Global and future perspectives of tsunami disaster mitigation

- Impacts of sea level rise on tsunami hazards
- Contributions of Japanese tsunami engineering

Anawat Suppasri
Tsunami Engineering Laboratory
International Research Institute of Disaster Science (IRIDeS)
Tohoku University
Sendai, Japan

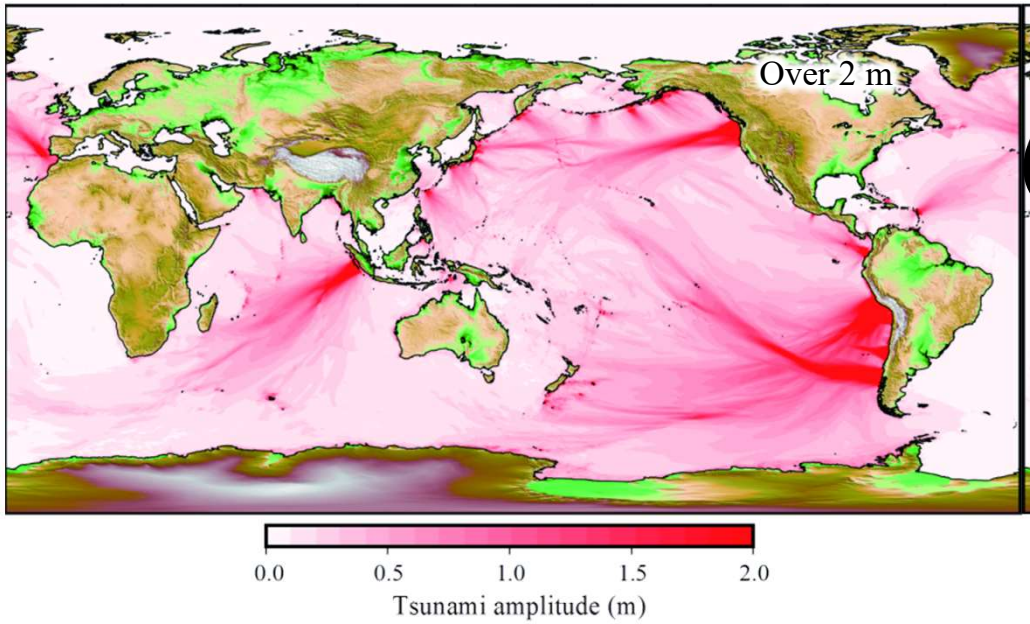
TOHOKU UNIVERSITY

Tohoku Univ. IRIDeS
Tsunami Engineering Lab

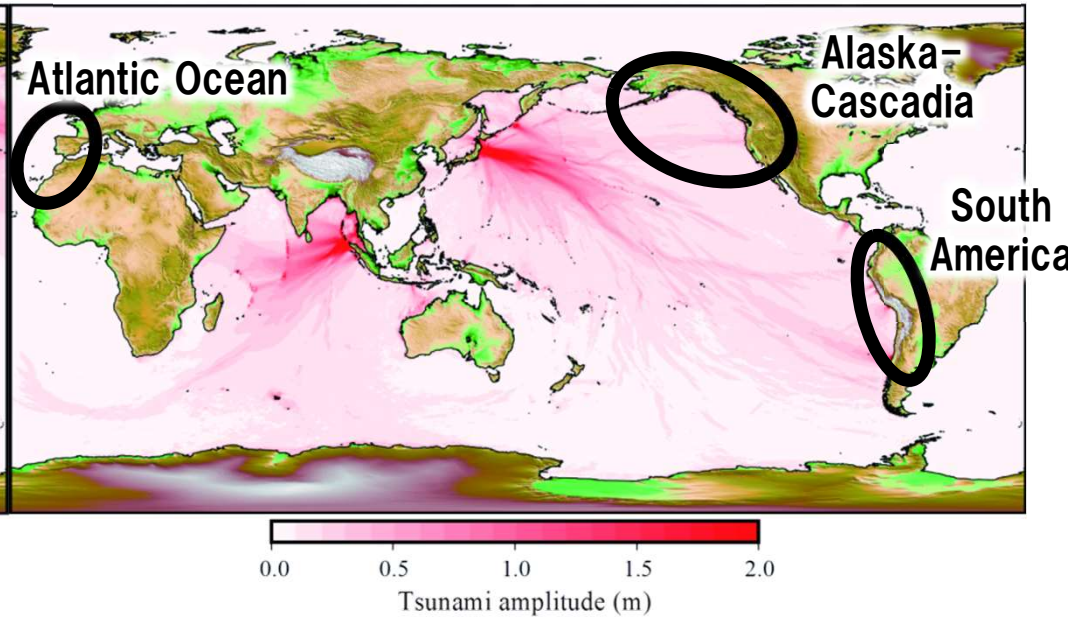
IRIDeS
International Research Institute of Disaster Science
災害科学国際研究所

Tsunami hazards from the last 400 years

1600-1969（64 events）



1970-2016（39 events）

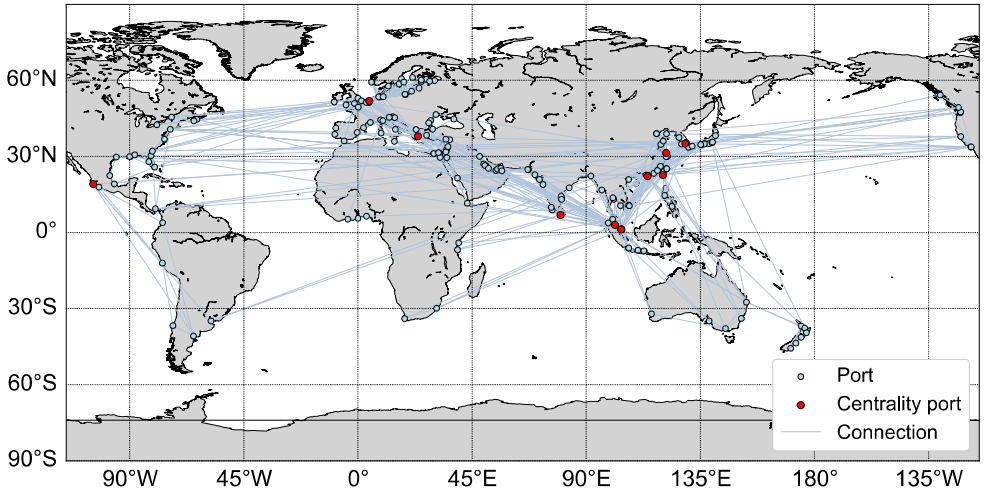


Damaging tsunamis that exceeded 2 m can be seen virtually everywhere, especially along the Pacific Rim including 1700 Cascadia (M9.0), 1755 Lisbon (M8.5), 1833 SW Sumatra (M8.3), 1868 Peru (M8.3), 1906 Ecuador (M8.8) and 1960 Chile (M9.5).

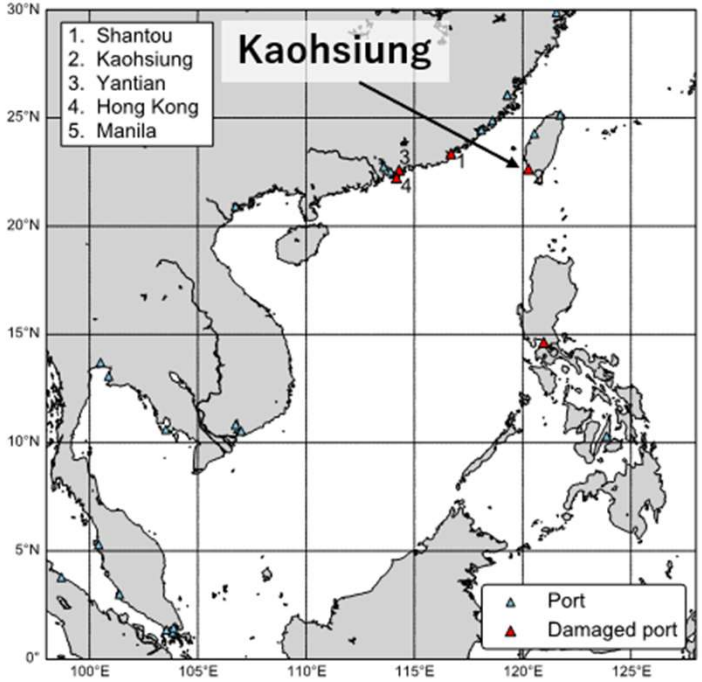
Only two major events, the 2004 Indian Ocean (M9.3) and Great East Japan (M9.0), classified as recent damaging tsunamis that exceeded 2 m and caused global impact meanwhile no major damaging tsunami in the east Pacific and Atlantic Ocean.

This observation demonstrates the importance of assessing or recognizing the hazards based on historical events beyond recent experiences.

Application for regional tsunami risk perspective



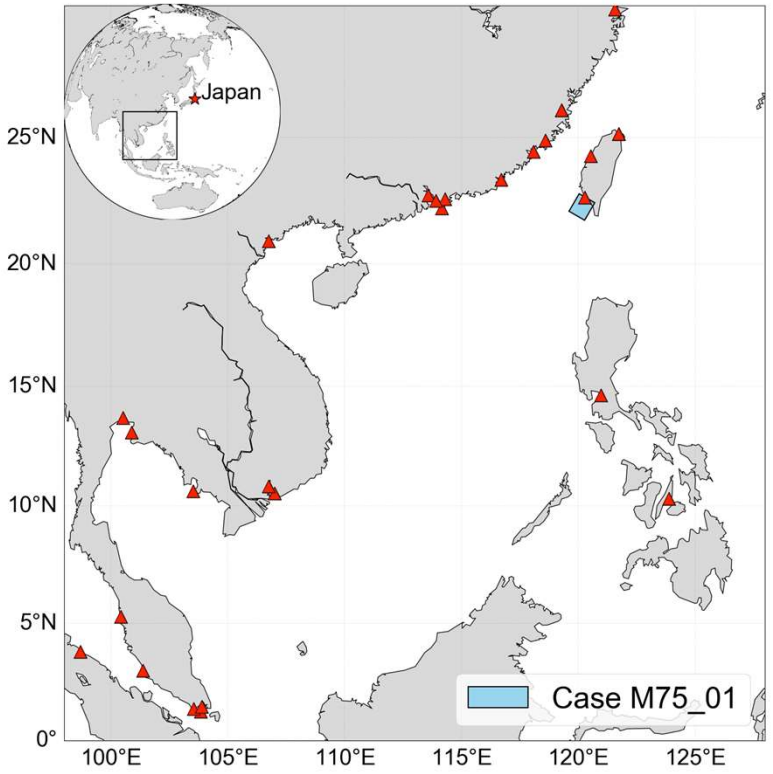
Distribution of ports and their network



Locations of damaged ports

Damage port from each scenario

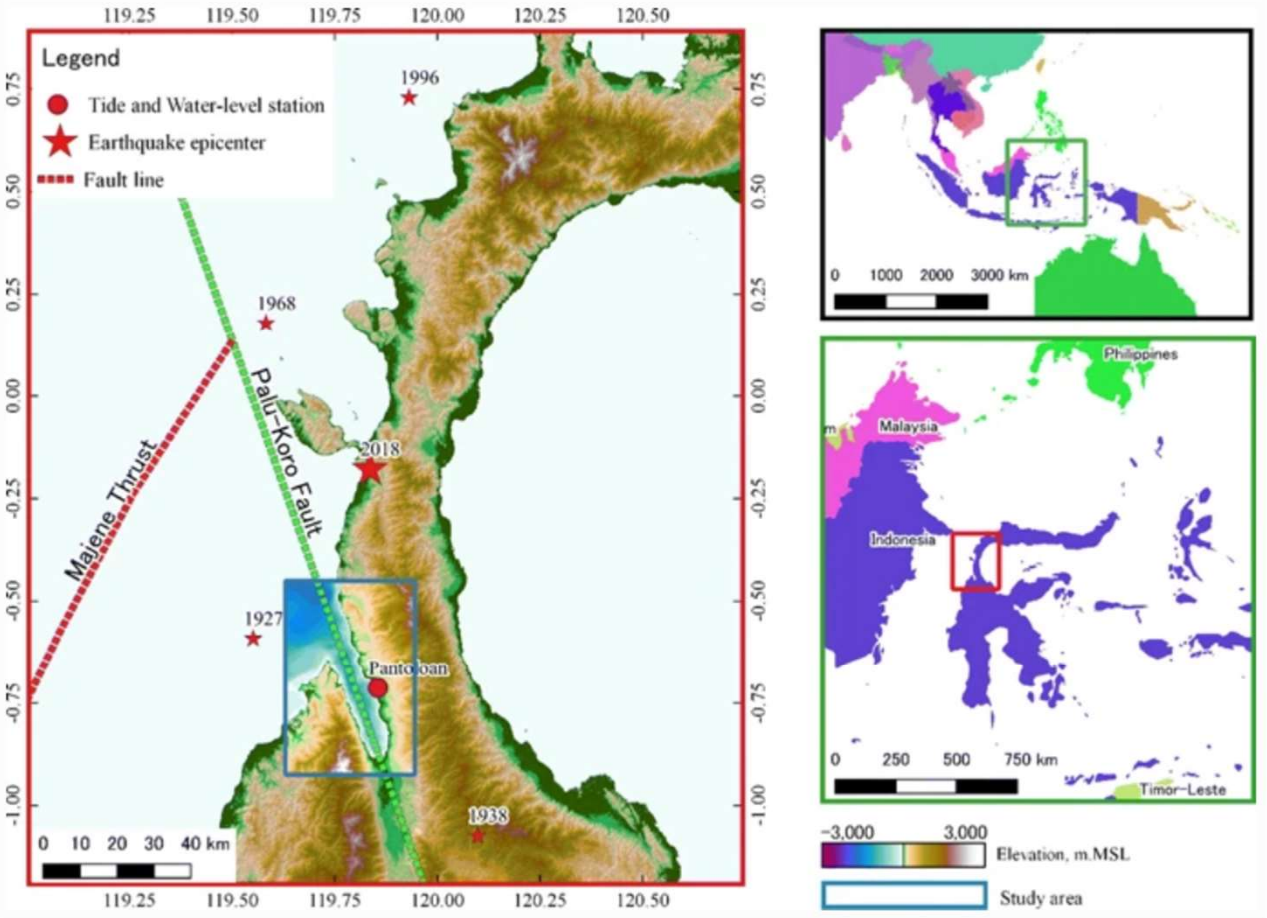
Scenario	Port name
M85_01	Kaohsiung
M85_02	Kaohsiung
M87_01	Kaohsiung, Shantou
M87_02	Kaohsiung
M87_03	Kaohsiung, Shantou
M89_01	Kaohsiung, Shantou, Yantian
M89_02	Kaohsiung, Shantou, Yantian
M89_03	Kaohsiung, Shantou, Yantian
M89_04	Kaohsiung, Shantou, Yantian
M89_05	Kaohsiung, Shantou, Yantian
M89_06	Kaohsiung
M89_08	Manila
M90_01	Kaohsiung, Shantou, Yantian, Hong Kong
M90_02	Kaohsiung, Shantou, Yantian
M90_03	Kaohsiung, Shantou, Yantian
M90_04	Kaohsiung, Shantou, Yantian
M90_05	Kaohsiung, Shantou, Yantian
M90_06	Kaohsiung, Manila
M90_07	Kaohsiung, Manila

