国際的な巨大災害と防災の観点・日本との比較

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http://www.tsunami.civil.tohoku.ac.jp/hokusai3/J/people/member/anawatto.html

東北大学　災害科学国際研究所

災害リスク研究部門　津波工学研究分野

2018年8月7日

IRIDeS

International Research Institute of Disaster Science

災害科学国際研究所

TOHOKU UNIVERSITY

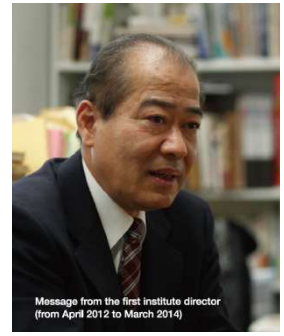
Contents

Introduction of IRIDeS

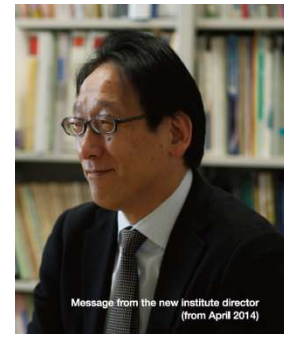
Introduction of IRIDeS, Tohoku University

Research group on disaster prevention and management

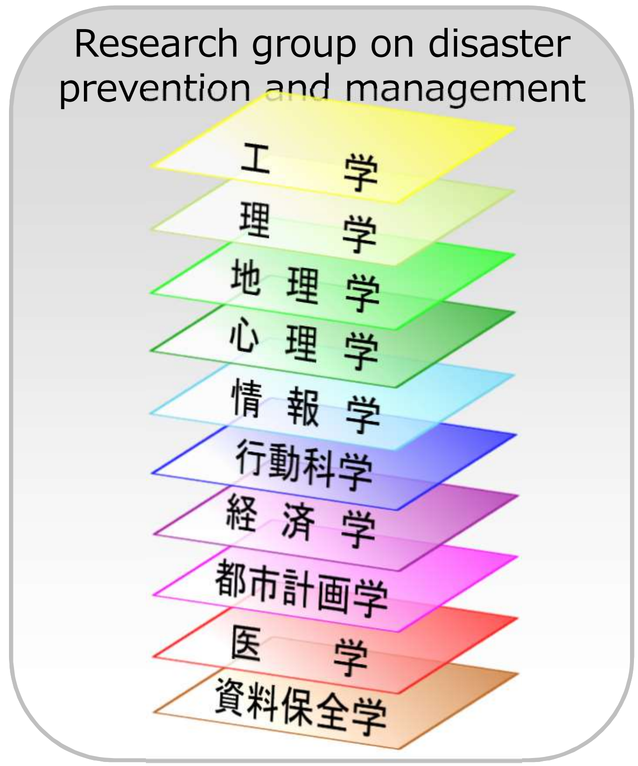
- To prepare for the recurring Miyagi offshore earthquake, an organization was formed to engage researchers working on [Disaster], [Disaster Prevention], and [Disaster Mitigation]
- Taking advantage of Interdisciplinary (Humanities, Science, Engineering, and Medicine) disaster prevention research in Tohoku University
- From 2007 to 2011, 8 departments and about 50 faculty members
    - Center of Northeast Asian studies
    - Disaster Control Research Center
    - Research Center for Prediction of Earthquakes and Volcanic Eruptions
    - Institute of Development, Aging and Cancer
    - Graduate School of Engineering
    - Graduate School of Science
    - Graduate School of Letters
    - Graduate School of Law
    - Graduate School of Economics
    - Graduate School of Information Science



Formal Director
Prof. Arata Hirakawa
(History)



Present Director
Prof. Fumihiko Imamura
(Tsunami Engineering)



Introduction of IRIDeS, Tohoku University

Establishment of IRIDeS

- To-date disaster mitigation efforts not sufficient
- Recent mega-disasters around the world
- Interdisciplinary collaboration necessary

University efforts before 2011 → From 2012

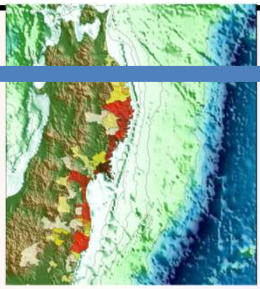
Development of disaster prevention technologies

- Earthquake and tsunami prediction and modeling technologies → Tsunami modeling technology transferred to over 30 countries
- Developing early warning technologies
- Enhancing seismic performance of structures

- Disaster Control Research Center [1990]
- Graduate school of science and graduate school of engineering [2006]
- Research group on disaster prevention and management [2007]

The 2011 Great East Japan Earthquake Disaster

- Complex mega disaster involving a megathrust earthquake, great tsunami, and nuclear power plant accident
- Revealed the limits and weaknesses of the state of the art of science and technology



Establishment of IRIDeS

- Rebuilding disaster mitigation infrastructure based on lessons learned from the 2011 event
- Supporting the affected areas
- Enhancing disaster-resiliency and performance of multiple-fail-safe systems in rural and urban areas
- Comprehensive study of the 2011 Great East Japan Earthquake and Tsunami disaster
- Establishing disaster medicine and medical health care systems focused on catastrophic natural disasters
- Developing a digital archive for passing on the lessons learned from the post-disaster reconstruction in rural and urban areas

Introduction of IRIDeS, Tohoku University

Logo

- IRIDeS
- Iris, Iris laevigata or Japanese Iris
- Symbol of hope and nobility

Logo meaning

- Overturning the Japanese character meaning disaster「災」= reconstruction and sustainable and resilient societies
- Purple is the color of the Tohoku University
- The Iris is the symbol of “hope” and “dignity”

IRIDeS
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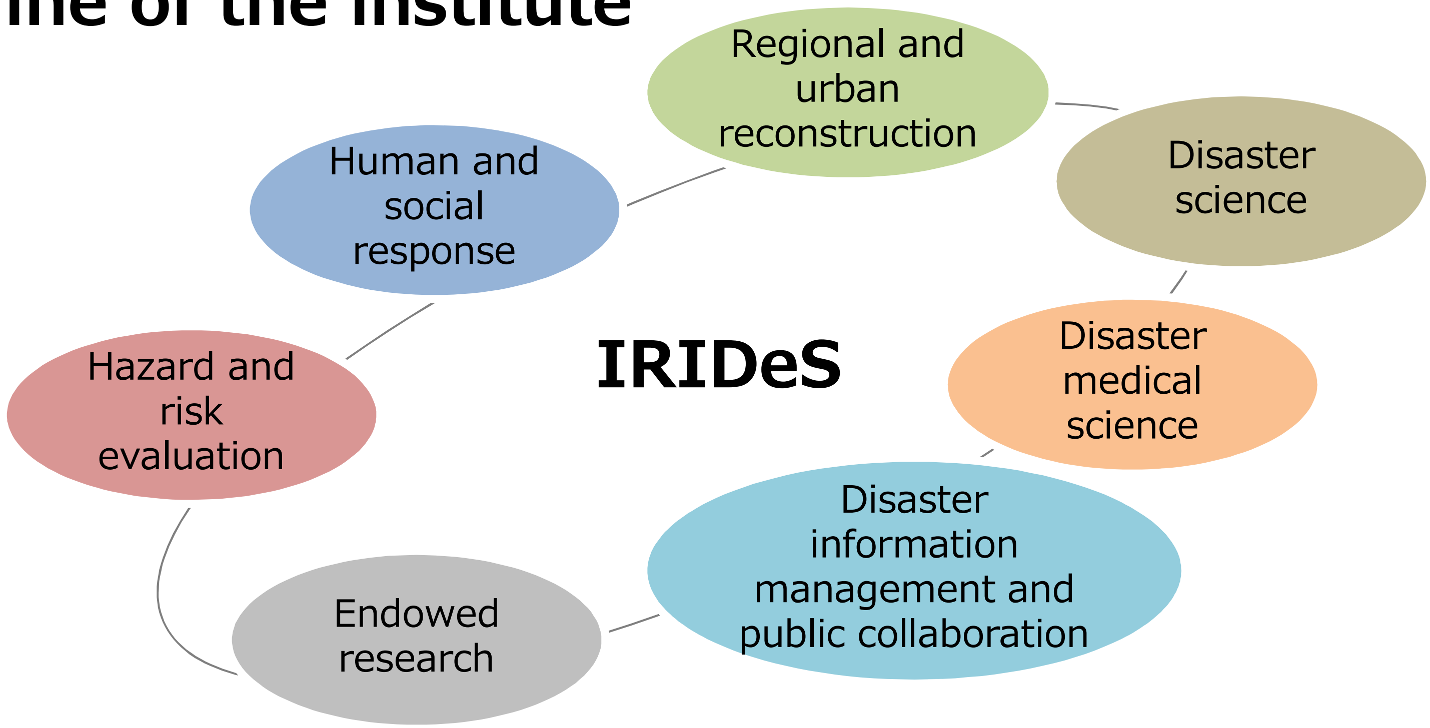
Introduction of IRIDeS, Tohoku University

Outline of the institute



The action-oriented research of IRIDeS focuses on;

① **Investing the physics of global scale natural disasters such as mega-earthquakes, tsunamis and extreme weather**

② **Reconstructing disaster response and mitigation technologies based on the lessons of the 2011 Great East Japan earthquake and tsunami disaster**

③ **Inventing "Affected Area Supportology" in the aftermath of natural disasters**

④ **Enhancing disaster-resiliency and performance of multiple-fail-safe systems in regional and urban areas**

⑤ **Establishing disaster medicine and medical service systems towards catastrophic natural disasters**

⑥ **Designing disaster-resilient societies and developing the digital archive system to pass the lessons from the disasters**

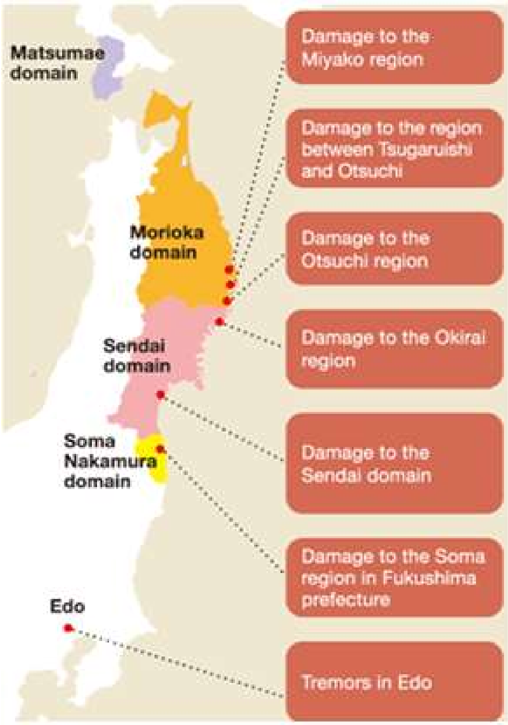
Academic partners

Signatories of the joint statement for international research collaboration at the Tohoku forum for international research collaboration on 11-Mar 2012

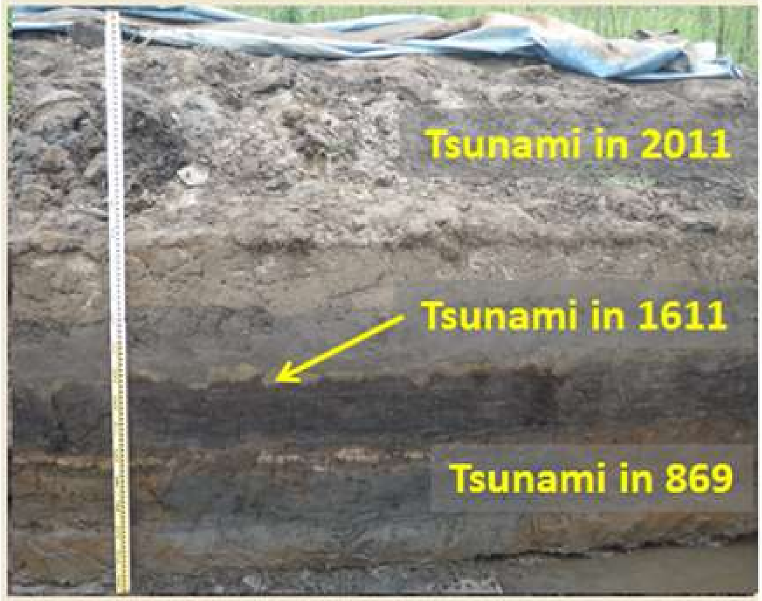
University of California, Los Angeles, USA
University of New South Wales, Australia
Tsinghua University and Sichuan University, China
University of Hawaii at Manoa, USA
Harvard University, USA
University of Florence, Italy
German Aerospace Center, Germany
University College London , UK
Istanbul Technical University, Turkey
University of Tokyo, Japan
Kyoto University, Japan
Kobe University, Japan
Fukushima University, Japan
Niigata University, Japan
Nagoya University, Japan

1611 Keicho Sanriku tsunami

History



● Geological layers on the coast of the Tohoku region



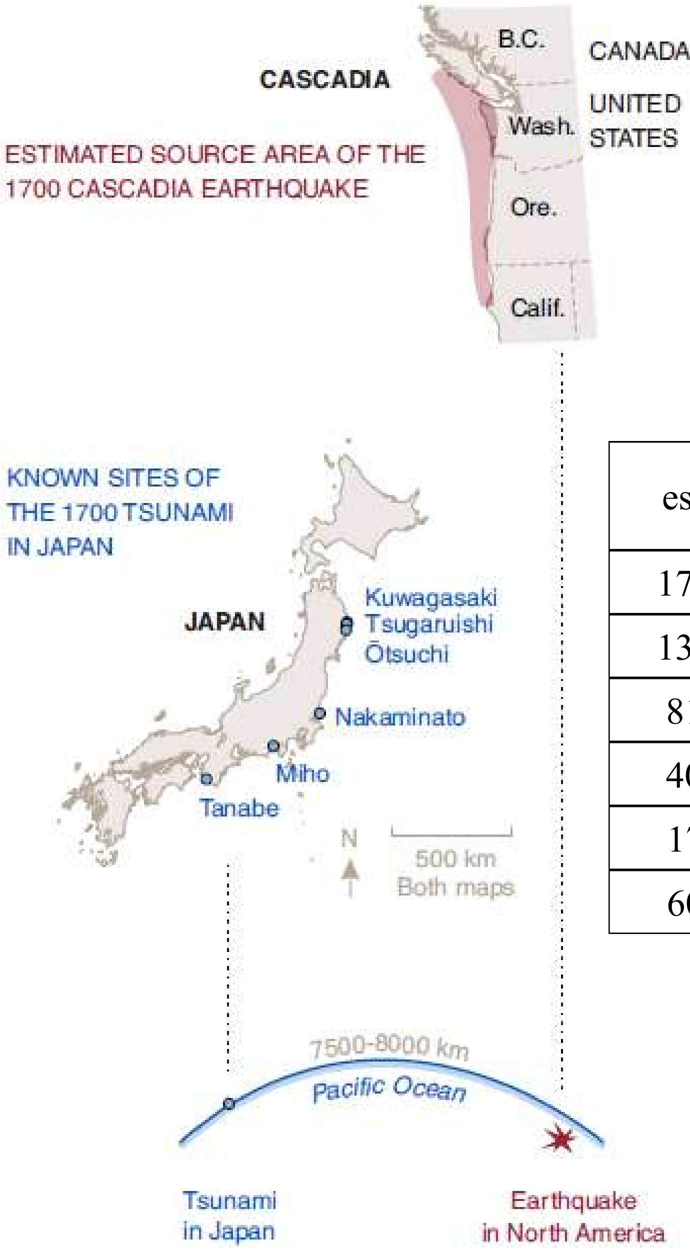
Layers formed of coastal sand and pieces of seashells are tsunami deposits.
The scope to analyze can enable researchers to discover the scale of past tsunamis.

Geological science

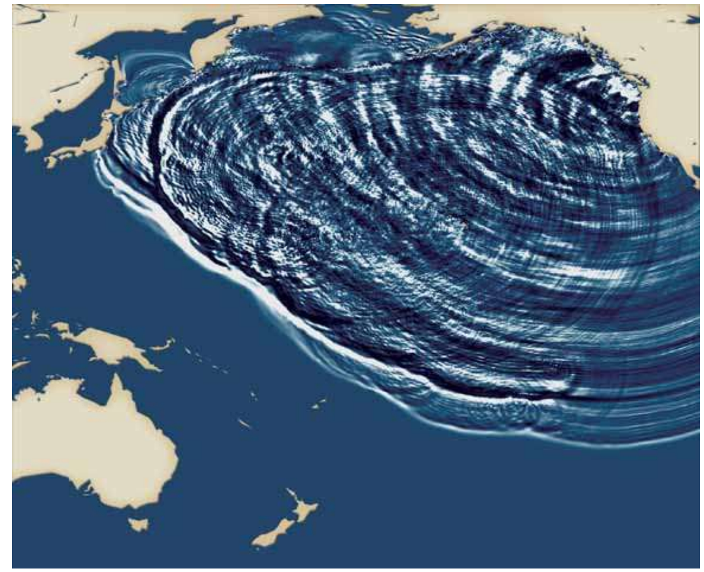
● Simulation image of the tsunami propagation that occurred in the Keicho Period Oshu Earthquake

Engineering

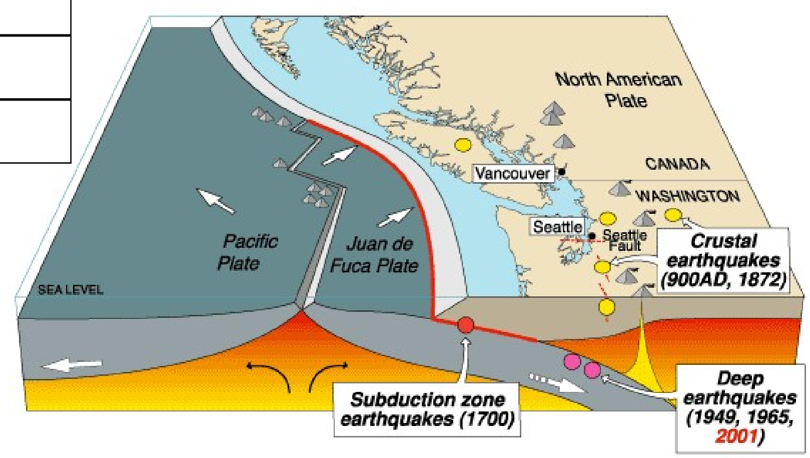
1700 Cascadia tsunami



est. year	Interval (years)
1700 AD	-
1310 AD	390
810 AD	500
400 AD	410
170 BC	570
600 BC	430



Cascadia earthquake sources



Selected projects
Integrated sciences for reconstruction after the 2011 Great East Japan earthquake and tsunami

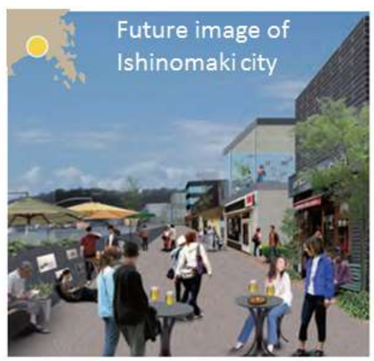
"Disaster medicine"

Tohoku University Medical Center held a major disaster prevention drill on November 9, 2012. The photograph shows injured patients awaiting triage. One year and 8 months have passed since the disaster, but still some staff recall the event clearly.

● MRI scans to measure brain activity and brain function mapping

"Disaster reconstruction"

There is a big difference in the extent of damage across only several meters difference in altitude. By combining relocation to slightly higher ground with other disaster prevention measures, disaster-resilient towns can be developed without the need to relocate to distant locales.



"Disaster evacuation"

Traffic jam during tsunami evacuation drill in Yamamoto town

Tsunami evacuation drill using expressway in Iwanuma city

カケアガレ! 日本

Kakeagare! Japan **(Get Going! Japan)**

Protecting life and locality: practical action for tsunami risk reduction

Photo 2: Elementary school pupils wearing protective hoods rush to the school building of Tamaura Middle School (Tsunami evacuation drill, Iwanuma City, 2012)

"Digital archive"

Michinoku Shinrokuden

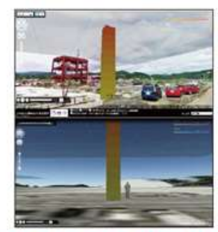
● http://shinrokuden.irides.tohoku.ac.jp/

"Michinoku Shinrokuden" is an archive project that has IRIDeS linking with industry, government, and academic institutions to collect memories, records, case studies, and knowledge relating to the Great East Japan Earthquake to share both inside and outside Japan, and with future generations. This project can be utilized in countermeasures for future earthquakes feared to occur in the Tokai, Tonankai, and Nankai regions.

March 11th tsunami flooding as seen by human eyes

● http://michinoku.irides.tohoku.ac.jp/ttjt/ttjt_view.html

This site displays the water-mark of the tsunami that occurred in the Great East Japan Earthquake in Google Earth as a polygon bar, to enable a birds-eye view of the height of tsunami to be easily visualized. It enables people to experience the height of the tsunami and how terrible it really was.



Scenery changing due to reconstruction efforts

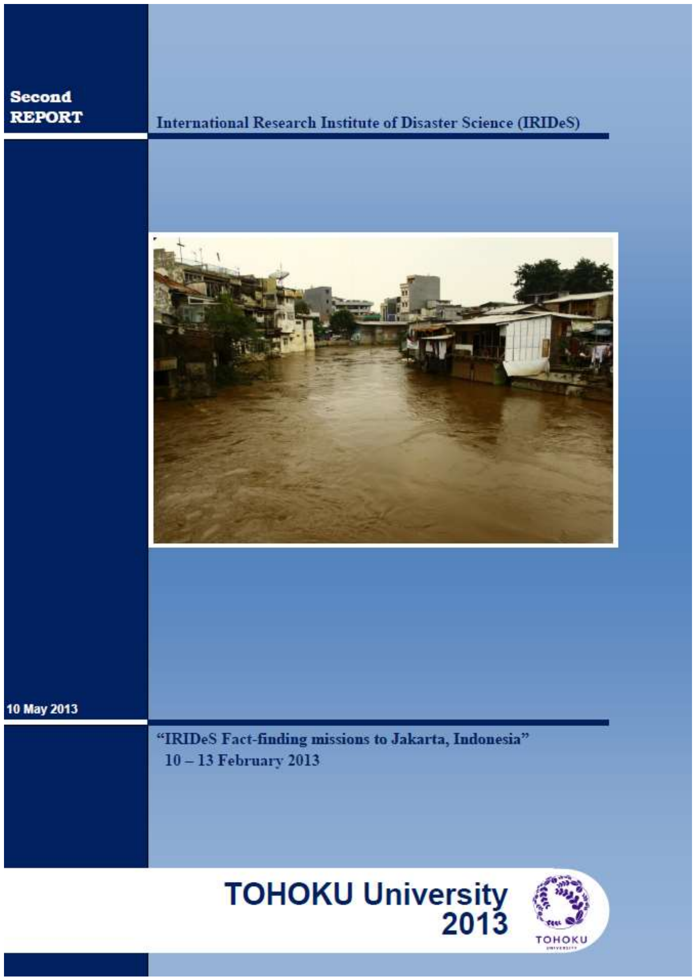
● http://michinoku.irides.tohoku.ac.jp/photovr/map.html

"Michinoku Shinrokuden" continues to collect photos of disaster sites captured in the same place but at different times. The project also has a website that enables these photos to be viewed while comparing them. On the site, balloons on the map can be clicked to move a time slider that enables changing scenery to be viewed.

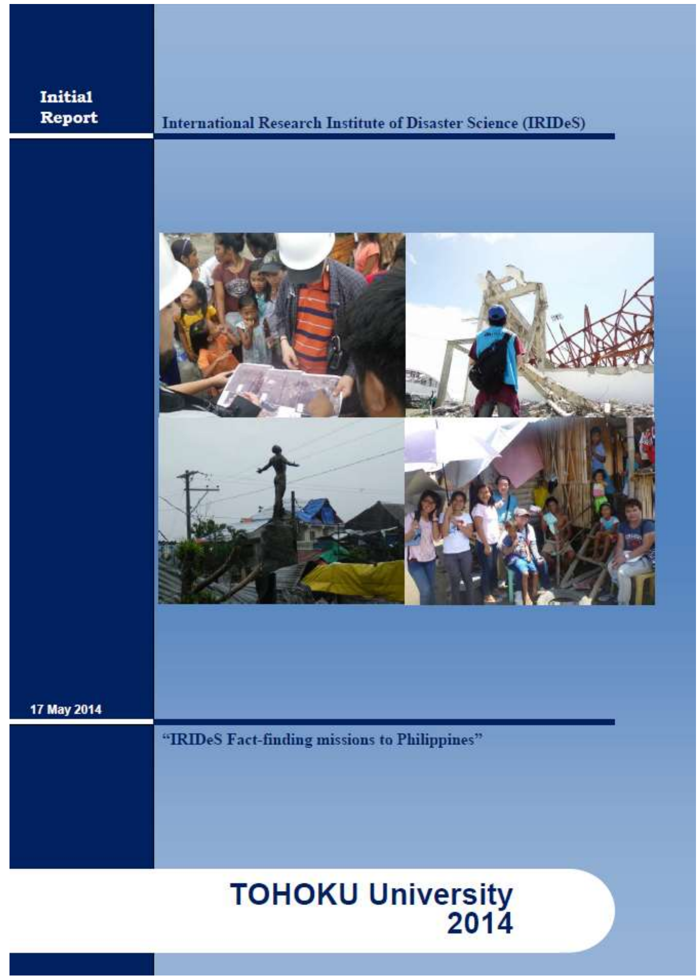
Introduction of IRIDeS, Tohoku University

Lessons learned from recent disasters

2013 IRIDeS Fact-finding missions to Indonesia



2014 IRIDeS Fact-finding missions to the Philippines



UNISDR and UNDP related activities

New International Framework for Disaster Risk Reduction

Promote International Movement on Disaster Risk Reduction

- Too late to respond to disasters
- Paradigm shift to reduce disaster risks

Source: Yuichi Ono, Assistant Director and Professor, IRIDeS, Tohoku University

Toward the 3rd WCDRR 2015 in Sendai

IRIDeS's HFA IRIDeS Review Report
Focusing on 2011 Great East Japan Earthquake

During that decade, the Great East Japan Earthquake with Mw 9.0 occurred on March 11, 2011. We must learn from such devastating experiences for the sake of future societies. To this end IRIDeS issued "HFA IRIDeS Review Report Focusing on 2011 Great East Japan Earthquake" in October 2013 in terms of HFA guidelines from the academic viewpoints of professors at IRIDeS to disseminate the event's lessons learned. This review analyzes the five goals of the HFA from a unique perspective. It highlights good practices and problems and recommendations that can be taken in the future.

Bitter lessons learnt from the 1970 East Pakistan Cyclone

produced

Cyclone Preparedness Programme in Bangladesh - 1971

Cyclone Preparedness Program

Early Warning System, flags and laud speakers, International Cooperation, Shelter, Evacuation, Public Awareness and Education, Volunteers, Community-based strategy, traditional knowledge, protecting animals, etc.

The Pakistan/Bangladesh Tragedy triggered a new global movement to manage disasters

from

Disaster management

to

Disaster reduction

UN and international organizations such as International Federation of Red Cross and Red Crescent Societies (IFRC) supported by member countries raised voice to reduce disasters before they hit

1971 Office of the United Nations Disaster Relief Coordinator (UNDRO)

1990-99 International Decade of Natural Disaster Reduction (IDNDR) --- with a secretariat for a 10-year term

1992 Department of Humanitarian Affairs (DHA) established and the UNDRO was united

1997 Office for the Coordination of Humanitarian Affairs (OCHA) established and the DHA was united

1994 Japan hosted a first World Conference on Disaster Reduction in Yokohama --- Yokohama Strategy and Plan of Action --- culminating the IDNDR movement

Late 1990s IDNDR malfunctioned (then, WB, IFRC, UNDP – struggled for supremacy)

2000- International Strategy for Disaster Reduction (ISDR)

2000- International Strategy for Disaster Reduction (ISDR)

2005 Japan hosted a second World Conference on Disaster Reduction in Kobe, Hyogo Framework for Action

2015 Japan hosted a third World Conference on Disaster Risk Reduction in Sendai, Sendai Framework for Disaster Risk Reduction (SFDRR) (refined framework and targets)

Value of the SFDRR

A negotiated document though the UN process
- committed by 187 countries

Sendai Framework for Disaster Risk Reduction 2015-2030

Adopted by 187 countries at the World Conference on Disaster Risk Reduction, 18 March 2015

I. Preamble

II. Expected outcome and goal

Seven targets

III. Guiding principles

IV. Priorities for action

Priority 1: Understanding disaster risk
Priority 2: Strengthening disaster risk governance to manage disaster risk
Priority 3: Investing in disaster risk reduction for resilience
Priority 4: Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation and reconstruction

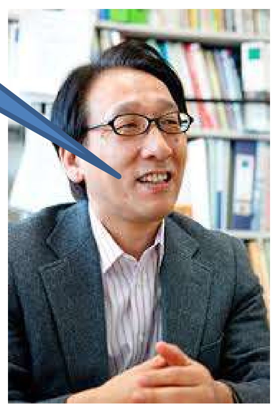
V. Role of stakeholders

VI. International cooperation and global partnership

Where is science in the SFDRR?

APRU!

IRIDeS!



Who wants to commit in the implementing the SFDRR in the area of science and technology?

1. Global Centre for Disaster Statistics

Launch of the Global Centre for Disaster Statistics during the WCDRR in Sendai (15 March 2015)

Background of GCDS

United Nations Development Program (UNDP) and the International Research Institute of Disaster Science (IRIDeS) at Tohoku University jointly announced the establishment of the Global Centre for Disaster Statistics (GCDS) in March 2015 during the Third UN World Conference on Disaster Risk Reduction (WCDRR) in Sendai.

Voices of support and expectation to this initiative were received, including the UN Secretary-General Ban Ki-moon.

Establishment ceremony of GCDS at the WCDRR

UN Secretary-General Ban Ki-moon's speech at Tohoku University Symposium Forum held in the WCDRR

Purpose of GCDS

At the WCDRR a new framework Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR) was adopted by 187 countries including seven global targets.

In addition, Post-2015 Sustainable Development Goals (SDGs) were adopted in September 2015 with 17 global goals and 169 targets.

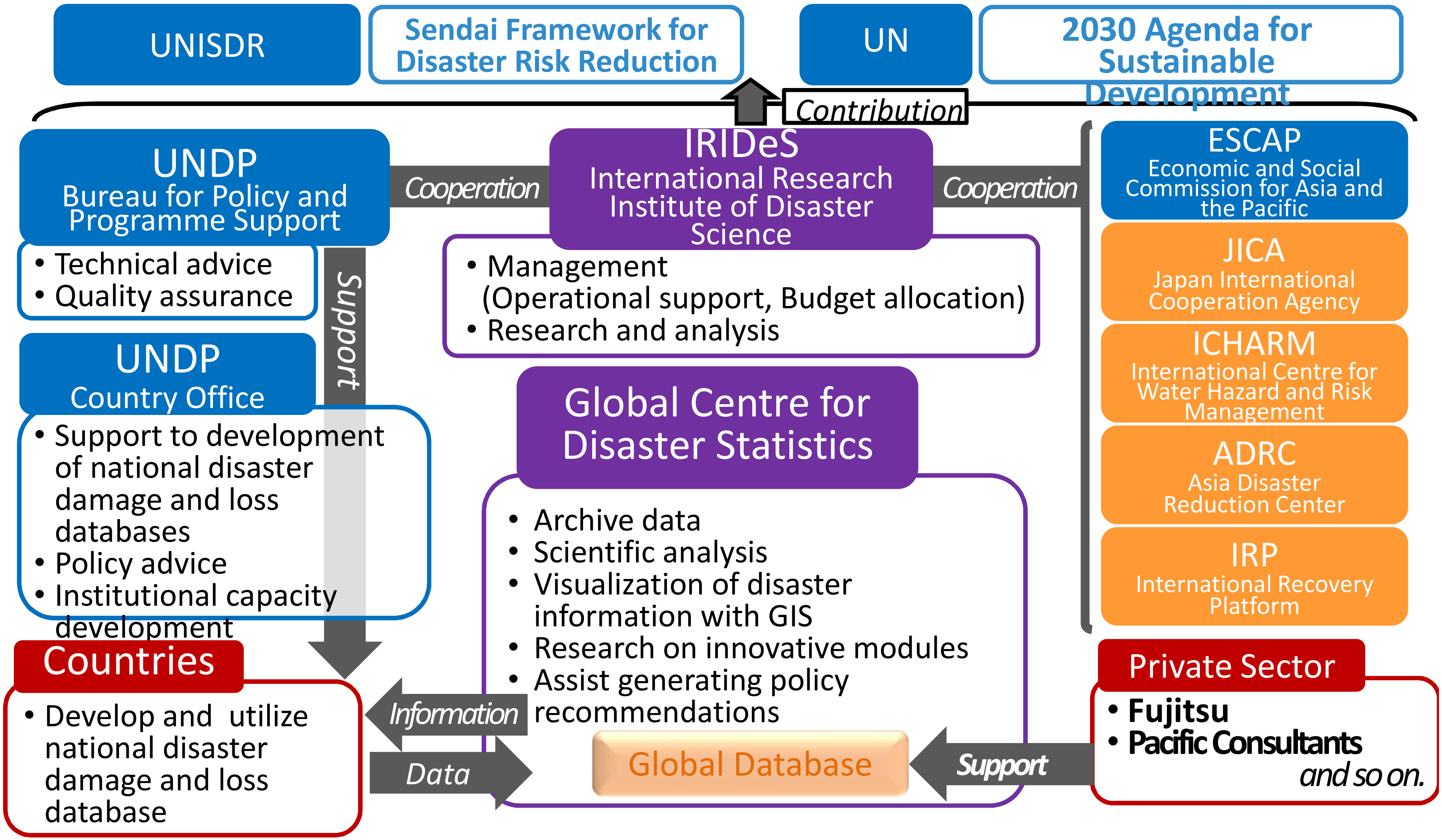
These targets include reducing the disaster mortality, number of affected people, and the direct economic losses.

Therefore, development of sound disaster loss and damage system in no longer a choice but a *"Must thing"* for countries.

SFDRR Targets that can be monitored by the GCDS

Mortality	**Yes**
Number of affected people	**Yes**
Direct disaster economic loss	**Yes**
Damage to critical infrastructure	Yes/ No
# of countries with DRR strategies	No
International cooperation	No
Access to multi-hazard early warning system and disaster risk information and assessments	No

Structure of GCDS



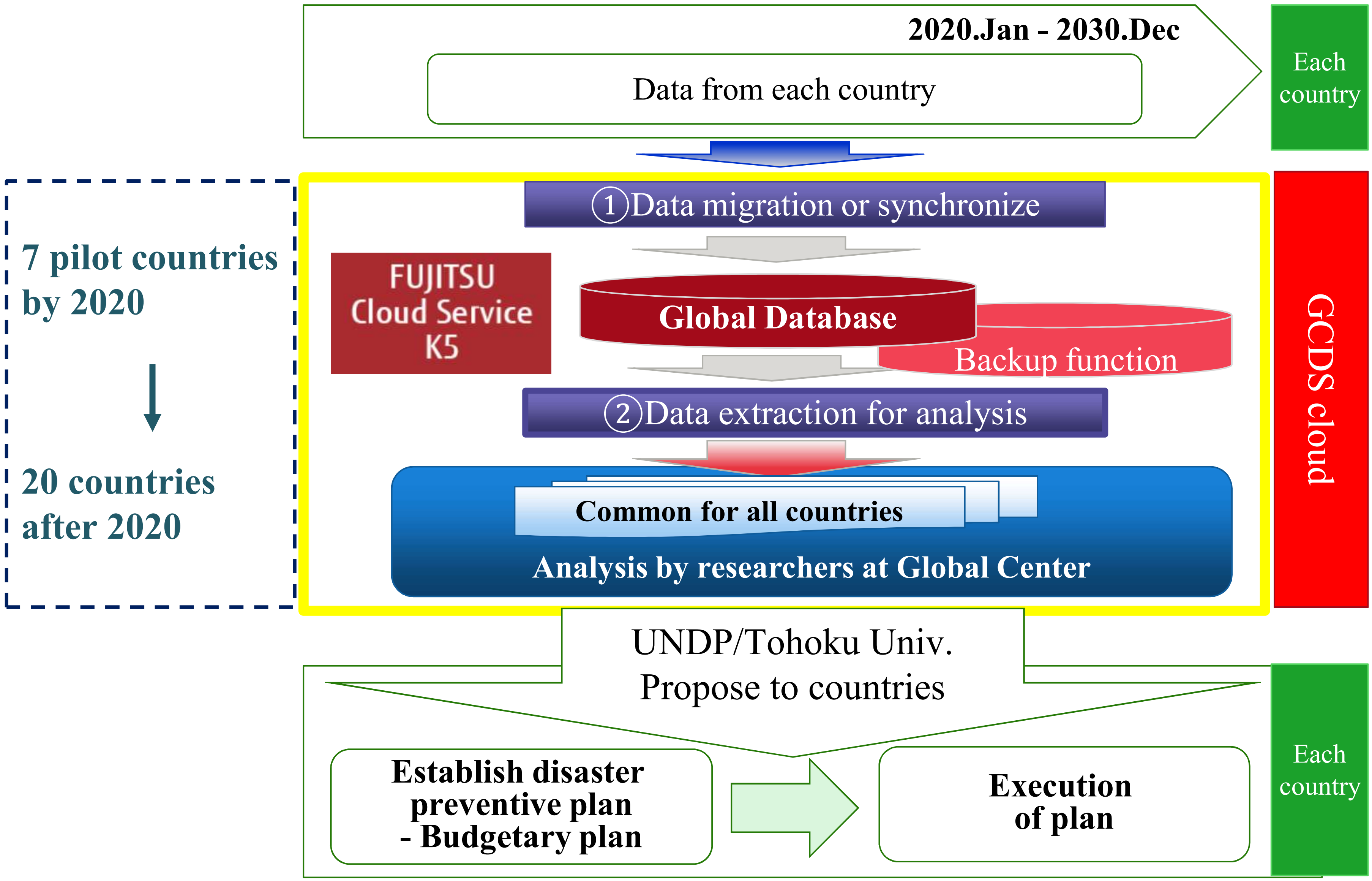
Pilot countries of GCDS

The GCDS is now conducting case studies in the following seven pilot countries. In addition, Japanese cases will also be examined soon.

Seven Pilot Countries

Indonesia	**Sri Lanka**	**Myanmar**
Cambodia	**Maldives**	**Nepal**
	Philippines	

Expectation of GCDS



Future Actions after the UN WCDRR(2)

- World Bosai Forum (tentative)

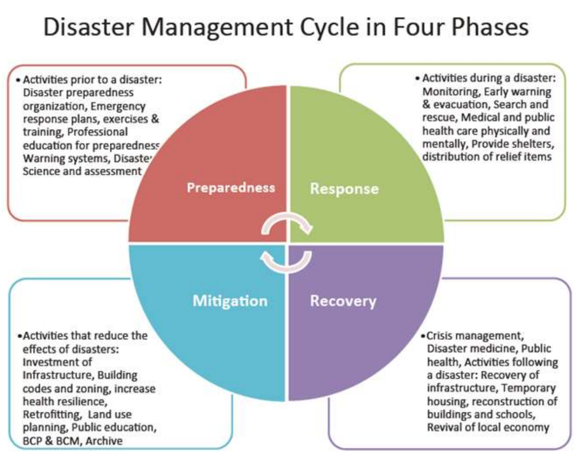
- Continue discussions generated during the 3rd United Nations World Conference on Disaster Risk Reduction.

- Theme: The broad setting of disaster risk reduction and recovery

- Periodic meetings (once every two years) in Tohoku and Sendai to contribute to the efforts for disaster risk reduction in Japan and overseas while continuing the support for the recovery of Tohoku.

