

Advancing local flood
decision-making for
disaster risk reduction

CRRP2021-13MY-Opdyke

2024



THE UNIVERSITY OF
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Project Leader and Contact Details:

- Dr Aaron Opdyke (School of Civil Engineering, The University of Sydney)
aaron.opdyke@sydney.edu.au

Collaborators and Contact Details:

- Isaac Besarra (School of Civil Engineering, The University of Sydney)
isaac.besarra@sydney.edu.au
- Jerico E. Mendoza, EnP (University of the Philippines Resilience Institute)
jemendoza1@up.edu.ph
- Patricia Anne S. Delmendo (University of the Philippines Resilience Institute)
psdelmendo@up.edu.ph
- Joy T. Santiago, EnP (University of the Philippines Resilience Institute)
jtsantiago2@up.edu.ph
- Professor Ella Meilianda (Tsunami and Disaster Mitigation Research Center)
ella_meilianda@usk.ac.id
- Dedy Alfian (Tsunami and Disaster Mitigation Research Center)
dalfianlaksana27@gmail.com
- Zoe Latham (School of Civil Engineering, The University of Sydney)
zoecaitlynlatham@gmail.com
- Grace Barrett-Lennard (School of Civil Engineering, The University of Sydney)
gracebarrettlennard@gmail.com
- Dino John T. Evangelista (University of the Philippines Resilience Institute)
dtevangalista@up.edu.ph
- Emily Nabong (School of Civil Engineering, The University of Sydney)
emily.nabong@sydney.edu.au
- Professor Alfredo Mahar Francisco A. Lagmay (University of the Philippines Resilience Institute) aalagmay@up.edu.ph

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1. Summary

Disasters pose a significant threat to global development and poverty reduction. This research sought to transform disaster risk assessments by understanding how climate change will impact localised flood risk and unpack how these assessments can be better incorporated into local planning processes. The project focused on in-depth study of two catchment basins located in the Municipality of Carigara (Leyte, Philippines) and the Regency of Singkil (Aceh, Indonesia). Hydrological modelling incorporated downscaled climate change models, in combination with vulnerability assessments, to examine shifting flood risk patterns. As part of this we created new localised residential vulnerability functions which were used to quantitatively evaluate probabilistic flood damages across expected climate change scenarios. Our results show that while climate change has the potential to make flooding more likely in some scenarios, changes in vulnerability and exposure appear to be larger drivers of increasing flood risk. To aid local governments in adapting to these future changes, we developed a serious game to introduce climate change concepts, create exposure to new adaptation strategies, and illuminate collaborative governance structures. The results of this research provide new knowledge of the unfolding impacts of climate change on flooding and offers guidance to enable more effective adaptation decision-making.

2. Objectives

The overall objective of this project sought to support local governments in developing urban communities to incorporate climate change into flood risk assessments and mobilise knowledge to realise resilient and sustainable development. As a result of better understanding the influence of climate change on flood risk, local governments and communities now have access to new flood risk information to make more informed decisions on their development pathways. Increased access to flood risk assessments that forecast future changes offers a means to not only reduce risk, but also prevent the creation of new risk – a growing concern. This knowledge holds potential to save lives and prevent economic losses. The project also sought to facilitate the exchange of flood risk reduction lessons from across the Philippines and Indonesia, which was accomplished through bringing together local and provincial governments together. Our approach sought to interrogate how local governments value, use, and understand climate change models to design more engaging and collaborative learning and planning tools for the development of adaptation strategies.

3. Outputs, Outcomes and Impacts

Outputs	Outcomes	Impacts
Household surveys, interviews, and focus groups to understand localised flood impacts on housing and communities	Create new fragility and vulnerability functions to capture the relationship between flood inundation and damage to residential structures	More granular flood models to capture predicted damage
Probabilistic flood risk assessments across future climate change scenarios	Increase spatial knowledge on probable flooding occurrence and corresponding impacts associated with different climate change projections	Mainstream disaster risk reduction and climate change adaptation knowledge to inform better planning, budgeting, and resource allocation
Knowledge exchange workshop with 50+ participants from Indonesia and the Philippines involving local and provincial governments	Transfer of flood risk management lessons between local stakeholders across countries	Innovative disaster risk reduction practices that address emerging challenges under climate change

4. Key facts/figures

- Two watersheds provided with high resolution flood hazard models, maps, and projected damage assessments
- Involved more than 200 individuals in the development of a new open-access serious game on managing flood risk under climate change
- New guidelines on developing serious games for climate change adaptation
- 5 journal articles (3 published, 2 under review) and 2 peer-reviewed conference proceedings produced from project research
- 14 conference presentations and public talks showcasing project findings

