Flood Management in Japan

13 March 2012

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1. Comprehensive Flood Control Measures
2. Provision of River information
3. Responses to the Niigata Torrential Rain Disaster
4. About ICHARM
5. Responses to 2011 Thailand Floods
6. Outline of the Tsunami-Resilient City

Occurrence of Heavy Rain with Hourly Rainfall of over 100 mm

Heavy rain with an hourly rainfall of over 100 mm occurred in various parts of Japan, causing inundation.

Damage caused by torrential downpour in Chugoku and Northern Kyushu districts in July 2009

○ Hourly rainfall of 116 mm (Fukuoka city, Fukuoka pref. (Hakata))
○ Hourly rainfall of 72.5 mm (Hofu city, Yamaguchi pref. (Hofu))
○ Damage caused by debris flow, etc. in Northern Kyushu and Chugoku districts
  Deaths: 31
  Houses flooded above floor level: 2,152, Below floor level: 9,285

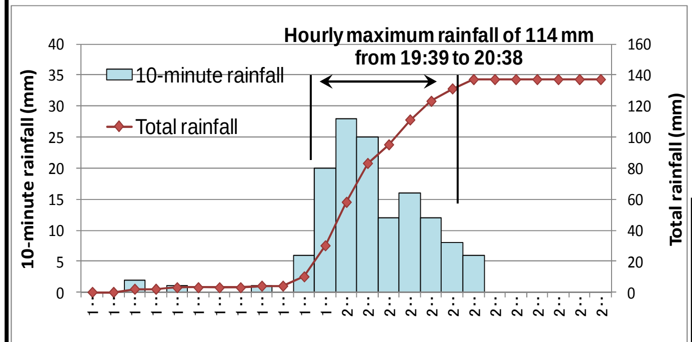
※Based on investigation by Fire Disaster Management Agency on September 3, 2009

Damage in a part of the Kyushu Expressway

Damage of a special nursery home for the elderly

Damage caused by "guerrilla downpour" in Itabashi Ward, Tokyo on July 5, 2010

○ Hourly rainfall of 114 mm (Itabashi Observation Station (Shakujii River Basin))
○ Hourly rainfall of 82 mm (Aogishi Bridge Observation Station (Zanbori River Basin))
○ Shakujii River flooded, causing inundation damage in Itabashi.
 Houses flooded above floor level: 58, Below floor level: 50 ※数値は速報値



Itabashi Observation Station

Water level rose by 3.45 m in 10 minutes from 19:50 to 20:00.

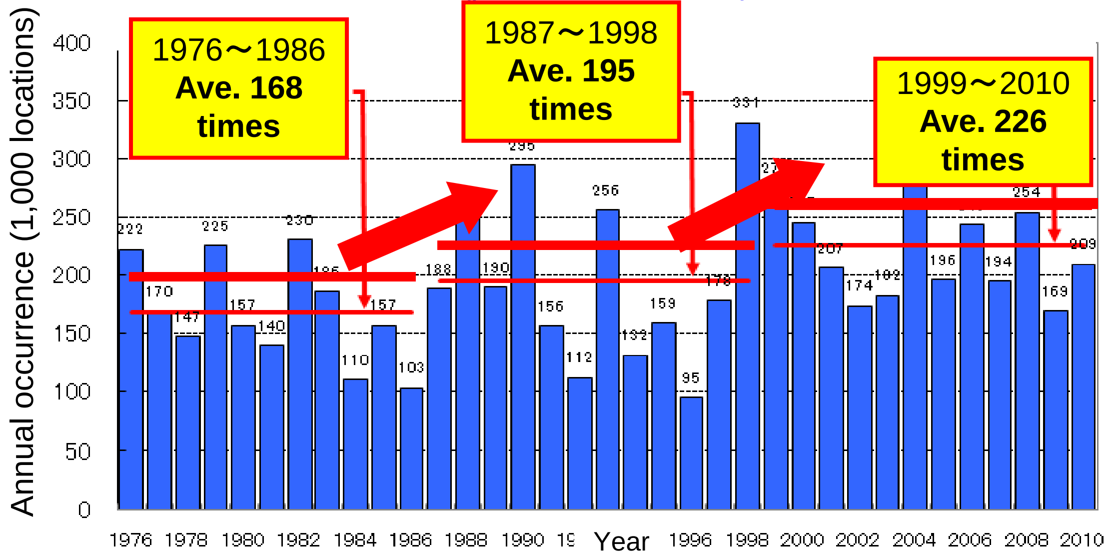
Change of water level in Shakujii River

Based on investigation by Disaster Prevention Office, Fire Disaster Management Agency on September 11, 2009

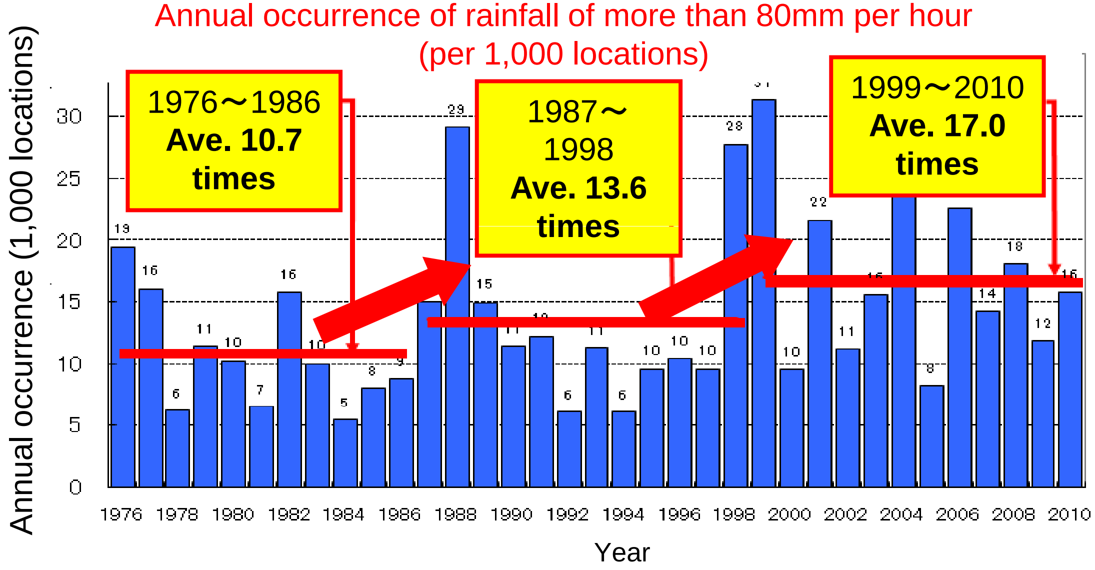
Heavy Rainfall in the Recent Years

Heavy rainfall of more than 50mm or 80mm per hour is tending to increase in the recent years

Annual occurrence of rainfall of more than 50mm per hour
(per 1,000 locations)



Annual occurrence of rainfall of more than 80mm per hour
(per 1,000 locations)



* The graph on the left is the number of annual occurrence of intense rain in a short time - more than 50mm and 80mm per hour, which were observed by AMEDAS (Automated Meteorological Data Acquisition System).

* The number of locations observed by AMEDAS was around 800 in 1976 when the observation started. In time, the locations have been added and has reached approximately 1,300 locations in 2010 (note*). Therefore in order to avoid the fluctuation caused by the number of locations, the occurrence per 1,000 locations is used for the comparison.

(note*): Terminated robot radio rain-gauge stations that were located in the mountainous areas are not included.

(For reference)

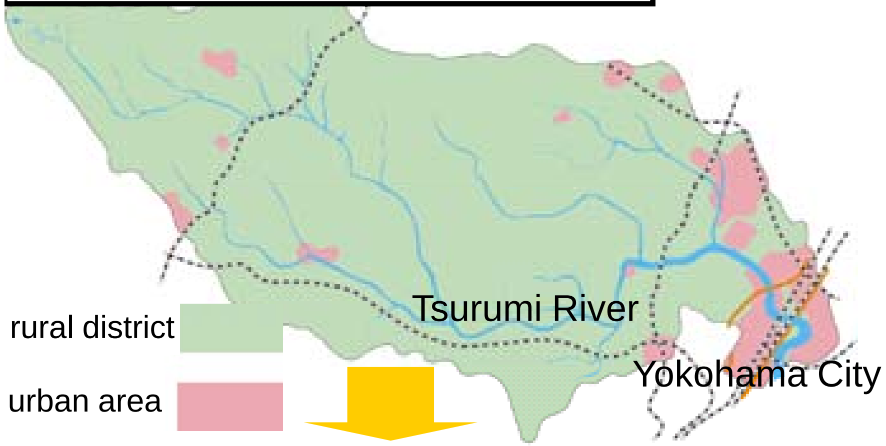
Intensity of rain and its behavior (abstract)			
Hourly rainfall (mm)	Impression of the rain	Influence to human	Outdoor condition
10mm ～less than 20mm	Hard rain	Splashes from the ground wet the legs	Puddles appear all over the ground
20mm ～less than 30mm	Intense rain	Wet, even under an umbrella	
30mm ～less than 50mm	Raining buckets		The road turns into a river
50mm ～less than 80mm	Raining like a waterfall (roaring rain continues)	Umbrellas become totally useless	The area is covered in white colored splashes, and visibility is worsened
80mm or more	Threatened by the pressure and feel suffocated		

Material by JMA

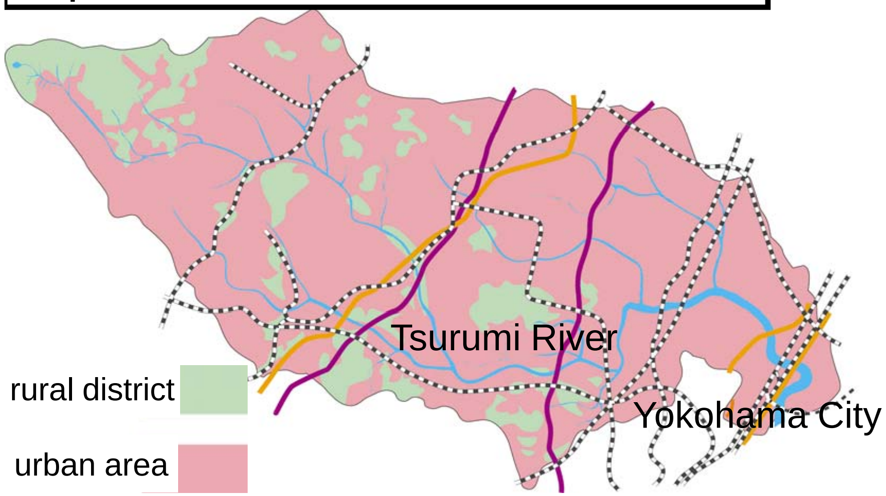
Influences of Urbanization on Floods

Tsurumi River

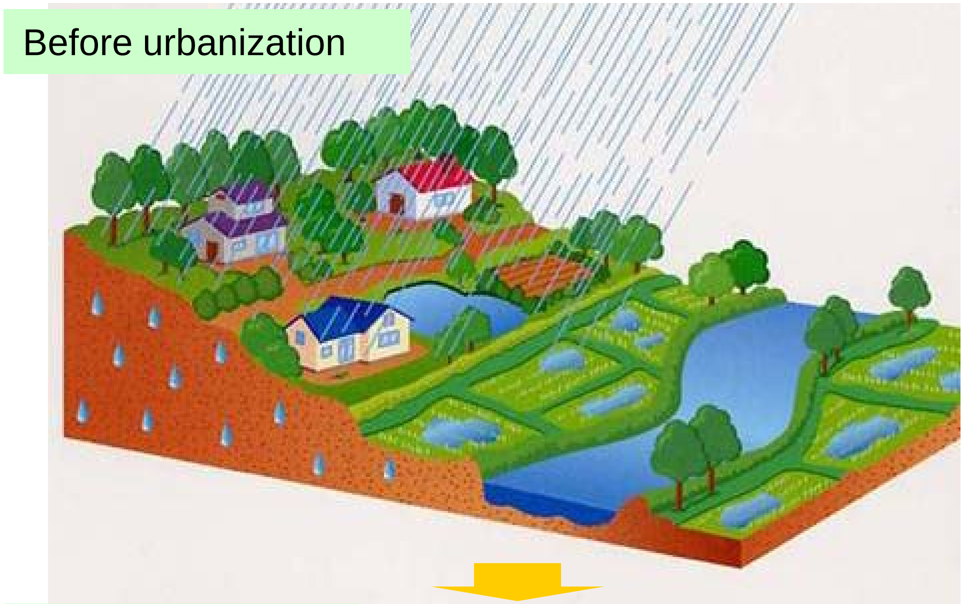
1958
Urbanization rate: About10%
Population: About 450,000

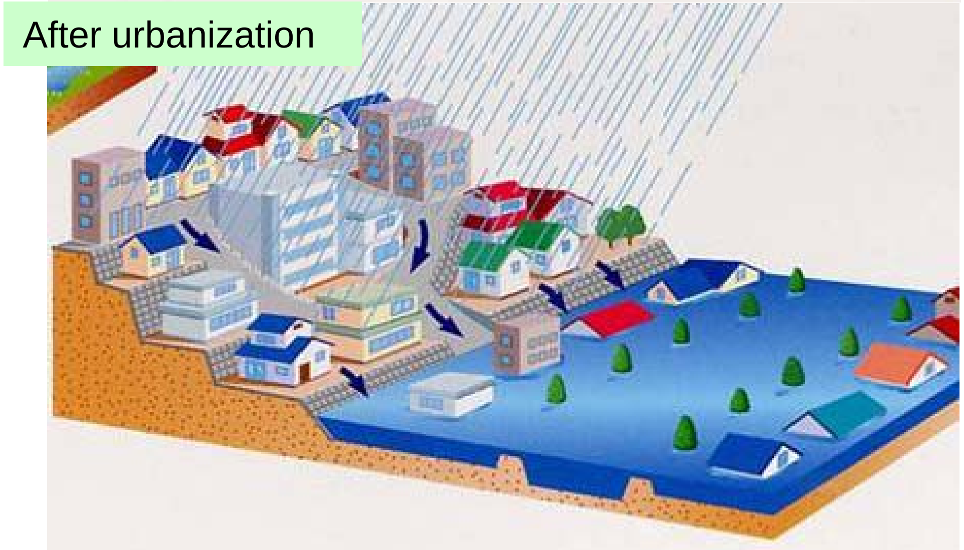


2004
Urbanization rate: About 85%
Population: About 1.88million



Rapid urbanization has resulted in the elimination of rice fields and forests that naturally serve to hold rainwater and absorb it into the ground. There has thus been an increase in the amount of surface runoff flowing into the river, increasing the chances of flooding.





Comprehensive flood control measures to secure sustainable development

1)River improvement

- River channel improvement
- Construction of dams, retarding basins and discharge channels etc.

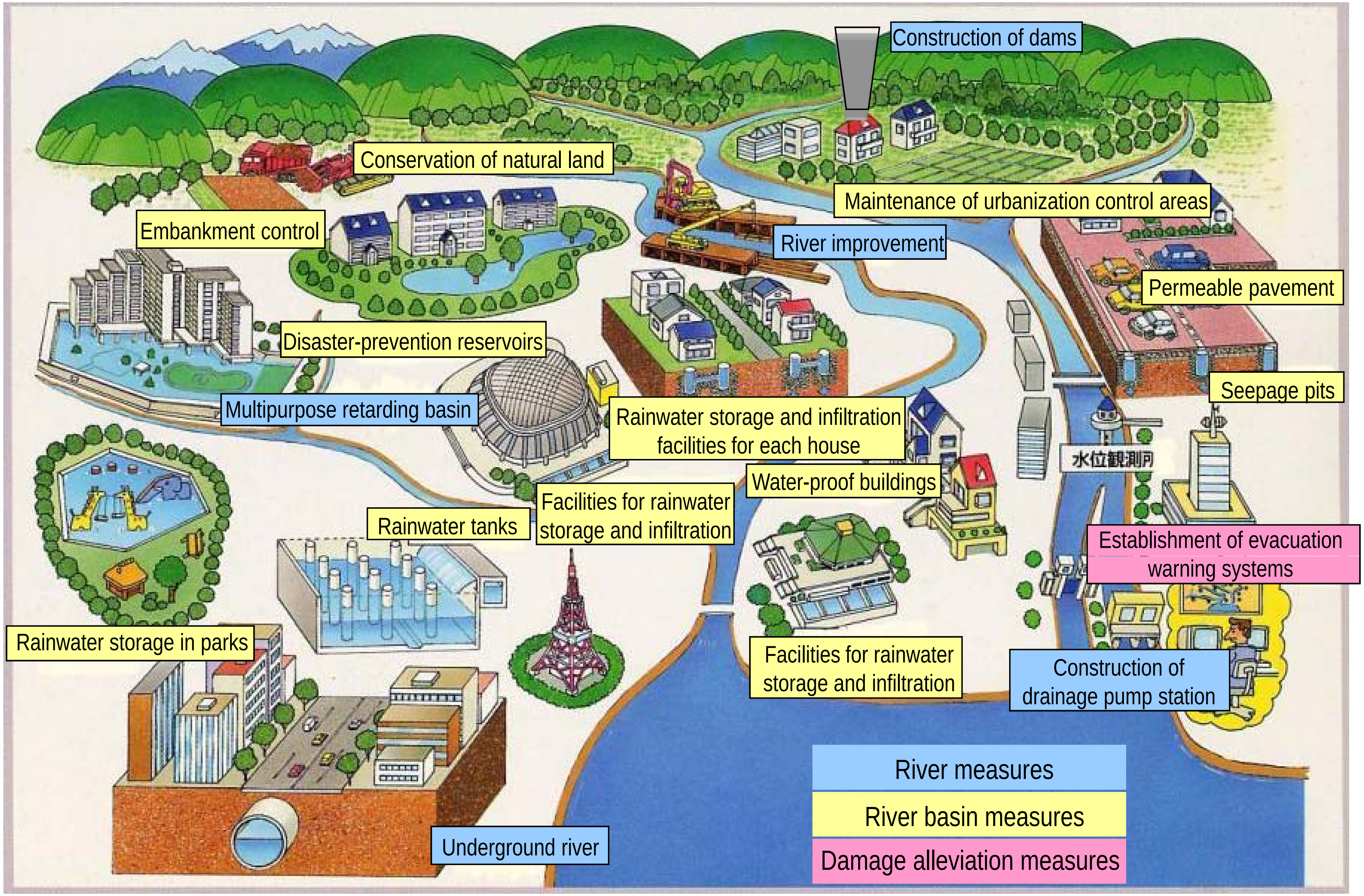
2)Measures for river basins

- Maintaining urbanization control areas
- Conservation of fields
- Constructing reservoirs
- Constructing rainwater tanks
- Constructing permeable pavements and seepage pits

3)Measures to alleviate damage

- Establishing the evacuation warning systems
- Upgrading flood diffence systems
- Promoting awareness of local residents

Comprehensive Flood Control Measures in River Basin

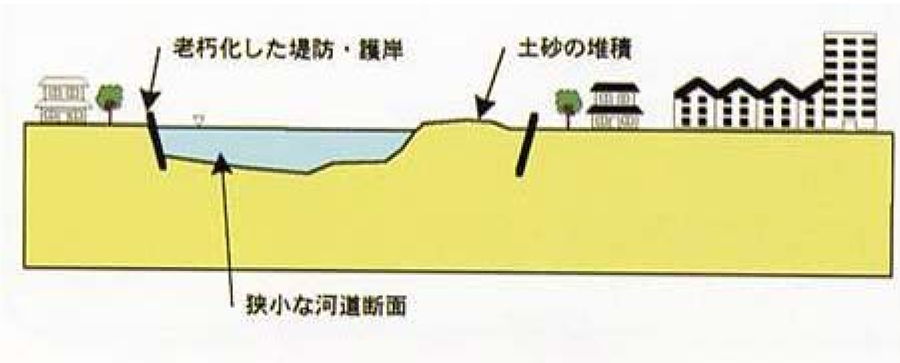


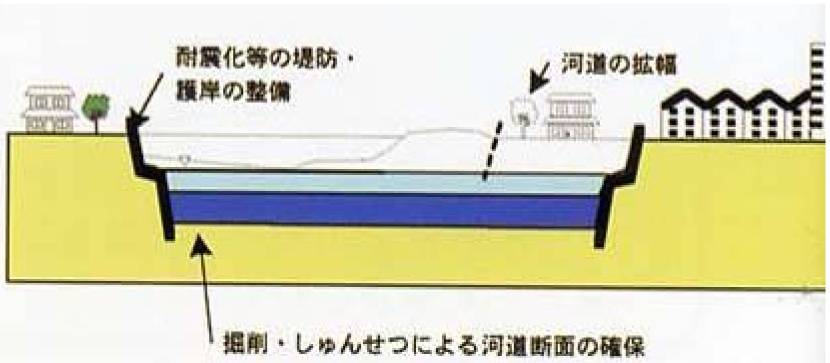
River channel improvement

Widen and dredge rivers

before

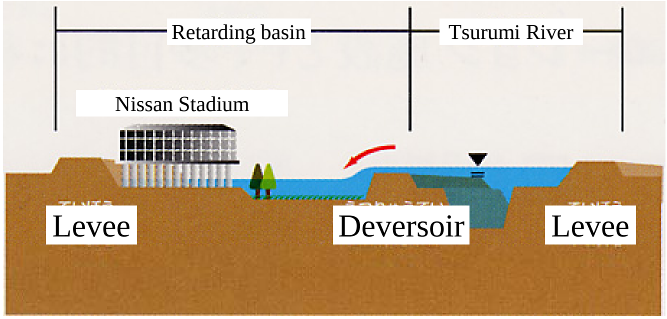
after

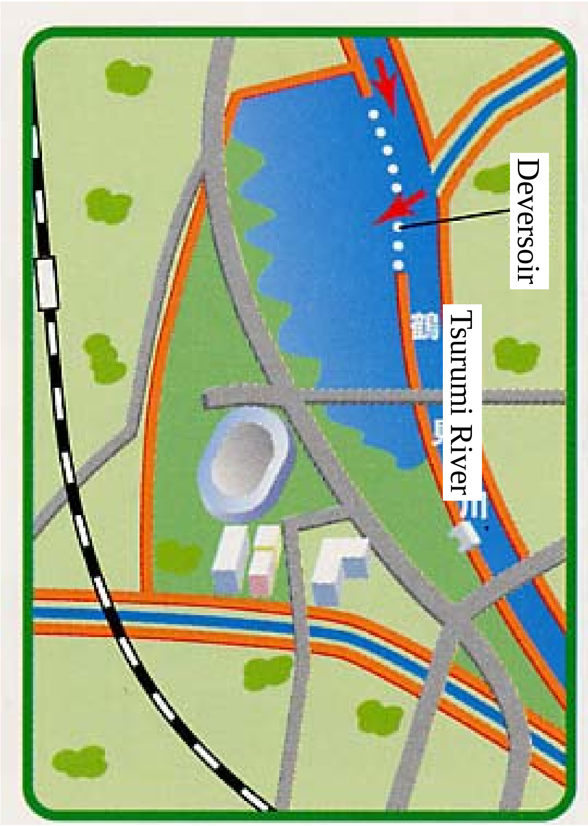




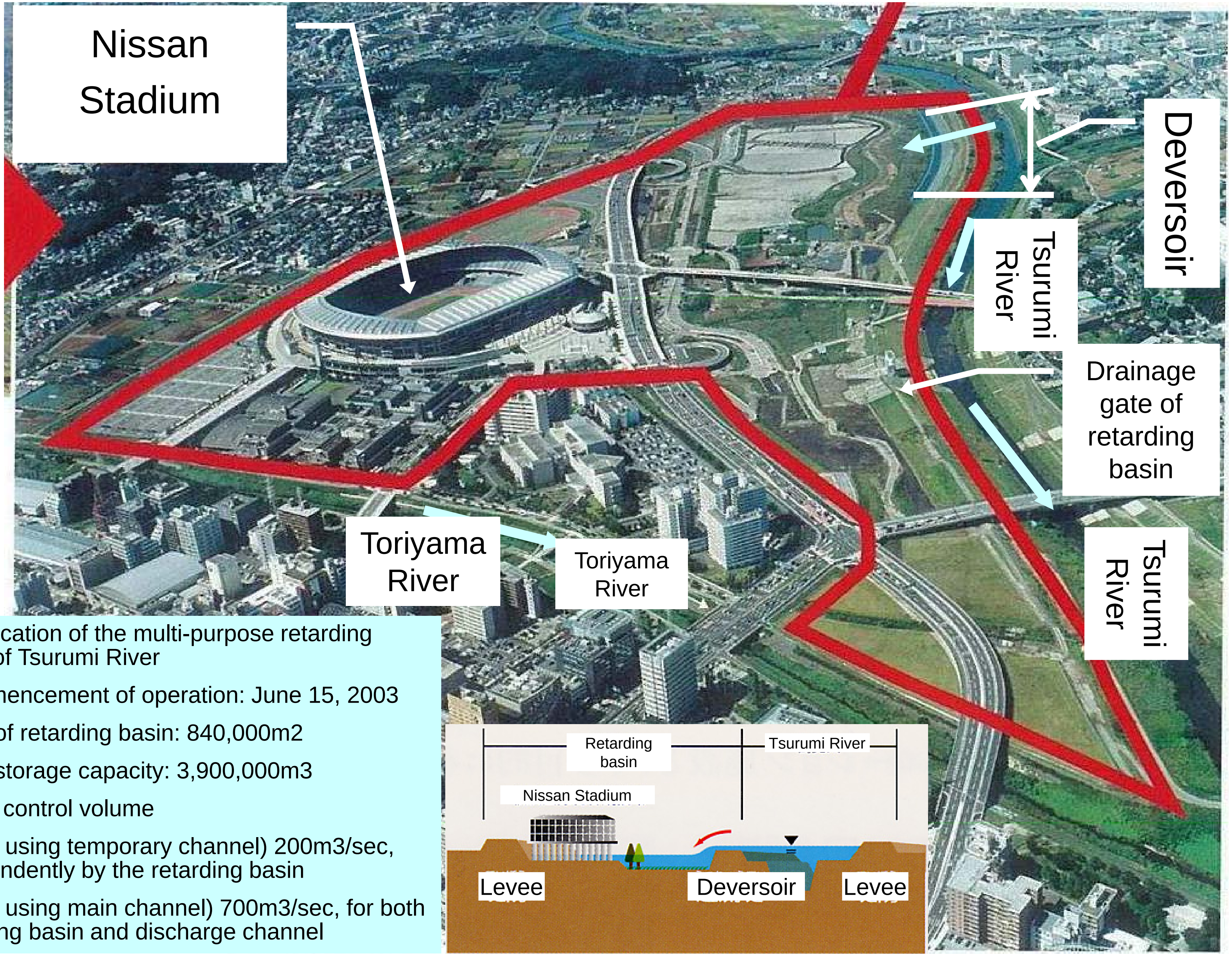
River Improvement (Construction of Retarding Basin, Discharge Channel, etc.)