- Planning creative events such as plenary meetings, symposiums and exhibition and think together with the government, international agencies including the United Nations, companies, academia, NGOs and citizens

- Collaboration with ISDR and Global Risk Forum (Davos)



Association of Pacific Rim Universities (APRU) Multi-Hazards Program

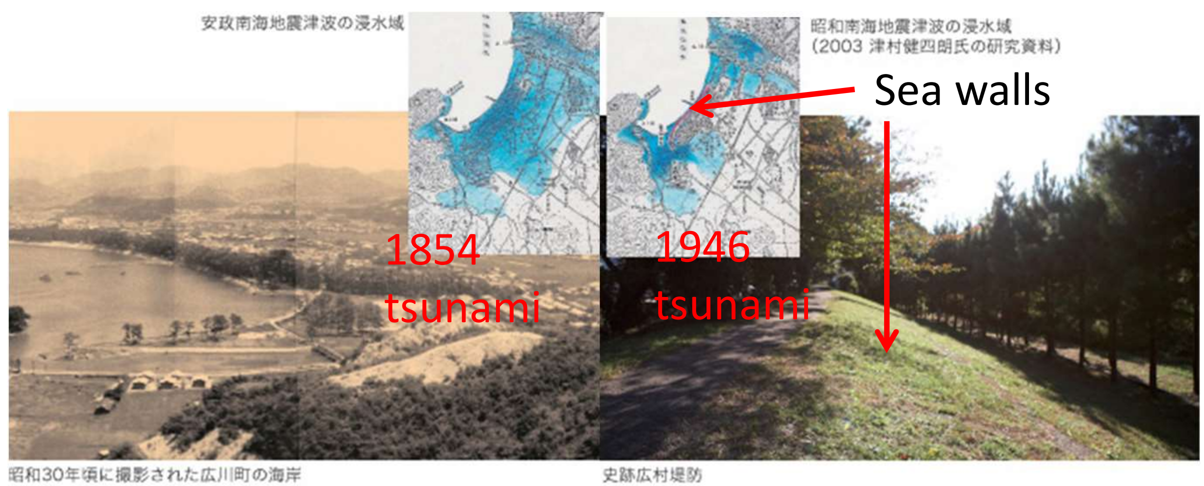
World Tsunami Awareness Day

In December 2015, the UN General Assembly designated 5 November as World Tsunami Awareness Day.

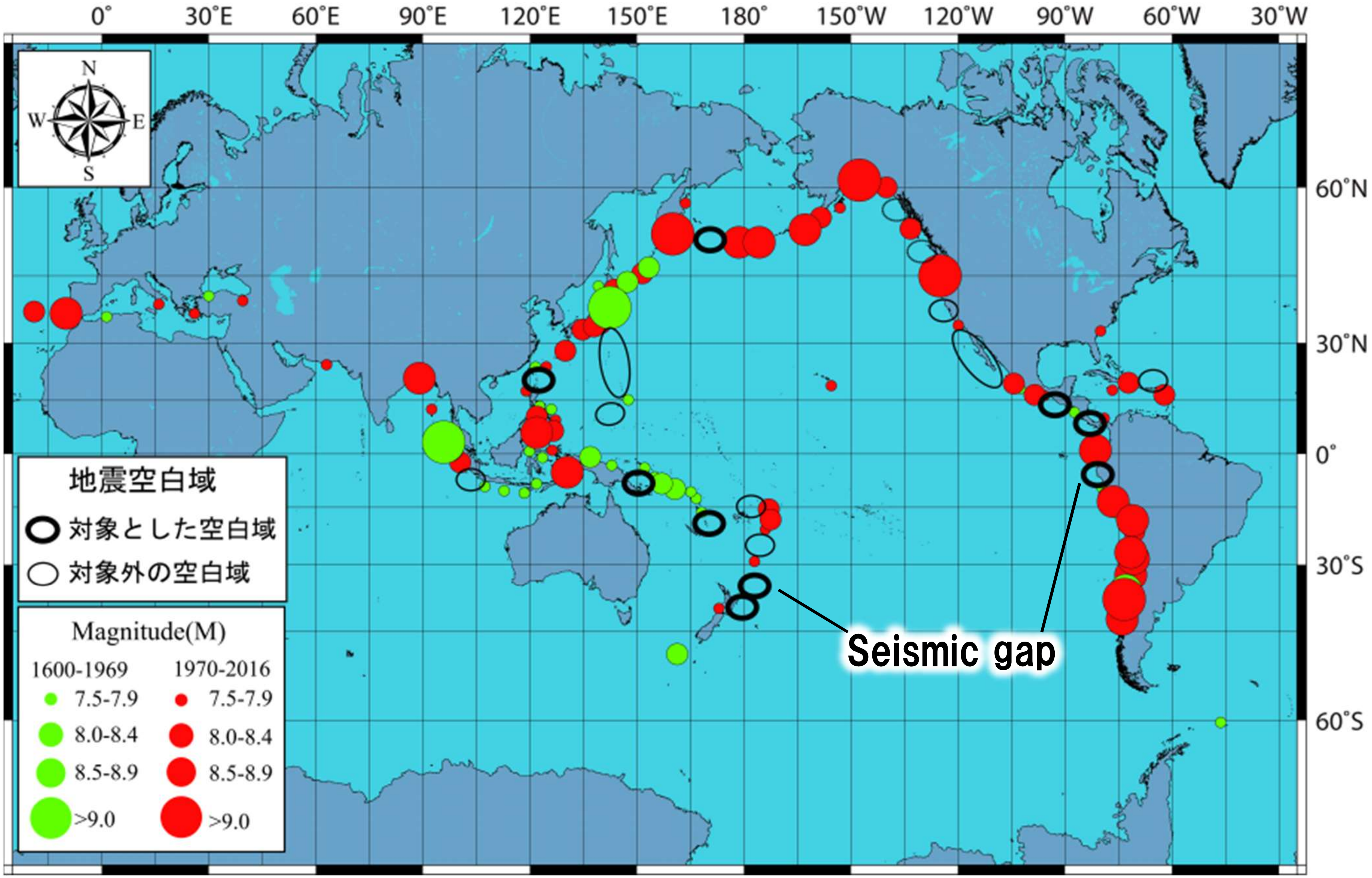
World Tsunami Awareness Day was the brainchild of Japan, which due to its repeated, bitter experience has over the years built up major expertise in areas such as tsunami early warning, public action and building back better after a disaster to reduce future impacts.

The date for the annual celebration was chosen in honor of the Japanese story of "Inamura-no-hi", meaning the "burning of the rice sheaves". During an 1854 earthquake a farmer saw the tide receding, a sign of a looming tsunami. He set fire to his entire harvest to warn villagers, who fled to high ground. Afterwards, he built an embankment and planted trees as a buffer against future waves.

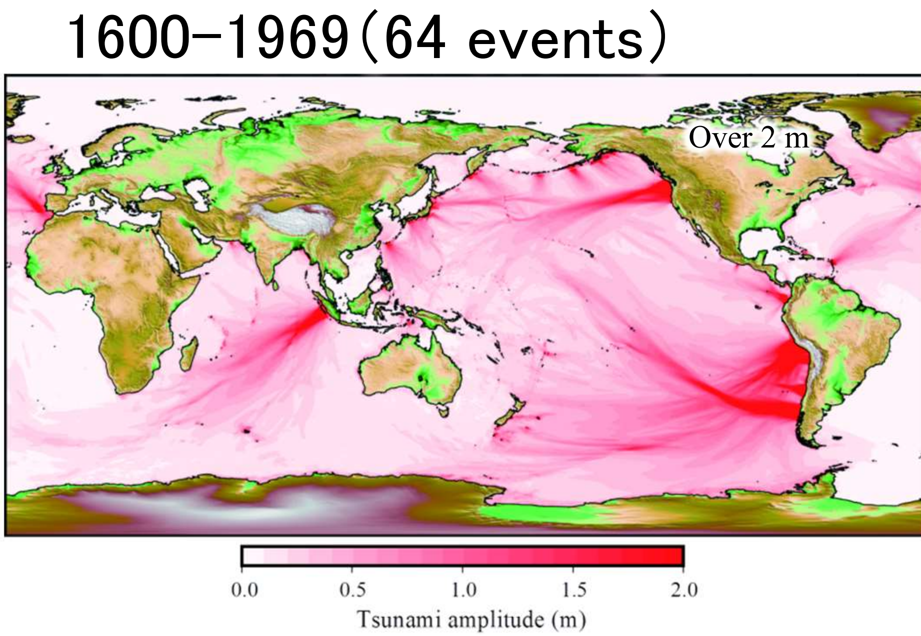
Goryo setting fire to his rice shaves

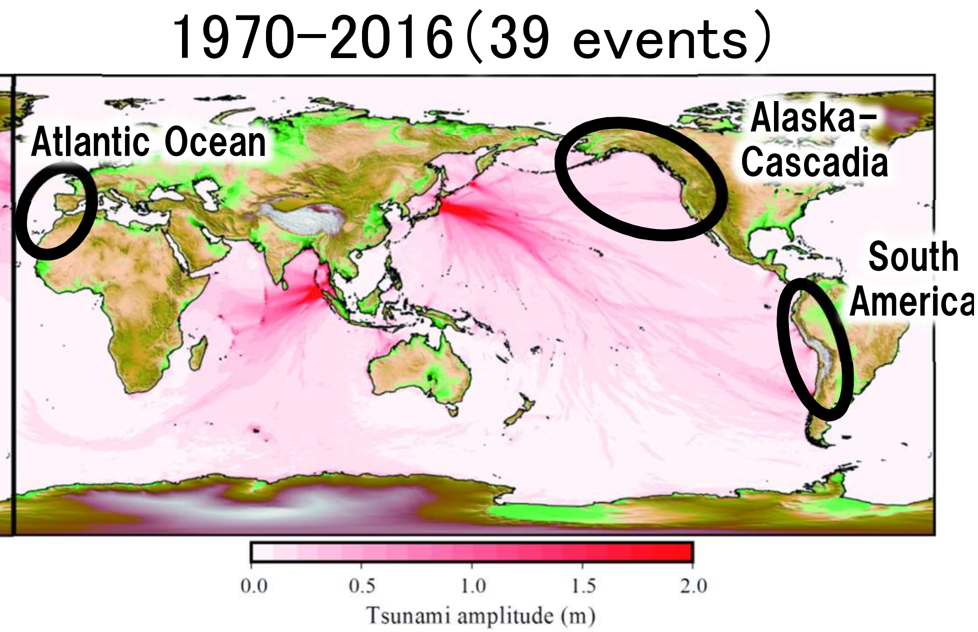


Distributions of the historical and future events



Hazards from the last 400 years



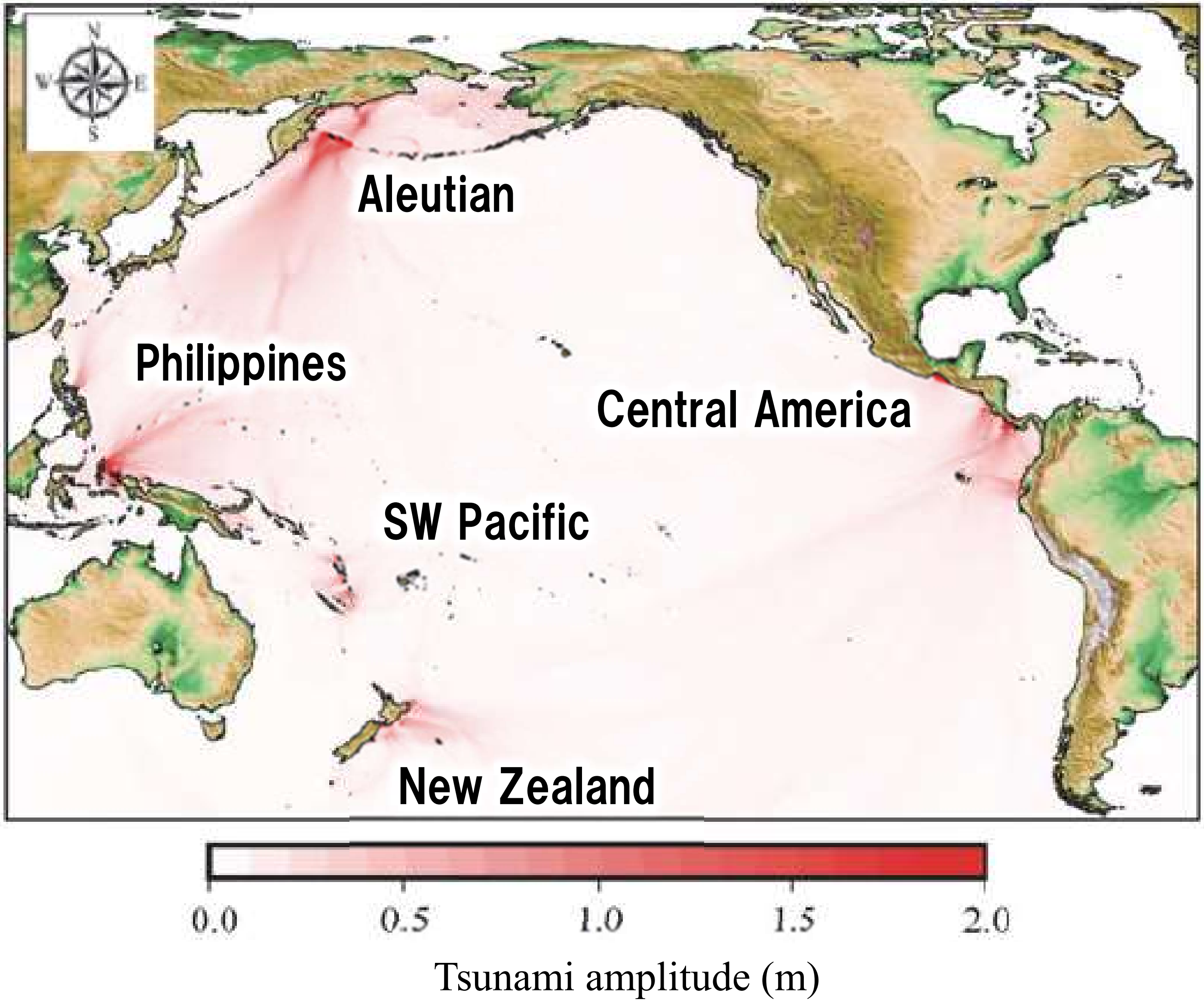


Damaging tsunamis that exceeded 2 m can be seen virtually everywhere, especially along the Pacific Rim including 1700 Cascadia (M9.0), 1755 Lisbon (M8.5), 1833 SW Sumatra (M8.3), 1868 Peru (M8.3), 1906 Ecuador (M8.8) and 1960 Chile (M9.5).

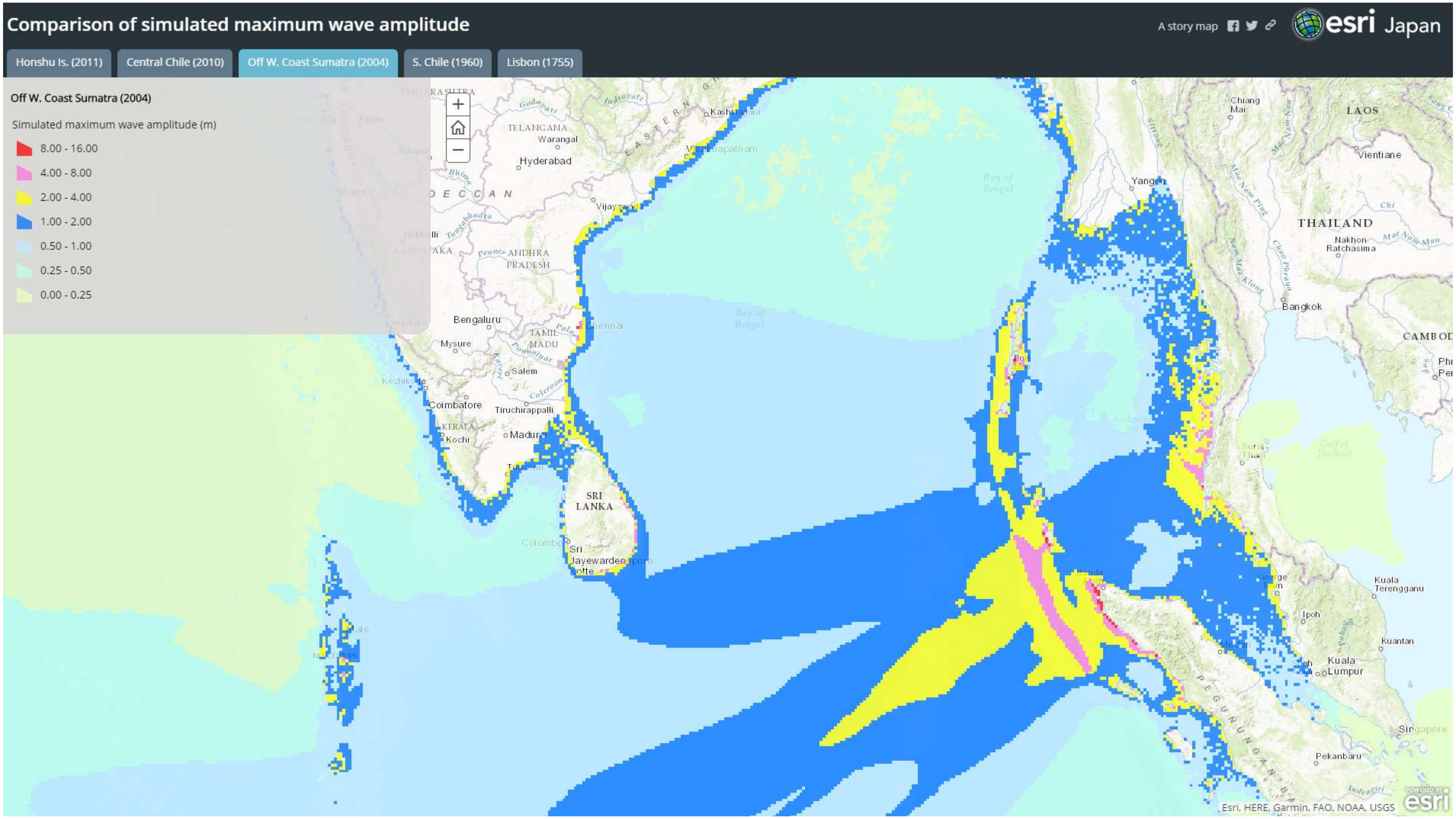
Only two major events, the 2004 Indian Ocean (M9.3) and Great East Japan (M9.0), classified as recent damaging tsunamis that exceeded 2 m and caused global impact meanwhile no major damaging tsunami in the east Pacific and Atlantic Ocean.

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

Hazards from the future events

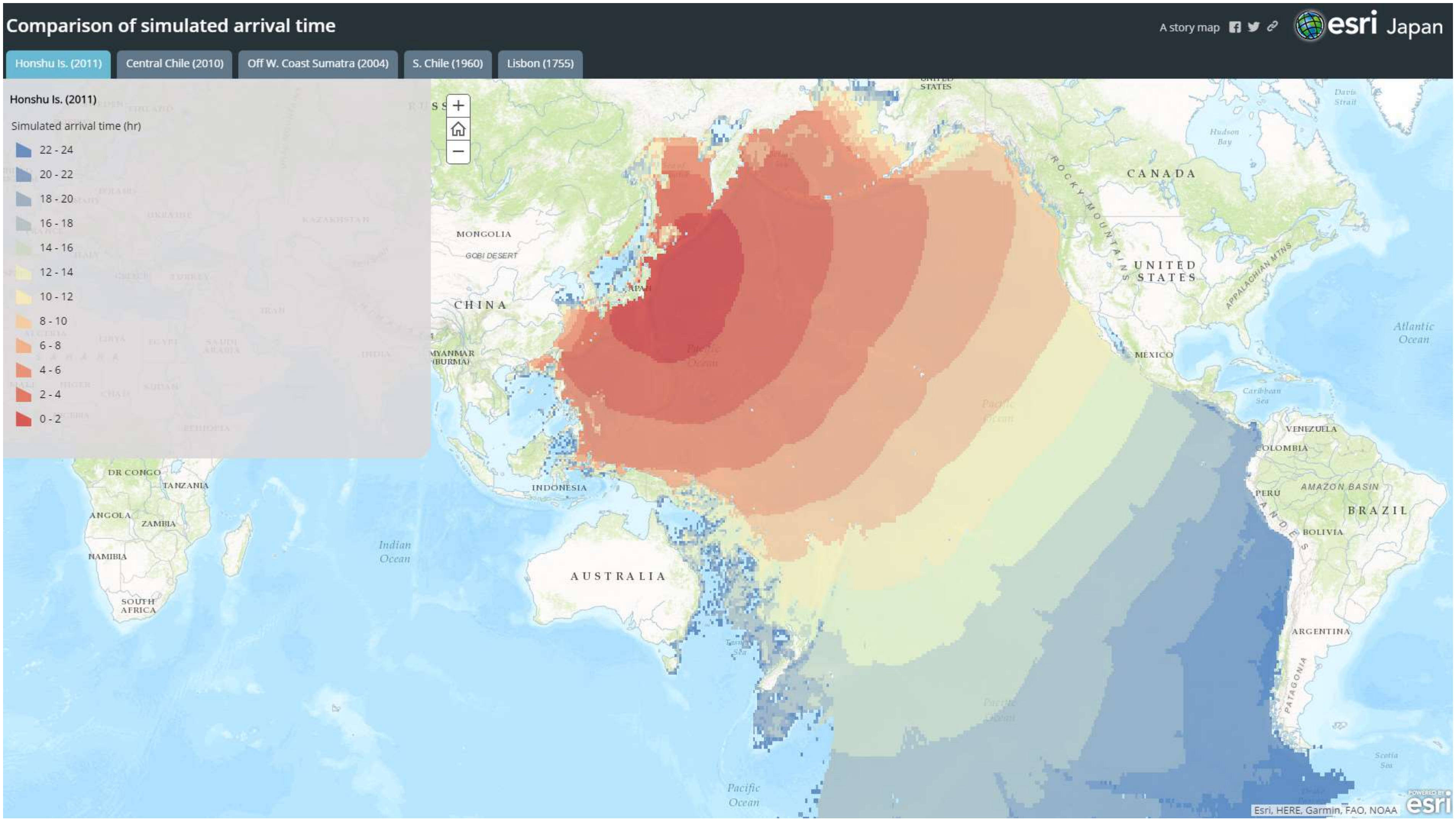


Web GIS (esri Japan): tsunami amplitude



http://www.arcgis.com/apps/MapSeries/index.html?appid=858c422f0d3644f492a8104a9deed001

Web GIS (esri Japan): tsunami arrival time

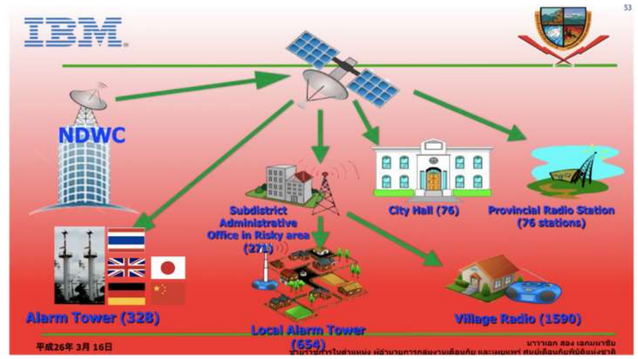


http://www.arcgis.com/apps/MapSeries/index.html?appid=7ea0485f8eb940ac9888239bf5b2178b

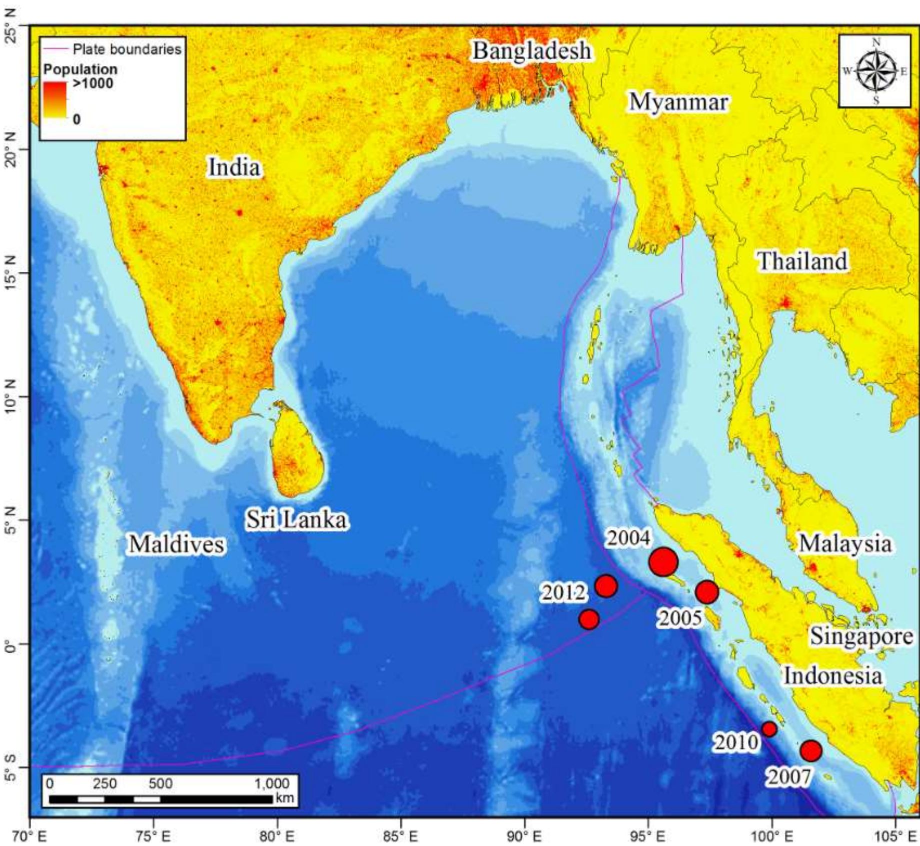
2004 Indian Ocean tsunami

Contents

- Tsunami warning
- Disaster education
- Tsunami memorial
- Housing reconstructi



The 2004 Indian Ocean tsunami and aftershocks

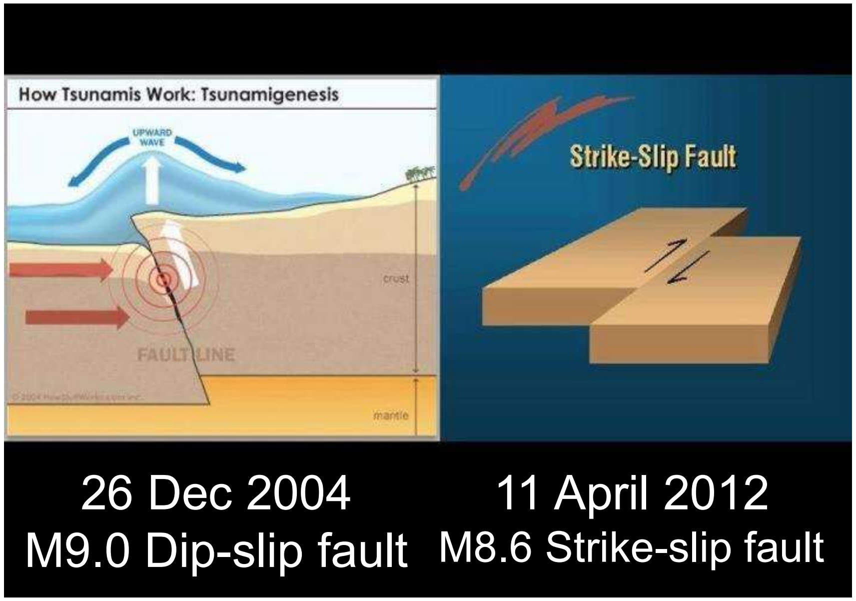


Date	Cause	Tsunami Source Location		Tsunami Parameters		Effects	
	Earth-quake Mag			Max Water Height	Num. of Runups	Deaths	
Year		Country	Name			Num	De
2004	7.5	INDONESIA	KEPULAUAN ALOR		3		
2004	9.1	INDONESIA	OFF W. COAST OF SUMATRA	50.90	1509	226898	4
2005	8.7	INDONESIA	INDONESIA	4.20	61	10	1
2005	6.7	INDONESIA	KEPULAUAN MENTAWAI	.40	1		
2006	7.7	INDONESIA	SOUTH OF JAVA	20.90	196	802	3
2007	8.4	INDONESIA	SUMATRA	5.00	47		
2008	6.5	INDONESIA	SUMATRA	.12	1		
2009	7.5	INDIA	ANDAMAN ISLANDS	.01	1		
2009	6.7	INDONESIA	SUMATRA	.18	1		
2009	7.5	INDONESIA	SUMATRA	.27	1		
2010	7.8	INDONESIA	SUMATRA	.44	6		
2010	7.5	INDIA	LITTLE NICOBAR ISLAND	.03	1		
2010	7.8	INDONESIA	SUMATRA	9.30	89	431	3
2012	8.6	INDONESIA	OFF W. COAST OF N SUMATRA		20		
2012	8.2	INDONESIA	OFF W. COAST OF N SUMATRA		4		
2013	*	PAKISTAN	OFF COAST GWADAR	.26	4		

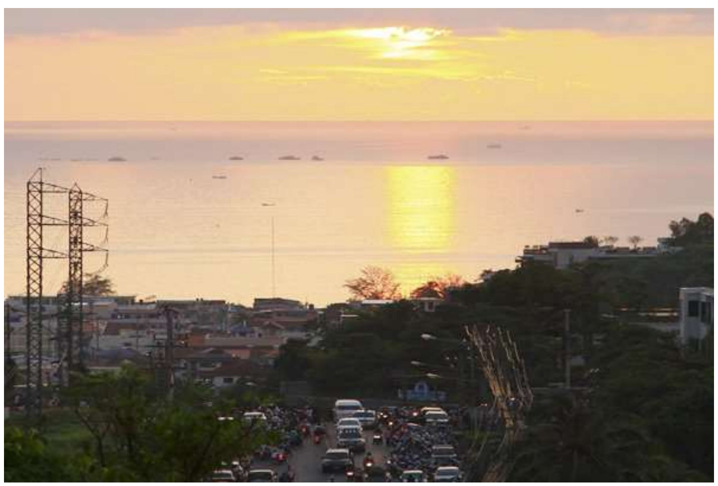
Source: NOAA tsunami event database

Importance of education

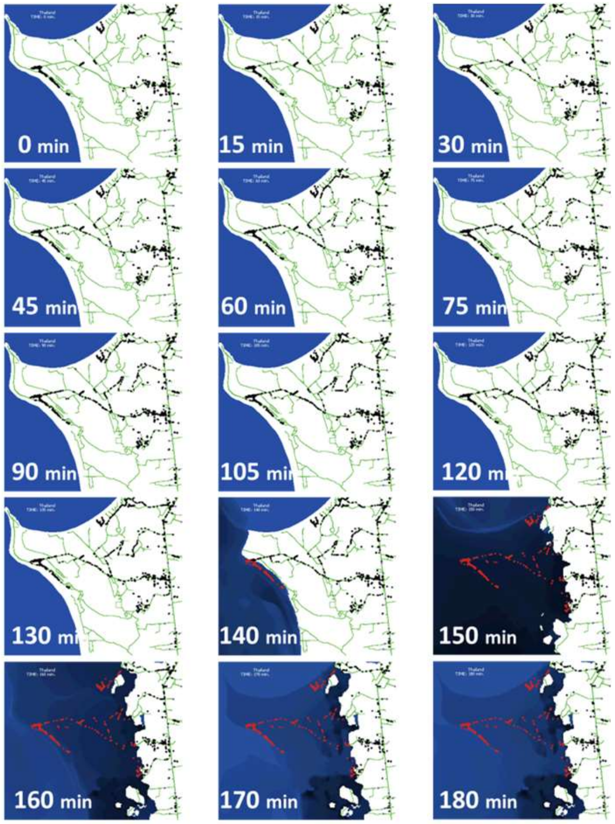
EX: Tsunami warning on 11 April 2012



No tsunami but very serious traffic jam



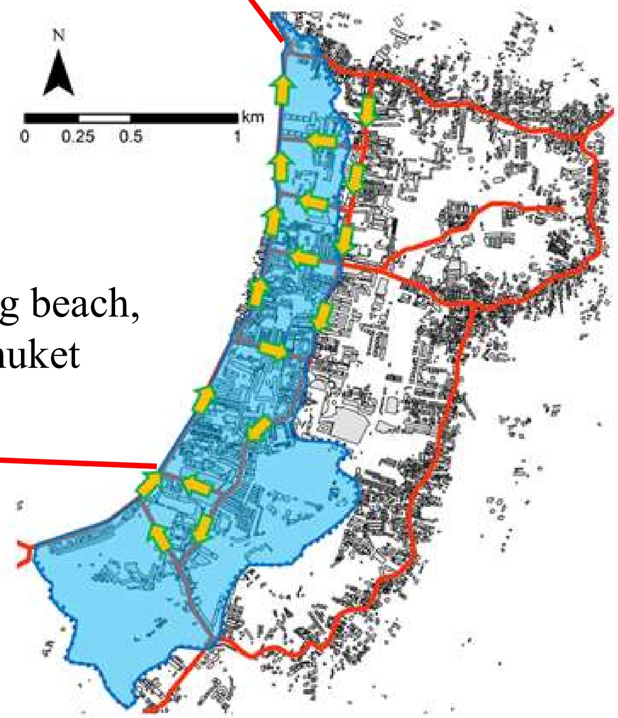
Traffic jam after warning



V (%)	E (μ) (min)	F (%)
0	30	23%
0	60	26%
0	90	30%
0	120	34%
25	30	9%
25	60	14%
25	90	21%
25	120	26%
50	30	7%
50	60	10%
50	90	16%
50	120	22%
75	30	6%
75	60	10%
75	90	16%
75	120	21%
100	30	7%
100	60	11%
100	90	15%
100	120	22%

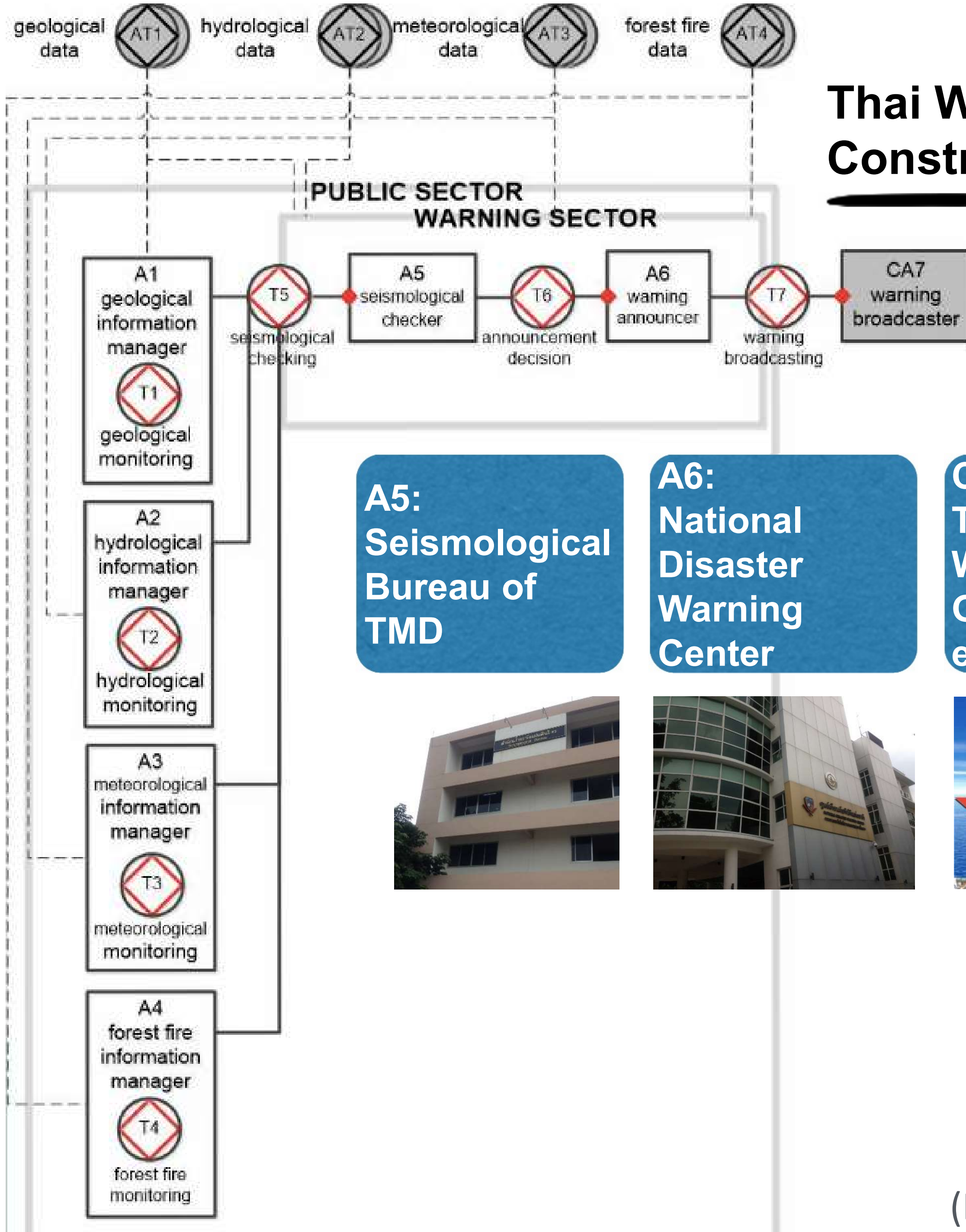
"V" ratio of using cars, one car four persons, "E(μ) " average starting time of evacuation and "F" fatality ratio

Real situation in 2012



Patong beach, Phuket

Thai Warning System Construction Model



A1: Dept. Mineral Resources

A2: Royal Irrigation Dept. (RID)

A3: Thai Meteorological Dept. (TMD)

A4: Royal Forest Dept.

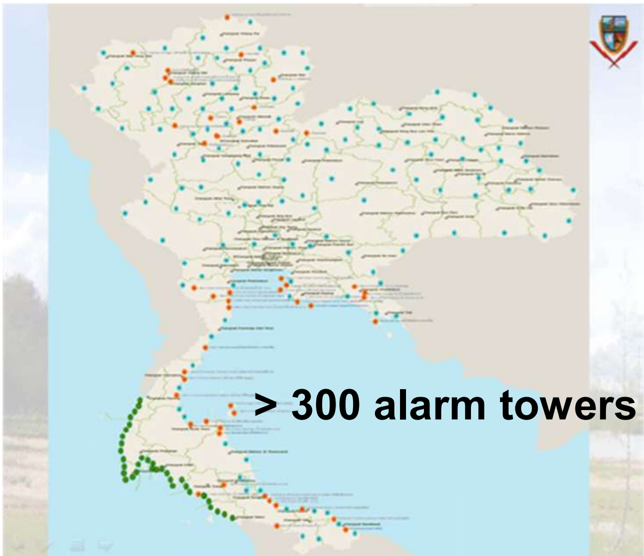
A5: Seismological Bureau of TMD

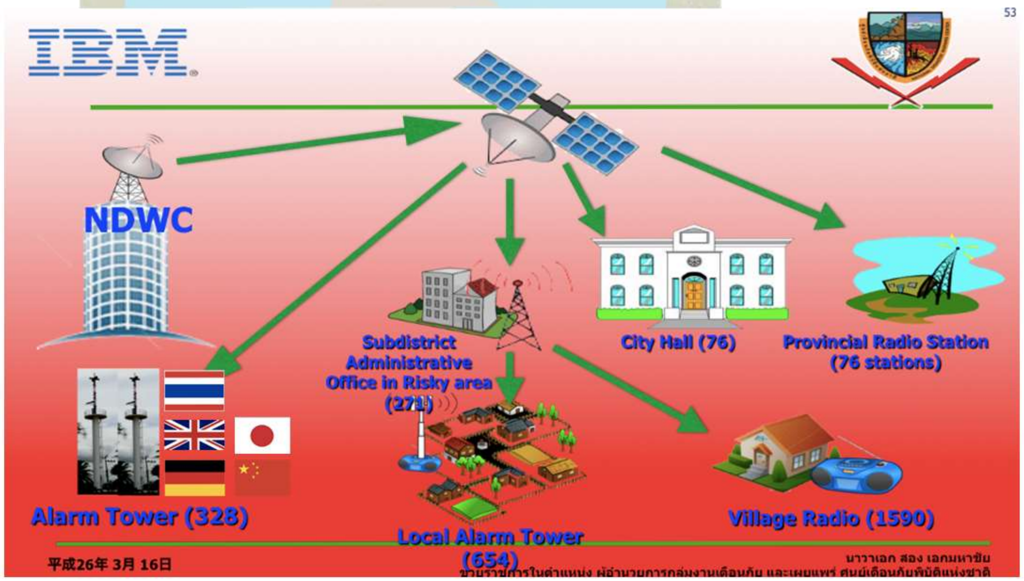
A6: National Disaster Warning Center

CA7: TV Pool, Warning tower, Gov. Info Network, etc.