5. Publications

Journal Articles

- Latham, Z., Barrett-Lennard, G., & Opdyke, A. (2024) "Archetypes of Local Governance for Flood Risk Reduction Decision-Making Under Uncertain Climate Change Futures." *Sustainable Cities and Society*. 112, 105632. <https://doi.org/10.1016/j.scs.2024.105632>
- Nabong, E. and Opdyke, A. (2024) "Designing Serious Games to Advance Climate Change Adaptation." *Environmental Research Communications*. 6, 091501. <https://doi.org/10.1088/2515-7620/ad6f75>
- Besarra, I., Opdyke, A., Aquino, D.H., Santiago, J., Mendoza, J.E., and Lagmay, A.M.F.A. "Residential Building Flood Fragility and Vulnerability Curves for the Province of Leyte, Philippines." *Journal of Flood Risk Management*. <https://doi.org/10.1111/jfr3.13043>

Journal Articles (Submitted and Under Review)

- Besarra, I., Opdyke, A., Mendoza, J.E., Delmendo, P.A., Santiago, J., Evangelista, D.J., and Lagmay, A.M.F.A., "The Cost of Flooding on Housing under Climate Change in the Philippines: Examining Projected Damage at the Local Scale." <https://dx.doi.org/10.2139/ssrn.4896490>
- Opdyke, A., Meilianda, E., Alfian, D., Santiago, J., Mendoza, J.E., Delmendo, P.A., Besarra, I., Lagmay, A.M.F.A. "Comparing Flood Risk Drivers and Adaptation Responses in Indonesia and the Philippines"

Conference Papers

- Alfian, D., Meilianda, E., Ahmad, A., Syukri, M., and Opdyke, A. (2024) "Application of Spatial Model the Contribution of Land Subsidence Caused by Palm Oil Plantations Land Clearing to the Escalating Flood Risk in the Trumon Area, South Aceh Regency, Indonesia." *Aceh International Symposium on Civil Engineering*. Banda Aceh, Indonesia. October 2023. <https://doi.org/10.1051/e3sconf/202447601056>
- Alfian, D., Meilianda, E., Ahmad, A., Syukri, M., and Opdyke, A. (2023) "Flood Simulation to Determine Flood Hazard Susceptibility of Downstream Singkil Watershed in Aceh Province" *Aceh International Workshop and Expo on Sustainable Tsunami Disaster Recovery*. Banda Aceh, Indonesia. October 2023. <https://doi.org/10.1051/e3sconf/202344701007>

Serious Game

- Opdyke, A., Latham, Z., and Barrett-Lennard, G. "Uncertain Waters: A Game of Collective Cooperation and Climate Change." The University of Sydney. <https://doi.org/10.25910/0vev-ab45>

Datasets

- Opdyke, A. and Besarra, I. (2024) "High-Resolution Elevation Model and Orthomosaic of the Municipality of Carigara, Leyte, Philippines." The University of Sydney. doi: <https://doi.org/10.25910/rebb-0936>

6. Media reports, videos and other digital content

Milestones and Project Coverage

- [Manila is reeling after a super typhoon. We must prepare fast-growing megacities for worsening disasters | The Conversation](#)
- [Final project workshop | University of the Philippines Resilience Institute](#)
- [Final project workshop | USK TDMRC](#)
- [Project output presentation and serious game turnover | UPRI](#)
- [Resilience Live Ep.5: Serious Games for Participatory Flood Risk Governance | UPRI](#)
- [Resilience Live Ep.5: Identifying Archetypes of Participatory Flood Risk Governance under Uncertain Climate Futures | YouTube](#)
- [Three ways our researchers are aiding disaster risk reduction | USYD](#)
- [Examining climate change resilience through serious games | SEI](#)

Project Updates

- [Final workshop | Humanitarian Frontiers Lab Facebook](#)
- [Final workshop | UPRI Facebook](#)
- [Project output presentation and serious game turnover | UP NOAH Facebook](#)
- [Final Philippines dissemination workshop | Humanitarian Frontiers Lab Facebook](#)
- [Project output presentation and serious game turnover | UPRI Facebook](#)
- [Testing serious game | Humanitarian Frontiers Lab Facebook](#)
- [Data gathering for serious game | Humanitarian Frontiers Lab Facebook](#)
- [Drone surveys for high-resolution aerial images and elevation data | UPRI Facebook](#)
- [Fieldwork and data gathering in Carigara, Leyte | Humanitarian Frontiers Lab Facebook](#)
- [Consultation with Carigara DRRM Office | UPRI Facebook](#)