Multi-purpose retarding basin of Tsurumi River





Multi-Purpose Retarding Basin of Tsurumi River



Specification of the multi-purpose retarding basin of Tsurumi River

- Commencement of operation: June 15, 2003
- Area of retarding basin: 840,000m2
- Total storage capacity: 3,900,000m3
- Flood control volume

(When using temporary channel) 200m3/sec, independently by the retarding basin

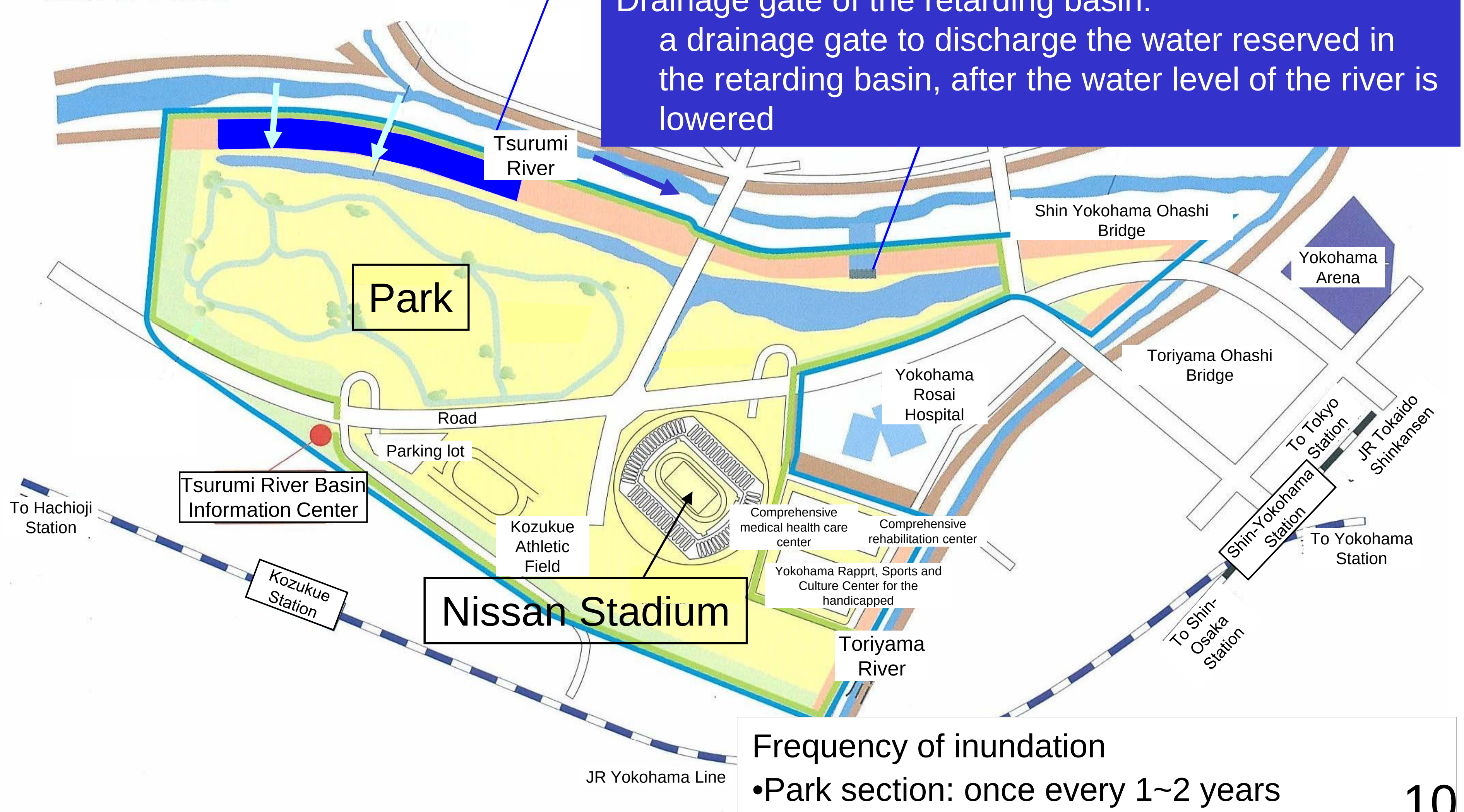
(When using main channel) 700m3/sec, for both retarding basin and discharge channel

Overview of the Retarding Basin of Tsurumi River

Deversoir: the levee at the lowest stage to allow the flooded river into the retarding basin

Drainage gate of the retarding basin: a drainage gate to discharge the water reserved in the retarding basin, after the water level of the river is lowered

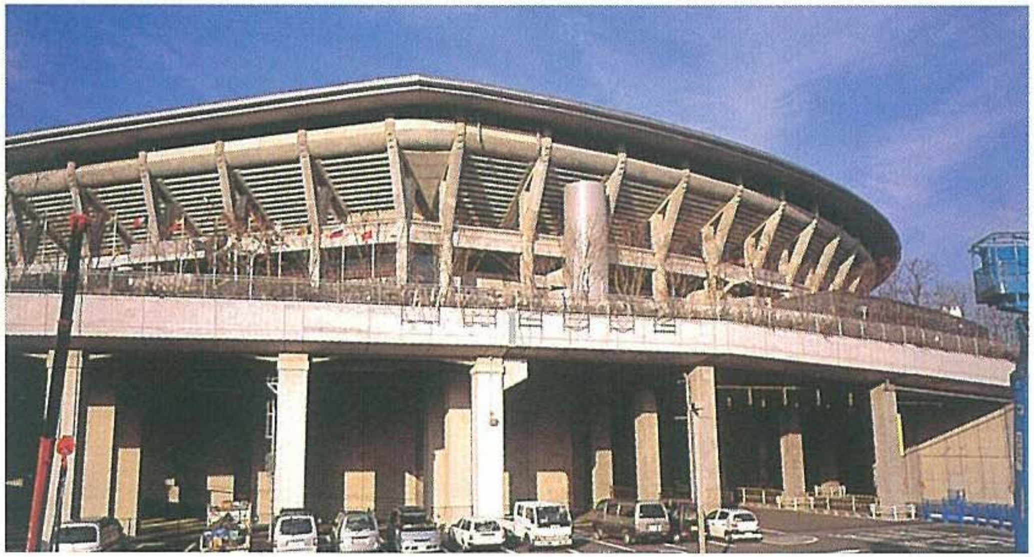
Plain view of the retarding basin



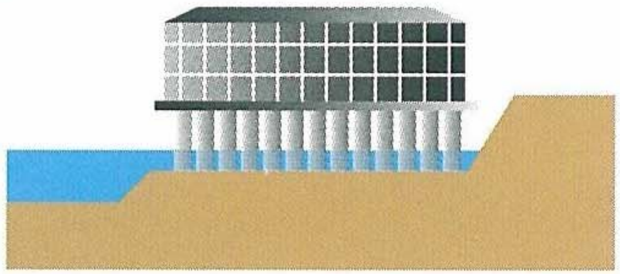
Frequency of inundation
- Park section: once every 1~2 years
- Athletic field section: once every 4~5 years

Introduction of Pilotis

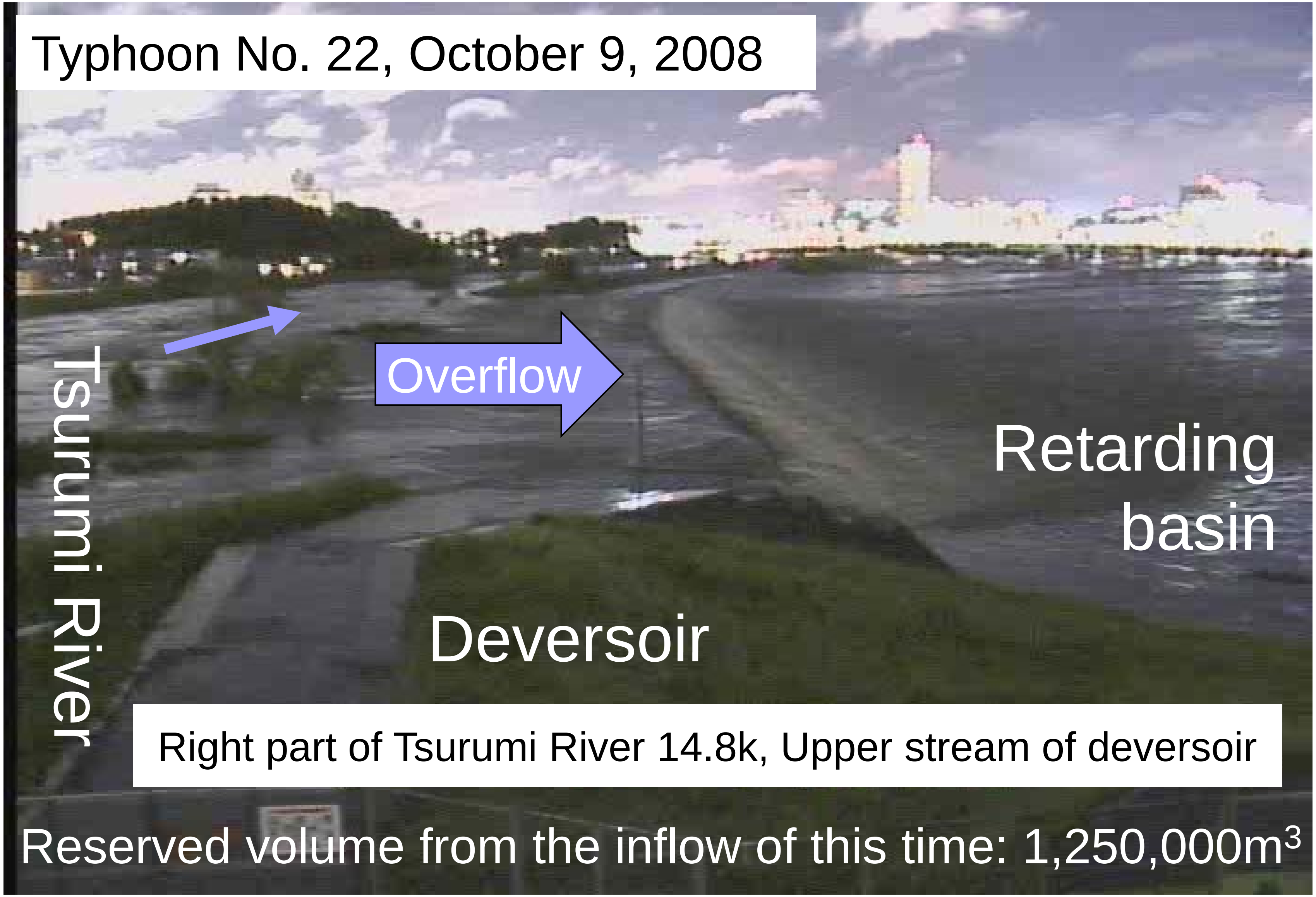
Facilities are built in the retarding basin including the Nissan Stadium, the comprehensive medical health care center, the Sports and Culture Center for the handicapped of Yokohama Rapport, etc. These facilities are built on pilotis (raised-floor) in order to avoid submergence in case of the river overflowing into the retarding basin.



Pilotis structure employed for Nissan Stadium



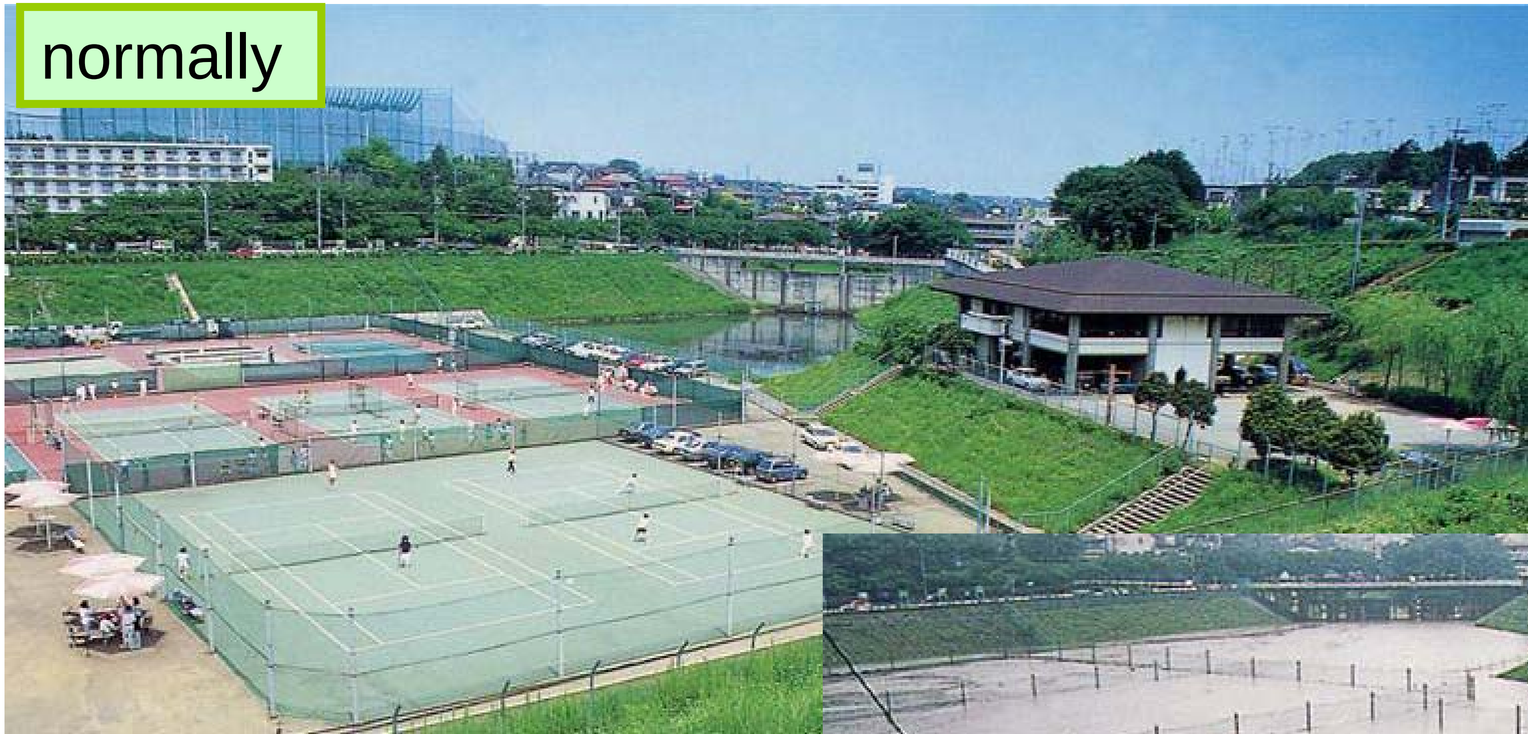
Condition of Inflow into the Multi-Purpose Retarding Basin of Tsurumi River



Construction of subterranean regulation reservoir

Constructing flood control pond

Flood control pond temporarily stores rainfall so that it does not inundate rivers all at once .



Kirigaoka reservoirs
（Tsurumi River）

Development of rainwater storage facilities

Storing rainwater in a schoolyard

normally

flooded

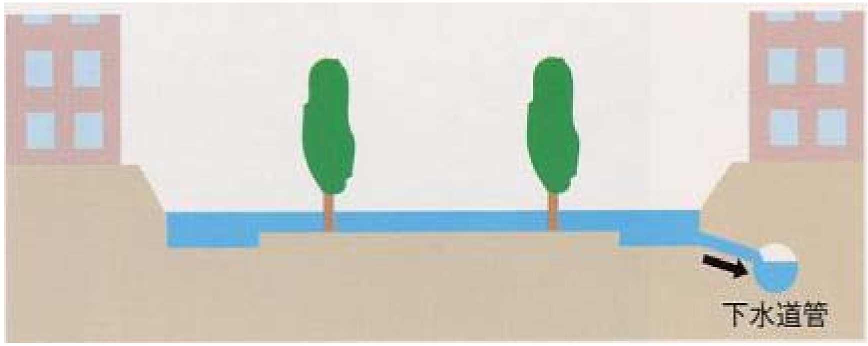
Constructing permeable pavements

permeable pavement

permeable tile pavement

Tokyo

Rainwater storage between buildings in apartment complexes



Installation of Infiltration facilities

Seepage pits･Seepage trench

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Issues in Past Disasters

(1) Near small and medium-sized rivers with relatively small catchment area, when localized torrential rain occurs frequently, adequate steps were not taken for evacuation of residents due to the poor information provision structure.

(2) The elderly, small children and others needing assistance in a disaster were frequent victims, showing problems with the warning and evacuation system.

(3) Evacuation orders, etc. were slow in coming or were ignored by many residents, indicating the need for greater awareness of disaster information on both issuing and receiving ends.

(4) With more people using subways and underground shopping areas, etc., which frequently become inundated, the need arose for flood prevention measures and effective evacuation systems.

In light of these issues, the Flood Control Act was revised twice, in June 2001 and May 2005.

Overflowing of smaller rivers (Ikarashi River) (July 2004 Niigata-Fukushima Flood Disaster)

A junior high school cut off by flood waters (July 2004 Niigata-Fukushima Flood Disaster) Source: Kyodo News

Residents who were slow to evacuate being rescued by SDF (Sept. 2000 Tokai Flood Disaster)

Bus stranded on highway after flooding along Yura River (Typhoon Tokage, Oct. 2004) Source: Yomiuri Shimbun

Flooded underground passageway (Sept. 2000 Tokai Flood Disaster)

Hakata subway flooding (Fukuoka flood of July 2003)

Elaboration of Information Dissemination during Floods

The Governors of each prefecture shall conduct forecasting of floods in rivers with large scale catchments except those designated by the Minister of MLIT which are vulnerable to large scale of flood damage (Article 11 of “Flood Fighting Act”).

Before Amendment

The Minister of MLIT designates the rivers, which likely bring about serious damage by floods to people’s livelihood, and conduct flood forecasting.

After Amendment

In addition to the Minster of MLIT, the Governors of Prefectures newly designate the rivers, which likely bring about serious damage by floods and conduct flood forecasting.

As for the major rivers except those in which flood forecasting is to be conducted, the water levels for starting evacuation shall be decided and the rivers concerned shall be designated.

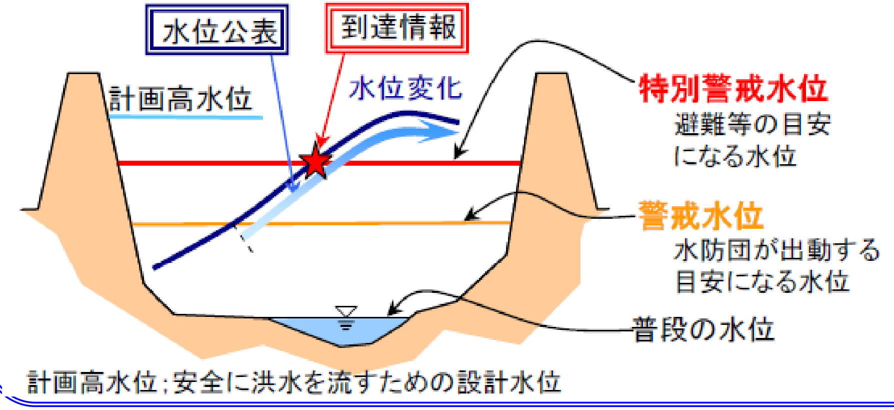
Before Amendment

- In the rivers having a large catchment area, flood forecasting shall be conducted.

- As the medium and small-sized rivers in which flood forecasting is difficult, essential water level information for evacuation has not been provided before.

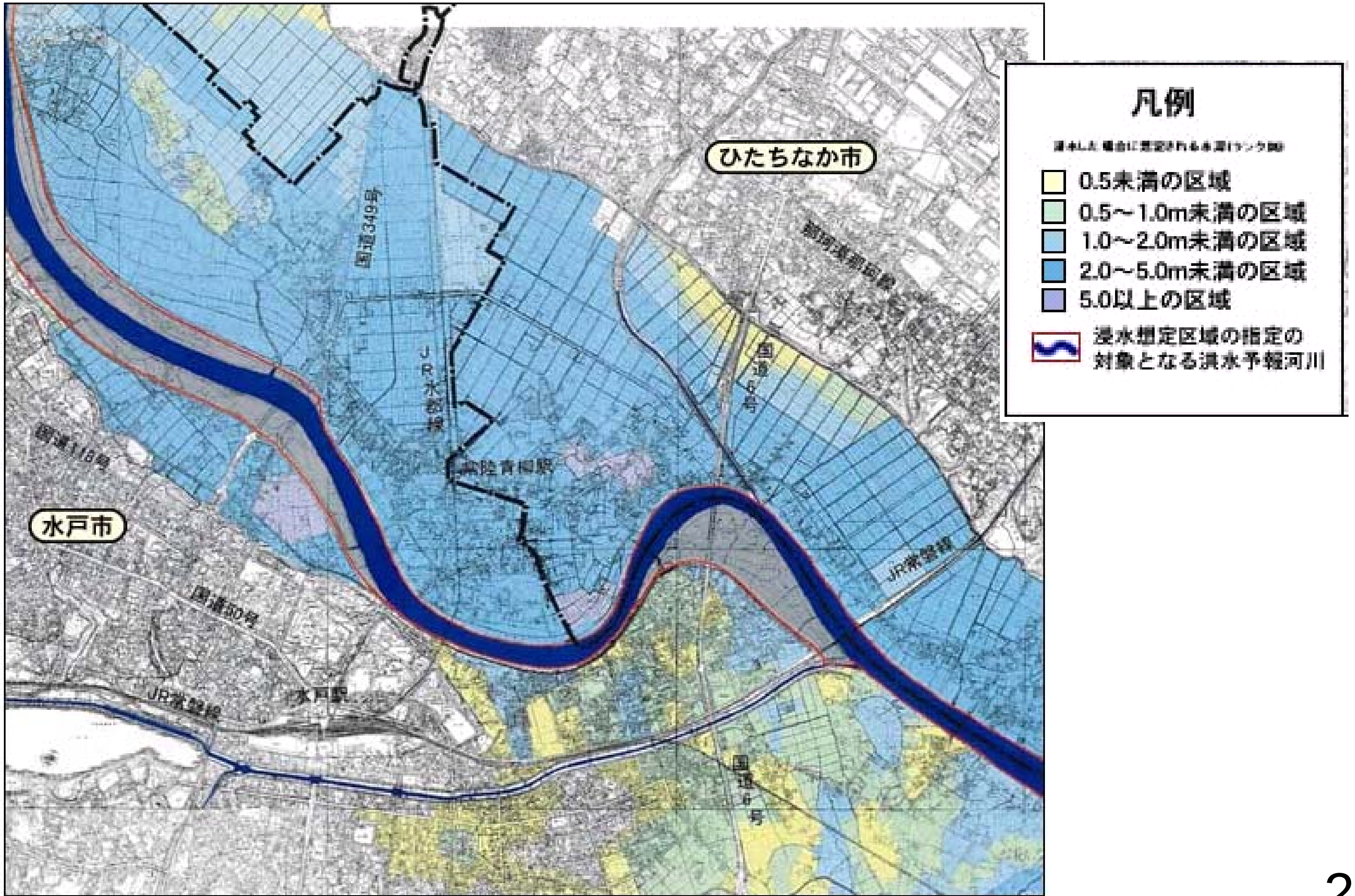
After Amendment

In the major medium and small sized river, the information that the water level has been reached to the concerned level for evacuation



Designation and publication of flood inundation areas

Based of the article 14 of the flood-fighting Act, river administrators (MLIT and prefectural governments) designate areas that may be inundated in the event of flooding as flood inundation areas.

