness: earthquake evacuation protocols and drills, (iii) background noise analysis of seismic sites for EEW purposes. Carrying out educational activities by teaching earthquake-related topics in classrooms, conducting earthquake evacuation drills in schools in a regular manner, offering training to teachers supports raising earthquake awareness and lesson learned are crucial for the successful implementation of EEW. More essentially, we will study background noise of 15 sites for future installation of seismic sensors with early warning purposes.

**Hidden threats from volcanic seamounts in Southeast Asia.  
What should we be prepared for and where?**

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Southeast Asia (SEA) and nearby regions host only three submarine volcanoes (i.e. seamounts) with recorded Holocene eruptions according to the Global Volcanism Program (GVP). However, if we include GVP seamounts of inferred Pleistocene age, and seamounts detected through satellite-derived and geophysical methods, the number increases significantly (n= 466). With this newly compiled list of seamounts in SEA and surrounding areas (SEATANI: SEA + Taiwan + Andaman & Nicobar Islands), we aim to assess on a regional basis their hazard potential and exposure potential as a springboard for future more quantitative hazard studies for the region. The hazard potential was assessed through seamount morphological/structural analysis to determine the seamount evolution stage and grade of maturity. The exposure potential was evaluated through two different approaches: An areal analysis of the number of assets within a 100 km radius of each seamount; and the development of a hazard-weighted seamount density map to highlight potential areas of interest for future more-in-depth studies.

Our results show that Taiwan and eastern Indonesia are the countries potentially more exposed to a future submarine volcanic eruption in the region. Based on this, we considered several candidate seamounts from which we can conduct numerical simulations of specific hazard scenarios with the aim of assessing how key countries in the region can be affected, with a focus on Singapore, as part of the National Sea Level Programme (NSLP), funded by the National Environment Agency (NEA) of Singapore. Information should be given with significantly large weights in the early warning system. Back-projection of regional and teleseismic array waveform data is another important method that can quickly determine the rupture directivity and dimension of large earthquakes, hence could be an important component of early warning system.

### **Twenty-eight Years after the 1991 Mount Pinatubo Eruptions: Examining the Conditions of Burgos-Baquilan Resettlement Community, Botolan, Zambales, Philippines**

Ma. Charisma T. Malenab <sup>2,3\*</sup>, Kyle Pierre Israel <sup>4</sup>, Mabel G. Vallena <sup>2</sup>, Rico C. Ancog <sup>5</sup>, Josefina T. Dizon <sup>6</sup>, Merlyne P. Pagnolgui <sup>7</sup>, and Maria Victoria O. Espaldon <sup>5</sup>

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Critics position relocation as a limited risk reduction and recovery strategy. Literature provides cases which show of communities that have been resettled properly; yet amidst its consequential positive opportunities that may result in improved well-being, relocation is still accompanied by losses of various forms. This research, as guided by the socio-ecological systems analysis approach, examined the perceived biophysical and socio-economic changes in the conditions of the Burgos-Baquilan resettlement and its farming community twenty-eight years after the 1991 Mount Pinatubo eruptions. Focus group discussion participants and key informants, through various methods, shared their insights and experiences as they recovered within the disaster-altered landscape. They further described their desired future state for each of the examined elements. Complemented by the land cover change analysis of Burgos, Botolan, Zambales using Normalized Difference Vegetation Index (NDVI) maps, this research provides a localized context of the changes in the land cover. This case follows a pattern in disaster recovery wherein displaced communities stayed at multiple evacuation areas before they could resettle. Results indicate four organic elements that are important in the establishment and formation of the Burgos-Baquilan resettlement community in a new village with a corresponding environment that promotes post-disaster recovery. And it presents the analyzed trends in some elements of the resettlement that allowed the relocates to manage day-to-day risk at their new resettlement. This research contributes a case that exemplifies the importance of giving proper consideration to the perceptions, experiences, and judgements of the relocates for an improved community relocation livability. It supports the premise that community livability is best comprehended from the viewpoint of the relocated community. This may result in a better integration of relocation policies, projects, and efforts as a disaster risk management strategy for resettlement planning and community-building.



**DAY 1 - 29 November 2023**

**Oral Presentations**

**Breakout Session 3: 4 PM - 5:30 PM**

**Topic: PUBLIC HEALTH & ENVIRONMENTAL HAZARDS**  
3.c. Novel methods for studying environmental hazards

**Doing History in the Anthropocene: Interdisciplinary Approaches to Complex Problems**

Fiona Williamson

*Singapore Management University*

The climatic and environmental challenges that we are facing today are not able to be addressed by single-disciplinary approaches. In this short talk, I put forward a case for the better integration of historical research into the sciences, through an historical case-study of managing drought in Singapore. The years 1877, 1902 and 1911 have been identified by scientists as having experienced strong El Niño events globally. In Singapore, the town experienced some of its worst known droughts since the British had established a settlement there in 1819. Scientific studies that have recreated El Niño through evidence from Sea Surface Temperature (SST), Niño-3 and Niño-3.4 indices, the Southern Oscillation Index (SOI) or drought indices back this up, suggesting that the 1877 event in particular, was one of the strongest to have occurred within the historical instrumental record period. Yet, this paper contends that while the impacts of the 1877 event were incredibly severe in many places, the impacts of the event on Singapore were not necessarily worse than those resulting from the slightly weaker events that took place in 1902 and, in 1911 especially. To explain this, the talk looks to the atmosphere and to the ground, to unpack the nexus of nature-inspired versus human-induced vulnerability to drought within the context of colonial urbanisation. While grounded in an historical study, I argue that understanding the dynamics of this nexus are important as we move into ever more uncertain climates, to enable us to be prepared for future eventualities.

**A Deep Learning Approach to Map Riverbed Sand Mining Budgets in Large Tropical Deltas**

Sonu Kumar <sup>1,2</sup>, Edward Park <sup>1,2</sup>, and Adam Douglas Switzer <sup>2</sup>

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Riverbed sand is widely used in concrete production, land reclamation, and high-tech industries due to its angular shape and mineral richness. This has resulted in an unsustainable rate of sand mining leading to adverse social-environmental consequences. However, information on the sand mining budget, crucial for understanding their impacts, is scant due to a lack of monitoring systems and costly bathymetry surveys. Here, we develop a Remote Sensing-based Deep Learning (DL) framework to map sand mining budgets in the Vietnamese Mekong Delta (VMD), a global sand mining hotspot.

We trained our DL model to identify three boat classes in Sentinel-1 imagery: Barge with Crane (BC), Sand Transport Boat (STB), and all other boats on the river. Our DL model demonstrated high accuracy for all mapped classes (Mean Average Precision, mAP=96.1%), particularly for BC class, which is used to create a sand mining boat density map, mAP of 98.4%. Our estimated budget between 2015-2022 indicates that about 366 Mm<sup>3</sup> of sand has been extracted across the VMD, with an annual increment of around 2.79 Mm<sup>3</sup>. At the provincial scale, Dong Thap, An Giang, Vinh Long, Tien Giang, and Can Tho were the primary mining zones, accounting for 89.20% of total extraction. Our budget in the VMD establishes a new baseline reference that is necessary not only for a better understanding of its environmental consequences but also for developing regulatory frameworks for sustainable mining. Importantly, the framework developed in this study has a high potential to be applied in other deltas facing excessive sand mining.

**Reimagining Earth Ambassadors: Empowering Youth for Holistic Health through the One Health Approach**

Dona Lyn M. Piamonte\*

*University of the Philippines Open University*

In 2013, the University of the Philippines Open University (UPOU) initiated a project through its Faculty of Management and Development Studies (FMDS) with the primary objective of preserving socio-ecological production landscapes, satoyama, and satoyama-like landscapes that encapsulate societies' eroding culture. This initiative gave rise to the UPOU Earth Ambassadors (EA), a group primarily comprised of young individuals, often students from partner schools. Their mission is to raise awareness and engage in activities within their local schools and communities that align with sustainable development, environmental conservation, and responsible natural resource management.

Fast forward to 2020, a global pandemic prompted a reevaluation of approaches to address health challenges. One such approach that gained prominence was the One Health Approach, which recognizes the intricate interplay between human, animal, and environmental health. The COVID-19 pandemic vividly highlighted the interconnectedness of these domains, illustrating how diseases originating in animals and wildlife can spillover to humans due to a variety of factors, including population growth, climate change, wildlife trade, and international movement of humans, animals, and animal products, all of which impact our shared environment.

Building upon its previous accomplishments, the UPOU EA project now shifts its focus towards integrating the One Health Approach under the banner of "Reimagining Earth Ambassador through One Health Approach." This strategic evolution aims to optimize health outcomes by synergizing efforts in human, animal, and environmental health.

Through the FMDS and the UPOU EA Project, the goal is to cultivate a comprehensive understanding among K–12 students and communities in Los Baños and neighboring areas regarding the intricate interplay between humans, animals, wildlife, and the shared environment in shaping holistic health.

This proposal employs a mixed-method research design to comprehensively explore the transformative potential of the One Health Approach in enhancing well-being and fostering environmental consciousness. It delves into the perspectives of the Earth Ambassadors within the context of the UPOU Earth Ambassadors initiative. Empowering elementary students as Earth Ambassadors amplifies the potential impact of the One Health Approach, as it equips them to advocate for a sustainable and harmonious future, where the health of humans, animals, and the environment are inextricably linked.

# DAY 1 - 29 November 2023

## Poster Presentations

### CLIMATE HAZARDS

#### **Meteorological Drought Risk Assessment in Helmand River Basin (HRB) Using SPI Numerical Model**

Hayatullah Mushwani\*

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Meteorological droughts that arise from a repetitive and transient natural calamity, and insufficient precipitation has the potential to cause substantial economic damage. The prevention of meteorological droughts is impossible, however, its detrimental effects can be mitigated by closely monitoring. This study aims to assess the meteorological drought in the Helmand River Basin (HRB) using the Standardized Precipitation Index (SPI) model. The hydrometeorological data used during this analysis was collected from the Ministry of Energy and Water, Afghanistan (MEW). The precipitation data collected from MEW covered 40 years from 1979 – 2021. The analysis was conducted using the SPI model. It reveals that 1990, 1991, and 1992 were moderately wet, while 1982, 1983, 1995-1998, 2005, 2014, and 2015 were nearly normal. However, moderately dry conditions were observed in 2000, 2001, 2018, and 2021. Among the sampled stations, Waras and Gardez had consistently low drought levels, while Tarnak, Shila-i-charkha, and Khwabgah stations experienced moderate level drought. Meanwhile, Lashkargah and Adraskan stations exhibited relatively high levels of drought. In conclusion, the research on the HRB using the SPI method has contributed valuable knowledge to our understanding of drought dynamics in the region. The findings emphasize the importance of region-specific analysis, the need for sustainable water management strategies, and the global significance of addressing drought as a pressing environmental challenge.

#### **The Relationship between Climate and the Suitability of *Aedes aegypti* Mosquitoes' Habitat with DHF IR in Two Regions with Different Geographic Conditions**

Alfina Virayani\*, Rini Hidayati

*IPB University, Bogor, Indonesia*

DHF is found in almost all regions of Indonesia, including Tegal City and Wonogiri Regency. These two regions have different geographical conditions, which will affect suitability of *Aedes aegypti*'s habitat. This study aims to determine the relationship between DHF IR with climate variables and suitability level of *Aedes aegypti* mosquitoes' habitat, indicated by Ecoclimatix Index value. Spearman correlation and plotting data analyses are used to determine relationship between DHF IR with climate variables and EI. The results indicate that DHF IR in Tegal City tends to be high when air humidity ranges between 80-84%, average air temperature ranges between 27,9-29°C, and rainfall ranges between 240-537 mm. DHF IR in Wonogiri Regency tends to be high when air humidity ranges between 85-88%, average air temperature ranges between 25,5-26,5°C, and rainfall ranges between 139-604 mm.

Climate variables with DHF IR show different time lags in both regions because climate variables influence DHF transmission through complex mechanism. The monthly of EI and DHF IR in Tegal City have significant relationship at confidence level of 90%, while in Wonogiri Regency don't have significant relationship. Nevertheless, peak periods of DHF IR almost always coincide with high EI periods in both regions, particularly in Tegal City.