Conference Presentations

- Besarra I., Opdyke A., Delmendo P., Mendoza J., Santiago J., Evangelista D., and Lagmay A., Webber, S. "What is the Cost of Climate Change? Examining Flood Risk at the Municipal Scale in the Philippines." *7th Annual Conference of the Association of Pacific Rim Universities – Sustainable Cities and Landscapes and 3rd International Conference on Human Settlements Planning and Development*. Manila, Philippines. August 2024.
- Opdyke, A. "Vulnerability as a Function of Impact." *Risk Index for Climate Displacement Co-creation Symposium*. Bangkok, Thailand. July 2024
- Besarra, I., Opdyke, A., Santiago, J., Mendoza, J., Delmendo, P., Evangelista, D., Lagmay, M., and Webber, S., "Climate Change-Induced Flood Risk Scenarios for Residential Buildings in the Philippines. *Association for Pacific Rim Universities (APRU) Multi-Hazards Symposium*. Singapore. November 2023
- Opdyke, A. "Modelling Vulnerability to Build Safer Infrastructure and Communities." (Keynote Presentation) *Aceh International Symposium on Civil Engineering*. Banda Aceh, Indonesia. October 2023.

- Nabong, E., Barrett-Lennard, G., Latham, Z., Opdyke, A. "Using Serious Games to Advance Understanding of Climate Change Impacts." *i-Rec Conference*. Sendai, Japan. June 2023.
- Besarra, I., Opdyke, A., Webber, S., Santiago, J., Mendoza, J., Delmendo, P., Evangelista, D., and Lagmay, M. "Modelling Flood Risk Patterns Under Climate Change in the Philippines." *i-Rec Conference*. Sendai, Japan. June 2023.
- Opdyke, A. "Participatory Technologies as a Catalyst to Reduce Disaster Risk." (Keynote Presentation) *Association for Pacific Rim Universities (APRU) Multi-Hazards Symposium*. Bangkok, Thailand. November 2022.
- Alfian, D., Meilianda, E., and Opdyke, A. "The Role of Land Subsidence Induced by Palm Oil Plantation Land Clearing to Escalating Flood Disaster Events at Trumon Area, South Aceh Regency of Indonesia" *Aceh International Workshop and Expo on Sustainable Tsunami Disaster Recovery*. Sydney, Australia. September 2022.
- Besarra, I., Opdyke, A., Santiago, J., Lagmay, M., and Mendoza, J. "Developing Flood Vulnerability Curves for Leyte, Philippines." *Aceh International Workshop and Expo on Sustainable Tsunami Disaster Recovery*. Sydney, Australia. September 2022.
- Meilianda, E., Alfian, D., and Opdyke, A. "Overview of Spatiotemporal Dynamics of Coastal Residential Areas Affected by Tsunami, Co-seismic Land Subsidence, and River Flood at Aceh Singkil Regency of Indonesia." *Aceh International Workshop and Expo on Sustainable Tsunami Disaster Recovery*. Sydney, Australia. September 2022.

Talks

- Opdyke, A. (2024) "Identifying Archetypes of Participatory Flood Risk Governance under Uncertain Climate Futures." *University of the Philippines Resilience Institute – Resilience Live Webinar Series*. January 2024.
- Opdyke, A. (2023) "Navigating Knowledge Co-Production of Disaster Risk for Resilient Buildings and Communities." *Joint Centre for Disaster Research, Massey University*. December 2023.
- Opdyke, A. (2023) "Navigating Knowledge Co-Production of Disaster Risk and Climate Change Adaptation." *The University of Auckland and Auckland University of Technology – Disaster Prevention and Management Seminar Series*, Auckland, New Zealand. November 2023.
- Opdyke, A. (2023) "Navigating Knowledge Co-Production of Disaster Risk for Resilient Buildings." *QuakeCoRE – New Zealand Centre for Earthquake Resilience*. October 2023.

7. Pull quotes

"It is important that we co-produce knowledge with communities. There is much more collective demand for disaster risk reduction measures where we can communicate disaster and climate science in a way that is connected to people's lived realities. In this project, we've developed extremely granular assessments of flood risk under change, but we've also worked hard to create engaging tools that can help local governments make better decisions that relate to their priorities" – Dr Aaron Opdyke

"This project advanced understanding of complex systems of flooding. The serious game on flood risk management contributed to a transformative impact, particularly local government officials, by fostering engagement, enhancing understanding, and supporting decision-making. The project enhanced learning across all the stakeholders involved through interactive learning and dialogue. It has transformed traditional training and policy development, making a proactive, engaging, and data-informed contribution to tackle managing complex flood risk challenges." – Prof Ella Meilianda

"The business of hazard mapping is not only to find out where the hazards are. The business of hazard mapping is to find safe areas for development. So regardless of the multitude of hazards present in the Philippines, with frontline science, we are able to locate evacuation centers and development centers...." – Prof Mahar Lagmay

8. Acknowledgments

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