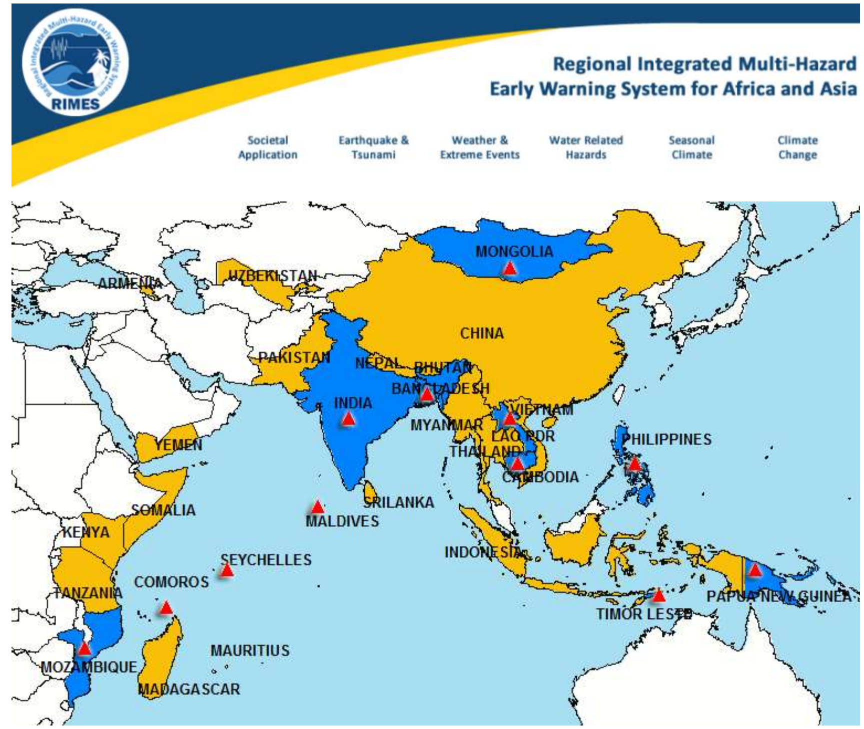
(Leelawat et al, 2015)

Tsunami warning systems





Source: Ekmahachai (2013)



Regional Integrated Multi-Hazard Early Warning System for Africa and Asia

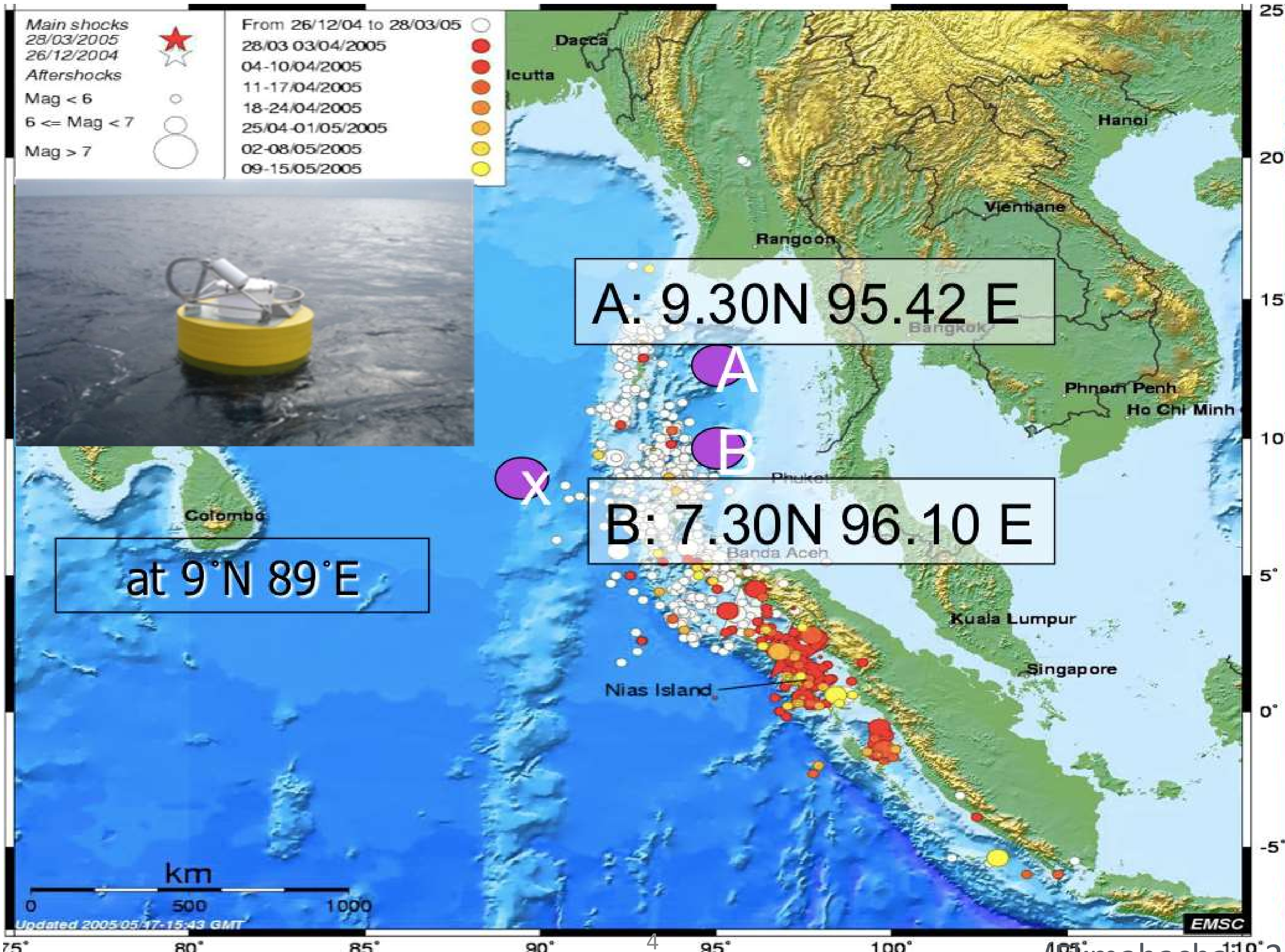
National Disaster Warning Center (NDWC), Thailand

Oversea Sources

- Pacific Tsunami Warning Center (PTWC)
- Japan Meteorological Agency (JMA)
- United States Geological Survey (USGS)
- National Oceanic and Atmospheric Administration (NOAA)
- European - Mediterranean and Seismological Center (EMSC)
- Malaysian Meteorological Service (MMS)
- Intergovernmental Oceanographic Commission of UNESCO (IOC)
- German Research Centre for Geosciences (GFZ)
- Global Disaster Alert and Coordination System (GDACS)

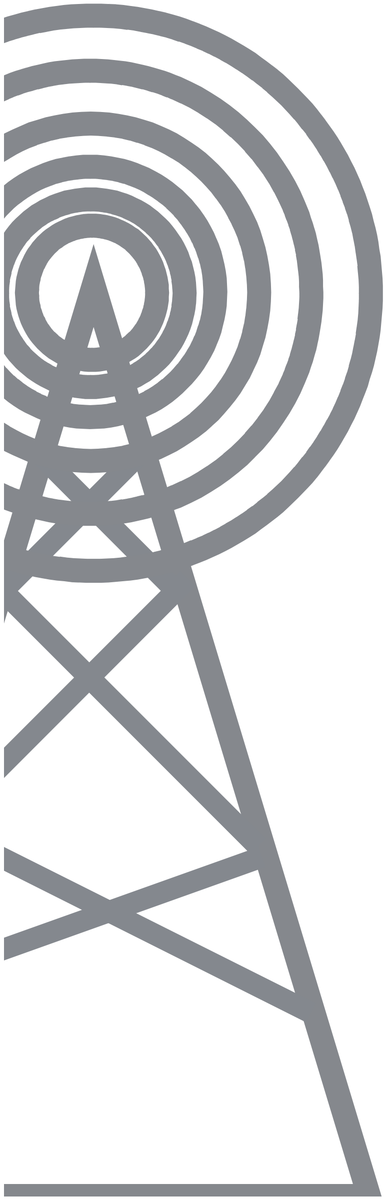
(Leelawat et al, 2015)

Buoy location



(Ekmahachai, 2013)

Broadcasting Mediums



- **SMS** (>= 20M numbers)
- Automatic **FAX** (16 machines)
- **Direct call center** (8 lines)
- **E-mail**
- **TV Pool**
- **Alarm tower** (328 towers)
- **Warning box** at City Hall (166 boxes)

- **Subdistrict Administrative Office** in Risky area (271 stations)
- **Local alarm tower** (654 towers) and village radio (1,590 devices)
- **News call center '192'** (70 terminals)
- **Government Information Network**
- **Smart Phone server** (600,000 licenses)
- **Web EOC**

(Leelawat et al., 2015)

Disaster reduction class in ASEAN countries

Phuket, Krabi and Bangkok
(Eight schools = 400 students)

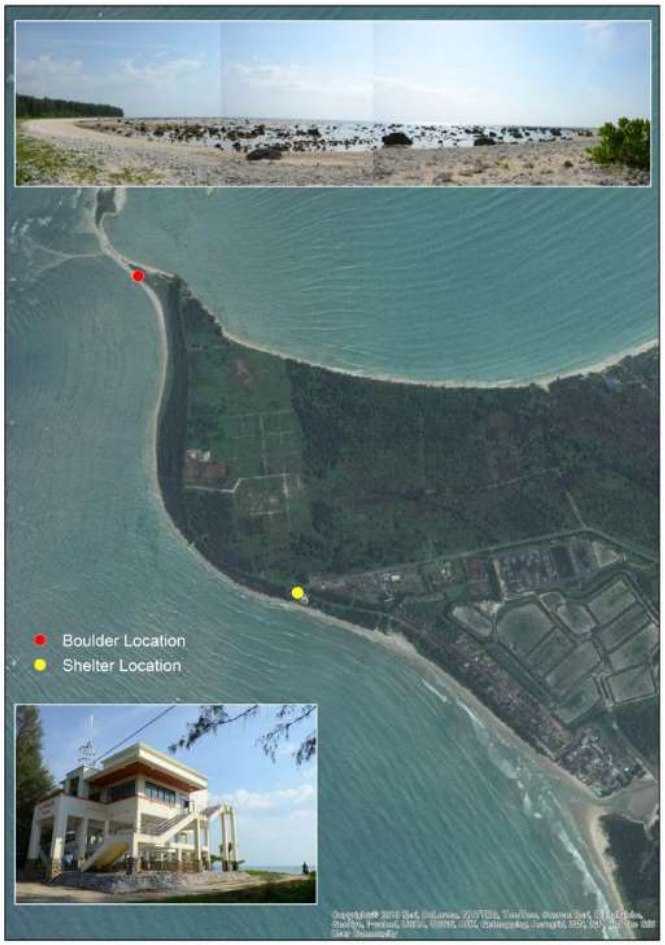
Banda Aceh, Indonesia (Two schools × two times = 200 students)

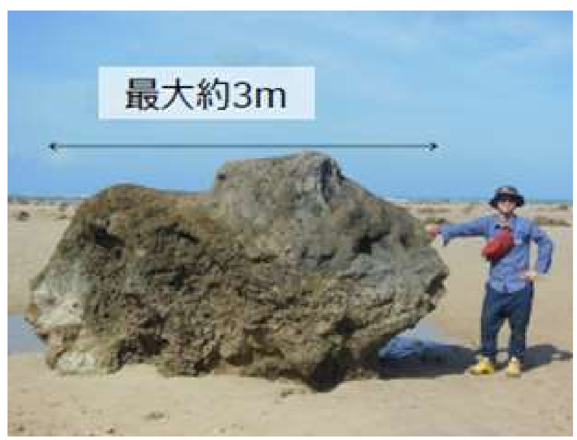
Layte Island, the Philippines (Four schools = 200 students)

Lessons from the 2004 Indian Ocean tsunami in rebuilding of the school

- At the time of the 2004 tsunami, the school had only two stories and the tsunami was higher than the school.
- The school was then rebuilt with three stories. In case of earthquake and tsunami, they will gather at the third floor.
- In case the school got some damages or the estimated tsunami is higher than the third floor, we organized a drill so that they can evacuate to the hill behind.

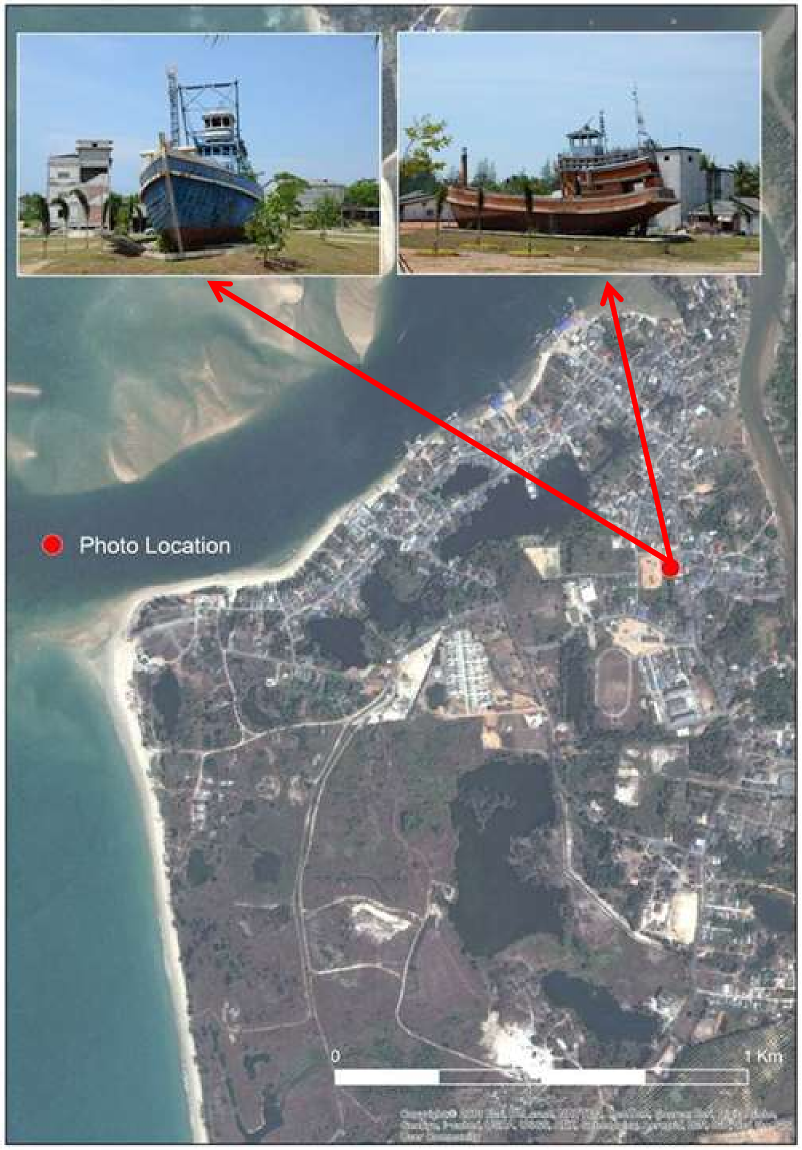
Remaining geological evidences and evacuation facility





Tsunami memorial: T. 813 boat

Tsunami memorial: Two fishing boats and tsunami signs



Housing issues / evaluation of new houses after the tsunami

1. Tsunami hit the villages and destroy houses.

2. Emergency shelter

3. Temporary house

Most residents in Namkem area evacuated to temporary shelter at SAO (Sub district Administrative Organization) Baan muang and stay at temporary shelter for **6 months**, during that time rescue and cleaning continued in the Tsunami damaged area with the assistance of many organizations and volunteers.

Housing issues / evaluation of new houses after the tsunami

Provide

These shop house types are priority for resident who have land title. Government can build the new house on their land immediately. But house is quite small and material is not good quality. Most villagers complain that they have to renovate, fix the roof or extend the house later. In many cases users change the donated house to be storage or other function.

3

The houses and lands were provided by government and relocated 10 km away from Namkem. This place is far from the sea and located in a non-tsunami risk area according to risk map. Most of resident don't know each other before and random receive house.

4

Non-relocate

Relocate

2

This group of resident have land right and negotiate with government to have money instead of provide house because not satisfy with design of PNR house and don't want to relocated. They got haft of the provided house price, used their own money to top up and buy material together, design house according to each family need and build by themselves.

1

This groups of villagers who previously lived in slum area and have no land titles, they were living in rental houses. After the 2004 tsunami most villagers were afraid of tsunami so they wanted to move a little far from the sea but still in Namkem area. Now they have land sharing and pay rental fee every months after 15 years they will have land right ownership.

Self-built

Conclusions

- Tsunami warning

✓ Greatly improve of the warning time from 20 min at the beginning to 5 min since many years ago.

- Disaster education

✓ Importance of media for warning dissemination and basic knowledge on fault mechanisms/tsunami characteristics.

- Tsunami memorial

✓ Need great effort of maintenance and attraction.

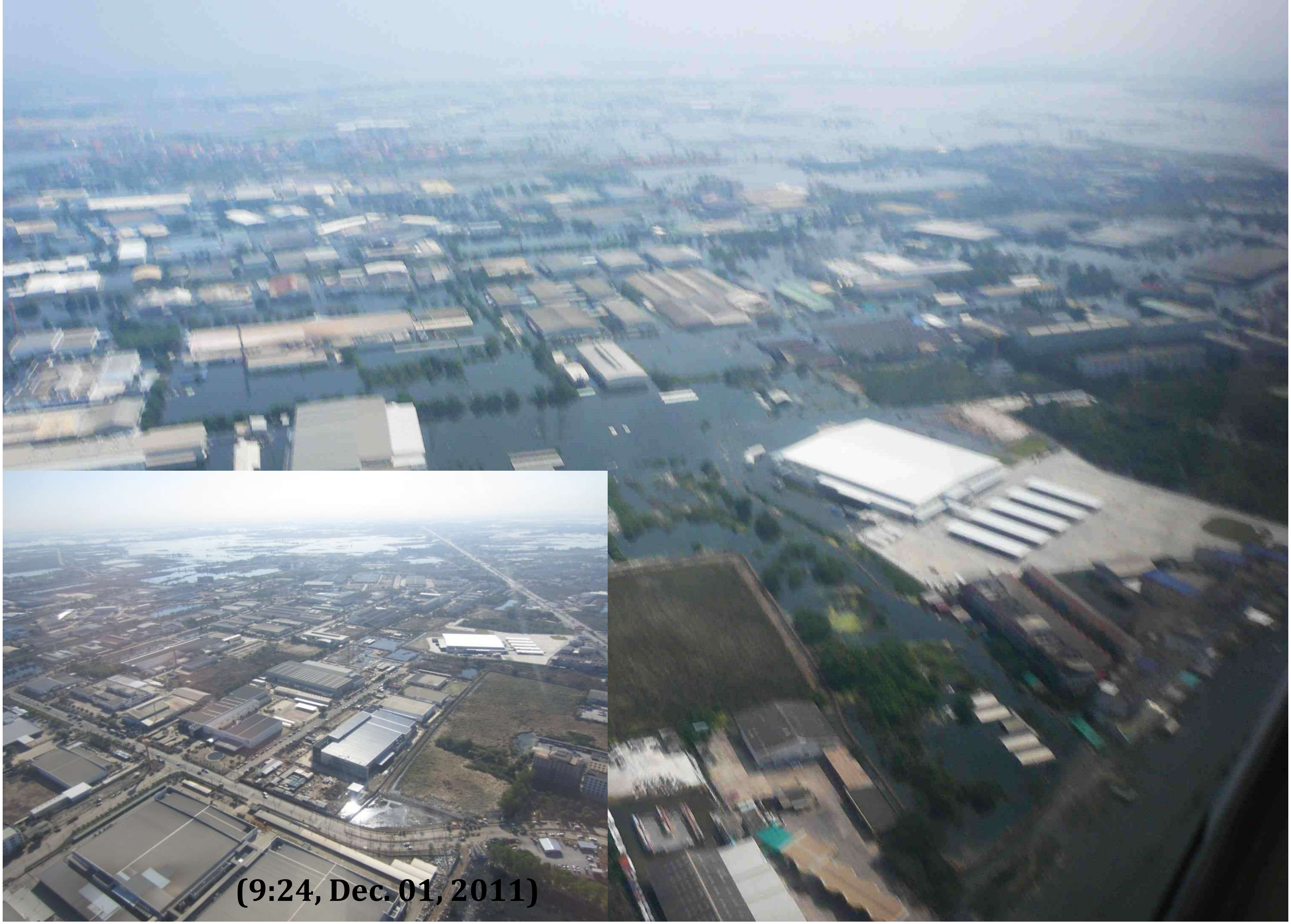
- Housing reconstruction

✓ A challenge in applying the lessons to reconstruction of future events.

2011 Floods in Thailand

1942年洪水氾濫，ラーマ5世像とアナンタ・サマーコム宮殿（旧国会議事堂）

Rojana Industrial Park (11:43, Oct. 21, 2011) 提供：JICA



(9:24, Dec. 01, 2011)

Rojana Industrial Park (11:41, Oct. 21, 2011) 提供：JICA

Ayutthaya (11:46, Oct. 21, 2011) 提供：JICA

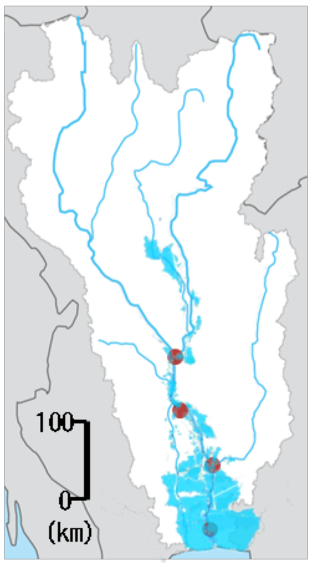
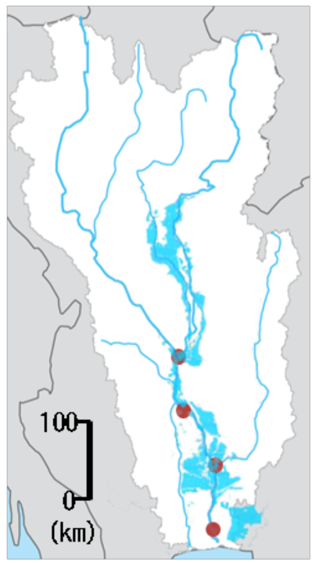
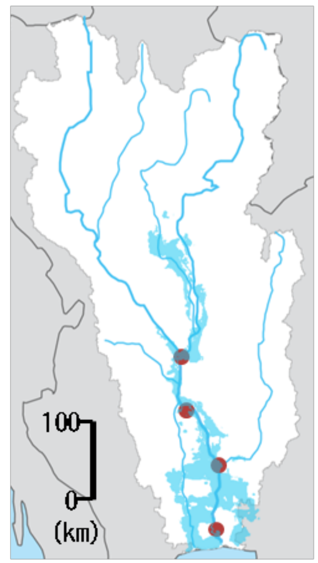
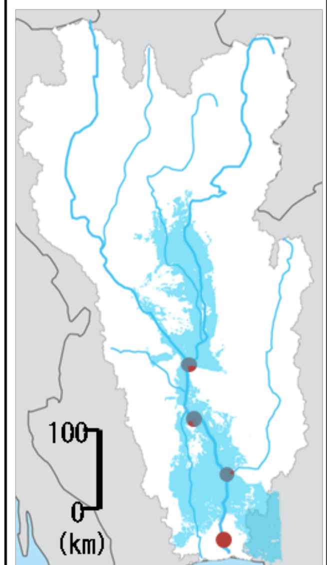
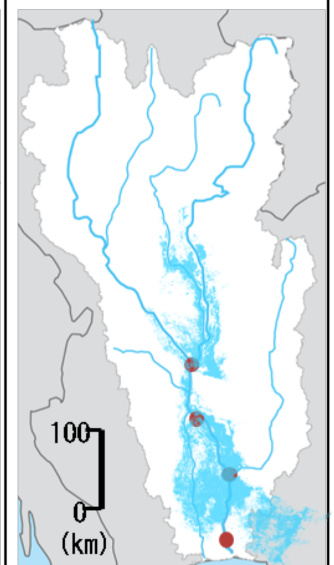
(Dec. 8, 2011)


AFP
BB News
ธนาคารออมสิน

Flood in Thailand

- The 2011 greatest flood on records brought 813 dead and 3 missing nationwide (as of Jan. 8, 2012; Thai Ministry of Interior, 2012).
- The area of damaged agricultural land throughout Thailand peaked at 18,291 km^2 (as of Nov. 14, 2011; Thai Ministry of Interior, 2012).
- In the industrial sector, 7 industrial estates and 804 companies were struck with inundation damage, and of those, 449 companies were Japanese companies (Japan External Trade Organization, 2011).
- The World Bank (as of Dec., 2011) estimates total loss of 1.36 trillion baht (approx. 3.5 trillion yen) due to this flood. This is the 4th economic amount of damage in the world that are the East Japan great earthquake, the hurricane "Katrina", and the Great Hanshin-Awaji Earthquake.
- Japanese nonlife insurance company pays 900 billion yen to a Japanese company.
  - ✓ It was greatly exceed 600 billion yen of payment to companies for the East Japan great earthquake.

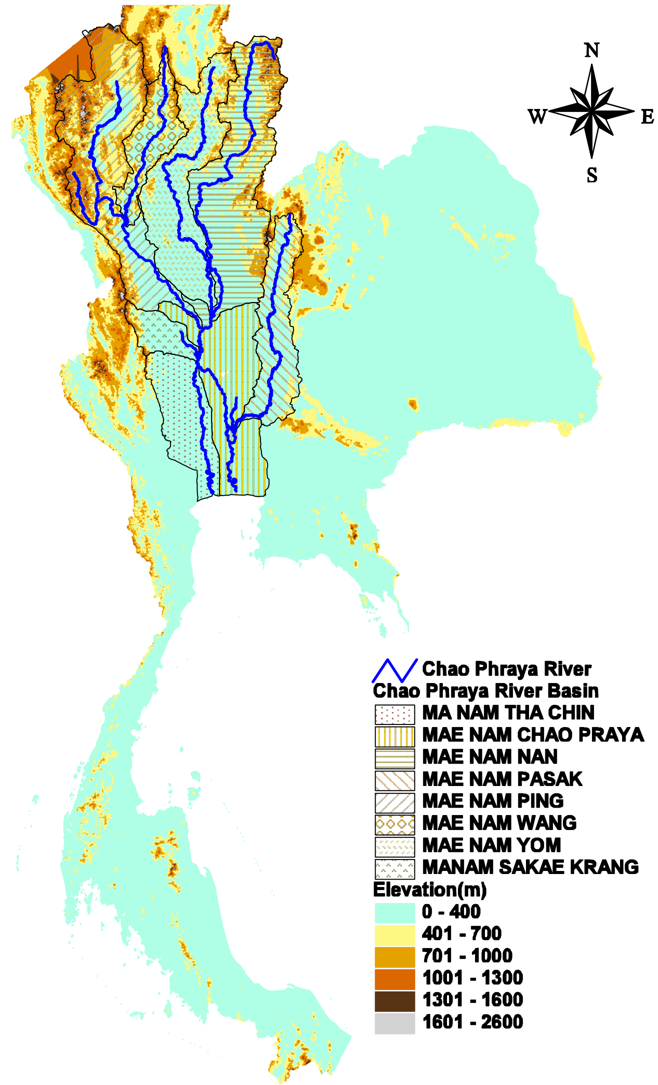
Past flood in the Chao Phraya river

年	1983	1995	1996	2006	2011
浸水域図					
浸水面積 (k㎡)	11,900	6,140	7,120	19,000	18,000以上 ※全国の農地被害面積から推計
被害額 (億バーツ)	66	78	20	42	13,600 ※不動産等資産損害及び機会損失額のみ

チャオプラヤ川流域における過去の洪水

CHAO PHRAYA RIVER BASIN (CPRB)

- Largest basin in Thailand
- C.A. 157,925 km^2
- 29 provinces
- Almost 30% of the country's area



CHAO PHRAYA RIVER BASIN (CPRB)

- The Ping (36,018 km^2)
- The Wang (11,708 km^2)
- The Yom (24,720 km^2)
- The Nan (34,557 km^2)

- Bhumibol Reservoir was constructed in 1964 on ping river.
- Sirikit Reservoir was constructed in 1977 on Nan river.

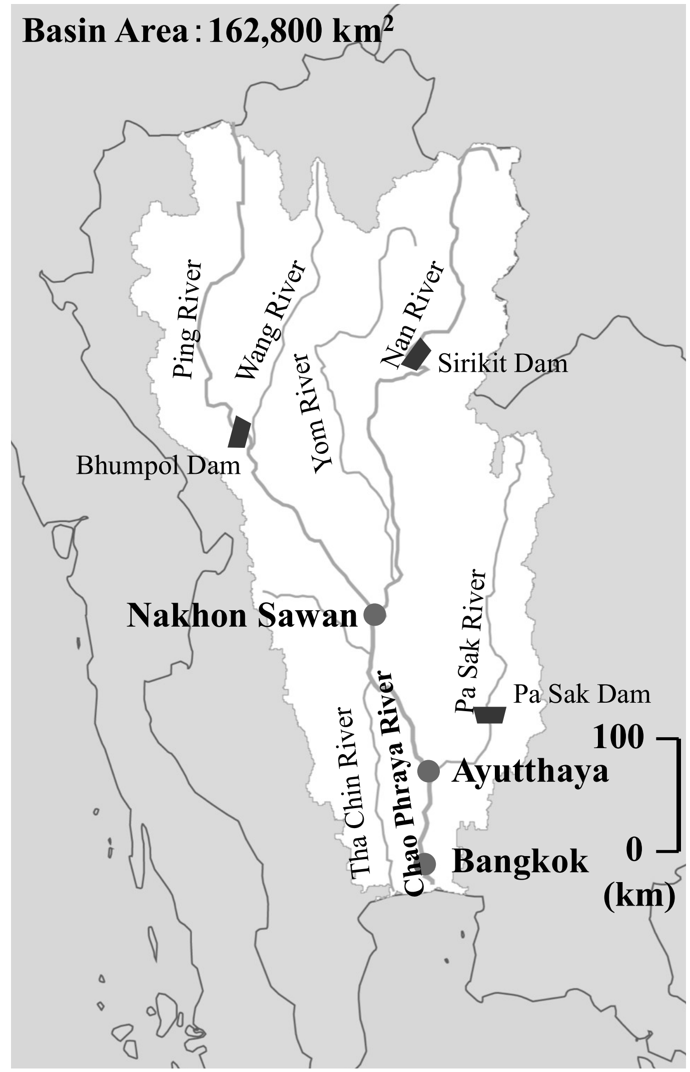


Figure 1. Diagram of the Chao Phraya River watershed.

- The Chao Phraya River watershed is divided into an upper watershed and lower watershed by the narrowed section at Nakhon Sawan.

- In upper watershed, Ping River, Wang River, Yom River, Nan River flow down from the northern mountain system and join together at Nakhon Sawan.

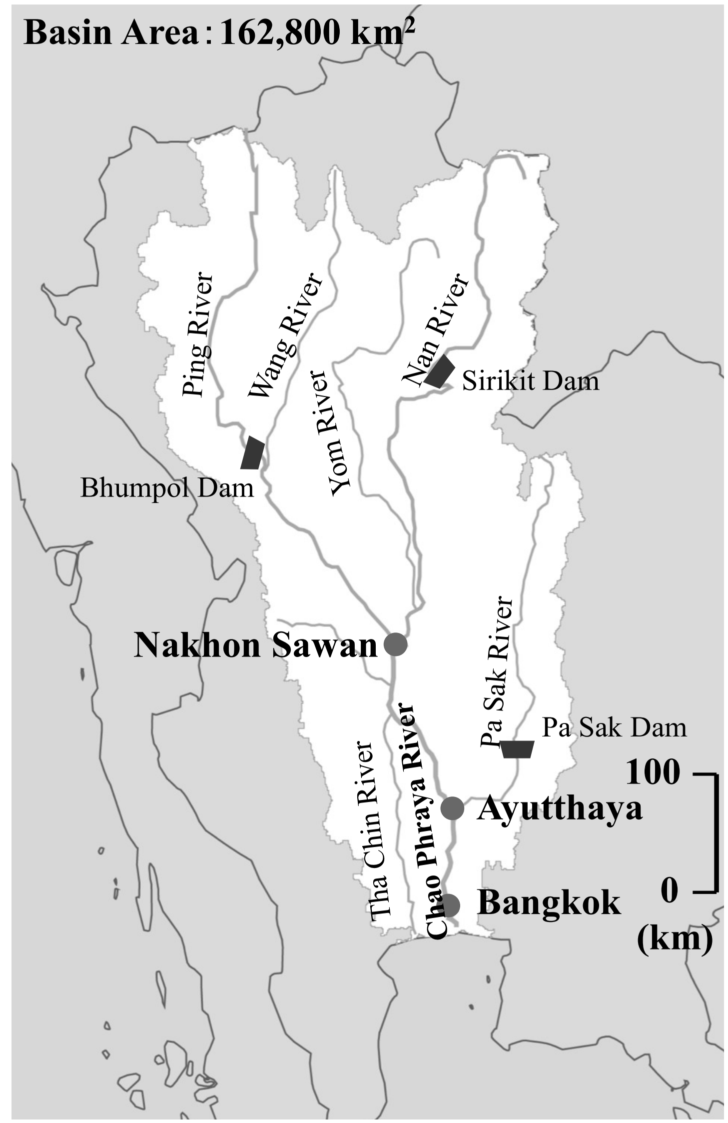


Figure 1. Diagram of the Chao Phraya River watershed.

Reservoirs

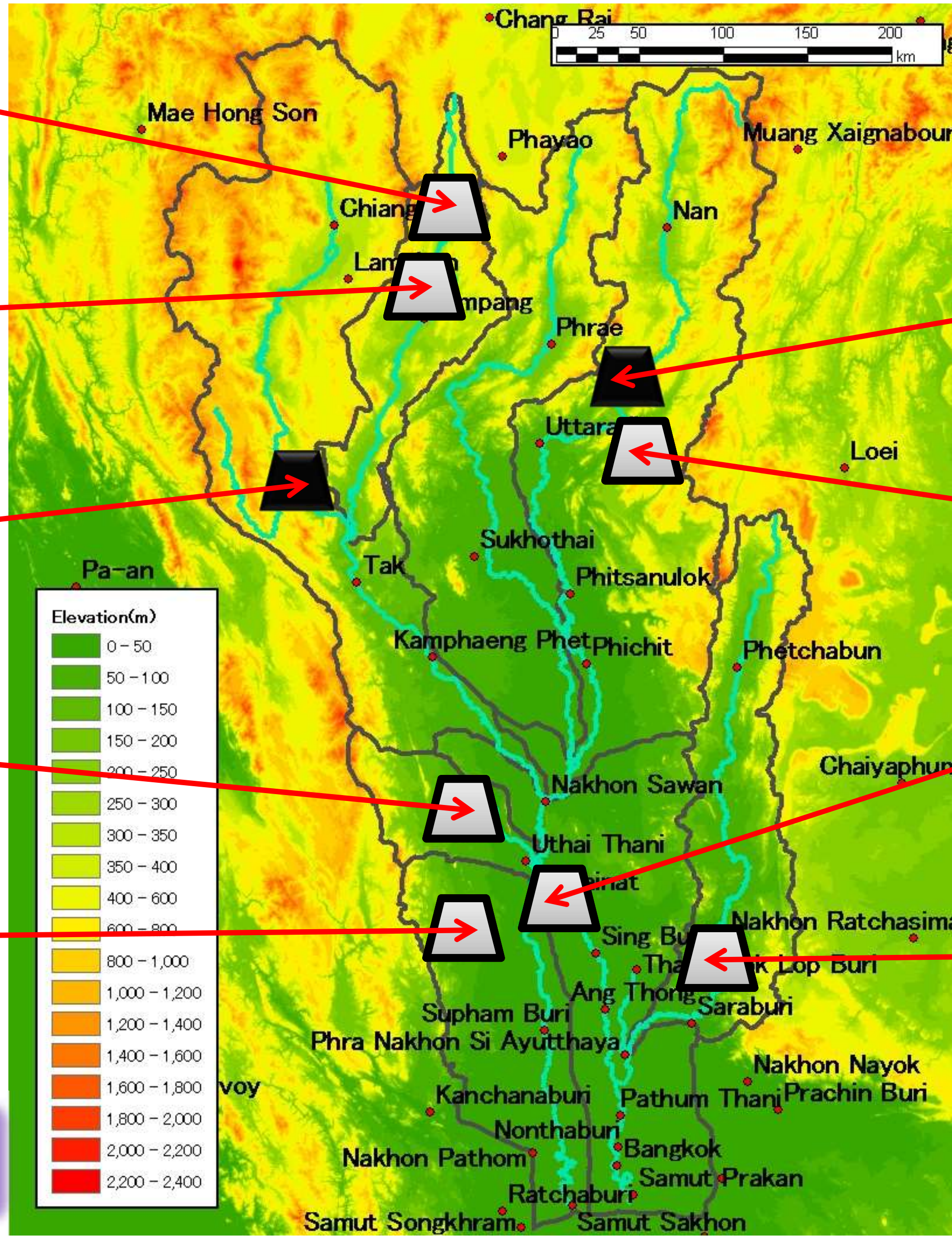
Kiew Kar Mha
171 (MCM)
RID

Kiew Lom
112(MCM)
RID

Bhumibol
13,462(MCM)
EGAT

Tab Salao
160(MCM)
RID

Krasiao
240(MCM)
RID



Sirikit
9,510(MCM)
EGAT

Kaew Noi
766(MCM)
RID

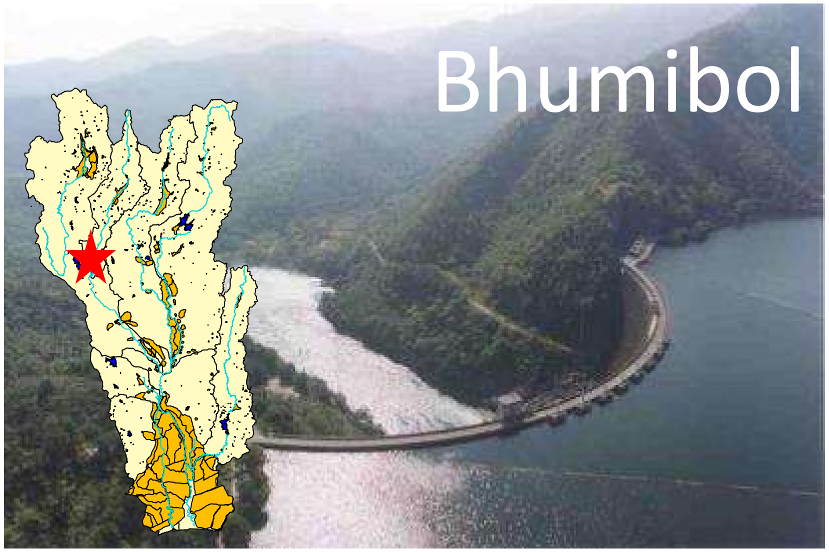
Chao Phraya
Barrage
RID

Pasak
960(MCM)
RID

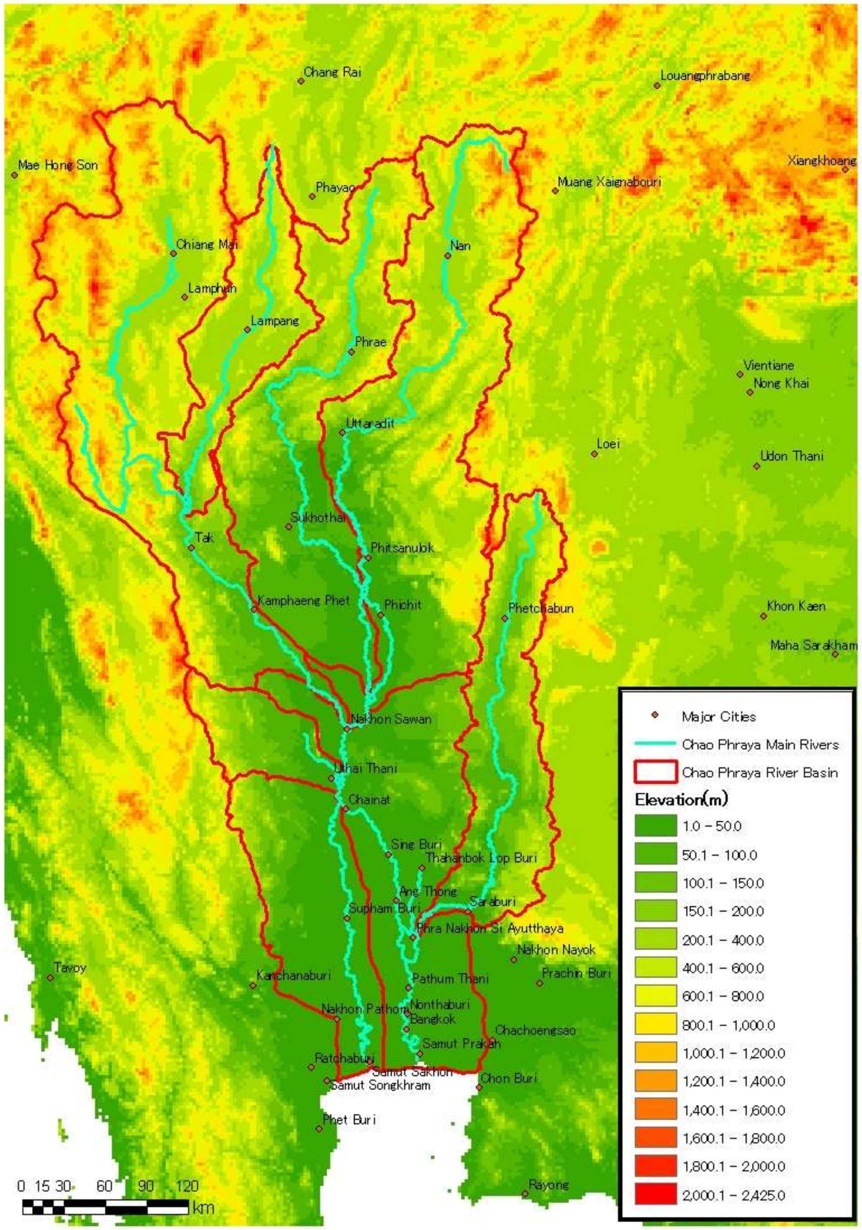
Total 25 Billion m^3

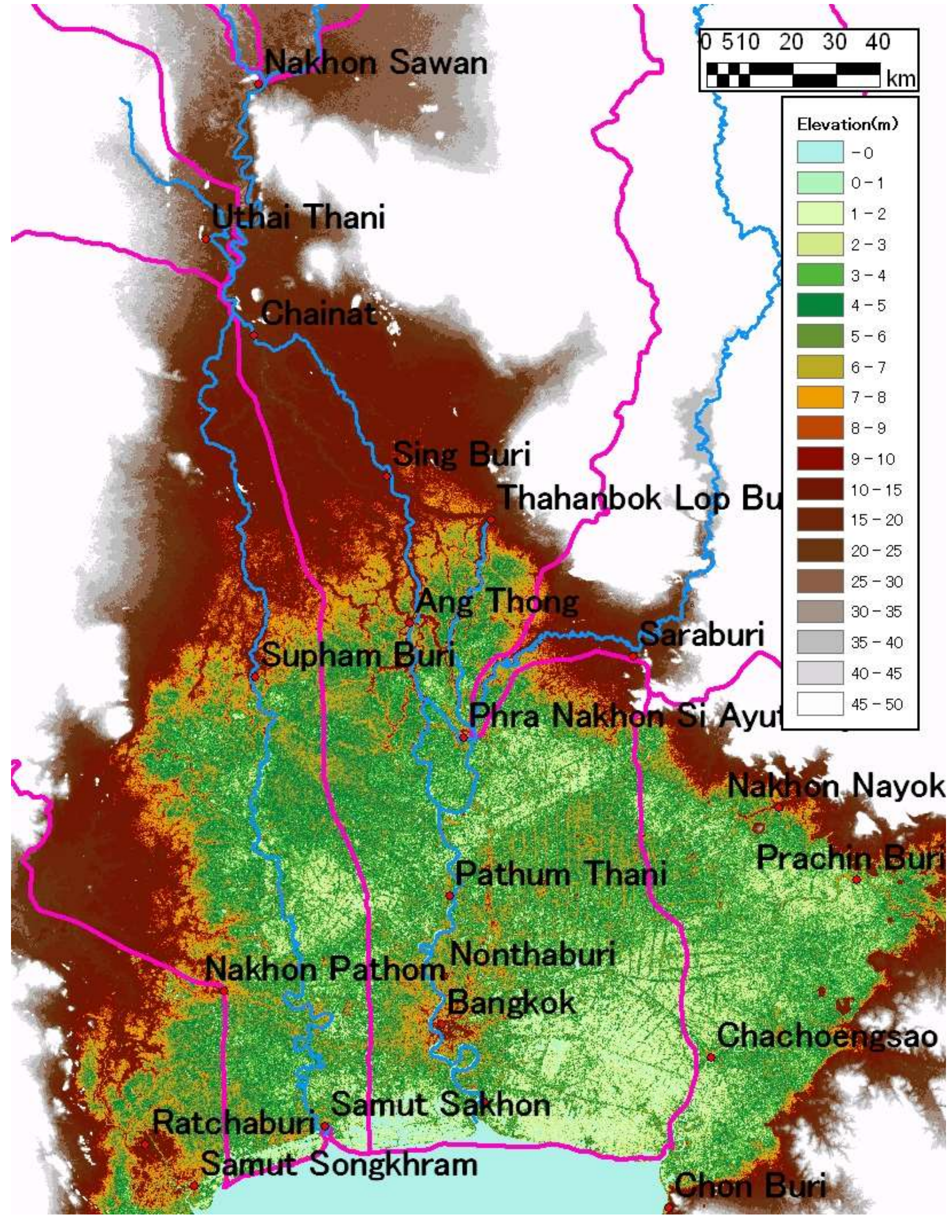
Large-scale reservoirs

Name	Bhumibol	Sirikit
Purpose	Irrigation Power Generation Flood Control	Irrigation Power Generation Flood Control
Under Operation by	EGAT	EGAT
River	Ping	Nan
Drainage Area(sq. km)	26,386	13,130
Annual Inflow(MCM)	5,256	5,600
Annual Inflow(mm)	199.2	427.5
Storage at max. water level(MCM)	13,462	10,508
Resevoir Surface Area(sq. km)	316.0	260.0
Dam Type	Gravity Arch	Earthfill