#### **Characteristics of Residual Water Level During Coastal Flooding in North Sulawesi, Indonesia**

Audia Azizah Azani\*

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North Sulawesi is a province in Indonesia that is geographically bordered by water bodies like the Sulawesi Sea, Molucca Sea, and Northwest Pacific Ocean, making it prone to coastal flooding events. In 2021, the National Agency for Disaster Management recorded four cases of coastal flooding in North Sulawesi. This study aims to identify and analyze the specific characteristics of the water level that remains after a coastal flood event subsides. The data used in this study are tidal data from the Geospatial Information Agency, rainfall data from GSMaP, and significant wave height data as well as wind direction and speed from the Copernicus Climate Data Center. The residual water level is identified by performing harmonic analysis with Unified Tidal Analysis and Prediction (UTide) methods. Temporal sequences are constructed from the precipitation data, while significant wave height, wind speed, and wind direction data are mapped with GrADS. The findings reveal a consistent pattern wherein these occurrences are associated with robust winds reaching velocities of up to 30 knots moving to the impacted area, and significant wave height up to 2 m, aligning with peak tide conditions. However, the rainfall intensity does not significantly affect the events. By identifying the unique attributes of residual water levels, this research can be used to develop strategies that bolster the region's preparedness and resilience to these events, especially for early warning purposes.

We use the double-difference method and resulted in a northeast-southwest trending lineation. The depth of the earthquakes is improved from being dominated by fixed depth to being varied with dominance at depths of 8-14 km. An important feature of the relocation results is that the fault structure is well delineated showing lineation of the structure with a steep dip of ~50° to the southeast. The northeast-southwest oriented lineation is thought to be associated with high-angle normal faulting activity which indicates a northwest-southeast trending tensional regime in the south of Teluti Bay. A small strike-slip component on the source mechanism of the mainshock is validated by a 11 mm northward surface displacement from the geodetic observation. The results of this study indicate the activeness of the tensional regime on Seram Island which can be used as a basis for seismic hazard assessment.

### **Tsunami Disaster Mitigation Strategies Due to The Landslide of The Mount Anak Krakatau in Banten Province of Indonesia Using Geographic Information System (GIS) Models**

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The collapse of Mount Anak Krakatau on 22nd December 2018 caused an eruption due to an avalanche of volcanic material on the flank of the mount amidst the full moon phenomenon releasing pressure on the magma system and resulting a tsunami with waves 13 m high that hit the Pandeglang area, Banten Province, Indonesia. This incident resulted in a height reduction of the mountain from 338 to 157 m, as well as causing losses of more than 40.000 people and damage to the infrastructure. Referring to the Geographic Information System (GIS), it is known that Mount Anak Krakatau consists of pyroclastic material in the form of volcanic ash and lapilli, as well as lava material in the form of andesitic and basaltic. Based on the rock characteristic of Mount Anak Krakatau, this mountain was formed from the deposition of an old mountain, so it is unstable. This mountain is on the northeast side of the trench which has a depth of 220 m and has a migration direction closer to the edge of the trench. The landslide phenomenon was not caused by changes in magmatic activity, however caused by the characteristics of Mount Anak Krakatau itself, so this event could not be predicted using an early warning system. Therefore, Banten Province needs disaster mitigation through creating a Disaster-Prone Areas Map and producing an Emergency Response Plan (ERP). To improve hazard management strategy, it is necessary to evaluate volcanic deformation patterns in long-term growth and develop non-seismic tsunami detection methods.

### **Potential tsunami hazards to Southeast Asia from sources in the South China Sea**

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With a coastal population of more than 250 million people, the South China Sea holds important oil and gas facilities, a large comprehensive network of submarine cables for communication and plays an increasingly vital role in maritime trade as it connects shipments from southeast to east Asia. Despite its importance, available studies on coastal hazards, like tsunamis, in Southeast Asia are few and often very localised. Hence, this study aims to address these gaps by evaluating the tsunamigenic hazard from potential earthquake and landslide sources for a hundred and seven (107) Southeast Asian ports and populated areas around the South China Sea. Currently, we simulated 50 earthquakes and their corresponding fault rupture scenarios for each magnitude (Mw) ranging from 7.0 to 8.4 from the southern portion of the Manila Trench and modelled their wave propagation using the Cornell Multi-grid Coupled Tsunami Model (COMCOT). From the obtained waveforms, we calculated the mean and maximum peak nearshore tsunami amplitude (PNTA) for each site. Based on our preliminary result, we found that infrastructures and cities along the coast of the Philippines and Vietnam can experience wave heights exceeding 5 meters. Coupled with the relatively short wave arrival timings of less than 2 hours, the hazards in these areas are deemed to be high. On the contrary, countries that lie further away from the fault, like Singapore, western Malaysia, Cambodia and Thailand have a low risk due to their low wave amplitude (not exceeding 1 meter) and long wave travel times exceeding 9 hours. disaster mitigation through creating a Disaster-Prone Areas Map and producing an Emergency Response Plan (ERP). To improve hazard management strategy, it is necessary to evaluate volcanic deformation patterns in long-term growth and develop non-seismic tsunami detection methods.

### **Investigation of landslides and geoenvironment analysis in Chittagong, Rangamati and adjoining areas of south-eastern hilly districts, Bangladesh**

Lubna Yesmin Khondakar <sup>1\*</sup>, Dr Michel Jaboyedoff <sup>2</sup>, Dr Ivanna Penna <sup>3</sup>, Dr M. Zillur Rahman <sup>4</sup>

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Landslides have become an increasingly serious hazard in Bangladesh, posing a challenge to the country's development process. It is crucial to identify the areas prone to landslides to develop appropriate risk management strategies. The study area covers parts of the southeastern tertiary hilly region, and the elevation varies from one place to another.

To map the landslide hazard, experimental analysis of slope soils, geoenvironment analysis, and landslide risk assessment and management plan, 12 landslide locations in Chittagong district and 20 landslide locations in Rangamati district were selected. The study primarily relies on a fieldwork-based landslide inventory, collection of soil samples, and secondary data analysis. Google Earth images and the Geological Map of Bangladesh, GPS, and clinometers are used in the field to identify the landslide location, geology, and slope angle. Disturbed and undisturbed soil samples from different hills where landslides occurred or may occur soon are collected to analyze soil properties related to shear strength. The displaced slope materials are mainly sand and silt. Rainfall is analyzed using IMERG images. Preliminary results show that extreme rainfall in a short period is the main cause of all landslides. The higher pore water pressure generates tension cracks in the slope of the hills, leading to slope failure. Although the physical causes of many landslides cannot be removed, they can be mitigated by proper geologic investigations and effective enforcement of land use management regulations.

# DAY 1 - 29 November 2023

## Poster Presentations

### TECTONIC HAZARDS

#### **Cities at risk from volcanic hazards: changes in city proximity and exposure through time**

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Cities located in close proximity to volcanoes place dense concentrations of populations, buildings, and infrastructure at risk of volcanic hazards. Past analyses have considered the exposure of cities using the location of their footprint's centroids relative to nearby volcanoes. As this approach fails to capture the preferential and often irregular urban expansions through time, we assess here the exposure of all cities with populations of greater than 50,000 people located within 100 km of a volcano using the evolution of their areas obtained from the Global Human Settlement (GHS) Model. For key cities, we identify those exposed to multiple volcanoes and determine if cities are growing radially towards volcanoes or only in a particular direction. We constrain changes in the cities' shape and direction of expansion and identify those cities growing towards one or multiple volcanoes. We then compare these changes to prevailing wind direction data and flow directionality to assess the evolving exposure of cities to tephra fall and block-and-ash flow hazard over time. This study provides a global perspective on the spatio-temporal evolution of the exposure of cities to volcanic hazards, which allows for the identification of areas for future research and mitigation efforts. The research on the HRB using the SPI method has contributed valuable knowledge to our understanding of drought dynamics in the region. The findings emphasize the importance of region-specific analysis, the need for sustainable water management strategies, and the global significance of addressing drought as a pressing environmental challenge.

#### **Advancing User-Friendly Tsunami Hazard Mapping: MATLAB-based Applications for FUNWAVE modelling**

Raquel Felix<sup>1\*</sup>, Masashi Watanabe<sup>1</sup>, Andrea Verolino<sup>1</sup>, Elaine Tan<sup>1,2</sup>, Puah Jun Yu<sup>1,2</sup>, and Adam D. Switzer<sup>1,2</sup>

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Tsunami modelling plays an important role in understanding both past tsunamis and for evaluating potential future tsunami hazards and risks. The preparation of input files and the subsequent post-processing of output files of tsunami models often demand a substantial amount of time. This delay in the workflow can impede modellers from starting the analysis of the results at an earlier stage. In this study, we address this issue by introducing standalone applications designed to streamline these tasks, with the goal of optimising the efficiency of both tsunami model preparation and post-processing stages. We present two MATLAB-based user-friendly applications designed to efficiently generate input files and output tsunami hazard maps.

The applications were designed to align with the required input and expected output files of the Fully Nonlinear Boussinesq Wave (FUNWAVE) model - a well-established open-source model, extensively validated through analytical solutions and experimental investigations. To facilitate ease of use, the applications incorporate tool tips and context menus that provide comprehensive guide for users. Within the input-generator application, visual warnings pre-empt potential errors in tsunami simulations. Meanwhile, the output map generator application not only facilitates the creation of maps, but also offers users the convenience of converting these maps into raster files, KML, or shapefiles. This versatility ensures compatibility with various programming and Geographic Information System (GIS) platforms. We tested the functionality of the applications using the benchmark examples from the FUNWAVE model. Through the development of these applications, we aim to advance tsunami modelling research by enhancing technological accessibility, hence reducing the complexity, especially for individuals new to tsunami modelling. The map-generator application can be adapted for use with outputs from other modelling software that share similar file extensions. This adaptability enables efficient hazard modelling and supports risk assessment efforts. be high when air humidity ranges between 85-88%, average air temperature ranges between 25,5-26,5°C, and rainfall ranges between 139-604 mm. pre-empt potential errors in tsunami simulations. Meanwhile, the output map generator application not only facilitates the creation of maps, but also offers users the convenience of converting these maps into raster files, KML, or shapefiles. This versatility ensures compatibility with various programming and Geographic Information System (GIS) platforms. We tested the functionality of the applications using the benchmark examples from the FUNWAVE model. Through the development of these applications, we aim to advance tsunami modelling research by enhancing technological accessibility, hence reducing the complexity, especially for individuals new to tsunami modelling. The map-generator application can be adapted for use with outputs from other modelling software that share similar file extensions. This adaptability enables efficient hazard modelling and supports risk assessment efforts. be high when air humidity ranges between 85-88%, average air temperature ranges between 25,5-26,5°C, and rainfall ranges between 139-604 mm.

#### **High-Angle Normal Fault Activity on Seram Island (Molucca, Indonesia) Revealed by the 2021 Mw 6.0 Tehoru Earthquake and Its Aftershocks**

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Agency for Meteorology Climatology and Geophysics (BMKG) of Indonesia 1, Jakarta, Indonesia

Seram Island is the northern part of the Banda subduction which has complex tectonic setting consist of subduction structure on Seram Trench and a strike-slip deformation zone named Kawa Fault. On June 16, 2021 a Mw 6.0 earthquake occurred on the south coast of Seram, in Tehoru to be precise, which followed by a 51 cm high tsunami wave which is thought to have been generated by an underwater landslide. This earthquake has a normal fault mechanism which is quite rare on Seram Island. To investigate the earthquake source, we performed a seismicity analysis using well relocated hypocenter of the mainshock and the aftershocks sequence.

## Coastal Erosion on the East Coast of India: A Case Study from Pentha Sea Beach, Odisha

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Coastal erosion is a natural process, locally enhanced by human activities and the effects of climate change. In recent years, the East Coast of India has witnessed a significant increase in coastal erosion, potentially caused by local geomorphic factors and/or cyclones. Pentha Sea Beach in Odisha, India, is one of the locations that is particularly vulnerable to coastal erosion due to its location on the northern tip of Bay of Bengal, a hotbed of cyclone activity. This coast has experienced considerable changes in the spits and barrier islands, and potentially in the river systems. Also, the area has been severely affected by the Odisha Super Cyclone in 1999 and Cyclone Fani in 2019, as well as a series of historical cyclones. This study aims to comprehensively analyse the changes in the Pentha Sea Beach over the past 14 years due to coastal erosion. We used satellite images from 2009 to 2023 to map the temporal changes in the shoreline caused by coastal erosion. The analysis revealed that the coastline has shifted landward by ~150 m over the last 14 years, with an average rate exceeding 10 m/year. The data indicates that coastal erosion has had a significant impact on Pentha Sea Beach, leading to the loss of land, mangrove depletion, and changes in the coastal configuration. The outcome from this study emphasizes the importance of implementing sustainable and resilient coastal management strategies to mitigate the impacts of coastal erosion and ensure the long-term sustainability of coastal communities and ecosystems. Occurrences are associated with robust winds reaching velocities of up to 30 knots moving to the impacted area, and significant wave height up to 2 m, aligning with peak tide conditions. However, the rainfall intensity does not significantly affect the events. By identifying the unique attributes of residual water levels, this research can be used to develop strategies that bolster the region's preparedness and resilience to these events, especially for early warning purposes.

