
[Itsuo Inouyue, Associated Press]

Tsunami risk to critical infrastructure: Research challenges and potential

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2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Economic impacts of disasters to critical infrastructure

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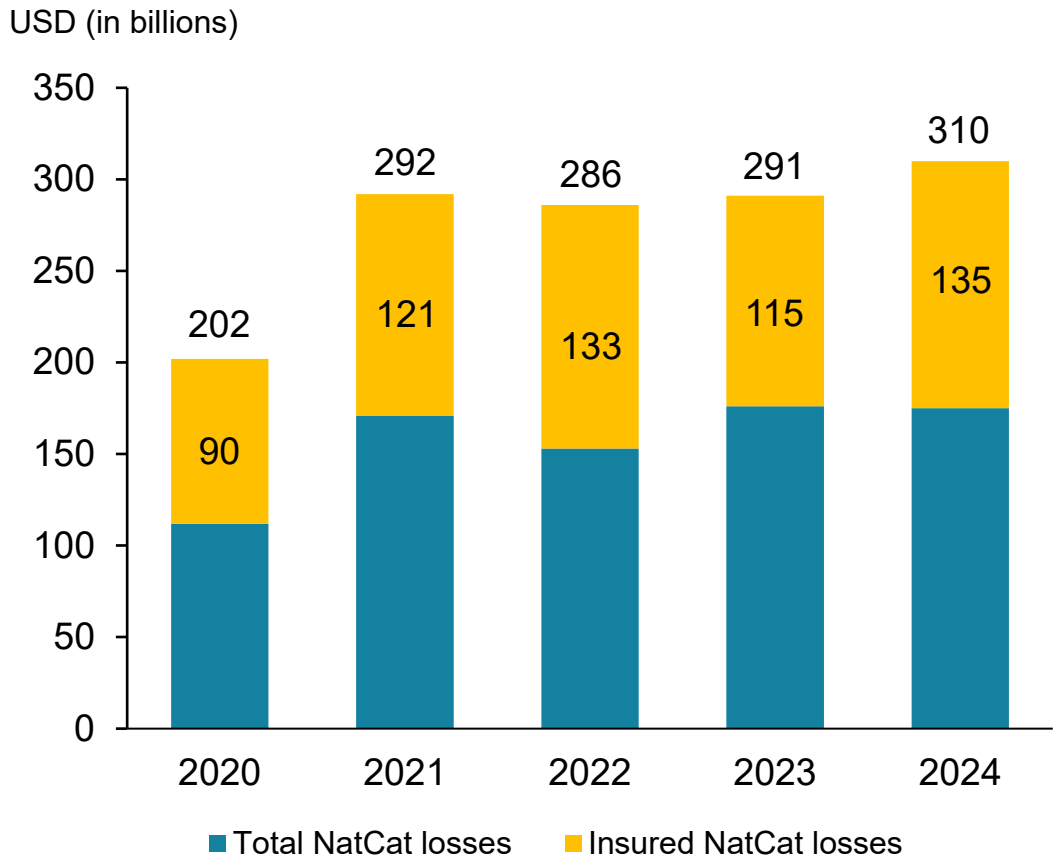
- Global Average Annual Loss (AAL) due to disasters for infrastructure sectors approximate to USD 301 billion[1]
- Physical assets expected to increase. Annual investments of USD 3.7 trillion in infrastructure will be needed till 2035, to keep up with projected global growth rates[1]
- Disaster risk financing systems unable to keep up with the pace of increasing economic losses



[Swiss Re, 2021 - 2024]

[1] UNDP-CDRI A Biennial Report from the Coalition for Disaster Resilient Infrastructure

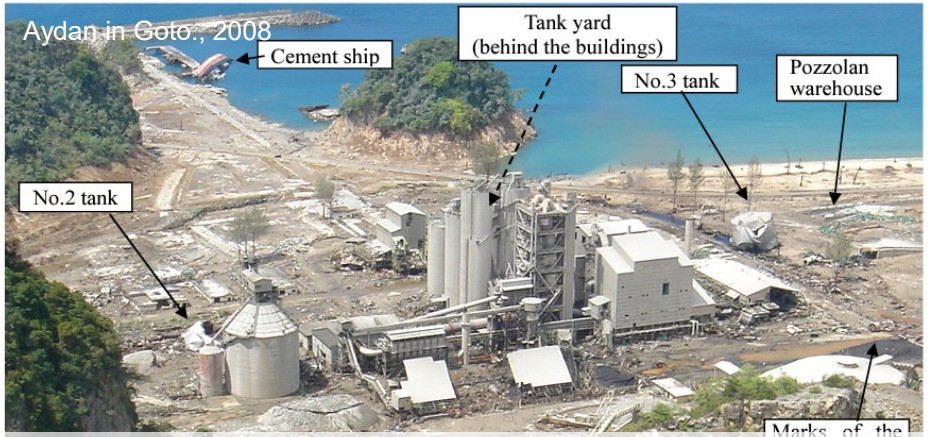
Tsunami damage to power generators in Japan