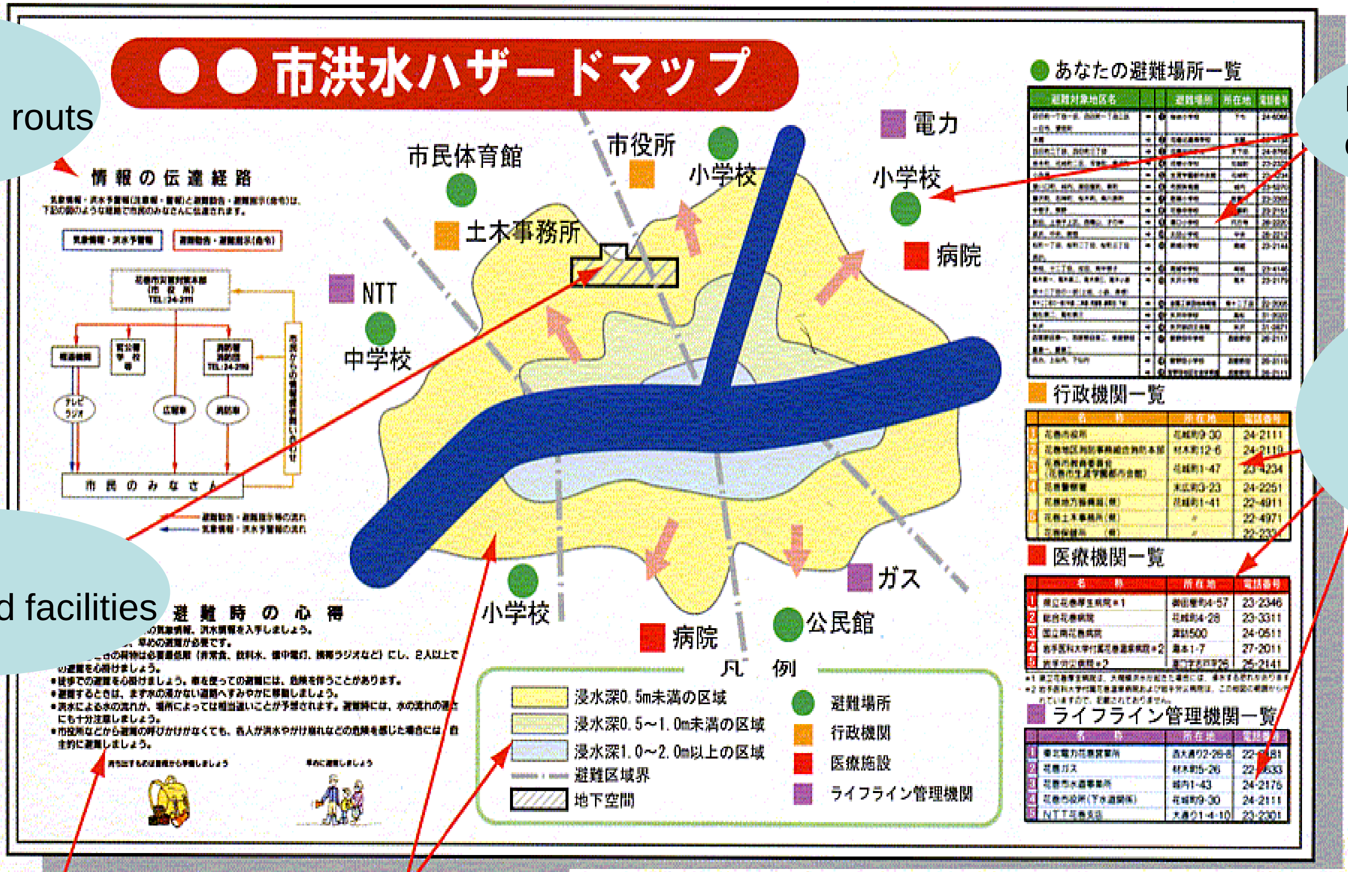


Preparation and dissemination of flood hazard maps

Based on the article 15 of the flood-fighting Act, municipalities prepare and disseminate flood hazard maps to residents on the basis of flood inundation area maps.

Information transmission routs

Names, locations of evacuation sites



Contact information (government offices, hospitals, public utilities)

Location of underground facilities

Tips, things to bring when evacuating

Designated flood inundation area and expected depth

Forecasting Flooding by Large Rivers

With regard to waterways running through two or more prefecture districts, the Minister of Land, Infrastructure and Transport must indicate the water level or flow rate after flooding, or the areas to be inundated after overflow and the depth, and must notify the situation to the local governors as well as to the general public with the cooperation of news media as necessary. (Article 10 (2) of Flood Control Act)

Before

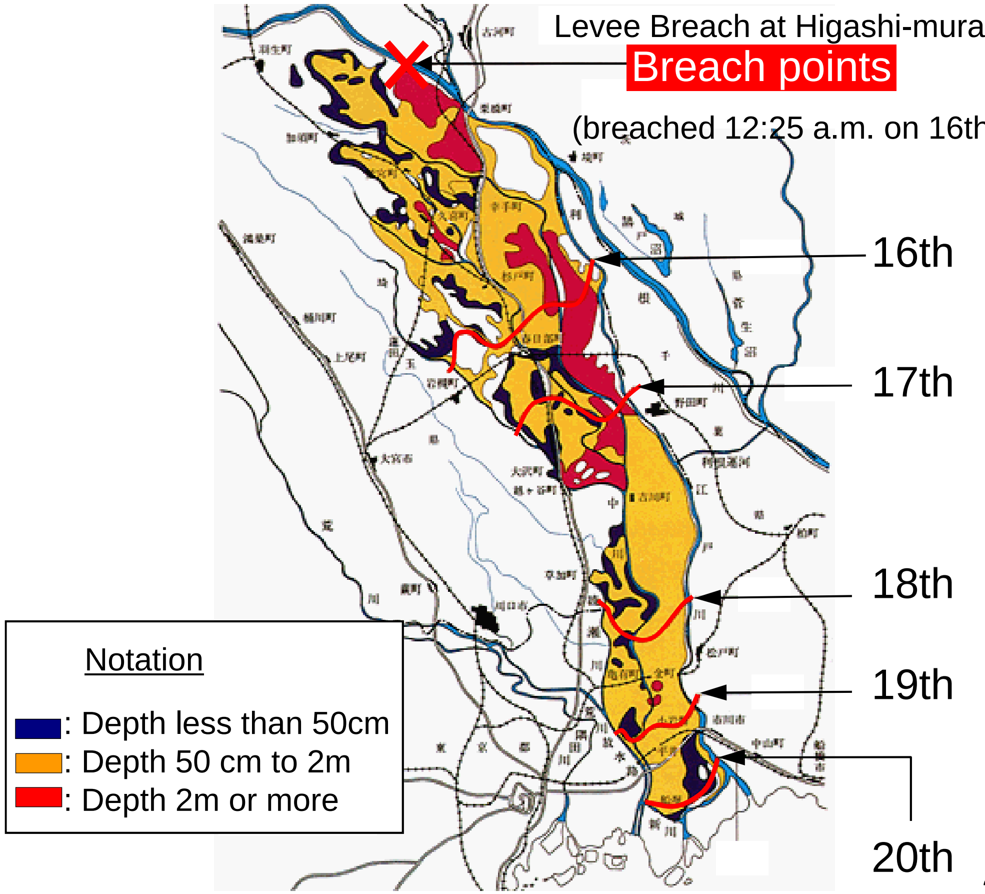
Flood forecasting based only on river water level and flow rate.

After revision

In addition to conventional flood forecasting data, also forecast the areas to be inundated after overflow and the depth so that residents can be evacuated properly.

*The waterways and districts are selected for forecasts of inundation levels considering the population and assets inside the area and the time flood waters are expected to reach the area.

Flooding of Tone Basin by Typhoon Kathleen (Sept. 1947)



Issuing Flood Forecasts (example for Tone River)

In floods, actual and forecast rainfall, water levels and other data are used to calculate inundation in real time, and the areas and depth of flooding are forecast based on the results.

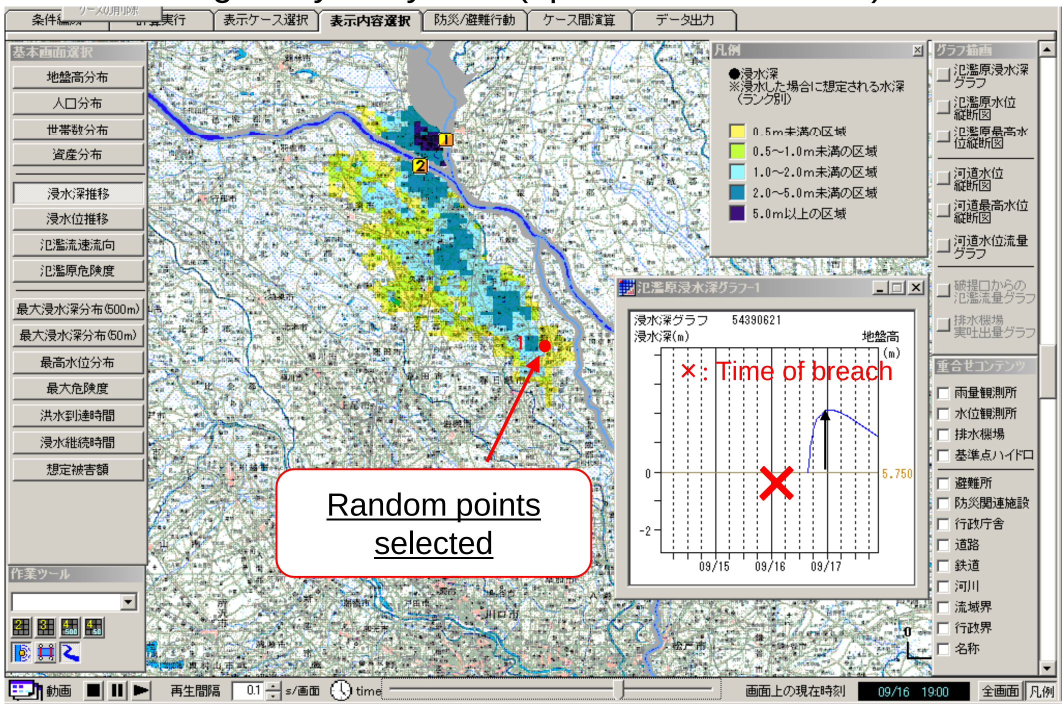
Flood forecasting steps (guidelines)

(1) Collect and exchange data

(2) Forecast flooding

(3) Forecast flood levels

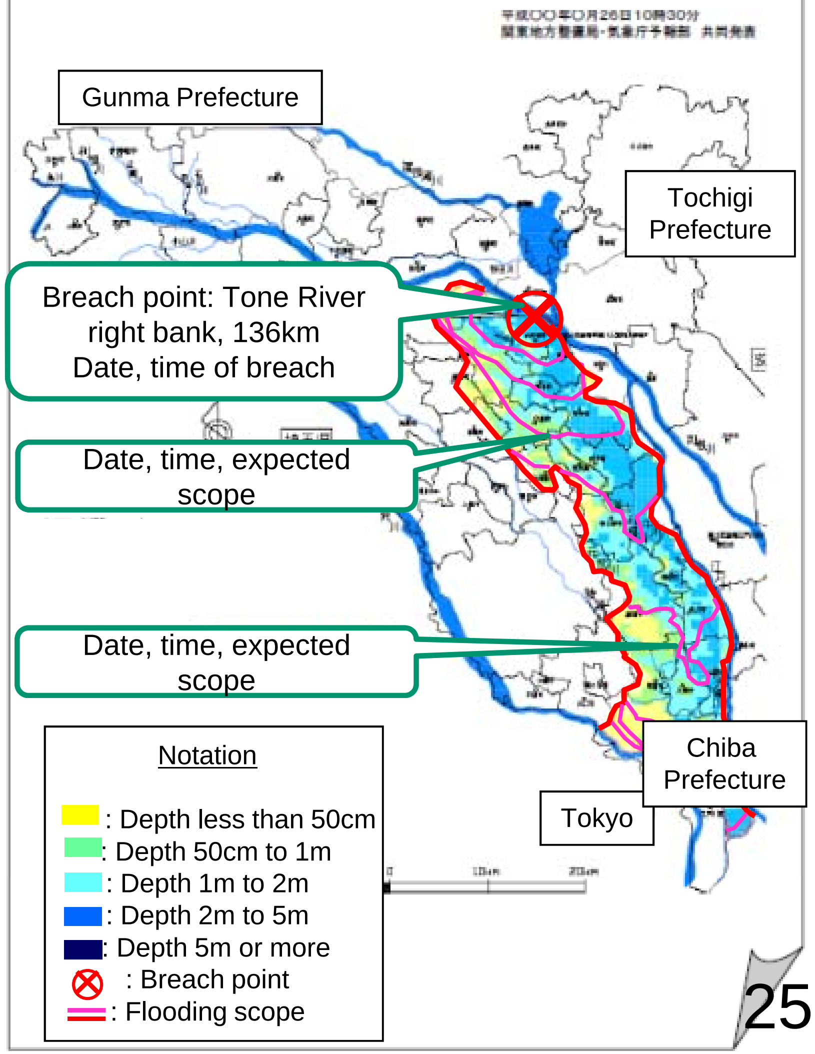
Flooding analysis system (upstream Tone River)



(4) Write up announcement

(5) Issue forecast

Reference figure for flooding forecast announcement:
Progression of flooding



Improvement of Technical Terms for Disaster Management of Floods, etc.

To provide understandable disaster information aiming to lead appropriate judgment and actions by receivers, following improvements are conducted:

- Setting-up of water levels: To set-up risk level of water levels considering extent of

※To unify the color over the country to recognize the risk level

Risk Level	Water level	Rivers designated for flood forecasting / Rivers to be known water levels	Action required by local governments and inhabitants
5	Occurrence of inundation	Information of occurrence of inundation in ○○River	Rescue of inhabitants who out slipped for evacuation
4 (Dangerous)	Critical water level of inundation	Information of dangers of inundation in ○○River	Completion of evacuation by inhabitants
3 (Alert)	Warning water level to start evacuation	Information of warning of inundation in ○○River In case that WL has reached the warning water level to start evacuation or is anticipated to reach up to the Critical Water Level of inundation.	Issuance of advice for conducting evacuation
2 (Caution)	Pre-cautious water level of inundation	Pre-cautios water level of inundation in ○○River	Issuance of information for preparation of evacuation
1	Water level for stand-by of flood fighting corp.	Warning for flood fighting	Stand-by of flood fighting corp.

Provision of river information

Routinely measured river information* is provided in real-time (24hours a day, 365 days a year) to river managers, municipal supervisors, and other state departments.
*Includes various data from radar, rainfall measurement stations, river water level meter stations, dams

The Ministry of Land, Infrastructure, Transport and Tourism provides river information in real time, 24hours a day, 365 days a year throughout Japan to help protect lives and property from rainfall-induced river and land-based hazards

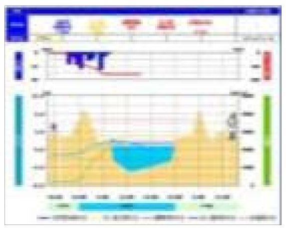
Nationwide data on radar-measured rainfall, river water level/flow rate, ground-level rainfall, dam influx/discharge etc. is measured and sent by telemetry

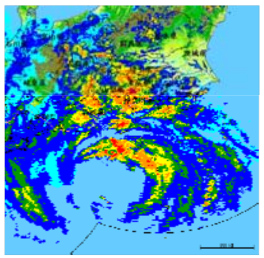
Data is collected, processed and edited into an easy-to-use form and transmitted

Collection
Data is acquired from 17,300 stations nationwide every 10 minutes.

Processing • Editing
Collected data is processed and edited into easily understood tables, graphs, maps, diagrams etc.

Transmission
Data is provided to each user in an easy-to-use form depending on their needs.
(information by time/location provided as needed)





Sent to river managers, municipalities, state depts. etc. via Internet and cell phone

River manager

Municipalities

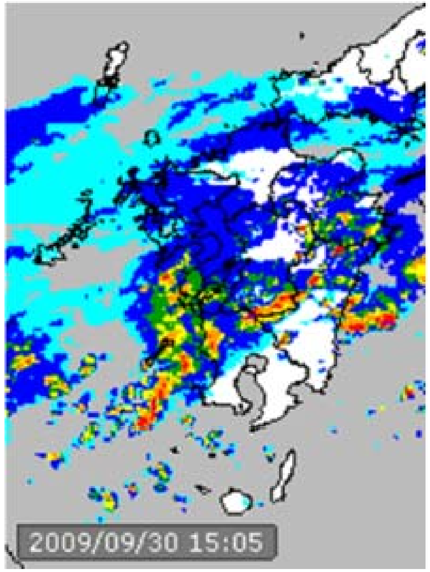
State depts.

Provision of River Information

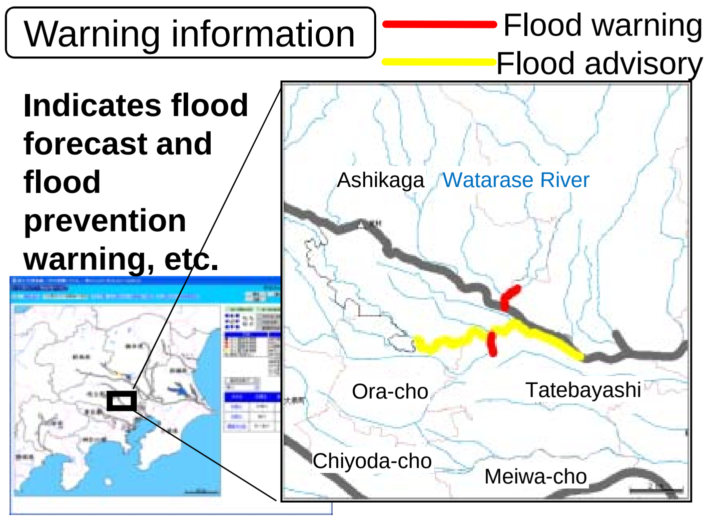
River information that are provided

Radar rainfall

Rainfall distribution, rainfall intensity can be viewed in time series in the transition of rain area



Warning information

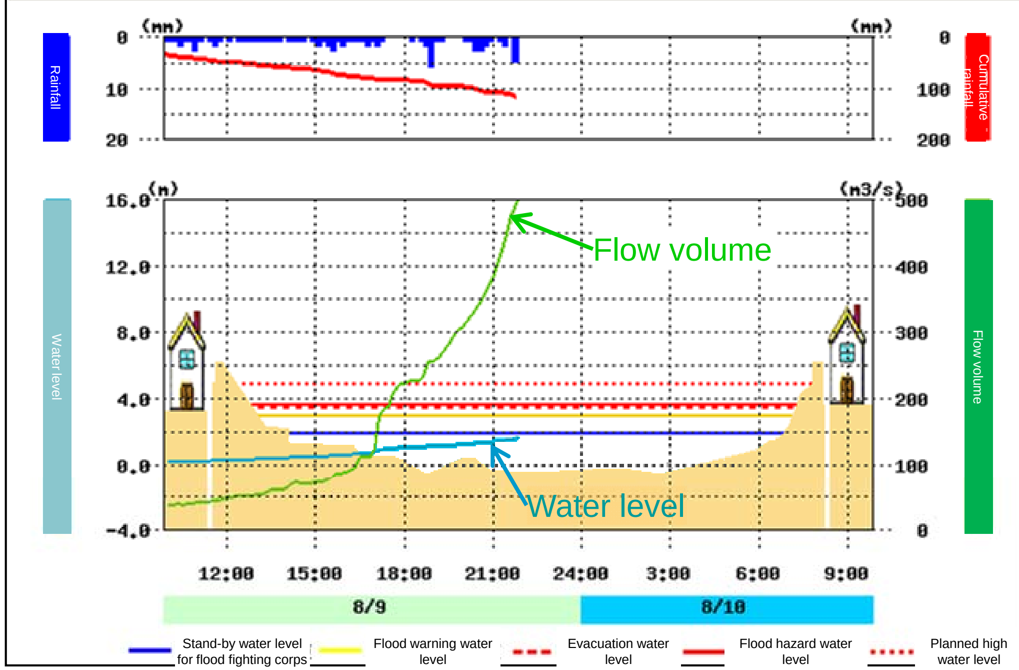


Indicates flood forecast and flood prevention warning, etc.

Rainfall/water level/flow volume

Indicates relation between water level of the river etc. or standard water level, and level of residential area

Item						Planned Maximum water volume
Standard	Sustainable water level of flood fighting corps 2.00m	Flood warning water level 3.00m	Evacuation water level 3.50m	Flood hazard water level 3.70m	Planned high water level 4.87m	3400.00m³/s
Level		1	2	3	4	
Current value	1.53m↑					498.04m³/s(15%)



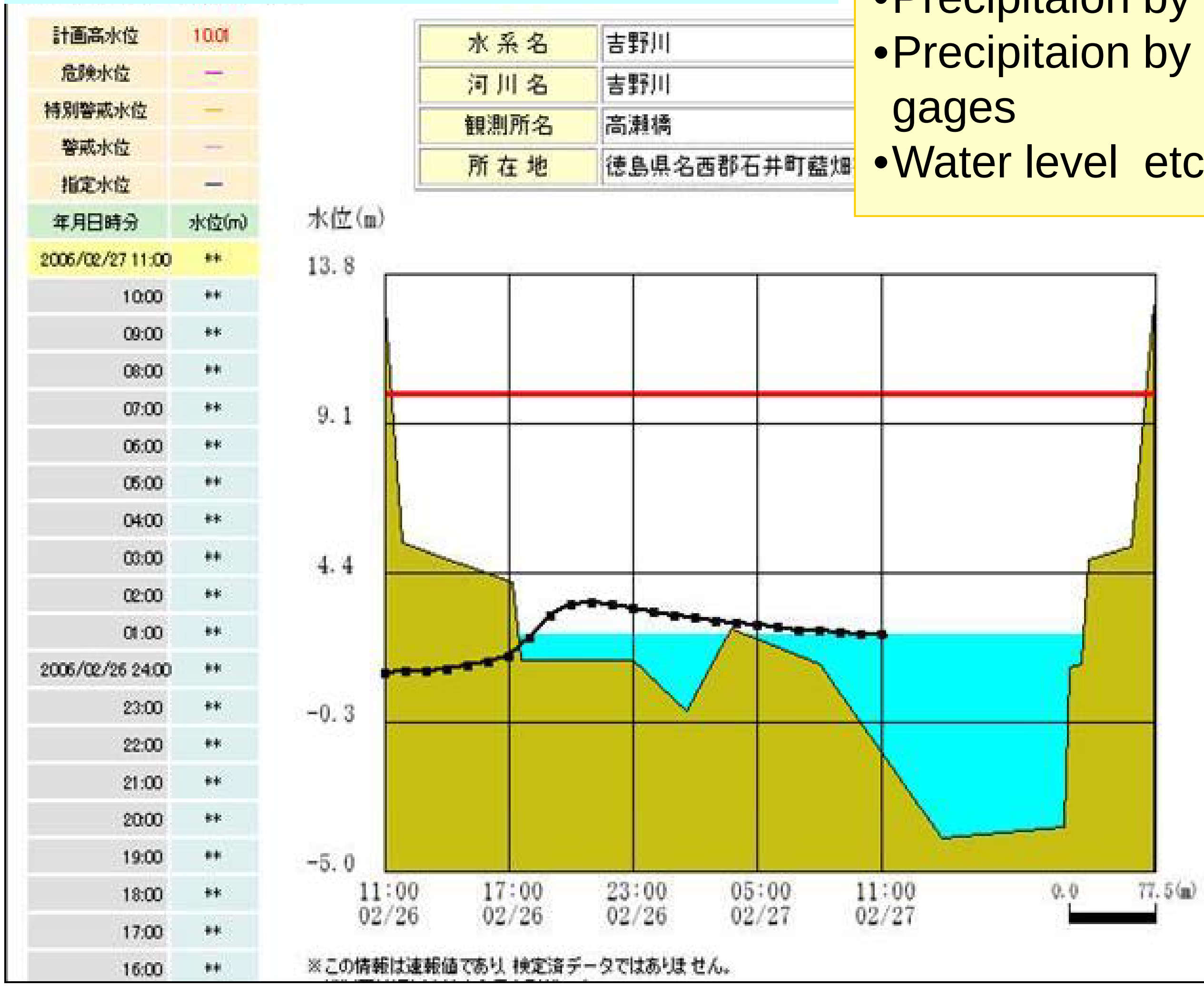
List of water level above the standard

Lists water level observation stations that indicate a level above the standard, such as flood hazard etc.