## Investigating the lowest of lows: A perspective on extreme sea levels from Southeast Asian tide gauge records

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Conventional research into extreme sea levels has tended to focus on the extreme highs, especially with the attention accorded to global sea level rise; however, no work has been done so far on the extreme lows at the other end of the spectrum.

Lower than normal sea levels have the potential to interfere with port infrastructure and navigation, and they may also negatively impact coastal ecosystems and communities. An understanding of these events will be fundamental in preparing for and mitigating these repercussions successfully. In this study, we use historical tide gauge data to examine extreme low sea levels at seven locations around Southeast Asia. By applying a peaks-over-threshold (POT) methodology to select extreme values, we are undertaking a temporal analysis of the lowest 1% of sea levels. We will determine if there has been a change in both the frequency and magnitude of extreme lows over the course of the instrumental record, and if these observations are associated with annual fluctuations in both the ENSO (El Niño – Southern Oscillation) and monsoon indices. This novel investigation will hopefully shed some light on the relative importance of considering extreme lows in future sea level research. Air temperature ranges between 27.9–29°C, and rainfall ranges between 240–537 mm. DHF IR in Wonogiri Regency tends to be high when air humidity ranges between 85–88%, average air temperature ranges between 25.5–26.5°C, and rainfall ranges between 139–604 mm.

## Documenting the Marine Heatwaves during triple-dip La Nina in Indonesia Water

Andhika Hermawanto\*

BMKG, Indonesia

When La Niña occurs, Indonesian waters transform into a warm pool. In 1998 and 2016, during La Niña events, Indonesia was recorded to have experienced marine heatwaves. In the years 2020/2021/2022, La Niña occurred for three consecutive years. This research aims to document the occurrence of marine heatwaves in the waters off the west coast of Sumatra, Indonesia, during these three consecutive La Niña periods. Utilizing sea surface temperature (SST) data from the National Oceanic and Atmospheric Administration (NOAA) Optimum Interpolation (OI) SST V2 high-resolution dataset, the results provide information on the date, duration, and extent of marine heatwaves area. It is expected that the findings of this research will confirm information regarding potential disasters in Indonesian waters that are likely to increase in the future.

# DAY 1 - 29 November 2023

## Poster Presentations

### PUBLIC HEALTH & ENVIRONMENTAL HAZARDS

#### **The Effect of Chemical Release Due to Volcanic Eruption on Indonesia's Air Pollution**

Haiqa Sabrina Ramadhani\*, Sarah Farsya Nurulnisa

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Air pollution is made out of gases and small particles that can harm human health. It is the sixth-leading factor of worldwide deaths of up to 4.14 million. Adding to that, exposure to air pollutants can cause short and long term diseases. Short-term effects are common which include asthma, wheezing, and coughing. Long-term effects from pollution include but are not limited to chronic asthma, pulmonary insufficiency, and cardiovascular diseases. This study aims to ascertain conclusions on health and correlation between the air quality index to one of the main causes that affects it.

In general, volcanic eruptions are known to cause up to 5% of ozone damage. Its eruptions also release carbon dioxide, sulfur dioxide, and nitrogen which are known to be main chemicals that cause air pollution. Due to the fact that there are 45 active volcanoes in Indonesia, it is not surprising that air pollution is not something out of the ordinary for the country. The effect of chemical release due to volcanic eruption on the air pollution in Indonesia is studied using linear regression models. This study uses AQI (air quality index) data, which is a tool used to evaluate and express the air quality of a region. The result is elaborated on the air quality within a region.

#### **Assessing the Impact of Urban Green Spaces on Respiratory Health: A Novel Approach to Mitigating Environmental Hazards**

Rachael Gakii Murithi\*

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In rapidly urbanizing environments, the escalating burden of respiratory diseases and the prevalence of environmental hazards pose significant challenges to public health. This research pioneers a novel investigation into the potential of urban green spaces as a proactive solution to mitigate respiratory health risks associated with environmental hazards. Leveraging advanced geospatial and health data analytics, this study examines the intricate relationship between urban green space distribution, air quality, and respiratory health outcomes. By employing cutting-edge sensor technologies for real-time air quality monitoring, coupled with health data integration and spatial modeling, the research aims to unveil the direct impact of accessible green spaces on respiratory health improvement and hazard mitigation. The findings from this study not only contribute to advancing our understanding of the intricate interplay between environmental hazards and public health but also offer evidence-based insights to urban planners, policymakers, and healthcare practitioners for informed decision-making. This innovative approach holds the potential to revolutionize urban planning strategies, fostering healthier and more resilient cities while addressing the urgent need for effective solutions to the intersecting challenges of public health and environmental hazards.

#### **Dispersion Modelling in Gas Leakage Risk Management of Biogas Powerplant**

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Gas leak incident at the biogas power plant facility will release toxic and flammable chemicals that harmful to human and environment. Risk management was necessary to minimize the potential for biogas leakage incidents that can endanger employees and the community around the facility. . In the case of a gas leak incident, there are many factors that will affect the level of consequences resulting from the leak, these consequences can be in the form of disruption of the health of employees and residents around the facility, property damage, to mass death and this incident can be categorized into Tier 1 - Event Indicator Process Safety. Mitigation action plans are carried out based on a risk assessment using existing scientific and technical data. This research was carried out with the aim of analyzing the impact caused by the incident of gas leakage from the biogas power plant facility, determining the distance of exposure to gas leakage from the facility using a dispersion model, determining the Emergency Evacuation Plan for the gas leakage incident and formulating recommendations of mitigation action for gas leakage incident at biogas power plant facility. This research was carried out at one of the biogas power plant facilities located in Riau Province, Indonesia by taking operational data of facility and the average wind speed and wind direction data from the Central Statistics Agency (BPS) of Riau Province. The data is processed using ALOHA software to determine the distribution of gas leaks that occur. Our results show that gas leak incidents can lead to the formation of vapor cloud explosions, heat radiation, explosions, and disruption of community activities, thus requiring an emergency evacuation plan that is qualified and includes mitigation actions taken to prevent or minimize impacts that can occur.

#### **Evaluation of the Plan of Action to Implement the ASEAN Leaders' Declaration on Disaster Health Management in the ASEAN Founding Members: A glimpse on One Health Initiative in ASEAN**

Amen G. Quizon-Letana\*, Myra D. Oruga, MPH

*University of the Philippines Open University, Los Baños, Philippines*

One Health, a United Nations' (UN) global campaign, is a multi-sectoral and interdisciplinary approach to "sustainably balance and optimize the health of people, animals, and ecosystems" through robust research and policymaking. The UN 2030 Agenda outlining 17 Sustainable Development Goals (SDGs) is considered to be the practical applications to achieving One Health. The SDG declaration became a global driving force for countries to recalibrate and align their development plans to SDG No. 3.d, which states, "Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction, and management of national and global health risks."



At midpoint of SDG enforcement since 2016, its special edition report published July 2023 lacked update on SDG 3.d. On the other hand, the Association of Southeast Asian Nations (ASEAN) in 2017 adopted the ASEAN Leaders' Declaration (ALD) on Disaster Health Management (DHM), followed in 2019 by its operationalization document—the Plan of Action (POA) to Implement the ALD on DHM. Four years after launch and two years before deadline, an evaluation on the POA to Implement the ALD on DHM is timely and needed. Using Continuous Learning Framework, the study evaluated the quality of implementation of the POA, bringing to the forefront the strengths and gaps in implementation from an internal evaluation perspective. Finally, the study attempted to answer the question whether One Health is a good fit for ASEAN context, implicative of the future of disaster health management and One Health in the region.

Topic: **ECONOMIC RESILIENCE: FINANCE & RISK**  
4.a. Measuring economic losses and resilience

#### **International study on determinants of flood insurance demand. Impact of risk perception, loss size and financial aid from public entities**

Maria Forlicz<sup>1,\*</sup>, Patrycja Kowalczyk-Rólczyńska<sup>2</sup>

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Attitude to insurance against floods is affected by the perception of risk that is the feelings of individuals regarding the inevitability of events, and their individual belief that it is worth insuring themselves because the threat is real. To answer the research questions (Is being insured at the time of the flood damage related to the percentage of losses covered by the public entities? Is the current possession of a flood insurance policy related to the amount of the percentage of losses covered by the public entities for the previously incurred flood loss? Are the flood risk assessment by the head of the household and the amount of previously suffered flood damage different among the insured and the uninsured?) a survey among households that were recently affected by flooding was conducted in four European Union countries: the Netherlands (N=300), Germany (N=300), Spain (N=300) and Poland (N=208). Results show that only in Poland there is a significant difference between the percentage of losses covered by the public entities among then insured and uninsured (lower among the insured households) but there are no differences between the percentages of losses covered by the public entities in last flooding among currently insured and uninsured. In Poland and Spain, those who are insured estimate the probability of future flooding significantly higher than those who are not insured. In Poland and Spain values of previously suffered flood damage differ significantly between the insured and the uninsured (higher for the insured).

#### **How can a collaborative approach help enhance the application of a local catastrophe model for effective seismic risk management? Evaluation of the MAIPARK Catastrophe Model (MCM)**

Gizem Mestav Sarica <sup>1</sup>, Hengki Eko Putra <sup>2</sup>, Alif Azfar Badaruddin <sup>2</sup>, Brad Weir <sup>1</sup>

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Catastrophe models are routinely used in the (re)insurance industry to facilitate effective disaster risk management through risk assessment and risk transfer subjected to natural hazards. MAIPARK Catastrophe Model (MCM) was developed by MAIPARK, a reinsurance company specializing in natural hazards in Indonesia that is owned by the Indonesian general insurance industry. Leveraging off MAIPARK's expertise in seismic risk research, this model provides a local context for the industry through a state-of-the-art seismic source model and comprehensive industry data. Although catastrophe models developed by global model vendors are widely used in Indonesia, they will not have the same level of insight, data or experience inherent within the MCM.

Due to the existing application of global models in international risk transfer, understanding the model and how it represents the local insurance risk through a model validation process is required to build confidence and enable broader acceptance. Independent expert review prior to adoption is an important step that can accelerate the acceptance of MCM by the industry. This study focuses on a process of evaluation targeting fundamental components of a catastrophe model including hazard, vulnerability, exposure, and financial modules. By this way, relative importance of each input can be assessed, key model advantages highlighted, limitations identified, and potential improvements prioritized. Improving our understanding and communication of catastrophe risk through MCM which has unique access to local insight around risk and data helps us form a more informed view which leads to a transparent and robust decision-making on disaster risk management for insurance, public education, emergency preparedness, and mitigation.

#### **Singapore Cloudburst GCAT model**

*Velautham Daksiya\*, Daniel Knös, Narathip Sutchiewcharn, Mark Weatherhead*

*Guy Carpenter*

Recent flood events manifest changing flooding patterns in Singapore. Impact of climate change on intensity and frequency of rainfall and rapidly changing topography are major reasons behind those events. Guy Carpenter's Cloudburst GCAT model for Singapore estimates urban flood losses accounting most recent land-use, drainage/flood defense and meteorological data sets. The model combines a stochastic event set with a detailed build environment and proprietary vulnerability functions to compute losses. The hazard component is built from a stochastic event set of rainfall events which is generated from local rainfall data. The inundation depths are modelled at 1m resolution for each individual precipitation event using different flow routing and hydraulic modelling techniques. Detailed vulnerability functions are developed for 18 different occupancies includes secondary modifiers such as number of stories, floor location and basement information. Build environment disaggregation engine is developed at individual building level using land use data from Singapore authorities. The model provides various level of outputs includes Average Annual Loss, Event loss Table and Loss Exceedance Probabilities accounting current climate condition. Further, the model is enhanced project climate change impact on losses based on Representative Concentration Pathway (RCP) and Network for Greening the Financial System (NGFS) climate scenarios. This Model is suitable for underwriting purposes, risk management and regulatory requirement with supported data at high resolution. GCAT models are built under the Oasis Loss Modelling Framework (Oasis LMF).