2011 Tohoku tsunami

- 11 of 54 nuclear reactors were impacted
- Affected national supply - blackouts

Tsunami damage to other infrastructure

2018 Palu tsunami
- Fallen gantry crane at Port Pantoloan



2004 Indian Ocean tsunami
- Damage to cement factory in Lho'nga

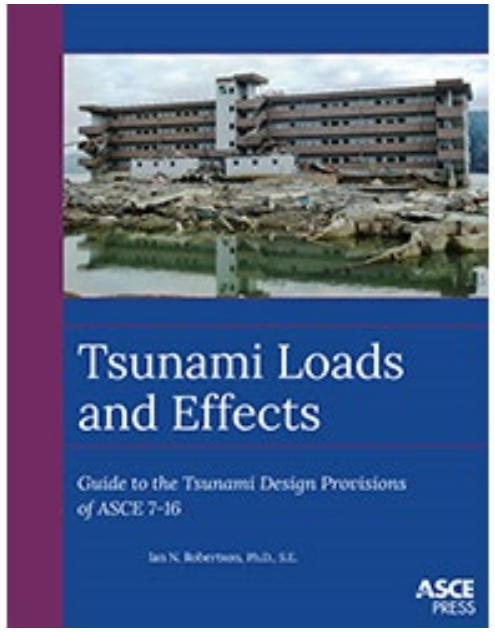
2004 India Ocean tsunami
- Collapsed road in Galle, Sri Lanka

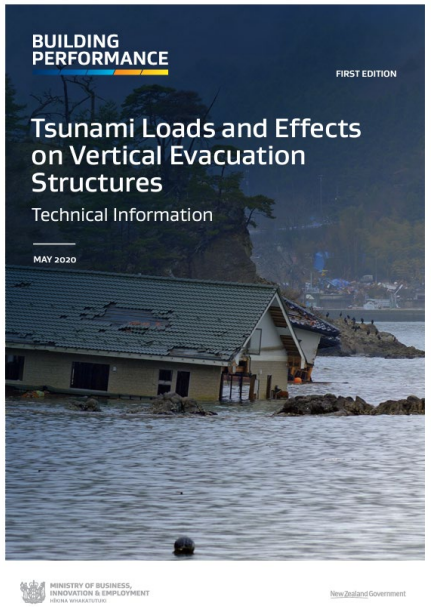
2011 Tohoku tsunami
- Damaged utility pole in Ishinomaki

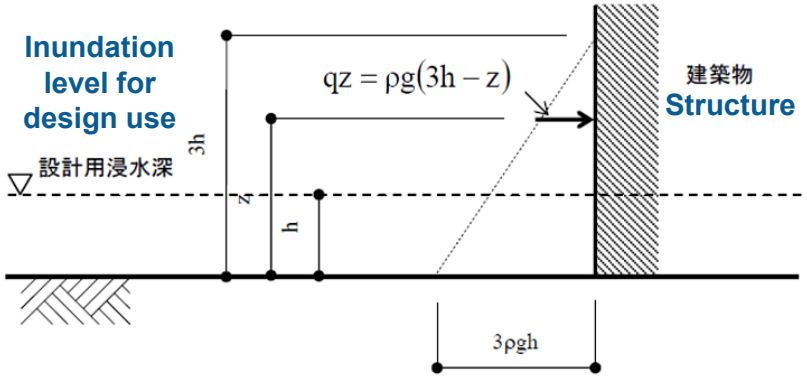
2011 Tohoku tsunami
- Floating tank in Ishinomaki

2011 Tohoku tsunami
- Tsuya railway bridge damaged

Guidelines on tsunami building design







The Design Method of Safe Buildings that are Structurally Resistant to Tsunamis (MLIT Technical Advice No. 2570)

MLIT 2570 (Japan, 2011)

- Building code (revised in 1981; 2000) only accounts for earthquake
- Guidelines for tsunami evacuation buildings in 2005
- Provisional amendments after 2011 tsunami to consider tsunami loads in building design