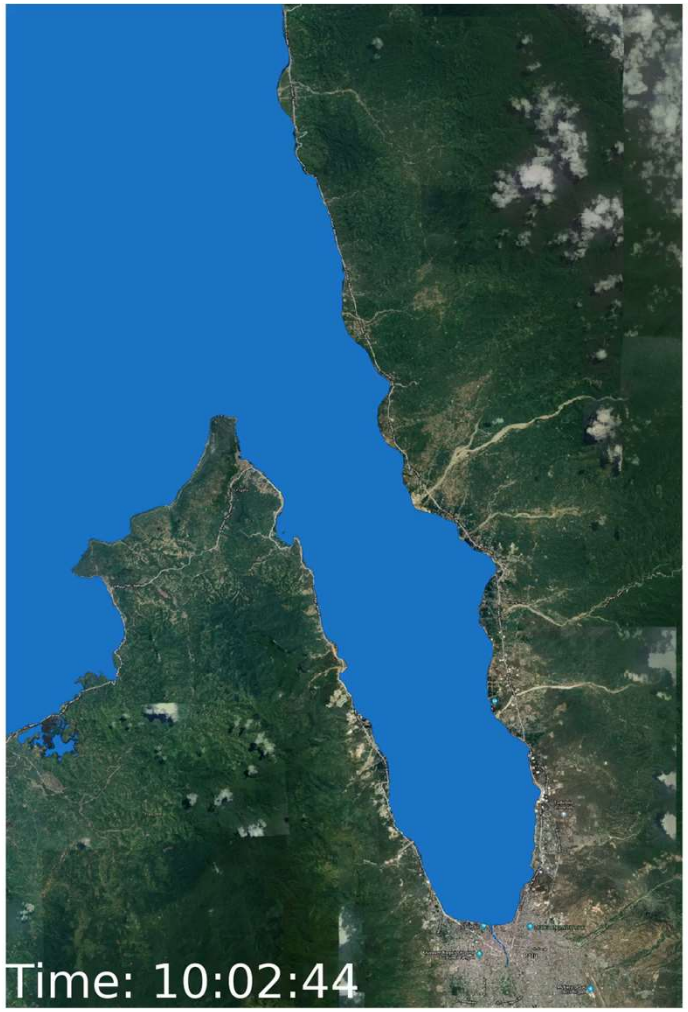


Future tsunamis in the South China Sea

Non-seismic tsunami: Submarine landslide

2018 Sulawesi Island (Palu) tsunami

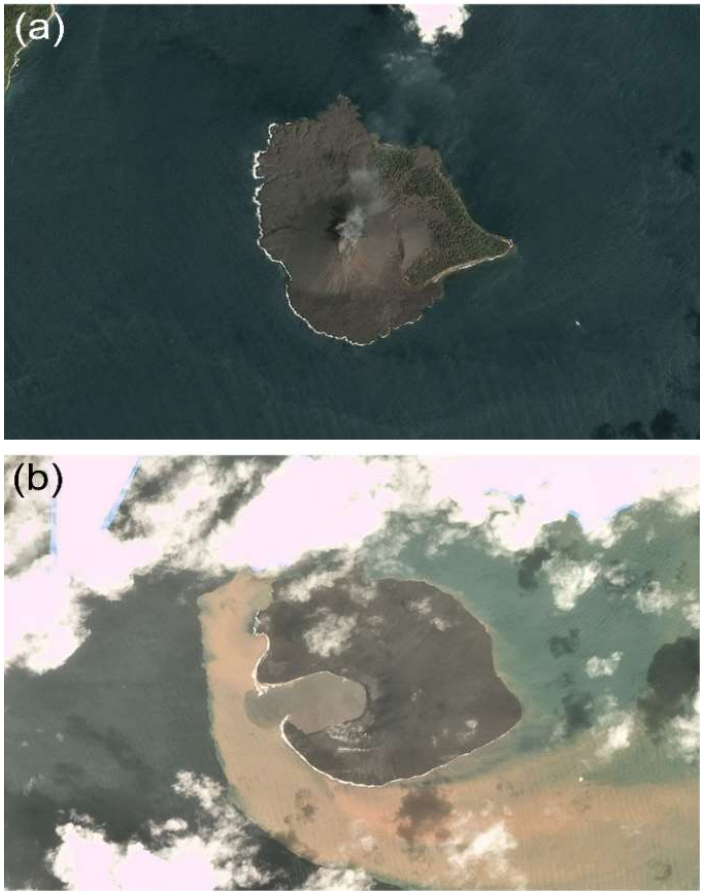




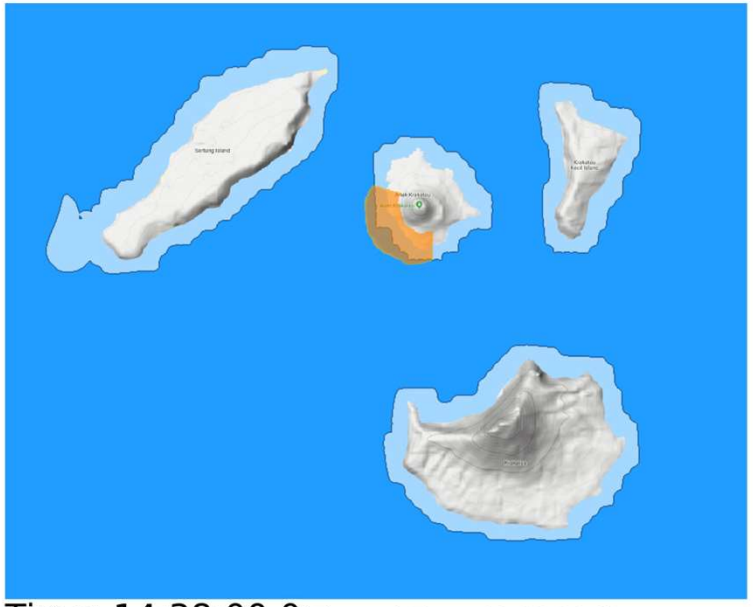
Pakoksung et al., 2019 PAGEOPH

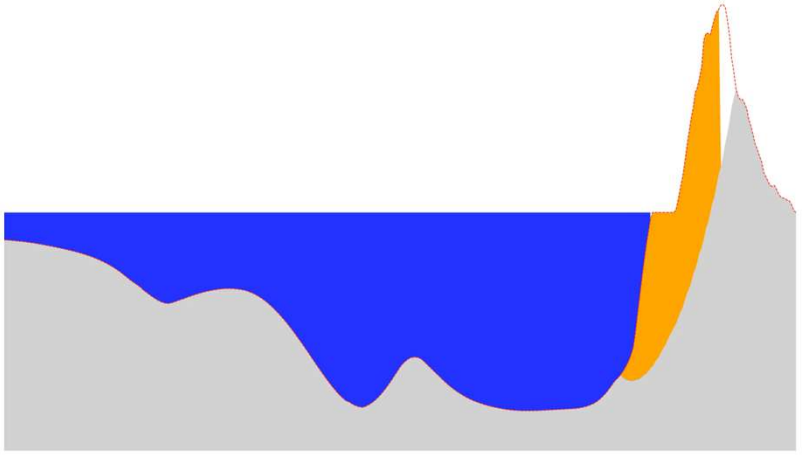
Non-seismic tsunami: Aerial landslide

2018 Sunda Strait tsunami



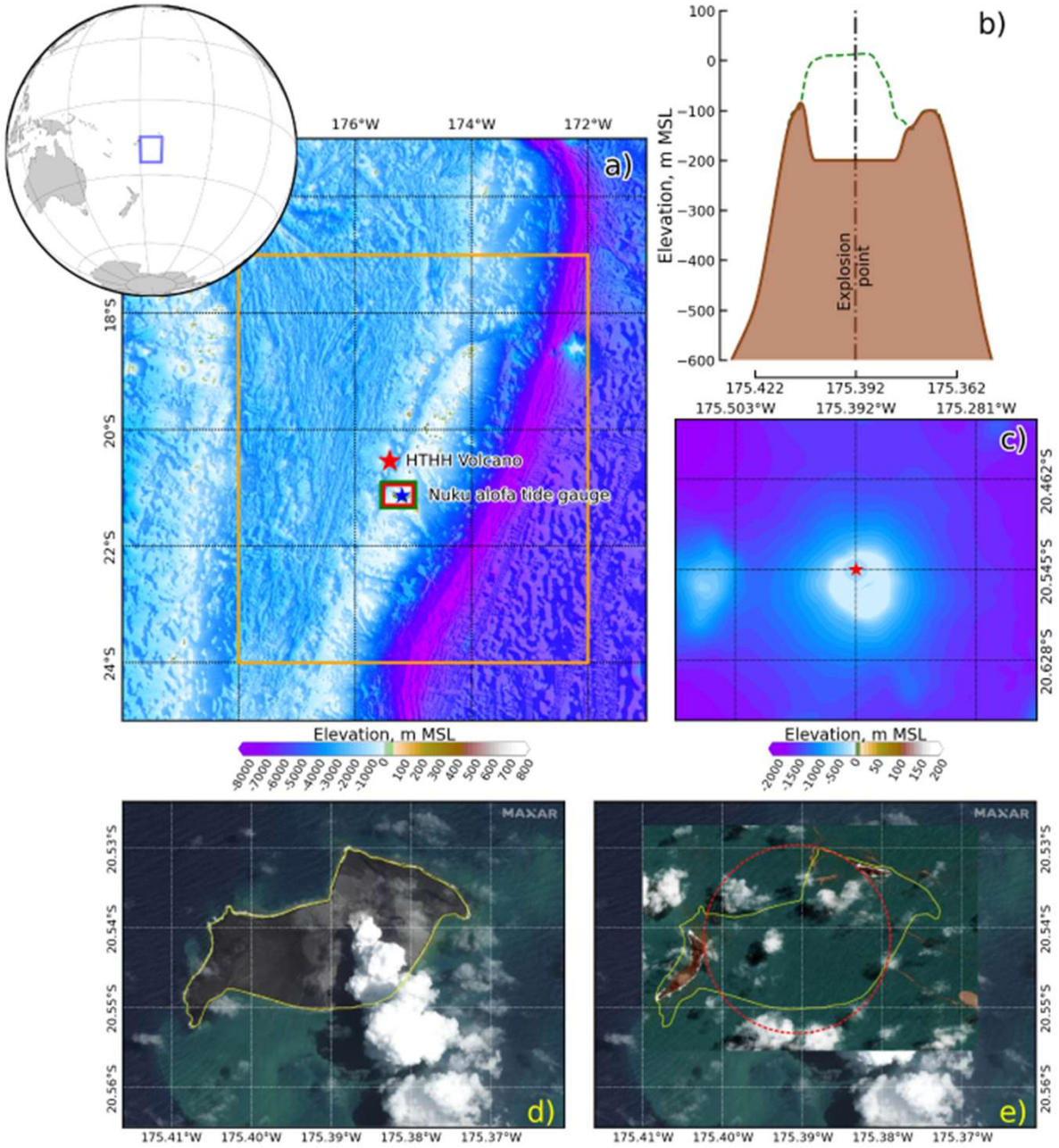
a) image on December 17, 2019
b) image on December 30, 2018



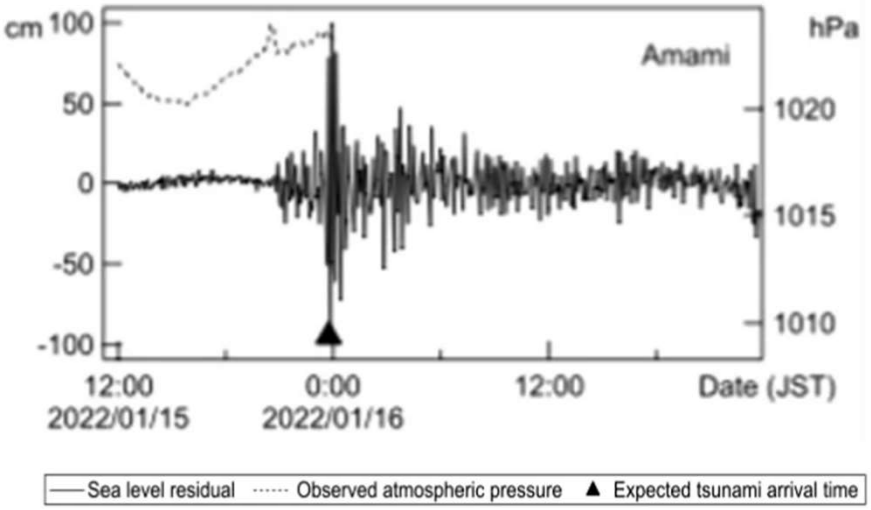


Pakoksung et al., 2020 Geoscience Letters

Non-seismic tsunami: Volcanic eruption

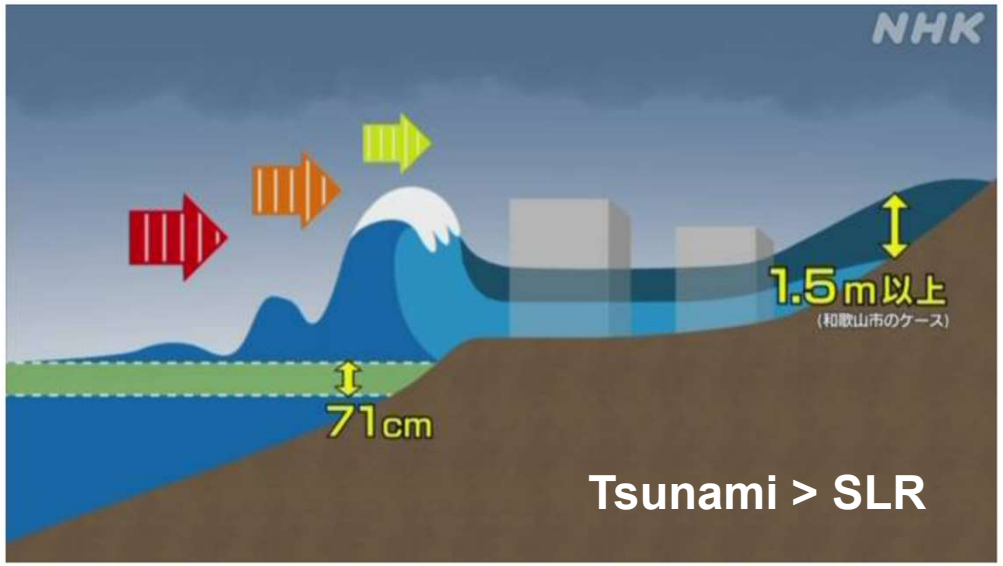


The 15 January 2022 Huga Tonga Hunga Ha'apai volcanic eruption

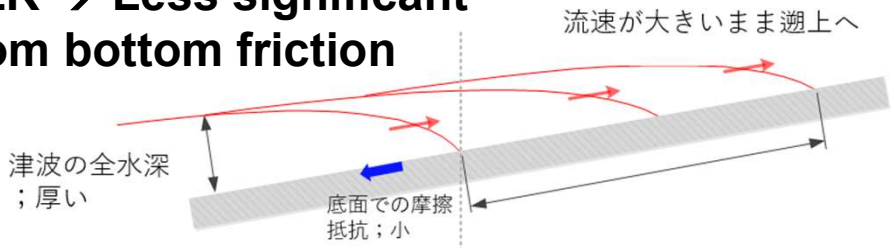


Air pressure generated tsunami that arrived Japan earlier than expected

Impact of sea level rise (SLR) on tsunami

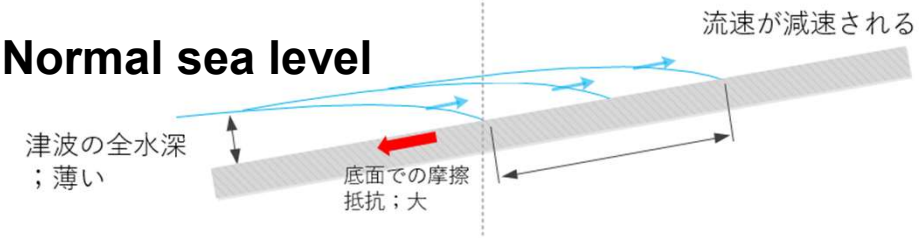


SLR → Less significant from bottom friction

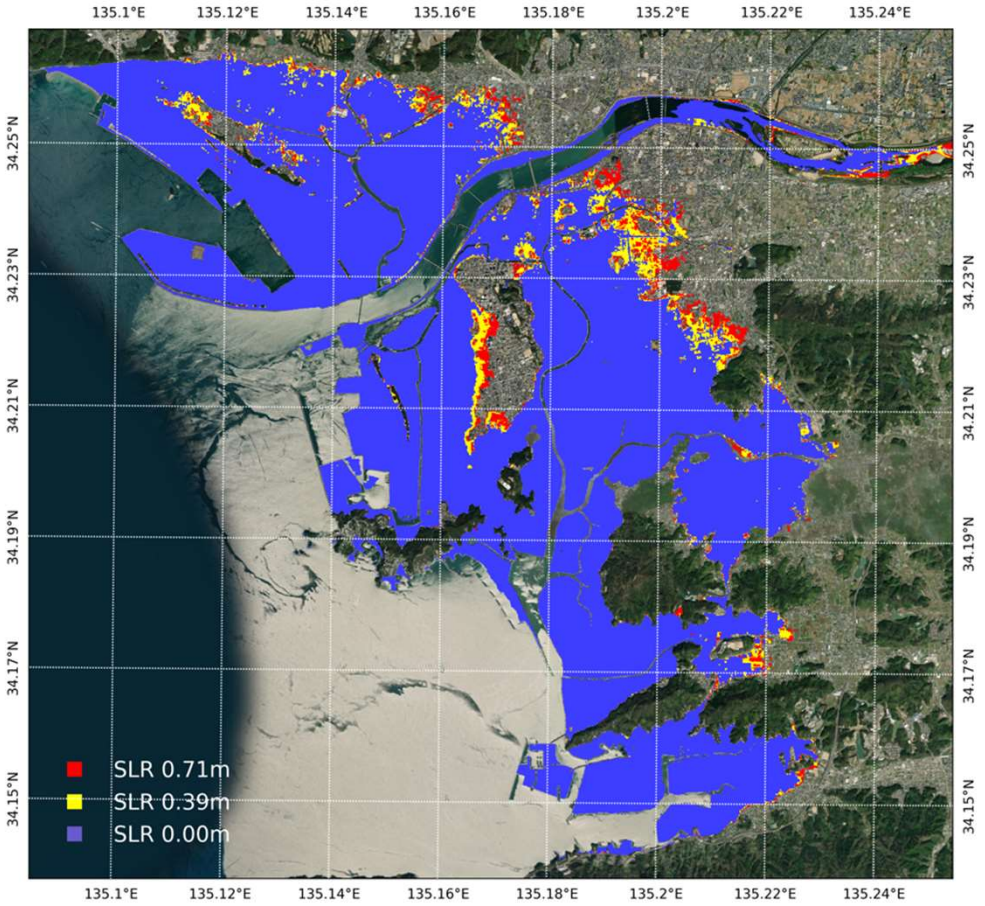


0.71m海面上昇した状況での津波遡上

Normal sea level



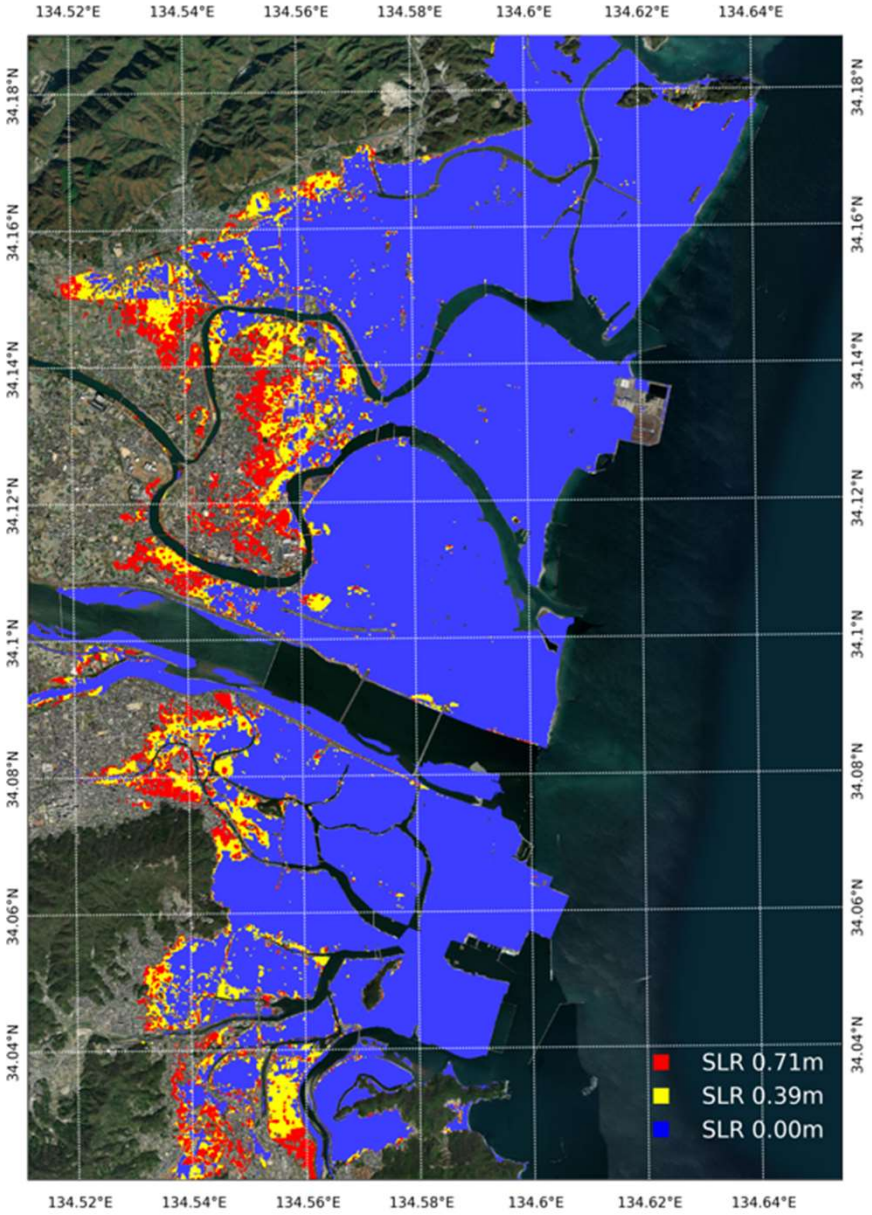
現在の海面状況での津波遡上



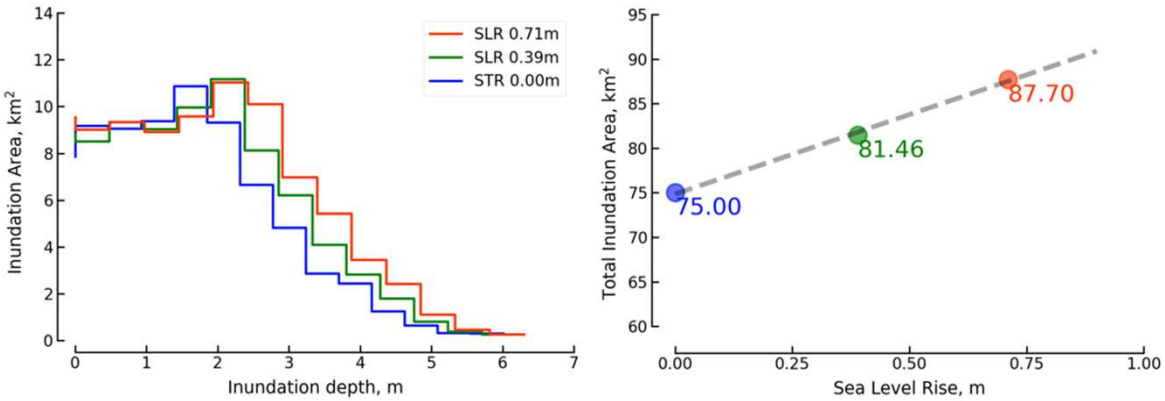
Inundation map

https://www3.nhk.or.jp/news/html/20211115/k10013349011000.html

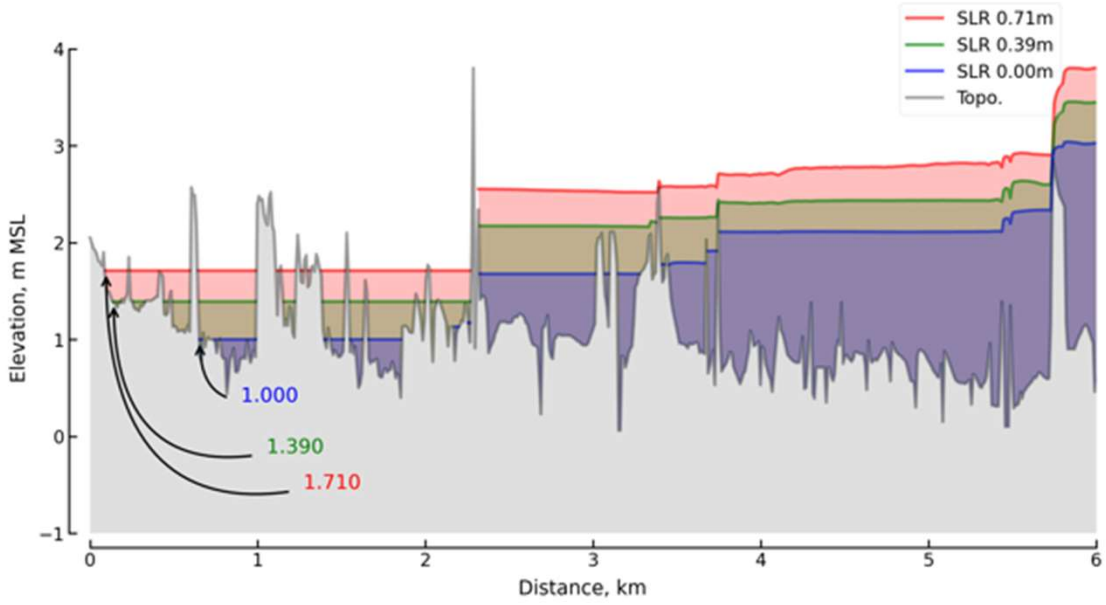
Impact of sea level rise (SLR) on tsunami



Inundation map



Increase of flow depth (left) inundation area (right)



Cross section of tsunami inundation

Impact of sea level rise (SLR) on tsunami

SLR impact on the 2011 Great East Japan Earthquake and Tsunami?