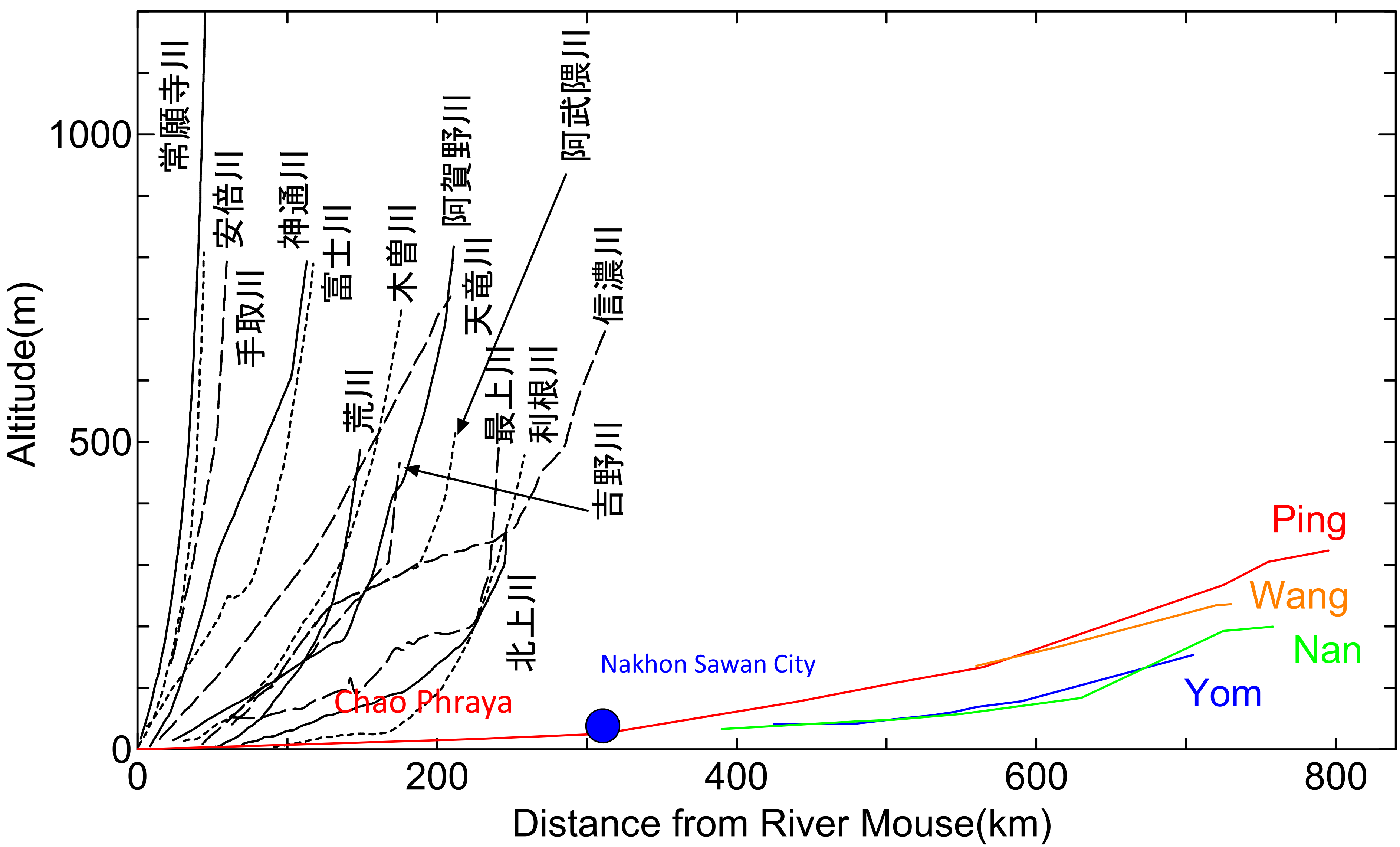


Flat topography (1)





Flat topography (2)



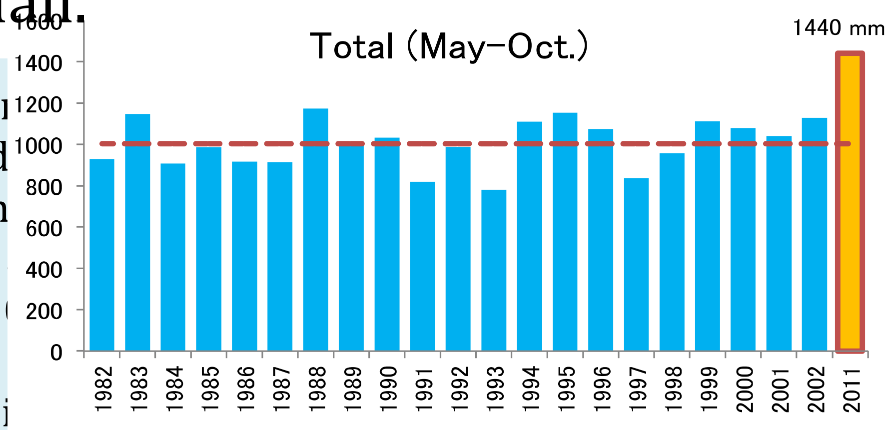
Rainfall condition in 2011

- In 2011, the highest values during 1982-2002 were recorded in July and

The exceedance probability of this rainfall is 2 %, and it can be regarded as a 50-year probability rainfall.

average monthly rainfall during 1982-2002.

- The total rainfall during the rainy season was 1,439 mm, which was 143 % of the period average total rainfall.



Monthly ai
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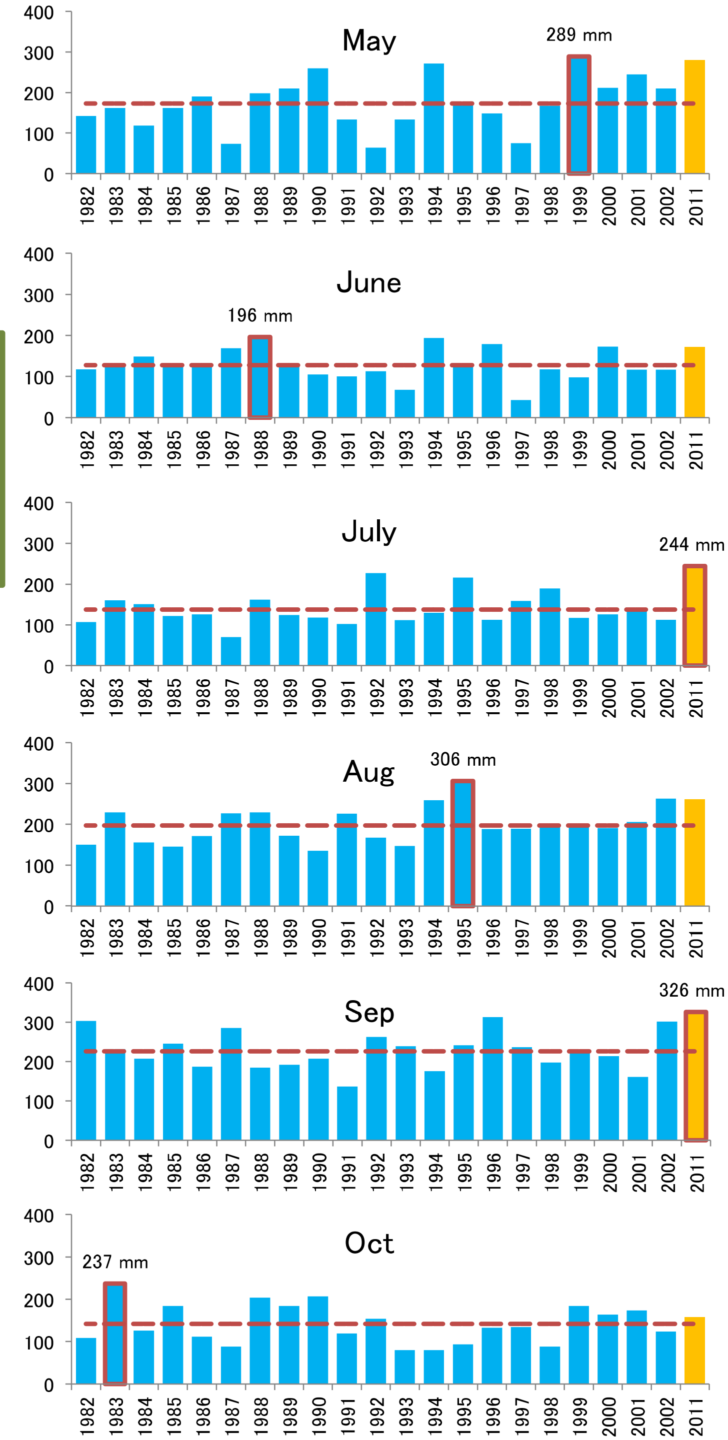
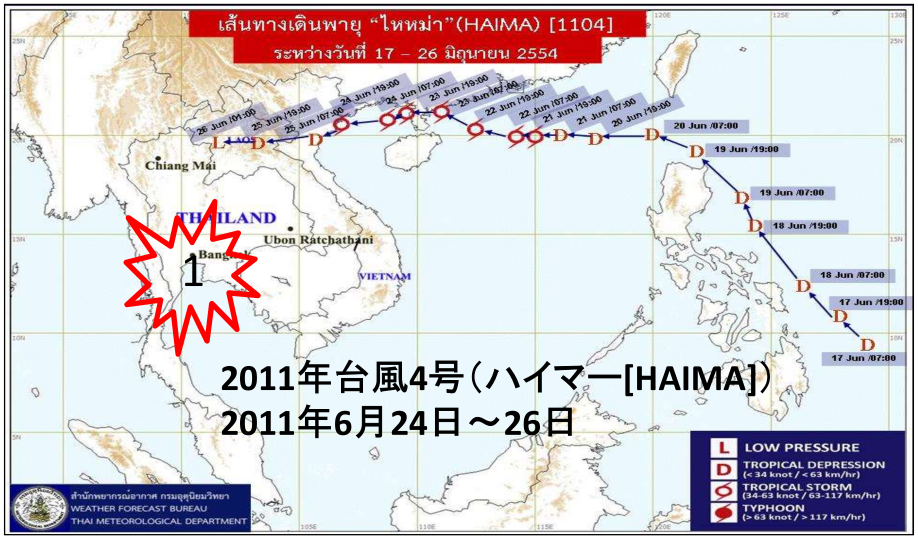
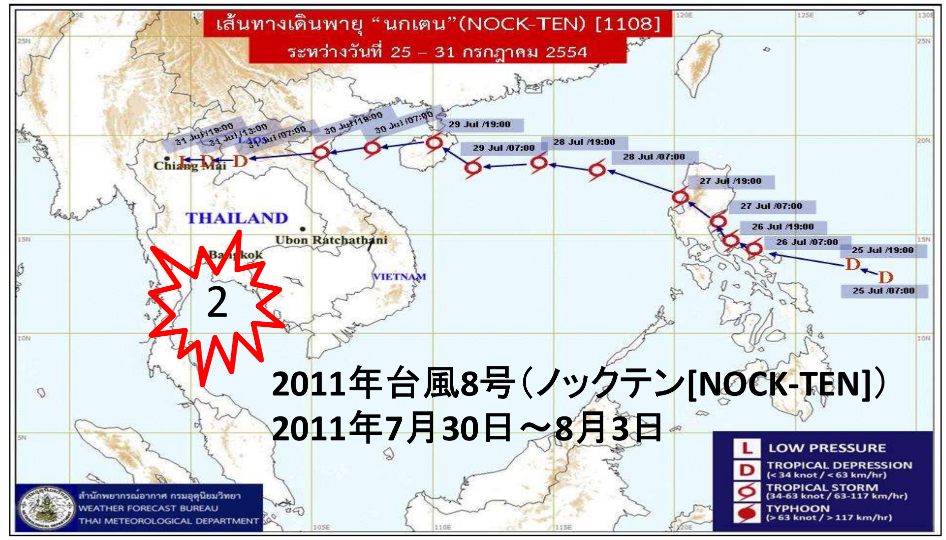
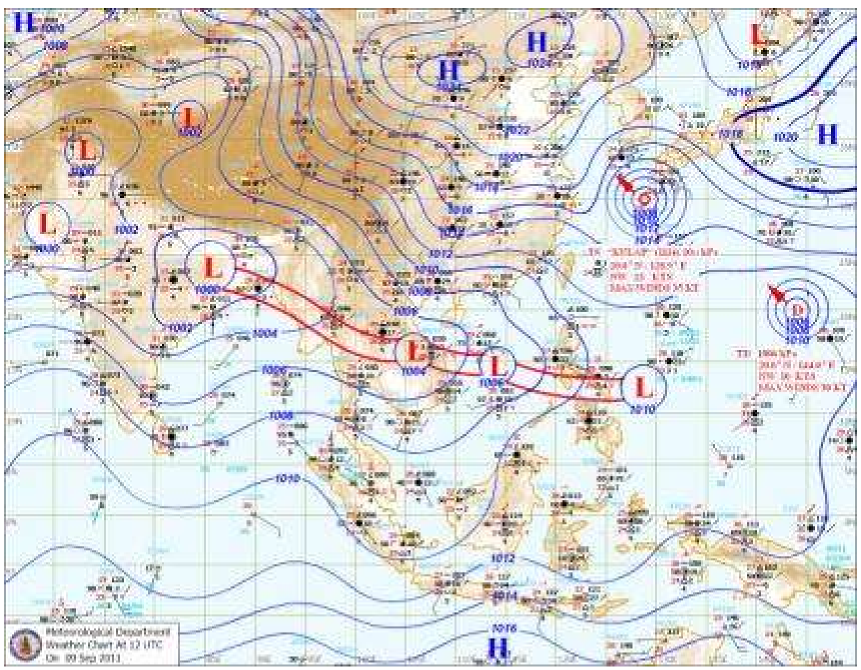


Climate Condition (1)

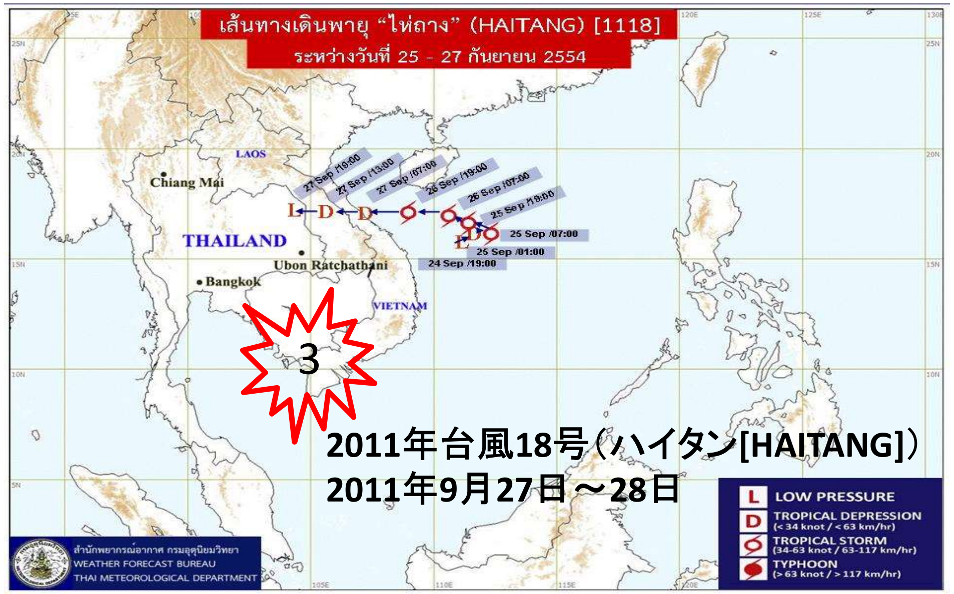




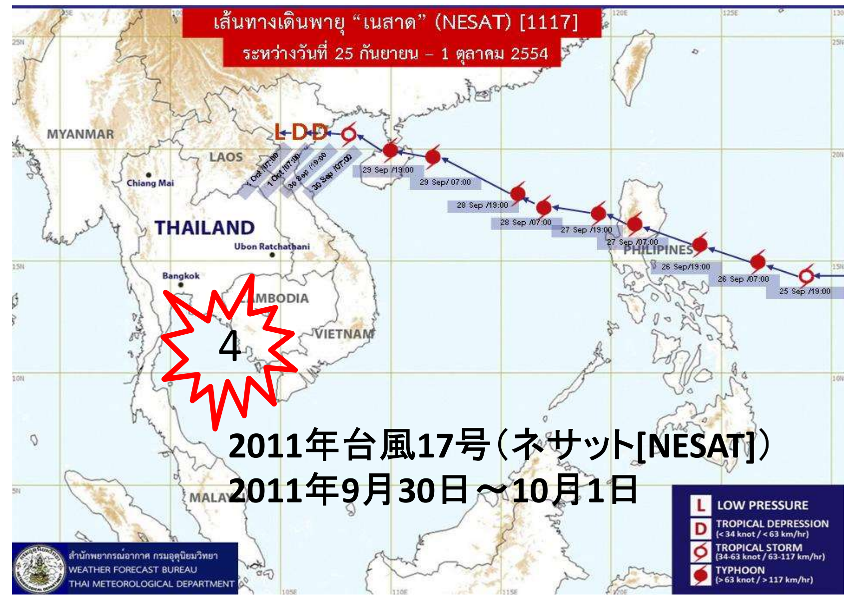


タイ北部で発達した強い低気圧
8月10日～12日，15日～19日
9月8日～12日

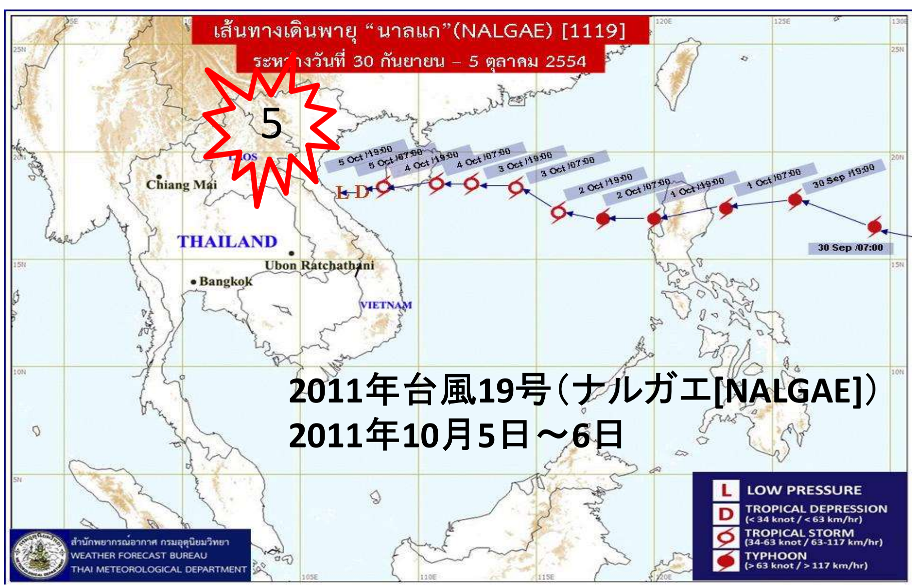
Climate Condition (2)



2011年台風18号（ハイタン[HAITANG]）
2011年9月27日～28日



2011年台風17号（ネサット[NESAT]）
2011年9月30日～10月1日

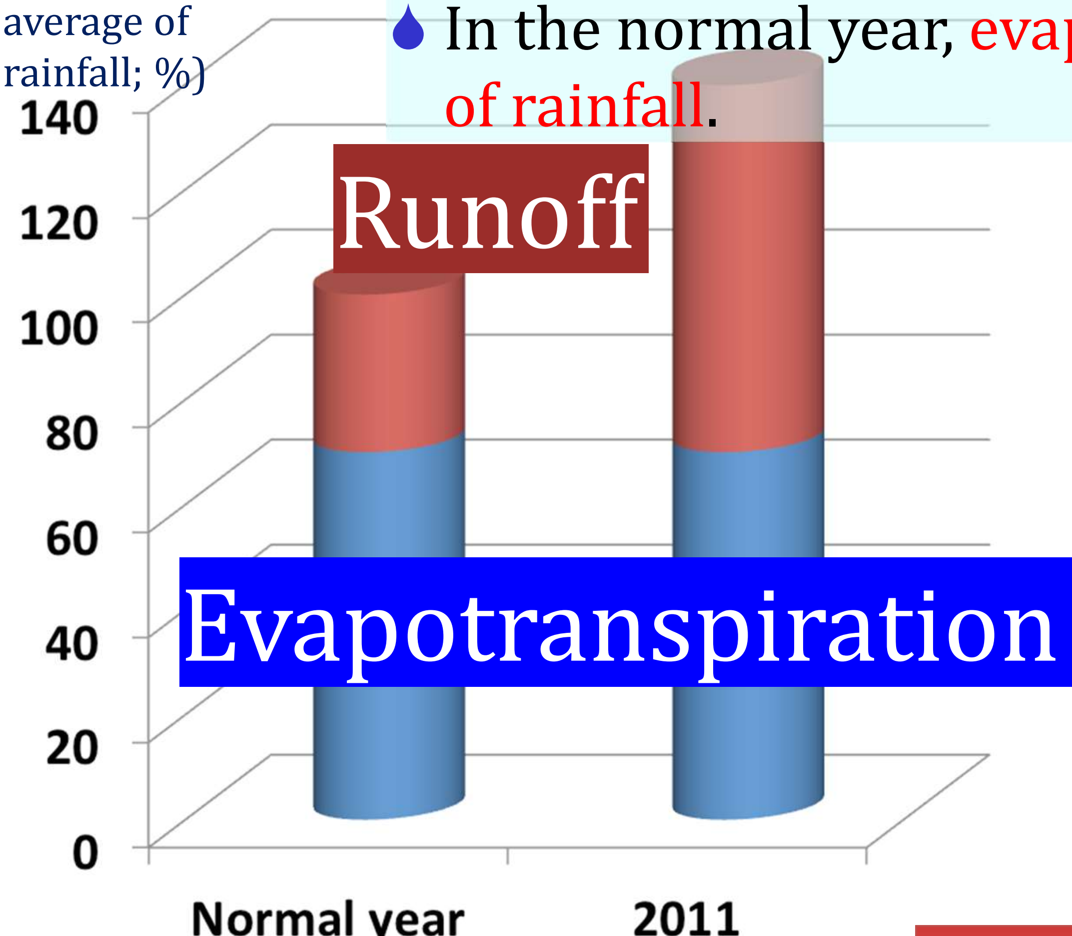


2011年台風19号（ナルガエ[NALGAE]）
2011年10月5日～6日

5 Typhoons and strong low pressure attacked during Jun. and Oct.

Rough estimation from the water budget

- Rainfall = Evapotranspiration + Runoff + Infiltration
- In the normal year, evapotranspiration [ET] is 70 % of rainfall.



100 – 30 = 70
↓Japan
143 – 30 = 113

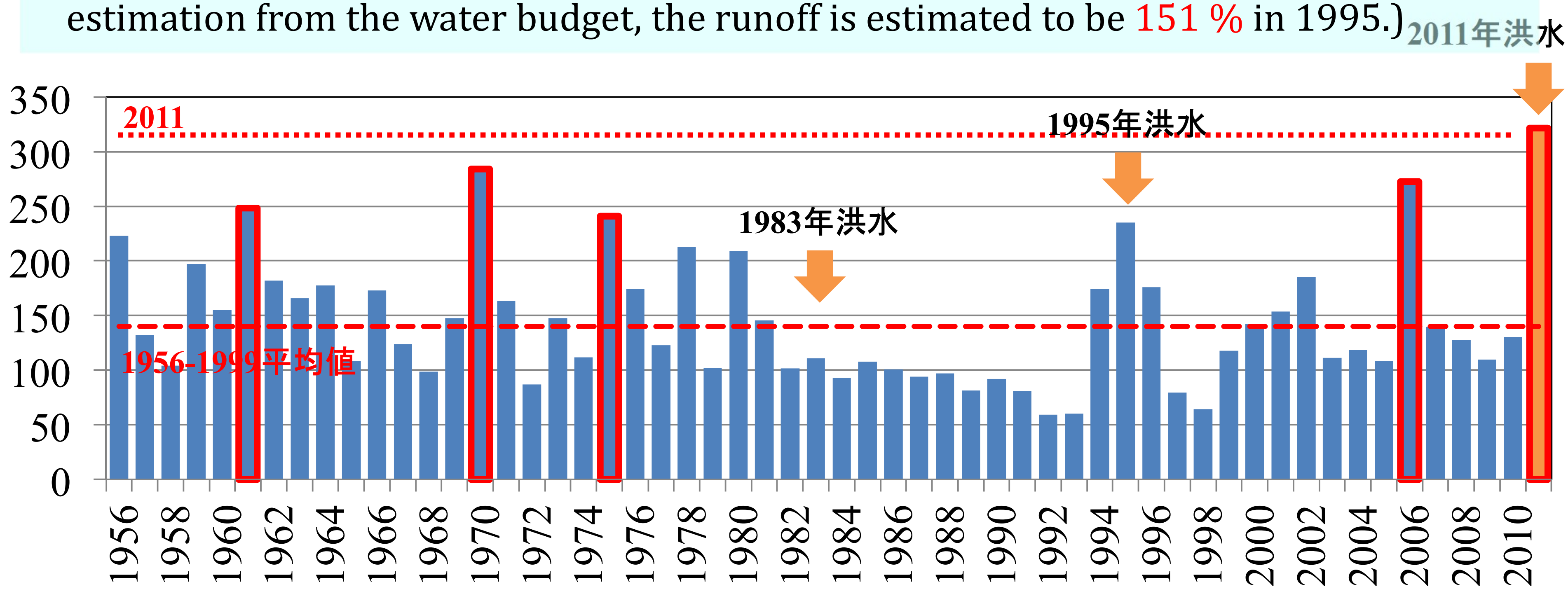
rainfall ET Runoff

100 – 70 = 30
↓
143 – 70 = 73

143 % of normal average of rainfall → 243 (=73/30) % of normal average of river discharge

River discharge at Nakhon Sawan

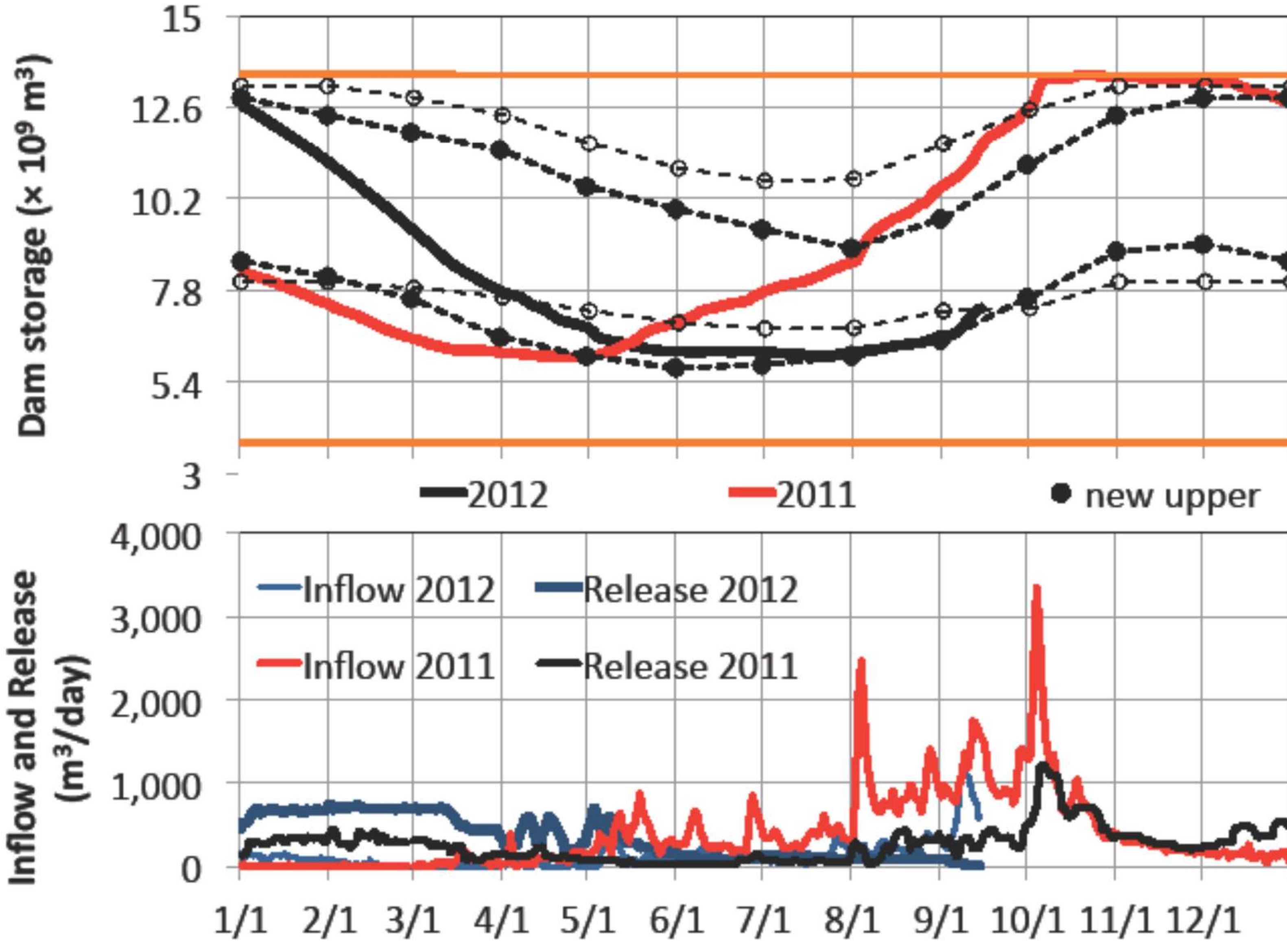
- The total discharge in 2011 was 32.6 billion m^3, which was 232 % of the period average in 1956-1999.
- Total discharge recorded in the flood year of 1995 was 23.5 billion m^3, which is 167 % of the period average in 1956-1999. (Applying runoff estimation from the water budget, the runoff is estimated to be 151 % in 1995.)



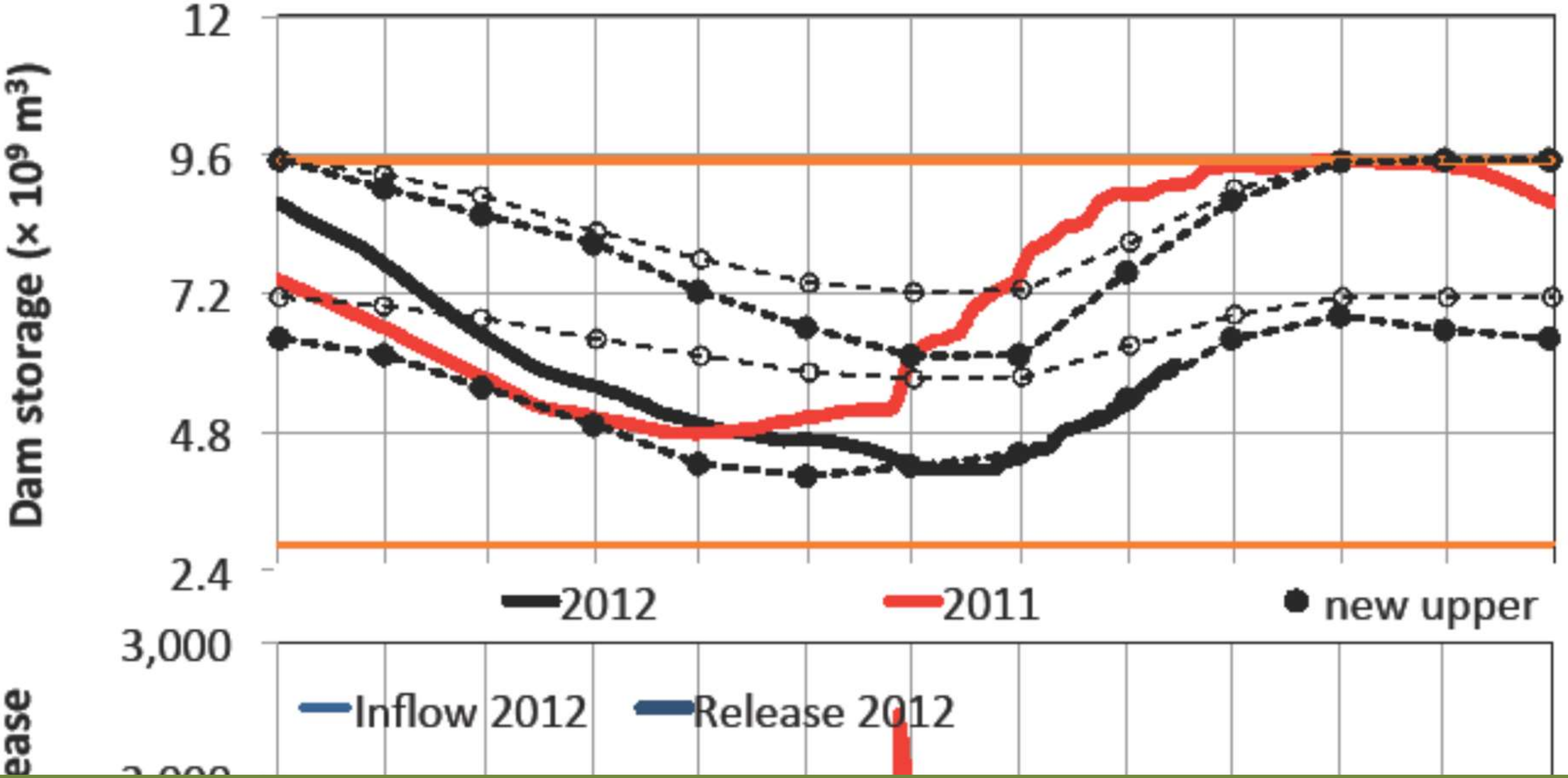
Total discharge of the Chao Phraya River at Nakhon Sawan from June to October in 1956–1999 and 2011. Dashed line indicates the average for the period 1956–1999, and dot line indicates total discharge in 2011. Bar frame indicates the top 5 total discharge events in 1982–2002 and 2011.

Bhumibol dam

Maximum Storage Capacity 13.5 km^3



Sirikit dam



The two dam reservoirs stored approximately 10 billion m^3, which is an amount equivalent to two-thirds of the total flood volume, and this effectively mitigated the flooding.

Dam reservoir operation

- Is there any better dam reservoir operation to mitigate flood damage in 2011?
  - ✓ To more mitigate flood damage, we need to reduce the storage water before August when it starts to inundate at the downstream of the dam reservoirs.
  - ✓ If we could forecast rainfall condition in 2011, we might make more flood capacity at dam reservoirs.

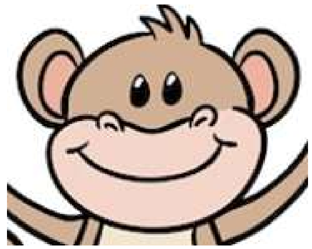
- However, seasonal weather forecasting is still within a research phase and is difficult to incorporate into operational use.