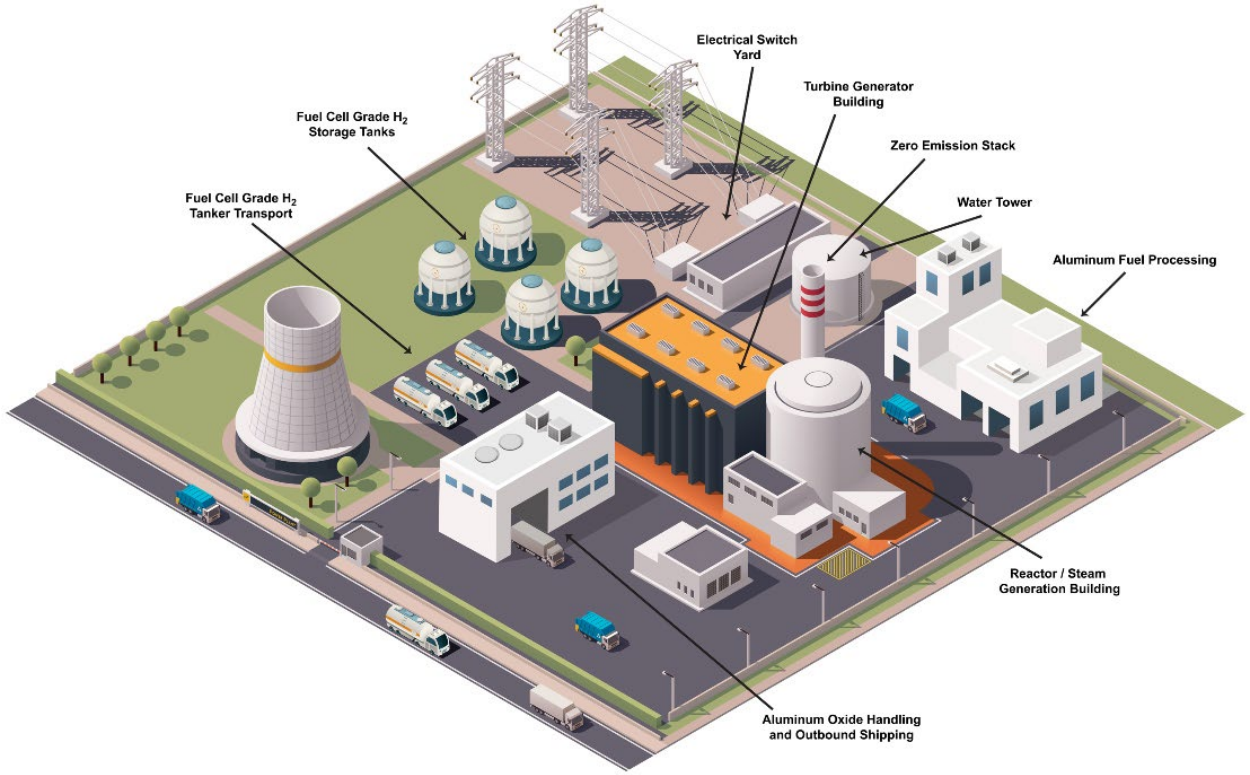
ASCE 7-16 (United States, 2016)

- Included a whole new chapter on tsunami loads
- World's first tsunami design code written in mandatory language
- Considers critical infrastructure (Risk Category IV)

MBIE Tsunami loads and effects (New Zealand, 2020)

- Adapted from ASCE 7-16

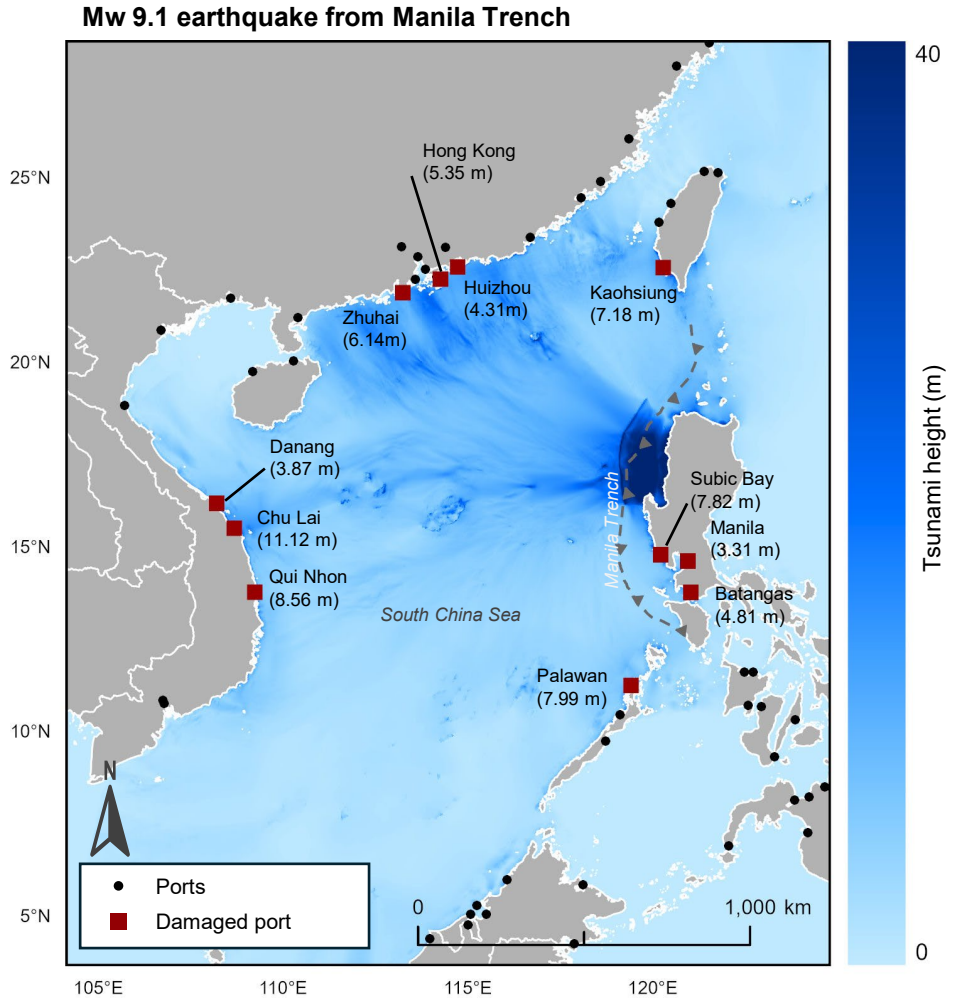
Challenges in quantifying tsunami risk to CI