90 lives of children and teachers might not be safe

Source: TBS TV

Impact of sea level rise (SLR) on tsunami

SLR impact on the 2011 Great East Japan Earthquake and Tsunami?

Inundation distance will be larger
Flow depth will be larger
→ More casualty and damage

Source: TBS TV

Previous studies: Banda Aceh

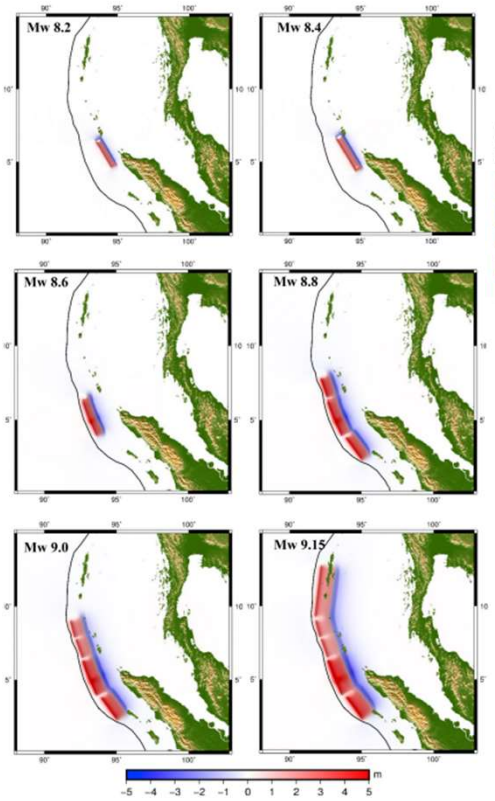
Contents lists available at ScienceDirect

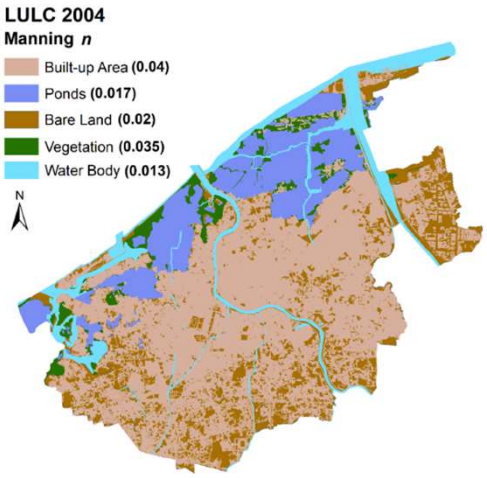
International Journal of Disaster Risk Reduction

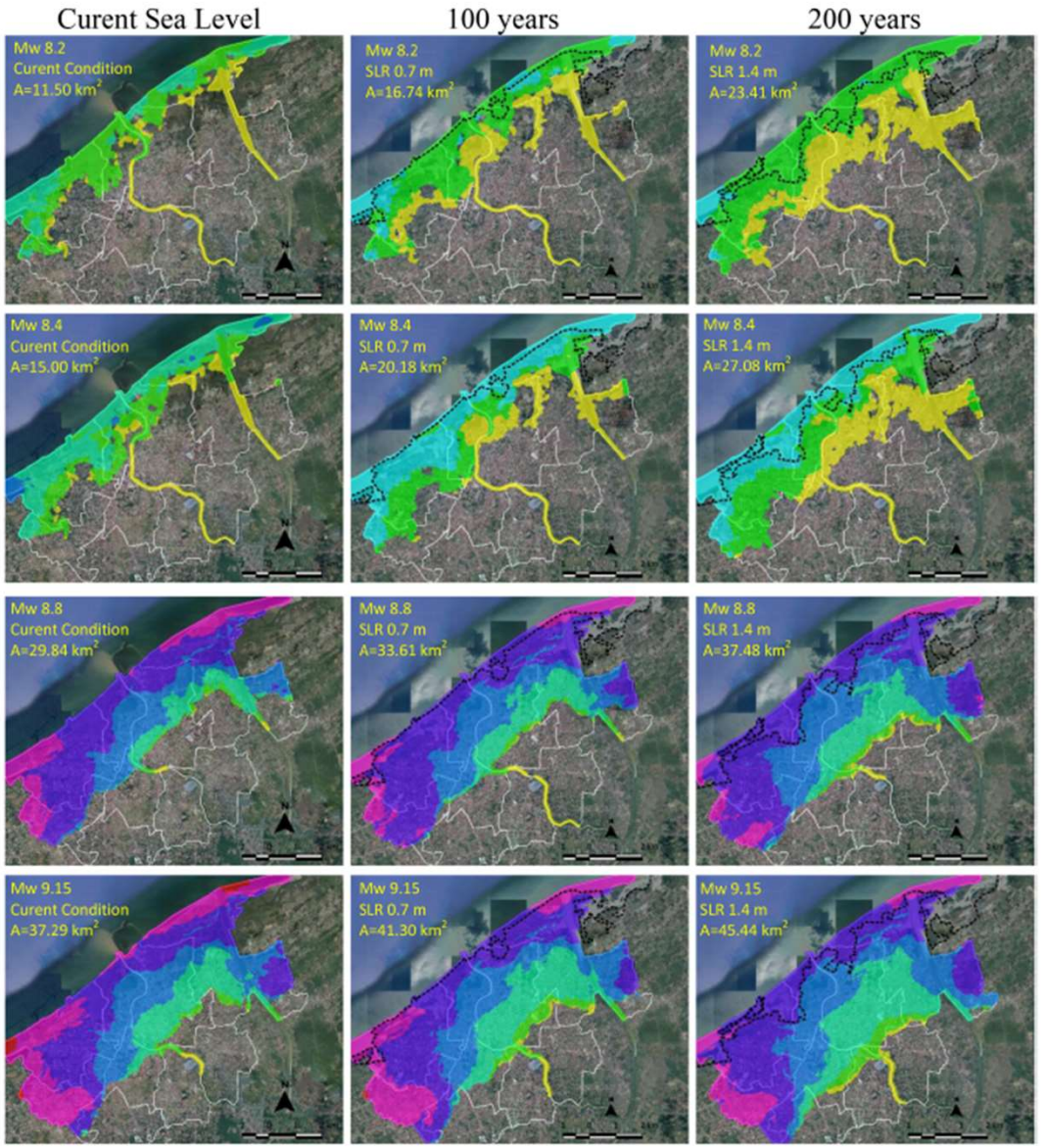
journal homepage: http://www.elsevier.com/locate/ijdrr

Coupling sea-level rise with tsunamis: Projected adverse impact of future tsunamis on Banda Aceh city, Indonesia

Tursina [a,b], Syamsidik [a,b,c,*], Shigeru Kato [a,d], Mochammad Afifuddin [a,e]







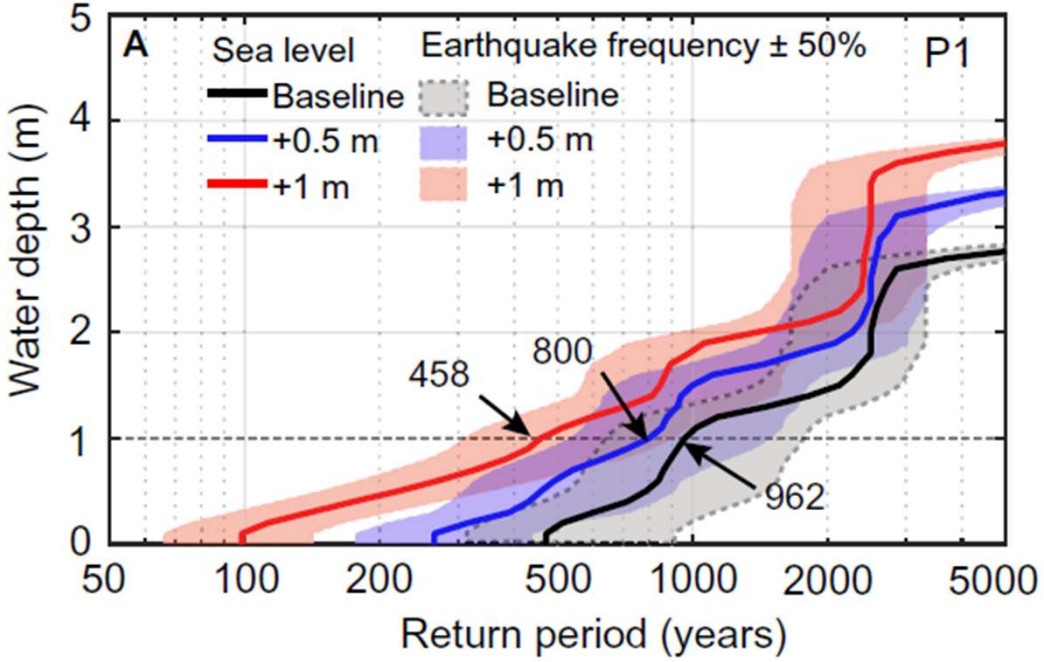
Previous studies: Macau

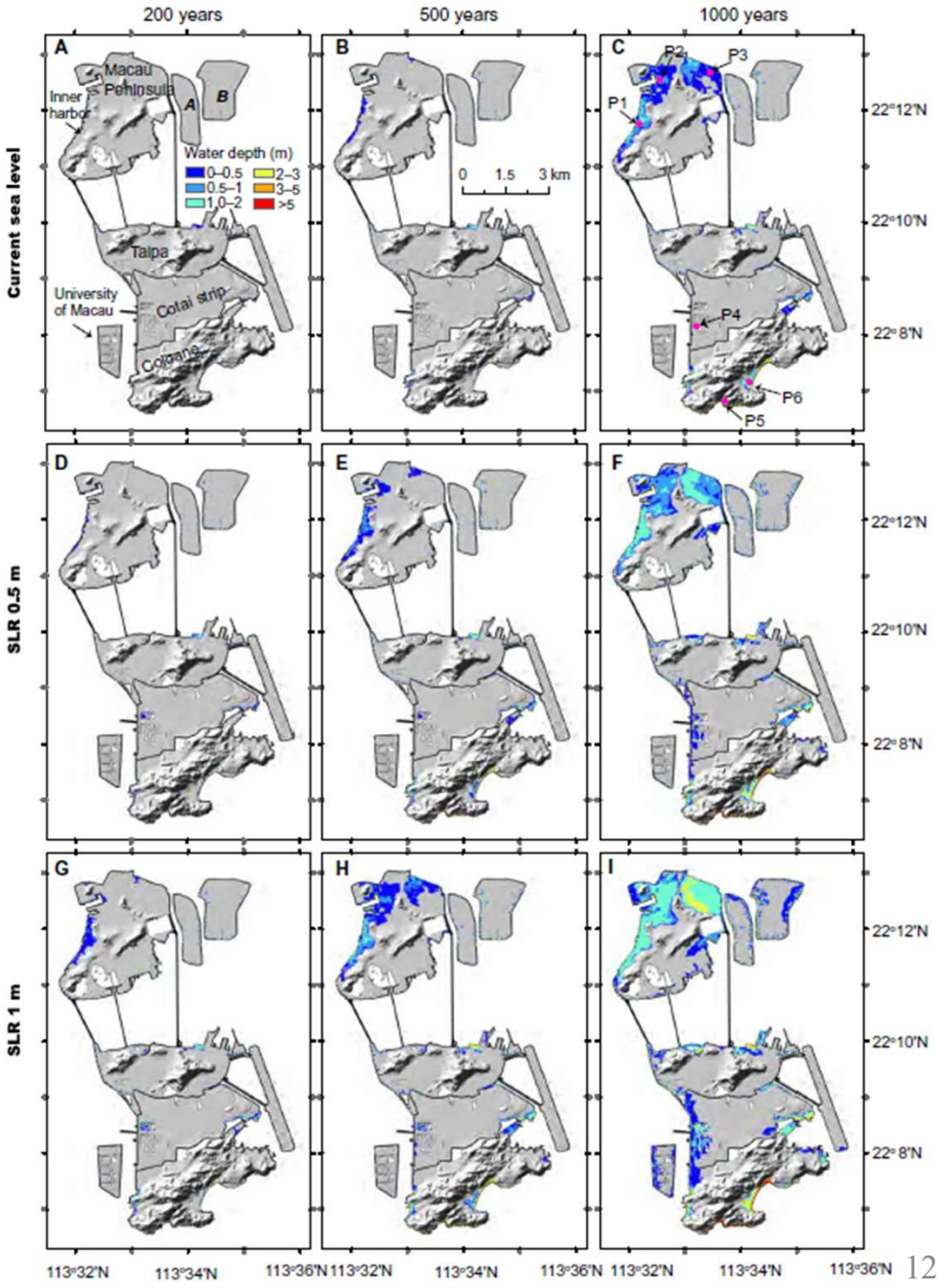
SCIENCE ADVANCES | RESEARCH ARTICLE

ENVIRONMENTAL STUDIES

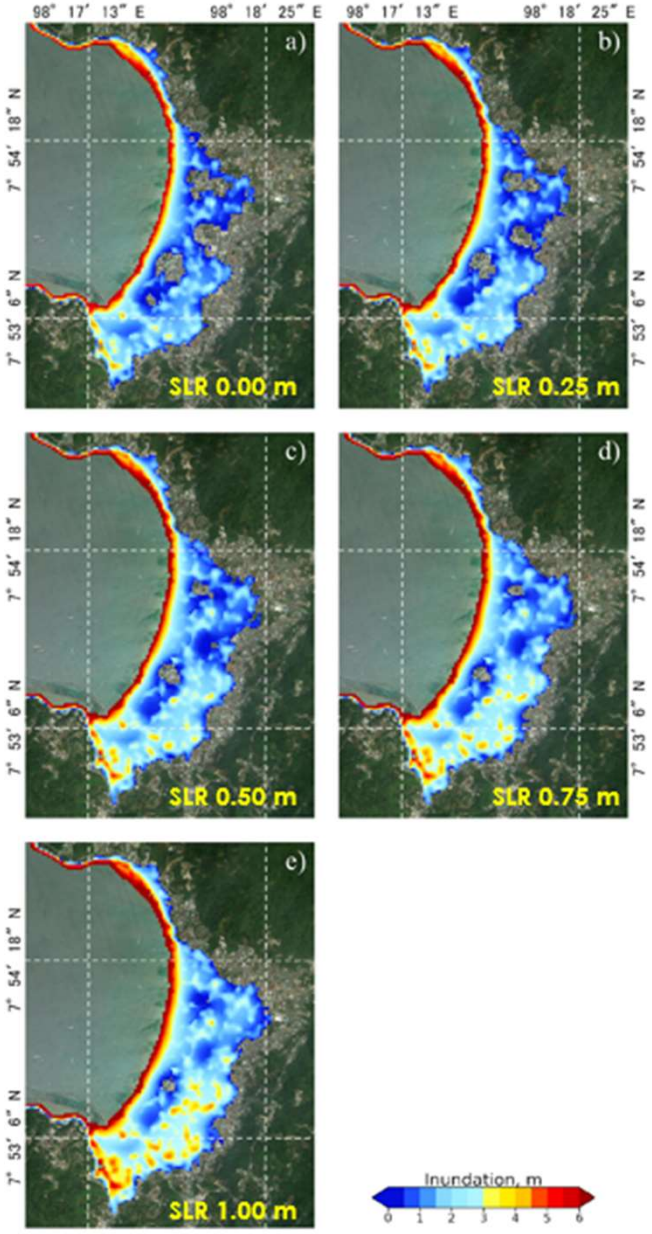
A modest 0.5-m rise in sea level will double the tsunami hazard in Macau

Linlin Li[1]*, Adam D. Switzer[1,2]*, Yu Wang[1,3], Chung-Han Chan[1], Qiang Qiu[2], Robert Weiss[4]

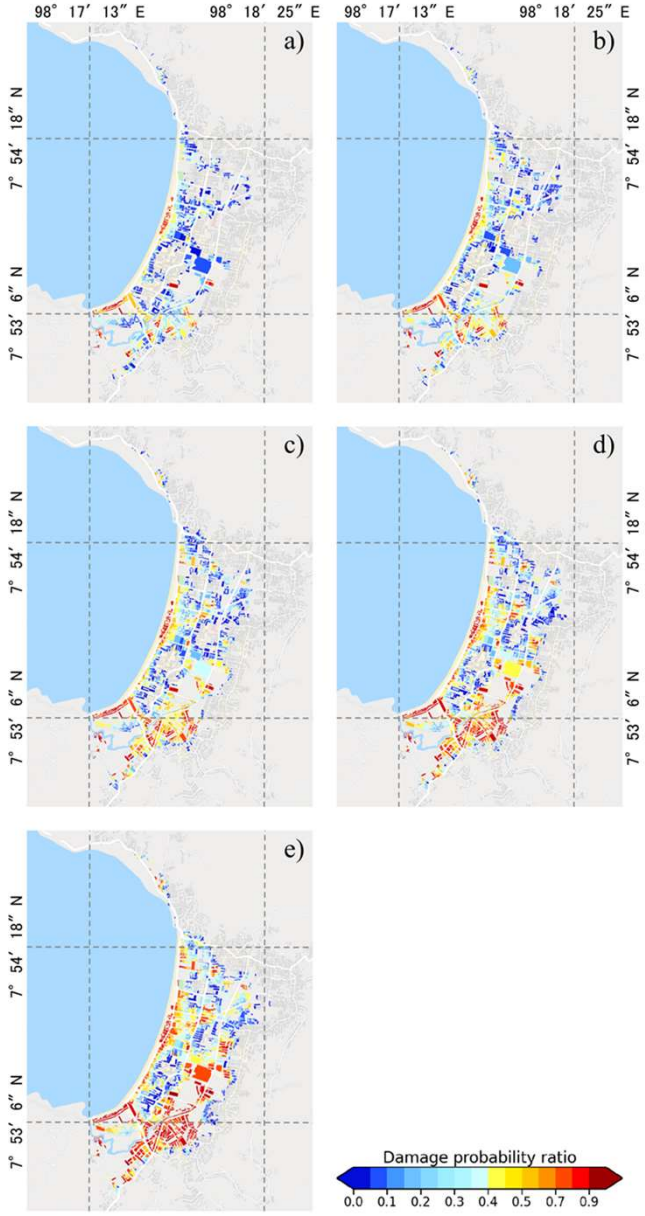




Previous studies: Patong Beach



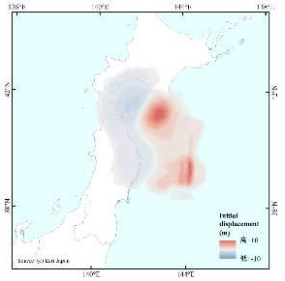
Max. inundation depth

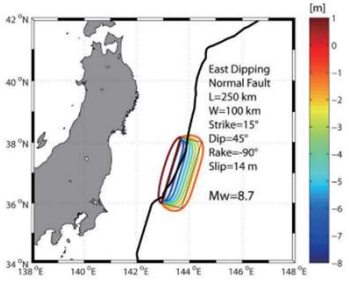


Damage probability

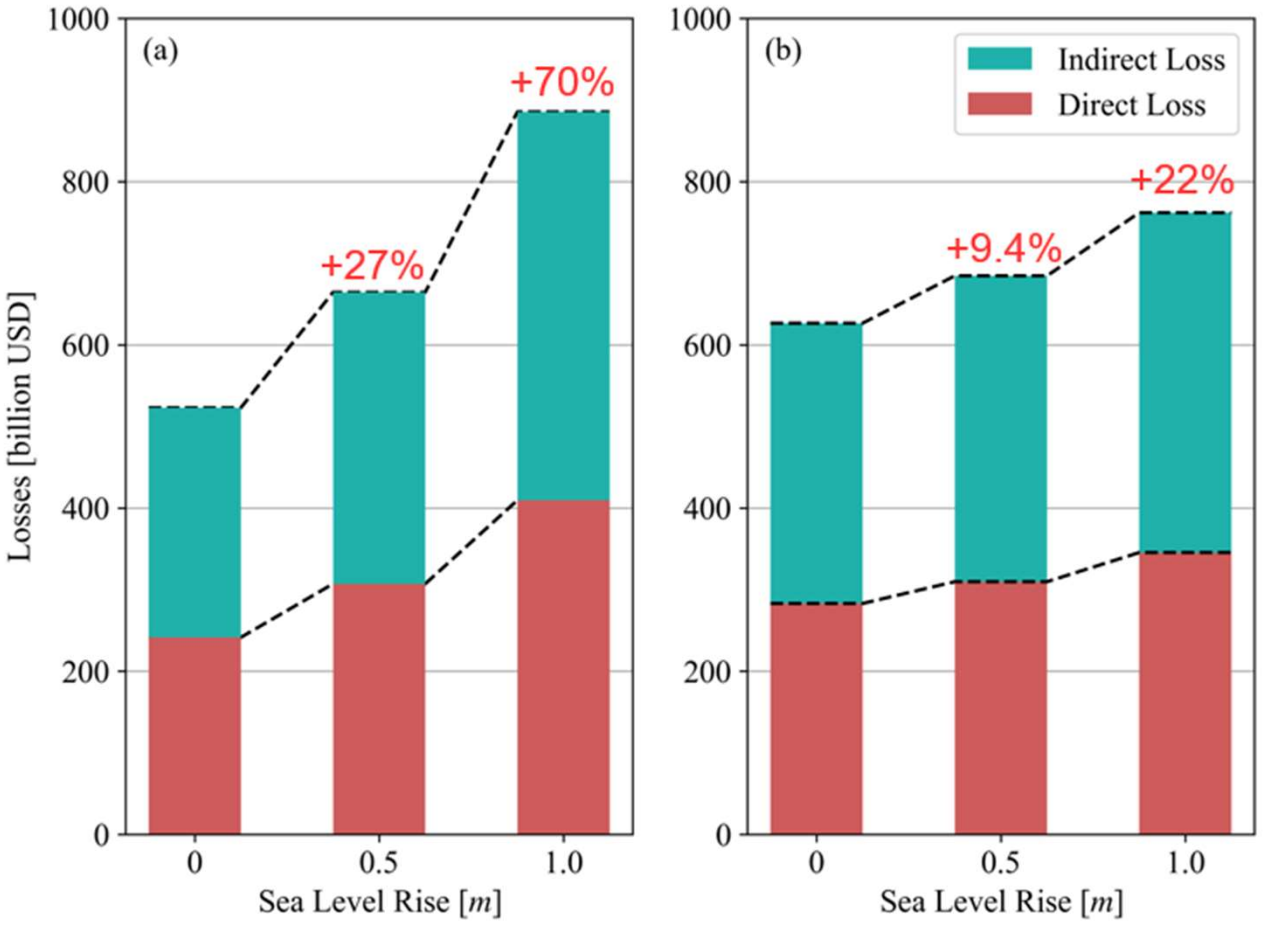
Quantitatively assessed changing of the maximum inundation depth and damage probability as increasing of sea level rise

Japan case study: SLR impact on total loss





Japan trench model | Outer rise model



- Indirect Loss / Total Loss :
  63~66%
- In the case of 0m sea level rise,
  Japan trench model : 440 bil. USD
  Outer rise model : 520 bil. USD
- In the case of 1m sea level rise,
  Japan trench model : 70% up
  Outer rise model : 22% up

▼

The Japan trench model is more susceptible to SLR.