Observation station name	Water system	River name	▼Water level (m)	Time of observation	Standard water level (m)					Location	Management
					Stand-by for flood fighting corps	Flood warning	Evacuation	Flood hazard	Planned high		
Ashinoko Lake	Kanto, others	Ashinoko lake	2.47	13:40	2.35	2.50	2.60	—	—	—	Municipality
Mt. Makio	Yodo River	Uji River	2.17→	13:50	2.00	3.00	3.50	3.60	—	Left bank 51.90k	National river

Provision of River information by mobile phone

Information provided on the internet



Information provided to mobile phones

Contents
- Precipitaion by hyeto meter
- Precipitaion by rader rain gages
- Water level etc.

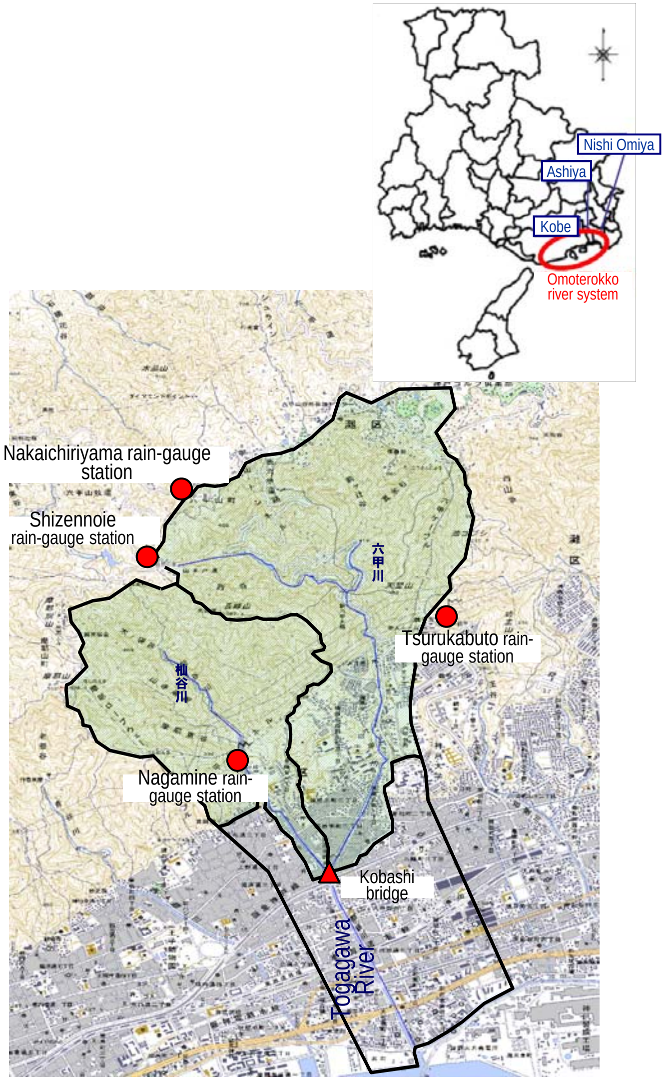
Improvement of information systems for gathering and analyzing

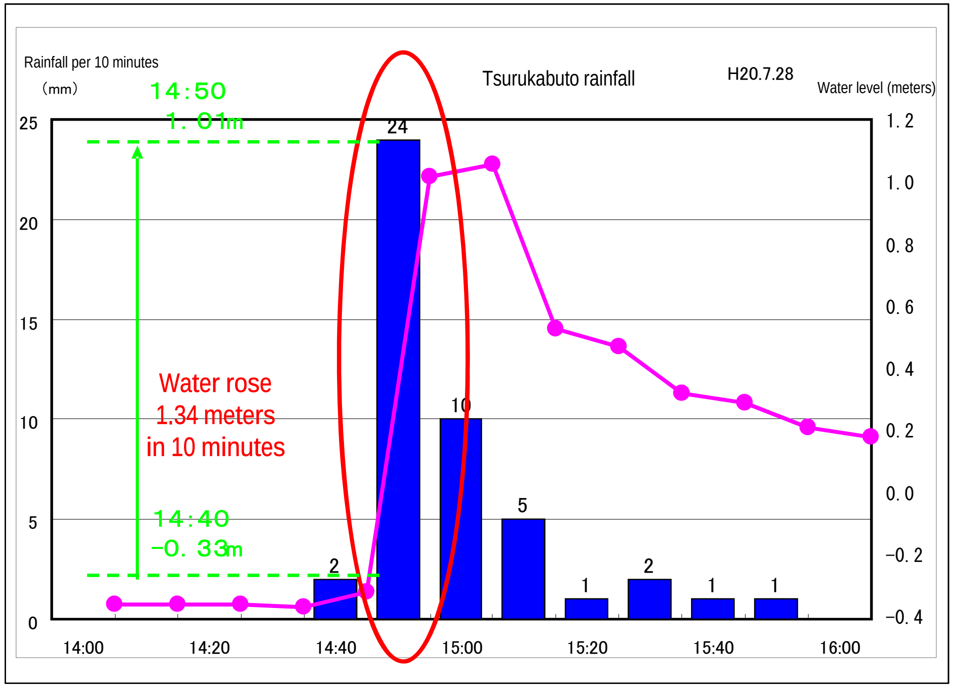
○When a disaster occurs, bases are established to collect information and respond to the disaster.
○It is necessary to establish systems to gather, analyze, and share various kinds of information such as water levels, flow rates, and precipitation.

写真：国土交通省関東地方整備局

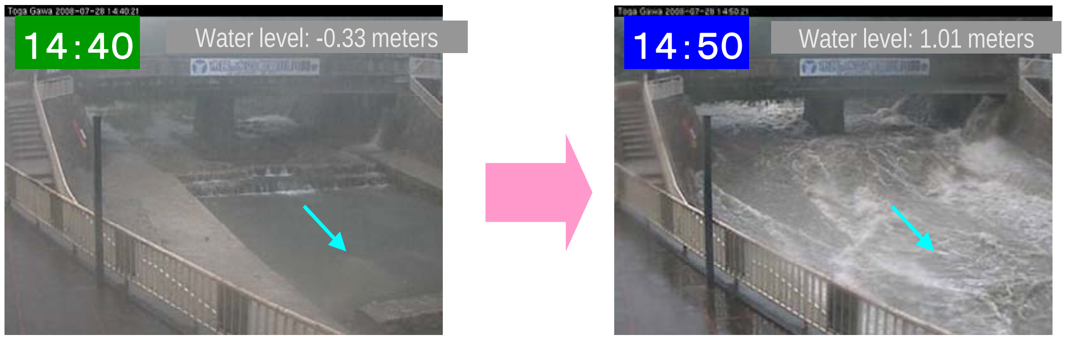
Water levels and rainfall at the Kobashi Bridge on the Togagawa River, July 28, 2008

- An intense rainstorm hit the Togagawa River basin from 2:30 to 3 p.m. A 10-minute period was particular intense in Nagamine and Tsurukabuto starting at 2:40 p.m.
- At the Kobashi water-level station, the water level rose 1.34 meters in 10 minutes between 2:40 and 2:50, almost simultaneously with the downpour
- Five people were killed, including 3 children, 11 people rescued, and 41 people evacuated





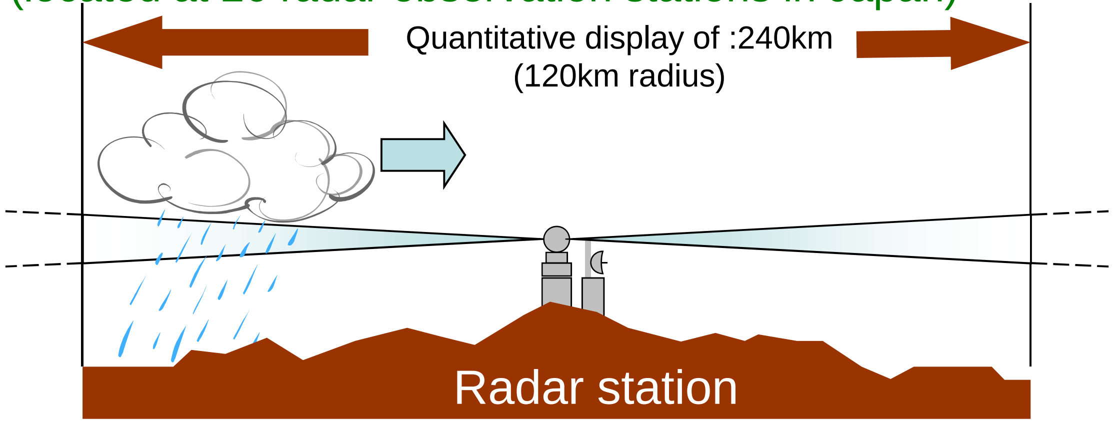
Rising water levels at the Kobashi bridge (photos from a Kobe monitoring camera)



Rainfall Observation in the Past

- 26 units of C-band radars monitor across Japan as well as the conventional ground rain gauge, for monitoring the rainfall in a wide-area.
- Although effective for observing frontal heavy rain in a wide-area, detecting sudden intense rainfall in details may be difficult.

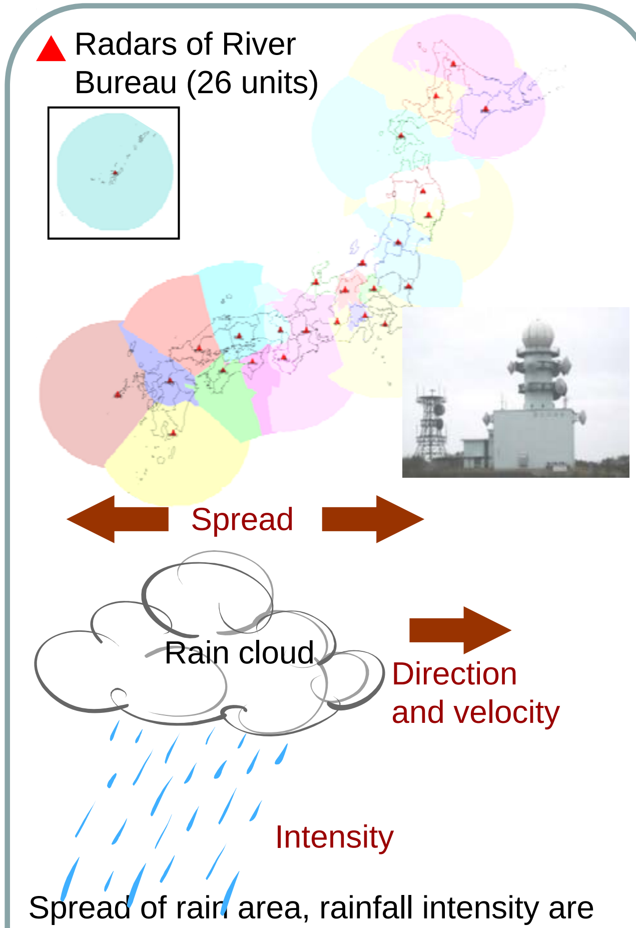
Radar rain gauge system
(located at 26 radar observation stations in Japan)



Detects rainfall in a wide-area

Conventional rain gauge system
(located at around 9,000 rainfall observation stations in Japan)

Detects rainfall only at the observation point

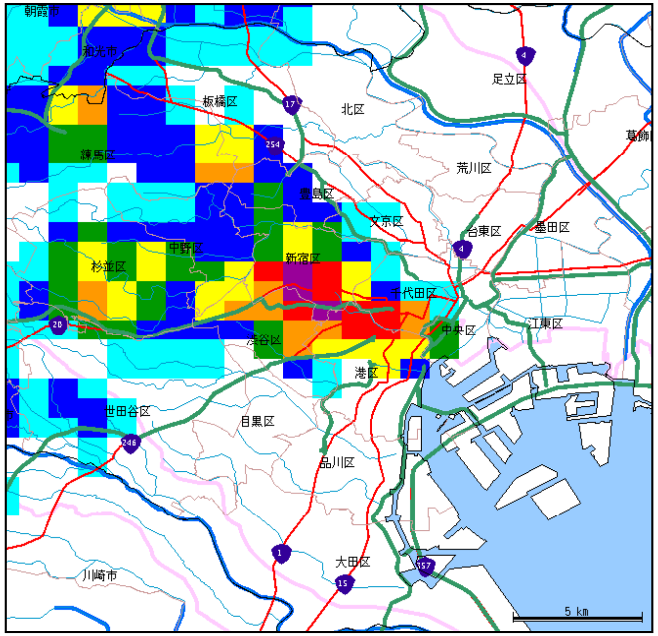


Spread of rain area, rainfall intensity are observed every 5 minutes, which enables predict direction of transition of rain area as well as its prosperity and decline

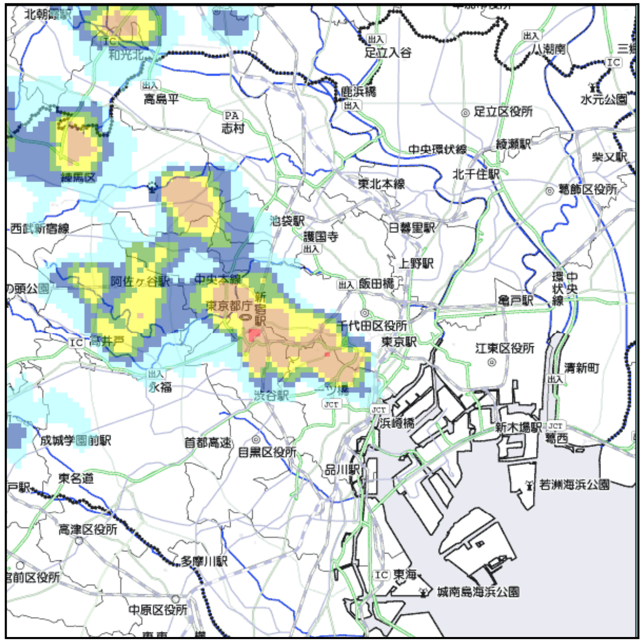
X-band multi-parameter rain radar for torrential rain

Existing radar (C-band radar)
- **Min. observation area: 1 km mesh**
- **Observation interval: 5 minutes**
- **Time to end user: 5 to 10 minutes**
- **Obs. Radius: 120 km**

X-band MP radar
- **Min observation area: 250 m mesh**
- **Observation interval: 1 minute**
- **Time to end user: 1 to 2 minutes**
- **Obs. Radius: 60 km**



High frequency (5-fold)
High resolution (16-fold)

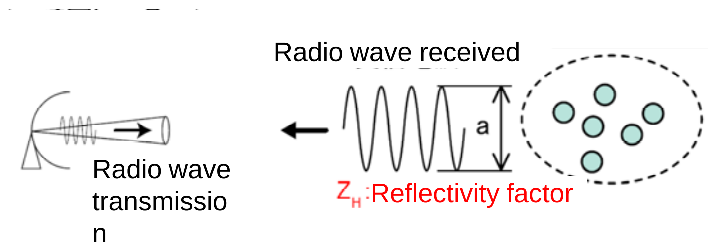


*In contrast to C-band radar (observation radius of 120 km), which is suited for broad-area precipitation observations, with X-band radar (observation radius of 60 km), detailed and real-time observation of local heavy rain is possible though the observable area is small.

Characteristics of the X Band MP Radar

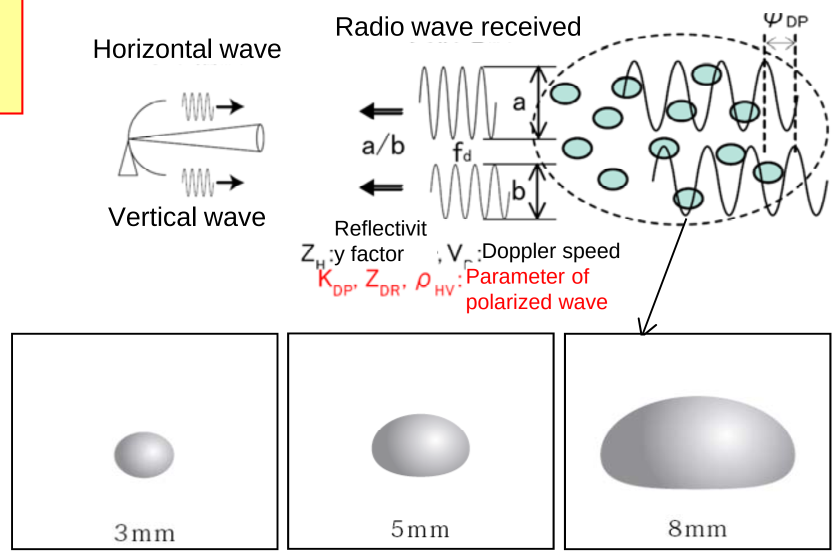
1. High resolution (characteristic of X band)

- Wavelength of X band radar is shorter compared to C band radar, and enables observation of high resolution.



2. High real-time performance (characteristic of MP radar)

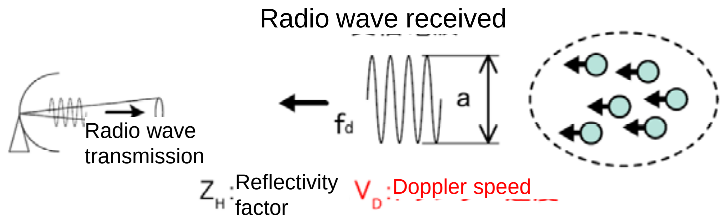
- By transmitting 2 types of polarized waves (horizontal and vertical), the shape of the raindrops are detected, and from the ellipticity of the raindrops, the rainfall quantity can be estimated.
- A highly accurate rainfall observation data can be transmitted almost at real-time without correction made by the ground rain gauge.



Detect and analyze transformation of raindrops

3. Wind observation (Doppler function)

- Wind observation by measuring the raindrop speed using the Doppler function.



Difference between Conventional Radars and X-Band MP Radars

[Comparison between X-band MP radar and existing radar]

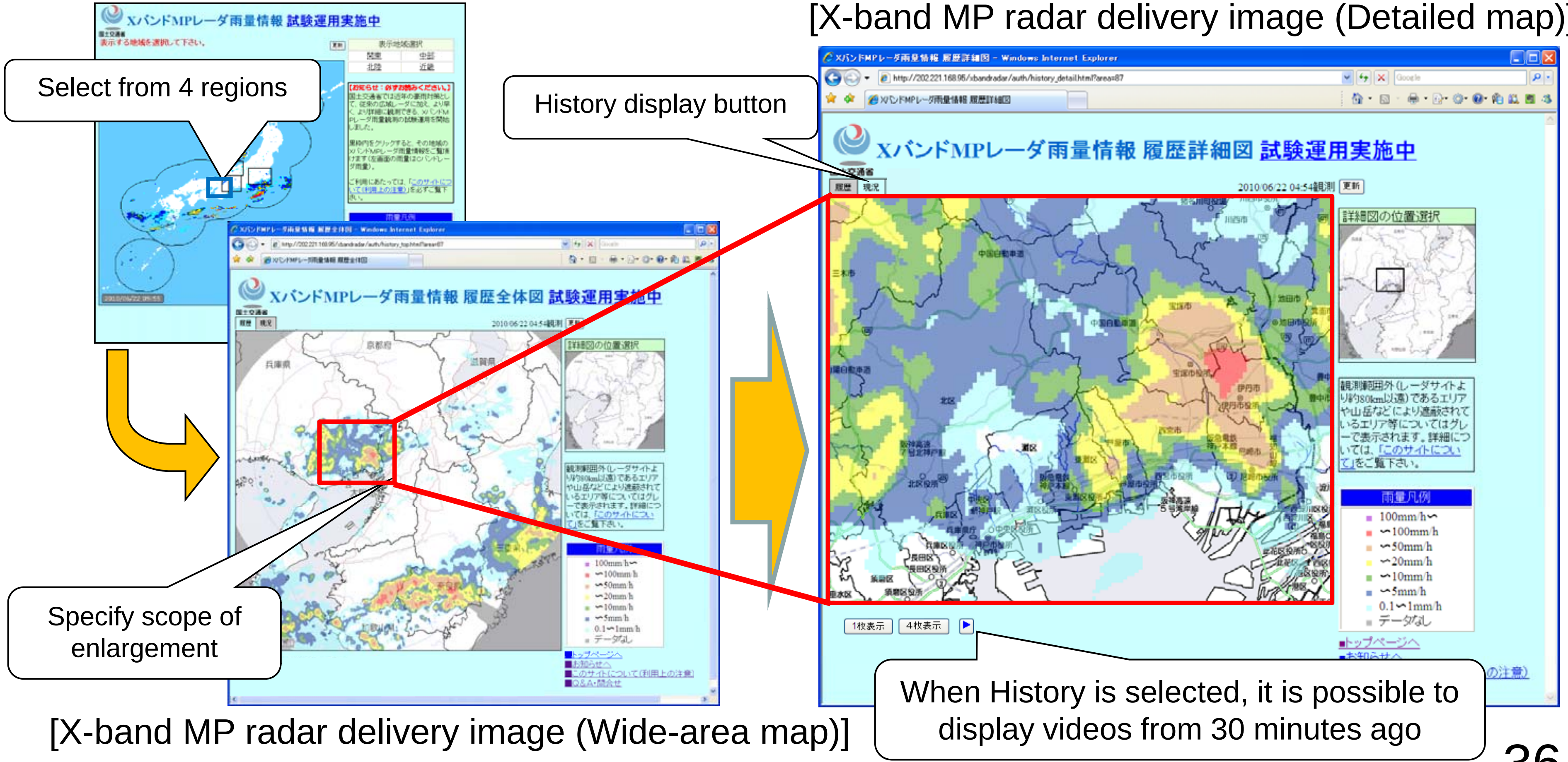
Radar type	**C-band radar (existing)**	**X-band radar (new)**
Frequency and wavelength	4 to 8 GHz, about 5 centimeters	8 to 12 GHz, about 3 centimeters
Measurement application	Measure rainfall (broad area)	• Measure rainfall (narrow area, detailed) • Measure occurrence of rainy area and movement path
Measurement interval	Five minutes	One minute (target)
Time lag to data announcement	Five to 10 minutes	One to two minutes (target)
Resolution of provided data	1 kilometer	250 to 500 meters
Doppler measurements (wind measurements)	Partial (possible at some stations)	Available
Scan directionality	Planar scan	3D scan (ascertain the raindrop formation process)
Dual polarization radar (determine state of raindrops)	Partial (possible at some stations)	Available

Delivery of X-band MP radar（Lanch on 7.2010）

- Observation information that is acquired based on test operation is delivered as Web images.
- The observation areas for which information delivery implemented at this time are the 4 areas of Kanto Chubu, Kinki and Hokuriku.
- 2 types—current rainfall images (updated every minute) and historical images (from 30 minutes beforehand to current state).
- Delivery of observation information is carried out through the following URL. http://www.river.go.jp/xbandradar/

