

# Global Coastal Hazard Perspectives: Insights from the 2025 Advanced Studies Institute Graduate Training Program on Multidisciplinary Coastal Zone Hazards in Java, Indonesia



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## PROGRAM OVERVIEW

Comprehensive understanding of coastal zone hazards requires a multidisciplinary approach integrating geoscience, ecosystem dynamics and community engagement. These interconnected hazards are increasingly exacerbated by climate change and unsustainable development practices. Java, the most densely populated island in Indonesia, faces a complex suite of hazards-namely land subsidence, flooding, earthquakes, tsunamis and volcanic activity-that make it an ideal region to study hazard interactions, test mitigation strategies and examine community resilience.

The 2025 Advanced Studies Institute (ASI) Graduate Training Program on Multidisciplinary Coastal Zone Hazards brought together fifteen graduate students from the United States and Indonesia to investigate hazard dynamics and community impacts. The two-week program, co-led by American and Indonesian faculty, included place-based classroom lectures, field-based learning, stakeholder engagement and community interaction.

In Semarang, Northern Java, participants observed flooding caused by subsidence, groundwater extraction, sea-level rise and colonial land use legacies. Students discussed flooding-related challenges with affected residents and toured large-scale infrastructure interventions intended to mitigate the flooding. In Yogyakarta, Southern Java, students studied tectonic hazards associated with the Sunda subduction zone, including earthquakes, tsunamis and volcanic eruptions, as well as Indonesia's early warning systems. Students completed projects highlighting earthquake risks, flood vulnerability, natural subsidence mitigation strategies, water pollution mitigation in North-Central Java and coral ecosystem responses near Java's coast. Through transdisciplinary and cross-cultural collaboration, students gained a deeper understanding of coastal hazard systems, developed place-based research approaches and built lasting partnerships to help address the escalating risks faced by coastal communities.



## RESEARCH PROJECTS

### From rivers to reefs: Linking climate, sediment supply, and coastal ecosystem dynamics

- This project investigates the relationship between the river deltas on Java and the nearby coral reefs
- Northern Java is experiencing rapid subsidence with rates of 1-30 cm/yr for the past several decades (Marafi & King, 2008)
- Small deltas are the only areas of progradation (Hoekstra 1987; 1993)
- These deltas could be used as a nature-based solute to mitigate subsidence along the coast (*sensu* Moodie et al. 2019)
- Changing delta locations and sediment supply could affect coral
- Heat waves, ocean acidification, disease and changing sedimentation/turbidity serve as global change factors for coral
- What are the environmental drivers that dictate the growth and form of corals around Java?
- Combing the expertise of coral reef and geomorphology experts, this work proposed to investigate how river deltas producing sediment will directly affect the nearby reefs over time

Reimer et al. (2024)

### Shared Challenges and Practical Science

- Residents of Puerto Rico and Java face similar geological and coastal hazards.
- Comparing challenges, adaptations, and policies can help communities prepare for these hazards globally
- In this project, we look at Puerto Rico and Java as two case studies to examine the similarities, differences and improvements in practical coastal hazard mitigation and management in two regions through time.

Shared challenges: Puerto Rico and Java  
El Faro, southwest coast of Puerto Rico  
2020 Earthquake Subsidence Tidal Floods

Tsunami warning systems  
DART (Deep-Ocean Assessment and Reporting of Tsunamis) Systems  
• Record bottom pressure in deep ocean  
• ~70 deployed worldwide  
• ~10% not operational at any given time

Coastal Sea Level Gauges  
• Record elevated sea level for long period waves at the coasts  
• Affected by nearshore processes  
• Latency

Early warning post-2004 Sumatra disaster  
The good: increased capacity for earthquake and earthquake-induced tsunami detection!  
• Indonesia Tsunami Early Warning System (ITWES) created in 2008 (development began in 2005)  
• Put out more tide gauge buoys in 2005  
• 6x increase in DART buoys from NOAA, started putting them in the Southern Hemisphere  
• Indian Ocean Tsunami Warning System created!

### Overlap of historic hazard hotspots and future flood risk in Demak

- How do land subsidence, coastal retreat, and mangrove restoration interact to shape coastal vulnerability in Demak?
- What level of flood modeling is feasible in Demak given available data?

Ismanto et al. (2025)

### Mitigation Strategies for Batik Water Pollution in North-Central Java

**Background:**

- Batik is traditional made by boiling waxed cloth in dyes
  - Uses large amounts of groundwater and can lead to river pollution
- Increased pollution and increased groundwater extraction can lead to increased subsidence, flooding, and salinization
- Difficult to identify best locations for wastewater treatment plants due to cottage industry
- Many polluted canals are small and drainage patterns are unknown

**Proposed Project:**

- Map the drainage network using GPS/RTK and monitor pollution in-situ
  - Incorporate remote sensing data to identify hotspots of pollution
- Identify unused treatment plants near areas of highest wastewater
- Work with communities to transition to eco-friendly dyes that are less harmful to the environment

*This workshop provided an incredible opportunity to observe and learn firsthand from community members, local professors, and fellow students about the coastal hazards that are impacting and have impacted Indonesia.*  
**Tyler Lynn**

*I loved meeting so many graduate students studying unique yet interrelated aspects of the coastal system and finding connections between our work. Who knew that local corals record the history of large earthquakes in Indonesia?!*  
**Julia Grossman**

## Workshop Impacts

*Meeting and working alongside graduate students and researchers from various scientific and cultural backgrounds enriched my experience and provided numerous new research avenues for my future career.*  
**Luke Gezovich**

*Working interdisciplinary with graduate students from all over the world was an amazing experience! The connections I made will allow me to continue learning from everyone throughout my time as a graduate student!*  
**Cat Hauser**

## Learning Objectives

- Develop an inter- and transdisciplinary understanding of coastal marine geosciences and disaster science through field-based training and lectures in a range of disciplines, including marine and structural geology, climate change, coastal hazards, computing and data sciences, decision support systems, and survey sensor technology.
- Understand the role of physical-social-ecological factors in coastal zone management and conservation.
- Learn about SAR and Optical Remote Sensing, Deep Learning, AI and other advanced computing techniques applied to coastal zone research.
- Obtain practical scientific skills and expand scientific network through the implementation of independent projects.
- Acquire modern scientific communication skills through readings, lectures, and writing a series of blogs.
- Gain scientific presentation skills in a range of modalities by writing a report summarizing their research findings and presenting their project during a presentation at the end of each ASI during a student symposium.

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### References