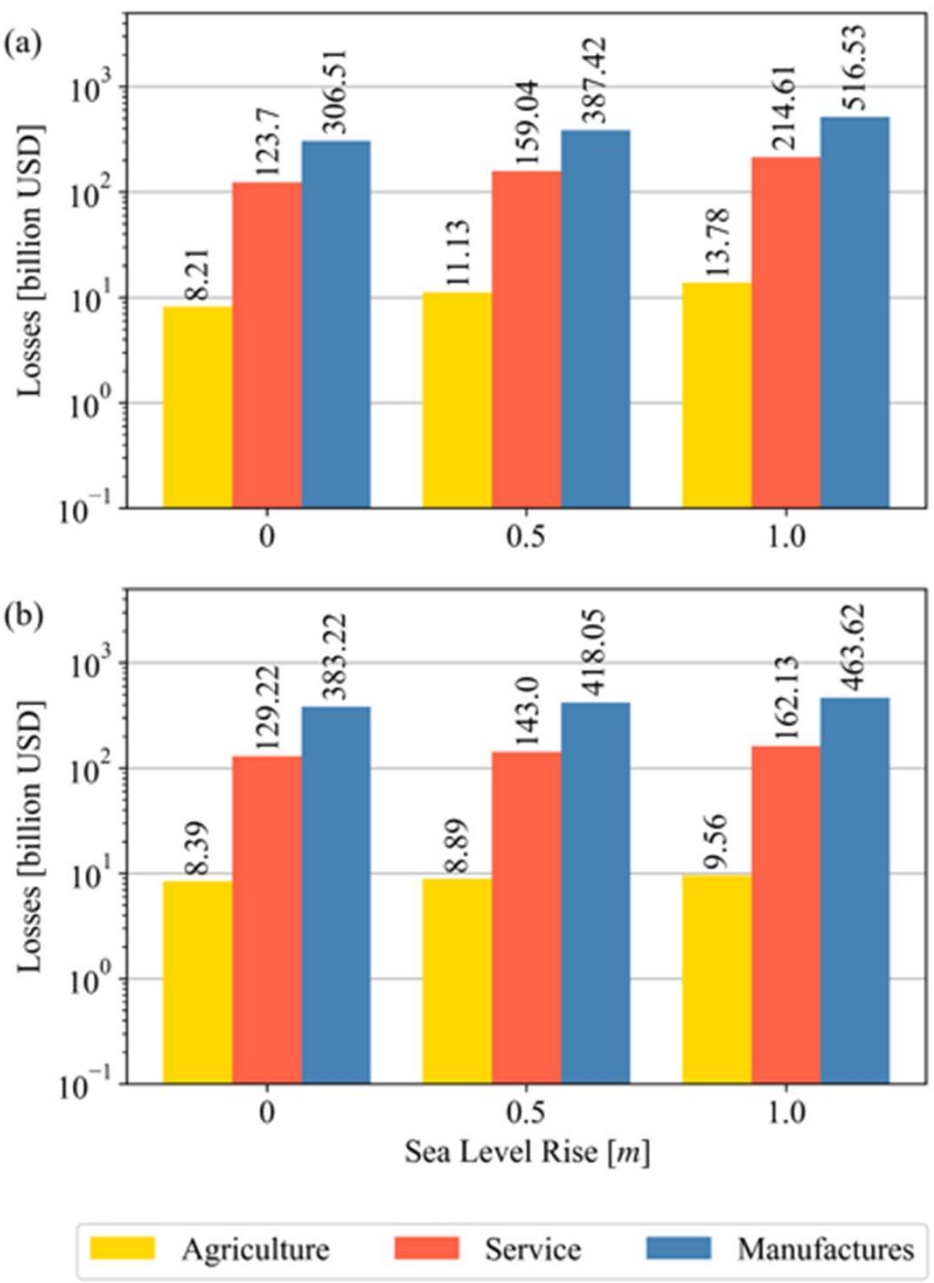
↑

M_w 9.0 (Japan trench model)
M_w 8.7 (Outer rise model)

Japan case study: SLR impact (by sector)

Japan trench model

Outer rise model



Economic Losses:

Agriculture < Service < Manufactures

▼

- ✓ Manufactures are concentrated in the coastal areas.
- ✓ Agriculture has a low unit cost.

In the case of 1m sea level rise,

Japan trench model : 67~74% up

Outer rise model : 13~26% up

▼

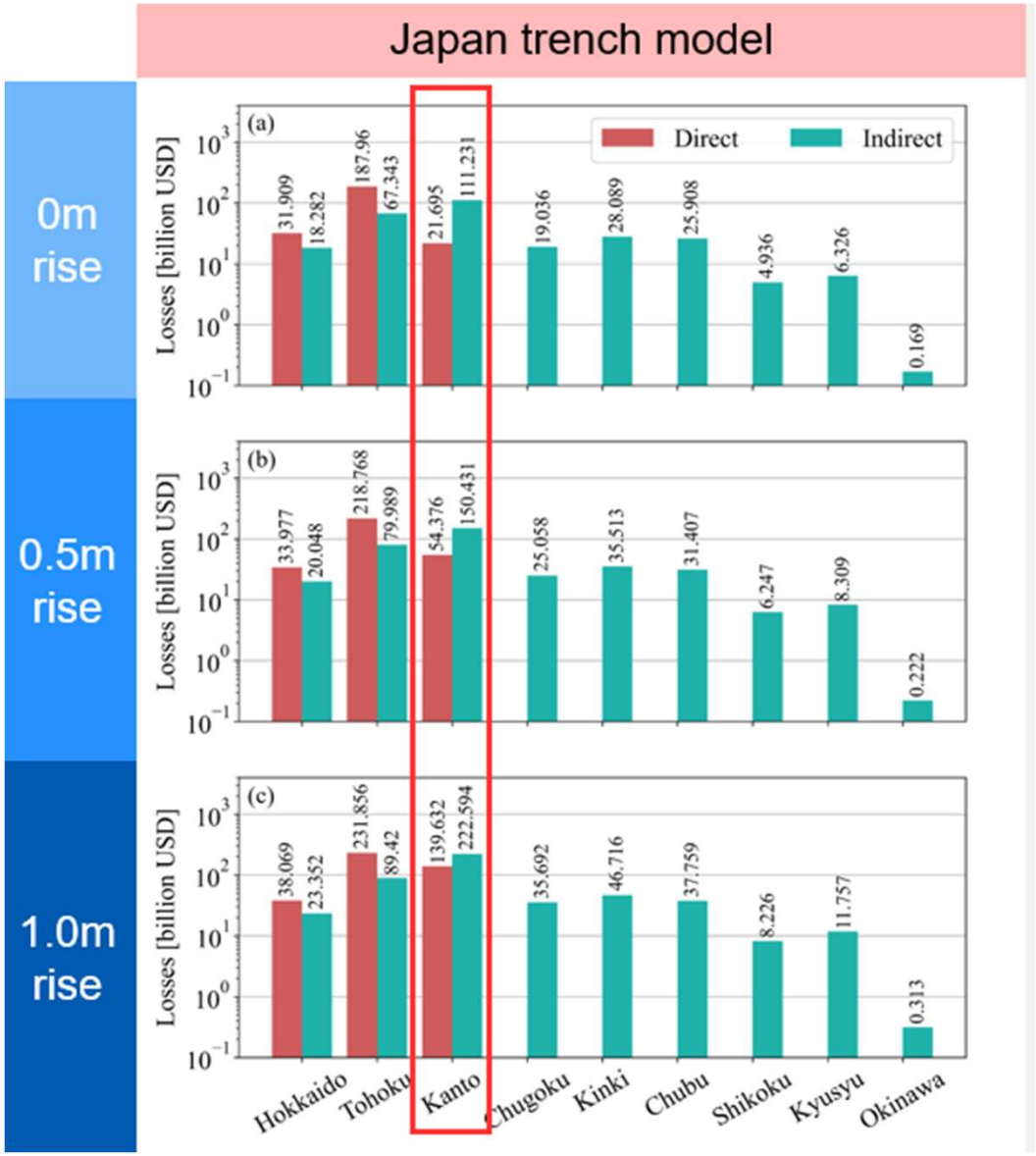
The Japan trench model is more susceptible to SLR.

↑

M_w 9.0 (Japan trench model)

M_w 8.7 (Outer rise model)

Japan case study: SLR impact (by region)

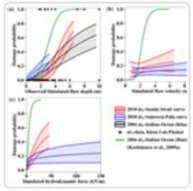


- In particular, the Japan Trench model shows a 173% increase in the Kanto region due to a 1 m rise in sea level.
- The Kanto region is home to the capital, Tokyo, and is the economic center of Japan.
- Therefore, the increase in direct damage in the Kanto region is thought to have resulted in significant indirect damage.

Protecting economically important cities will reduce indirect damage to other areas and lead to a reduction in damage to the country as a whole.

Scientific collaboration
Building damage characteristics

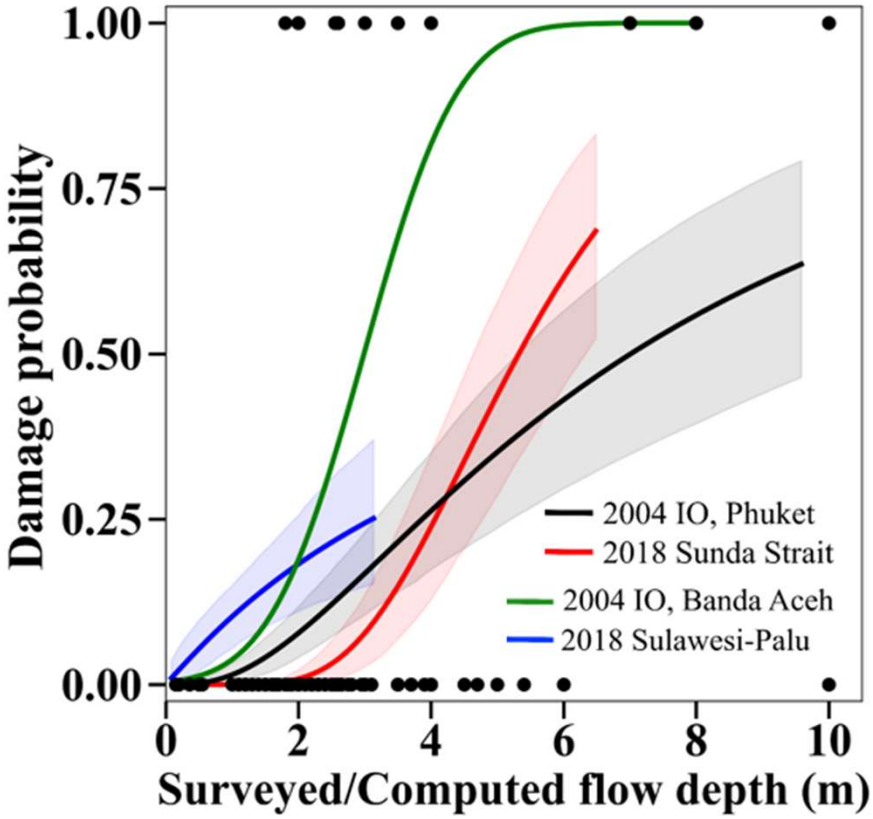
Characteristics of building fragility curves for seismic and non-seismic tsunamis: case studies of the 2018 Sunda Strait, 2018 Sulawesi–Palu, and 2004 Indian Ocean tsunamis



Elisa Lahcene[1], Ioanna Ioannou[2], Anawat Suppasri[3], Kwanchai Pakoksung[3], Ryan Paulik[4], Syamsidik Syamsidik[5], Frederic Bouchette[1], and Fumihiko Imamura[3]

[1]Geosciences Montpellier, Montpellier University II, Montpellier, France
[2]Department of Civil, Environmental & Geomatic Engineering, University College London, United Kingdom
[3]International Research Institute of Disaster Science, Tohoku University, Sendai, Japan
[4]National Institute of Water and Atmospheric Research (NIWA), Wellington, New Zealand
[5]Tsunami and Disaster Mitigation Research Center (TDMRC), Universitas Syiah Kuala, Banda Aceh, Indonesia

https://nhess.copernicus.org/articles/21/2313/2021/nhess-21-2313-2021.html



Indonesia faced recent tsunamis

Tsunami event	1. Indian Ocean (the 26th Dec. 2004)	2. Sunda Strait (the 22nd Dec. 2018)	3. Sulawesi-Palu (the 26th Sept. 2018)
Tsunami source (considered in this study)	Indian Ocean Earthquake	Flank failure of the Anak Krakatau	Subaerial/Submarine landslides

Scientific collaboration
Multi-layered countermeasure

With Syiah Kuala University (Indonesia)

Systematic Evaluation of Different Infrastructure Systems for Tsunami Defense in Sendai City

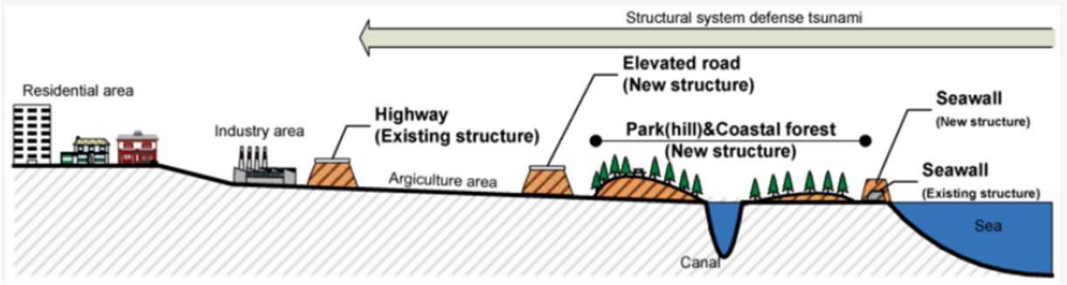
by Kwanchai Pakoksung *, Anawat Suppasri and Fumihiko Imamura

International Research Institute of Disaster Science, Tohoku University, 468-1 Aramaki-Aza, Aoba-ku, Sendai 980-0845, Japan

* Author to whom correspondence should be addressed.

Geosciences **2018**, *8*(5), 173; https://doi.org/10.3390/geosciences8050173

https://www.mdpi.com/2076-3263/8/5/173/htm



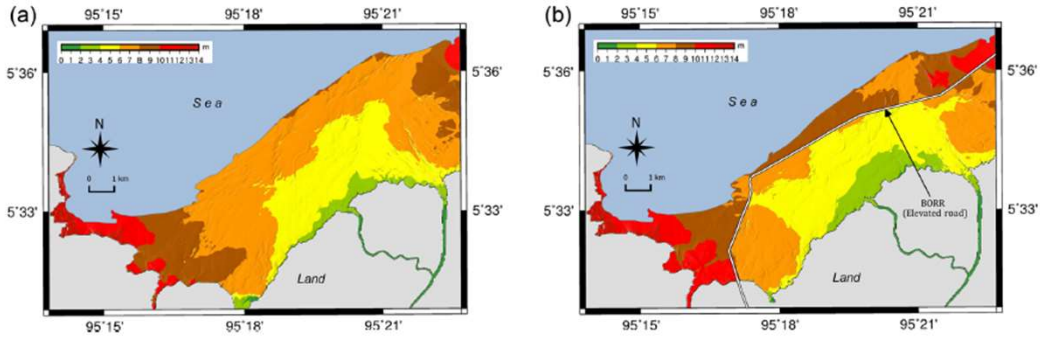


Figure 10. Maximum tsunami wave depths based on the 9.15 M_W earthquake without BORR (**a**) and with BORR (**b**). The simulations are shown for the land use type before the 2004 Indian Ocean tsunami.