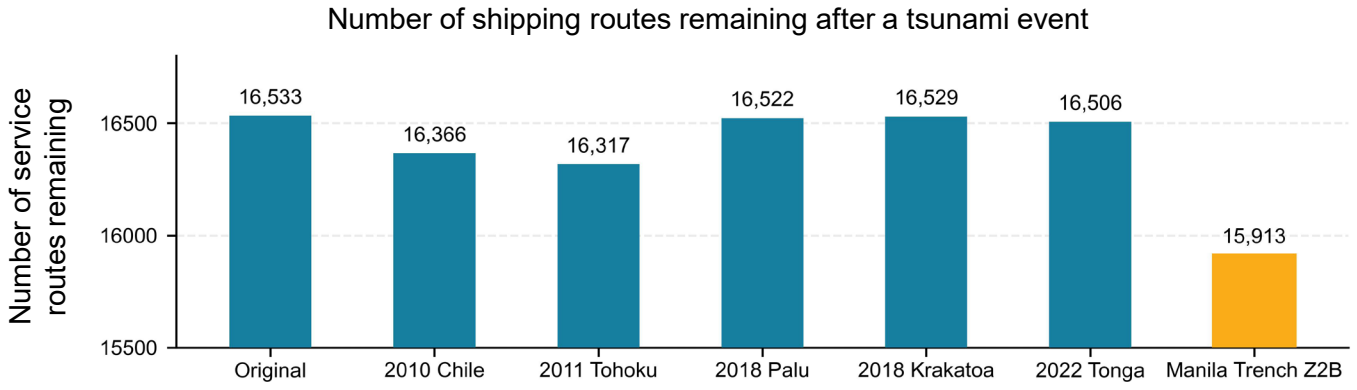
[Hydrogen Production & Electricity Generation Power Plant. Image source: GH Power]

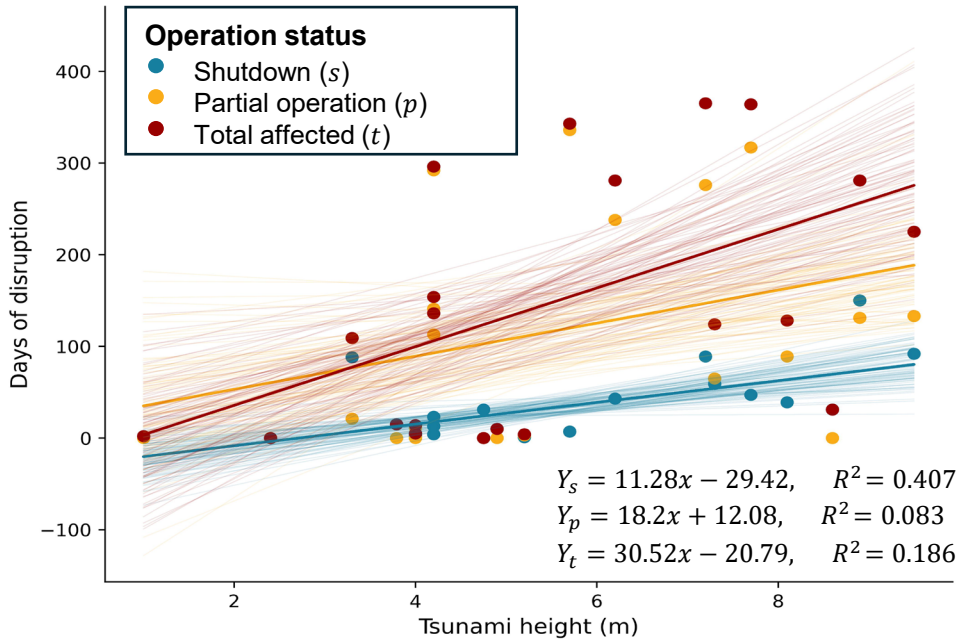
- Tsunami events are infrequent. Lack of observational data.
- Heterogeneous design and configurations of components. Difficult to assign common scale for risk assessment
- Critical infrastructure systems are interrelated and complex – components may originate from different technological domains
- Damage observed to one component or facility may not be a result of a direct impact from tsunami waves

Cascading impacts of a tsunami from Manila Trench



Chua et al. (npj Natural Hazards, 2024)