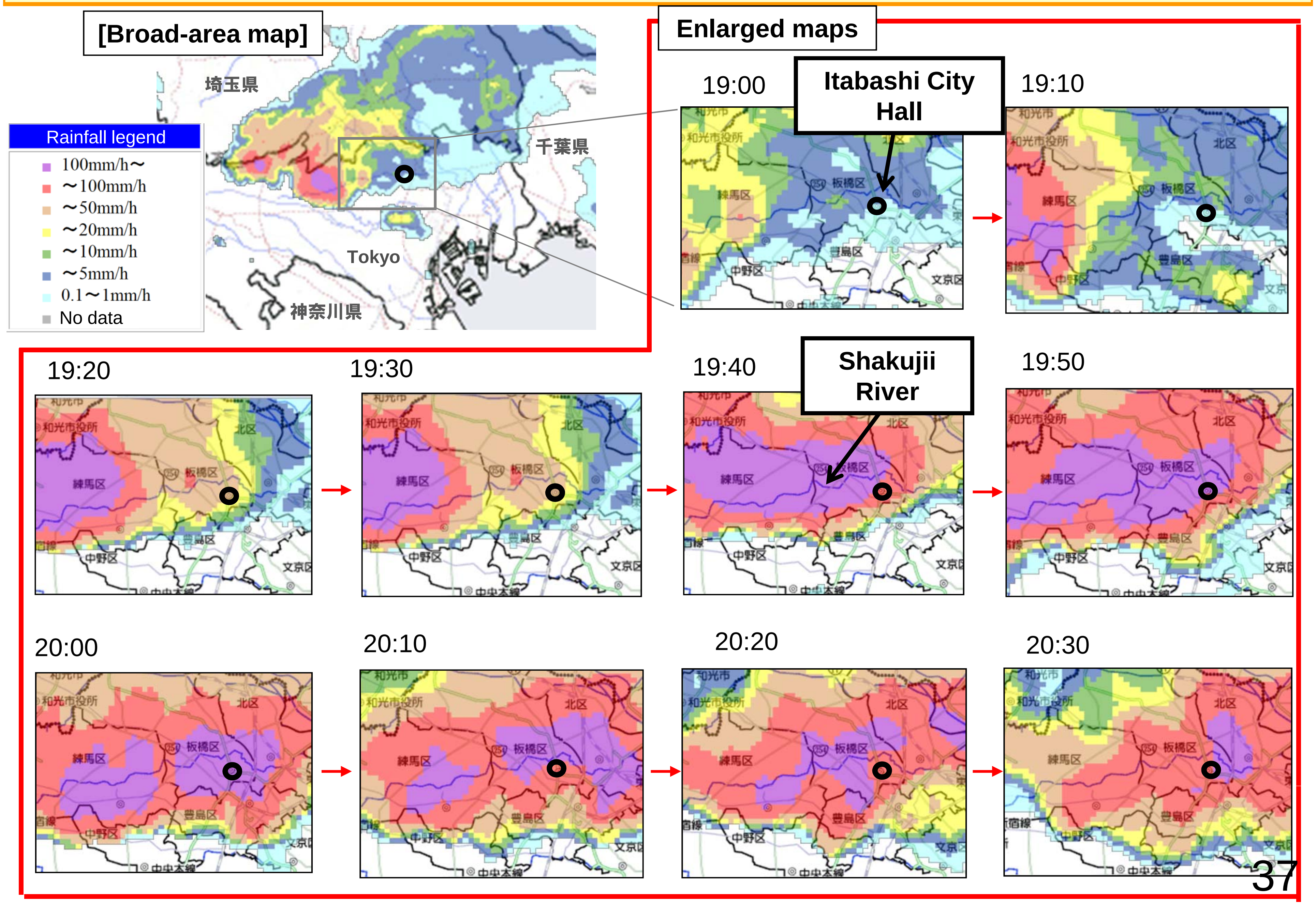
[X-band MP radar delivery image (Nationwide version)]

[X-band MP radar delivery image (Detailed map)]

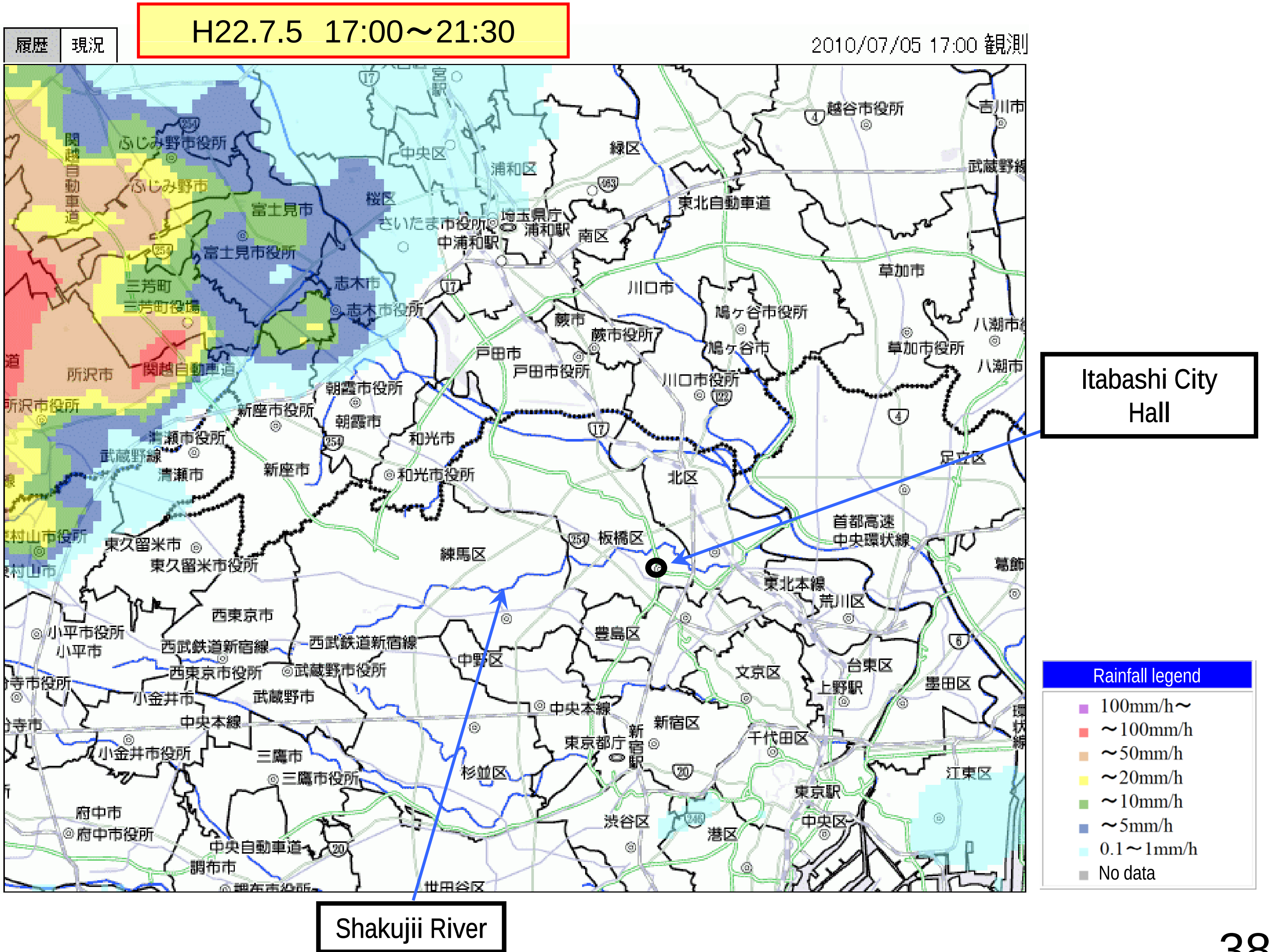


[X-band MP radar delivery image (Wide-area map)]

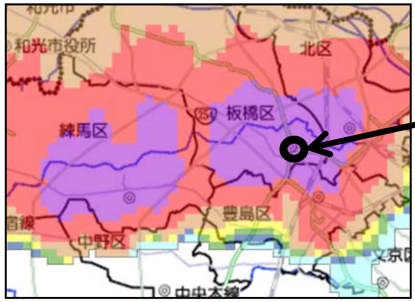
Actual Observation Samples with X-Band MP Radar (Heavy Rain in Itabashi on July 5, 2010)



Actual Observation Samples with X-Band MP Radar (17:00 to 21:30)



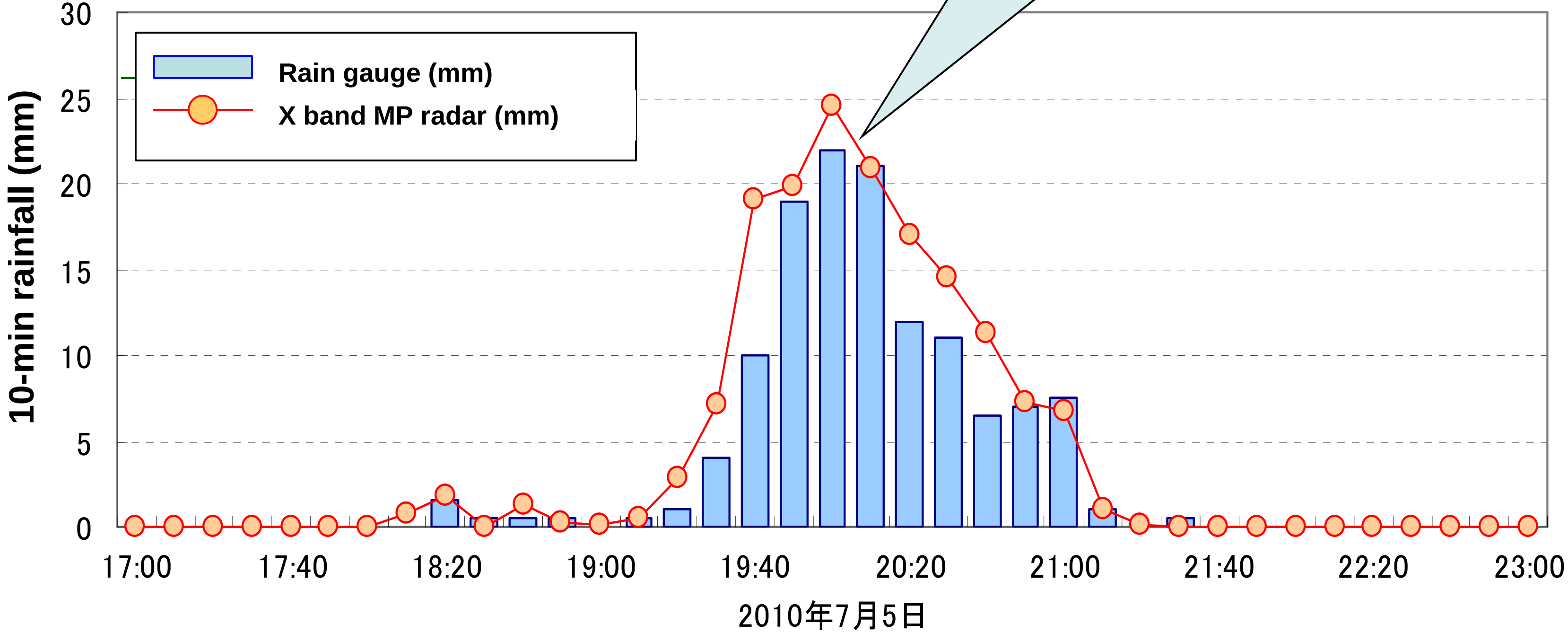
Comparison with rain gauge (Tokyo, July 5, 2010)



Itabashi, Tokyo

X band MP radar provides accurate and quasi-realtime rain data without rain gauge calibration.

Itabashi



Terrestrial Digital Broadcasting in Kyushu Region (July 20, 2010)

Approximately 4 to 6 screens created for each prefecture. Screens can be switched arbitrarily using a remote control.

For rainfall, the four shades as represented by the circles express the intensity of rain, and the maximum number of observation locations is 9 locations.

The squares on the map are water level observation locations. For selected observation locations, the color flashes. Information for the selected observation location (changes in water level), and the current level, etc. are displayed.

Flood Management in Japan

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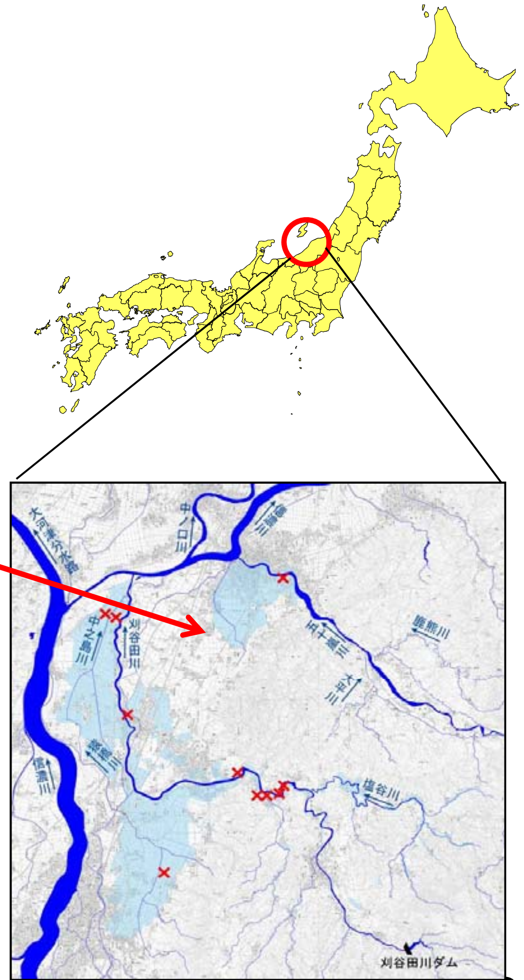
2004 Niigata Torrential Rain Disaster

July 2004 torrential rain caused inundation in large areas, resulting in extensive damages (Fatalities were 15 and approx. 21,000 buildings were damaged in Niigata prefecture※).

※: Niigata Disaster Management Office (March 23, 2005)

Inundation caused by Ikarashi River levee failure
(Sanjo City, Niigata Prefecture)



Damages caused by 2004 Niigata Torrential Rain Disaster

Inundation caused by Ikarashi River levee failure (Sanjo City, Niigata).

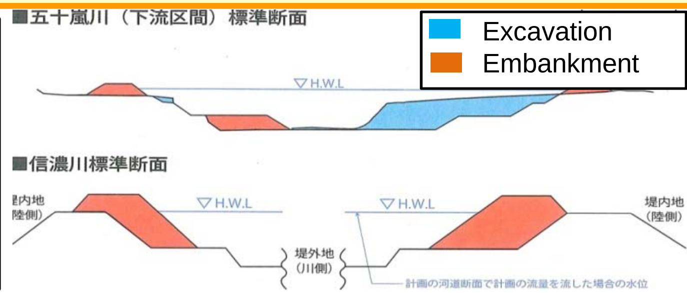
Inundation due to Kariyata River levee failure (Mitsuke City, Niigata)

Inundation due to Kariyata River levee failure (Nakanoshima Town, Niigata)

River Improvements in consideration of 2004 Disaster

River improvements were implemented in consideration of July 2004 flood.

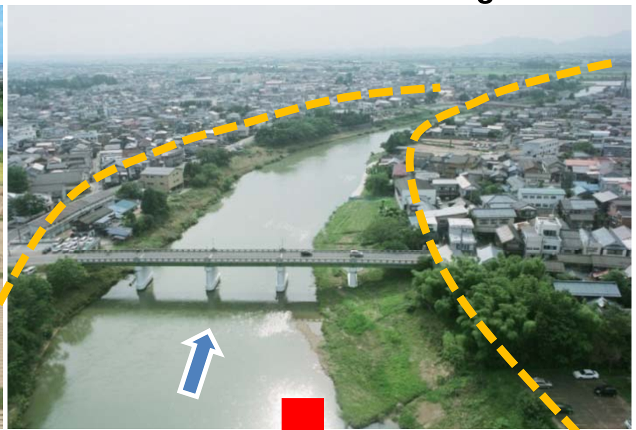
Shinano River（L=34.2km）（2004 – 2009）
Ikarashi River（L=3.9km）　（2004 – 2010）
Kariyata River (L=24.5km）（2004 – 2010）



Downstream of Shinano River Shimohachimai District

（September 2008）

Ikarashi River Tokiwa Bridge



（August 2005）

Kariyata River Nakanoshima Bridge

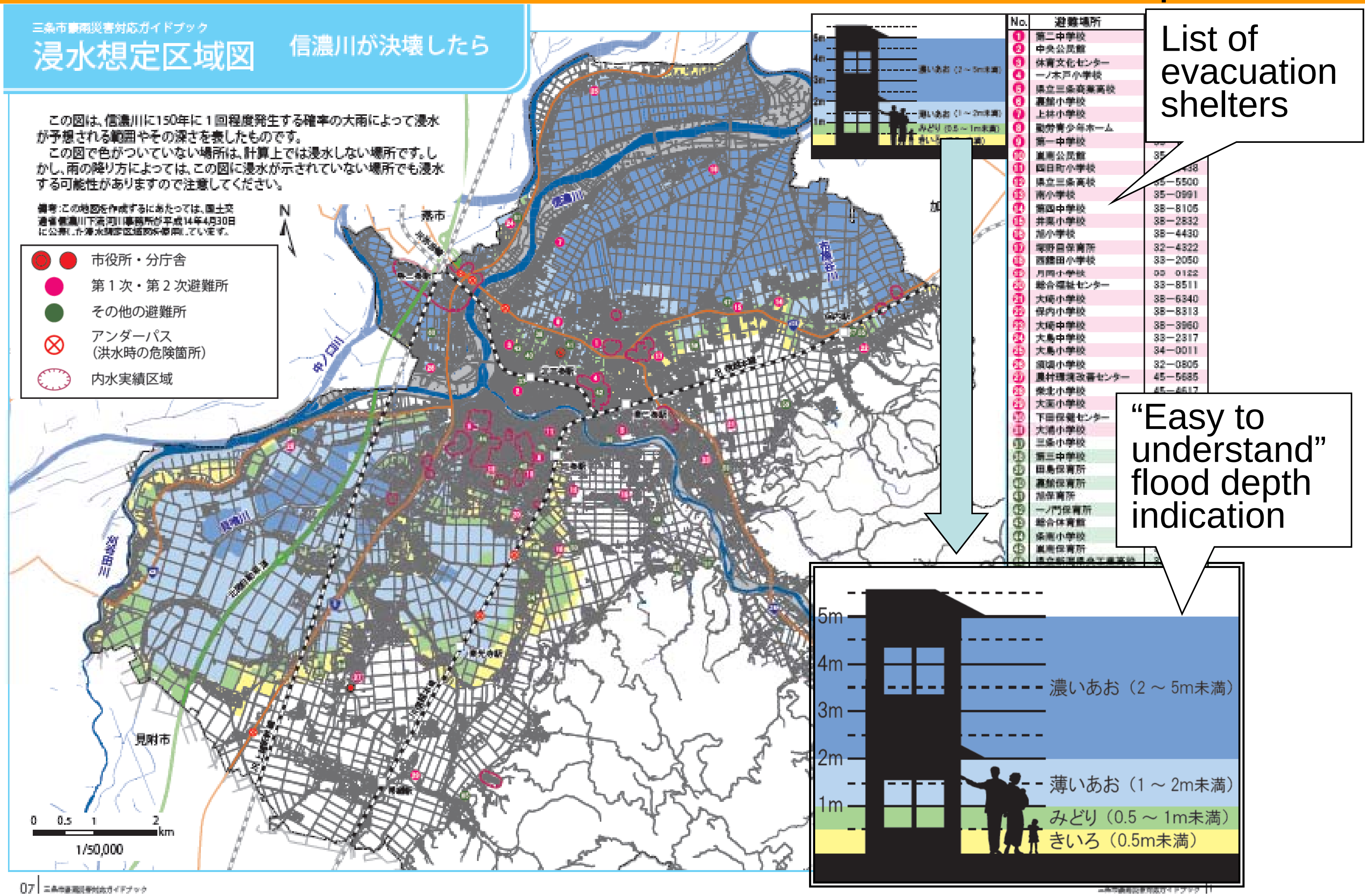
（June 2009）

Levee Improvement
（March 2009）

Widening & Excavation
（December 2010）

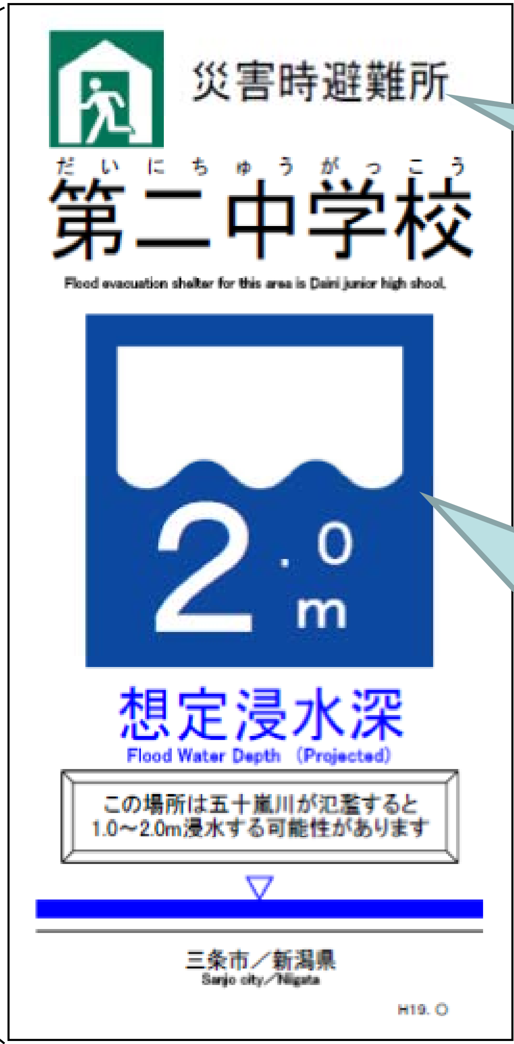
River Channel & Levee Improvement（December 2010）

Raising Public Awareness by Disseminating "Easy to Understand" Disaster Prevention Information such as Hazard Maps



Hazard Map - Sanjo City Torrential Rain Disaster Handbook -

On-Site Display of Past Inundation Levels (Marugoto-Machigoto Hazard Map）



Closest evacuation shelter

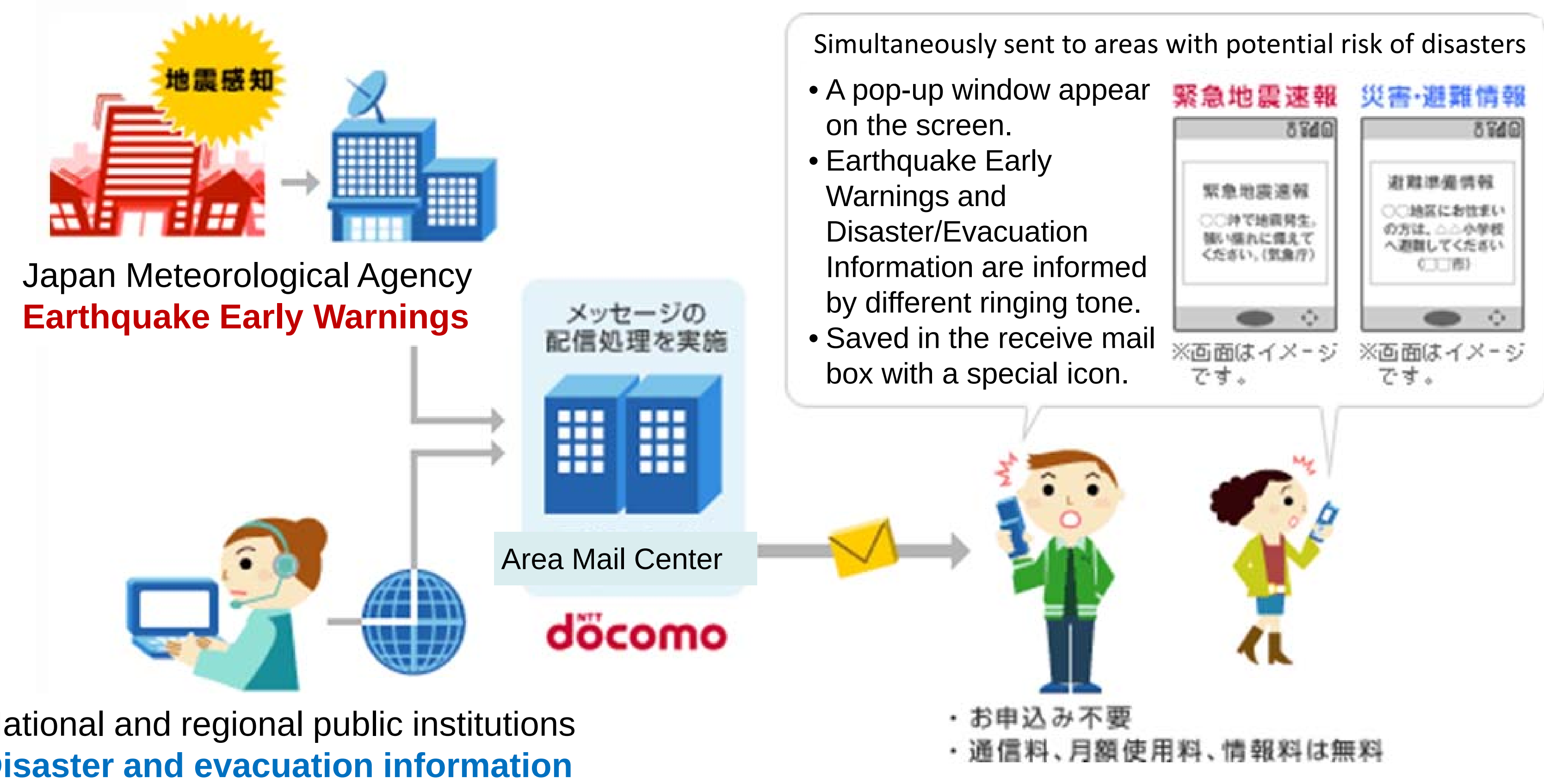
Maximum inundation depth expected at the location

Provision of Evacuation Information using Mobile Phone “Area Mail”

Early Warning “Area Mail”

Provides disaster information such as Earthquake Early Warnings issued by the Japan Meteorological Agency and disaster and evacuation information issued by national and regional public institutions to subscribers in afflicted areas.