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Nat. Hazards Earth Syst. Sci., 19, 299–312, 2019
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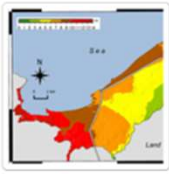
Research article

31 Jan 2019

Assessing the tsunami mitigation effectiveness of the planned Banda Aceh Outer Ring Road (BORR), Indonesia



Syamsidik[1,4], Tursina[1,3], Anawat Suppasri[2], Musa Al'ala[1,3], Mumtaz Luthfi[1], and Louise K. Comfort[5]

[1]Tsunami and Disaster Mitigation Research Center (TDMRC), Syiah Kuala University, Gampong Pie, Banda Aceh 23233, Indonesia
[2]International Research Institute of Disaster Science (IRIDeS), Tohoku University, Aramaki Aza-Aoba 468-1, Aoba-ku, Sendai 980-0845, Japan
[3]Civil Engineering Department, Syiah Kuala University, Jl. Syeh Abdurrauf No. 7, Banda Aceh 23111, Indonesia
[4]Civil Engineering Department, Faculty of Engineering, Syiah Kuala University, Jl. Syeh Abdurrauf No. 7, Banda Aceh 23111, Indonesia
[5]Graduate School of Public International Affairs, University of Pittsburgh, Pittsburgh, USA

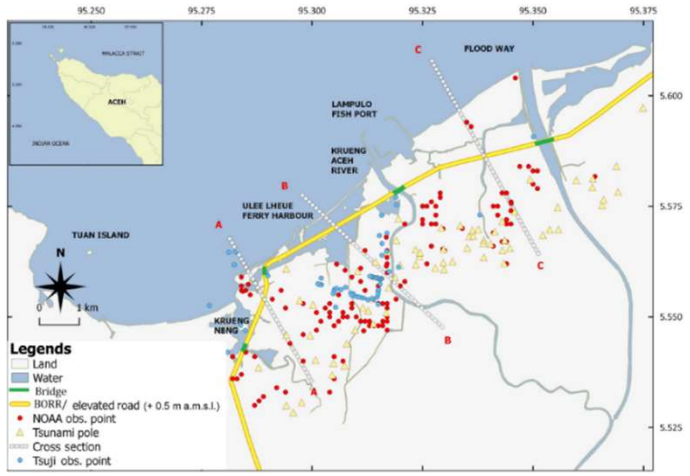
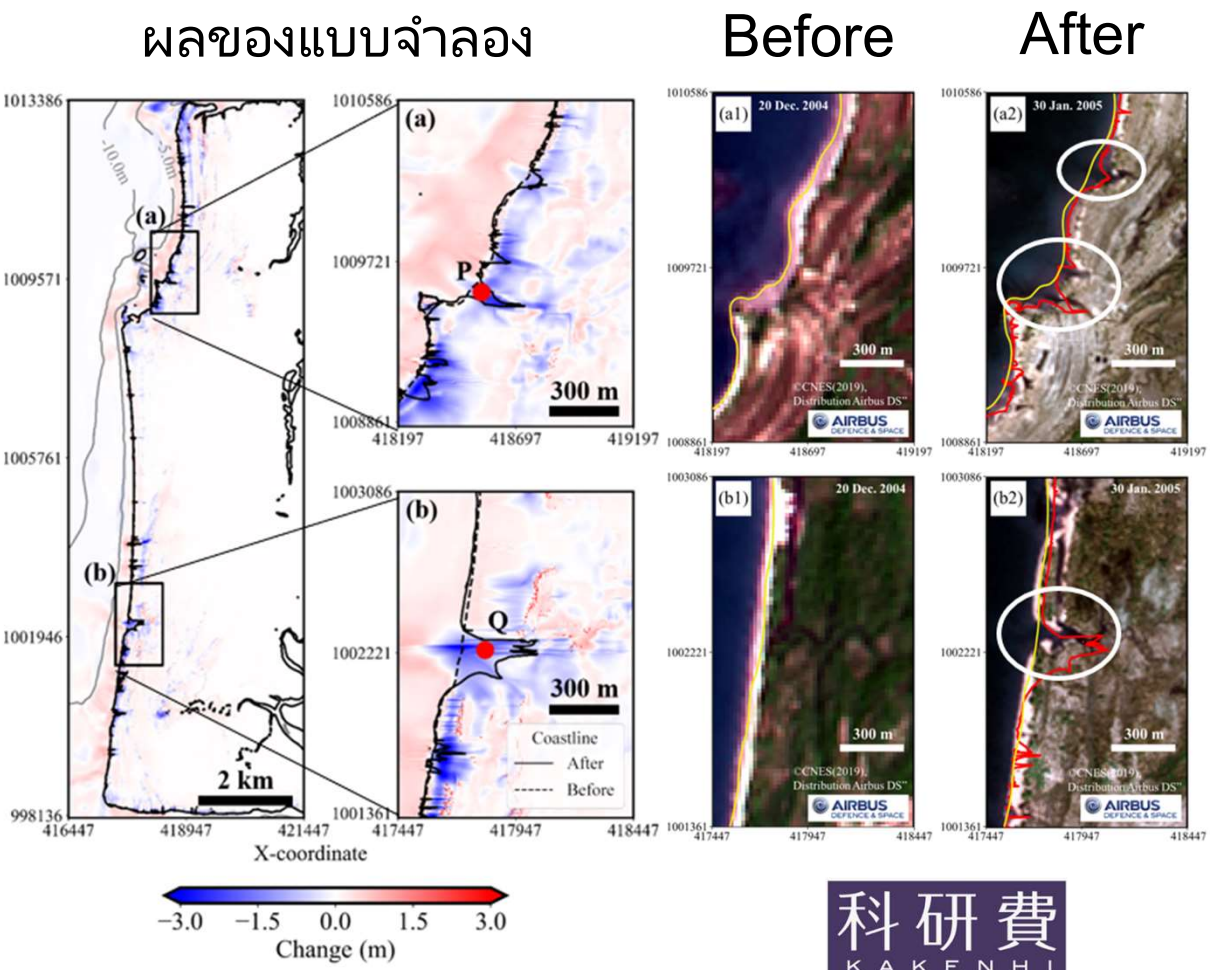
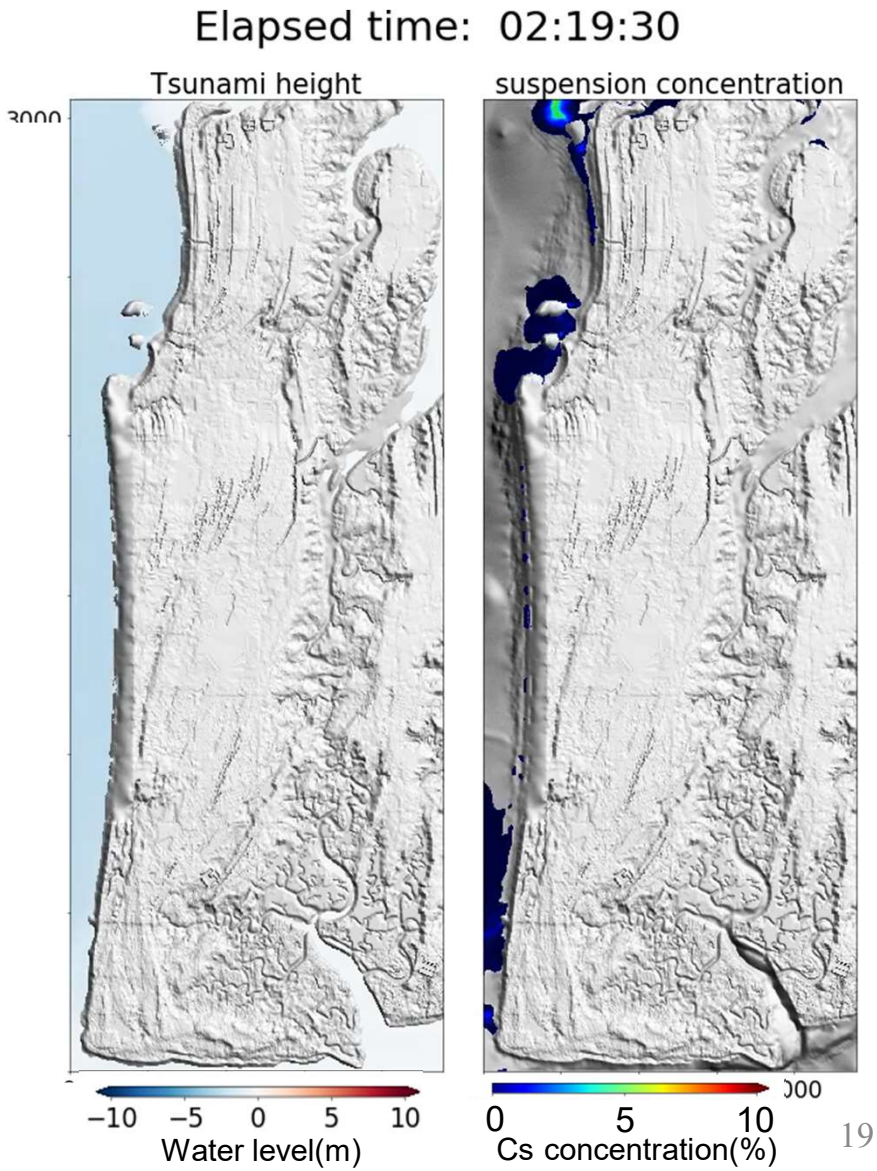


Figure 1. The study area. The elevated road (yellow line) is part of the city's development planning documents. There are 139 points of the 2004 tsunami heights measured by NOAA (red dots) (NOAA, 2018) and 56 locations of tsunami poles representing water marks based on eyewitness accounts (yellow triangles).

Scientific collaboration
Tsunami sediment transport modeling

With Chulalongkorn University (Thailand)
Masaya et al (2020) Natural Hazards and Earth System Sciences
Masaya et al (2020) Coastal Engineering (JSCE)
Masaya et al (2021) Coastal Engineering (JSCE)





科研費 KAKENHI

Scientific collaboration
Disaster mitigation class in Hawaii

Collaboration with Thai media and local organization

Thai PBS every Saturday11:00-11:30

Joint field survey of Japanese researcher, TMD, Thai PBS

Tsunami museum Khao Lak

International workshop

New exphibition

Integrated collaboration through SATREPS

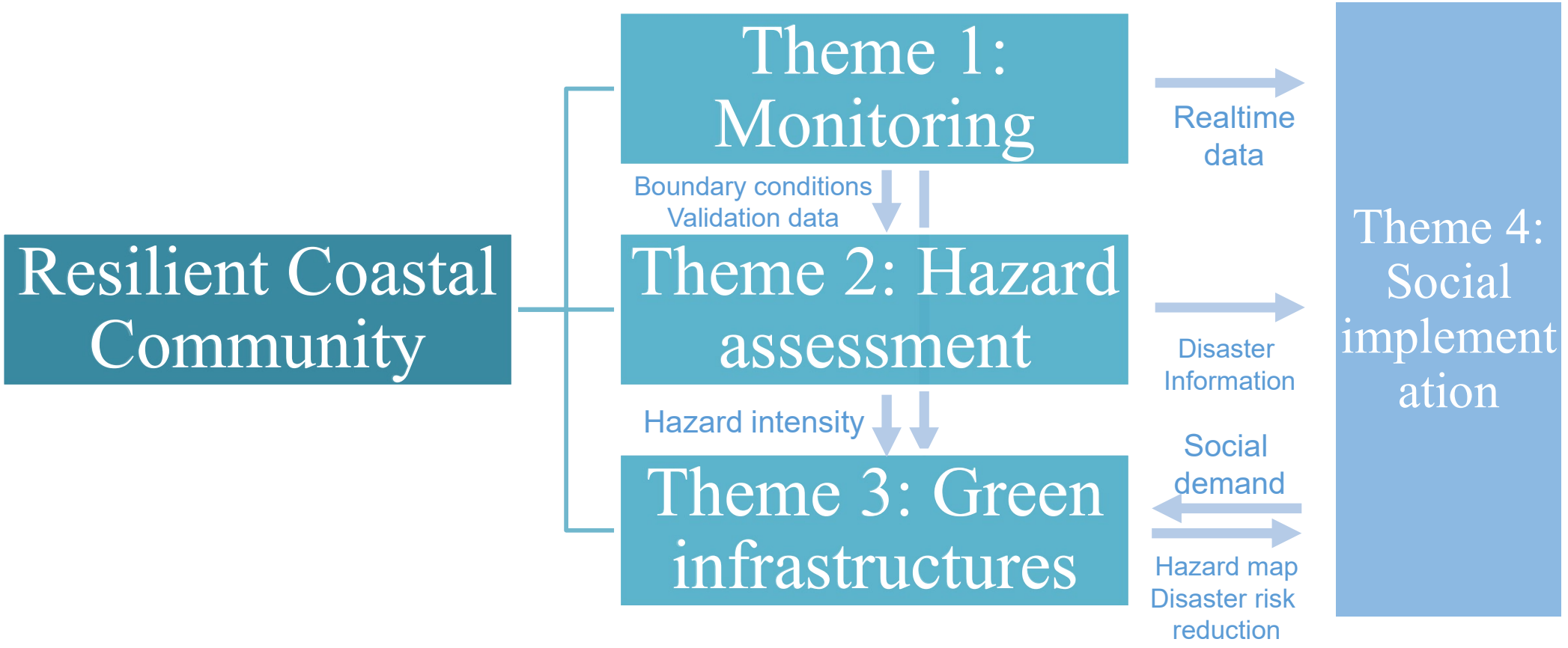
Building Sustainable System for Resilience and Innovation in Coastal Community "BRICC"

1. Development of coastal monitoring system
   Nobuhito Mori (Kyoto University)
   Mohammad Farid (ITB)
2. Coastal multi-hazard risk assessment
   Anawat Suppasri (Tohoku University)
   Abdul Muhari (BNPB)
3. Development of Eco-DRR/Nature-based solution
   Kojiro Suzuki (PARI)
   Djati Mardiatno (UGM)
4. Development of Inclusive and Evidence-based Decision Support Platform
   Taro Arikawa (Chuo University)
   Dicky Pelupessy (UI)

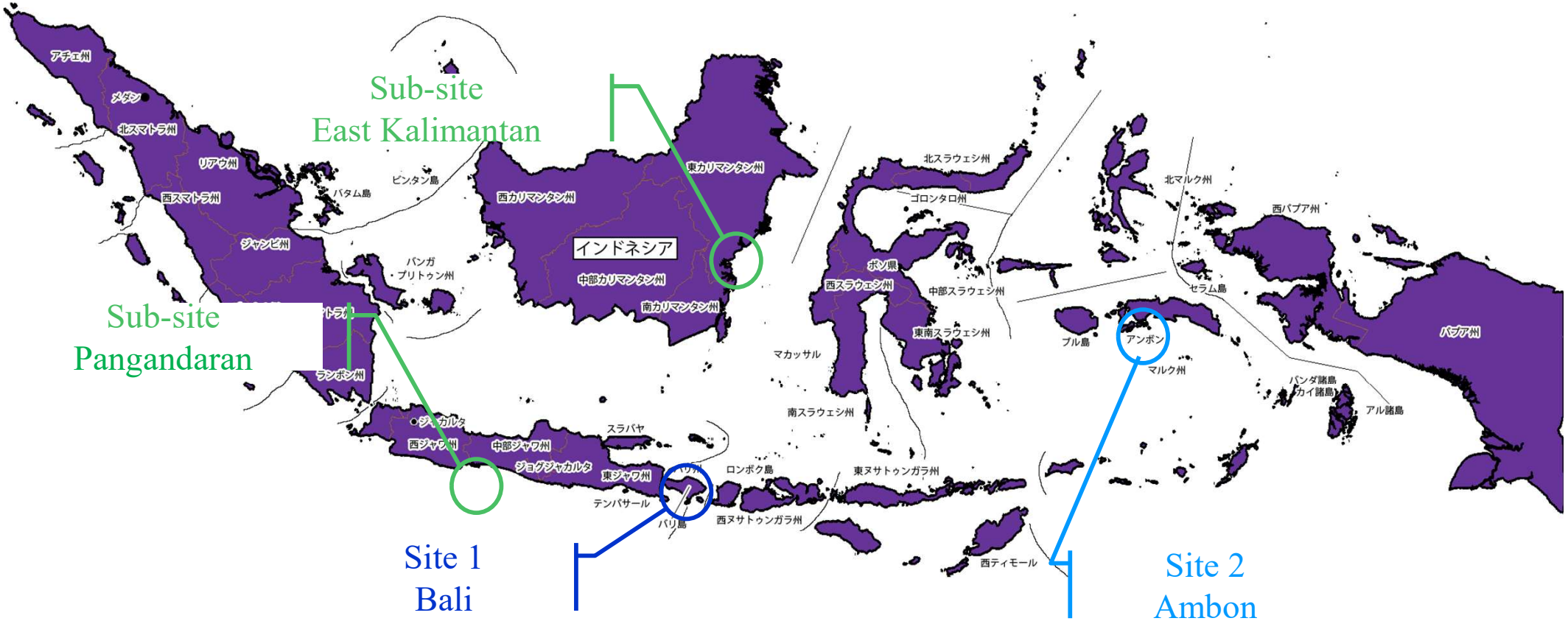
Integrated collaboration through SATREPS

- Project objective
  - Multi-hazard assessment of coastal areas by applying the latest monitoring and modeling techniques
  - Establish a coastal defense function methodology using Eco-DRR/Green Infrastructure
  - Establish an intgrated platform for natural adaptive coastal defense technologies
  - 5-10 years later: Creative social implementation of coastal areas in harmony with disaster risk reduction, environment and economy
- SDGs
  - Goal 11: SUSTAINABLE CITIES AND COMMUNITI
  - Goal 9: INDUSTRY, INNOVATION AND INFRASTR R
  - Goal 13: CLIMATE ACTION
  - SENDAI Framework: Global Target ABCEFG

Integrated collaboration through SATREPS



Integrated collaboration through SATREPS

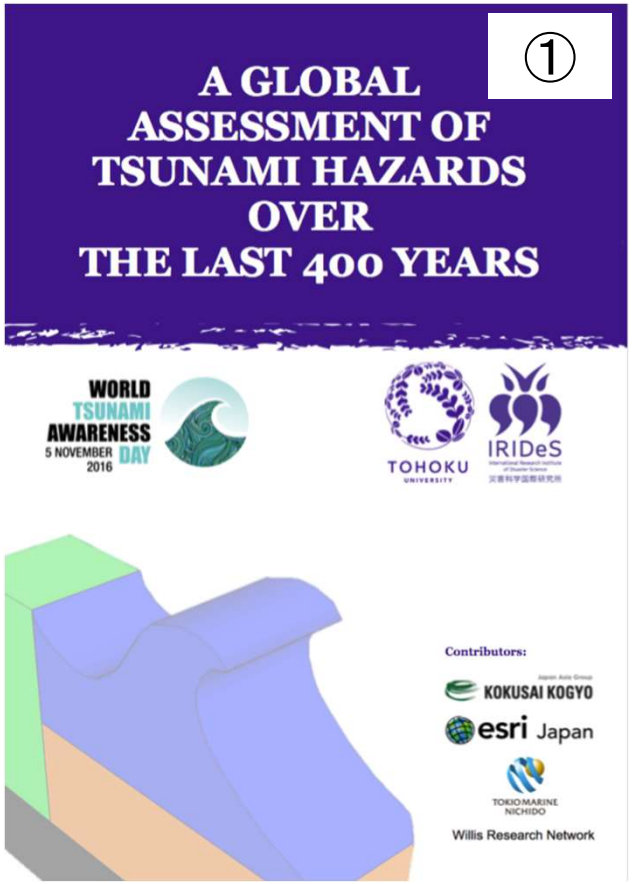


- Sever coastal erosion
- Important for tourism
- Potential multi-coastal hazards

- Developing area (6.9%/yr population increase)
- 15 rivers with mangroves
- Potential large earthquake and tsunami

Collaboration with UN organizations

①UNDRR：World Tsunami Awareness Day, World Tsunami Museum Conference
②UNDP：School project, Global Center for Disaster Statistics
③UNESCO - IOC：Evaluation of tsunami in South China Sea
④UNITAR：Capacity building of community leaders



Intergovernmental Oceanographic Commission
Workshop Report No. 275

③

Scientific meeting of experts for coordinated scenario analysis of future tsunami events and hazard mitigation schemes for the South China sea region