Up to 200 days of disruption to port functions

Changes in demand of port functions in S. China Sea

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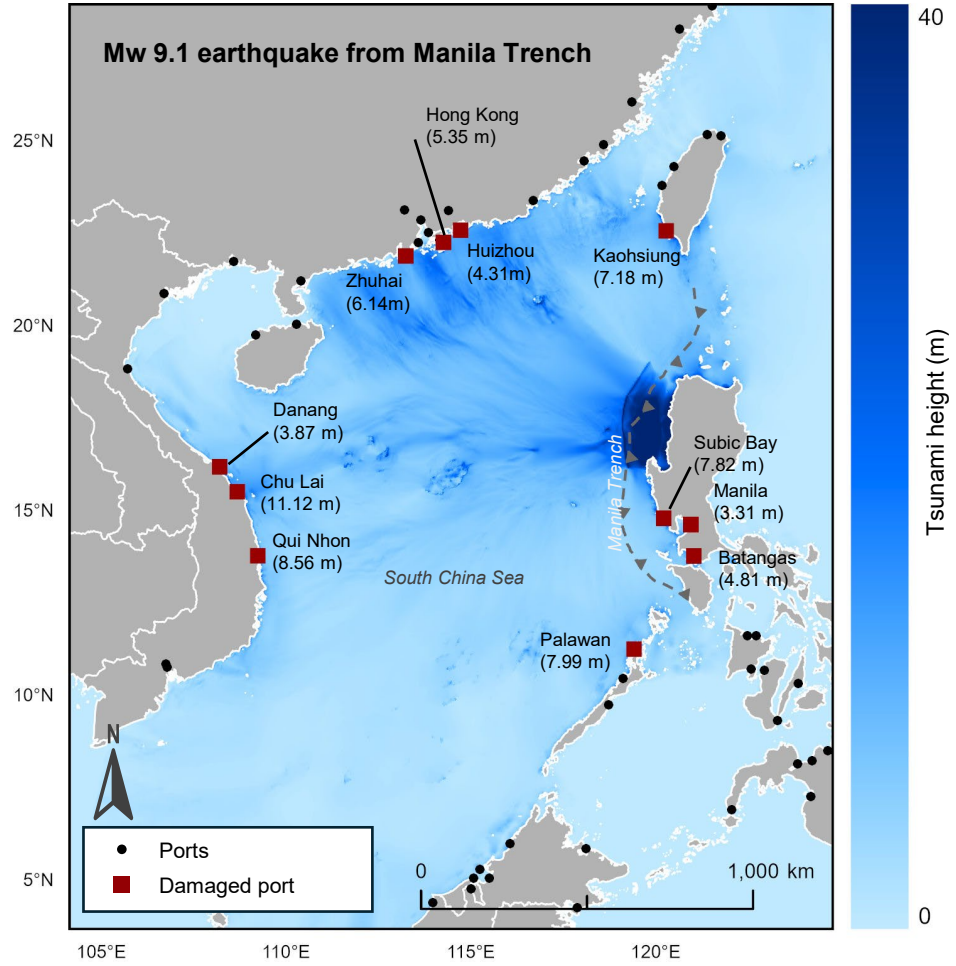
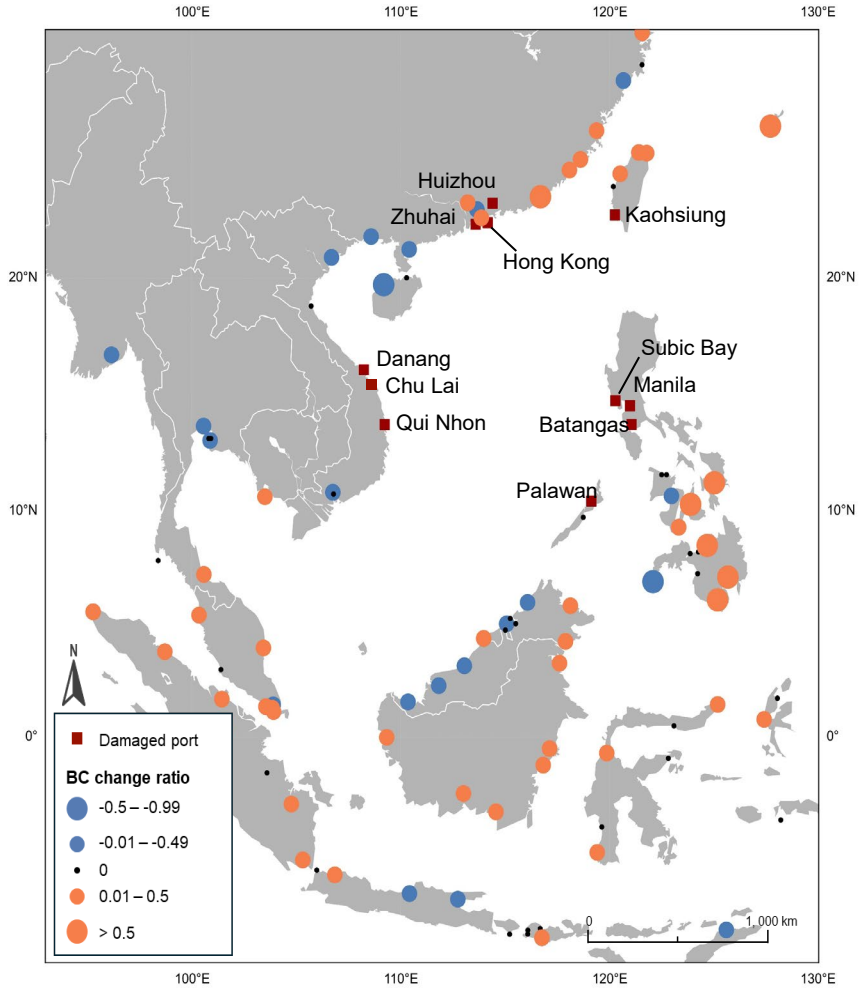
Identification of damaged ports