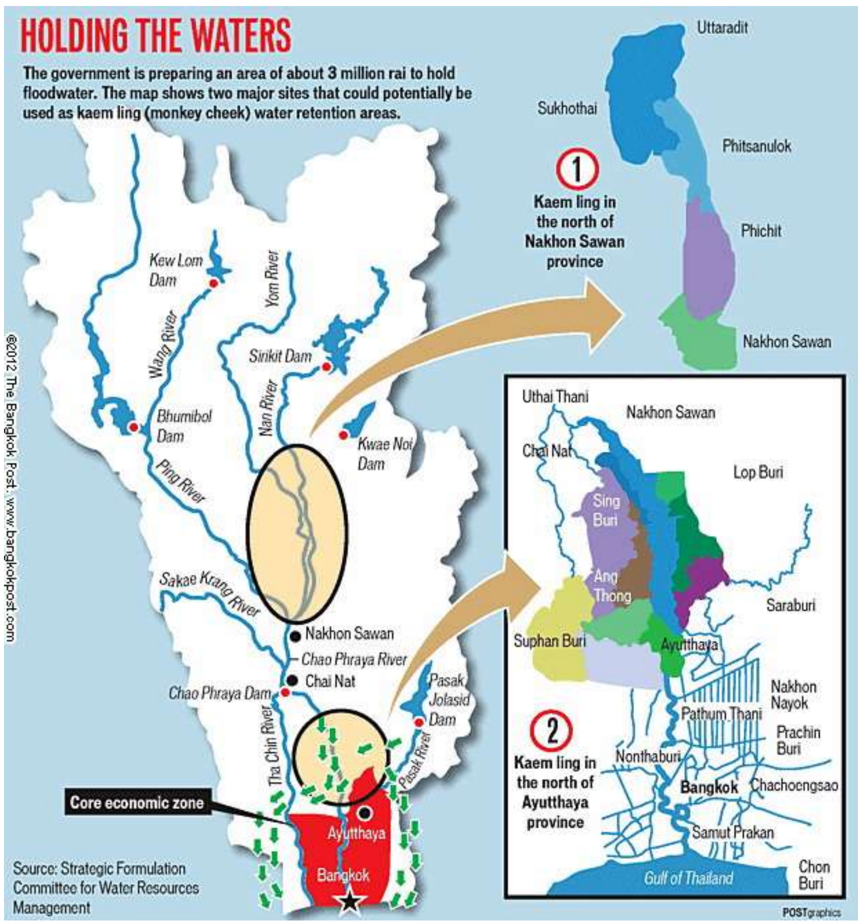
- In Japan, the flood capacity at the dam reservoirs are previously prepared by the release for flood control when the flood is foreseen.
  - ✓ It is capable of accurate weather forecast on -1 week scale and have the flood capacity at the dam reservoirs in the flood season.

Conclusions

- The 2011 Chao Phraya River flood was caused by high seasonal rainfall. Increased rainfall by 143% over doubled runoff.
- Chao Phraya river is gently sloped and wide watershed, and thus daily and/or weekly heavy rainfall are not caused a gigantic flood like 2011.
- The spatiotemporal scale of floods in Thailand are quite different from Japanese floods which are caused by -1 week heavy rainfall such as typhoons.
  - ✓ It is necessary to recognize that a flood prediction and preparation of flood prevention on the spatiotemporal scale are also completely different according to it.

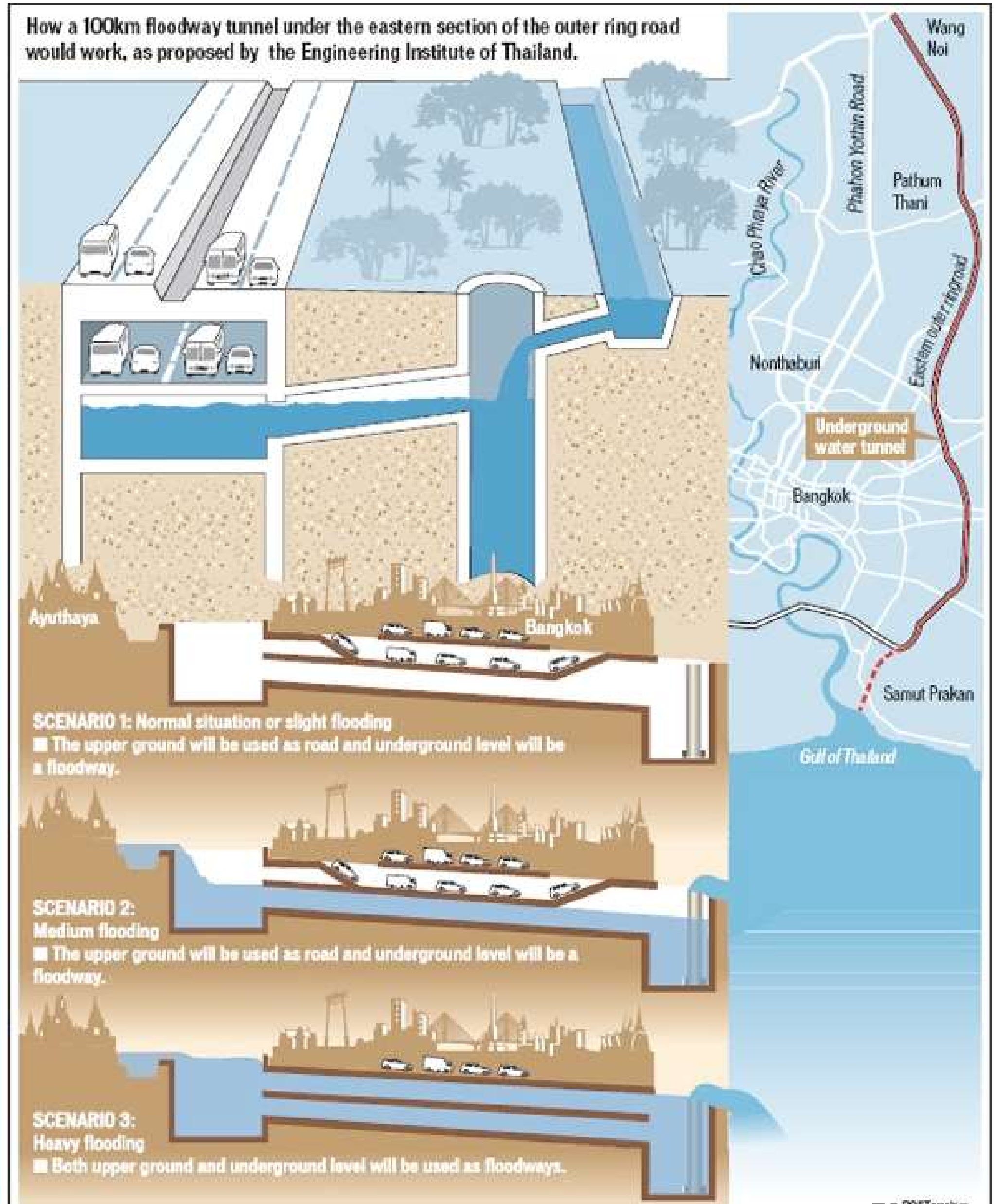
Retention pond (Monkey cheek)





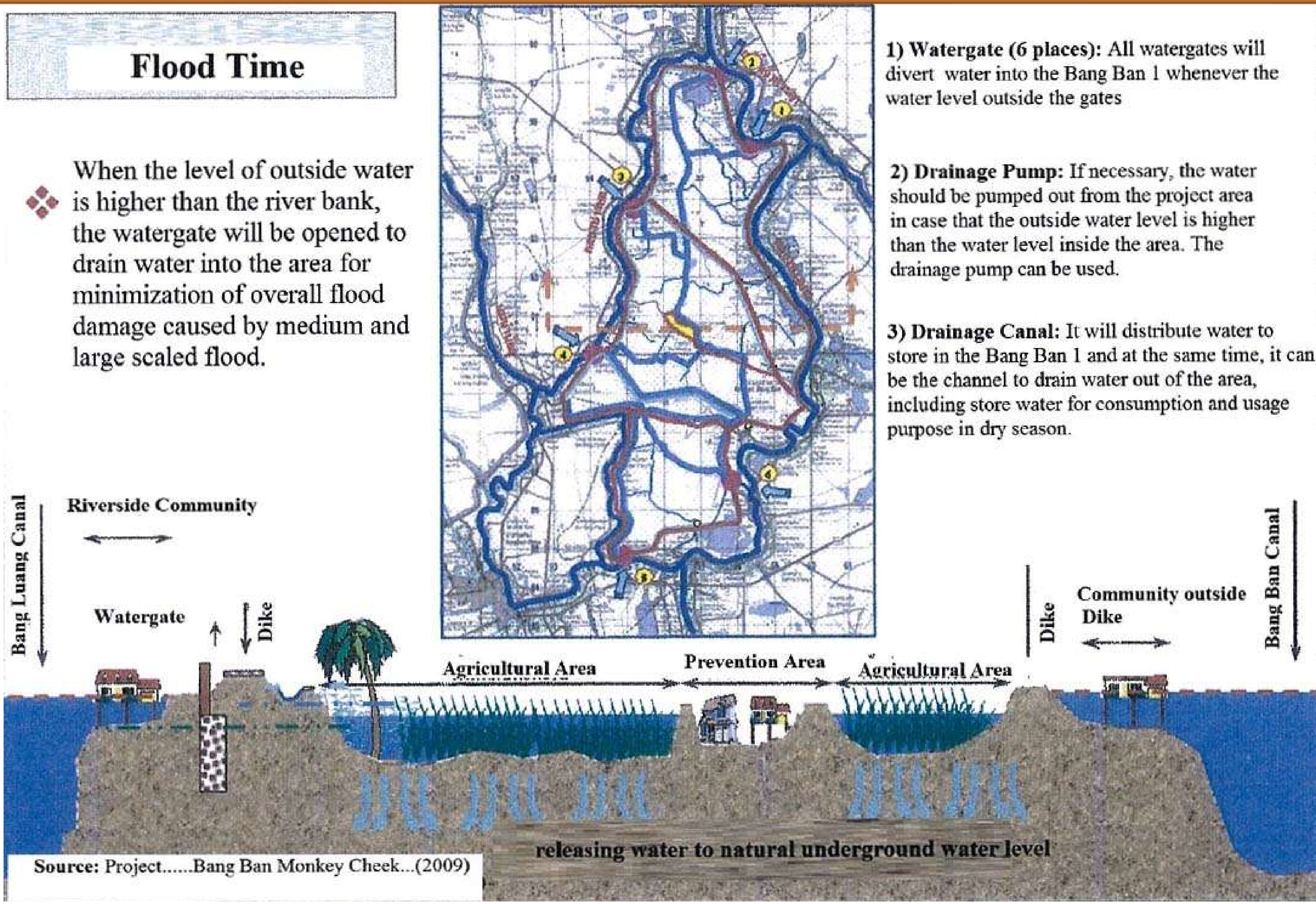
http://thailand.prd.go.th/file_content/images/1272100505p.jpg

Floodway

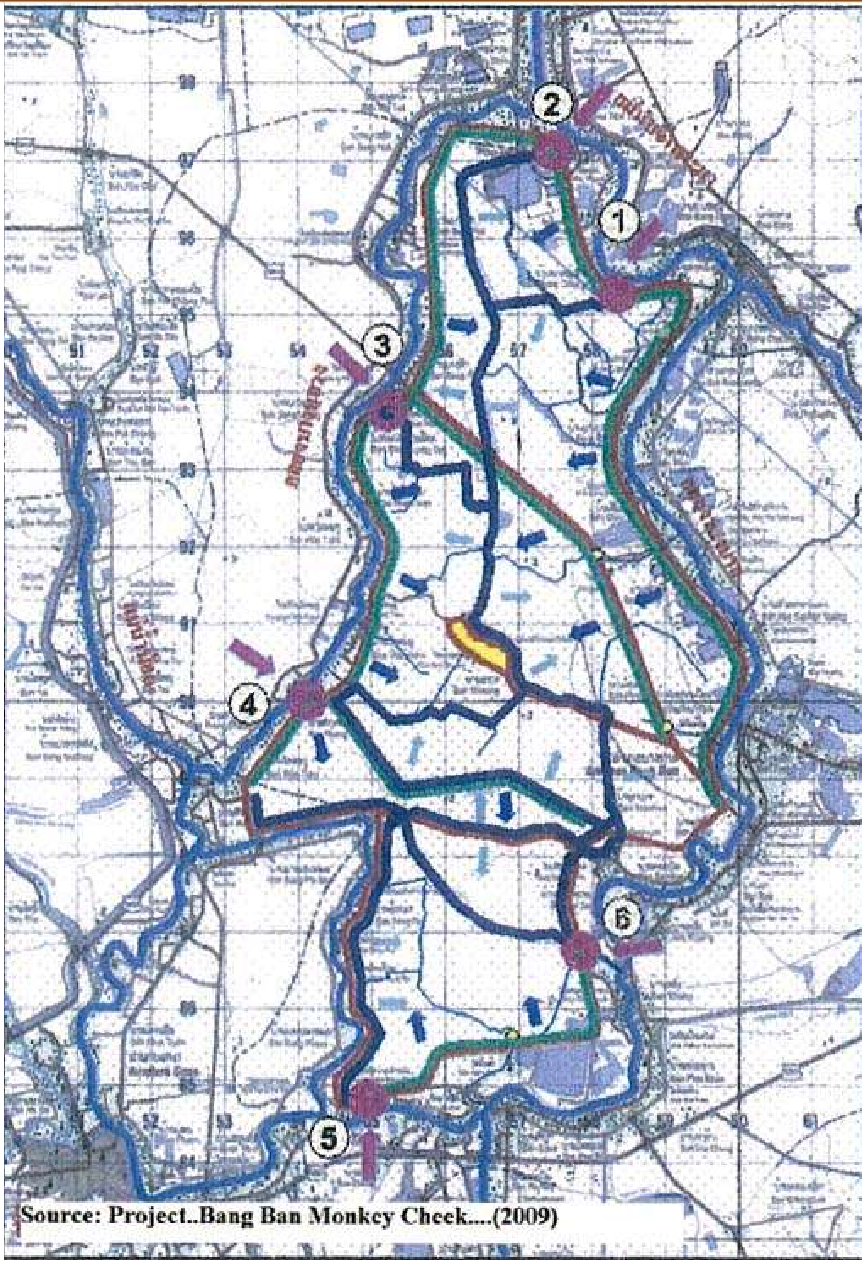


http://tunnellingjournal.com/news/files/2011/12/Bangkok-tunnel.jpg

Monkey Cheek](2)



モンキーチーク[Monkey Cheek](3)



Source: Project..Bang Ban Monkey Cheek....(2009)

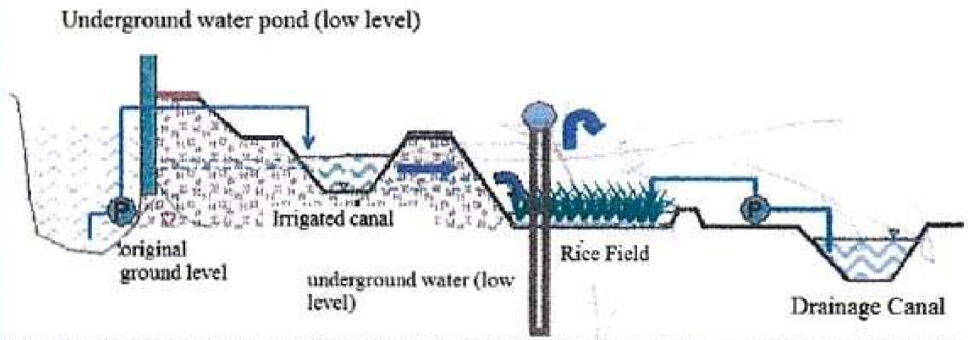
- **Provision of sufficient water/rice pricing control could help to increase the rice productivity after flood time.**

Schedule of Rice Planting in the Monkey Cheek Area

1st Time: December-March
2nd Time: March-June
3rd Time: July-December

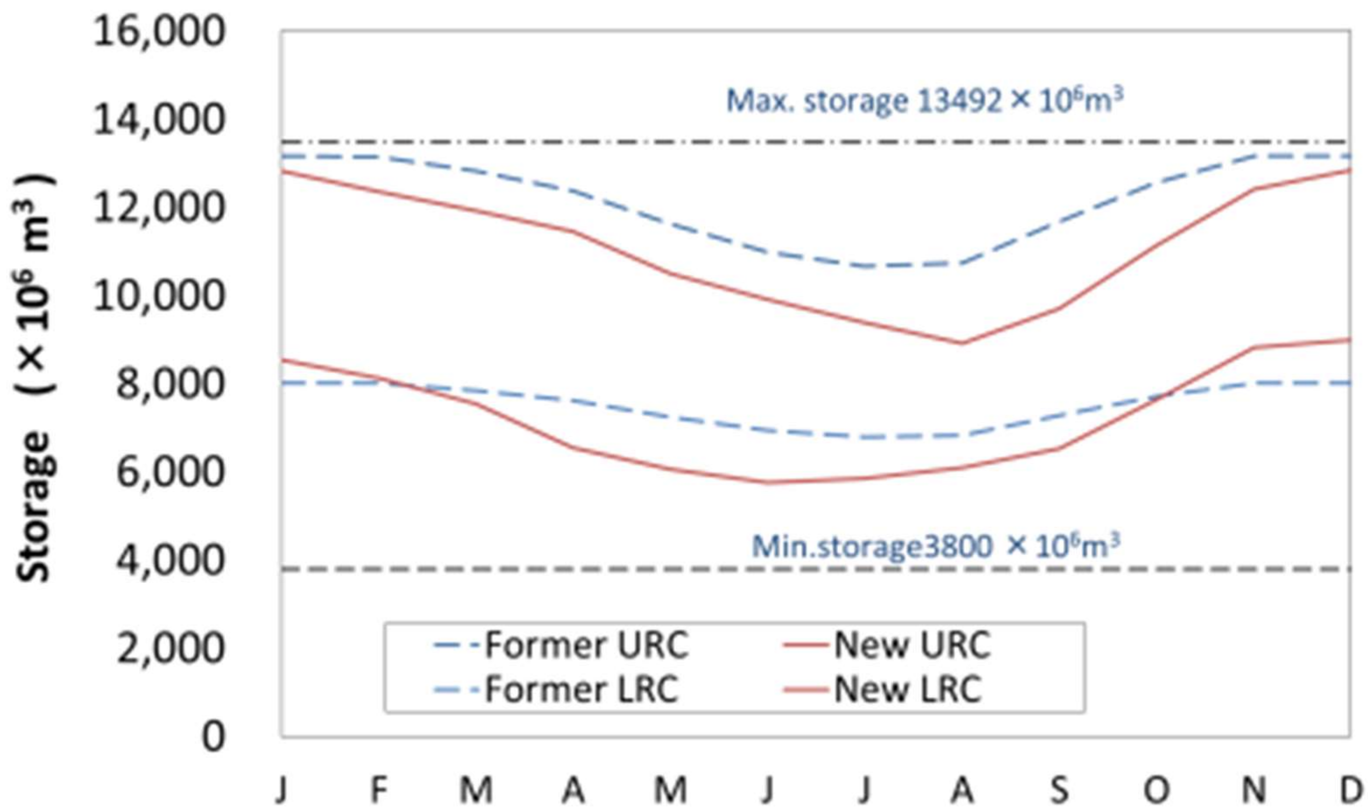
Pumping Station and Irrigated Canal: Pumping water from the river to irrigated canal and realeasing water into the agricultural area

Drainage Canal in the Area: Close/Open the watergate in order to store water in the canal for agriculture



New operation rule curve of the reservoirs after the 2011 great flood

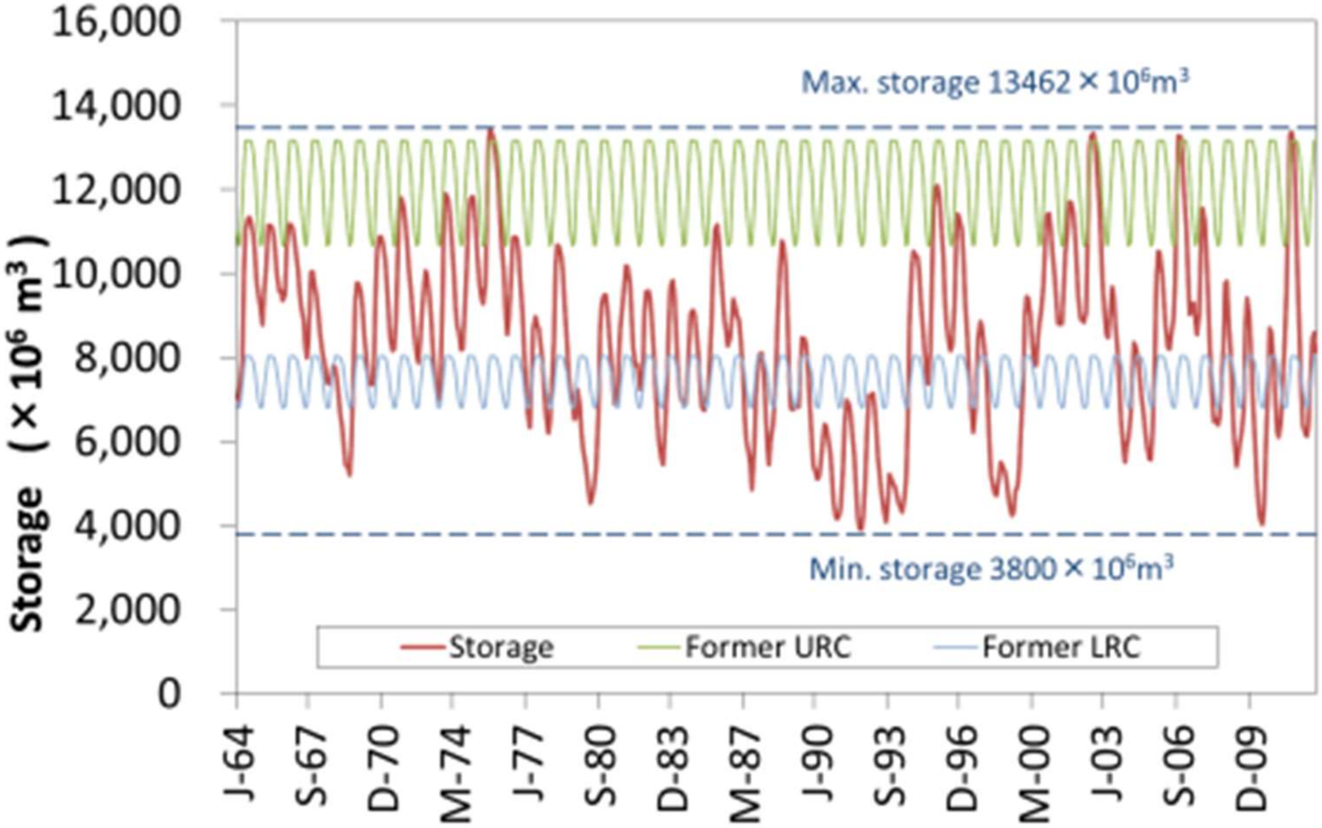
Bhumibol



Lower and upper rule curves were decreased during the wet period in order to prepare the large flood such as 2011 flood, but lower rule curves were increased during the dry period in order for the sufficient water use. This implies a complicated gate operation would be required.

Historical operations of Bhumibol dam reservoir

Bhumibol

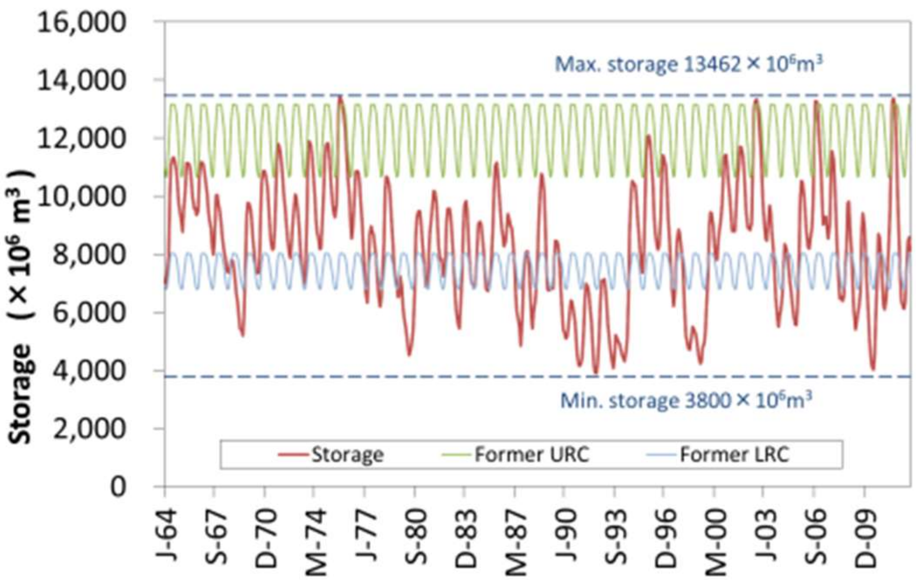


There were severe drought periods in CPRB and historical storages were below the lower rule curve at many years.

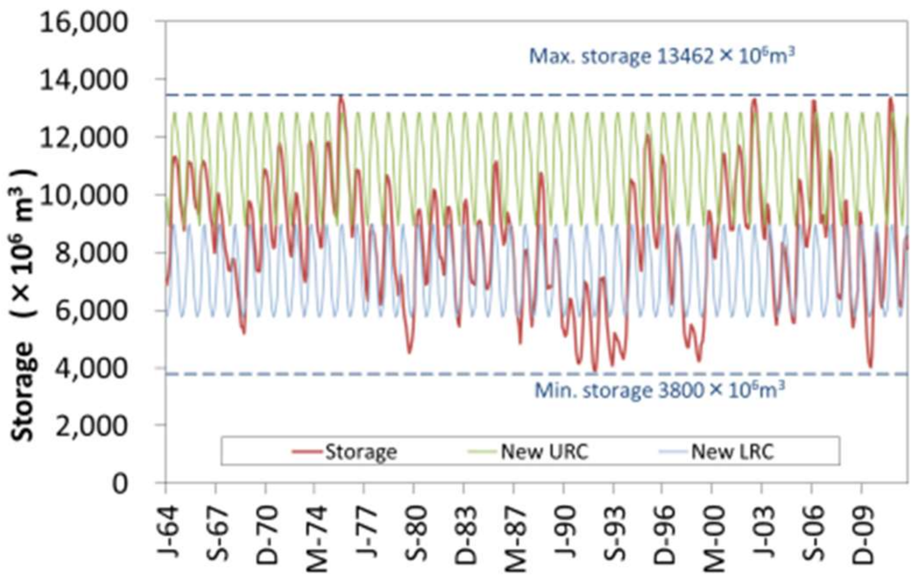
Historical operations of Bhumibol dam reservoir

Bhumibol

Former rule curve



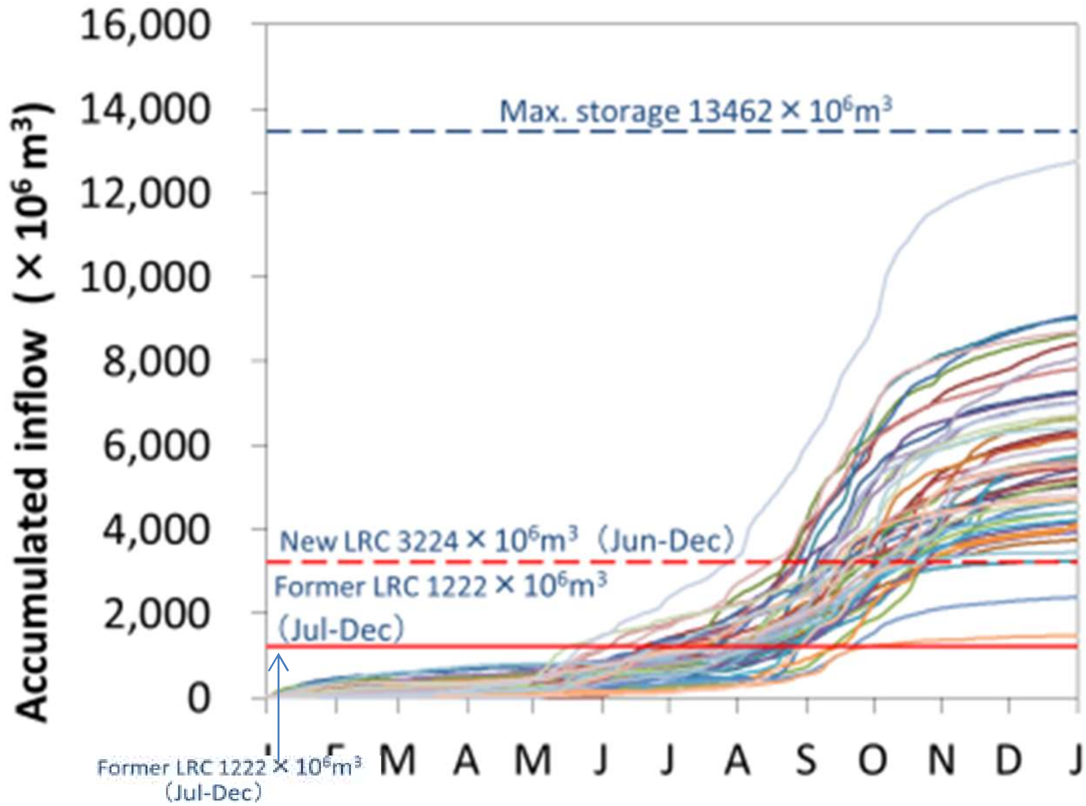
New rule curve



The Bhumibol Dam reservoir would be unable to avoid the shortage of the water storage, especially under the new rule curves.

Accumulated inflow of the Bhumibol dam reservoir

Bhumibol



Accumulated inflow over a year could not reach required lower rule curve storage at severe drought years.


2011


2015

2011 Central Thailand Flood

Sub Sector	Disaster Effects			Ownership	
	Damage	Losses	Total	Public	Private
Infrastructure					
Water Resources Management	8,715	-	**8,715**	8,715	-
Transport	23,538	6,938	**30,476**	30,326	150
Telecommunication	1,290	2,558	**3,848**	1,597	2,251
Electricity	3,186	5,716	**8,901**	5,385	3,517
Water Supply and Sanitation	3,497	1,984	**5,481**	5,481	
Productive					
Agriculture, Livestock and Fishery	5,666	34,715	**40,381**	-	40,381
Manufacturing	513,881	493,258	**1,007,139**	-	1,007,139
Tourism	5,134	89,673	**94,808**	403	94,405
Finance & Banking	-	115,276	**115,276**	74,076	41,200
Social					
Health	1,684	2,133	**3,817**	1,627	2,190
Social	-	-	-	-	-
Education	13,051	1,798	**14,849**	10,614	4,235
Housing	45,908	37,889	**83,797**	12,500	71,297
Cultural Heritage	4,429	3,076	**7,505**	3,041	4,463
Cross Cutting					
Environment	375	176	**551**	212	339
TOTAL	**630,354**	**795,191**	**1,425,544**	**141,477**	**1,284,066**

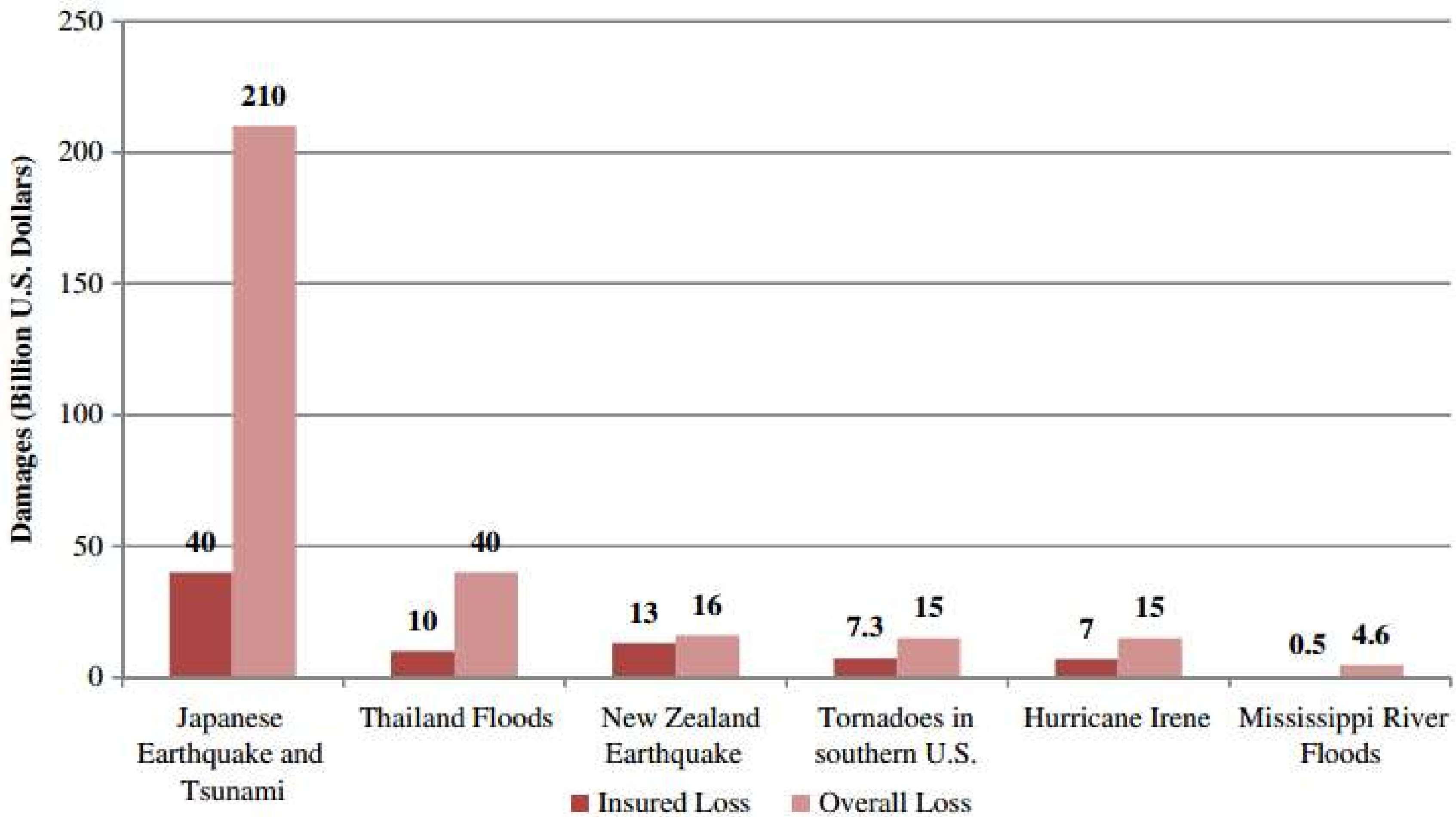
Source: DALA estimates, NESDB, and Ministry for Industry damages and losses.

90% of damages and losses are PRIVATE SECTOR (Manufacturing sector) BUT covered less than 0.1% of flooded area

Impact of 2011 floods in Thailand.

Impacted households [a]	1,886,000
Destroyed homes [b]	19,000 homes
Displaced people[a] (Affected people)	2.5 million people
Casualty	813 people
Impacted farm land[a]	17,578 square kilometers
Overall economic damage and losses[b]	Thai Baht 1.43 trillion (USD 46.5 billion)
Economic damage and losses in manufacturing sector	Thai Baht 1007 billion (USD 32 billion)

[a] The Goverment of Thailand [24].
[b] The World Bank [25].



Damages (Billion U.S. Dollars)
250
200
150
100
50
0
210
40
40
10
13
16
7.3
15
7
15
0.5
4.6
Japanese Earthquake and Tsunami
Thailand Floods
New Zealand Earthquake
Tornadoes in southern U.S.
Hurricane Irene
Mississippi River Floods
Insured Loss
Overall Loss

National Level DRR related laws and regulations

The 11th National Economy and Social Dev… ment Plan

- Happy society with fairness and resilient
- Build a secure natural resources and envir… by supporting community participation an… resilient

Master Plan on Water Resource… pment

- Action plan for short term
- Action plan for long term

National Disaster Preventi… igation Plan (2010 – 2014)

- Prevention and im… on
- Disaster emerge… ement
- Preparedness arrangement
- Post disaster management

Strategic Natio… Disaster Risk Reduction (2010 – 2019)

- Form under Hy… o Framework for Action (HFA)
- Participation of multi-stakeholders

Simple plans with proper implementation are much better than great plans on shelf

Thailand Policies for DRR (National Reform Commission)

- DRR is a national priority for all levels
- Identify, assess and monitor disaster risks and enhance early warning and preparedness.
- Use knowledge, innovation and education to build cultures of safety and resilience at all levels.

Sub-committee for DRR

- Build up Risk Awareness at all levels
- Public participation in DRR
- Facilitate Technology and Information transferred
- Organization structural reforms to facilitate exchanges, actions and implementations
- Make/amend related laws and regulations to facilitate DRR in all levels/risks

Community’s Role

- Understand the disaster risks and ensure that they can protect and make themselves safe to minimize losses and damage when a disaster strikes.

PASSIVE ROLE → **PRO-ACTIVE ROLE**

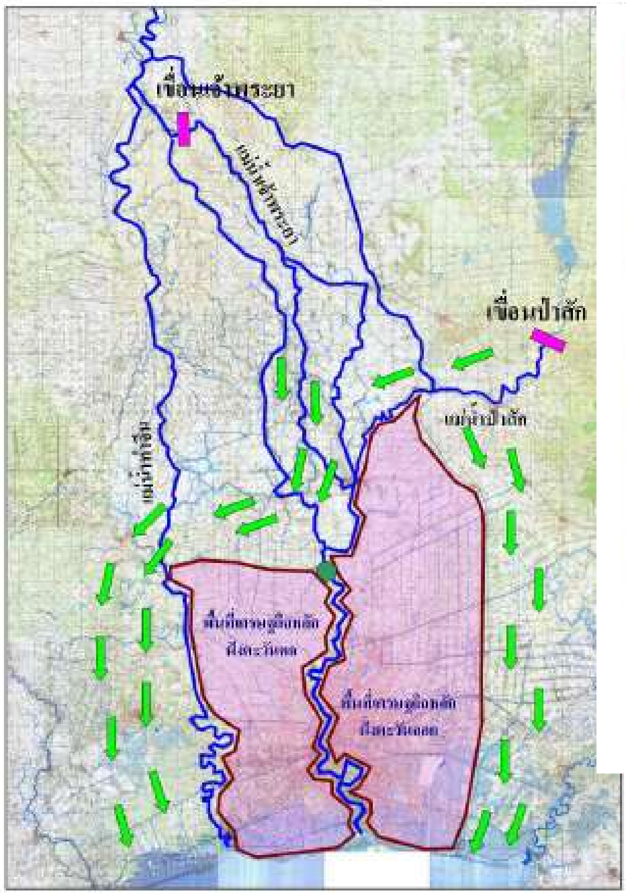
PASSIVE ROLE	PRO-ACTIVE ROLE
Wait for help	Learn the risks, Networking
No preparedness	Preparedness, Build sustain
Lack information, etc.	Acquire information
	Inclusive innovation, etc.