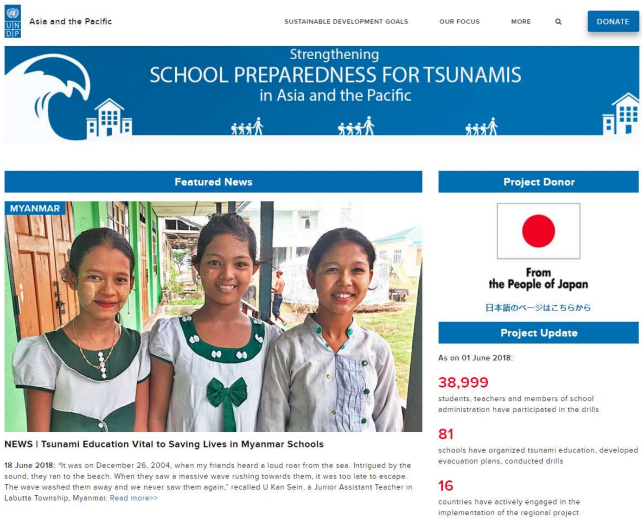
Xiamen, China
16–18 November 2015

UNESCO

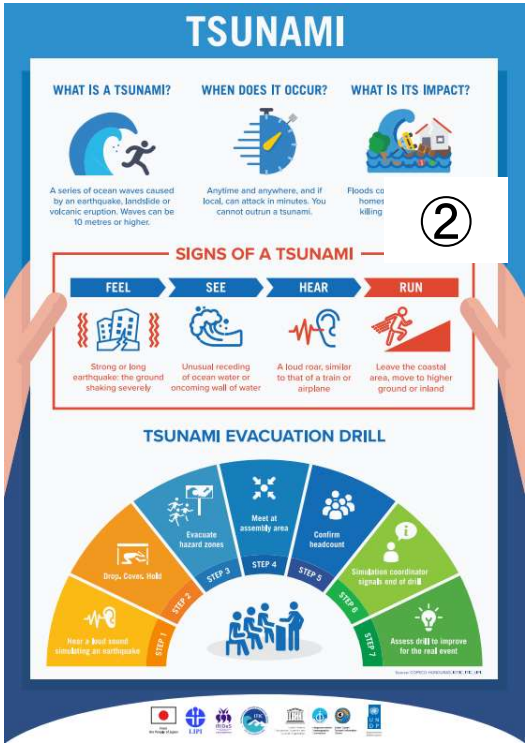
Tsunami evacuation in schools

Collaboration with UNDP

Tsunami evacuation drill in schools



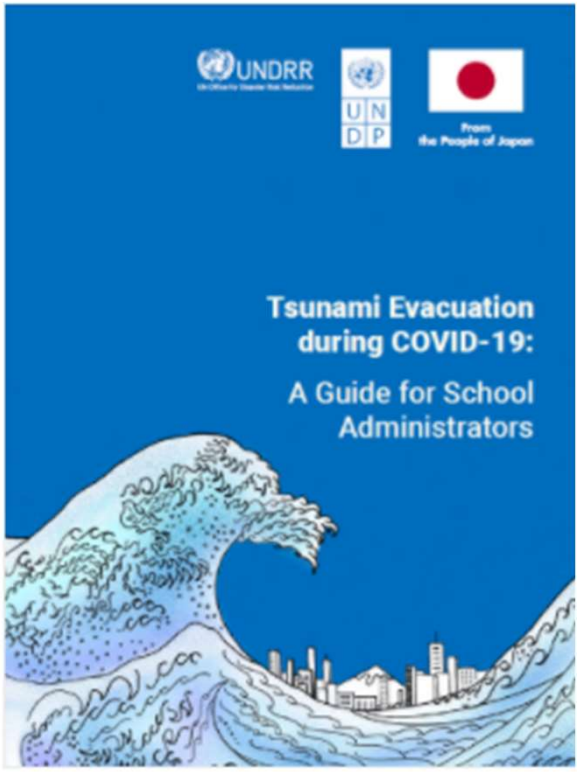
Evacuation drill planning in schools



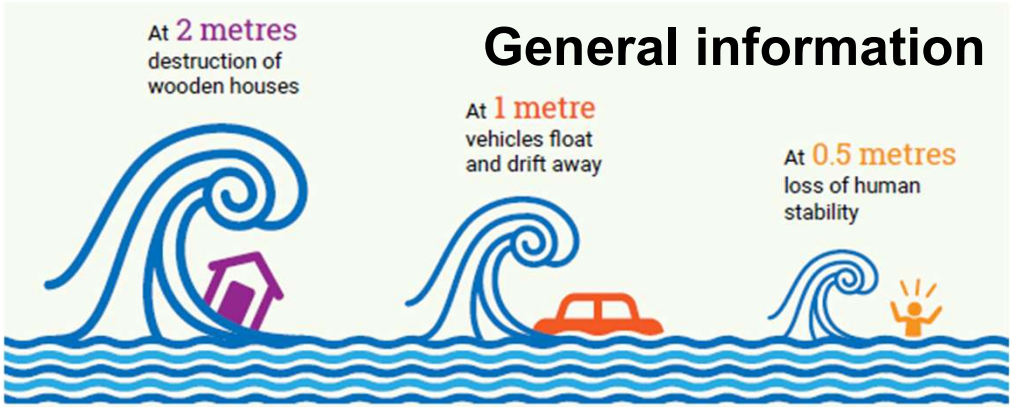
Tsunami information poster

Tsunami evacuation during COVID-19 pandemic

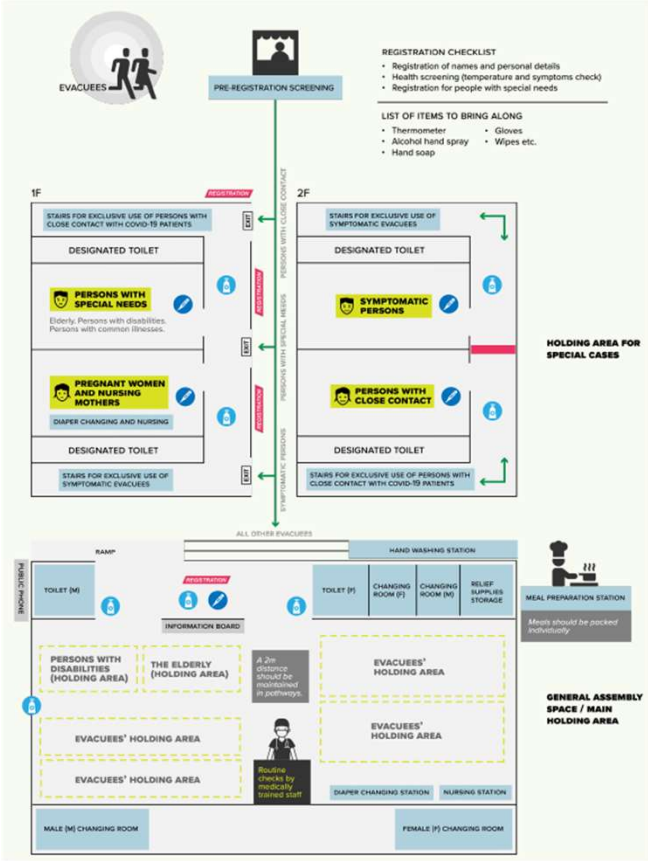
Collaboration with UNDRR・UNDP



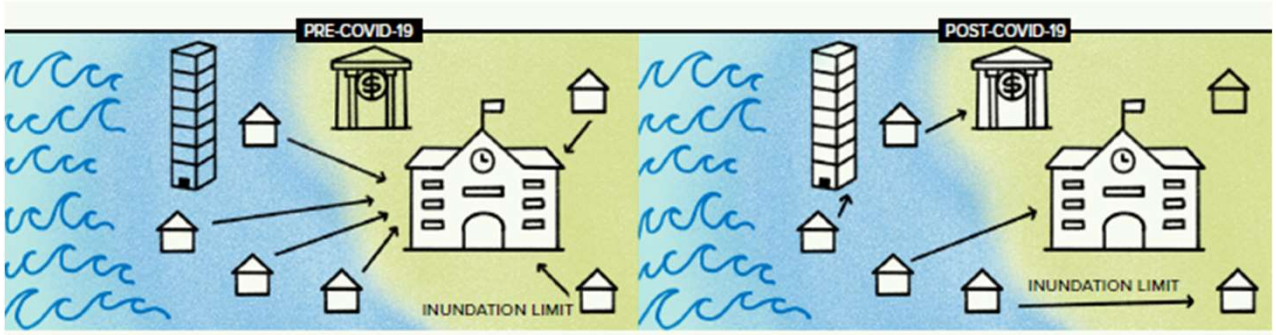
General information



Layout of evacuation shelter



Post-COVID evacuation



https://www.undrr.org/publication/tsunami-evacuation-during-covid-19-guide-school-administrators

Thank you for your kind attention

Heritage, or Just Garbage?

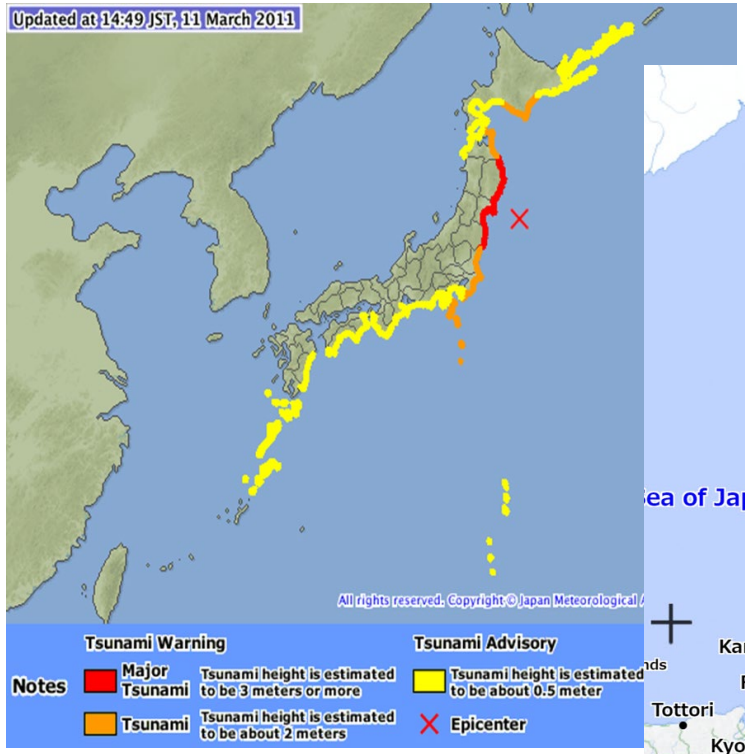
How Private Documents Can Help Disaster Survivors and Communities: Stories from Northeastern Japan, 2011

J.F. MORRIS and KAMIYAMA Machiko
Visiting Professors,
International Research Institute of Disaster Science,
Tohoku University, Sendai, Japan

Photo compliments of SATŌ Shū'ichi

Disaster Hits: 11th March, 2011, Miyagi Prefecture

Map 1

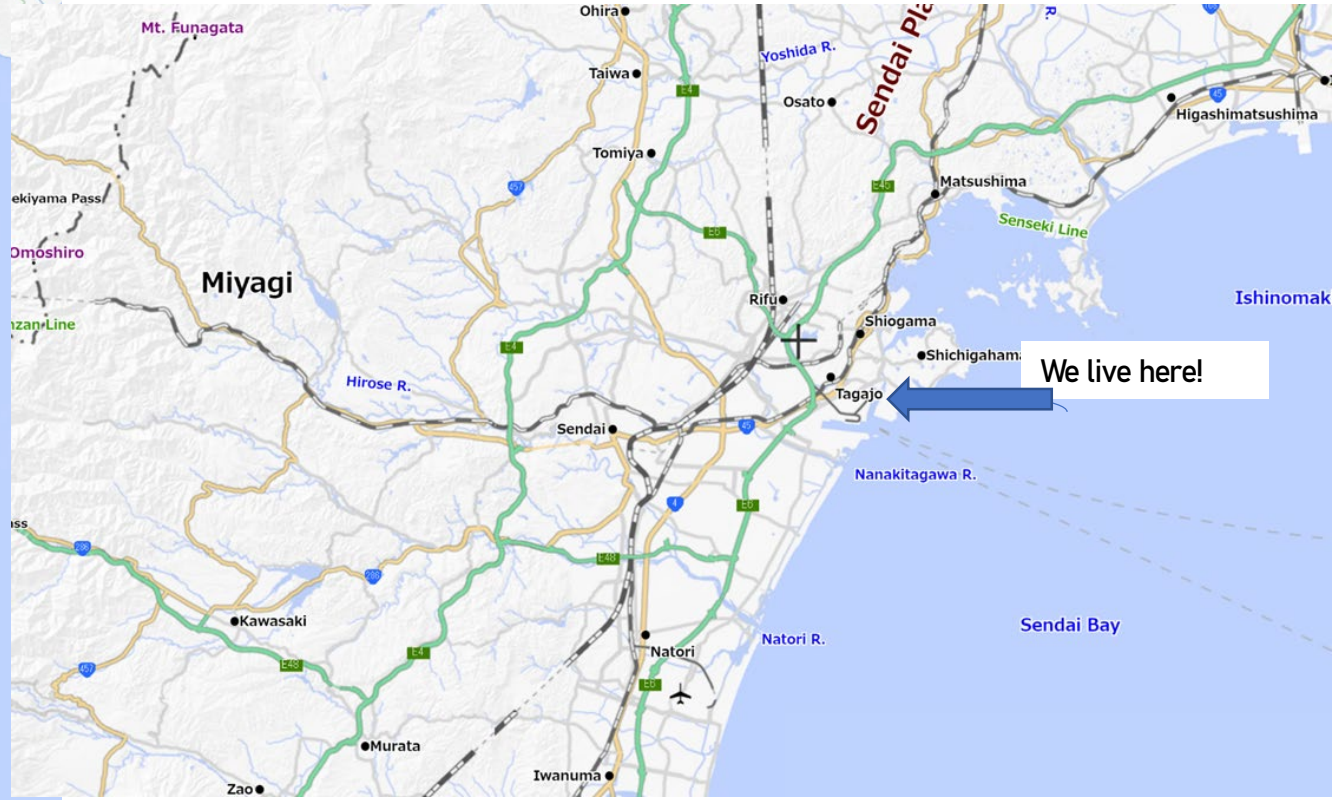


http://www.jma.go.jp/en/tsunami/focus_04_20110311145000.html Japan Metrological Agency

Map 2

Triple disaster of earthquake, tsunami & nuclear reactor explosion hit the northeast coast of Honshu

Map 3



Geospatial Information Authority of Japan
https://maps.gsi.go.jp/multil/index.html#11/38.310413/140.984802/&base=pale2&ls=pale2%7Chillshademap%2C0.1%7Cchuki_eng&blend=0&disp=111&lcd=chuki_eng&vs=c1

Our city before and after the tsunami

Aerial photos of Tagajo City 河北新報社『みやぎの海辺　思い出の風景　航空写真集
2011・3・11を境に』　(2012年, pp. 62-63

How things looked from the ground

http://infra-archive311.jp/data/pic/305436.jpg Tohoku Regional Bureau, Ministry of Land, Infrastructure, Transport and Tourism Earthquake Memorial Museum http://infra-archive311.jp/en/

Quick recovery requires a quick clean-up…

- The first step in regaining normalcy required that all debris be speedily disposed of.
- But what is the dividing line between ‘debris,’ ‘garbage’ and ‘heritage’

???? Why does ‘heritage’ come up here ?????

An Unlikely Couple: ‘Heritage’ & DDR

Getting down to fundamentals:

- Are culture, heritage, and cultural heritage relevant to DDR?
- Can culture, heritage, and cultural heritage save lives?

The answer to both questions is a strongly affirmative ‘YES’

A Copernican change occurred between Hyōgo 2005 and Sendai 2015: From ‘culture of resilience’ to ‘cultural resilience

Culture,Heritage & DDR: Hyōgo Framework 2005

Hyōgo Framework for Action 2005-2015 (HFA) identified 5 priorities

- Priority No. 3
  Use knowledge, innovation and education to build a culture of safety and resilience at all levels

  Mobilising knowledge, innovation and education to build 'a culture of safety and resilience' is listed as a core priority, but neither culture, heritage, nor cultural heritage are identified as an independent variable which can support resilience and drive innovation.

- 2015 *Synthesis Report* conclusion: *the focus of national and international attention must shift from protecting social and economic development against external shocks, to transforming growth and development to manage risks, in a holistic manner.*

UNDDR *Synthesis report on consultations on the post-2015 framework on disaster risk reduction (HFA2)* https://www.preventionweb.net/sendai-framework/Hyogo-Framework-for-Action

Culture, Heritage & DDR: Sendai Framework 2015

Sendai Framework for Disaster Risk Reduction 2015-2030 indentified 7 Targets and 4 Action Priorities

- **Priority 3: Investing in disaster risk reduction for resilience**
  29. Public and private investment in disaster risk prevention and reduction through structural and non-structural measures are essential to enhance the economic, social, health and cultural resilience of persons, communities, countries and their assets, as well as the environment. These can be drivers of innovation, growth and job creation. Such measures are cost-effective and instrumental to save lives, prevent and reduce losses and ensure effective recovery and rehabilitation

  'Cultural resilience' can drive innovation, growth and employment, & is cost effective!
  'Culture of safety and resilience' 'cultural resilience' (=economic, social & health resilience)

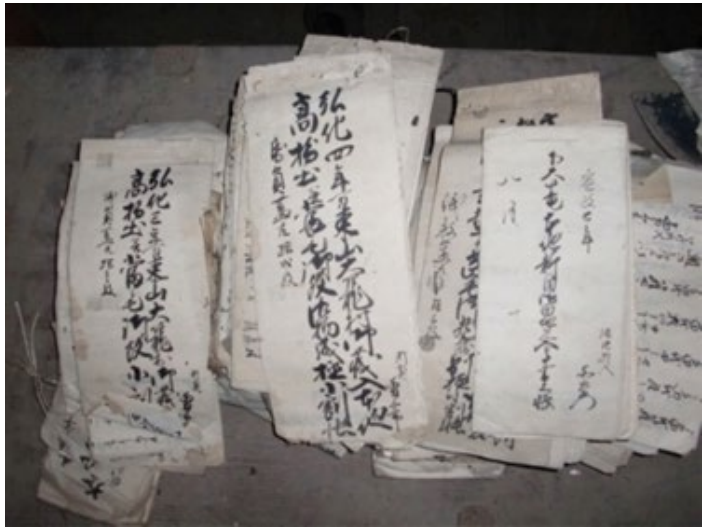
- National and local levels
  30. To achieve this, it is important:
  (d) To protect or support the protection of cultural and collecting institutions and other sites of historical, cultural heritage and religious interest;

  'Culture' is embedded in museums etc, and physical sites i.e. Big Heritage

Who/what/how do you define(s) ‘Heritage?’

- *Sendai Framework for DDR* sees heritage as the Big Heritage enshrined in public museums, libraries and art galleries, and in national sites of memory.
- This kind of heritage is commonly designated as such by local, regional, national or international governments of public institutions, and are often protected by public institutions and/or laws.
- The heritage commonly relates to the memory and identity at regional, national or international levels Big heritage
- But what about the memories of individuals, families or local communities, and the repositories of these memories Little heritage

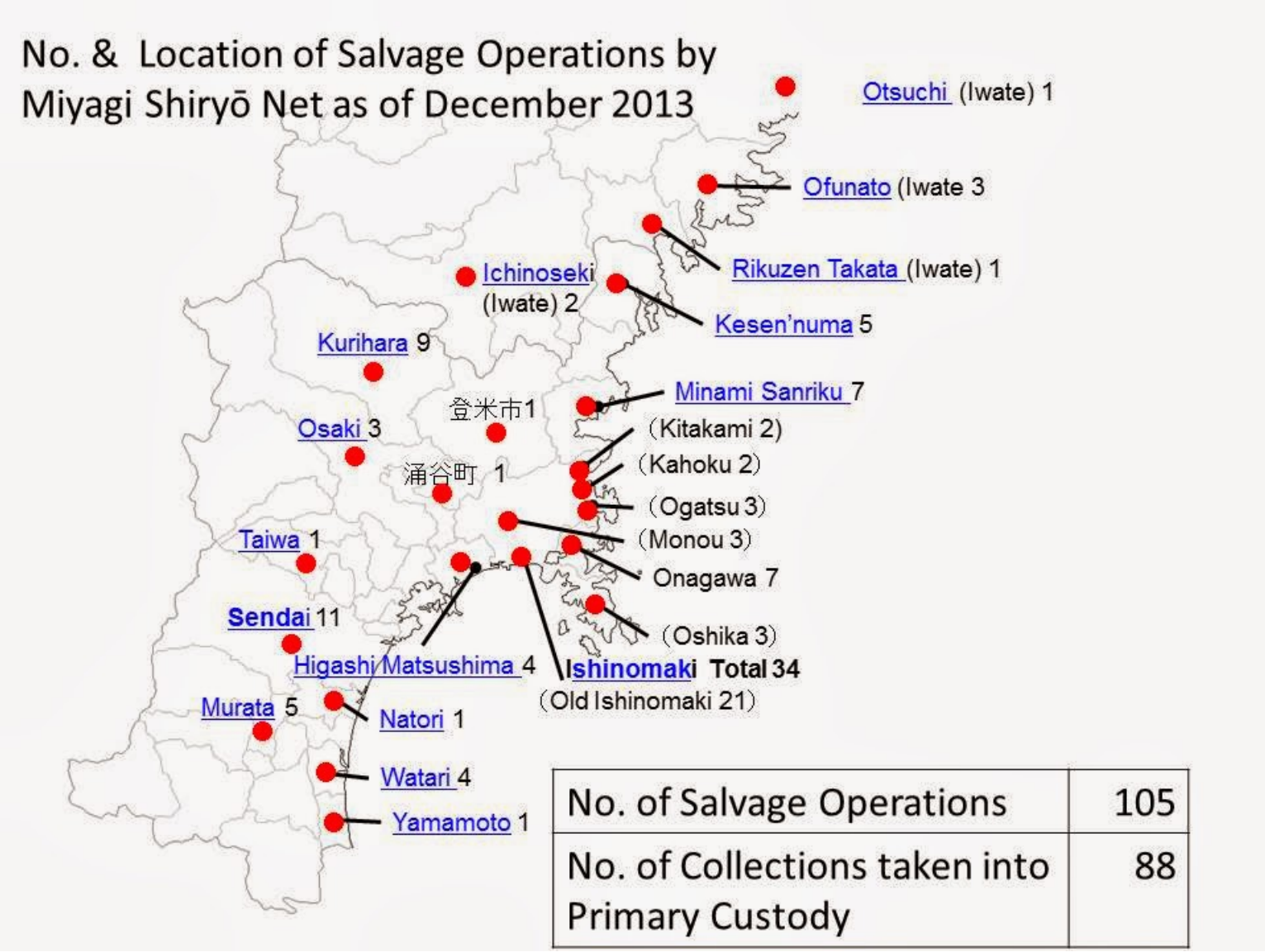
Japan’s hidden heritage: private documents



Documents held in private hands are estimated to number about 2,000,000,000 items

Photos compliments of SATŌ Daisuke

Heritage salvage after 2011: easier said than done



The Miyagi Shiryō Net (MSN) is an NGO whose members are professional academics, amateur historians and interested citizens, who work on a volunteer basis to identify, record and preserve the historical heritage of Miyagi Prefecture. MSN was founded in July 2003 in response to the recurring earthquakes and subsequent loss of the historical heritage of Miyagi Prefecture. Major earthquakes occurred again in 2005 and 2008, and culminated the Great East Japan Earthquake of March 2011.

How salvaging heritage generates powerful psychosocial support: Part 1

- The salvage operations, and the on-going storing and treating of materiels at risk (still continuing 11 years on) can provide vital bridging and linking social capital between heritage owners and a wide variety of people outside the owners' community.
- Serving as volunteers provides an avenue for a wide variety of people, especially elderly people, to participate in contributing to recovery from the disaster. Continued participation in treating damaged documents provides participants with a place, companionship, and a sense of purpose.