## **Quantifying the value of Nature-based Solutions for flood risk reduction and well-being protection**

Alina Bill-Weilandt <sup>1</sup>, Perrine Hamel <sup>1</sup>, Dennis Wagenaar <sup>1</sup>,  
Ashwin Katuwal <sup>2</sup>, Parichat Pinsri <sup>3</sup>, Ridhi Saluja <sup>3</sup>, Thanapon  
Piman <sup>3</sup>, Ho Huu Loc <sup>2</sup>, David Lallemand <sup>1</sup>

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<sup>3</sup> *Stockholm Environment Institute, Bangkok, Thailand*

Given limited resources for flood risk management and a need to convince co-financiers and donors to support investments, governments and development organizations conduct economic analyses to identify the most efficient policies and investments to reach their objectives. Traditional risk assessments measure benefits in terms of avoided asset losses. This approach leads to a prioritization of locations where assets and wealth are accumulated, shifting the focus away from locations where people are more vulnerable. Nature-based Solutions (NbS) are promising solutions to reduce flood impacts on vulnerable communities. However, no universal economic analysis approach for NbS exists, nor is social vulnerability considered in existing studies. Non-asset-based flood risk assessments provide an opportunity to align economic analyses methods for NbS with the objective of governments to support the most vulnerable. This study proposes a well-being-based flood risk assessment approach to quantify the value of NbS. It expands a probabilistic flood risk modelling framework for ecosystem service assessment by accounting for climate change and social vulnerability. The framework is applied in the Lower Songkhram River Basin, in Northeast Thailand, to estimate the impact of flooding on well-being under different climate and disaster risk management scenarios. Local data on physical and social vulnerability, on flood impacts on livelihoods, and on financial resilience was collected in a household survey (n=588). Using a well-being-based approach in economic analysis of NbS, the framework enables the identification of risk management measures (including NbS and rice insurance) that best protect well-being. are widely used in Indonesia, they will not have the same level of insight, data or experience inherent within the MCM.

## **Social Dynamics of Climate Change Mitigation**

Chin-Hsien Cheng\*, Simon S.A.T. Redfern

*Asian School of the Environment, Nanyang Technological University*

While we are certain about the impact of anthropogenic greenhouse gas (GHG) emission on climate change, the emission projections in Earth System Models (ESMs) are still scenario-based without considering the feedback of how climate change influences the mitigation efforts. We will present our attempt addressing this important modelling gap with the aim of recommending more effective approaches for mitigating climate change. We compare the global GHG emission projections between our simple model and the 2023 publications by Internal Energy Agency (IEA) and Organization of the Petroleum Exporting Countries (OPEC). Google trends, energy and carbon pricing data are used to support the rationale of our model assumptions. Eventually, we propose stages of feedback processes from rising global temperatures, impact of key influencers, the nature of incentive or fear-driven communication frames, to mitigation actions, energy and carbon prices.

Topic: STRATEGIES FOR SOCIOECOLOGICAL RESILIENCE  
4.b. Nature-based solutions for risk management

#### **Indicators for Assessing the benefits of Nature-based Solutions for Disaster Risk Reduction in Southeast Asia**

Erich Wolff\*, Perrine Hamel

*Asian School of the Environment, Earth Observatory of Singapore, Nanyang Technological University, Singapore*

Research indicates that nature-based solutions, including green roofs, raingardens and constructed wetlands can significantly contribute to disaster risk reduction strategies. However, recent studies suggest that more research is necessary to understand how these solutions can be appropriately evaluated and monitored. In the context of Southeast Asia, where urban centres have grown at accelerated rates, developing monitoring frameworks to assess ecosystem services is particularly relevant. Ensuring that nature-based solutions are providing benefits to the most vulnerable communities is central to debates about climate justice and effective community-based disaster risk reduction. Contributing to this debate, we sought to find indicators of resilience that are appropriate to the context of Bangkok. Based on interviews conducted with key stakeholders in Thailand, we interrogate the motivation behind the implementation of nature-based solutions and infer a series of indicators that can be used to measure their effects in terms of disaster risk reduction. We identify indicators that assess (i) the physical extent of nature-based solutions, (ii) the provision of resilience-related ecosystem services and (iii) the benefits of these services to the community. We propose a monitoring framework to evaluate if and how existing nature-based solutions in Bangkok can contribute to climate resilience. Drawing on the lessons from this case study, we stress the importance of monitoring the effects of nature-based solutions using context-appropriate indicators of ecosystem services and resilience. We highlight challenges for monitoring of these solutions in informal settlements, where local uses of nature influence the social, economic and environmental aspects of resilience eventualities.

#### **Shared Ecologies: A reinterpretation of eco-philosophy in Feng Shui and its scientific principles for making city resilient**

Wenjian Pan\*

*School of Architecture and Urban Planning, Huazhong University of Science and Technology, Wuhan, China*

Blue-green infrastructure plays a crucial role in forming urban morphologies, maintaining urban operation while mitigating environmental risks. Feng Shui, a theorization of Chinese ancients' habitation experiences, has provided many philosophical insights and scientific guidance on dealing with environmental changes to make habitats resilient. Using Hong Village as a standard application model for Feng Shui, this study reinterprets the naturally adaptable principles in Feng Shui and analyses how its passive strategies can be adopted in dwelling systems at macro-, meso-, and micro-scales.

It finds that Feng Shui advocates a "system-oriented" and "shared" ecological thought to co-op elopement with nature. It treats human settlements as organic living systems that interlink and co-develop with surrounding environments. Specifically, it highlights flowing air (Feng) and flowing water (Shui) as two fundamental natural elements to be utilized and integrated into construction and daily activities, which can contribute to accumulation and circulation of energies, materials, and social dynamics. As such, seeking a balance state between humans' activities and natural processes is critical in Feng Shui. Based on these reinterpretations, the Cheonggyecheon urban restoration project in South Korea and the Yanweizhou landscape rehabilitation project in China are taken as two typical cases for showcasing successful integrations of Feng Shui's eco-principles into modern city governance, and they aim to respond to the challenges of increasing urban heat waves and flood hazards, respectively. Ultimately, a few nature-based solutions and soft interventions are outlined for the construction and adjustment of blue-green infrastructure in contemporary cities to strengthen urban resilience.

#### **Towards an Enabling Environment for Cities to Develop Nature-Based Solutions for Urban Climate Adaptation**

Loan Diep<sup>1</sup>, Timon McPhearson<sup>1,2</sup>

<sup>1</sup> *Urban Systems Lab, The New School, New York, NY, United States*

<sup>2</sup> *Cary Institute of Ecosystem Studies, Millbrook, NY, United States  
Stockholm Resilience Centre, Stockholm University, Stockholm, Sweden*

Each passing year shatters new climate records, making climate change cause unprecedented damage. As the majority of the world's population now resides in urban areas, cities have become climate hotspots. The latest assessment report of the Intergovernmental Panel on Climate Change released in 2022 has highlighted the need for adaptation measures to manage climate impacts to safeguard urban lives and livelihoods. For chapter "Cities, Settlements and Key Infrastructure", Working Group II (WGII) comprehensively assessed current evidence of risks and solutions in cities. While cities are at the confluence of risks, they also are key to addressing the climate crisis. WGII has highlighted the potential of Nature-based Solutions (NbS) to become a key part of climate adaptation. NbS help respond to climate challenges while providing co-benefits to both people and nature. However, city leaders around the world face important barriers to the planning, implementation, and management of NbS. This starts with mitigation action being where most climate action is taken, leaving little room for investment in adaptation measures. This talk revisits some of the key institutional barriers faced by city leaders in all the world regions as they try to integrate NbS into policy and planning. It further highlights examples of successful initiatives worldwide and emphasize four areas of action that will support the creation of an enabling environment for cities to develop NbS: 1) consolidating existing knowledge and addressing knowledge gaps; 2) creating a supportive political and policy environment; 3) improving cities' access to finance; 4) making space for horizontal city collaboration and environmental health.

## Community-led planning and implementation of NbS in an informal settlement in Honiara, Solomon Islands

Darryn McEvoy\*

RMIT University

This presentation will focus on the potential value of nature-based solutions (NbS) in urban environments based on the experience of implementing four NbS pilots to address climate adaptation and disaster risk reduction in Koa Hill informal settlement in Honiara, Solomon Islands. The project, funded by the Swedish International Development Cooperation Agency (SIDA), employed an inclusive co-production approach, with the local project team engaging closely with community members and local stakeholders throughout the planning, design, and implementation stages. Findings reinforced the importance of long-term engagement and trust-building with members of the community, capacity strengthening, inclusion of local knowledge, and longer-term monitoring and evaluation to establish the foundations for a 'successful' NbS project. Findings also underscore the value of empowering local partners in project design and implementation in the Pacific, as well as illustrating the significance of inclusive engagement processes, committed local leadership, promotion of learning opportunities, and the use of discretionary funds, to maximise a sense of ownership and sustainability of NbS interventions. The presentation will showcase the local processes that were involved, as well as highlighting the key insights and lessons learned from the proof-of-concept project which can usefully inform the scaling up of NbS initiatives to achieve multiple benefits in other 'ocean cities'.

## Synergizing Nature, Climate, and Humanity: Advancing Conservation and Landuse Through Spatial Modelling and Machine Learning Integration

Yiwen Zhang<sup>1\*</sup>, Yiting Wang<sup>2</sup>, Simon A.T. Redfern<sup>1</sup>

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(Please contact at [yiwen004@e.ntu.edu.sg](mailto:yiwen004@e.ntu.edu.sg) to obtain the below figures)

In an era marked by climate challenges, with the flourishing of AI-empowered big data analysis, applying useful tools to provide nature-based climate solutions is a valuable research question to study. The research includes three sections:

Figure 1. Basic data analysis in Peru:

- Spatial distribution of targeted threatened species.
- CO<sub>2</sub> emissions if the planning unit is cleared; Conservation cost of the planning unit; Deforestation risk; Existing protected areas.
- Total carbon stock.
- Identified areas without additionality.

Figure 2. Results Visualization in Peru: e) Natural habitats that would generate revenue at different carbon prices. f) Trade-off analysis of the CO<sub>2</sub> emissions penalty. g) Final optimization result for conservation projects.

The first section, centred on conservation project planning in Peru, addresses the pressing issue of biodiversity and indigenous community preservation in the face of resource extraction. The process of the identification of target areas includes accounting for biodiversity co-benefits, carbon pricing, additionality analysis, and trade-off (cost-benefit) analysis. Utilizing spatial optimization models and Pareto analysis, the regions that offer the most significant potential for conservation success in a nature-human coupled system were identified.

Figure 3. Land classification map of Singapore with machine learning prediction.

The second section is to check the feasibility of machine learning applications in land classification accuracy. As a result, the Random Forest model (Accuracy 87%) performed better than the CART model (Accuracy 78%) in Singapore, the unmanaged vegetation (96%) and the built environment (90%) regions were predicted most accurately.

Figure 4. Results of the third section: h) Tree cover data comparison from left to right: Original data; NDVI-corrected data; Real satellite image. i) Land cover change of the project region.

The third section is a tree cover change study in Papua, New Guinea over the past 20 years. The NDVI index-corrected result is more accurate, which could be incorporated into the ML land classification method to improve the effectiveness and to fasten the due diligence process of carbon credit projects, including the additionality, baseline, and leakage issues.

The research could enhance the positive effect of the carbon market on nature and furthermore help enhance the synergy between nature, climate, and human society.