- Each base station simultaneously transmit mail to all users in the coverage area.
- Information can be received without the impact of line congestion as it uses cell broadcast service (CBS).



NTTdocomo HP

Distribution of “Emergency Announcement FM Radio”

Emergency Announcement FM Radio

It can be automatically switched on/off by central control (community broadcast or public administration) and can make announcements with high volume.

It is equipped with rechargeable batteries, and receive broadcasts even during power-outage.

Disaster Prevention Training in consideration of 2004 Disaster

【Comprehensive Disaster Prevention Training】

Sanjo City is conducting a comprehensive disaster prevention training every year in June, lead by the fire department. All community firefighters in Sanjo City participate and visit homes of those people with special needs.

【Community Disaster Prevention Drills】

Local communities within Sanjo City conduct their own evacuation drills with the firefighters.

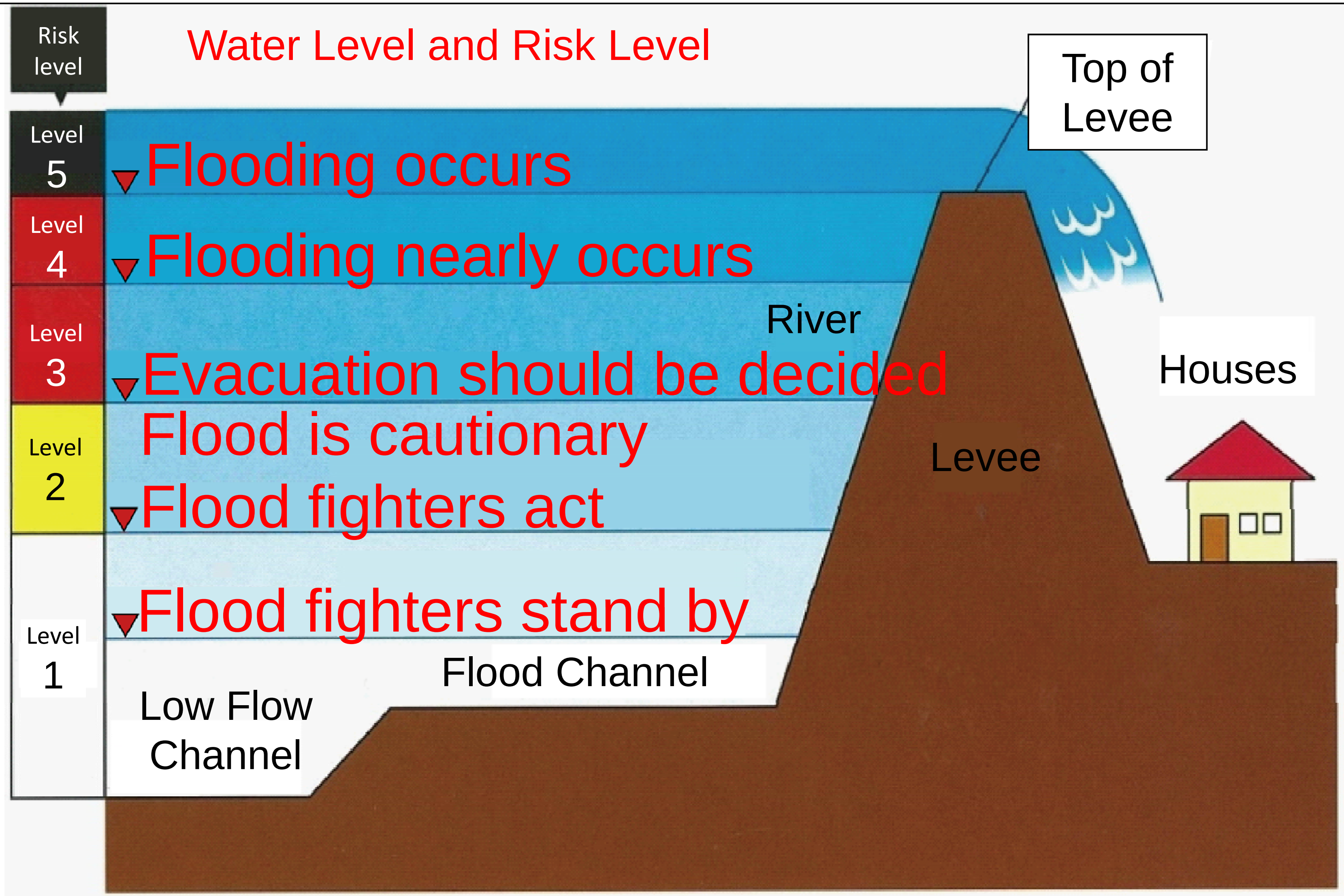
【Voluntary Disaster Prevention Organizations】

40 to 50 voluntary disaster prevention organizations were established after the 2004 flood disaster.

Photos：May 2010 Shinaogawa-Karyu Water Disaster Drills

Establishment of Standards for Evacuation Orders

In order to promote smooth evacuation actions reference to water levels for evacuation orders have been established and categorization of water levels based on risk levels have been implemented.

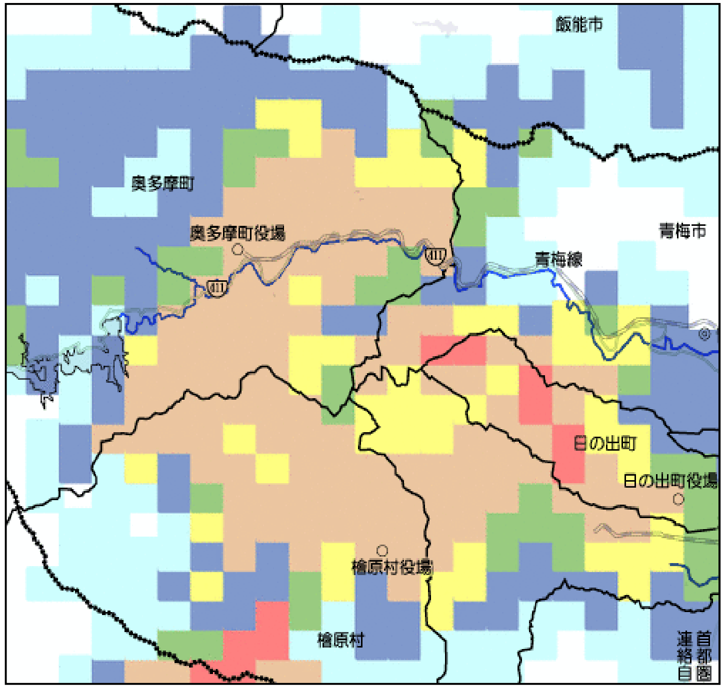


Installation of X Band MP Radar

○X Band MP Radar is being installed in urban areas to enforce real-time observation of localized torrential rainfall, so called “guerilla rainfall”, and to mitigate damages.

○Compared to the conventional radar (C Band Radar) observation with higher frequency (x5) and higher resolution (x16) is possible. Time required for dissemination is reduced from 5-10 minutes to 1-2 minutes.

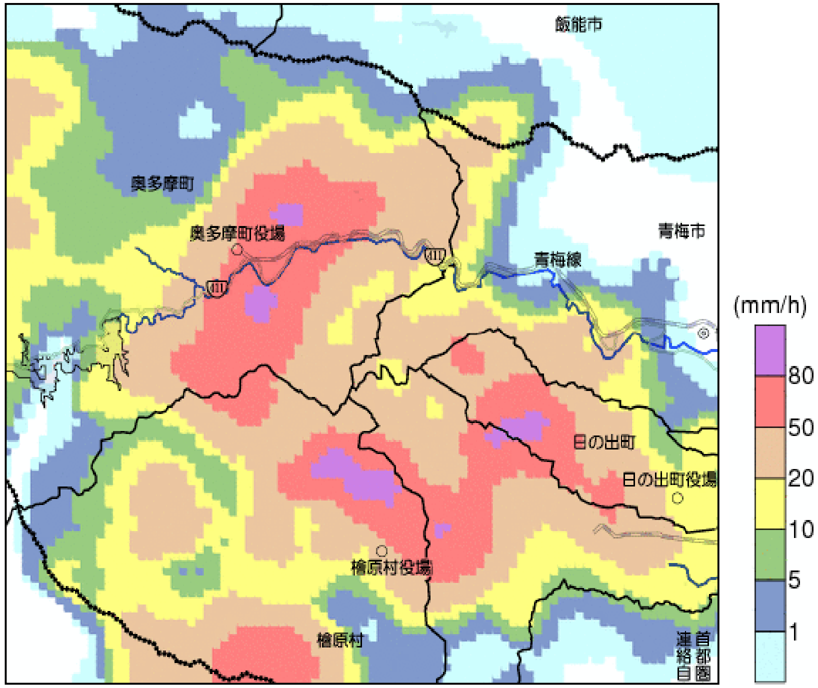
【Conventional Radar (C Band Radar)】



High Frequency (x 5)

High Resolution (x16)

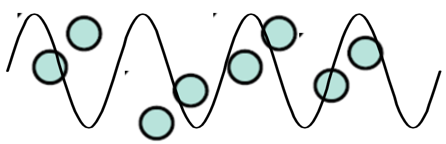
【X Band MP Radar】



Precipitation Information by X Band MP Radar

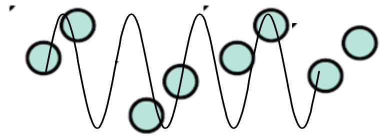
○X Band Radar enables higher resolution observation (250m grid)due to shorter wave length.

【C Band Radar (longer wave length) 】



⇨ Enable observation of long distance

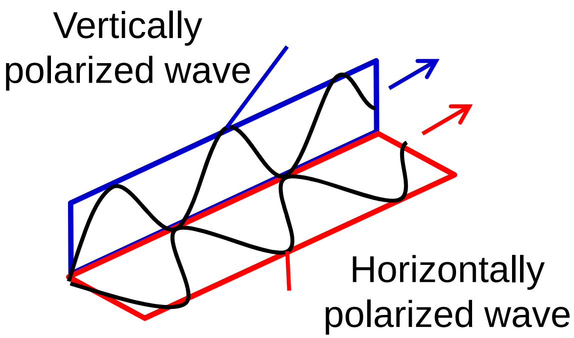
【X Band Radar (shorter wave length) 】



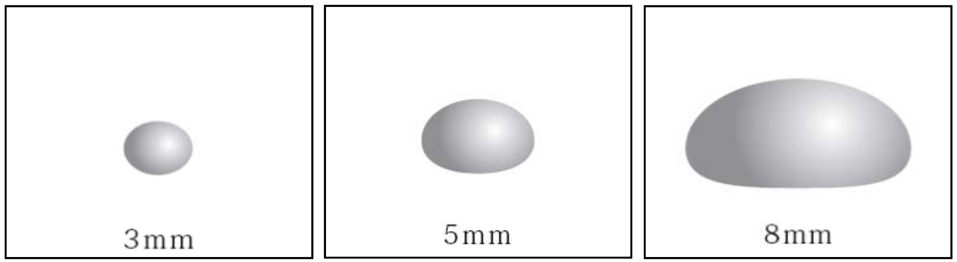
⇨ Detailed observation is possible but with smaller observation range

○ MP (Multi-Parameter) Radar captures the configuration of rain drops and accurately estimate precipitation amount, and does not require correction using ground gauges. ⇒ Information can be disseminated with almost no lag time.

【Multi Parameter Radar】



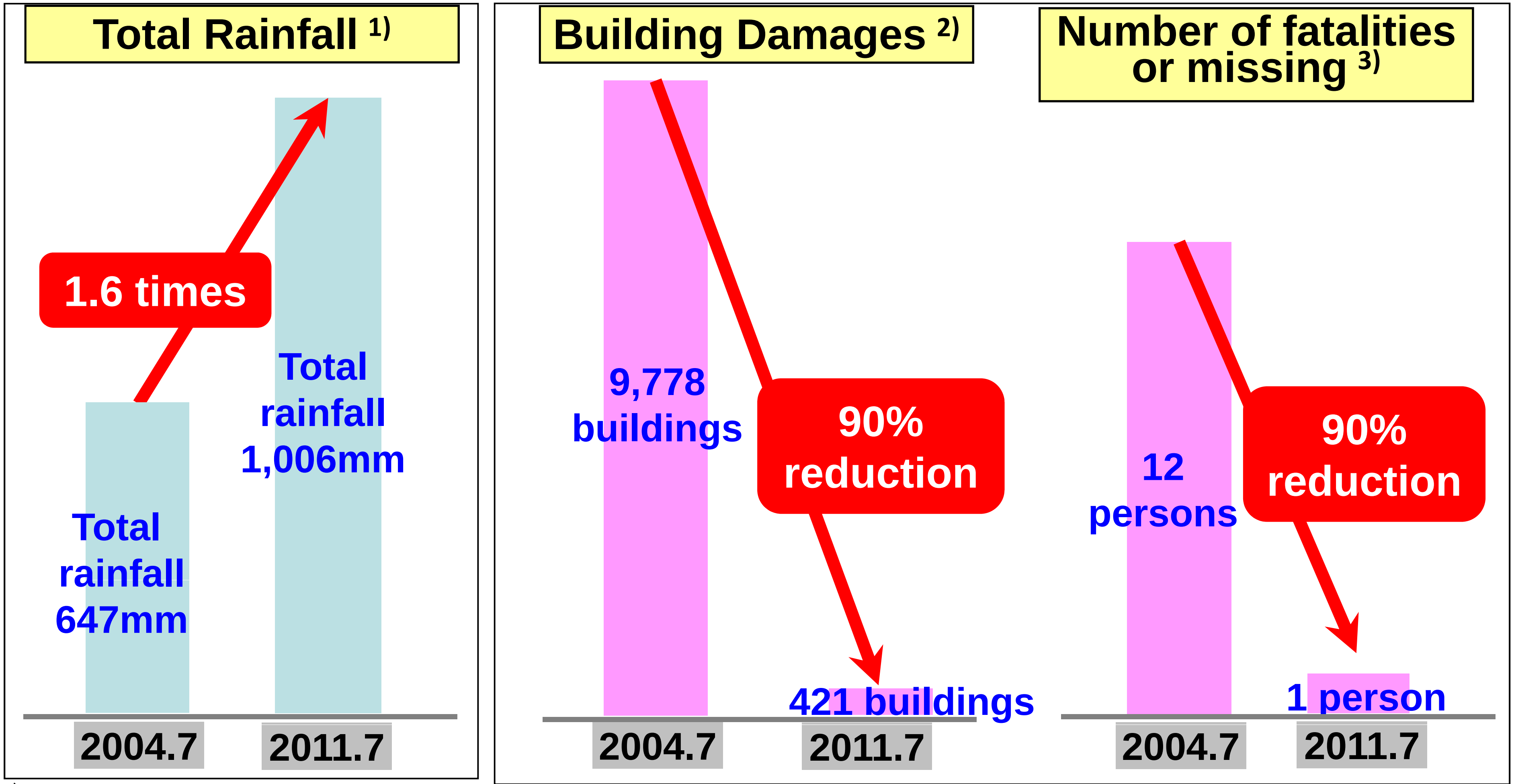
【Changing configuration of rain drops】



By transmitting two types of waves (vertical and horizontal) the configuration of rain drops can be captured.

Improvement of flood prevention facilities and enhancement of warning/evacuation procedures lead to reduction of damages

- In July 2011 the Shinano River Basin in Niigata experienced a torrential rainfall of approx. 1,000mm (cumulative rainfall), the largest rainfall in the recorded history.
- Total rainfall was 1.6 times more than that of July 2004 but both damages to buildings and human casualties were reduced dramatically.



1) Kasabori rain gauge station
2) 2004.7: 7.13 Rainfall and Flood Damage Report in Niigata (March 2006 Niigata Prefecture)
2011.7: Produced by Niigata Prefecture based on "First Niigata and Fukushima Rain Disaster Management Research Committee (Jul. 2011)"
3) Shinano River Downstream, Ikarashi River, Kariyata River Disaster Rehabilitation Emergency Project Pamphlet (Shinano Karyu River Office, Niigata Prefecture)

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ICHARM

International Centre for Water Hazard and Risk Management

Institute on 6 March 2006

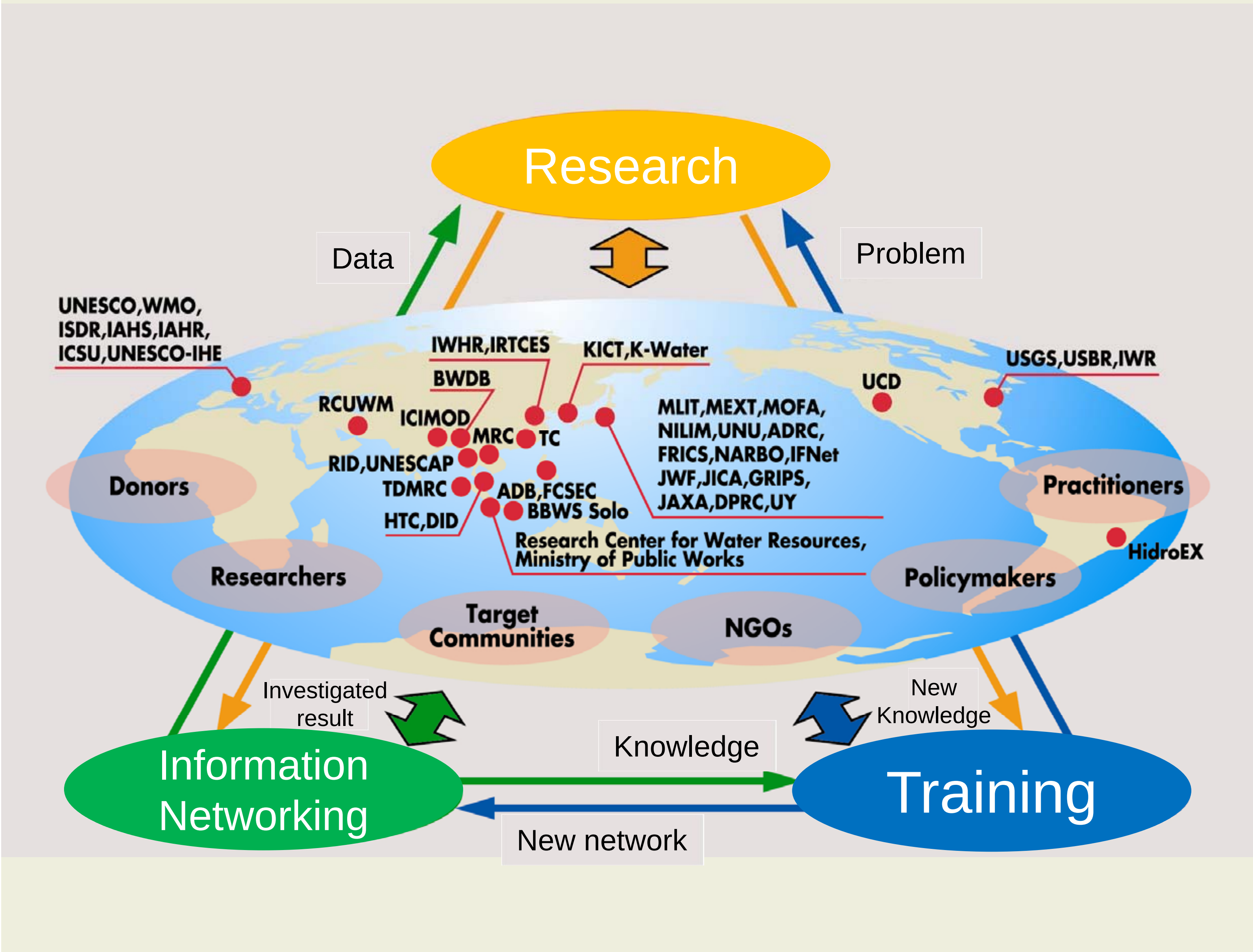
What Is ICHARM?

- A UNESCO Category II* centre established in March 2006 at the Public Works Research Institute (Tsukuba). Its mission is to be the world centre of excellence to provide and assist implementation of best practicable strategies to localities, nations, regions and the globe to manage the risk of water related disasters.
- As a UNESCO Water Centre under the International Hydrological Programme (IHP), it contributes to ensuring safety from water hazards around the world.

【March 6, 2006】 Establishment of ICHARM as an integral part of the Public Works Research Institute, with Dr. Kuniyoshi Takeuchi, then University of Yamanashi professor (now emeritus) and former Chairman of the UNESCO IHP Inter-Governmental Council, as founding Director.

*Category II Centre: An organization that, while not legally part of the UNESCO organization, is certified by UNESCO (33C/Resolution 90) as serving to boost UNESCO's worldwide activities.

Three Pillars of ICHARM Activities



What Is IFAS (Integrated Flood Analysis System)?

IFAS
Integrated Flood Analysis System

A system for calculating time and extent of river flow increase in heavy rain

Background

In developing nations that lack adequate provision and maintenance of hydrometric stations for measuring rainfall, river water level, and flow rate, it is difficult to set up evacuation warning systems, including flood warnings, for mitigating risks.

A system was developed mainly in ICHARM enabling data provision for flood forecasting and flood control planning even in areas without adequate hydrological data.