Digitally recording a private collection, August, 2007

Soaked documents in ice storage in the Nara City Fruit Markets, August 2011

Separating the congealed pages of old documents

Cleaning documents immersed in sea water

Photos compliments of SATŌ Daisuke

How salvaging heritage generates powerful psychosocial support: Part 2

- It is essential **to give feedback** on what can be learnt about a family or community's history from the salvaged documents. This can take the form of cataloguing the collection, providing print-outs of the digital record, public lectures to the community, and publishing.

Left: books published by members of MSN & Tôhoku Uni.
Right: a public lecture

- **Moreover, co-operating with other specialists, e.g. psychologists experienced in support for disaster survivors, can greatly enhance the positive effects of salvage operations for private heritage collections.**

Photo compliments of TAKAHASHI Yō'ichi

Owners in their own words: Case 1

A: Woman in her 70's

'I realised the meaning of why I was born into this world'

【Conflicting feelings】

I thought that losing everything in the tsunami was just a dream −

I was very happy +

Later on, I longed for the life that I had lost −

Thinking about it all is frustrating and painful +

I have come to see the world in new and positive light +

I was very grateful +

【Having Prof. C help me】

I was very grateful and glad when Prof. C rang me up +

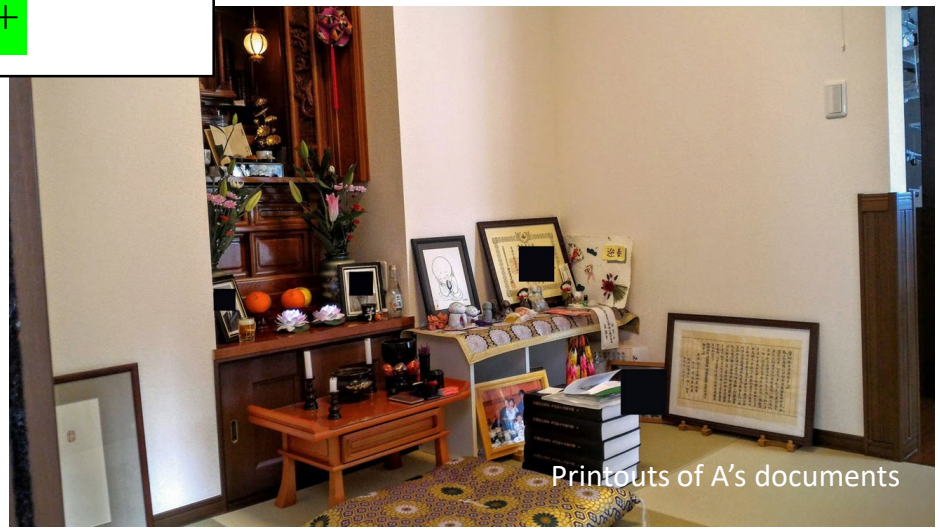
(Ranked as most important)

Prof. C gave me 10 copies of his book, and I gave them all to my relatives. It made me glad to see them all so happy to get the book. +

【Looking to the future】

I am proud of what my family has done +

I gave my grandchildren a copy each +



Printouts of A's documents

Owners in their own words: Case 2

B: A man in his 60's

'The earthquake is one part of our history, so I want to preserve the traces of it'

'Thanks to the tsunami, this place was really cleaned up'

【Learning from experience】

Passing on experience +

The earthquake −

Mutual aid +

【The meaning of recording history】

History +

A story +

Passing on experience +

(Ranked as most important)

【Recovery】

The past +

The future +

【Ideas associated with the event】

Appreciation +

Disaster −

Tsunami +

Epilogue: B’s warehouse today has become a repository of local memory

The warehouse sitting on a base of wooden piles as it is moved centimetre by centimetre to a new site to save it from demolition in the rezoning of the area after the tsunami

The warehouse today as a repository of local memories

Photo compliments of SATŌ Daisuke

Summing up: a Psychological Explication of the Two Cases

- Both A and B are elderly people, without unlimited time left them to rebuild their lives anew from scratch. However, by meeting and interacting with MSN, they became able to accept the reality of the disaster and to discover some positive meaning in all the loss and wreckage.
- In psychological terms, the disaster, taken as a whole experience, has enabled them to **reconstruct their ego integrity** (as defined by Erik Erikson) **within the span of their life cycle**.
- The key to understanding the benefits of restoring ‘memory’ in any form, is that psychological health (and disorders) and a healthy self-conception are deeply intertwined with memory.

Concluding Remarks Part 1

- Not all ‘heritage’ is world heritage, national heritage, heritage from ‘long ago,’ nor even ‘good heritage.’ But even so, it is still ‘heritage.’
- The dividing line between ‘heritage’ and ‘garbage’ is blurred, ever-changing, and often contested.
- A disaster can tear communities apart and alter familiar landscapes. Saving anything that records the past, the ‘little history’ of a community can provide members with links to loved but lost people and landscapes.
- These links transcend time, both PAST and FUTURE. They can give people driven into a dead-end, a different perspective to see themselves and each other, and provide a starting point for rebuilding lost human bonds and finding a way out of their dead-end.
- Not only disasters, but long-term socio-economic changes such as commercial ‘development’ can change societies and landscapes beyond recognition within a short span of time. Saving local heritage should be done before disaster strikes.

Concluding Remarks Part 2

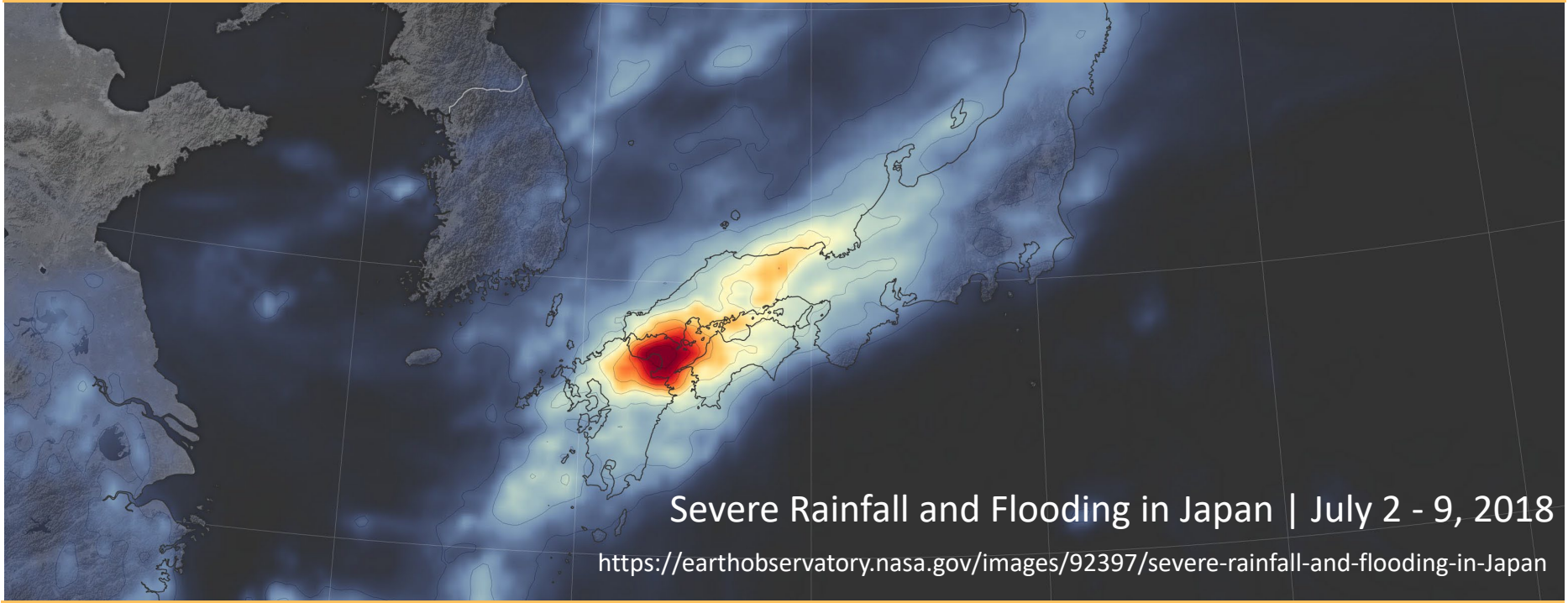
- The majority of materiel rescued by Miyagi Shiryō Net is less than 100 years old. Photos, old home movies, diaries, personal letters, school/class records, ledger books and other records of commercial activity, posters, etc. can all become a window into some aspect of life as it was.
- The work of volunteer groups such as MSN in Japan provide a cogent example of how items recording the history of a community can be transformed from ‘garbage’ into ‘heritage.’ Properly done, this whole process can become a powerful form of psychosocial support FOR ALL INVOLVED, and for the broader community as well.

A first-hand narrative from local government

- Please read the following online article, by MOMMA Takeshi: ‘Preservation of Historical and Cultural Heritage by Local Government within the Area Affected by the Fukushima Nuclear Reactor Accident,’ in J.F. Morris editor *History, Heritage, and Resilience: Case Studies in Saving Historical Heritage as Psychosocial Support* https://mgu.repo.nii.ac.jp/ The site is in Japanese, but look for the ‘Language’ button middle left of screen, to change to English, and look in ‘Miscellaneous’ section.
  .

Hazard-sensitive city planning in the era of climate change

APRU multi-hazards summer lecture series



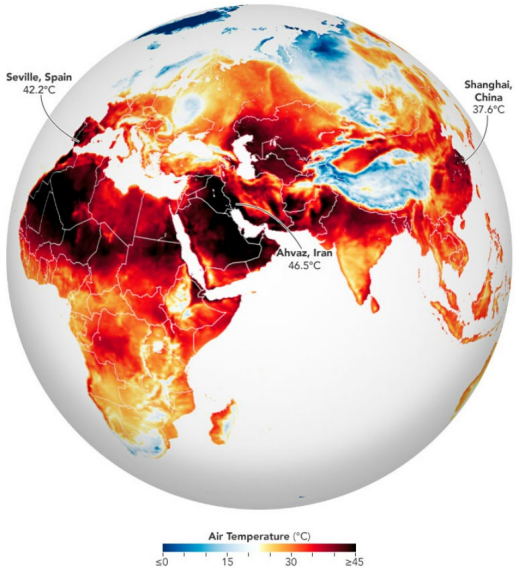
Kanako Iuchi

Tohoku University, IRIDeS | July 29, 2022

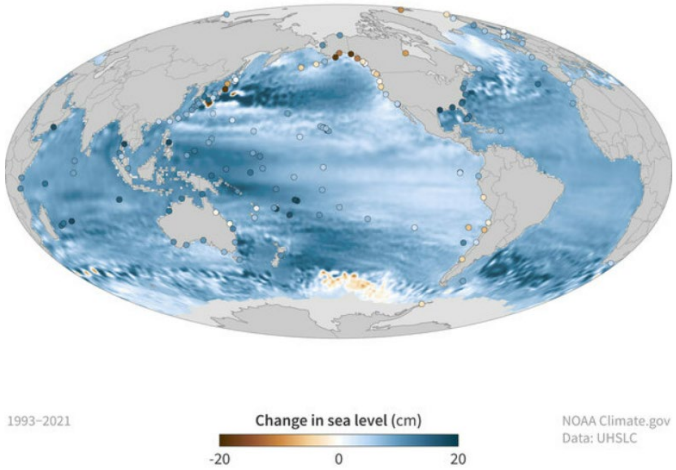
Source: NASA earth observatory

Changing climate, intensifying impacts

- Climate change is making different impacts on communities
  - Multiple heatwaves exceeding 40 Celsius hit northern hemisphere in June and July 2022
    - In Japan, worst record since 1875; national-wide heat level triggered electric shortage
  - Rising sea levels
    - Between 1993 and 2021, a rise of 15-20 cm in some ocean basin (NOAA, 2022). Across the world, sea levels are generally rising
  - Intensified meteorological disasters
    - Typhoons and intense rainfall are leading rivers to overflow, urban areas to be inundated, and mountainsides to slide



Source: NASA earth observatory

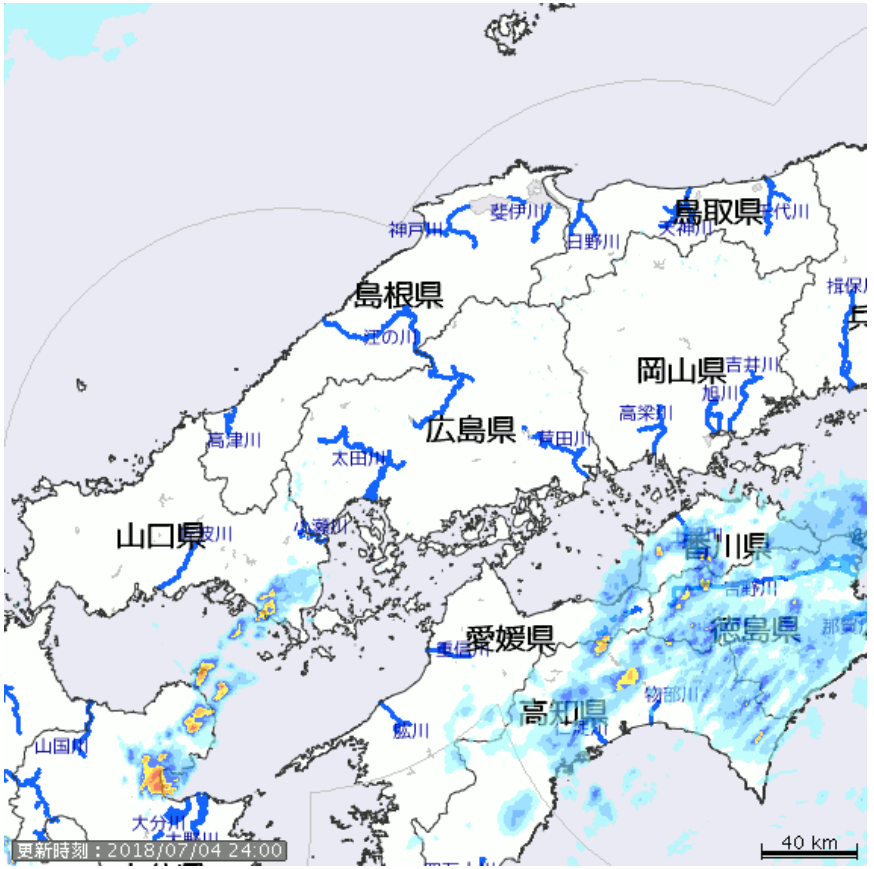


Source: NOAA

Japan is also facing change in climate: e.g., 2018 Western Japan Torrential Rain

- Intense rainfall for 10 consecutive days June 28 – July 8, more than usual recorded monthly average

- Death toll exceeded 200
- Among the worst meteorological disasters of the past 35 years

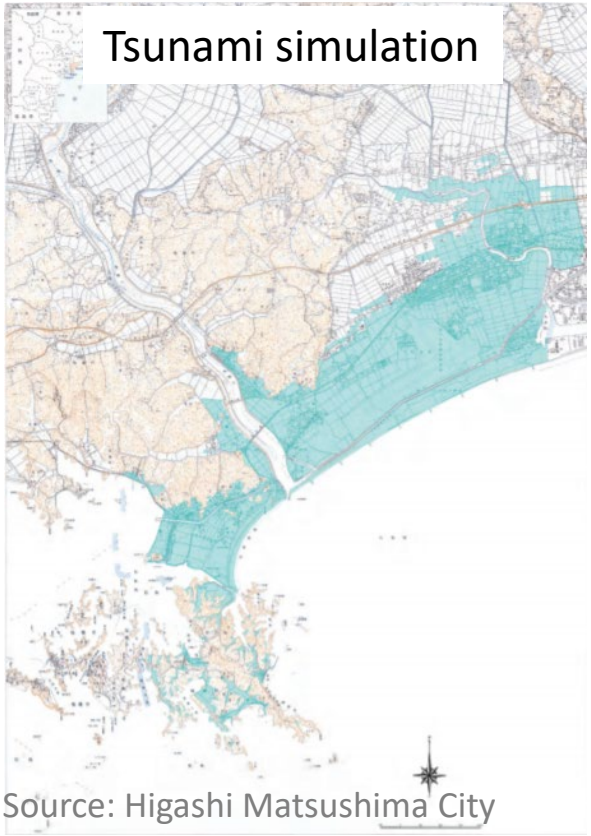


Original: "Information for flood prevention" on The Ministry of Land, Infrastructure, Transport and Tourism (Japan)（MLIT）, Add animation: Peka - MLIT「川の防災情報」Xバンドレーダ雨量分布 中国、as of 2018-07-10

Intensified meteorological damage has focused attention on land use controls for disaster mitigation

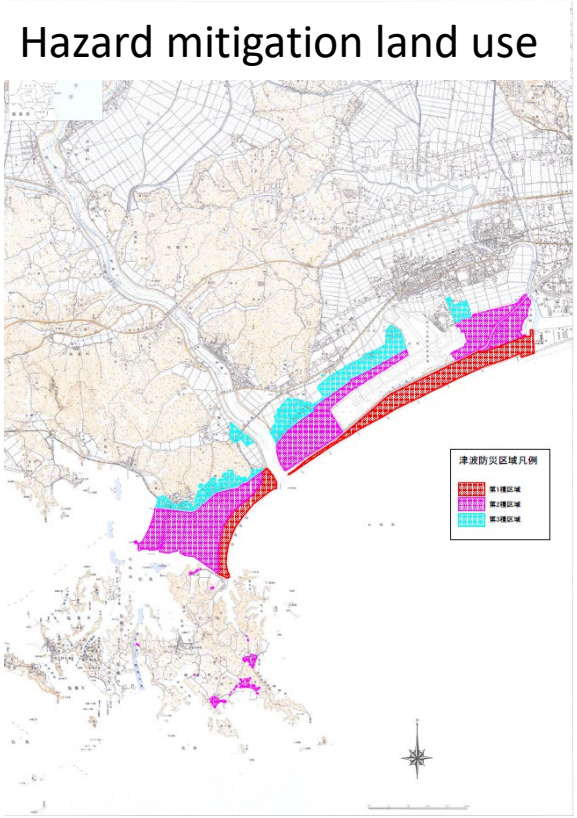
- Rationale: By restricting the use of hazardous areas, future loss of life and assets can be reduced
- Methods: Land use decisions based on hazard map information

Tsunami simulation

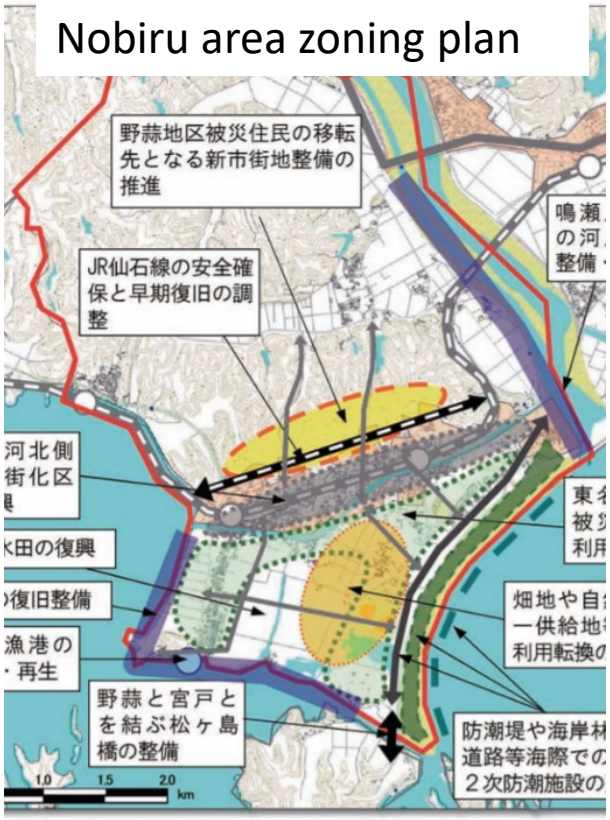


Source: Higashi Matsushima City

Hazard mitigation land use



Nobiru area zoning plan



Background for spatial risk management in Japan

Acts related to mitigation of water-related disasters

Disaster Countermeasures Basic Act (1961):	• Basis for current DRM framework • Protect citizens and social order • Set the stage for disaster management, including its planning system
Flood Control Act (1949):	• Protect citizens and assets through mitigation efforts against flooding, tsunami and storm surge • Give responsibilities to community groups for managing water-disasters
River Act (1964):	• Comprehensively manage rivers to mitigate flood disasters • Identify and match roles and responsibilities of entities

These acts proclaim to protect people and prepare for disasters; including the need to develop, share and use hazard information