Topic: **MANAGING RISK**  
4.c. Disaster response and risk reduction

#### **Assessment of Flood Control Measures (FCM) “Monkey’s Cheeks” in Chao Phraya River Basin, Thailand**

Angsana Chaksan <sup>1\*</sup>, Sarawut Ninsawat <sup>1</sup>, Indrajit Pal <sup>1</sup> and Shiro Ochi <sup>2</sup>

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<sup>2</sup> *Toyama University of International Studies, Toyama, Japan*

Floods, accounting for nearly 40 percent of natural disasters worldwide, are a significant concern in both developed and developing nations. The Southeast Asian region, in particular, is highly susceptible to floods, posing threats to communities and economies. This study delves into the assessment of the effectiveness of the Flood Control Measure (FCM) “Monkey’s Cheeks” in the Chao Phraya River Basin (CPRB), an area prone to recurrent flood disasters. This research examines the impact of FCM implementation before (2008-2016) and after (2017-2018), using flood inundation extent data from NASA’s daily Near Real-Time (NRT) MODIS water products. Additional datasets on key infrastructure and societal assets were incorporated to evaluate flood exposure. Spatial analysis techniques, including flood change analysis using the TerrSat system and ArcMap, were employed. Findings highlight that flood durations remained relatively unchanged post-FCM, but the measure effectively targeted areas with recurring flood histories. Variable annual rainfall patterns contributed to complex evaluations of FCM’s success. Furthermore, a reduction in flood-exposed elements was observed after FCM implementation in 2017 and 2018. The study underscores that elements vulnerable to flood exposure, such as residential areas and roads, were most affected during shorter flood durations before FCM implementation. The FCM demonstrated success in mitigating flood exposure in residential areas. In summary, the assessment of the Flood Control Measure “Monkey’s Cheeks” in the Chao Phraya River Basin showcases its effectiveness in reducing flood exposure and curtailing flood durations after implementation. The research contributes insights into flood control strategies and provides a foundation for informed decision-making in flood-prone regions.

#### **Monitoring and early warning of landslides in the Philippines: a case study of rainfall-triggered landslides in Iloilo Province during 2022 Severe Tropical Storm Nalgae**

Nathan Azriel S. Veracruz\*, Aletheia O. Amandy, Chad Lowe S. Aquino, Ann Nichole S. Dela Victoria, Chatty Mae M. Go, Rasty M. Rastrullo, Cathleen Joyce N. Cordero, Arturo S. Daag, and Teresito C. Bacolcol

*Department of Science and Technology – Philippine Institute of Volcanology and Seismology (DOST-PHIVOLCS), Quezon City, Philippines*

The Philippines faces significant landslide risks, which can lead to loss of life and extensive property damage.

To address this issue, the Dynaslope Project, a research program under the Department of Science and Technology – Philippine Institute of Volcanology and Seismology (DOST-PHIVOLCS), has developed a cost-effective and reliable early warning system for deep-seated landslides (EWS-L). The EWS-L uses sensor technology and community participation to monitor landslides in near real time. In October–November 2022, the EWS-L was put to the test when rainfalls from Severe Tropical Storm Nalgae triggered three concurrent landslide events in Iloilo Province. Data from subsurface tilt sensors and rain gauges were continuously collected through a data logger and transmitted to a central server. Local communities also contributed to surface ground movement monitoring using stakes and observation of surface features. Analyzed and interpreted data were then disseminated as early warning information to at-risk communities. While predicting the exact timing of a landslide remains challenging, the monitoring system successfully anticipated critical conditions, such as intense rainfall and ground movements. During the October–November 2022 landslides, peak one-day (~130 mm) and three-day rainfalls (~250 mm) preceded the critical ground movements by at least six hours. These rainfall levels may serve as potential thresholds for issuing landslide advisories in Iloilo. Implementing the EWS-L facilitated the timely evacuation of households within identified hazard zones, affirming its effectiveness. However, the continuing landslide activity and the likelihood of future rainfall triggers emphasize the continued importance of the EWS-L in mitigating potential disasters.

#### **Leveraging Earth Observation and Social Media Data for Timely Disaster Impact Assessment in the Philippines**

Neyzielle Ronnicque R. Cadiz\*, Karl Louie S. Mariano, John Bart Lovern C. Dumalag

*DOST-Advanced Science and Technology Institute, Quezon City, Philippines*

The Philippines is frequently challenged by extreme weather events, leading to recurrent floods and rain-induced landslides. In response, the DOST-Advanced Science and Technology Institute (DOST-ASTI) has established a robust system for generating flood impact maps covering potentially affected areas across the country. This paper presents the collaborative efforts of the DOST-ASTI SARwAIS Project in enhancing disaster management capabilities.

Dedicated to continuous monitoring, an agile flood processing workflow is in place, ready to assimilate new earth observation datasets as they become available. The SARwAIS Project aligns its objectives with those of various government agencies engaged in disaster management, seeking to complement their initiatives effectively.

Leveraging advanced Artificial Intelligence models within the agency’s framework, SAR data are analyzed to detect potentially inundated areas. This innovation provides crucial insights for early flood assessment and response.

To augment these insights, citizen scientists and stakeholders are also actively engaged in data gathering. Through the analysis of these reports, the team identifies areas of interest for targeted satellite tasking, maximizing the utility of limited resources and ensuring timely response to flooding events.

To facilitate rapid information dissemination and coordination, all relevant datasets, including images and shape files, are promptly shared via email with mandated agencies such as the National DRRM Council, affected local government units, and other relevant organizations.

This collaborative effort between the DOST-ASTI SARwAIS Project and various stakeholders exemplifies a proactive approach to disaster management, leveraging cutting-edge technology and community engagement to enhance flood impact assessment and response in the Philippines.

**DAY 2 - 30 November 2023**

**Oral Presentations**

**Breakout Session 5: 1:30 PM - 3 PM**

Topic: STRATEGIES FOR SOCIOECOLOGICAL  
RESILIENCE  
5.b. Disaster recovery and resilience

**A multimodal approach to framing urban resilience to climate change**

Lelani Mannetti\*

*Urban Studies Institute, Atlanta, Georgia, USA*

The aim of this paper is to examine how different approaches to framing urban resilience within a city address climate change, specifically disaster mitigation, preparedness and recovery, and the adaptation or transformation of the city. Using the City of Valdivia in Chile as a case study, we assess how government and civic actors envision resilient urban futures. We analyzed the content of planning documents pertaining to climate action and sustainability, responses to a semi-structured questionnaire, and strategies co-produced during a participatory scenario workshop. By analyzing, coding, and comparing data across these three different approaches, the study explores how climate resilience is framed by city stakeholders. Our findings suggest that in city planning documents, resilience to climate change and extreme events are largely framed as disaster mitigation (i.e., preventing disasters or ameliorating its effects), while respondents to the survey mostly frame it as adaptation (i.e., adjusting in response to actual or expected climate changes or its effects). Framings from the co-production setting tended to merge disaster mitigation, adaptation, and transformation (i.e., radical shifts in institutional and infrastructure systems). Across the three approaches, climate resilience in Valdivia is rarely conceptualized using an integrated social-ecological-technological systems lens. The research highlights techniques for diverse ways of envisioning and assessing resilient urban futures and the value of scenario co-production workshops as transformative spaces for collective future visioning.

**Social Media Content Analysis of the Lahaina Fires in Hawaii**

David Nguyen\*

*Tohoku University, Sendai, Japan*

On August 2023, a massive wildfire completely destroyed the town of Lahaina in Maui Island in the State of Hawaii. While the island regularly experiences wild fires, the combination of unusually powerful hurricane winds, and a dry climate, led to a chain of events that led to a massive wildfire. Lahaina, the area most affected by the fire, was renown for its historic district and was a popular tourism destination in the state. This study examines how social media played a key role in providing information to residents in the state during the response phase of the disaster. Content analysis was conducted to identify common themes that appeared on social media, and how it changed over the next several days after the event. This research was conducted with the support of the owner of the social media site.

The results of the content analysis can identify how such local and regional social media groups can provide a means to strengthen social capital in the community, strengthening communications, emotional support, and resource support (including financial, transportation, and accommodation resources). The results of this analysis can be used to inform future disaster planners on how they could better collaborate with social media based communities to provide various disaster risk reduction and response services during an emergency.

**Producing images of disaster urbanization in Manila's peri-urban fringe**

Timothy James L. Cipriano\*

*Department of Geography, University of the Philippines Diliman  
Faculty of Behavioral and Social Sciences, Philippine Normal University  
Manila*

Disasters have constantly shaped urban life and even space, and in turn reshaped by it. In this paper, I attempt to investigate how images of disaster urbanization were produced – drawing from the conceptualization of Madden's work (2021) – as a material and discursive mode of city making practice within and beyond cities. Deriving from the experiences of Barangay Banaba, San Mateo, Rizal – a peri-urban community located at the outskirts of Metro Manila, I argue that disasters (1) have shaped practices that enabled the production of urban spaces in different forms and spatial-temporal contexts; (2) have rearticulated paradoxical city making practices produced by the dominant mode of contemporary urbanization in Metro Manila and beyond; and (3) have transformed urban governance that saw the emergence of new "risky spaces" to further justify state interventions amid escalating disaster risks. While Madden (2021) argued that disaster urbanization would be a dominant mode of city making as disasters become more frequent and increasing in magnitude and intensity within and beyond the city, this should serve as an opportunity to remake cities to improve urban conditions amid the destructiveness that disasters have brought. With this, disaster risk reduction (DRR) initiatives must account for lived experiences, situated knowledges, and the intersectional oppressions experienced by dwellers of Banaba brought about by the prevailing neoliberal mode of urbanization.



## **Livelihood transformations and food (in)security during times of multiple crises: The case of Capiz, Philippines**

Anacorita O. Abasolo <sup>1</sup>, Maria Victoria O. Espaldon <sup>2</sup> and Decibel V. Faustino-Eslava <sup>2</sup>

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<sup>2</sup> *Professor, School of Environmental Science and Management, University of the Philippines Los Baños, Laguna, Philippines*

Capiz, dubbed as the “seafood capital of the Philippines” is one of the major provinces in the Philippines known for its abundant sources of marine and aquatic resources, and other agricultural products. Coastal communities in Capiz heavily rely on agri-fishery as a source of livelihood. However, in recent years, these agri-fishery communities have endured multiple crises – extreme weather events, the COVID-19 pandemic, and recently, the high economic inflation. Drawing from the qualitative field research in Capiz, this paper examines the diverse, complex, and interconnected livelihood sources and activities of coastal agri-fishery communities, especially in navigating the impacts of disasters that occur one after another, and of the multiple crises that develop subsequently on their livelihoods and livelihood insecurity. This paper delves into the questions: i) what are the major coastal livelihood activities in Capiz?, ii) how are these livelihoods ‘transformed’ as affected by the series of multiple crises experienced?, and iii) what are the impacts of these transformations on the food (in)security of affected households? A total of 181 fisherfolks and farmers were interviewed, as well as 16 local officials from 5 municipalities in 10 barangays of the Province. Major findings revealed that fishers are highly affected and are more vulnerable in the series of shocks as compared to farmers. However, the fishers engages in more types and complex livelihood activities than the farmers. Impacts to food (in)security varies across different livelihoods and the type of crisis. Understanding the complex processes of how coastal communities navigate and adapt to the crises will point to more direct interventions and improved policy recommendations. integrated social-ecological-technological systems lens. The research highlights techniques for diverse ways of envisioning and assessing resilient urban futures and the value of scenario co-production workshops as transformative spaces for collective future visioning.

# DAY 2 - 30 November 2023

## Oral Presentations

Breakout Session 5: 1:30 PM - 3 PM

Topic: **MANAGING RISK**  
5.c. Disaster policy and communication

### Uncovering the Factors Contributing to Disaster Risk Creation

Grace Muir\*, Aaron Opdyke

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Processes of disaster risk creation are outpacing the achievements of disaster risk reduction initiatives. Analysing patterns in how disaster risk is being generated could inform resilience-building strategies, enabling more effective management and mitigation of disaster risk. However, there is currently a gap in our understanding of precisely which factors are contributing to disaster risk creation, with the existing body of knowledge lacking explicit definition of the cascading impacts of these components. Although disaster risk creation is presented as “the evil twin” of risk reduction, it remains uncertain whether risk creation can and should be conceptually defined as its direct antonym. The subsequent appropriateness of directly inverting risk reducing elements to extract risk creating factors is questioned here, inspiring an exploration of potential disparities between the concepts. This review of literature seeks to dissect processes assumed to routinely undermine efforts to reduce disaster losses through mapping of peer-reviewed literature which conceptually defines the emergent notion of risk creation. Our approach draws on a thematic review of disaster scholarship using snowball sampling. This research aims to bridge gaps in our knowledge of risk creation processes by distilling how scholarship either implicitly or explicitly theorises the concept and its constituent components. The research outcomes have the potential to influence policy design and delivery so that identified factors can be targeted to counter existing patterns of risk creation. This research ultimately contributes a more nuanced conceptual definition of disaster risk creation, with the aim of enriching its application within the field of disaster studies.