How to Transfer/Modify/Include … Knowledge/Information/etc. so that Community does understand and aware of their risks

- Simple community based risk mitigation countermeasures with appropriate early warning system and community planning
- Sustain some basic community functions during disaster
- Partial self-recovery technology
- Safe structures are long term benefits though a little bit more costly at present

Flood Prevention Projects

COUNTRY LEVEL



แผนปฏิบัติการเร่งด่วน

1. แผนการบริหารจัดการเขื่อนเก็บน้ำหลัก
2. แผนฟื้นฟูและปรับปรุงประสิทธิภาพสิ่งก่อสร้าง
3. แผนการพัฒนาคลังข้อมูล ระบบพยากรณ์ และเตือนภัย
4. แผนงานเผชิญเหตุเฉพาะพื้นที่
5. แผนงานการกำหนดพื้นที่รับน้ำนองและมาตรการเยียวยา
6. แผนงานปรับปรุงองค์กรเพื่อบริหารจัดการน้ำ

ยุทธศาสตร์ระยะยาว

1. ฟื้นฟูและอนุรักษ์ป่าและระบบนิเวศ
2. สร้างเขื่อนกักเก็บน้ำ
3. บริหารจัดการใช้พื้นที่ราบลุ่ม (Floodplain)
4. แนวทางการบริหารจัดการและพัฒนาการใช้ที่ดิน
5. ระบบฐานข้อมูล การพยากรณ์และเตือนภัย
6. กฎหมายรองรับการชดเชยต่อเกษตรกรในพื้นที่รับน้ำหลาก
7. มีองค์กรบริหารจัดการน้ำรวมแบบเบ็ดเสร็จ
8. การสร้างความเข้าใจ การยอมรับ และการมีส่วนร่วมในการบริหารจัดการอุทกภัยขนาดใหญ่ของทุกภาคส่วน

ON OF

THAIPUBLICA

โครงการที่จะต้องจัดทำตามยุทธศาสตร์การบรรเทาอุทกภัยในพื้นที่ลุ่มแม่น้ำอื่นๆ (17 ลุ่มน้ำ) แบบบูรณาการและยั่งยืน (ระยะยาว)

	แผนงาน / โครงการ	พื้นที่ดำเนินการ	งบประมาณ (ล้านบาท)
①	แผนการฟื้นฟู อนุรักษ์ป่าและระบบนิเวศน์	-ลุ่มน้ำภาคใต้ในเขตจังหวัดสงขลา,นครศรีธรรมราช,พัทลุง,พังงา,ชุมพร -ลุ่มน้ำภาคอิสาน นครราชสีมา,ชัยภูมิ,เลย,นครพนม,อุบลราชธานี	6,000
②	แผนการสร้างอ่างเก็บน้ำในพื้นที่ลุ่มน้ำ	-ลุ่มน้ำภาคใต้ ลุ่มน้ำทะเลสาปสงขลา ลุ่มน้ำตาปี ลุ่มน้ำชายฝั่งตะวันตก -ลุ่มน้ำอิสาน ลุ่มน้ำเลย ลุ่มน้ำมูล-ชี และลุ่มน้ำสาขา	12,000
③	แผนการจัดทำผังการใช้ที่ดิน	-ลุ่มน้ำภาคใต้ ลุ่มน้ำทะเลสาปสงขลา,หาดใหญ่,นครศรีธรรมราช,พัทลุง, พังงา,ลุ่มน้ำตาปี,สุราษฎร์ธานี และลุ่มน้ำชายฝั่งทะเลตะวันออก -ลุ่มน้ำอิสาน,ในพื้นที่ลุ่มน้ำมูล-ชี,ชัยภูมิ,นครราชสีมา,อุบลราชธานี, ลุ่มน้ำเลย,ลุ่มน้ำโขง เช่น หนองคาย นครพนม อุดรธานี	10,000
④	แผนการปรับปรุงสภาพทางน้ำสายหลักและคันริมแม่น้ำ	-ลุ่มน้ำภาคใต้ ลุ่มน้ำตาปี ลุ่มน้ำทะเลสาปสงขลา ลุ่มน้ำชายฝั่งตะวันตก-ตะวันออก -ลุ่มน้ำอิสาน ลุ่มน้ำมูล-ชี, ลุ่มน้ำสาขา,ลุ่มน้ำเลย,ลุ่มน้ำสาขาของลุ่มน้ำโขง -ลุ่มน้ำตะวันตก ลุ่มน้ำจันทบุรี ลุ่มน้ำบางประกง –ลุ่มน้ำแม่กลอง-ลุ่มน้ำเพชรบุรี	10,000
⑤	แผนการพัฒนาคลังข้อมูลระบบพยากรณ์และเตือนภัย	-ลุ่มน้ำ 17 ลุ่มน้ำ ที่อยู่ในพื้นที่ภาคใต้ อิสาน พื้นที่ชายฝั่งตะวันตก-ตะวันออก	2,000
⑥	แผนการปรับปรุงองค์กร	-ลุ่มน้ำ 17 ลุ่มน้ำ ที่อยู่ในพื้นที่ภาคใต้ อิสาน พื้นที่ชายฝั่งตะวันตก-ตะวันออก	งานปกติ
	รวม		40,000

ที่มา : คณะกรรมการบริหารจัดการน้ำและอุทกภัย (กบอ.)

FAIL : BECAUSE OF NO SPECIFIC PLANING AND NO PUBLIC PARTICIPATION

MAIN DIFFICULTIES

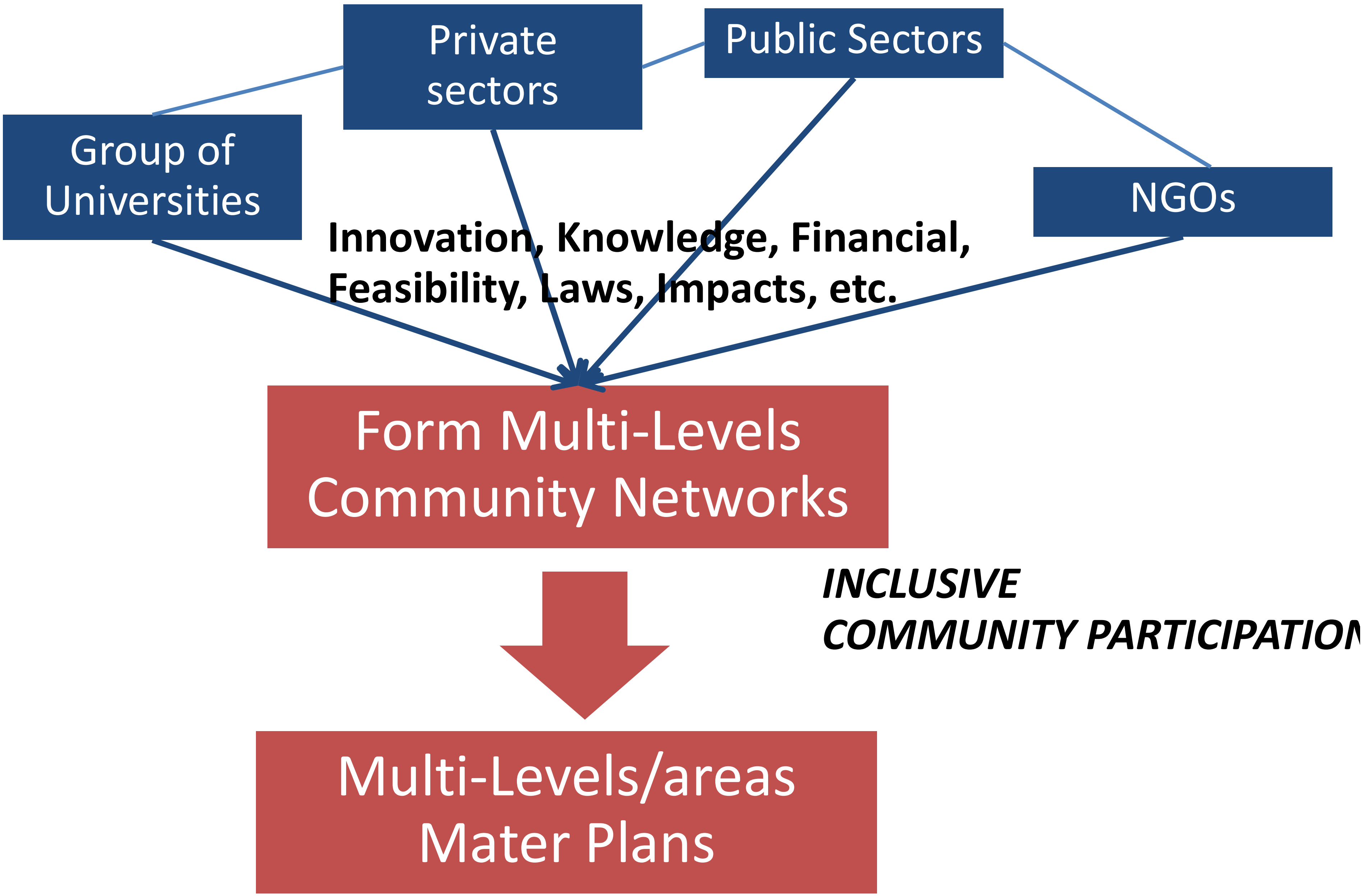
Have to sacrifice some areas to safe the others

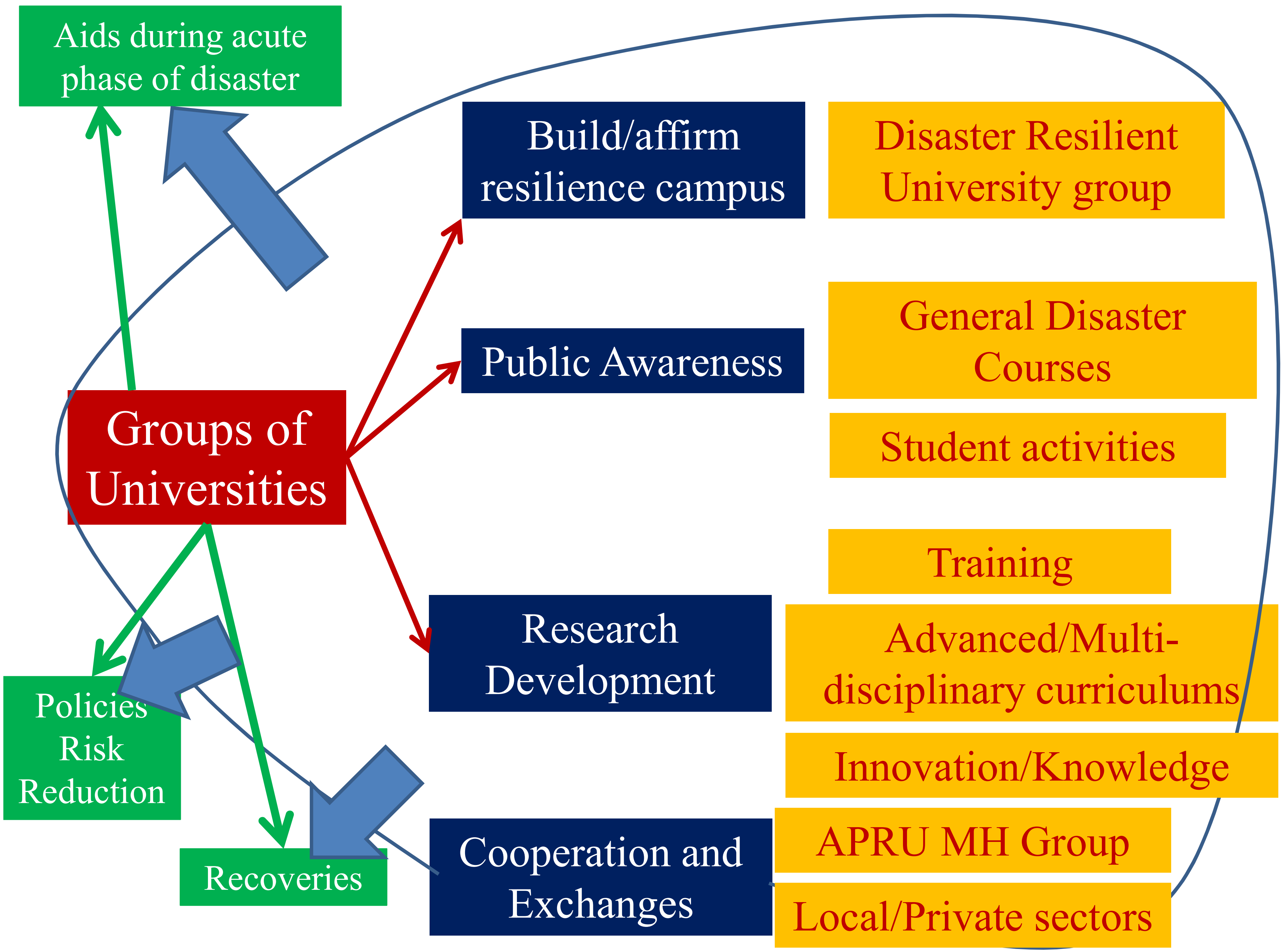
Massive and full scale public hearing and public participation

Proper compensation/subsidiary and post-supporting program

2011 floods, a few concrete scientific and engineered countermeasures were proposed but all were rejected

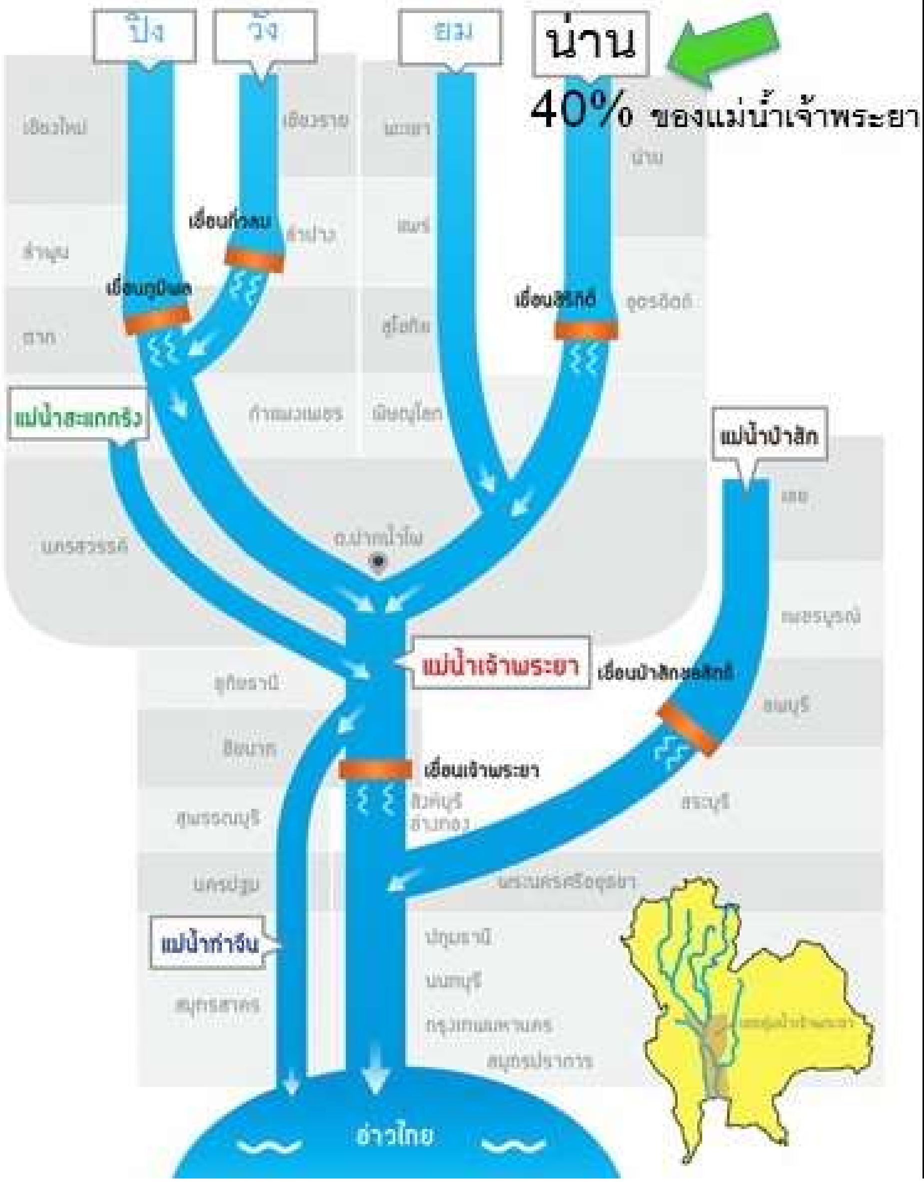
The new ideas to implement water resource project


Private sectors
Public Sectors
Group of Universities
NGOs
Innovation, Knowledge, Financial, Feasibility, Laws, Impacts, etc.
Form Multi-Levels Community Networks
INCLUSIVE COMMUNITY PARTICIPATION
Multi-Levels/areas Mater Plans


Aids during acute phase of disaster
Build/affirm resilience campus
Disaster Resilient University group
Public Awareness
General Disaster Courses
Student activities
Groups of Universities
Training
Research Development
Advanced/Multi-disciplinary curriculums
Innovation/Knowledge
Policies Risk Reduction
APRU MH Group
Cooperation and Exchanges
Recoveries
Local/Private sectors

NAN Provinces Agenda

แม่น้ำสายหลัก
ของประเทศไทย
ปิง วัง ยม น่าน
บรรจบรวมเป็น
แม่น้ำเจ้าพระยา



ที่มา : วิชาการธรณีไทย GeoThai.net

ความสัมพันธ์น้ำ

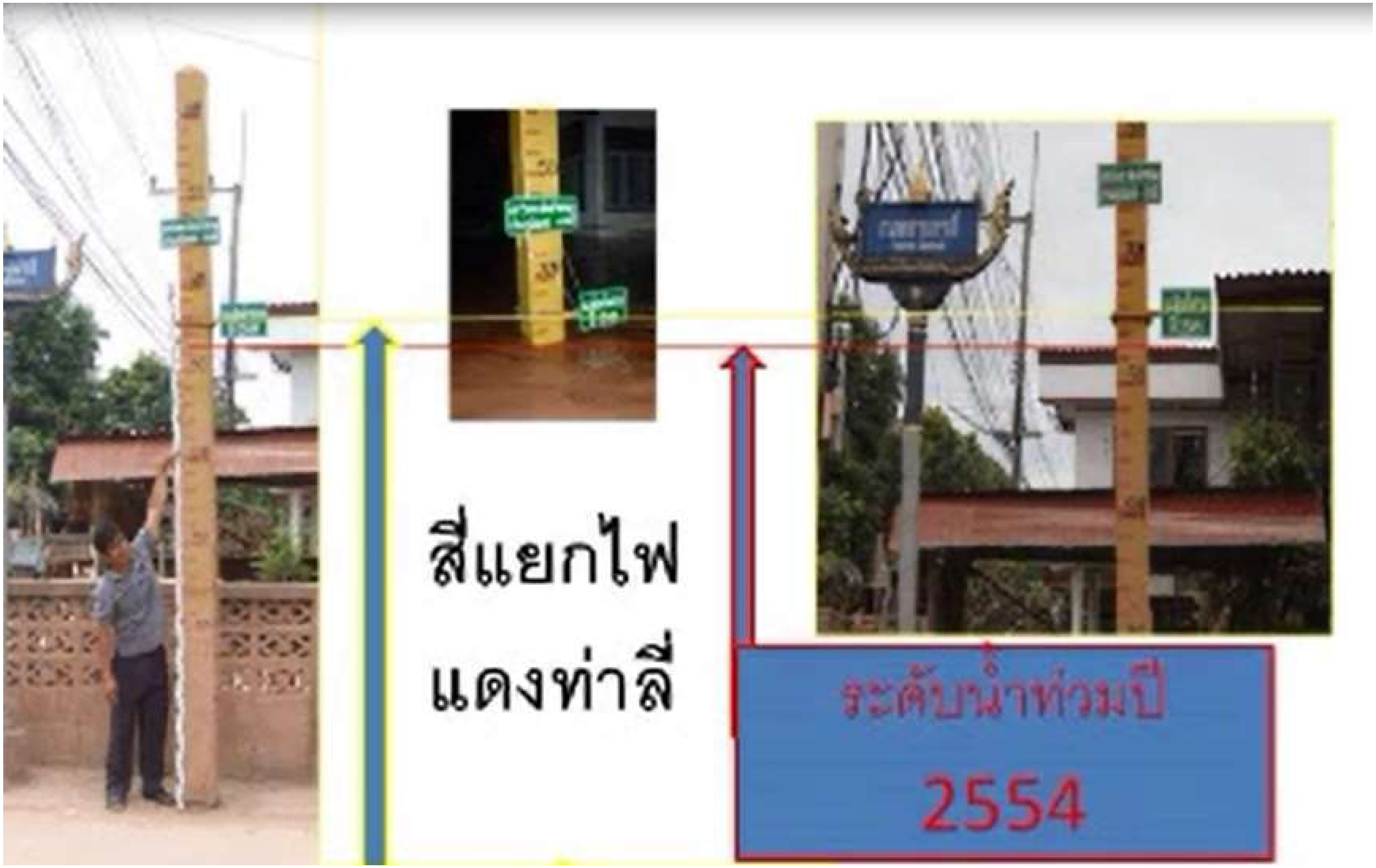
ระหว่างสถานี N64 (ผาขวาง) และสถานี N1 (กาดแลง)

	ปีท่วม	สถานี N64	สถานี N1
	2538	9.75	7.47
2006	2549	14.25	8.42
	2551	9.80	7.19
	2553	7.95	6.59
2011	2554	11.70	8.30

2011 : Alarm, Alert and Preparation were given a week before flooded

Vulnerable people were evacuated.


เสาวัดระดับน้ำท่วม
บ้านภูมินทร์ - ท่าลี่
3M
ระดับน้ำท่วม
ปี 2549


สี่แยกไฟ
แดงท่าลี่
ระดับน้ำท่วมปี
2554


นที่ประชุมชุมชนปลอดภัยภาคพื้นเอเชีย ณ เมืองปูซาน ประเทศเกาหลีใต้
Flood
20-21
August
2006
Flood
26-27
JUNE
12CM

How to make it being sustainable ?
How to make it being learnt, improved and shared through generation?

Formation of NAN AGENDA

วาระน่าน ๒๕๕๖ - ๒๕๖๐ “สร้างเมืองน่านน่าอยู่ คู่ป่าต้นน้ำ”

“Cultural City and Watershed forest”

- Form structures/agencies for drawing Intensive community participation of all levels and ages at all stages→ Family, Schools, NGOs, etc.
- Knowledge Management → Learning Community
- Transparency, Integrity, Accountability in all levels and stakeholders
- Inclusive : Technology and People
- How to stay with the risks; Appropriate and proper engineered infra-structures, well prepared society, etc.

Community Participation

Community Based Project Initiation

Survey and design by government agencies

Community wide hearing

Material procurement (Government)

Labor and construction by people in the related community

2013 Typhoon and storm surge in the Philippines

Super Typhoons in the past

The Washington Herald issue in November 20, 1912 published an article about a powerful typhoon that pounded on Tacloban and Capiz. Oklahoma-based newspaper Daily Armoreite also ran an October 1912 story of a storm that damaged Tacloban and surrounding areas.

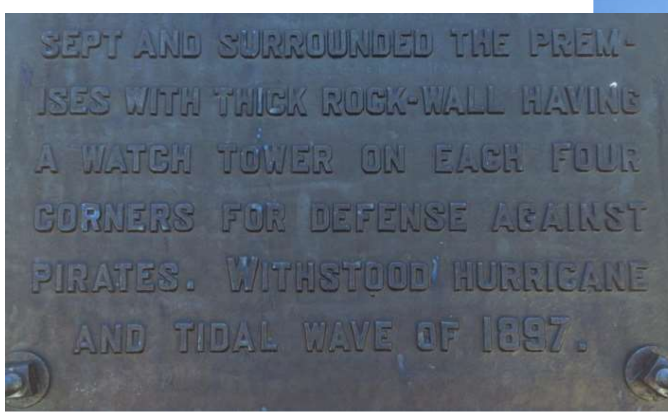
+ 7,000 dead by the typhoon in 1897 and recorded in a plaque in Tanauan Catholic Church

+ 15,000 dead by the typhoon in 1912

+ Low possibility for sand deposits by historical typhoons because of the severe coastal erosion.

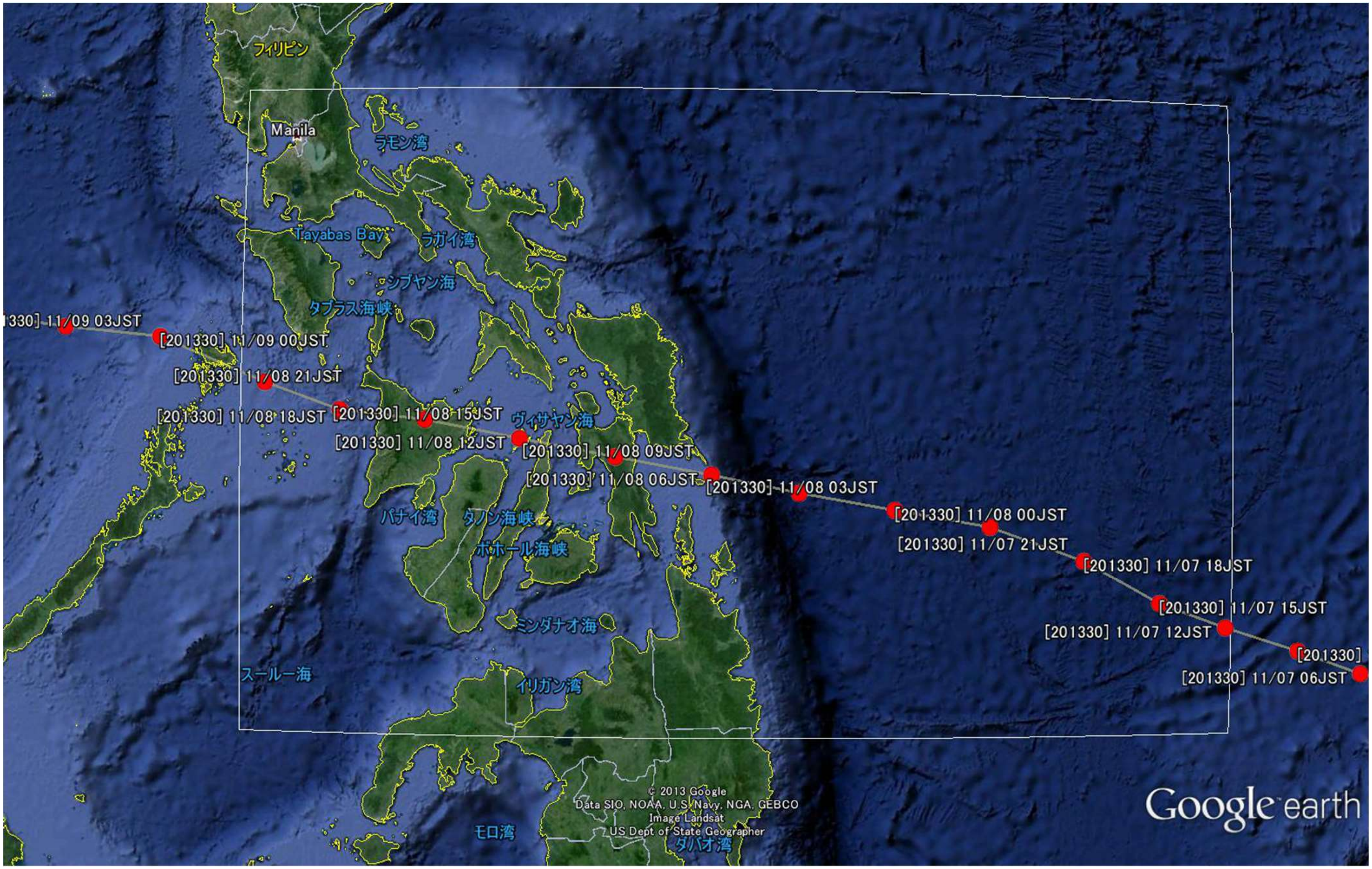
7000 Lives Lost.

Mail advices, brought by the steamer Gaelic from Chinese and other ports in the Far East, contain details of the fearful destruction wrought in the Phillipine Islands by the typhoon and tidal wave during October. It is estimated that 400 Europeans and 6000 natives lost their lives, many being drowned by the rush of water, while others were killed by the violence of the wind. Several towns have been swept or blown away. The hurricane first struck the Bay of Santa Paula, and devastated the districts lying to the south of it. No communication with the neighborhood was possible for two days. The hurricane reached Leyte on October 12, and striking Tacloban, the capital, with terrific force, reduced it to ruins in less than half an hour. The bodies of 126 Europeans have been recovered from the fallen buildings. Four hundred natives were buried in the ruins. A score of small trading vessels and two Sydney traders were wrecked on the southern coast, and their crews drowned. At Gamoa the sea swept inland for a mile, destroying property worth seven million dollars, and many natives lost their lives. The Government prison at Tacloban was wrecked, and of the 200 rebels therein half succeeded in making their escape. The town of Hernin was swept away by flood, and its 5000 inhabitants are missing. The small station of Weera, near Loog, is also gone, while in Loog itself only three houses are left standing. Thousands of natives are roaming about the devastated province seeking food and medical attendance. In many cases the corpses were mutilated as



Catholic Church in Tanauan

Track of Typhoon Yolanda



Summary of Damage by Typhoon Yolanda

- Casualties : 6,069 individuals were reported dead , 27,468 injured and 1,779 are still missing

- Damaged Houses : The number of damaged houses are 1,140,332 houses
    - Totally = 550,928
    - Partially = 589,404

Source :NDRRMC Update on Typhoon Yolanda As of Dec 16.2013, 6:00am

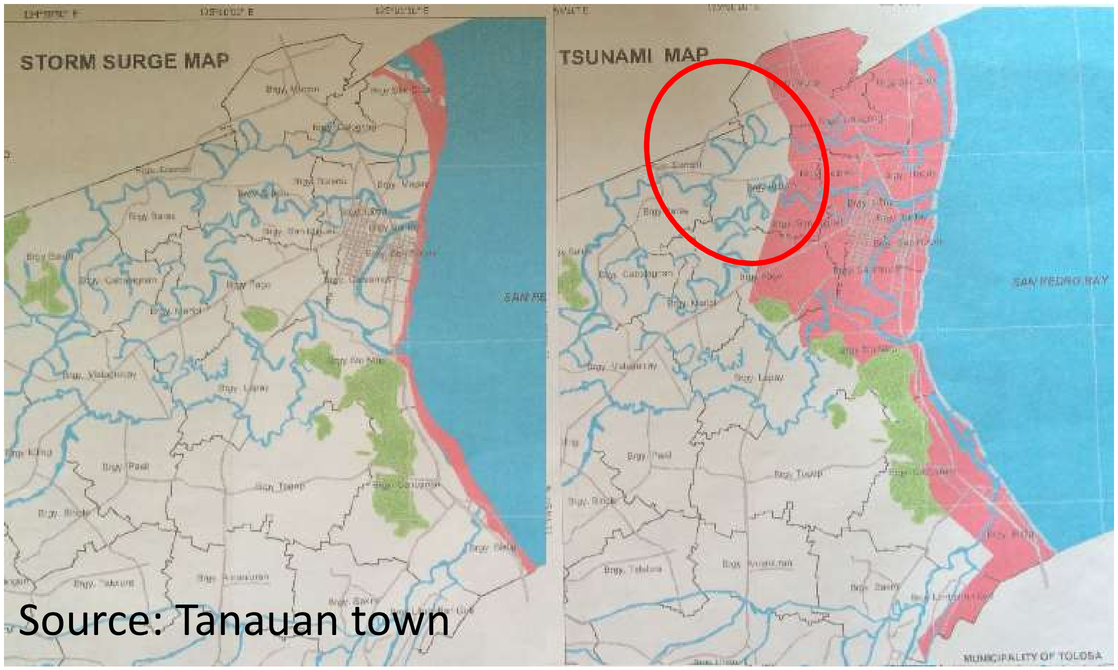
Vulnerability of the coastal zone

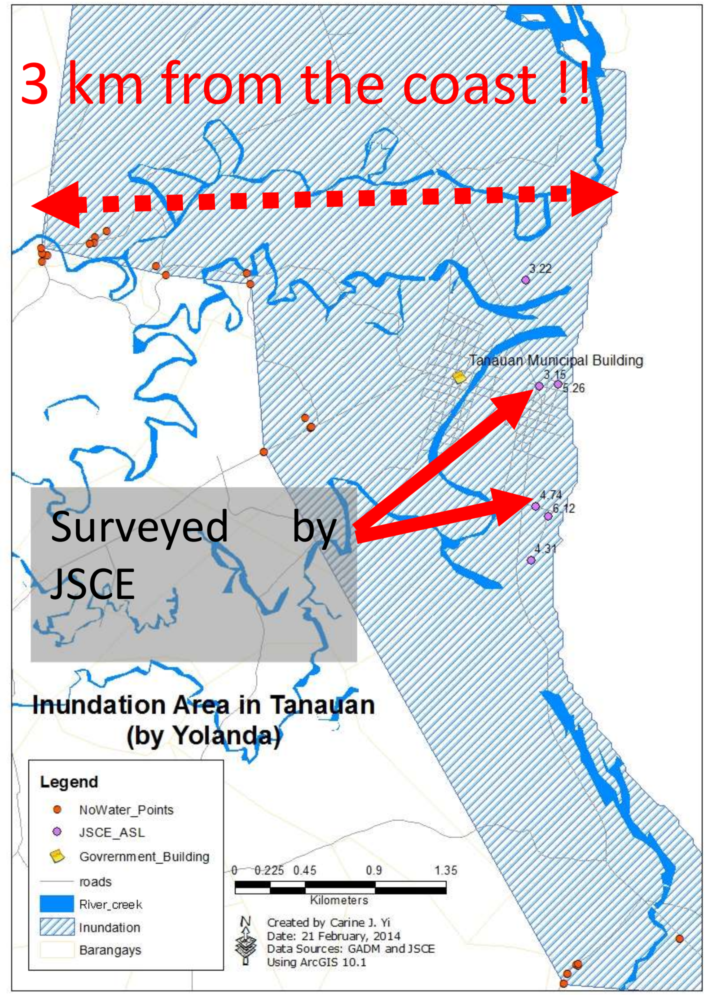
Google map around Tacloban city before Yolanda

Houses were concentrated in the coastal shorelines because of small or no payment for land owner.

Vulnerability of the coastal zone (Olavo et al., 2014)

Hazard maps prepared before the Haiyan and storm surge limit base on our findings (Tanauan)





What kind of houses they are living now

Fast (self) housing reconstruction

Rapid housing reconstruction using all available materials on ground. This can be built within only few days. However, concrete house may have to wait for 1-2 months due to the lacking of working machine

Using galvanized iron (GI) sheet

Using damaged container

`Nipa` material for roof (tree leaf)

Coconut lumber

Using internal organization tent

What kind of houses they are living now

Construction technique to protect the roof

Different housing materials

Imported wood log (coconut tree) from other provinces available after three months.

Traditional house: Cement floor and column and hollow-block wall in the first floor but all wood in the second floor to reduce cost

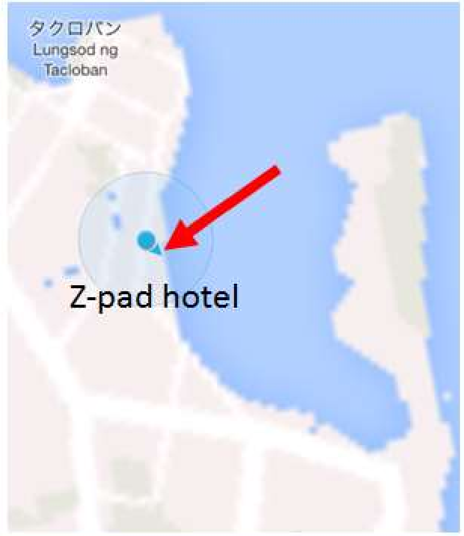
Wood

Hollow block

Those survived houses, their second floor are also cement and hollow-block structure.

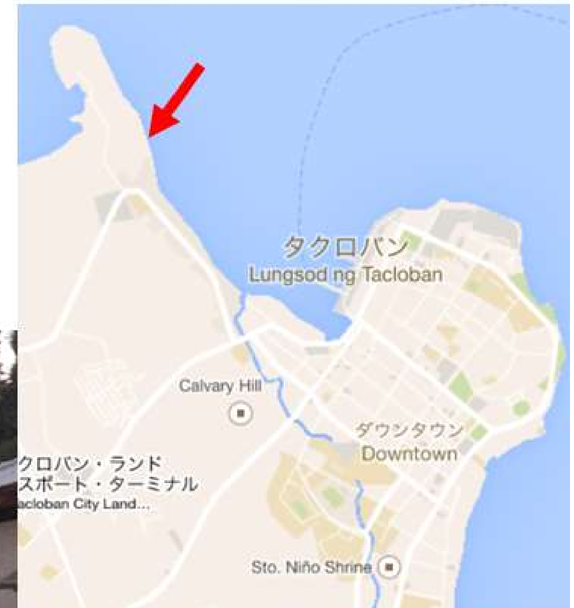
Where they are going to live in the future

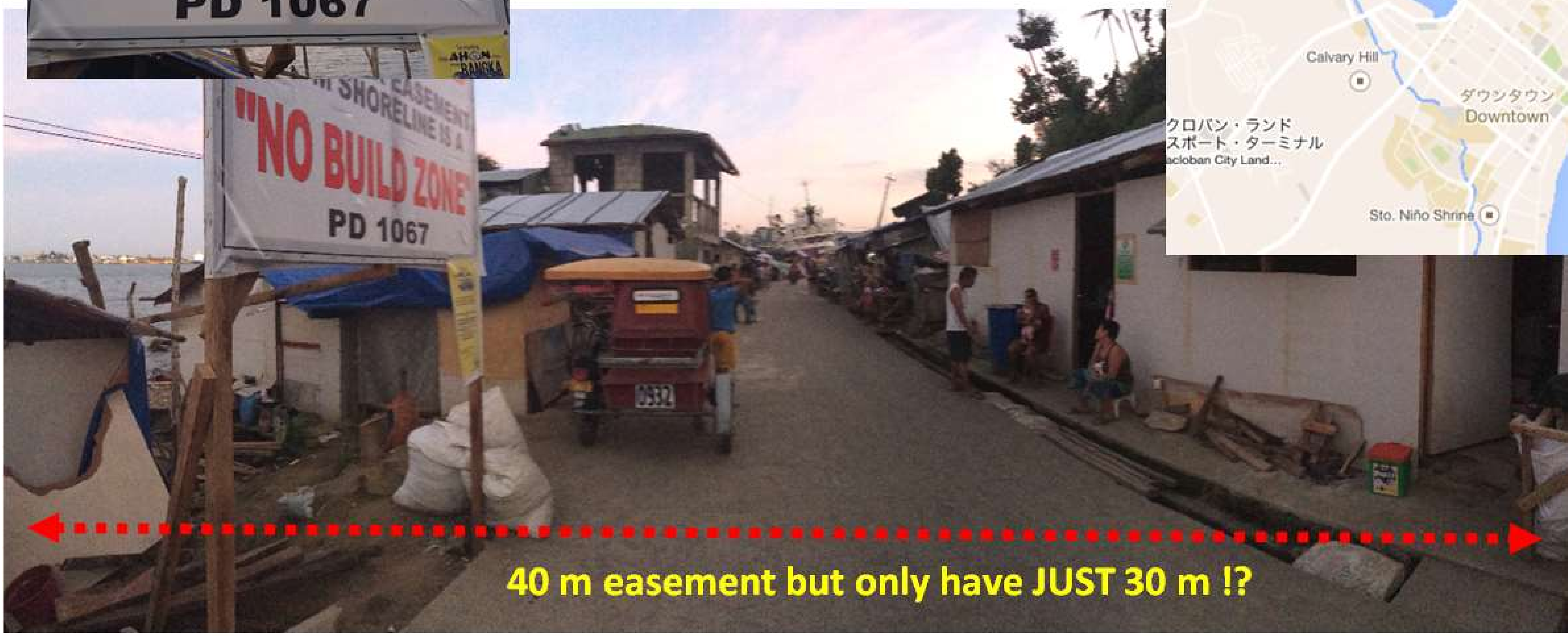
Zoning example (1)



Where they are going to live in the future

Zoning example (2)





Reasons for magnification of damage due to Yolanda

- Large Hazard

  Super typhoon (Category 5)

  Worst path to the densely populated area and generate significantly high surges and waves in the coastal area

- **Concentration of population** in the coastal area

- Weak mitigation system in terms of hard and soft measures

  vulnerable buildings

PAGASA Warning Records

11:00, 5th Nov., Weather Advisory #1

10:30, 6th Nov., Weather Advisory #2

23:00, 6th Nov., Severe Weather Bulletin #1

5:00, 7th Nov., Severe Weather Bulletin #2

11:00, 7th Nov., Severe Weather Bulletin #3

17:00, 7th Nov., Severe Weather Bulletin #4

20:00, 7th Nov., Severe Weather Bulletin #4-a

23:00, 7th Nov., Severe Weather Bulletin #5

2:00, 8th Nov., Severe Weather Bulletin #5-a

5:00, 8th Nov., Severe Weather Bulletin #6

11:00, 8th Nov., Severe Weather Bulletin #7

17:00, 8th Nov., Severe Weather Bulletin #8

23:00, 8th Nov., Severe Weather Bulletin #9

5:00, 9th Nov., Severe Weather Bulletin #10

11:00, 9th Nov., Severe Weather Bulletin #11

15:30, 9th Nov., Severe Weather Bulletin #12

18 hr

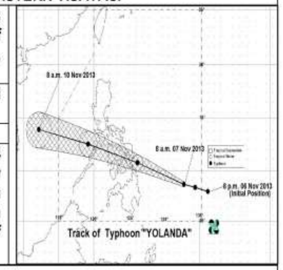
Landfall

Republic of the Philippines
Department of Science and Technology
PHILIPPINE ATMOSPHERIC, GEOPHYSICAL AND ASTRONOMICAL SERVICES ADMINISTRATION (PAGASA)
Weather Forecasting Section, Weather Branch
WFFC Bldg., BIR Road, Diliman, Quezon City 1100
TELEX: 66682 WXMNL PN FAX NOS: 9264258, 9282031, 9272877, 9271541
Website: http://www.pagasa.dost.gov.ph Email: pagasa.wb@pacific.net.ph Voice Server: 433-ULAN

SEVERE WEATHER BULLETIN NUMBER THREE
TROPICAL CYCLONE WARNING: TYPHOON "YOLANDA" (HAIYAN)
ISSUED AT 11:00 AM, 07 NOVEMBER 2013
(Valid for broadcast until the next bulletin to be issued at 5 PM today)

TYPHOON "YOLANDA HAS MAINTAINED ITS INTENSITY AS IT THREATENS EASTERN VISAYAS.