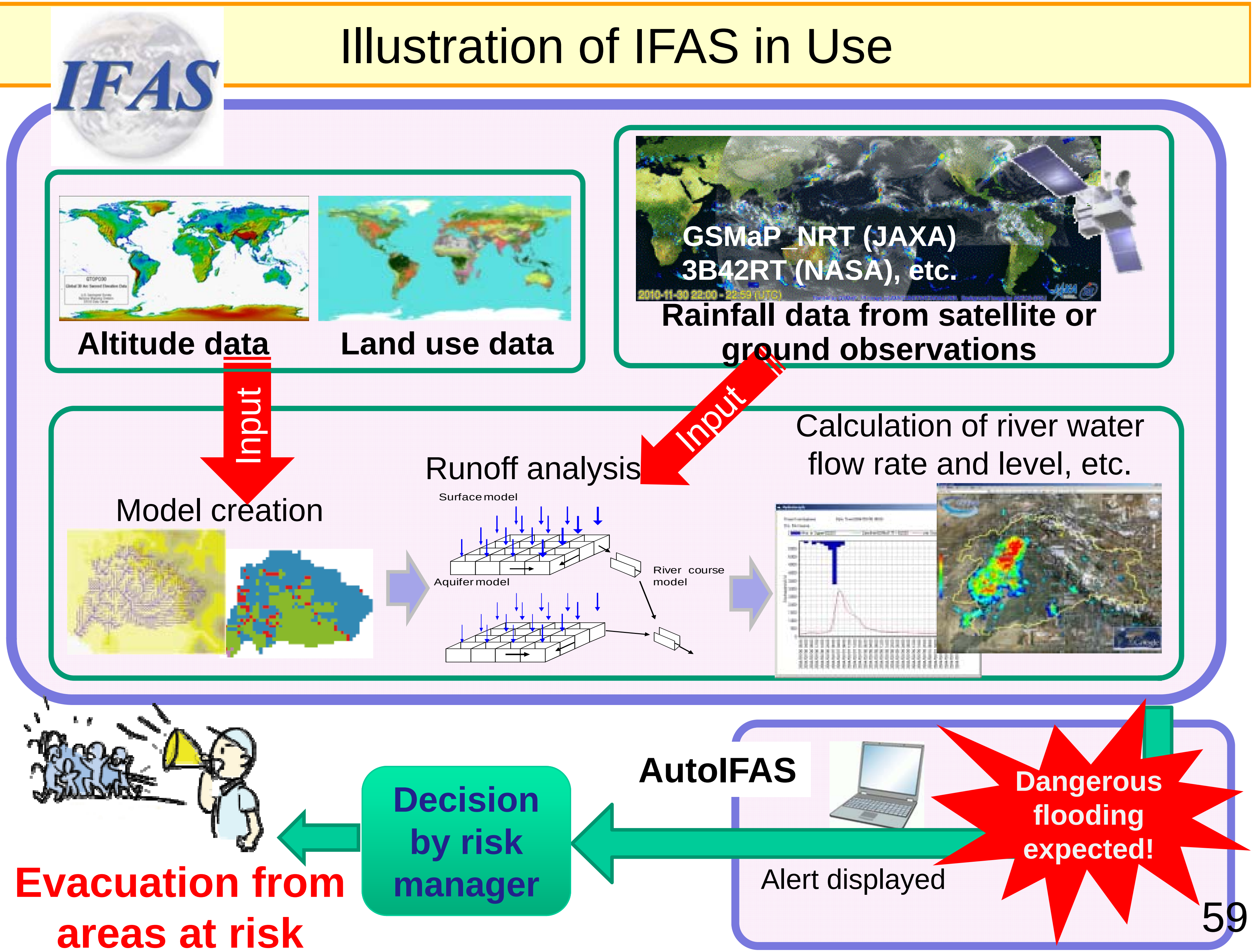
Features

Can **automatically collect** geographical data, land use data, and satellite rainfall data and use these to calculate river flow rate, etc.

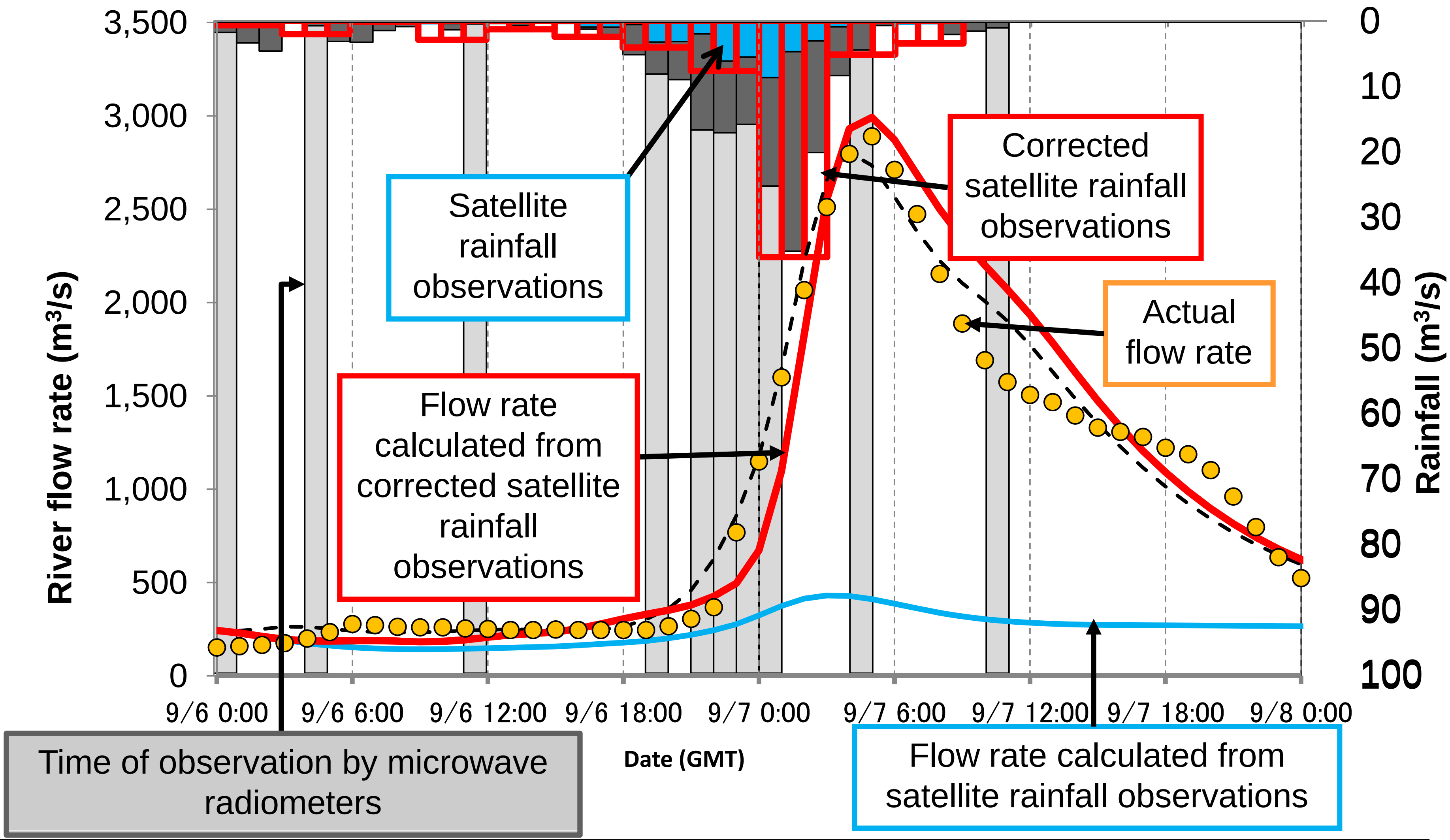
Analysis is possible from any Windows PC connected to the Internet.

IFAS can be downloaded from the ICHARM website.
http://www.icharm.pwri.go.jp/index.html

Illustration of IFAS in Use



Accuracy of rainfall runoff analysis when satellite-based microwave radiometry observations match timing of torrential rain



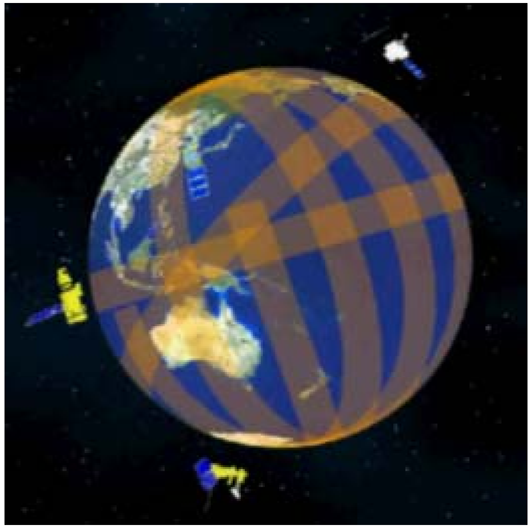
Thanks to frequent microwave measurements when storm fronts are developing, rainfall amounts are corrected with high precision enabling accurate calculations of river flow rate.

Issues for Obtaining Good Analysis Results with IFAS

Accuracy of satellite rainfall observations and of corrections depends on frequency of microwave radiometry observations.

(Because satellites circle the earth, they cannot measure at all times.)

If satellite microwave radiometry observations are not timed to rainfall peak, deviation between analysis results and actual flow rate is large.



Courtesy of JAXA

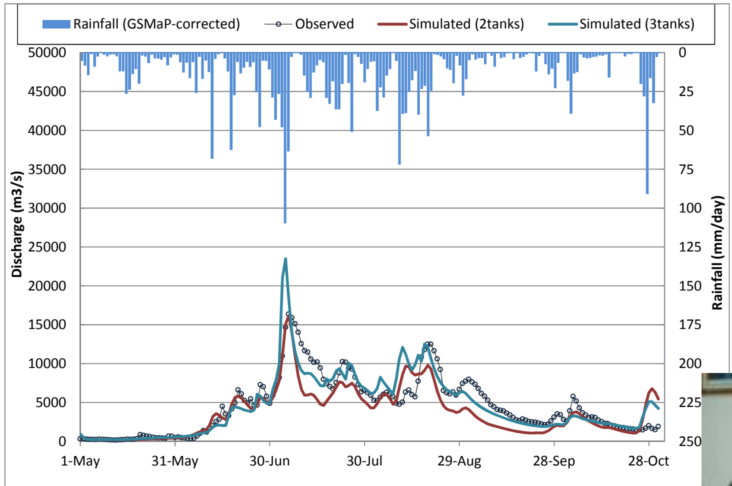
Microwave measurement from satellites

How to realize improvements:

- Have the world's aerospace organizations increase the number of satellites equipped with microwave radiometers to enable more frequent observations.
- Make maximum use of available rainfall data from ground observations (obtain data not dependent on satellites such as ground rain gauges and radar rain measurements).

IFAS Use Overseas

- Seminar held on IFAS use in six Asian nations (Indonesia, Thailand, Vietnam, Myanmar, Pakistan, India)
- Flood warning system using IFAS being built for Solo River in central Java, Indonesia in cooperation with Asian Development Bank (ADB) Solo River (scheduled for completion in March 2012)
- UNESCO project to provide flood warning system using IFAS for Indus River



Case study of IFAS use for rainfall/discharge analysis at IFAS seminar in Myanmar (June 2010)
Chindwin River, tributary of Irrawaddy River

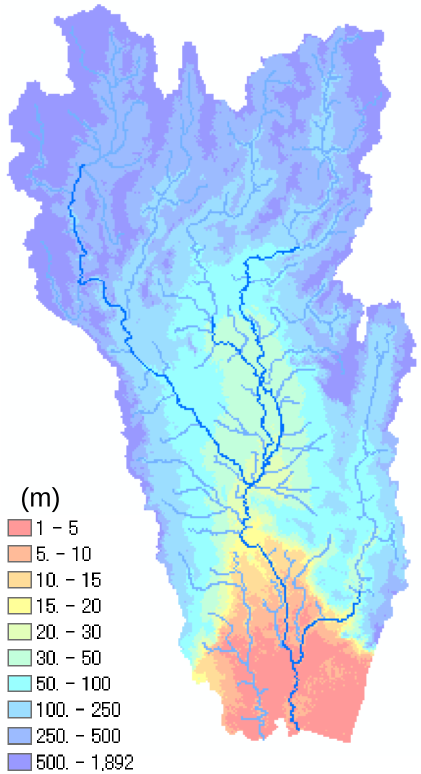
RAINFALL-RUNOFF-INUNDATION PREDICTION IN THE CHAO PHRAYA RIVER BASIN

2011 Chao Phraya flood in Thailand

Rainfall–Runoff–Inundation Prediction in the Chao Phraya

Rainfall-Runoff-Inundation Model (RRI Model)
RRI model is designed to analyze the entire process from river discharge to inundation by using rainfall as the input data.

- Damage status must be assessed based on limited information during a large-scale flooding event like the Thai flood.
- ICHARM is working on a new technology capable of flood simulation even in the middle of flooding to provide more information on inundation in addition to satellite remote sensing information.
- Flood data collection and analysis started last mid-October before the flood peak, and the results were released for governmental offices and the media.

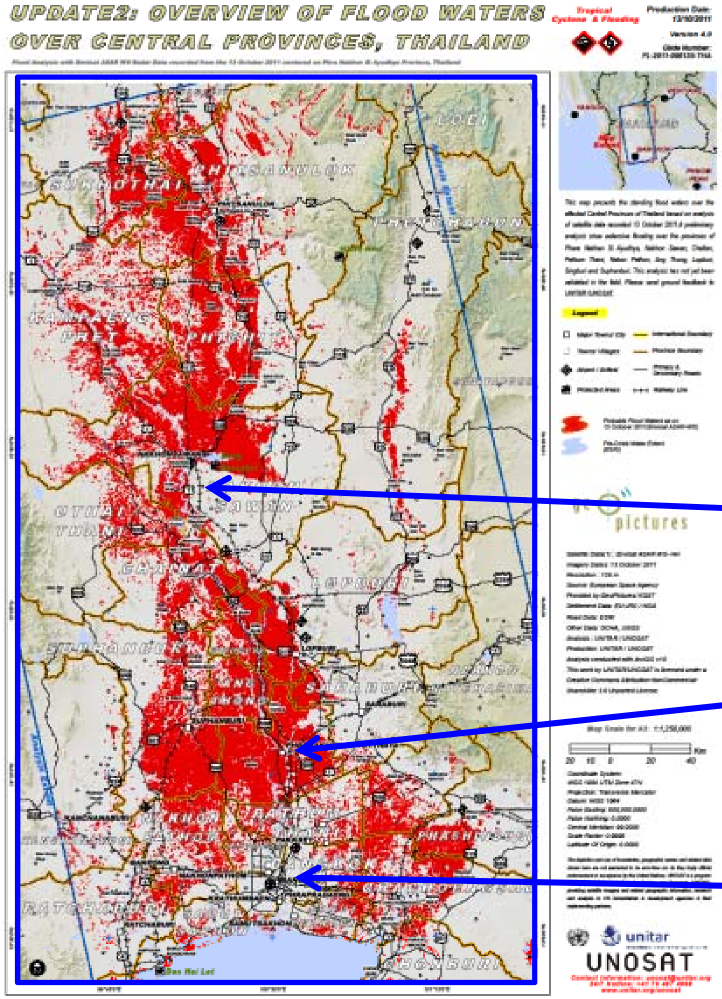


Satellite topographic data
& HydroSHEDS for river channels

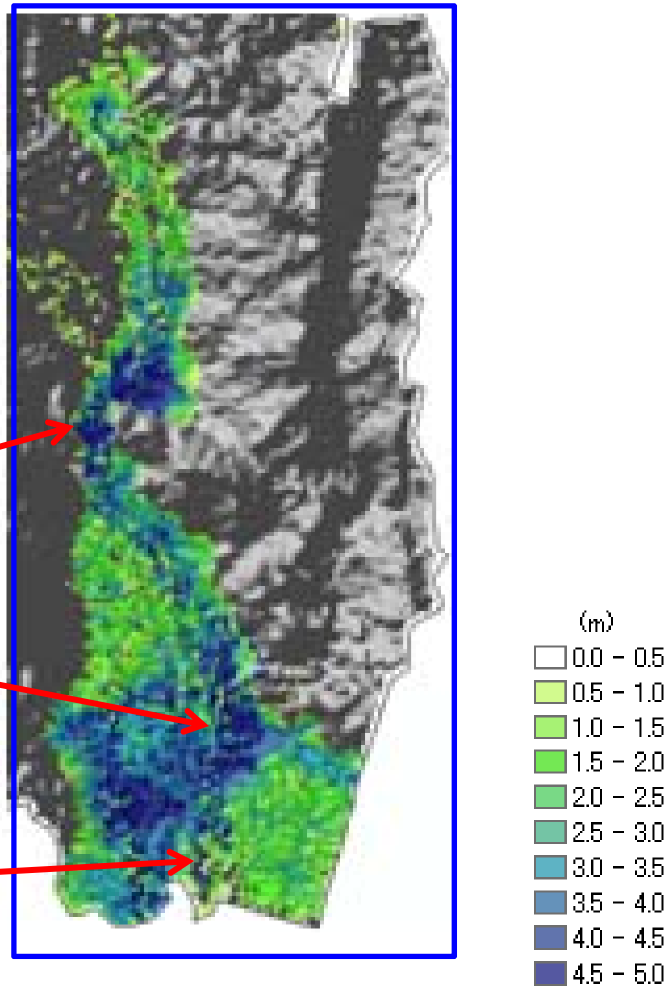
- RRI was introduced to analyze this flood event, specifically designed to forecast flood discharge and water level, **because RRI can holistically analyze river discharge and inundation by using rainfall as input**.
- Analysis was done based on satellite topographic and rainfall information.
- ICHARM is working to provide more detailed reproduction simulation that can reflect the effects of artificial structures and other relevant factors.

Simulation area: 163,293 km^2
Simulation period: 0:00, 1st July 2011 – 0:00, 30 Nov. 2011 (UTC)
Input rainfall: satellite rainfall, forecasted rainfall

Inundation based on satellite information (MODIS)
on 13 Oct. 2011



Simulated water depths
on 13 Oct. 2011



Nakhon Sawan

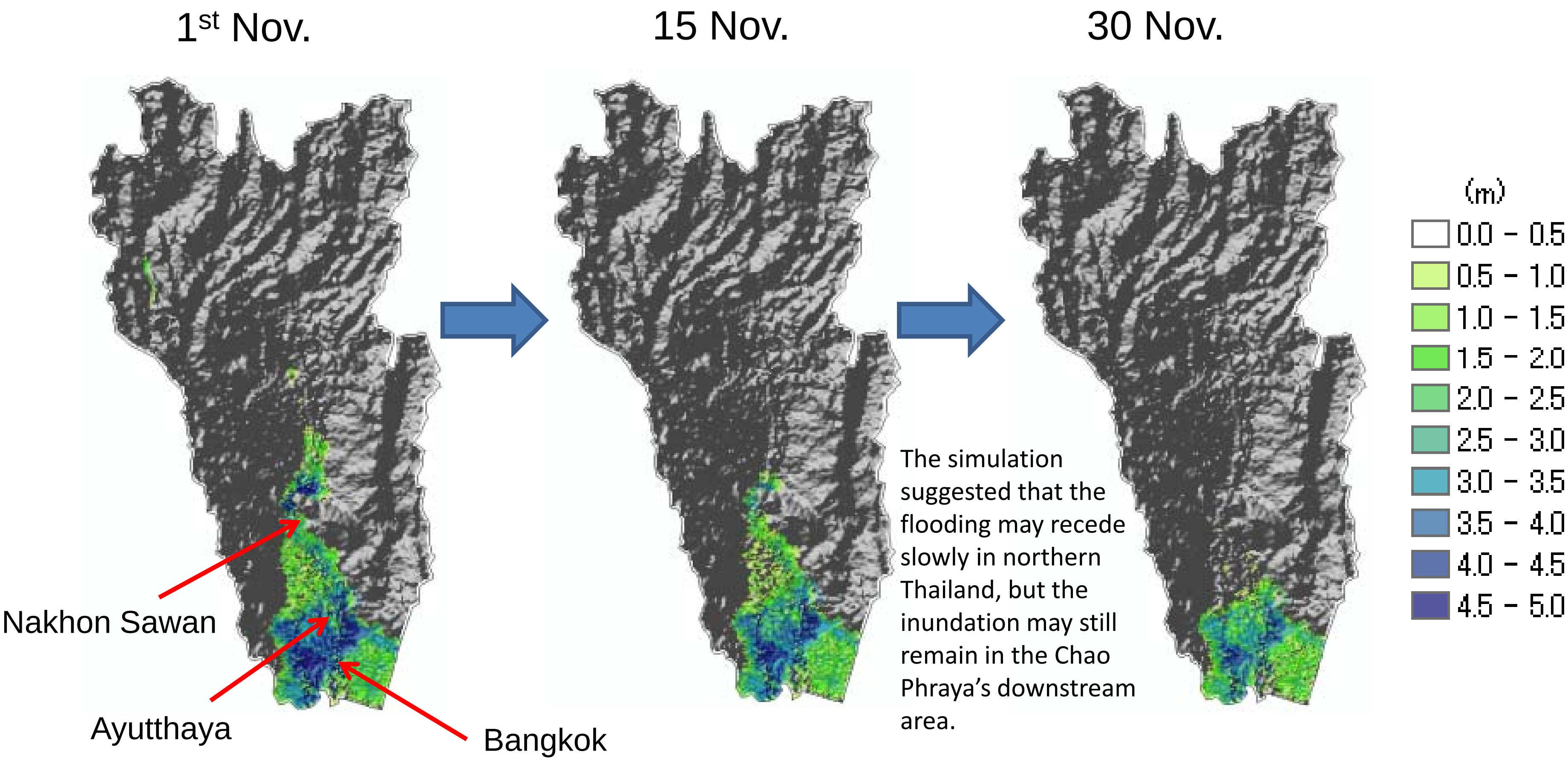
Ayutthaya

Bangkok

- The simulation largely well reproduced major inundation areas, such as Nakhon Sawan and Ayutthaya, on 13 Oct. 2011.
- Detailed reproduction of the inundation around Bangkok is not possible at this moment due to the difficulty of considering the effects of dykes and other factors.

Inundation Prediction up to late Nov. 2011 (as on 21 Oct. 2011)

The simulation results suggested that the inundation may continue to remain in the downstream area up to late Nov. 2011.



The simulation suggested that the flooding may recede slowly in northern Thailand, but the inundation may still remain in the Chao Phraya's downstream area.

*The simulation was done by ICHARM using the RRI model. (The inundation depth was simulated based on the satellite rainfall from 1 July to 0:00. 8 Nov. 2011 , JMA-forecasted rainfall from 6:00, 8 Nov. to 12:00, 15 Nov. 2011, and last year rainfall from 15:00, 15 Nov. to 30. Nov. 2010.)
*The degree of uncertainty is especially large in inundation depth around Bangkok located downstream of the Chao Phraya.
*The topographic map used for the simulation was created by ICHARM based on HydroSHEDS (USGS).

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Ministry of Land, Infrastructure, Transport and Tourism (MLIT) Response to Thailand Floods

MLIT is providing full support to Thailand for recovery and rebuilding from the flood damage, drawing on specialized knowledge.

1. Sending of experts

Japanese experts with experience responding to large-scale flood damage (flooding, drainage measures, airports, railways) were sent to Thailand.

2. Drainage of flood water

•At the request of the Thai government, 10 vehicles mounted with high-performance drainage pumps (each with the pumping capacity of 10 fire trucks), belonging to MLIT, were sent overseas for the first time as international disaster relief.

•The project was carried out by a joint public-private drainage team consisting of MLIT Regional Development Bureaus, Ministry of Foreign Affairs, JICA, and private companies. Some 51 persons (a total of 880 man-days) were engaged in the drainage work.

•The drainage work was initiated on Nov. 19 and completed in Thailand on Dec. 20 (total of 32 days).

•They succeeded in draining an area of 8.1 million m^3 (enough water to fill 23,000 25m swimming pools or Tokyo Dome 7 times) in the Rojana Industrial Park, Asian Institute of Technology, Plaibang residential area and other locations.

3. Sending of flood damage survey team

•Following on the success of water drainage work in Thailand, a joint team of MLIT and the Japan Society of Civil Engineers was sent to provide further aid in recovery and rebuilding from the disaster (7 days from Dec. 22 to 28).

4. Sharing Japan's experience

•MLIT, the Meteorological Agency, Japan Water Agency, and the University of Tokyo took part in the first Integrated Water Resources Management for Chao Phraya River Basin Seminar organized by JICA (Jan. 14, Bangkok).

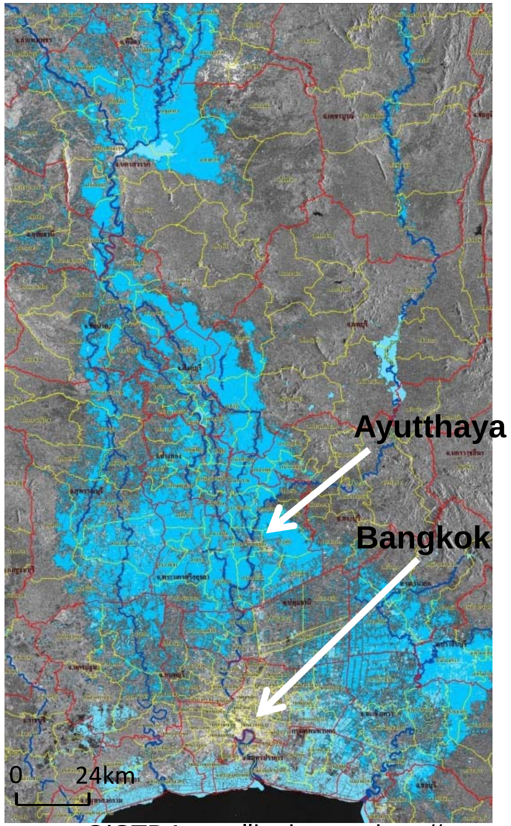
5. Worldwide provision of disaster readiness packages

•In addition to the response to the flood damage in Thailand, provision of a comprehensive disaster prevention system including disaster prevention information, warning and evacuation systems, infrastructure, land use restrictions, and institutions and organizational structures, along with a "disaster management package" involving collaboration among the related agencies, organizations, industry, and academia toward proper administration of the system, is under study.