### GEOVISUAL ANALYSIS OF CLIMATE-RELATED DISASTER EVENTS IN THE ASEAN REGION USING REMOTELY-SENSED DATA AND A PUBLIC REPORTS DATABASE

Keith Paolo C. Landicho, S. \*

*Rajaratnam School of International Studies-Nanyang Technological University, Singapore*

Southeast Asia’s disaster profile is very distinct. Its geographic location between the Pacific and Indian Oceans result in climate-variable hydrometeorological and cascading hazards that affect the Association of Southeast Asian Nations’ (ASEAN) member states. The ASEAN Disaster Information Network (ADINet), a comprehensive platform of disaster knowledge and information which also functions as a public regional disaster report database, substantiates this.

According to the database, from January 2013 to December 2022, 97 out of every 100 disaster events recorded has been hydrometeorological in nature. This is in consideration of the authority of the member state’s national disaster management organization/agency (NDMO/NDMA) in their respective territories as the primary reporting entities as well as for each event to meet a certain criteria to be considered a disaster—affected families/persons, internally displaced families/persons, number of houses damaged, significant attention etc. These indicators are also rooted in each member state’s NDMO/NDMA report, in recognition of differences in operations, and in conjunction with that of other international humanitarian actors’ reports. This study aims to describe climate hazard and management of risk in the ASEAN region through a geovisual analysis of remotely-sensed precipitation and flood data and hydrometeorological disaster reports from ADINet. This study also identifies hydrometeorological disaster hotspots and reporting coldspots that could prove useful for regional and national frameworks and/or guidelines, management of risk, and facilitation of humanitarian assistance and disaster relief.

### Scoping Analysis of Anticipatory Action in the Philippines

Kristoffer B. Berse, Giselle Louise Lapid

*National College of Public Administration and Governance, University of the Philippines, Quezon City, Philippines*

In the face of increasing climate-related hazards and their devastating impacts, the Philippines has recognized the urgency of adopting proactive approaches to disaster risk management. The Philippines ranks number one in the 2022 World Risk Report while damages caused by natural disasters have amounted to over 60 billion pesos in 2021. The rapid intensification of typhoons, in particular, have raised concern among climate scientists, thus underlying the need for local governments to anticipate worst case scenarios and mobilize resources accordingly.

In light of the foregoing, this study explores the concept of Anticipatory Action (AA) within the Philippine context, emphasizing its potential as a critical component of disaster risk reduction and response. It takes stock of the current landscape of AA in the Philippines, drawing lessons and insights from past and ongoing AA initiatives from 2015. To this end, data will be collected through a desk review of secondary sources ranging from both academic and gray literature such as project reports, journal articles, and other documents pertaining to the practice of AA in the country.

Key findings from the study will shed light on the benefits of AA, if any, as well as challenges that come with its implementation. By and large, it hopes to contribute to current and future discourses on the effectiveness of AA in the Philippines and its incorporation, if necessary, in national policies related to disaster and climate risk management.”

## **A Study of the Current Administrative Framework for Compound Disasters and Risk Communication in Japan: The Case of the July 2020 Torrential Rain Disaster**

Miwa ABE <sup>1</sup>, Takako IZUMI <sup>2</sup>, Kumiko FUJITA <sup>3</sup>

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<sup>2</sup> Sendai, Japan, Tohoku University

<sup>3</sup> Kyoto, Japan, International Consortium on Landslides

In July 2020, a torrential rain disaster centered on the southern region of Kumamoto Prefecture caused rivers to overflow in various areas, killing 84 people nationwide, 65 of whom were in Kumamoto Prefecture. This torrential rain disaster occurred during COVID-19 and forced a different disaster response due to complex factors, such as damage to a senior citizen facility caused by a river overflowing due to rain and a fire caused by a factory explosion due to flooding. In particular, the factory explosion caused by flooding is a typical example of a Natech (Natural Hazard Triggered Technological Disasters), despite the fact that similar explosions have occurred in the past, although no one was injured. It can be said that various organizations had to simultaneously deal with the spread of infectious diseases, firefighting activities against explosions and fires, warning residents against explosions, the impact of flooding on fields and other agriculture, and removal of disaster waste, rather than simply flooding houses. However, most of Japan's current "disaster response" focuses on natural disasters, and different organizations respond to various types of hazards that occur simultaneously, depending on what is damaged, making it difficult to say that there is coordination among the organizations that respond to hazards. Therefore, based on this flood disaster, this study examines the challenges of compound disaster response in the current administrative framework for compound disasters and the current status of risk communication among government, companies, and residents. This research ultimately contributes a more nuanced conceptual definition of disaster risk creation, with the aim of enriching its application within the field of disaster studies.

## **Octopuses or ostriches? Global evidence on natural hazard information-seeking**

Tra Thi Trinh\* and Olivia Jensen

*Institute for the Public Understanding of Risk, National University of*

*Singapore, Innovation 4.0,*

Ensuring that exposed populations receive accurate information about natural hazard risk is one of the most cost-effective interventions to reduce harm from these risks. To improve the effectiveness of communications about natural hazards, it is important to understand the heterogeneity in the sources of information that individuals use and trust. This study applies latent class analysis in a global dataset to identify different phenotypes of information users—subgroups that share information-seeking behaviors relating to natural hazards. We evaluate the impacts of covariates such as demographic characteristics, prior disaster experience, risk perception, and trust in information sources on phenotypes. Further, we investigate whether phenotypes help to explain whether individuals take protective action, indicated by whether they have an emergency plan.

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# DAY 2 - 30 November 2023

## Oral Presentations

Breakout Session 6: 4 PM - 5:30 PM

Topic: STRATEGIES FOR SOCIOECOLOGICAL RESILIENCE  
6.b. Education, Awareness and Preparedness

### Postcards from the Future: Visualizing Sea-Level Rise Resilience Utilizing Augmented Reality as a Platform for Transdisciplinary Collaboration and Public Engagement

Gabriel Kaprielian\*

California Polytechnic State University, San Luis Obispo, USA

“Postcards from the Future: Singapore 2122” is an interactive installation that invites the public to explore the past, present, and potential future transformations of the country’s shoreline. Augmented Reality (AR) installations visualize sea-level rise risk and potential resilience strategies. The result is a guided tour along Singapore’s historic shoreline that brings the past and future to life through interactive AR installations at 24 designated locations that build place-based knowledge, serve as a platform for collaboration across disciplines, and an interactive tool for public engagement.

The research and design project was a transnational and interdisciplinary partnership between scientists, architects, and artists to address the global challenges presented by climate change related hazards in coastal cities. By providing a platform to exchange knowledge and enable discourse about future sea-level rise, the project speculates on how Singapore can develop a long-term planning framework that supports climate change resilience and biodiversity in a win-win strategy that increases the role of nature-based solutions that embrace tidal ecologies in urban environments as a part of Singapore’s “Green Plan” and “City in Nature” vision.

The project serves as a useful model to consider how emergent technology such as AR and architectural visualizations can lead to collaboration, reach diverse stakeholders, and enable productive conversations that bring together designers, planners, engineers, scientists, policymakers, and the public to create a shared vision of future resilience and to inspire collective optimism. The goal of the symposium presentation is to gain feedback across disciplines and geographies to consider further development. “co-production workshops as transformative spaces for collective future visioning.

### Enhancing Disaster Resilience Education: Integrating DRRM into Civil Engineering Capstone Design Projects

SiddArtha Valle\*

University of Batangas, Batangas City, Philippines

The integration of Disaster Risk Reduction and Management (DRRM) into civil engineering curricula has gained prominence as a means to enhance graduates’ readiness to address emerging challenges in resilient infrastructure development. This study investigated the effectiveness of incorporating DRRM concepts within the Civil Engineering curriculum through capstone design projects. Feedback from 212 senior students at a private university in Batangas, Philippines was garnered via a self-assessment survey to evaluate their knowledge, awareness, and perception of DRRM.

The results underscore the positive impact of experiential learning. Students reported notably elevated levels of knowledge in disaster risk reduction concepts, including hazard identification, vulnerability and risk assessment, and mitigation strategies. Through designing for structural resilience, their awareness deepened regarding the social and cultural factors in disaster resilience, and the pivotal role of civil engineers in mitigating disaster risks. Moreover, students expressed how capstone projects augmented their comprehension of real-world disaster challenges. The collaborative nature of interdisciplinary efforts and engagement with stakeholders further enriched their understanding. These findings affirm that the integration of DRRM principles into senior design projects engenders a holistic grasp of disaster risk reduction’s practical implications. By fostering an experiential approach, students not only acquire theoretical knowledge but also develop a heightened awareness of the intricate interplay between engineering solutions and community welfare. As civil engineers assume critical roles in shaping resilient infrastructure, this study advocates for the continued integration of DRRM education in curricula, ensuring graduates are equipped to confront the dynamic landscape of disaster challenges. the owner of the social media site.

### Adaptive Tsunami Disaster Education in Dual-Level Schools: Addressing the Experience Gaps in Phuket, Thailand

Natt Leelawat <sup>1,2,3,4\*</sup>, Ampan Laosunthara <sup>2</sup>, Naphat Mahittikul <sup>2</sup>, Kodchakorn Krutphonng <sup>2</sup>, Kumpol Saengtabtim <sup>1</sup>, Wanit Treeranurat <sup>1</sup>, Peerada Tangprasert <sup>1</sup>, Penpitcha Arayachookiat <sup>3</sup>, Nattapon Trumikaborworn <sup>5</sup>, Korakoch Mongkornsuk <sup>3</sup>, Panon Latcharot <sup>6</sup>, and Jing Tang <sup>2,3,7</sup>

<sup>1</sup> Department of Industrial Engineering, Faculty of Engineering, Chulalongkorn University, Bangkok, Thailand

<sup>2</sup> Disaster and Risk Management Information Systems Research Unit, Chulalongkorn University, Bangkok, Thailand

<sup>3</sup> Risk and Disaster Management Program, Graduate School, Chulalongkorn University, Bangkok, Thailand

<sup>4</sup> Graduate School of System Design and Management, Keio University, Yokohama, Kanagawa, Japan

<sup>5</sup> Department of Development and Sustainability, Asian Institute of Technology, Pathum Thani, Thailand

<sup>6</sup> Department of Civil and Environmental Engineering, Faculty of Engineering, Mahidol University, Nakhon Pathom, Thailand

<sup>7</sup> International School of Engineering, Faculty of Engineering, Chulalongkorn University, Bangkok, Thailand

Disaster education is paramount in regions historically susceptible to natural calamities, particularly tsunamis. A school in Phuket, Thailand, educating elementary and middle-level students, is located in a disaster-prone zone due to its previous severe tsunami impact. Addressing this, we adopted an active learning approach, using lectures, board games, and a stamp rally designed to enhance tsunami disaster education. The board games, in particular, revealed distinct behavioral patterns among the students. Elementary students exhibited a keen focus on game mechanics, driven by a competitive desire to win against their classmates.

In contrast, middle school students played more strategically to satisfy the main goals of each activity. In addition, based on the games related to the decision toward the evacuation route, elementary and middle school students displayed similar behavior when unfamiliar with evacuation routes. Accordingly, they prioritized following evacuation signposts over following the crowd. This multi-faceted approach, integrating lectures with game-based learning, offers a holistic method for disaster education. The findings pinpoint the importance of tailoring educational strategies to different age groups together with emphasizing the universal significance of clear evacuation signage for the evacuation process. Our initiative campaign can propose integrating active learning methodologies, like game-based learning, into tsunami disaster education. As a result, it can ensure that the possible upcoming disaster is adequately well prepared. urbanization in Metro Manila and beyond; and (3) have transformed urban governance that saw the emergence of new “risky spaces” to further justify state interventions amid escalating disaster risks. While Madden (2021) argued that disaster urbanization would be a dominant mode of city making as disasters become more frequent and increasing in magnitude and intensity within and beyond the city, this should serve as an opportunity to remake cities to improve urban conditions amid the destructiveness that disasters have brought. With this, disaster risk reduction (DRR) initiatives must account for lived experiences, situated knowledges, and the intersectional oppressions experienced by dwellers of Banaba brought about by the prevailing neoliberal mode of urbanization.