Location of eye/center:	At **10:00 AM** today, the eye of Typhoon **"YOLANDA"** was located based on all available data at **637 km East of Hinatuan, Surigao Del Sur** or **738 km Southeast of Guiuan, Eastern Samar (8.9°N, 132.1°E).**
Strength:	Maximum sustained winds of **215 kph** near the center and gustiness of up to **250 kph**.
Movement:	Forecast to move **West Northwest** at **30 kph**.
Forecast Position:	Typhoon **"YOLANDA"** is expected to be still over the sea at **64 km Southeast of Guiuan, Eastern Samar** by tomorrow morning and expected to make landfall over Guiuan, Eastern Samar (9-10 am). It will be at **122 km West of Coron, Palawan** by Saturday morning. On Sunday, it will be at **954 km West of Manila or outside the Philippine Area of Responsibility.**



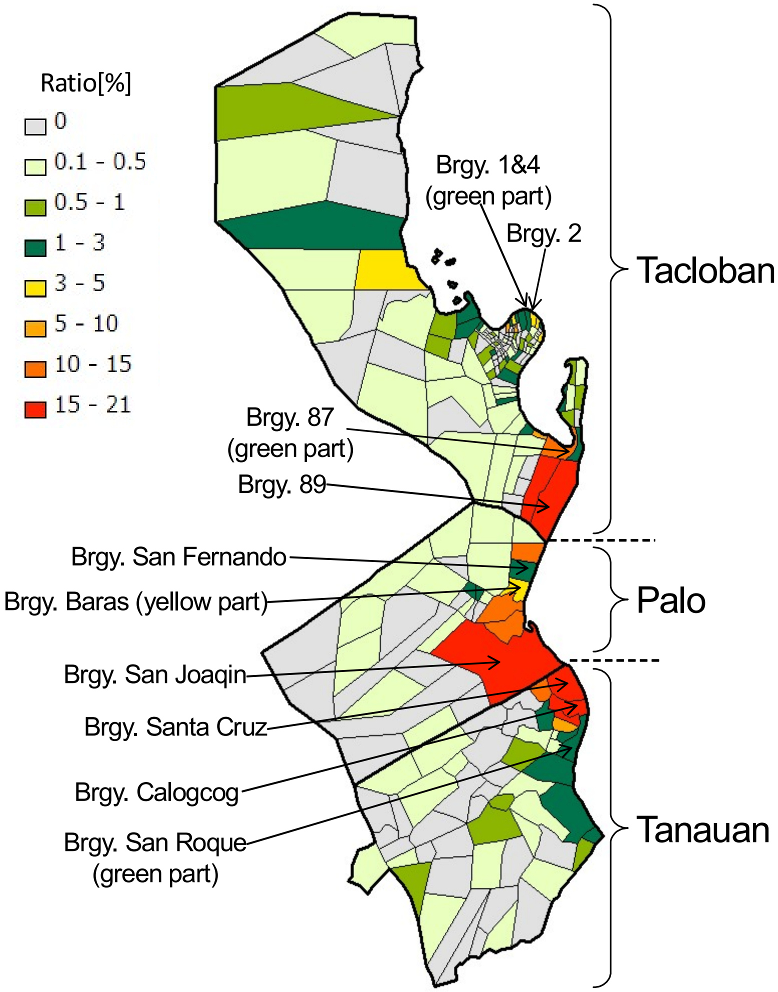
PUBLIC STORM WARNING SIGNAL

PSWS	LUZON	VISAYAS	MINDANAO	POTENTIAL IMPACTS OF THE WINDS
# 3 (Winds of 101 -185 kph is expected in at least 18 hrs)		Eastern Samar, Samar, Leyte and Southern Leyte.	Siargao Island and Dinagat Province	• Heavy damage to agriculture • Some large trees uprooted • Majority of nipa and cogon houses unroofed or destroyed considerable damage to structures of light to medium construction • Moderate to heavy disruption of electrical power and communication services • Travel by land, sea and air is dangerous
# 2 (Winds of 61-100 kph is expected in at least 24 hrs)	Sorsogon and Masbate including Ticao Island	Northern Samar, Biliran Province, Bantayan and Camotes Islands, Northern Cebu including Cebu City, and Bohol	Surigao Del Norte, Camiguin, Surigao Del Sur and Agusan Del Norte	• Moderate damage to agriculture • Rice and corn adversely affected • Few large trees uprooted • Large number of nipa and cogon houses partially or totally unroofed • Some old galvanized iron roofing may roll off • Travel by all types of sea vessels is risky • Travel by all types of aircrafts is risky
# 1 (Winds of 30-60 kph is expected in at least 36 hours)	Camarines Norte,Camarines Sur, Catanduanes, Albay, Mindoro Provinces, Burias Island, Romblon, Marinduque, Calamian Group of Island and Southern Quezon	Aklan, Capiz, Iloilo, Antique, Guimaras, Negros Occidental and Oriental, Rest of Cebu and Siquijor	Misamis Oriental and Agusan del Sur	• Twigs and branches of trees may be broken • Some banana plants may tilt or land flat on the ground • Rice in flowering stage may suffer significant damage • Some nipa and cogon houses may be partially unroofed • Sea travel of small seacrafts and fishing boats is risky

- Yolanda, after hitting Guiuan, is expected to traverse the provinces of Leyte, Biliran, Northern tip of Cebu, Iloilo, Capiz, Aklan, Romblon, Semirara Island, Southern part of Mindoro then Busuanga and will exit the Philippine landmass (Saturday Morning) towards the West Philippine Sea.
- Estimated rainfall amount is from 10.0 - 30.0 mm per hour (Heavy - Intense) within the **600 km** diameter of the Typhoon.
- Sea travel is risky over the northern and eastern seaboards of Northern Luzon and over the eastern seaboard of Central Luzon.
- Residents in low lying and mountainous areas under signal #3,#2 & #1 are alerted against possible flashfloods and landslides. Likewise, those living in coastal areas under signal #3 and #2 are alerted against storm surges which may reach up to 7-meter wave height.
- The public and the disaster risk reduction and management council concerned are advised to take appropriate actions and watch for the next bulletin to be issued at 5 PM today.

those living in coastal areas under signal #3 and #2 are alerted against storm surges which may reach **up to 7-meter** wave height.

Questionnaire survey (Jibiki et al., 2014)



Distribution of the death and missing ratio of each Barangay in survey area.

- ✓ 10 barangays in 3 sites
- ✓ Coastal area
- ✓ Damages: The death and missing ratio

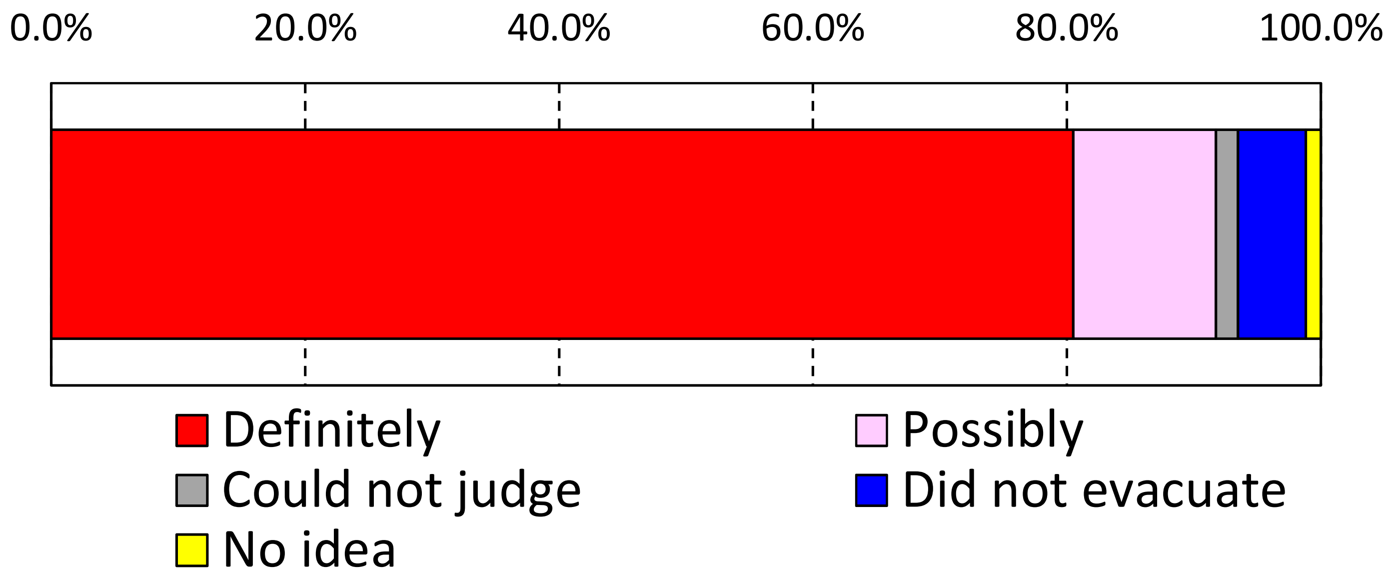
Respondents were selected depending on barangay damage in the coastal areas and population conditions of generation and gender in Philippines.

Terminology: Storm Surge VS Tsunami

- ✓ **Understood the meaning of "Storm Surge" *before* Yolanda?**

  → Yes = 12.8%

- ✓ **If you heard it was "tsunami", evacuated to anywhere else except your house?**



Questionnaire survey - Results -

- 641 valid respondents in Tacloban, Palo and Tanauan
- About 30% of the respondents did not evacuate to anywhere outside of their houses.
- Reasons for evacuation
  - Heard that super typhoon was coming
  - Felt that wind is getting stronger and stronger
  - **Order from Barangay leader**
- Reasons for not evacuated
  - **The wave should not be that large**
  - My house was strong enough
  - **Wanted to protect my house/belongings**
- Many peoples **do not understand "what a storm surge is"**
- **TV and Radio** are the main sources of information on typhoon

Questionnaire survey - Summary -

- Warnings were transferred relatively well to the coastal barangays
- TV, Radio and barangay leaders played important roles for the evacuation

However,

- many people **did not possess an accurate picture of the event** and **underestimate the impact** from Yolanda
- many people do not understand "what a storm surge is"
- Some people **wanted to protect their house/belongins**

Evacuation facility

- Evacuation facilities

Many facilities such as Tacloban convention center, Leyte convention center, schools, churches were not appropriate for the evacuation (Near sea side, severely damaged by strong wind, etc.).

Tacloban Convention Center

Leyte Convention Center (Palo)

Recommendations

- **Storm surge hazard maps** should be updated and developed in coastal areas in the Philippines **under the worst scenario** considering the impacts of climate change, worst path, land use/cover change, etc. And those hazard maps **should be provided to local communities**.

- Seawalls should be reconstructed and **multiple countermeasures** such as combinations of seawalls, tide-water control forests, no building zones, etc. should be developed from the view point of **efficiency, low cost and easy maintenance**.

Recommendations

- Selection and construction of **suitable evacuation centers** and places. However, it is **not easy** for the government to provide safe place for 200,000 people living in coastal areas of Tacloban city during the super typhoon.

- Education and training to emphasize the urgency of evacuation, especially for the **barangay leaders** (local communities).

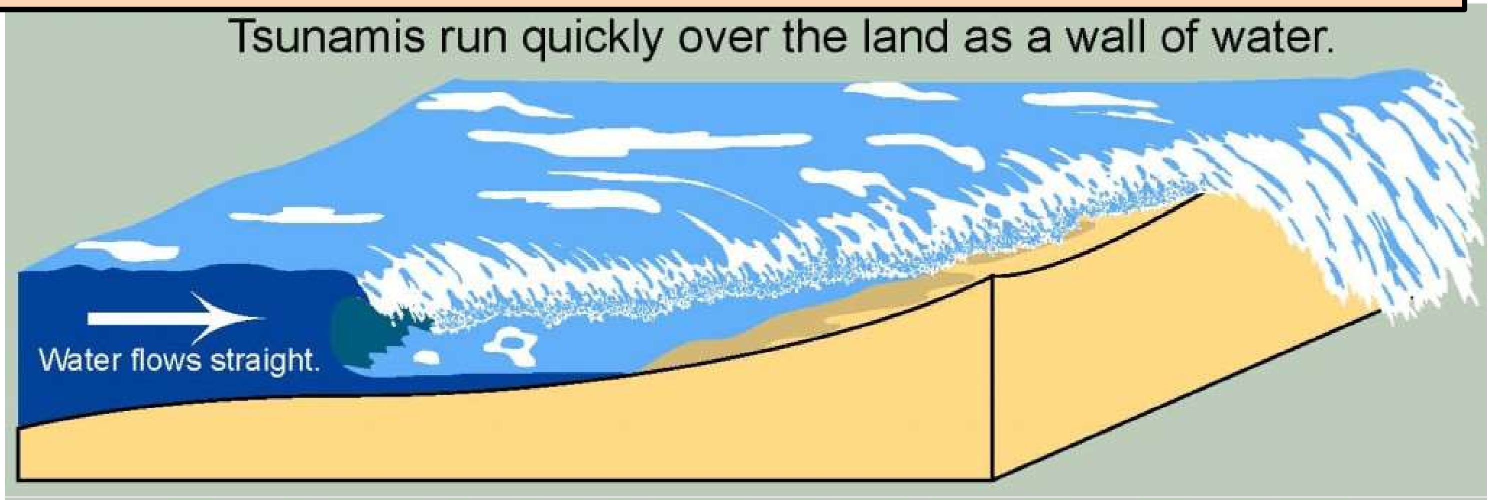
- Upgrade of an early warning system for storm surge inundation (**Downscale to the community level**).

- **Warning transfer system in the local communities** (Barangay level). Barangay leader's leadership for the evacuation and information from media are important.

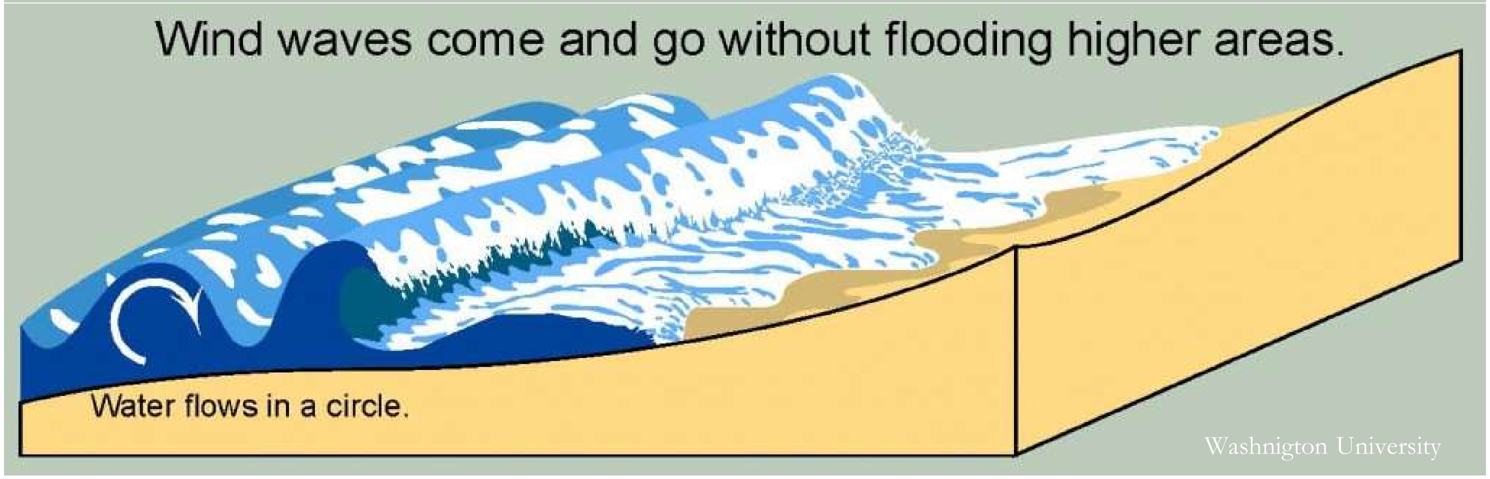
Tsunami VS Wind wave

+ 2011 Tohoku-oki tsunami and 2011 Haiyan typhoon are one of the biggest disaster in the world in the last five years.
+ Both of hydraulic characteristics are significantly different (e.g., water driving power (straight and circle), wave period (long, short)).

Tsunami

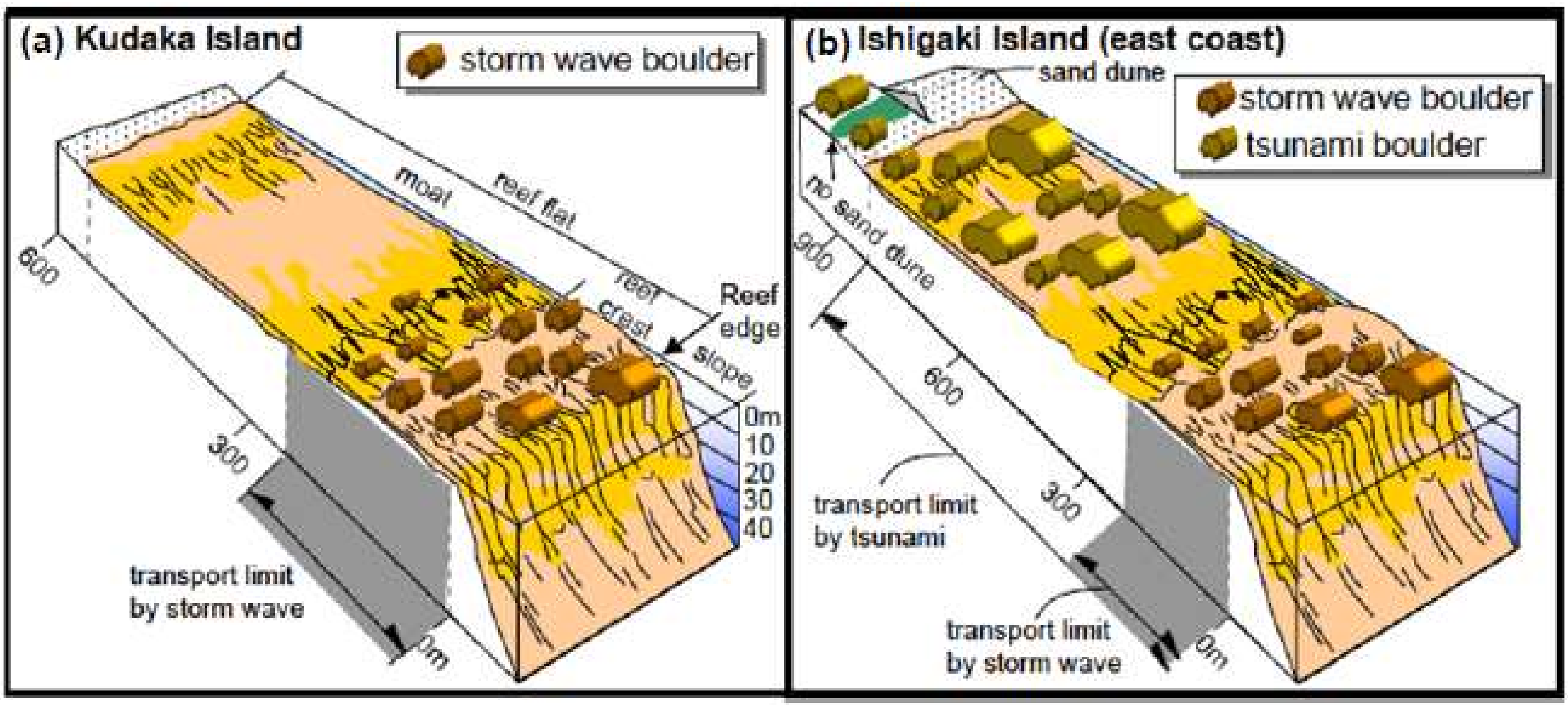


Wind wave



Tsunami VS Storm surge (boulders)

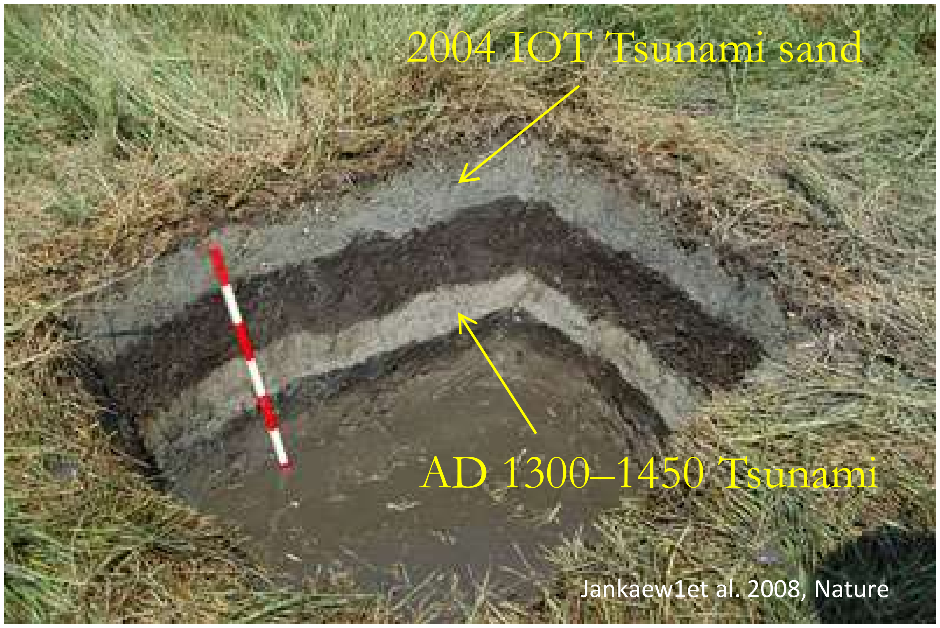
+ 2011 Tohoku-oki tsunami and 2013 Haiyan typhoon are one of the biggest disaster in the world in the last five years.
+ Both of hydraulic characteristics are significantly different (e.g., water driving power (straight and circle), wave period (long, short)).

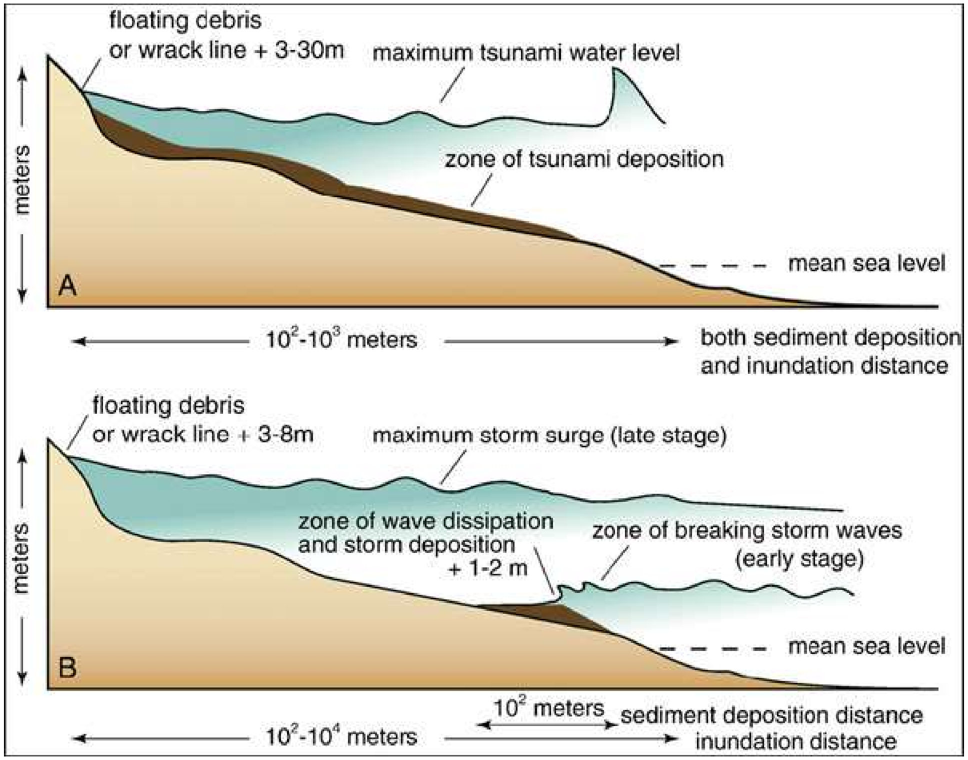


Tsunami VS Storm surge (sand deposits)

+ Ancient tsunami deposit and storm deposit are useful for estimating their recurrences intervals and magnitudes.

+ Distinguishing tsunami and storm deposits was important for understanding of ancient events from the deposit.

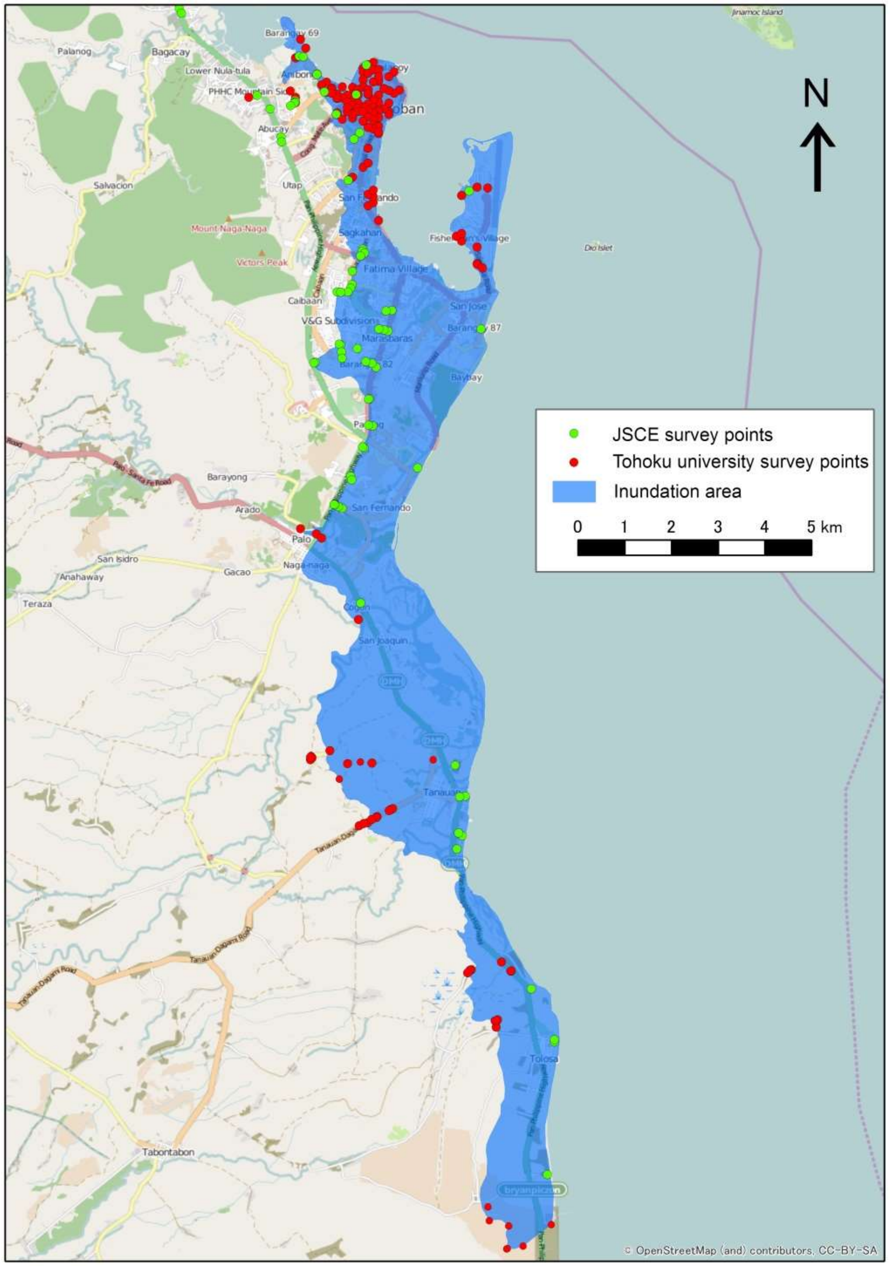




Differences in flow depths, inundation distances, and sediment-transport distances for sand beds deposited by (A) tsunamis and (B) coastal storms.

Morton et al. 2007, Sedimentary Geology

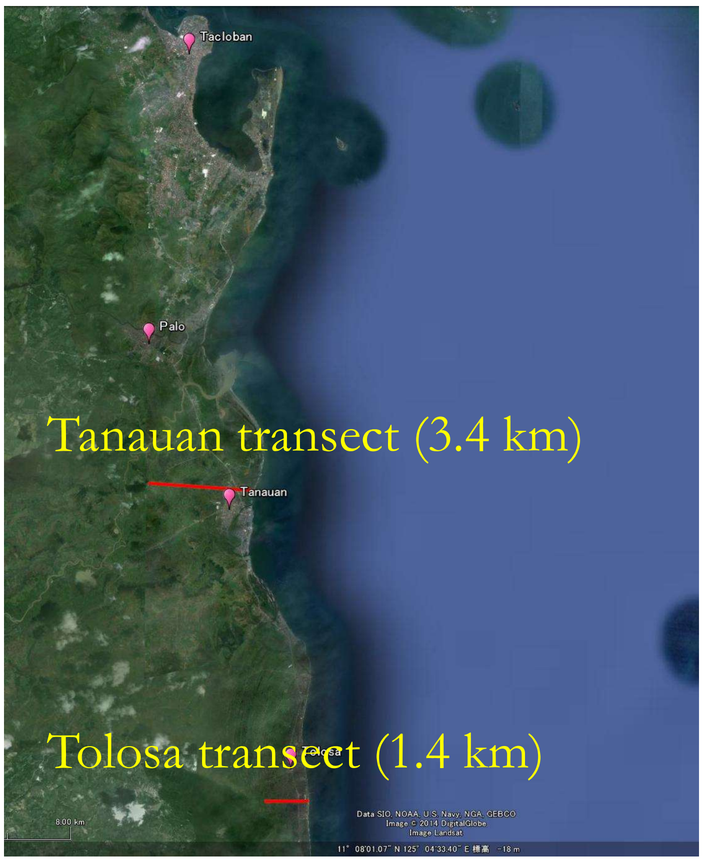
Method: Water height and area survey

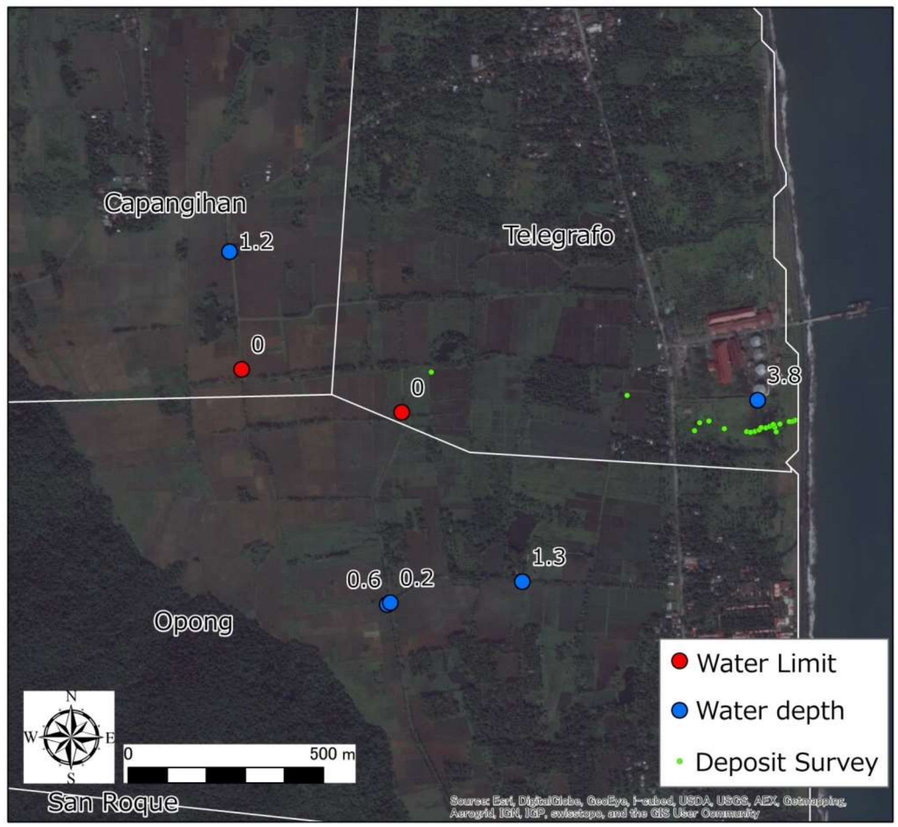


We recognized water height and inundation area based on water mark and interviewing to the local people.

Method: Geological survey

+ We conducted geological survey from 8th to 11th May 2014.
+ We set 3.4 km long transect in Tanauan and 1.4 km long transect in Tolosa from coastline to inundation limit.
+ We dig 41 small trench and observe thickness, grain size and sedimentary structures of Haiyan storm deposit.





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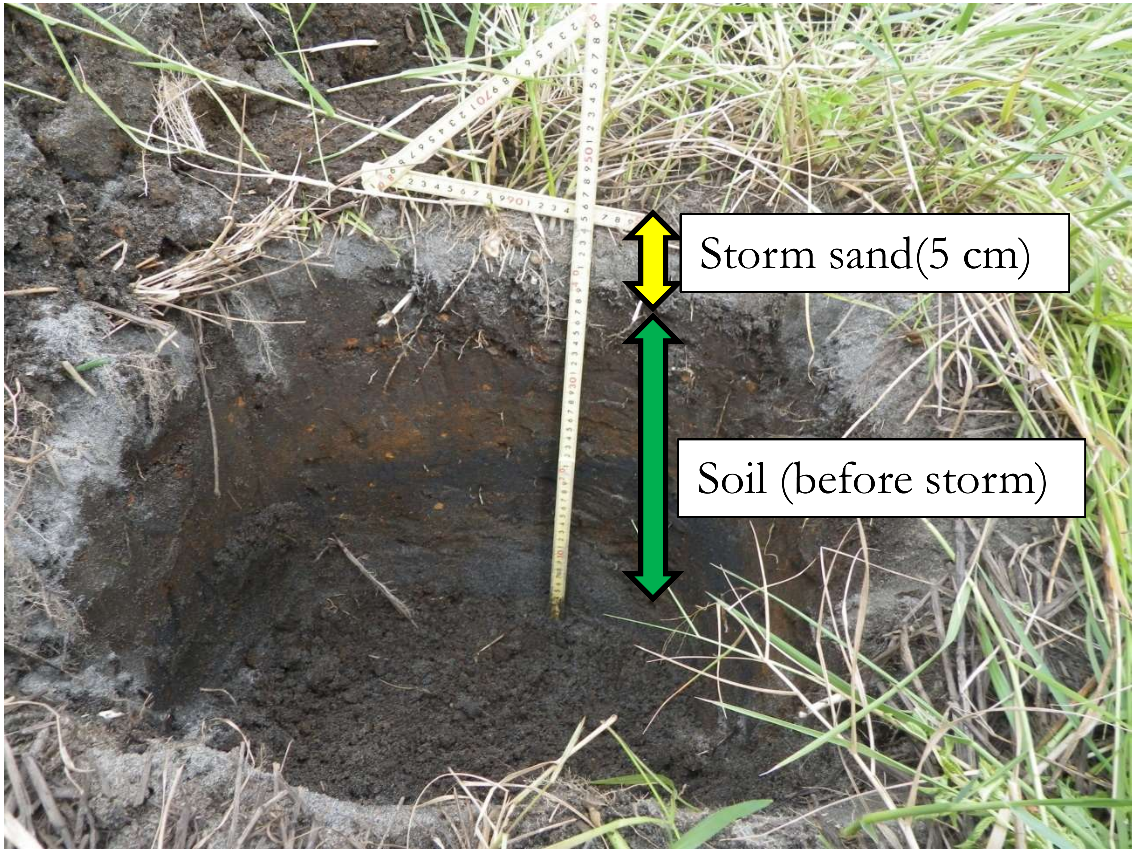
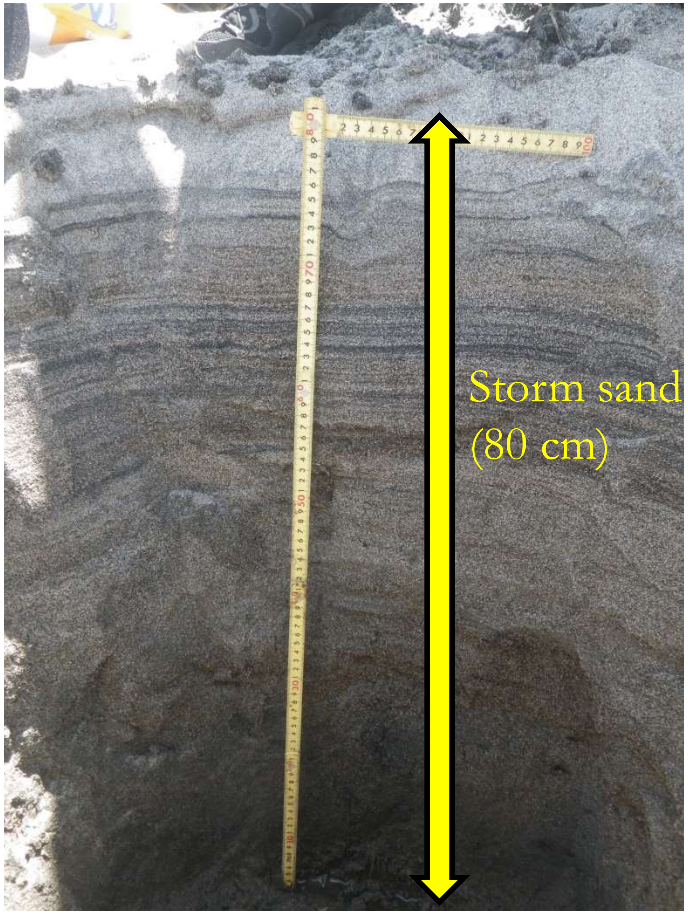
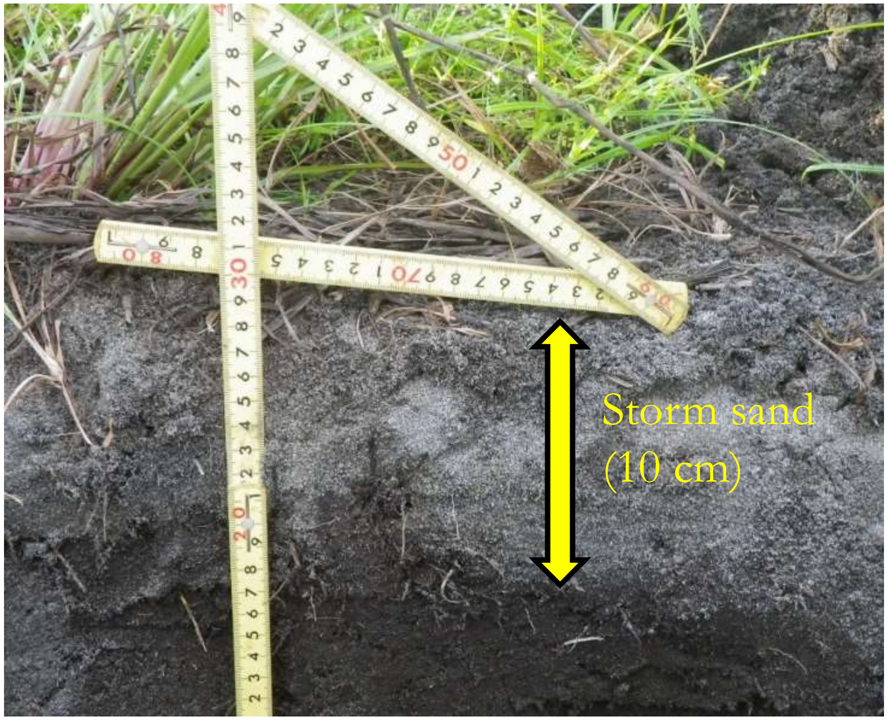


Result: Characteristics of Haiyan storm sand

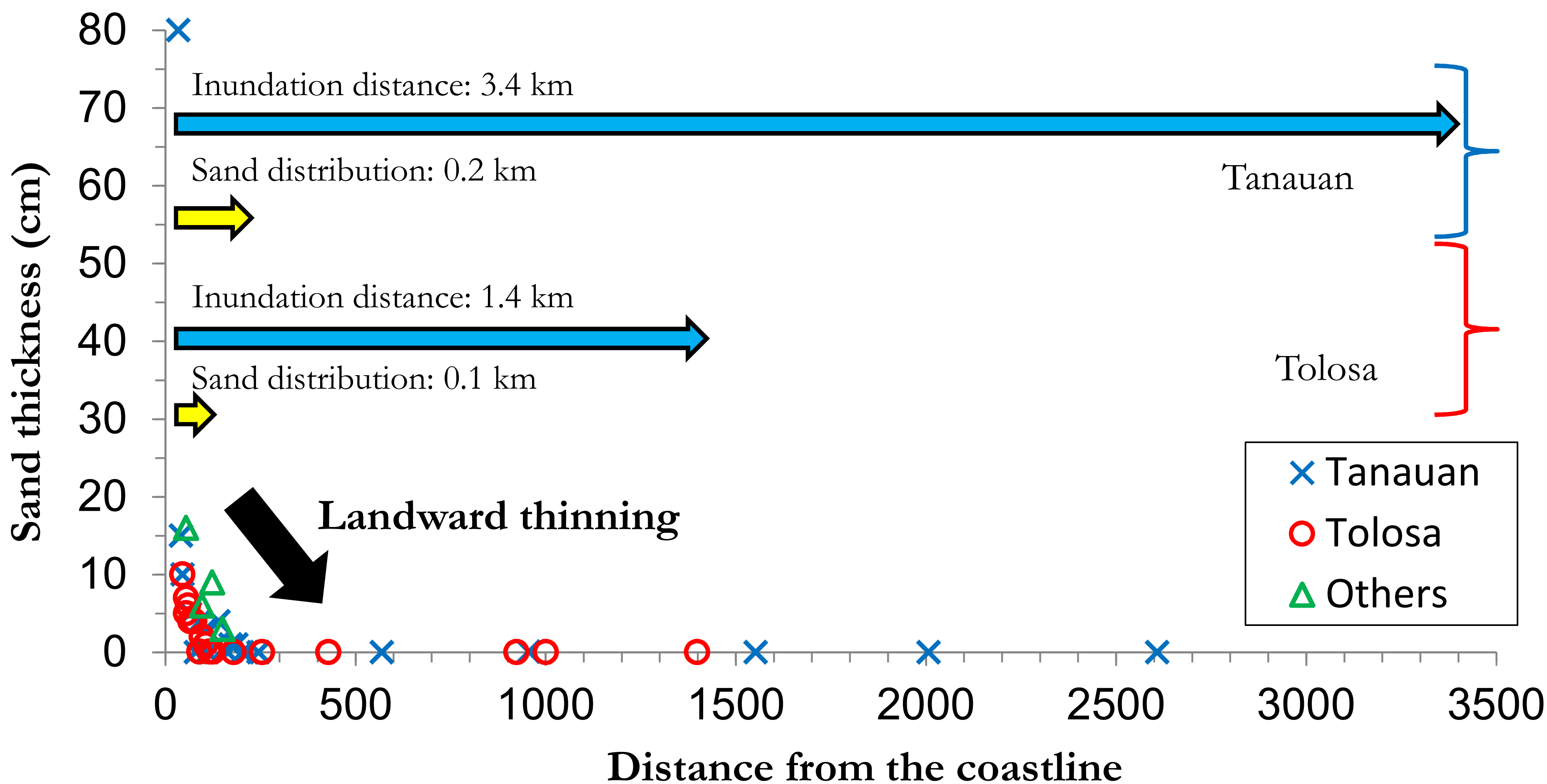
+ Grain size and minerals of storm sand were similar with that of beach sand and dune sand.
+ Storm sand should be sourced from beach or dune sand.
+ Thickness of storm sand was 80 cm at a maximum.