Chua et al. (npj Natural Hazards, 2024)

Changes in demand of other ports' functions



Impacts on CI dependencies in Cilacap, Indonesia

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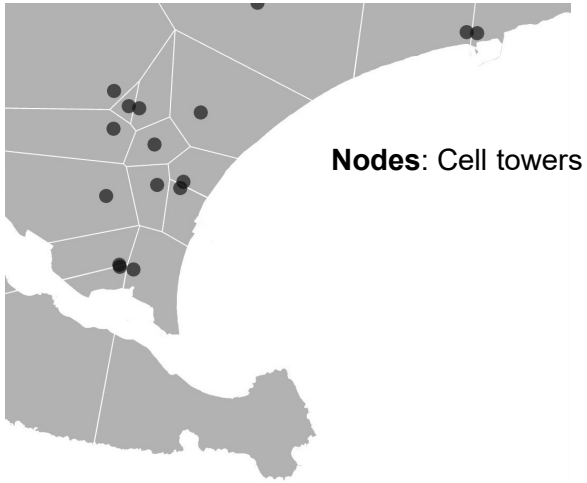
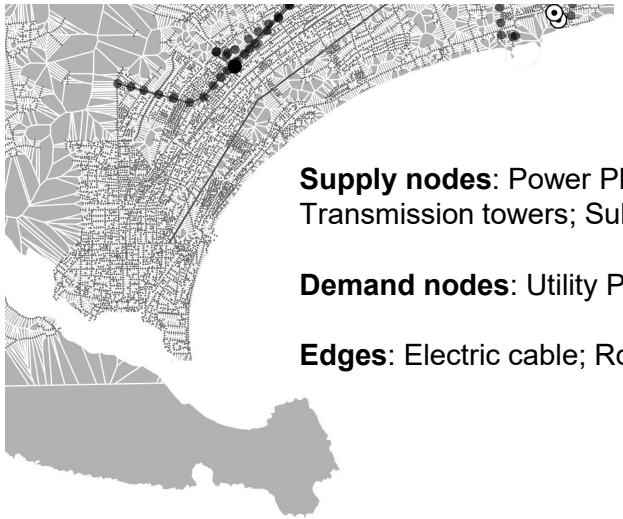
Telecommunication
Failure threshold: 2.5m