### **Ready for action: Global evidence on information-seeking and preparedness for natural hazards**

Olivia Jensen\*, Tra Thi Trinh

*LRF Institute for the Public Understanding of Risk, National University of Singapore, Singapore*

Ensuring that exposed populations receive accurate information is one of the most cost-effective interventions to reduce harm from natural hazard risk (Global Commission on Adaptation, 2019). Individuals exposed to these risks seek and receive information from different sources, such as government agencies, mass media, influential personalities, social media and friends and family and use this information to inform the protective actions they take. Understanding heterogeneity in the sources of information that people use and trust is key to improving the effectiveness of communications about natural hazard risk and to support people to take appropriate protective behaviours; however, it has not been studied in depth in the literature (Steelman et al., 2015). In this study, we study the factors that explain whether or not an individual has a plan of action in case of disaster. We employ data from the 2021 World Risk Poll data for more than 125,000 respondents in 121 countries. The global dataset enables cross-country/cross-region evaluations with wider variation in socio-demographic factors, disaster exposure, and access to information compared to country-specific studies (e.g., Sommerfeldt, 2015; Steelman et al., 2015). We apply latent class analysis to identify different subgroups – ‘phenotypes’ – of respondents that share certain information-seeking behaviors relating to natural hazards (e.g., limited/plentiful access, single/multiple source(s), official/unofficial source). Using the comprehensive information-seeking framework (Johnson et al., 1995), we evaluate the impacts of potential covariates (e.g., demographic characteristics, prior disaster experience) on class membership and the correlations between latent classes, risk perception and trust in information sources.

Further, we investigate the correlation between information-seeking and protective action, indicated by whether the respondent has an emergency plan. Initial findings show that socio-demographic variables such as education and age significantly predict information-seeking behaviors and that information-seeking phenotype in turn helps to explain whether the individual has a disaster plan. Young, educated individuals are more likely to seek information from social media and mass media, while older educated people are more reliant on official information. Comparing two groups of younger respondents with high access to social media, those with more education place more trust in social media than less educated peers. In addition, there is a small class of people who are highly reliant on influential personalities (e.g., religious leaders or famous people) for information and place high trust in those sources. The findings provide useful insights to design risk communication strategies tailored to the information-seeking characteristics of different groups.

Topic: **MANAGING RISK**  
6.c. Vulnerability and risk assessment

#### Climate change-induced flood risk scenarios for residential buildings in the Philippines

Isaac Besarra <sup>1</sup>, Aaron Opdyke <sup>1</sup>, Joy Santiago <sup>2</sup>, Jerico E. Mendoza <sup>2</sup>, Patricia Delmendo <sup>2</sup>, Dino Evangelista <sup>2</sup>, Alfredo Mahar Francisco A. Lagmay <sup>2</sup>, Sophie Webber <sup>3</sup>

<sup>1</sup> The University of Sydney, School of Civil Engineering, Sydney, 2006, New South Wales, Australia

<sup>2</sup> University of the Philippines Resilience Institute, Diliman, Quezon City, Philippines

<sup>3</sup> The University of Sydney, School of Geosciences, Sydney, 2006, New South Wales, Australia

Given the escalating frequency of flood impacts in the Philippines, disaster risk management approaches solely reliant on historical loss data need to be revised to capture futures under climate change trajectories. However, despite growing urgency, there is a significant gap which accounts for climate trajectories with current hazard models in the Philippines. Drawing upon Representative Concentration Pathway (RCP) scenarios, we use downscaled climate flood models with localised physical vulnerability functions to understand the shifting nature of flood risk through physical damage and losses of residential structures for coastal communities in the Municipality of Carigara. This research examines patterns of flood risk at a household level by quantifying risk changes through multiple flood hazard datasets generated through participatory mapping, historical probabilistic rainfall, and RCP 4.5- and RCP 8.5-modified rainfall. We combine these flood hazard models with localised physical vulnerability functions of residential structures to quantify and evaluate changes to flood risk for over 11,000 houses in the municipality. Our findings offer targeted strategies to reduce the impact of future flood events by communicating potential physical damage and losses to empower communities to focus on viable adaptation and resilience efforts. By transitioning to probabilistic climate-integrated approaches to flood risk assessments, our approach allows a more grounded estimation of future flood risk. This equips local governments with robust information to develop flood adaptation strategies, which is crucial under climate change uncertainties, notably absent within prevailing disaster risk models in the Philippines context. scholarship either implicitly or explicitly theorises the concept and its constituent components. The research outcomes have the potential to influence policy design and delivery so that identified factors can be targeted to counter existing patterns of risk creation. This research ultimately contributes a more nuanced conceptual definition of disaster risk creation, with the aim of enriching its application within the field of disaster studies.

#### Expansion of Tokyo Metropolitan Area since 1923 Great Kanto Earthquake

Osamu Murao <sup>1</sup>, Kyota Fujiwara <sup>2</sup>, Haruna Kato <sup>2</sup>, Fumitake Yonemura <sup>2</sup>, Keiko Inagaki <sup>3</sup>, and Kimiro Meguro <sup>4</sup>

<sup>1</sup> International Research Institute of Disaster Science, Tohoku University, Sendai, Japan

<sup>2</sup> Department of Architecture and Building Science, Graduate School of Engineering, Tohoku University, Sendai, Japan

<sup>3</sup> Institute of Urban Innovation, Yokohama National University, Yokohama, Japan

<sup>4</sup> Institute of Industrial Science, The University of Tokyo, Tokyo, Japan

The year 2023 marks the 100th commemoration of the disastrous Kanto Earthquake in Japan, which shattered the urban fabric of Tokyo and other southern prefectures. In the years following 1923, much research into disaster risk reduction (especially fire prevention) was undertaken. This study evaluated research trends and the impact of the earthquake on the city using metropolitan population data. The following is reported: (1) This study summarized English and Japanese academic papers and reports on the Great Kanto Earthquake that have been published over the last 100 years. (2) The area of fire spread and number of damaged buildings in Tokyo due to the Great Kanto Earthquake were overwhelmingly larger than those in other areas. (3) The difference in the relative amount of damage caused by natural disasters with more than 1,000 death toll to the annual national budget in Japan became clear. (4) The Great Kanto Earthquake was the only natural disaster that caused a net worth of damage exceeding the Japanese national budget by 3.8 times. (5) The expansion of the Tokyo metropolitan area over the 100 years since the Great Kanto Earthquake was visually clarified based on demographics. (6) Today, many people live densely on soft ground, with an amplification factor of 1.8 or higher, which is 23.0% of the total population."any, as well as challenges that come with its implementation. By and large, it hopes to contribute to current and future discourses on the effectiveness of AA in the Philippines and its incorporation, if necessary, in national policies related to disaster and climate risk management.

## **Assessing the climate disaster risks of the small islands of Cagayancillo, Palawan, Philippines**

Kristina Cordero-Bailey\*, Kysia Pineda, Secille Balita, Ma.  
Catriona Devanadera, Aldwin Almo, Laura David

*Dept. of Community and Environmental Resource Planning, College of Human Ecology, University of Los Banos, Laguna, Philippines.*

The archipelagic nature of the Philippines makes the Filipinos living near the coast extremely vulnerable to unexpected changes in climate. It is therefore imperative to identify the potential hazards that these communities may be exposed to in order to decrease the disaster risks and casualties. This study took a look into the potential impacts of climate change on the coastal communities in a small island group of Cagayancillo located in the middle of the Sulu Sea. The study used the Climate Disaster Risk Assessment (CDRA) analysis to gather the parameters for exposure, vulnerability/sensitivity, and adaptive capacity of the coastal villages. With sea level rise being one of the most imminent threats to all islands in Cagayancillo, our study identified that most of the town proper as critical areas that need to be prioritized for disaster preparedness. Recurrent recommended policy interventions among the natural hazards include: (1) retrofitting of households, facilities, and infrastructures to ensure that it can withstand the possible effects of possible disasters in the area, (2) identification of suitable areas for relocation for critical facilities, as well as households located in multiple hazard areas, and (3) appropriate allocation of budget for climate change adaptation and disaster risk reduction policies. The findings of the study were presented to the local government office and decision makers to support their municipal policies in regards to climate action.

## **Modelling dynamic vulnerability for large-scale risk analysis**

*Maricar L. Rabonza<sup>1</sup>, David Lallemand<sup>1,2</sup>*

*<sup>1</sup>Asian School of the Environment, Nanyang Technological University Singapore*

*<sup>2</sup>Earth Observatory of Singapore, Nanyang Technological University Singapore*

Proactive policy decisions for resilient cities rely on modeling large-scale risk amid dynamic urban changes, reflecting urban growth patterns and evolving vulnerability linked to time-dependent processes. However, recent methods for large-scale urban risk calculation mainly prioritize time-dependent hazards and exposure, lacking emphasis on time-dependent vulnerability. In seismic risk analysis, such time-dependent changes may entail an increase in vulnerability due to deterioration processes (e.g. corrosion, fatigue, creep, hazard-induced damage), or a decrease in vulnerability driven by strengthening interventions (e.g. retrofitting, maintenance, building replacement). Accounting for these dynamics is important to properly understand the hazard-related risk of infrastructure over their lifespan. This talk presents an approach to model time-vulnerability for large-scale risk analysis that utilizes a time-inhomogeneous Markov chain simulation. Multiple applications are demonstrated such as urban-scale seismic retrofitting policies based on various retrofit rates. Key takeaways include: (a) assuming static vulnerability in buildings may significantly underestimate seismic risk, and (b) despite the large uncertainties, disaster risk in cities is predictable and useful for risk-informed planning. The proposed framework can also assess time-dependent risk for hazards beyond earthquakes and loss metrics beyond physical impact.

# DAY 2 - 30 November 2023

## Poster Presentations

### ECONOMIC RESILIENCE: FINANCE & RISK

#### **Non-asset-based models for quantifying future climate risk**

Jeanette Choong <sup>1</sup>, David Lallemand <sup>1,2</sup>

<sup>1</sup>Asian School of the Environment, Nanyang Technological University, Singapore

<sup>2</sup>Earth Observatory of Singapore, Nanyang Technological University, Singapore

Conventional methods of assessing future climate risks are focused on the volume of assets potentially lost to a disaster. However, future climate risk stands at the intersection of several complex systems. This means that climate-induced hazards and extremes might have non-linear impacts on different communities, which are not only due to climatic drivers but the inherent complexities of the socioeconomic system. While asset-based metrics are important for providing an overview of immediate physical losses, they fail to fully capture the disparate impacts on different social groups and the knock-on impacts that people continue to experience post-disaster. For instance, relying on asset-based metrics alone could lead to climate adaptation decisions that prioritise the protection of asset-rich areas as they seemingly have more at risk. In doing so, it obscures the protection needs of asset-poor regions, and in extreme cases, could further exacerbate impacts and issues of inequity. This study uses a combination of a probabilistic coastal flood hazard model generated from millions of extreme event simulations, with a direct consequence model, to identify physical (asset) damages from coastal flooding in the Manila Bay area. We then use an adaptive economic model which investigates how individual household consumption is impacted, and how they recover such that well-being losses are minimised. We find that the same physical hazard can have vastly different impacts on household well-being, and this can therefore serve to better inform climate policies and target them to the most vulnerable. The air quality within a region.

#### **Enhanced Weathering Integrated with Vertical Farming (EWIVF) for Sustainable Urban Resilience: A Singapore Case Study**

Shang Ma <sup>1</sup>, Simon A.T. Redfern <sup>2</sup>

Asian School of the Environment, Nanyang Technological University

Weathering is a natural geological process which converts atmospheric carbon dioxide (CO<sub>2</sub>) into dissolved inorganic carbon or pedogenic carbonate, providing effective and long-term carbon storage over human-relevant timescales. However, the pace of natural weathering is too slow to significantly impact CO<sub>2</sub> levels within short timeframes. Recently, enhanced weathering has gained increasing attention as a greenhouse gas removal technology, involving the amendment of agricultural soils with crushed calcium- and magnesium-rich silicate rocks like basalt. This technology has been proved can be closely enhanced in warm tropical climates and productive crops will substantially enhance weathering rates, with potential co-benefits including decreased soil acidification and increased phosphorus supply promoting higher crop yields sparing forest for conservation and reduced cultural eutrophication.

In our modern world, cities face not only the challenges of global warming but also the instability of food supply chains, exacerbated by recent environmental hazards. Singapore, heavily reliant on food imports, is particularly vulnerable. To address these challenges, vertical farming has emerged as a promising solution for local food production. This study investigates the potential of Enhanced Weathering Integrated with Vertical Farming (EWIVF) as a holistic approach to address pressing issues of food security, carbon sequestration, and ecological sustainability in urban settings. Our findings emphasize the critical importance of embracing innovative strategies to enhance socioecological resilience in the face of global environmental challenges. The integration of enhanced weathering with vertical farming in Singapore serves as a pertinent case study, demonstrating the viability of this approach and offering valuable insights for similar urban environments worldwide.