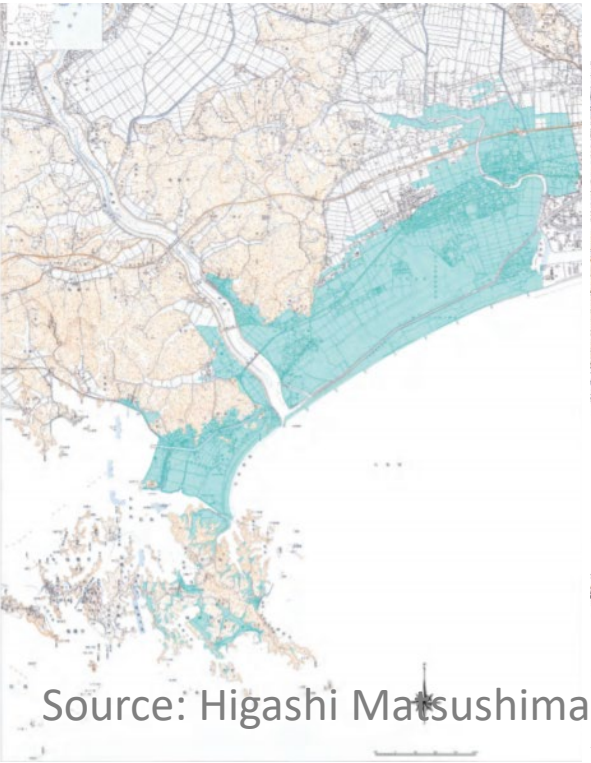
Spatial laws and regulations addressing disaster risk

- Building Standards Law, Article 39 (1950)
  - Local governments designate hazardous areas by enforcing ordinances and controlling building construction from disastrous events (e.g., land slides, surges, floods and tsunamis)
- City Planning Act (1968)
  - Article 7 regulates the need (of the local government) to classify land b/w urbanization promotion areas and urbanization control areas to prevent unregulated development
  - States to consider hazards upon defining land development
  - Article 33 on the development permit criteria allows of exclusion of lands not suitable for development due to hazard risk

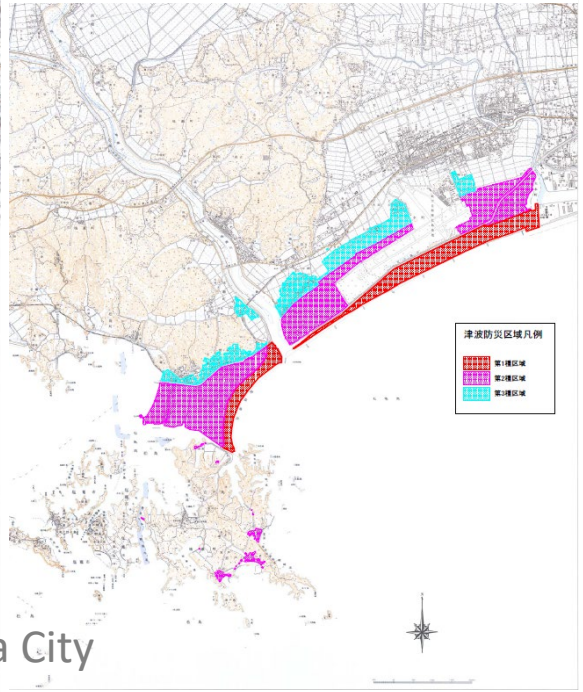
Approaches on land use decisions – the norms

- Develop/revise hazard maps: Incorporating knowledge on hazards
- Translating hazard information into local zoning (e.g., classifications by inundation depth)
- Different building criteria by defined zones
  - E.g., enforcing special building codes to certain zones

1. Hazard map development



2. Land use decisions based on hazard info



Source: Higashi Matsushima City

Zone 1	No residential and medical+welfare facilities
Zone 2	Building construction is resticted, but can be constructed with conditions
Zone 3	Buildings can be constructed by raising the floor level

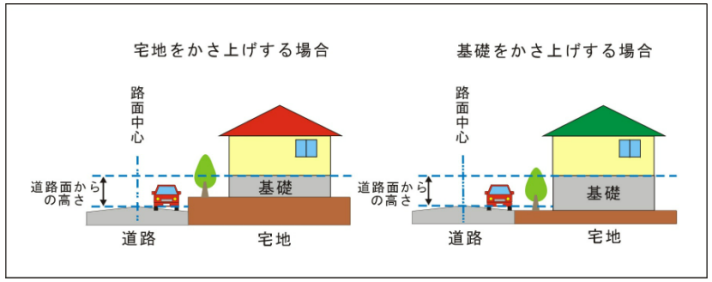
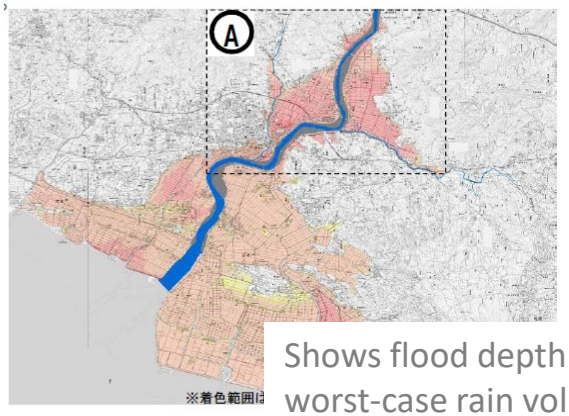


Figure source: MLIT

With intensified weather, hazard maps are changing

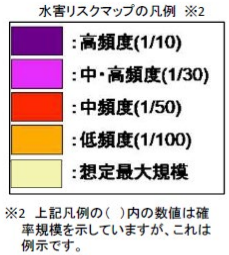
- Hazard maps and risk maps are revised/developed for the worst scenario --> hazardous areas are expanding
- Some high-risk lands are designated hazardous (red zones)

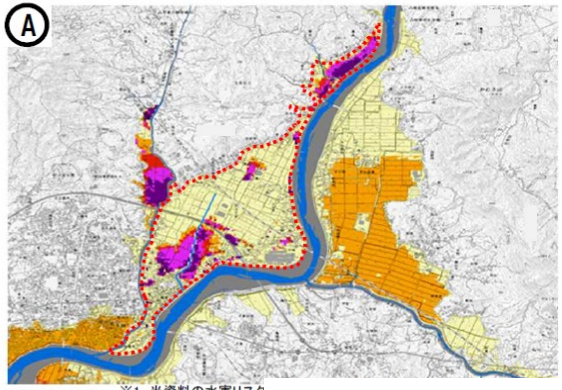
◯Flood hazard map



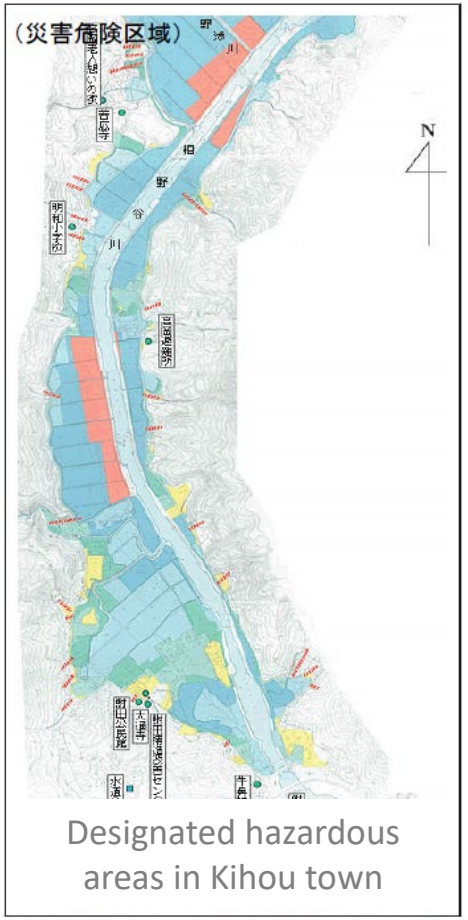
Shows flood depth with the worst-case rain volume

◯Flood risk map





Shows flood frequency with the worst-case rain volume

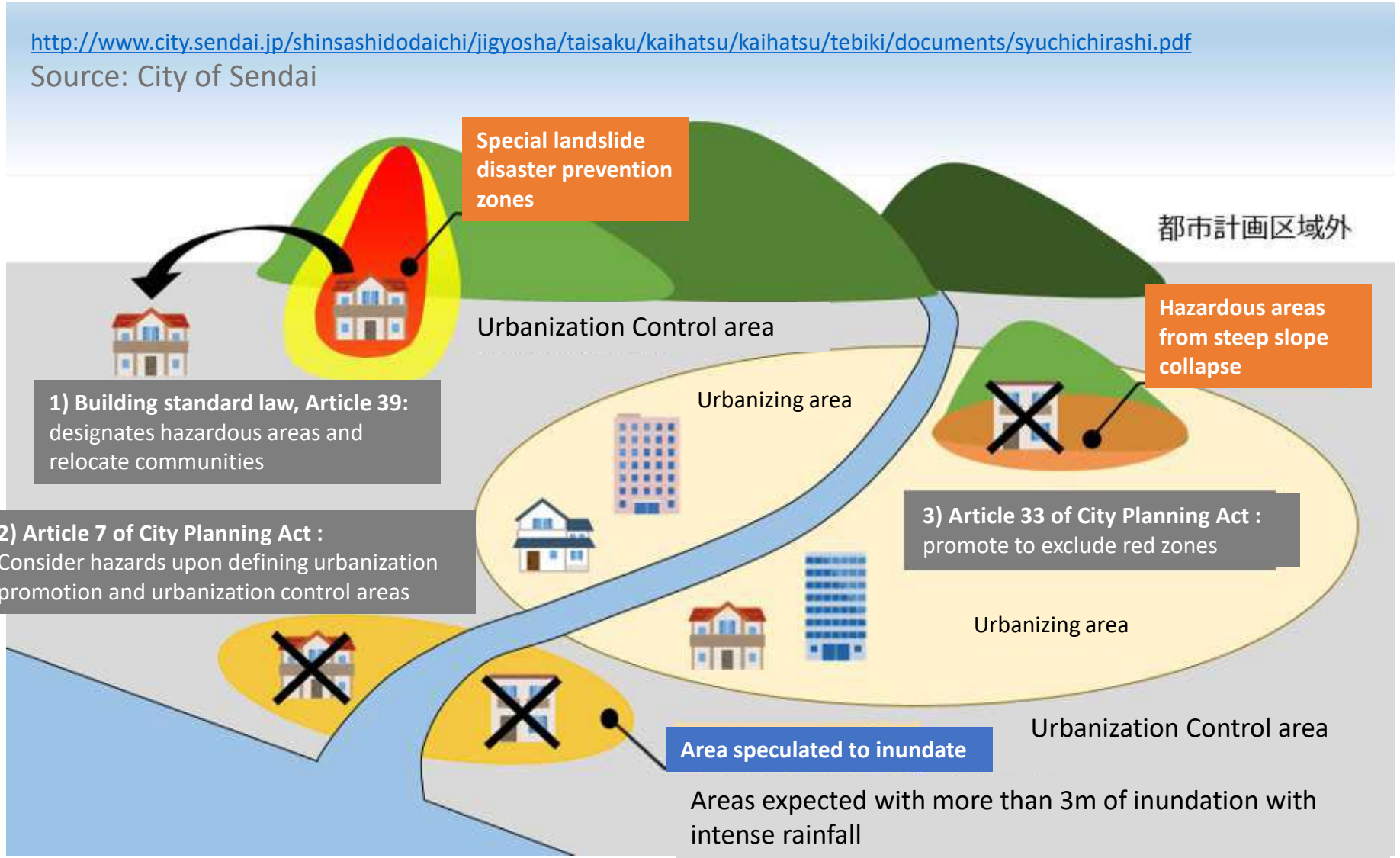


Designated hazardous areas in Kihou town

Source: All figures by MLIT

- Red zone: areas designated hazardous under evaluations guided by different Acts (e.g., Flooding, Landslides, mudslides, steep slope collapse)
- Increasingly, red zones are proactively considered upon city/land use planning

http://www.city.sendai.jp/shinsashidodaichi/jigyosha/taisaku/kaihatsu/kaihatsu/tebiki/documents/syuchichirashi.pdf
Source: City of Sendai



In practice, enforcing land use controls is difficult

- At normal times, local governments are hesitant to restrict the use of valuable land
- Locations designated hazardous have mostly resulted from spot and slope failures

Since 1950 when Article 39 of Building Standard Law was enacted

As of March 31, 2022

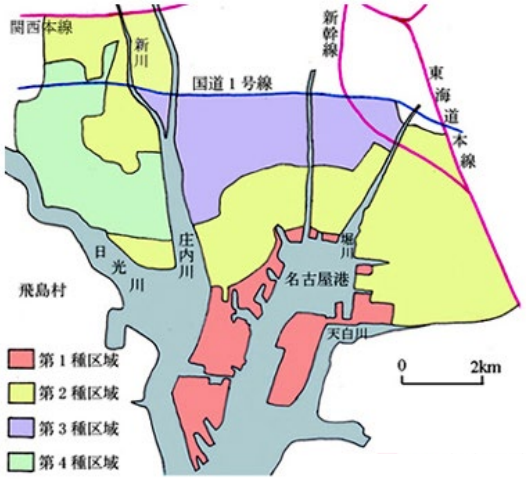
Mudslides		**Steep slope collapse**		**Landslides**		**Hazarouds locations for landslide disasters (Total)**	
Hazardous points	(Red zones)	Hazardous points	(Red zones)	Hazardous points	(Red zones)	Hazardous points	(Red zones)
215,276	156,806	**446,607**	423,308	**15,934**	1	**677,817**	580,115

Data by MLIT, retrieved on July 27 from: http://www.sabo.or.jp/topics/0005-0508/shitei-jyoukyou.htm

Historically, large hazardous areas (including red zones) are designated after significant disasters

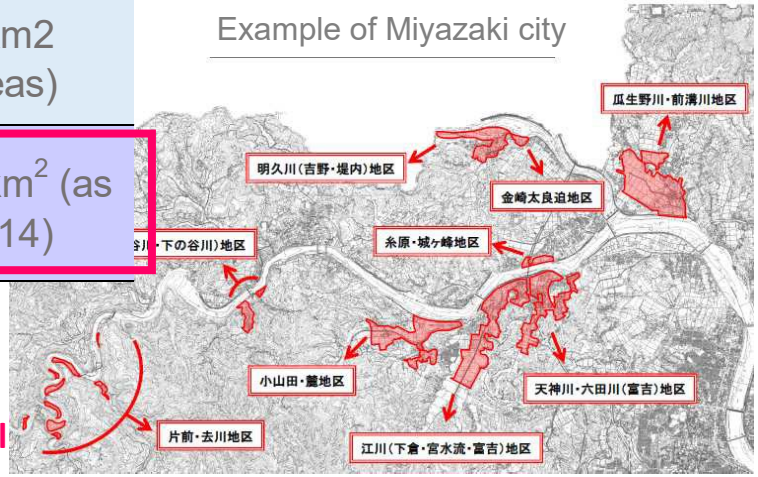
Location (City, Prefecture, year)	Triggering Event (Year)	Known area designated hazadous (km^2)
Nagoya, Aichi Pref. (Adopted 1961)	Isewan Typhoon (1959)	70.6km^2 (17 areas)
Kobe, Hyogo Prefecture (Adopted 199?)	Kobe earthquake (1995)	0.0195 km^2 (1.95 ha)
Nagaoka, Niigata Prefecture (Adopted 200?)	Chuetsu earthquake (2004)	0.2797 km^2 (27.97 ha)
Miyazaki, Miyazaki Pref. (Adopted 2005)	Typhoon No. 14 (2005)	n.a. km2 (7 areas)
Tohoku (Iwate, Miyagi, Fukushima Prefs.) (Adopted 2013 later revised)	The GEJE (2011)	157.23 km^2 (as of 2014)

Created: from various MLIT sources



Example of Nagoya city

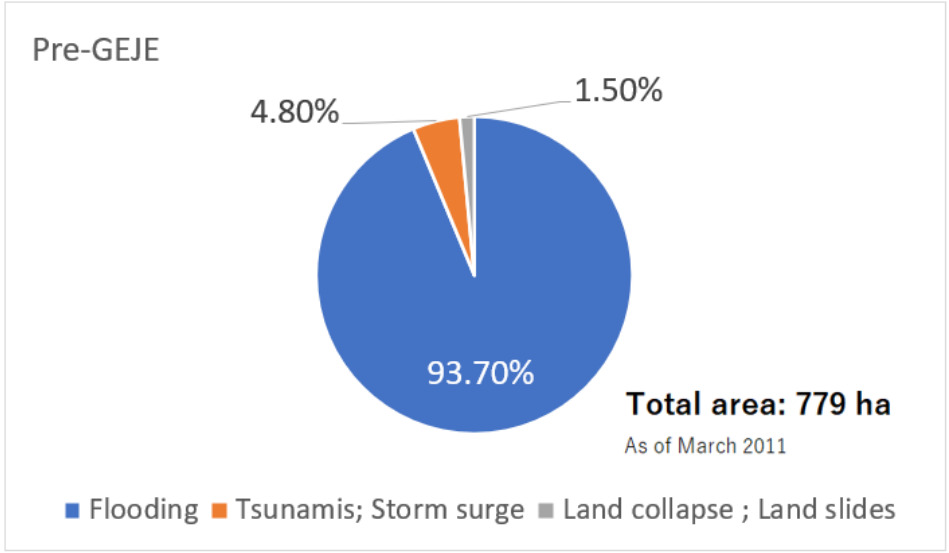
Example of Miyazaki city



Size of the lands was exceptional

Land designated hazardous is greatly increasing

- After the GEJE Tohoku, land area designated hazardous has increased by 21 times



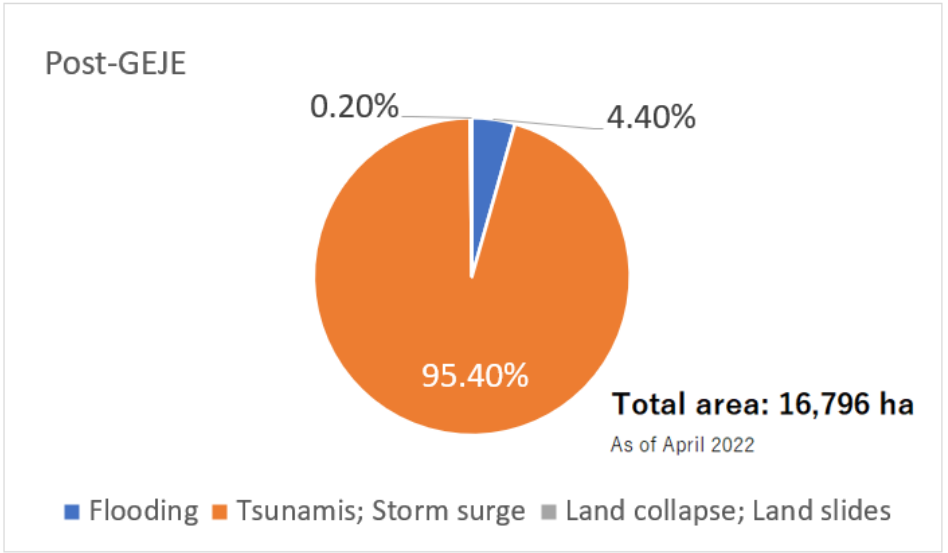
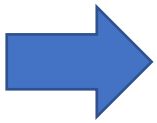


Chart developed based on the source: Nikkei Shinbun, retrieved July 27, 2022
https://www.nikkei.com/article/DGKKZO69032700Q1A210C2CC1000/

- Similar trends can be seen nationwide with increased meteorological disasters

Emerging issues and responses

- Designated hazardous lands had continued to increase for the past 70 years
- With intense weather, hazardous areas continue to widen in each location → not all the areas can be restricted
- Patterns of hazard forces (e.g., rain, typhoons) are increasingly unpredictable
- Hazard and risk maps prove to be less useful than anticipated



Some prefectures (e.g., Aichi in 2022) have reverted the restricted area – based on a revised hazard assessment

Reverting is the opportunities for better use of land; but keep sharing the past information is important → Hazard maps builds on assumptions

Conclusion

- Efforts to reduce hazard impacts will continue and grow
  - Improved technologies enable better predictions
  - Increase awareness and practice on hazard risk reduction, e.g., designating more hazardous lands
- However, the traditional approach to hazard-sensitive land use is at a point of shift in perspective
  - Extreme meteorological impacts of climate change bring unpredictable impacts
  - Traditional risk reduction efforts via hazard mapping/land use may not meet the speed of climate change
- Good news: We see changes on city/land use planning
  - As a sign of adaptation to the current environment, former land use decisions are revisited; reverting the restricted area

Studying better use hazard information and wisely adopting to the changing environment is important

Questions?

iuchi@tohoku.ac.jp