Nodes: Cell towers

Electric supply
Failure threshold: 2.5m

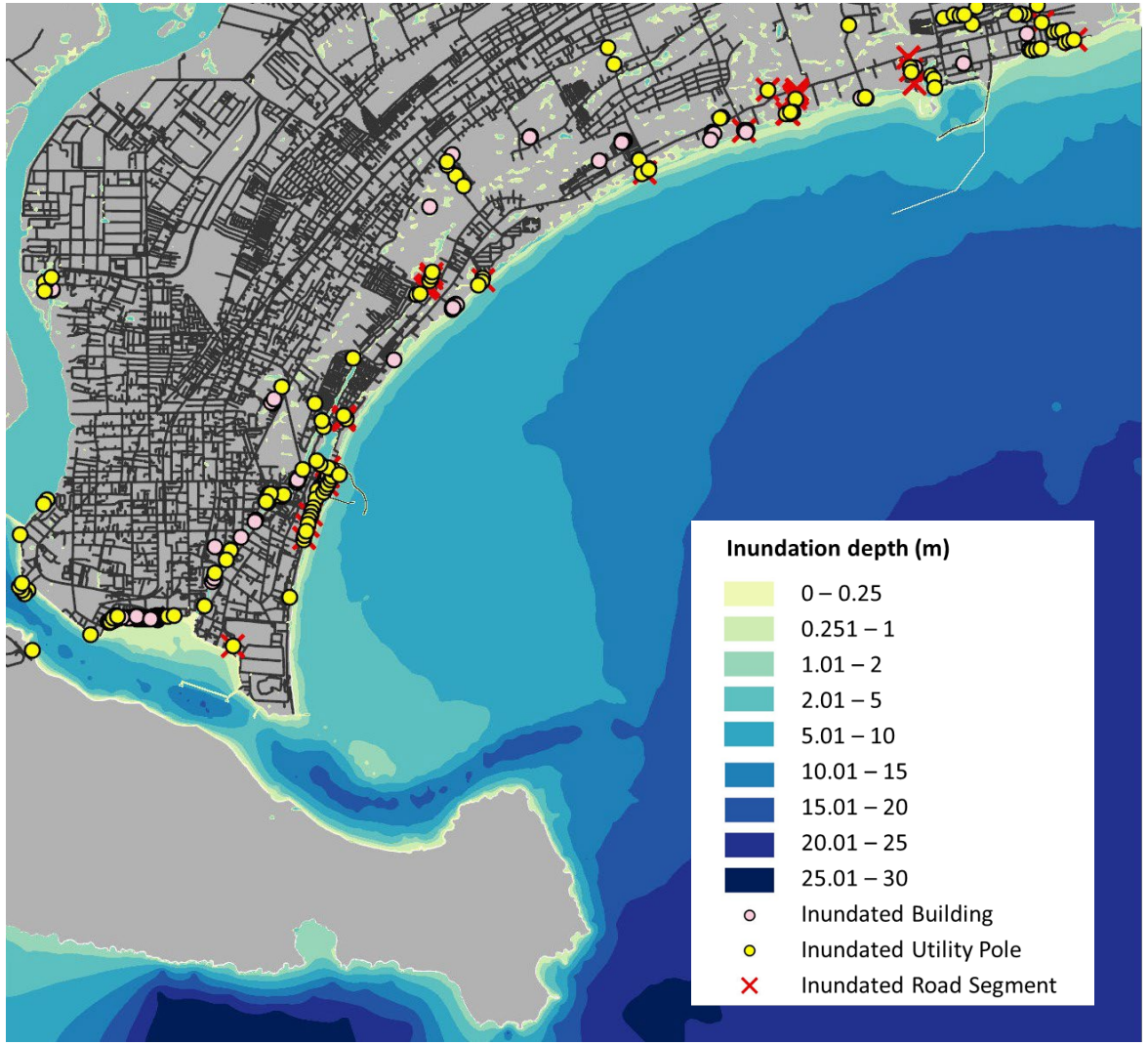


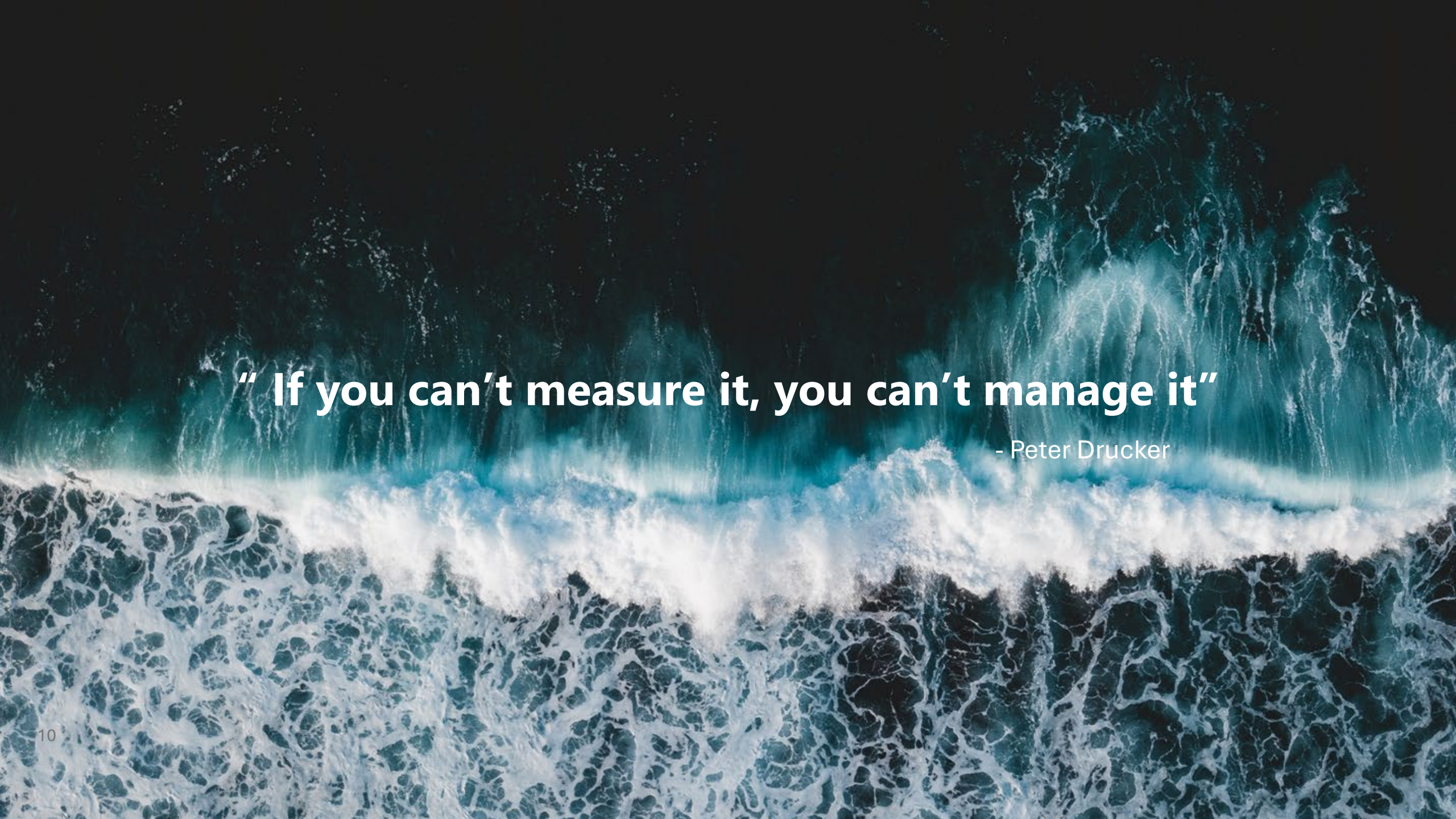
Supply nodes: Power Plants; Transmission towers; Substations