**DAY 2 - 30 November 2023**

**Poster Presentations**

# **STRATEGIES FOR SOCIOECOLOGICAL RESILIENCE**

## **Understanding the Impacts of Climate Change and Assessing Vulnerabilities of Capture Fisheries and Aquaculture Sectors Based on Selected Experienced Fisherfolk in Eastern Samar, Philippines**

Cristan Joy M. Campo <sup>1,2\*</sup>, Richard B. Parilla <sup>1,2</sup>, Rodelio F. Subade <sup>3</sup>, Maria Victoria O. Espaldon <sup>4</sup>

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<sup>3</sup> *University of the Philippines Visayas, Miag-ao, Iloilo*

<sup>4</sup> *University of the Philippines Los Banos, Los Banos, Laguna*

The fisheries sector of Eastern Samar is one of the poorest in the Philippines, and are already profoundly affected by the impacts of climate change (CC). Vulnerability Assessment (VA) is needed to assess the impacts of climate change on various systems and help develop fishing community adaptation strategies. This study aimed to understand and assess CC vulnerability of the fisheries sectors in Eastern Samar. In understanding CC, historical records and projections of crucial climatic parameters from contemporary datasets and models were evaluated for Eastern Samar. The upward trend of climate parameters is anticipated to exacerbate the impacts of severe climatological phenomena like typhoons and flooding in Eastern Samar. Moreover, VA employed the Fisheries Vulnerability Assessment Tool (Fish Vool) to assess the sensitivity, exposure, and adaptive capacity of fisherfolk households, represented by selected experienced fisherfolk (Ncapture=498; Naquaculture=53). The findings indicated high vulnerability for capture fisheries and low vulnerability for aquaculture sector. Both sectors had very high exposure due to frequent occurrence of typhoons. The pronounced dependency on fishery resource and observed reduction in fish catches were key indicators of heightened sensitivity among fishers. The adaptive capacity of fishers was at medium level, abated by low awareness, inadequate adaptive strategies, lack of income diversification, and non-modification of gears. The confluence of elevated exposure and sensitivity, coupled with a moderate level of adaptive capacity, suggested a high vulnerability for capture fisheries. In contrast, better socioeconomic status, awareness, diversified income, and improved support programs for fish farmers were determinants to a high adaptive capacity, and low sensitivity due to less dependence on aquaculture. These factors resulted to low overall vulnerability. Capacity building, infrastructure, integrated resource management, income diversification, institution and research are among key pre-existing areas requiring improvement to strengthen the adaptive capacity of fisherfolk against the impacts of climate change. how individual household consumption is impacted, and how they recover such that well-being losses are minimised. We find that the same physical hazard can have vastly different impacts on household well-being, and this can therefore serve to better inform climate policies and target them to the most vulnerable. the air quality within a region.

## **Synergistic Gains: Enhancing Food Resilience and Climate Benefits Through Urban Planting with Enhanced Rock Weathering on Tropical Rooftops.**

Z. Ouyang\*, S. A. T. Redfern

*Asian School of the Environment, Nanyang Technological University*

With climate change and rapid urbanisation, particularly in East Asia and the Pacific, Singapore is looking into highly productive, climate-resilient, and sustainable urban farming solutions. While urban surfaces like rooftops, balconies, and vertical spaces indoors are utilised, the high-power consumption for vertical farming could increase agricultural emissions. For instance, the 2021 Global Controlled Environment Agriculture Census Report states that vertical farms use an average of 38.8 kWh per kilogram of produce, which might result in 15.74 kg of CO<sub>2</sub> emissions based on Singapore's grid emission factor<sup>4</sup>. Enhancing rock weathering (ERW) as a negative emission cum productivity enhancing solution could be ideal for urban farming. ERW in croplands has consistently shown to be a significant carbon sink, with estimates of up to 1.15 GtCO<sub>2</sub> yr<sup>-1</sup>, especially in hot and humid climates<sup>8</sup>. However, with limited field trials in tropical conditions and the influence of typical agricultural inputs, a better estimate of carbon removal capability and productivity enhancement of ERW will require a more controlled experimental setup to isolate its impact<sup>9</sup>. We attempt to conduct experiments in a rooftop garden, to study the effect of material inputs, rock components, powder sizes, and soil matrix infiltration rates to some selected tropical crops, aiming for a carbon-neutral vertical farm in Singapore. With the soil-based setup, the results could offer useful information for estimating ERW mitigation rates and yield enhancement potential with typical ground-based tropical agriculture.

# DAY 2 - 30 November 2023

## Poster Presentations

### MANAGING RISK

#### **“Where is the Cyclone?”: Driving the attention of policymakers and researchers towards cyclone risk reduction and cyclone risk communication**

Md Sariful Islam <sup>1</sup>, Thomas W. Crawford <sup>2</sup>

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<sup>2</sup> Virginia Tech 2, Blacksburg, United States

Cyclones, as rapid onset hydrometeorological disasters, have caused significant loss of lives and economy in several countries and regions across the globe. This work explored the different kinds of themes of the research and review articles published on cyclones and found that when it comes to research published about cyclones, a significant share of research in prominent journals and publishing houses looks into the geophysical aspects of cyclones, such as their track, intensity, modelling and similar elements. However, given the increasing frequency and severity of the storms in recent years, it is vital to have multidisciplinary and interdisciplinary studies related to cyclones to mitigate and manage the associated risks effectively. This work finds that such studies are comparatively few and scattered across different niches and themes. As policymakers and other stakeholders related to disaster management increase their requirement for understanding the impact of the current systems, structures and initiatives to reduce the havoc caused by cyclones, there is a need to step up and shed more light on various studies related to cyclone risk reduction, such as cyclone risk communication and similar fields. The suggestions and scope of this review can be extended to other disasters and help bridge the gap between research and policymakers, plus other disaster management stakeholders' requirements.

#### **Vulnerability Assessment and Response Strategies Based on Large-Scale Disaster Damage Estimation System - Case Study of Taipei City**

Tsung-Yi Pan <sup>1</sup>, Jing-Ting Wang <sup>2</sup>, Yun-Zhong Yang <sup>3</sup>

<sup>1</sup> Center for Weather Climate and Disaster Research, National Taiwan University, Taipei, Taiwan

<sup>2</sup> Fire Department, Taipei City Government, Taipei, Taiwan

<sup>3</sup> Fire Department, Taipei City Government, Taipei, Taiwan

This study collected earthquake historical disaster data in Taipei City with a magnitude of 4 or higher in the past 30 years as a basis for assessing the risk of large-scale earthquakes, and proposed disaster scale assumptions and damage estimates. In the study, a list, database, and historical disaster record of important buildings, transportation roads, industries, infrastructure, pipelines, and dangerous goods locations in Taipei City were first established. In addition, special vulnerability indicators and areas were established based on the local characteristics of each administrative district. Finally, execution strategies and response strategies were established through a table top exercise.

The study found that Taipei City has a high risk of earthquake disasters, which are concentrated in old buildings, transportation roads, and important infrastructure. Old buildings are the main source of danger in earthquakes, and their collapse or damage can cause a large number of casualties and property losses. Transportation roads are also prone to earthquakes, and their damage can cause traffic disruptions, affecting rescue and recovery work. Important infrastructure such as electricity, water, and communication can also be seriously affected by damage.

The study proposed some effective response strategies and suggestions, which can be used as a reference for earthquake disaster reduction work in Taipei City."stakeholders' requirements.

#### **Establishment of a Comprehensive Disaster Risk Assessment Framework and Its Application in Strengthening Urban Disaster Resilience - A Case Study of Taipei City**

Tsung-Yi Pan <sup>1</sup>, Jing-Ting Wang <sup>2</sup>, Yun-Zhong Yang <sup>3</sup>

<sup>1</sup> Center for Weather Climate and Disaster Research, National Taiwan University, Taipei, Taiwan

<sup>2</sup> Fire Department, Taipei City Government, Taipei, Taiwan

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Climate change has led to more frequent and severe extreme weather events in Taiwan in recent years. These events, such as high temperatures, heavy rains, and droughts, have had a significant impact on the stability of urban life. In addition, the Central Weather Bureau has pointed out that Taiwan and the entire Pacific Ring of Fire are likely in a "seismically active period." If Taipei City, which is located near the Shanjiao fault, experiences a major earthquake, the city's resilience to disasters will determine the speed and quality of rescue and post-disaster recovery. Therefore, it is urgent and critical to establish a comprehensive disaster risk assessment framework that is suitable for Taipei City and apply it to strengthen the city's resilience to disasters.

Accordingly, this study explores the main disaster risk assessment methods used internationally, combines them with the localization characteristics of the city, and establishes the city's comprehensive disaster risk assessment framework. This study also conducts a comprehensive risk assessment of the main natural disasters in Taipei City. In order to effectively strengthen the disaster resilience of different communities in Taipei City, the study has increased the spatial resolution of hazard and vulnerability analysis from the traditional township scale to the village and community scale. Preliminary research results show that the proportion of vulnerable population in a community has a significant impact on the community's disaster vulnerability, which in turn affects the overall disaster risk assessment.

## Review on the Development of Disaster Education in China

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As one of the countries in the world where natural disasters are widespread, China has been improving people's awareness and adaptability to various disasters. Efforts have been made to strengthen disaster-related education. Besides, collaboration between government, educational institutions, NGOs and other stakeholders has been encouraged to enhance such efforts. However, the biggest challenge in the development of disaster education in China is the sheer scale and frequency of natural disasters which leads to the complexity of proper education implementation in different regions. In this regard, this review aims to investigate the development process of disaster education in China. This research is aimed at investigating the gaps between different prefectures and developing disaster education strategies with effective tools and activities. This may apply as a reference for other countries with similar social conditions. Besides, an investigation into the overall development of China's disaster education would be different from the previous studies. Since most of the studies regarding disaster education in China have only explored specific education patterns. As a result, we found out that although disaster education in China is consistent, the education approaches lack diversity and regional characteristics. The focus is placed on the dissemination of theoretical knowledge, but the necessity of practice is ignored. The evaluation mechanism for the effects of disaster education is not perfect, mainly involving teachers and experts, but lacks the participation of the audience. Besides, the development of resources for disaster education is not yet sufficient.

## Shifting Horizons: Coastal Erosion, Migration, and Resettlement in Bangladesh

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Coastal Bangladesh faces one of the highest rates of shoreline erosion worldwide, leading to a range of challenges, including population displacement and the loss of homes, assets, fertile lands, infrastructure, and livelihoods. With climate change and rising sea levels, it is expected that erosion will become even more severe in the future. This research aims to enhance our understanding of the factors influencing residents' predictions of coastal erosion risk. It utilizes spatially explicit erosion risk measures derived from Landsat satellite imagery and data gathered through a random survey of individuals residing along the eastern bank of the Meghna River in coastal Bangladesh. Previous empirical studies have documented extreme erosion rates in this region since 2000. To investigate the determinants of accurate risk predictions, this study employs Logistic Regression, examining the roles of demographic, economic, and geographical variables in predicting the accuracy of respondents' perceptions regarding future displacement.

The findings reveal that the physical location of households significantly influences the accurate prediction of future erosion risk. Additionally, factors such as proximity to the coast and whether respondents' homes are shielded by recently constructed revetments are strongly associated with accurate predictions of coastal erosion risk. This study underscores the pivotal role played by socio-economic and geographical attributes in shaping risk perception at the household level. These findings highlight the importance of raising awareness for improved planning and management of coastal areas. Furthermore, the research outcomes can inform the development of mitigation and adaptation strategies that better incorporate community perspectives on risk.

## Emerging Frontiers in Disaster Risk: Science, Technology, and Policy Advancements

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This study thesis examines the multidisciplinary nature of disaster hazard technological know-how, generation, and policy, shedding light on new perspectives and crucial challenges facing society in a high-risk global. Natural and man-made screw-ups pose severe threats to communities, ecosystems, and economies internationally. As the frequency and severity of incidents increase, it's imperative that we enhance our know-how, installation-reducing part technology, and expand robust plans to efficiently mitigate and manipulate risks position

This summary highlights the urgent need for interdisciplinary collaboration the usage of insights from weather technological know-how, geoscience, social technology, engineering, and clinical proof for effective disaster danger management, sustainable development, resilience, and community engagement were emphasized.

Advancing the science, generation, and coverage boundaries of catastrophe chance management, this study seeks to provide actionable insights that can inform policymakers, emergency responders, and communities in efforts to reduce vulnerability, grow preparedness, and ensure prompt and powerful response, in the end contributing to a more secure and more resilient global.