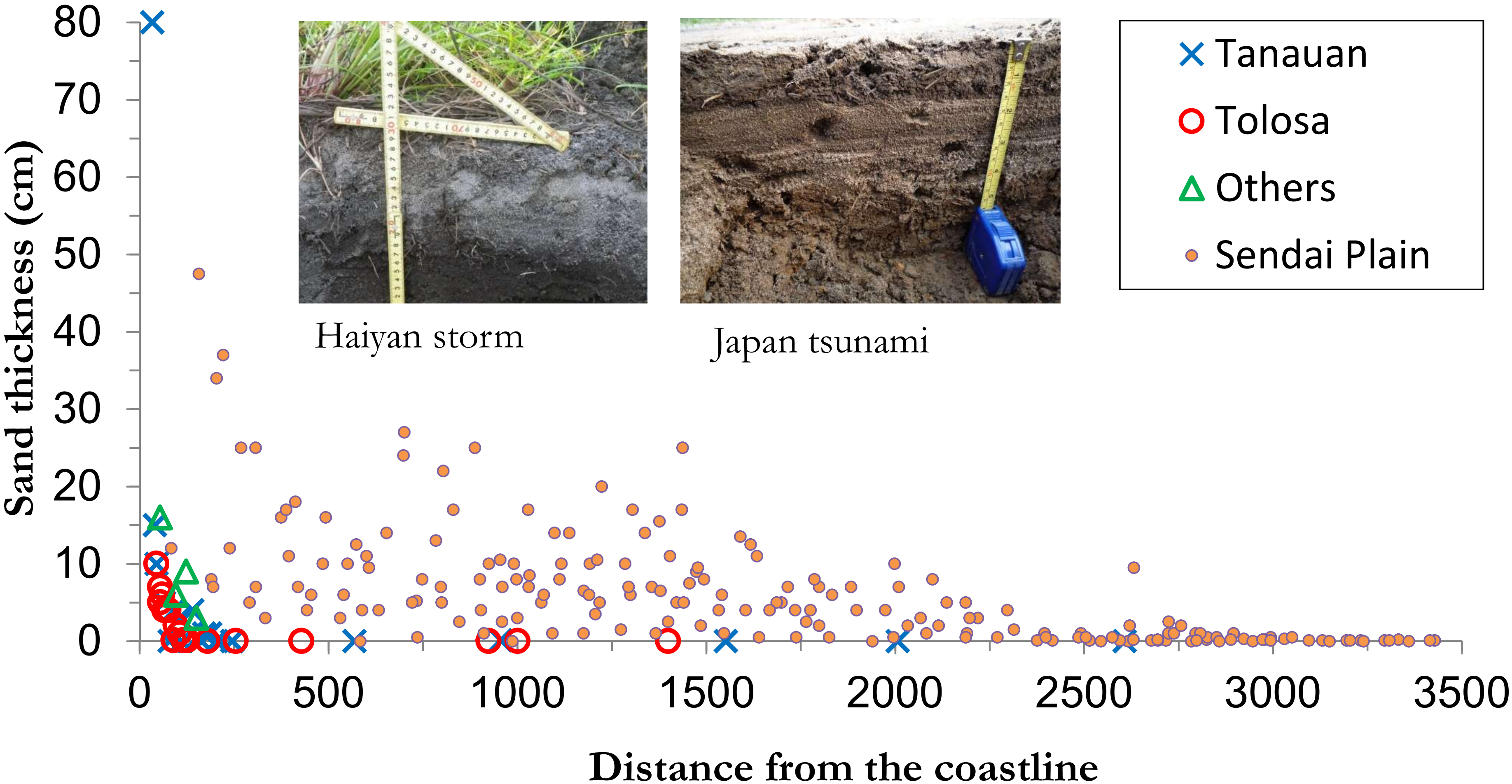
Result: Distribution of Haiyan storm sand

+ Haiyan storm sand generally thinned landward.
+ The sand limited 0.2 km inland in Tanauan transect with 3.4 km long
+ The sand limited 0.1 km inland in Tolosa transect with 1.4 km long



Result: Comparison between Haiyan storm sand and Tohoku-oki tsunami sand

Haiyan storm sand extended up to about 0.2 km inland.
Tohoku-oki tsunami sand extended up to about 3.0 km inland



Result: Sand limit vs Water limit

Tsunami

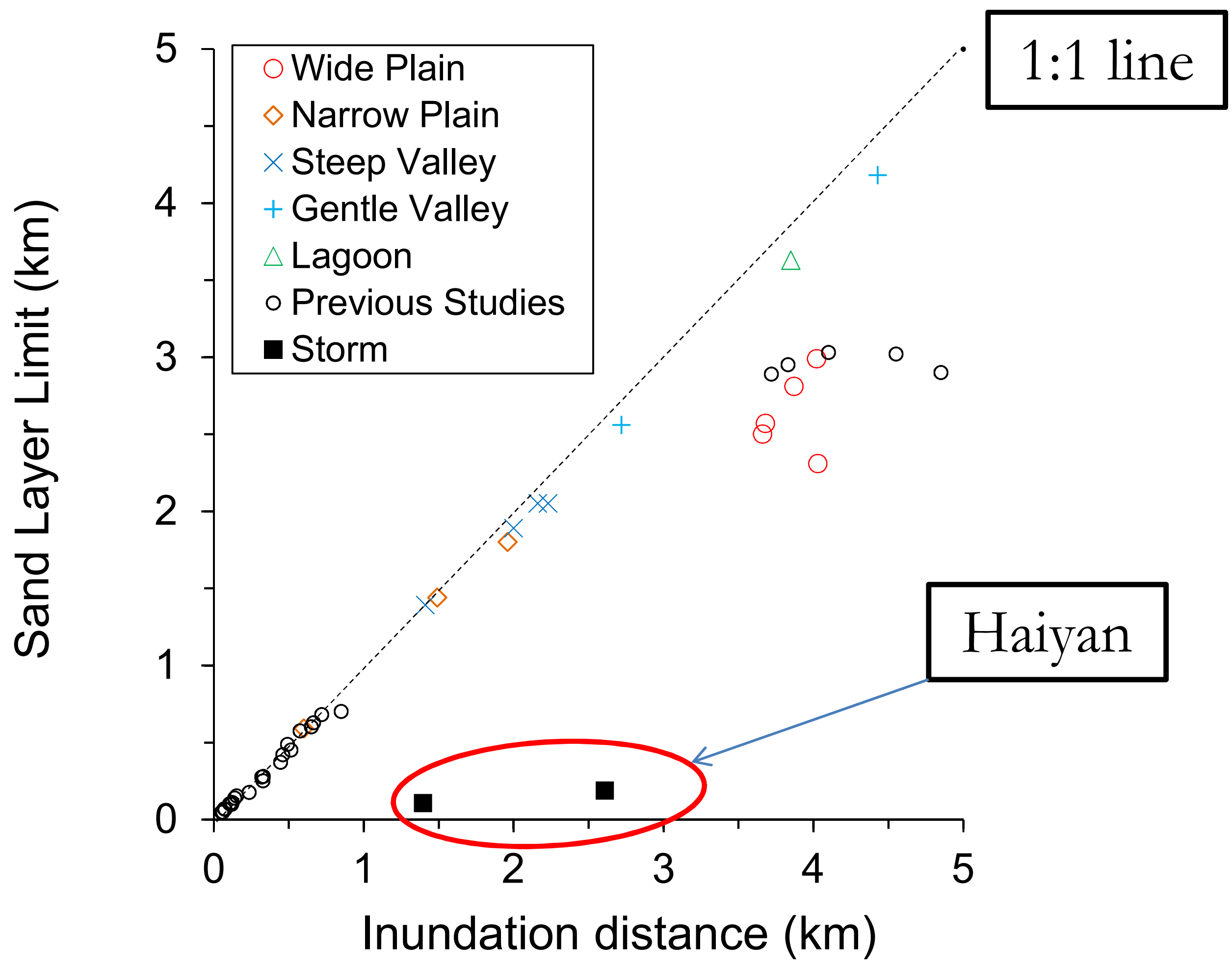
Inundation distance ~2.5 km: Water ≒ Sand (sand/water: 92-99%)

Inundation distance 2.5km~: Water ≠ Sand (sand/ water: 55-74%)

Storm

Water ≠ Sand

(sand/water: 7-8%)



Method: Numerical modeling

We run Delft-3D and SWAN together for numerical calculation

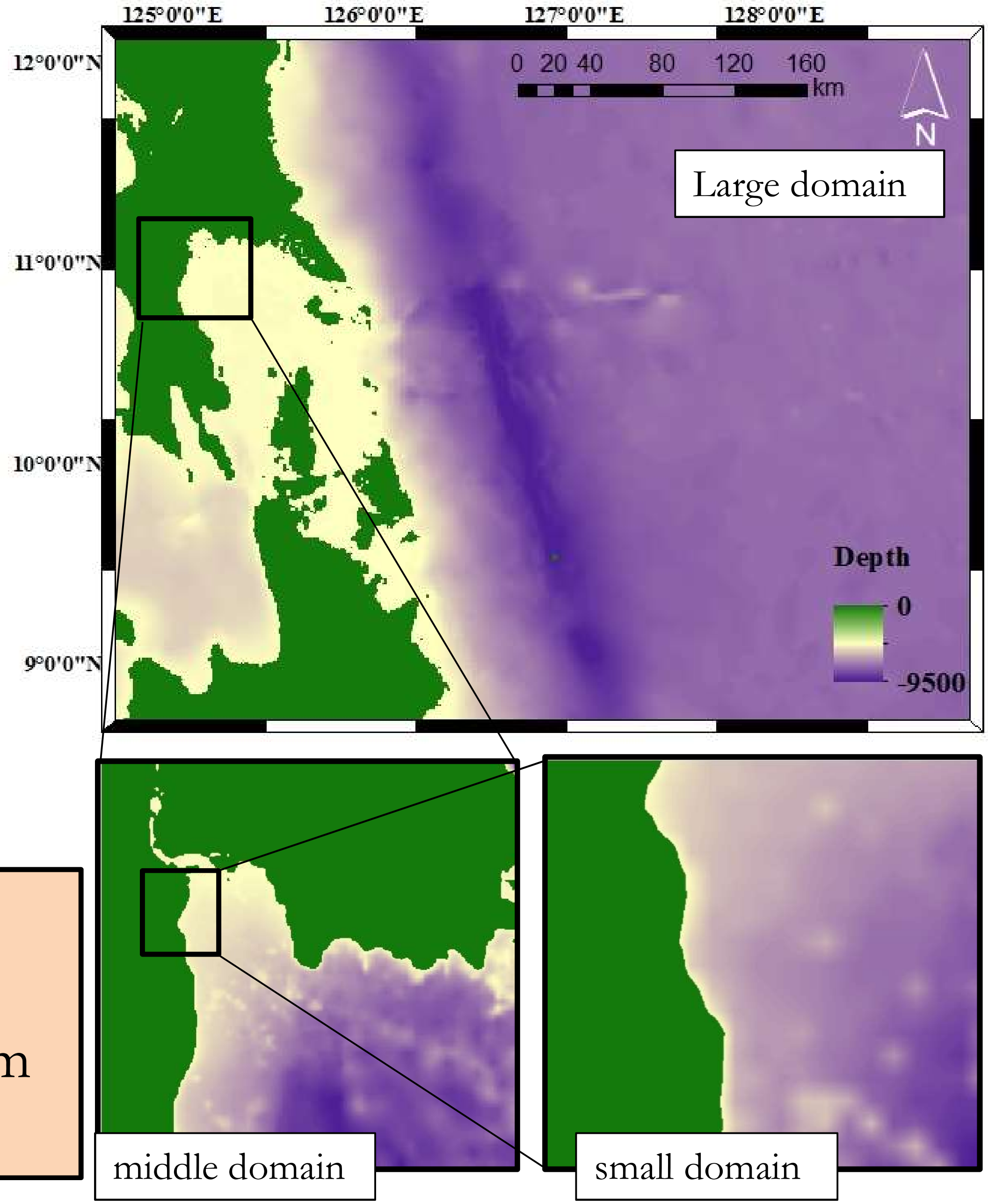
Domain ：0.01° ＞0.002° ＞0.0004°

Calculation time：2014/11/6～2014/11/9

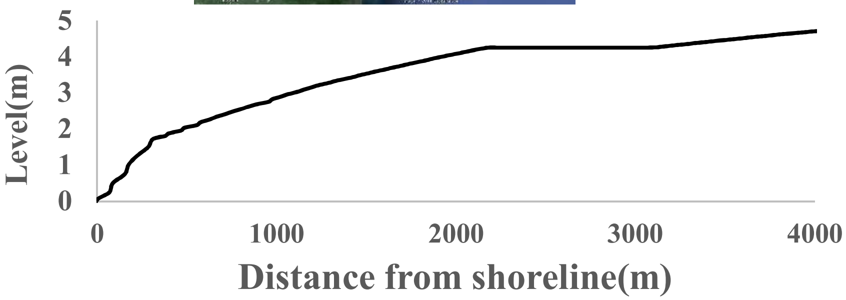
Delft-3D(hydrodynamic model) calculates water level and current fields.

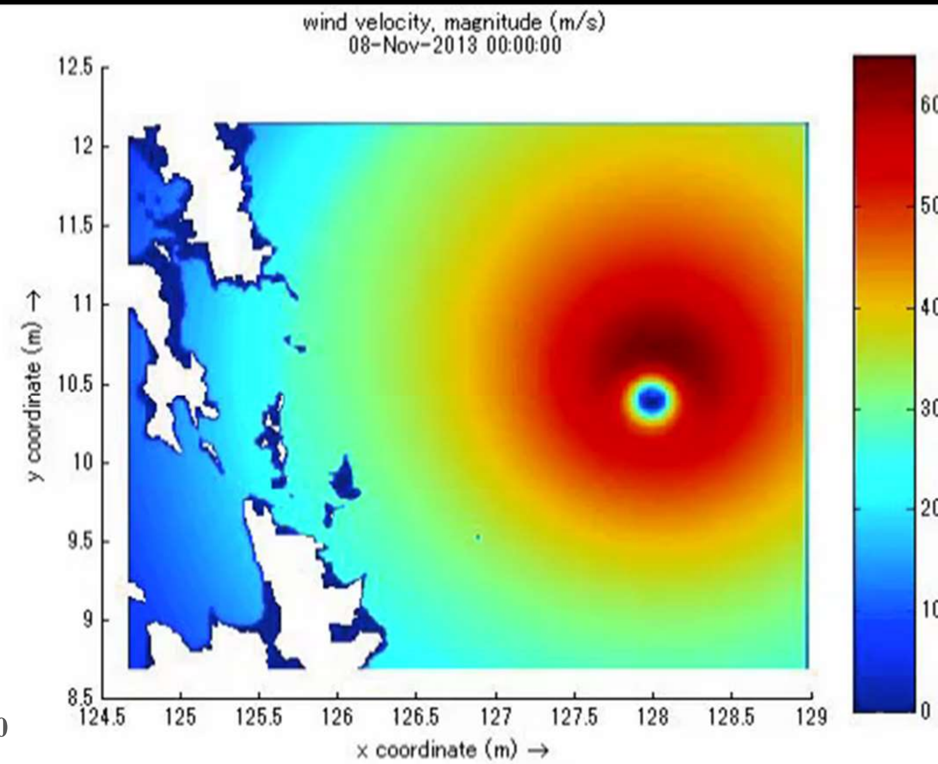
SWAN(spectral wave model) calculates wave field.

We investigated the relation between the storm wave hydrodynamic features and storm wave sediment characteristic.



Method: Numerical modeling



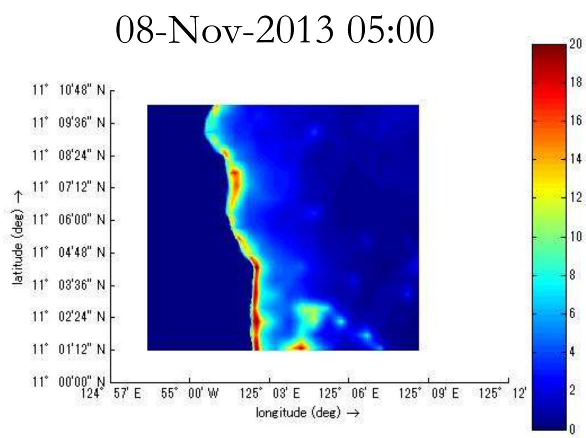


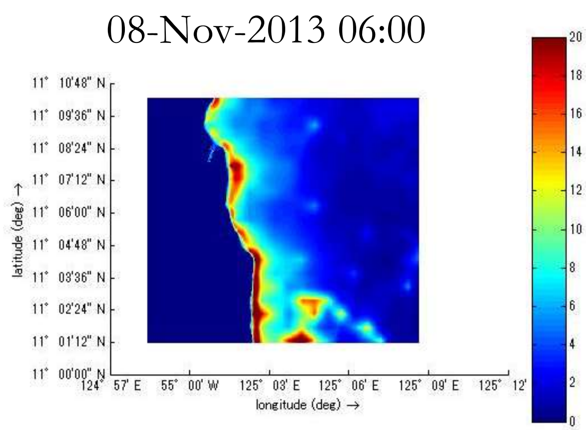
We used typhoon track data from JMA(Japan Meteorological Agency) and estimated wind field(Holland., 1980, Fujii et al., 1986) .

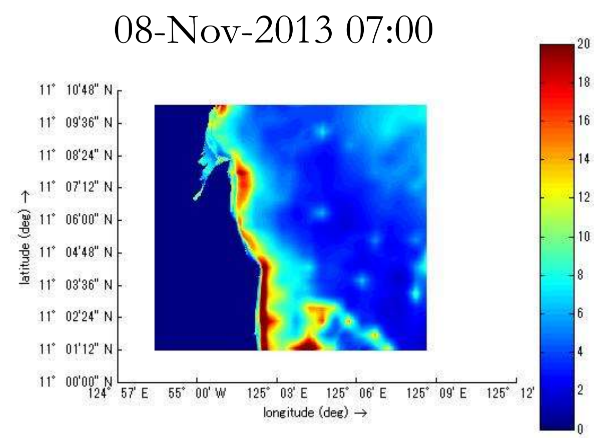
1. We estimated maximum bed shear stress due to storm wave.
2. We estimated wave velocity and flow depth across the Tanauan transect and investigated the relation between the storm wave hydrodynamic features and storm wave sediment characteristic .

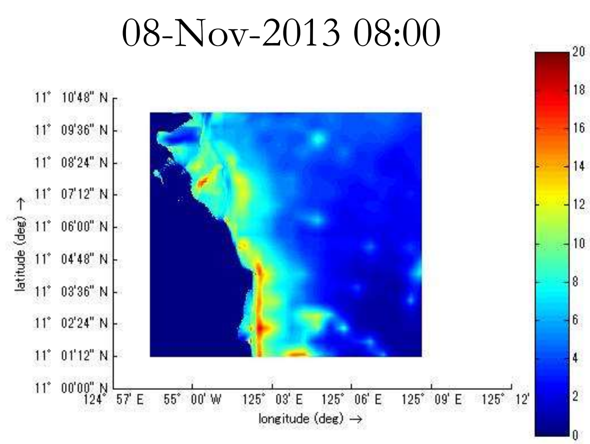
Result: Numerical modeling

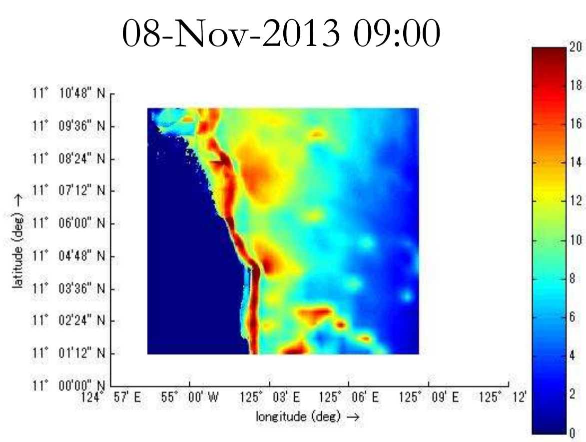
1. We estimated maximum bed shear stress.

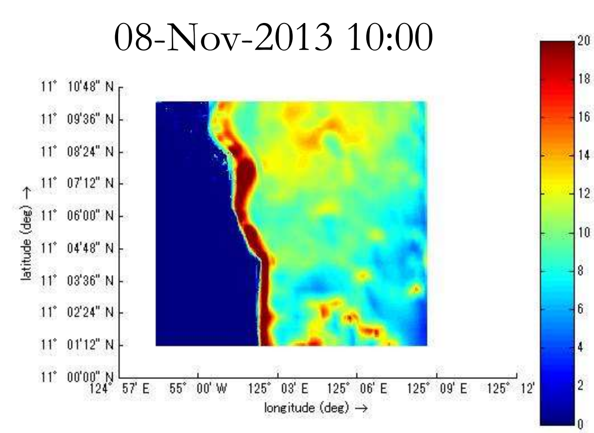










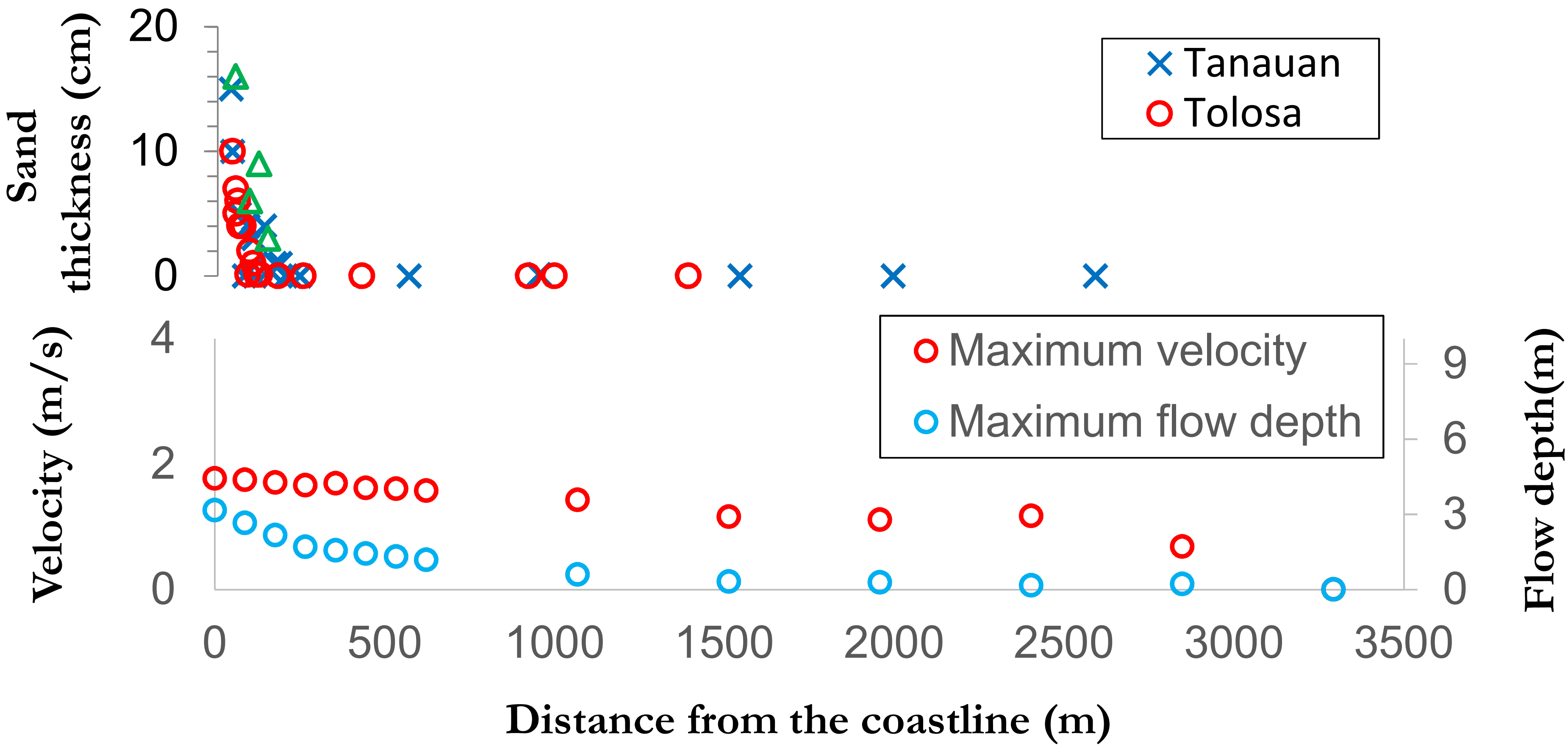


maximum bed shear stress is high on coastline.

→Sand dune on the coastline was eroded and transported inland.

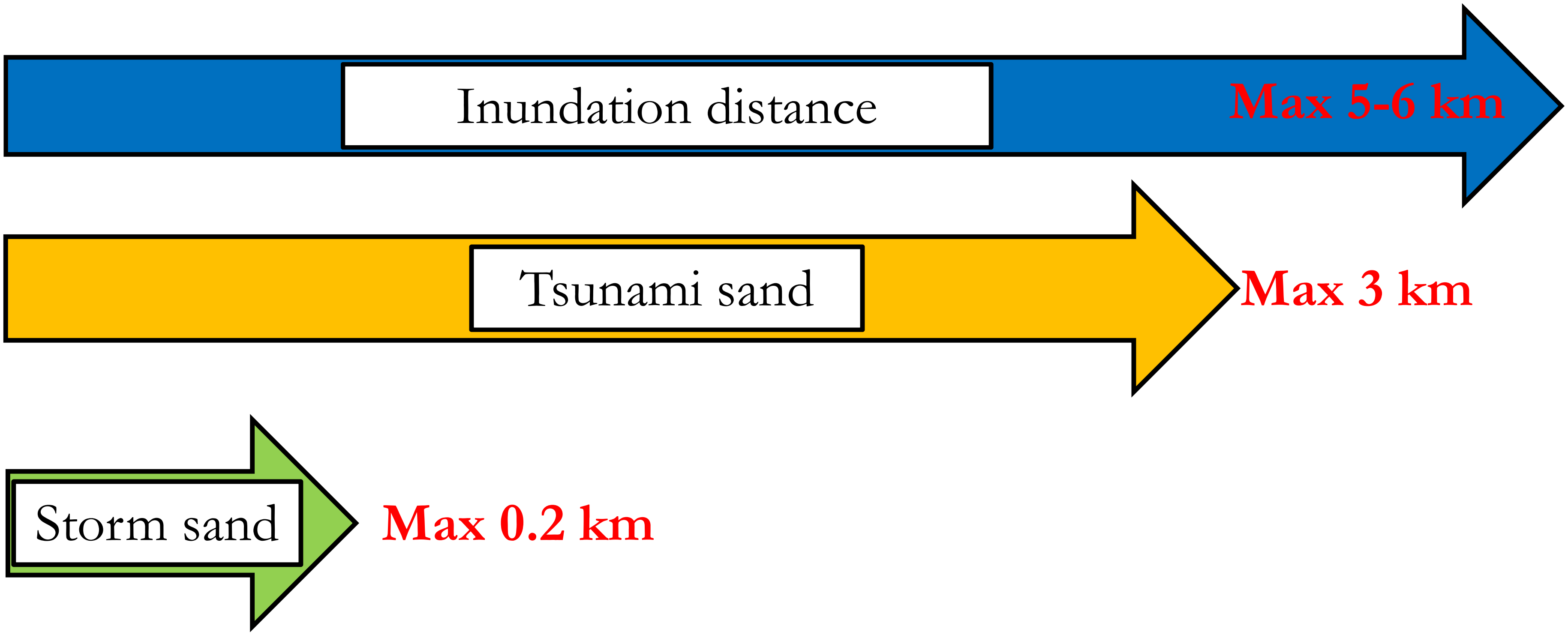
Result: Numerical modeling

2. We estimated wave velocity and flow depth across the Tanauan transect.



The flow depth is decreasing landward.
→The sand thickness is correlated with the flow depth as in the case of the tsunami (Goto et al., 2014).

Discussion



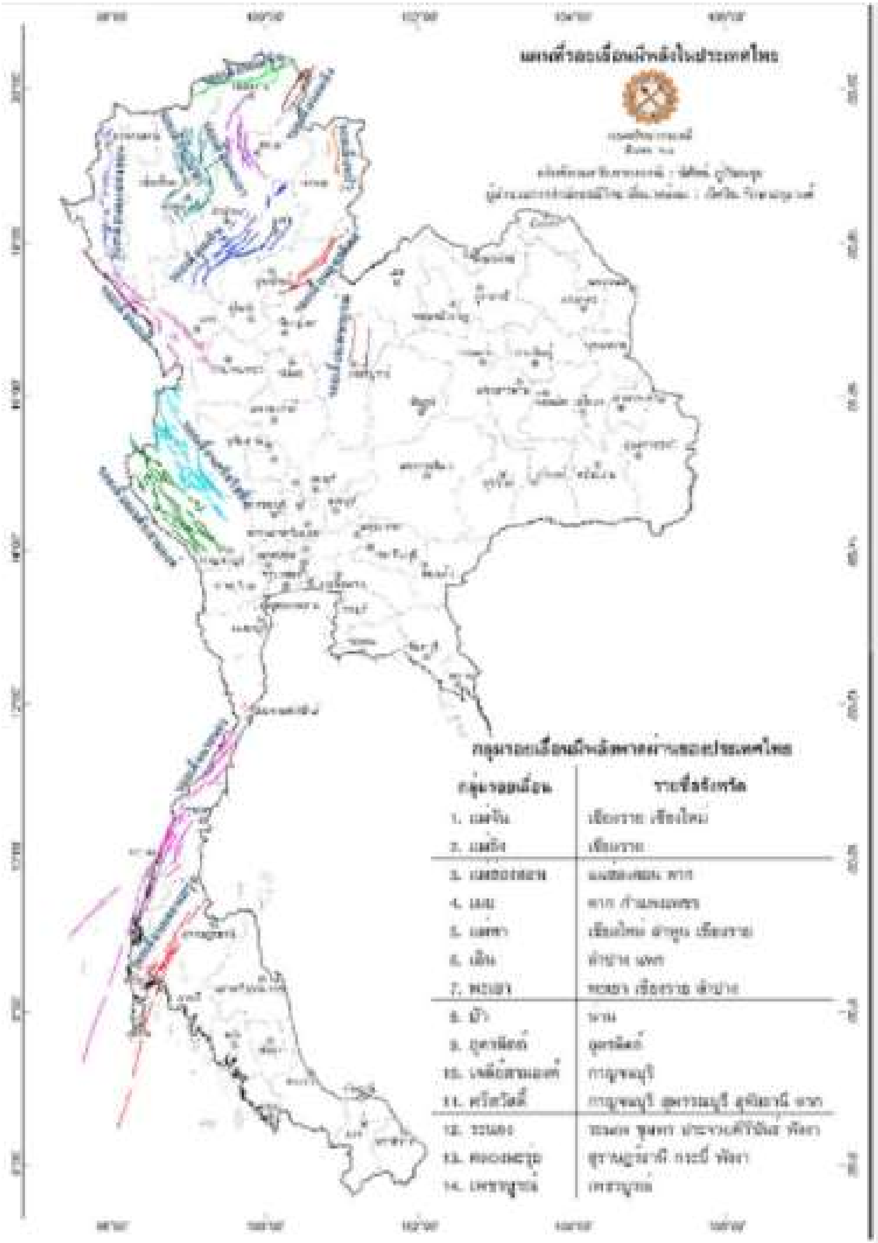
Inland sand extent between tsunami and storm could be impacted by stream power related to wave period (wave duration)

(Tsunami: shallow-water waves, with long periods and wave lengths)

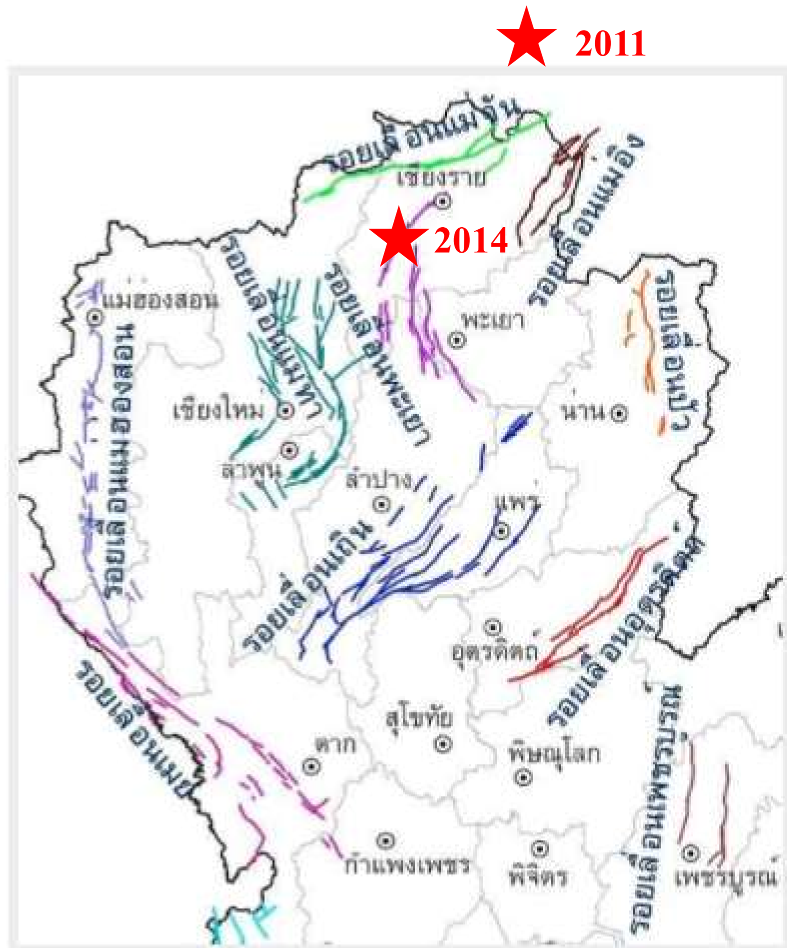
(Storm: wind-generated waves, with short periods and wave lengths)

2014 Earthquake in Thailand

Two earthquakes in 2011 and 2014



	Magnitude	Depth (km)	Deaths
2011 EQ	6.8	10	> 150 (1 in Thailand)
2014 EQ	6.3	7.4	2



Situation after four years

An example of damage evaluation

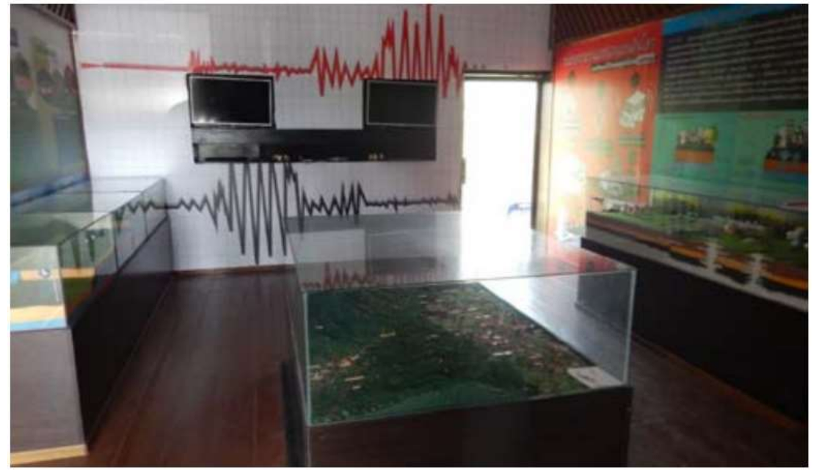
An example of damaged building

An example of non-engineered house

An example of rebuilt house

Situation after four years

Rebuilt school



Earthquake learning space

Damaged pagoda (> 700 years)

Damaged pagoda hospital

レポート

2カ国以上への被害・影響を起こした海外での災害を選択し、
以下の項目ごとに議論して下さい。

1) 何故このような広域被害が発生したのか？

2) 関係機関が緊急対応した中で、上手くいったこと

3) 次の同じような災害が発生するまで、改善するべきこと

4) それら「上手くいったこと」と「改善するべきこと」について、
日本の防災対策と比較する

フォーマット: ４ページ以内、スタイルは自由

言語: 日本語・英語

提出〆切: 2018年9月7日

提出先: suppasri@irides.tohoku.ac.jp

Report

Select one disaster that caused damage or impact to more than one country (not in your country) and discuss following issues.

1) Why such widely damage and impact occurred

2) What are good practices

3) What are lessons to be improved

4) Compare these good practices and lessons with disaster mitigation in your country

Format: Within four pages, no specific format

Language: Japanese or English

Deadline: 7 September 2018

Submit to: suppasri@irides.tohoku.ac.jp