Demand nodes: Utility Poles

Edges: Electric cable; Roads

Mw 8.9 earthquake from Java Trench, Indonesia




“ If you can’t measure it, you can’t manage it”
- Peter Drucker


[Itsuo Inouyue, Associated Press]

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Ms Anzhela Danilova

Organising and program committees
(First Ocean Decade International Coastal Cities Conference)

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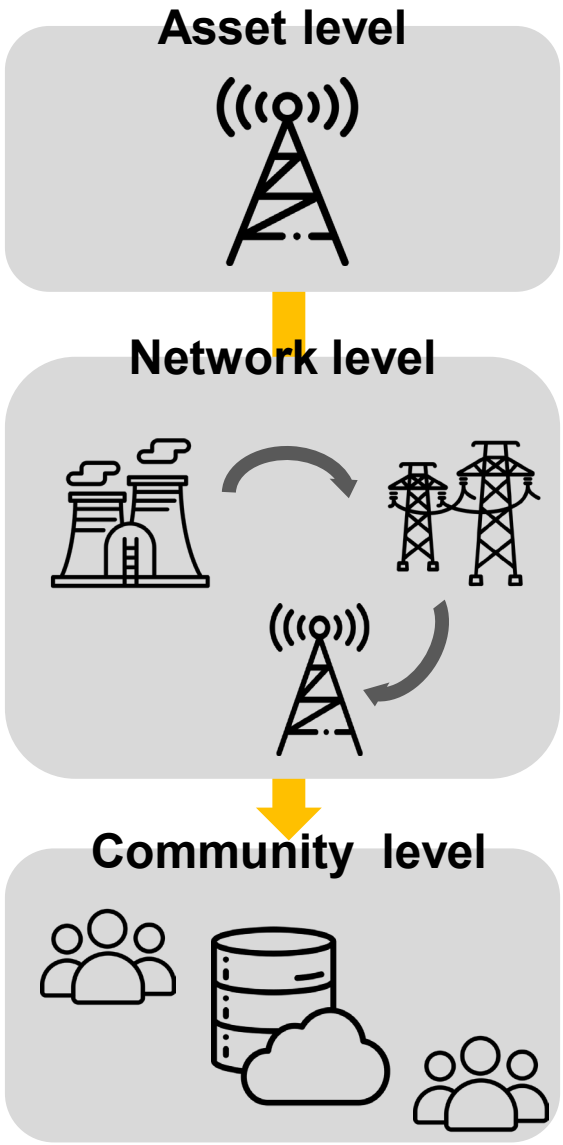
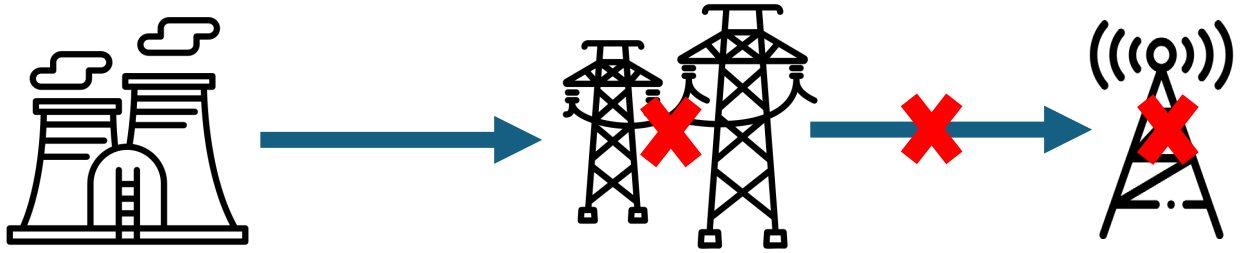
Way forward?



- Quantifying vulnerabilities by mapping CI systems according to their **functionalities**



- Assess **changes in demand** for these CI after a disaster -> Business continuity plans and recovery plans