Drainage Pump Vehicle Arrival Ceremony in Thailand (Nov. 18)

- As part of its drainage assistance to the flood-affected Thailand, MLIT sent its 10 high-capacity, high-mobility drainage pump vehicles to Thailand (first overseas dispatch).
- Each of the drainage pump vehicles has a drainage capacity of 30 m3/min and is capable of draining a 25-meter swimming pool in about 10 minutes. These pump vehicles were also used for drainage in the tsunami-affected areas following the Higashi Nihon Earthquake.
- The pump vehicles left Yokohama Port on November 5 and arrived at Thailand on November 18. At the heart of Bangkok, a drainage pump vehicle arrival ceremony was held in the presence of Deputy Prime Minister Yongyuth Wichaidit and other officials.

【 Satellite image of Thailand (Oct. 17) 】
(* Flooded areas shown in blue)



Source: GISTDA satellite image, http://www.gistda.or.th

【Arrival ceremony 】

Speech of Deputy Prime Minister Yongyuth Wichaidit

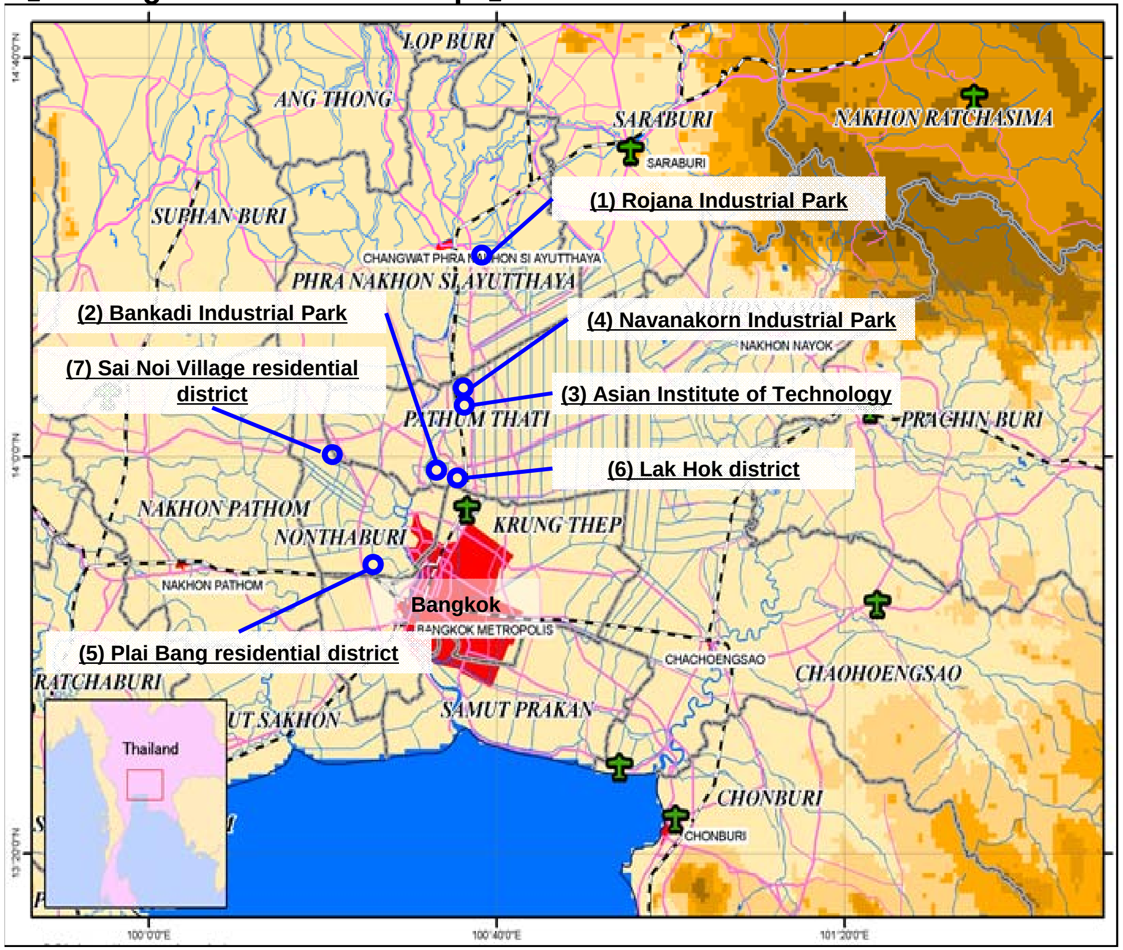
International emergency aid team expressing its determination

【Drainage pump vehicle 】

Activities of Drainage Pump Vehicle Team

- An international emergency aid team of experts (drainage pump vehicle team) consisting of 51 members of MLIT regional development bureaus, Ministry of Foreign Affairs, JICA and private-sector companies carried out drainage operation (880 person-days).
- Starting with the drainage operation at Rojana Industrial Park, the team drained a total of about 8.1 million cubic meters of water (approximately 7 times the volume of Tokyo Dome or 23,000 times the volume of a 25 m swimming pool).

【Drainage Area Location Map 】



Source: Geospatial Information Authority of Japan

【Drainage Activities 】

(1) Rojana Industrial Park: Nov. 19 to Nov. 27 (9 days)
Estimated drainage volume: about 2,300,000 m3 (about 6,400 times the volume of a 25 m swimming pool)

(2) Bankadi Industrial Park and surrounding residential district: Nov. 26 to Dec. 8 (13 days)
Estimated drainage volume: about 2,500,000 m3 (about 6,900 times the volume of a 25 m swimming pool)

(3) Asian Institute of Technology: Nov. 29 to Dec. 8 (10 days)
Estimated drainage volume: about 400,000 m3 (about 1,100 times the volume of a 25 m swimming pool)

(4) Navanakorn Industrial Park: Nov. 30 to Dec. 8 (9 days)
Estimated drainage volume: about 500,000 m3 (about 1,400 times the volume of a 25 m swimming pool)

(5) Plai Bang residential district: Dec. 8 to Dec. 14 (7 days)
Estimated drainage volume: about 400,000 m3 (about 1,100 times the volume of a 25 m swimming pool)

(6) Lak Hok district (Rangsit University and surrounding residential district): Dec. 9 to Dec. 17 (9 days)
Estimated drainage volume: about 300,000 m3 (about 800 times the volume of a 25 m swimming pool)

(7) Sai Noi Village residential district: Dec. 14 to Dec. 20 (7 days)
Estimated drainage volume: about 1,700,000 m3 (about 4,700 times the volume of a 25 m swimming pool)

Activities of Drainage Pump Vehicle Team

- Prior to pumping operation, the drainage pump vehicle team held meetings with the Thai government and the local people concerned and conducted site investigations.
- The team provided technical guidance to Thai workers concerning the movement, setup and management of the drainage pump vehicles.

Meeting with Thai government and people concerned

【Japan–Thailand conference (at Ministry of Industry)】

【Meeting with local businesses 】

Site investigation

Providing technical guidance to Thai workers

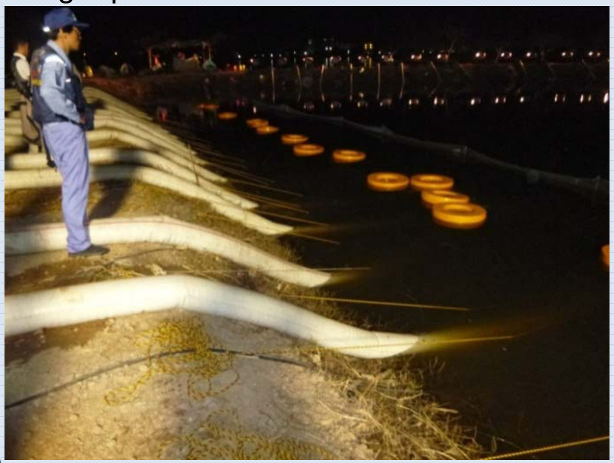
Activities of Drainage Pump Vehicle Team

・**Drainage was difficult mainly because of debris, oil and other foreign matter contained in the flood water, but appropriate response actions and around-the-clock drainage activities made it possible to complete drainage faster than expected by the local authorities.**

Drainage Operation

【Pumping】

【Night patrol】



Effect of Drainage

【Before (Nov. 23)】

【After (Nov. 26)】

【Before (Nov. 19)】

【After (Nov. 26)】

Completion Ceremony at Thailand's Ministry of Industry (Dec. 23)

- On December 23 (Fri), the drainage activity completion ceremony was held at the Ministry of Industry of Thailand.
- Industry Minister Wannarat Charnnukul expressed appreciation for the activities of the drainage pump vehicle team.

【Completion Ceremony 】

From left to right: Mr. Yoneda, Chief Representative of JICA Thailand Office, Ambassador Kojima, Industry Minister and Mr. Pasu, Director General of the Department of Industrial Promotion

Speech by Yanagisawa head

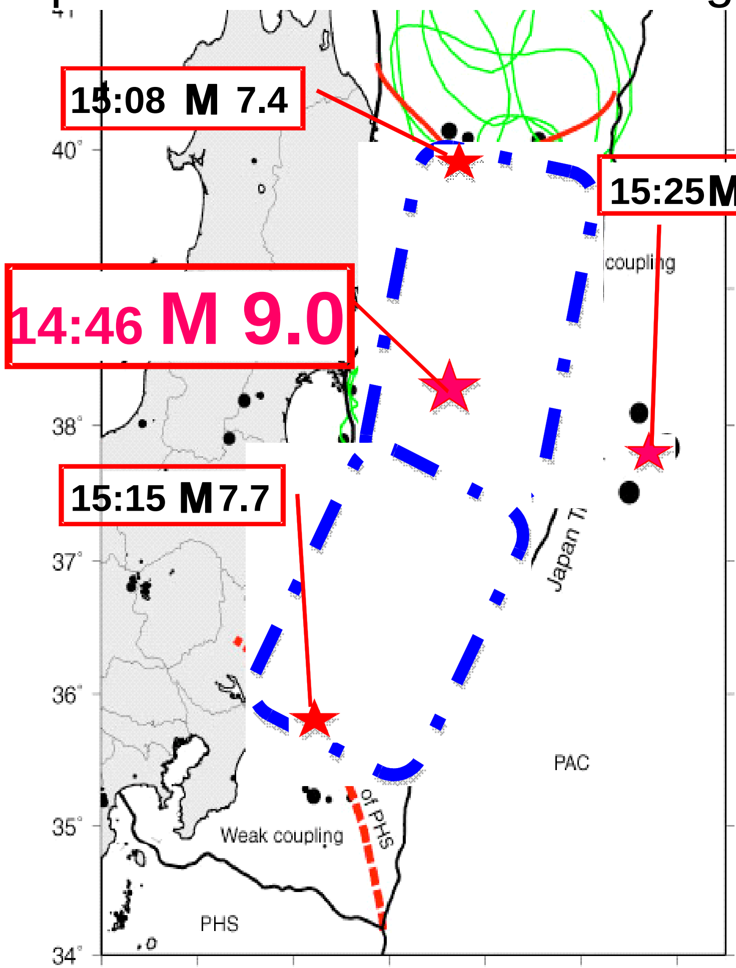
1. Comprehensive Flood Control Measures
2. Provision of River information
3. Responses to the Niigata Torrential Rain Disaster
4. About ICHARM
5. Responses to 2011 Thailand Floods
6. Outline of the Tsunami-Resilient City

Overview of Earthquake & Tsunami

- On March 11 a massive earthquake of magnitude 9.0 occurred off Sanriku coast. Strong shocks were widely observed.
- Focal region ranged over in the rectangle of around 450km long and 200km wide※.
- The earthquake caused massive tsunami from Hokkaido to Kanto.
- The scale of tsunami was equal to or larger than that of the Jogan Tsunami (869). The return period is estimated to be 500 to 1000 years.

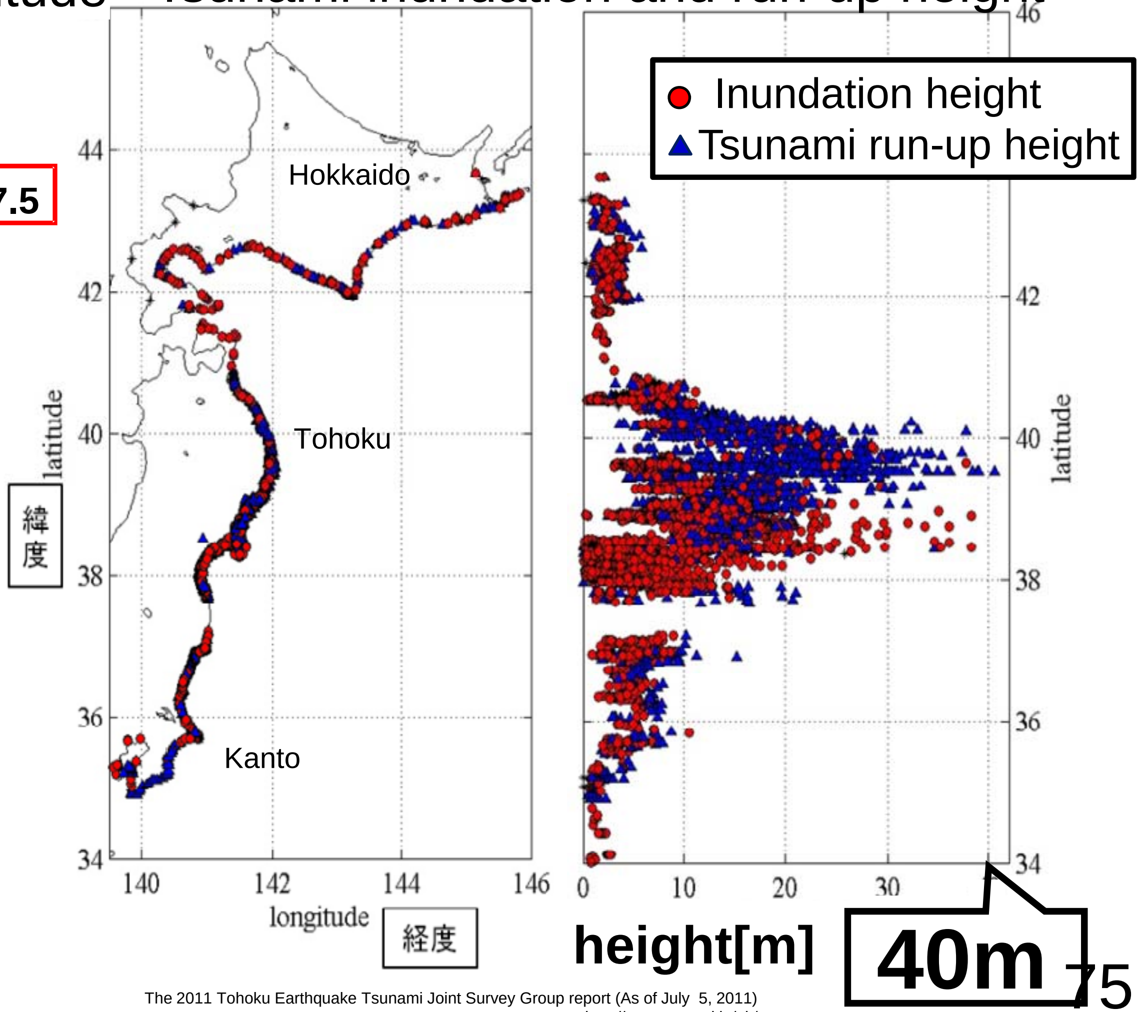
※White Paper on Disaster Management 2011, Cabinet Office, Government of Japan

Epicenter distribution and magnitude



Research Center for Prediction of Earthquakes and Volcanic Eruptions, Tohoku University
http://www.aob.geophys.tohoku.ac.jp/info/topics/20110311_news/index_html

Tsunami inundation and run-up height

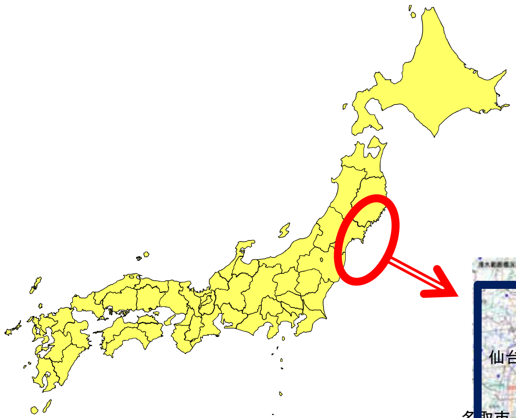


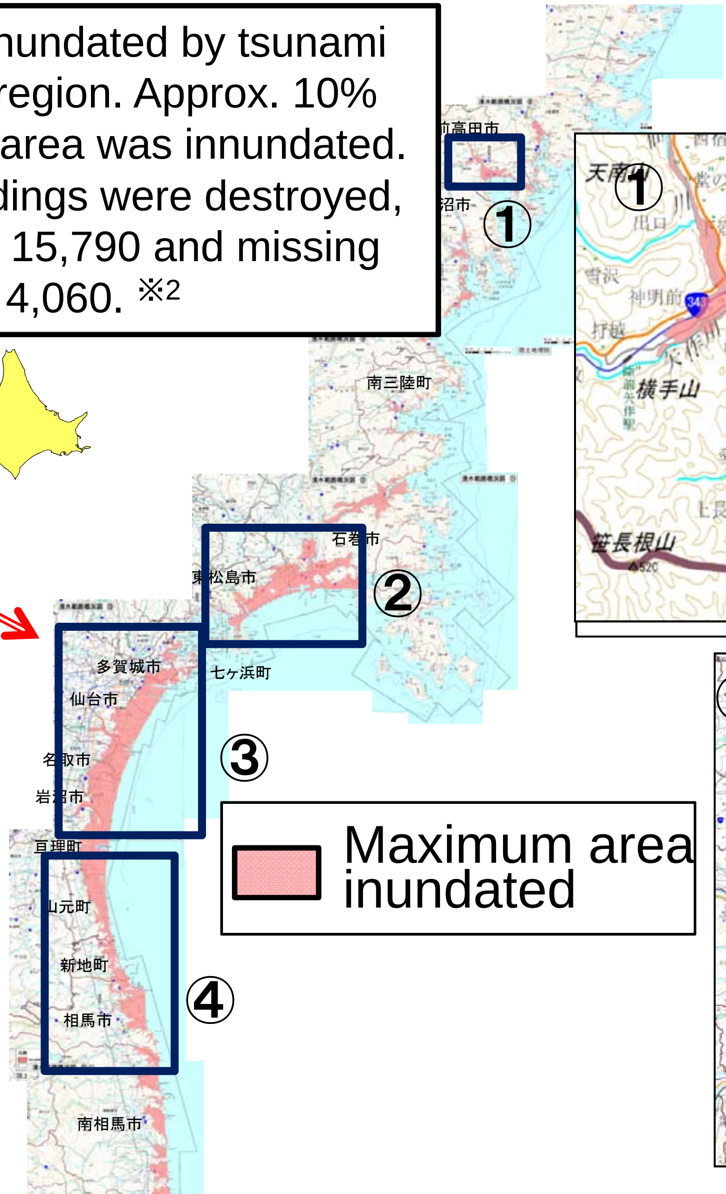
The 2011 Tohoku Earthquake Tsunami Joint Survey Group report (As of July 5, 2011)
http://www.coastal.jp/ttjt/

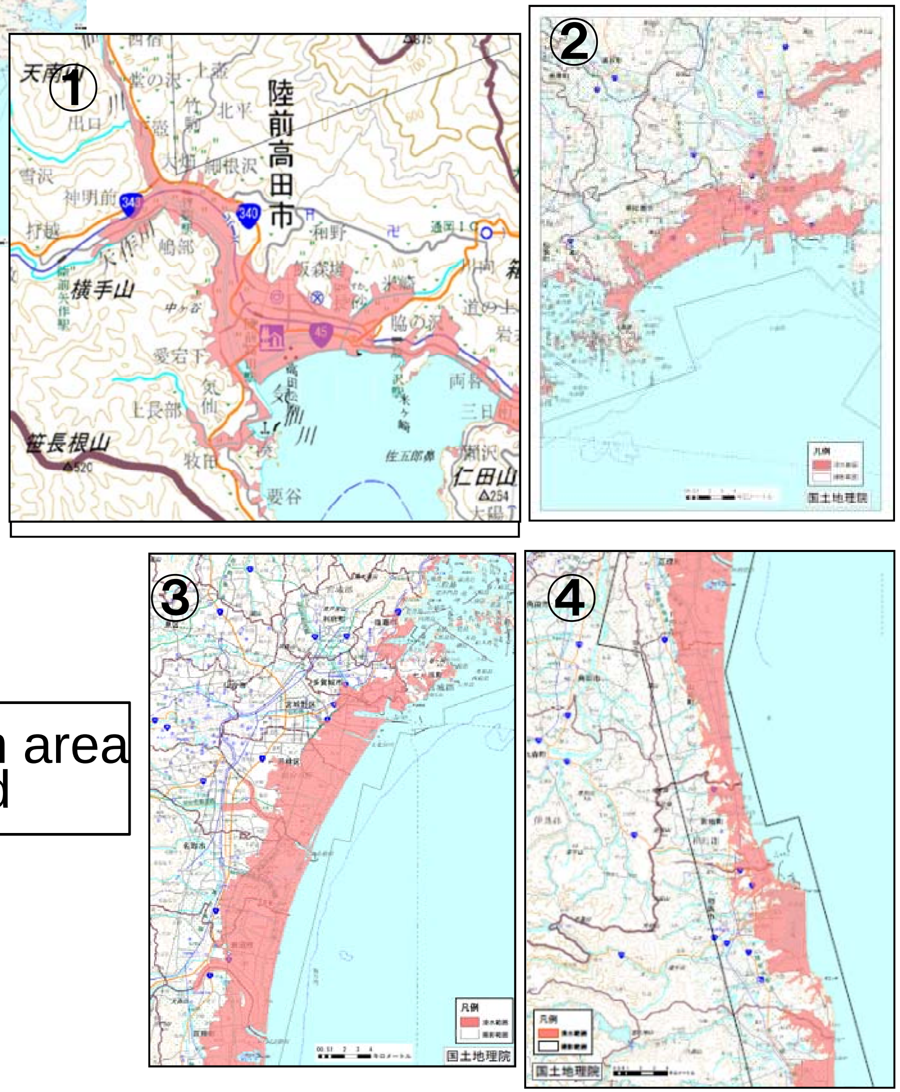
Damages caused by Tsunami (1/2)

○535km² of land was inundated by tsunami in Tohoku and Kanto region. Approx. 10% (119km²※1) of urban area was innundated.

○Approx. 115,000 buildings were destroyed, fatalities were around 15,790 and missing persons were around 4,060. ※2







※1: Aug 4 ,2011 press release by City Bureau
※2: Produced from "Damage Situation and Police Countermeasures associated with 2011 Tohoku district - off the Pacific Ocean Earthquake" by National Police Agency (As of Sept 16, 2011)

Produced from "Inundation Condition Map" by Geospatial Information Authority

Fundamental Strategy for Tsunami Disaster Measures

Reducing human and economic damages by “disaster mitigation” is the fundamental for all levels of tsunami.

Comparatively Frequent Tsunami

- Aim to ensure protection of human lives, assets and national land (coastal line), etc against comparatively frequent tsunami (once every several tens of year to a hundred year and several tens of year) on the basis of constructing coastal protection facilities.
- Conduct technical development and improvement of structures so that they cannot be easily broken even when the tsunami height exceeds the design level.

Largest Scale Tsunami

- Aim to prevent as much human damages as possible against largest scale tsunami by “Integrated Prevention” combining structural and non-structural measures such as land use regulation, building code and emergency/evacuation procedures.

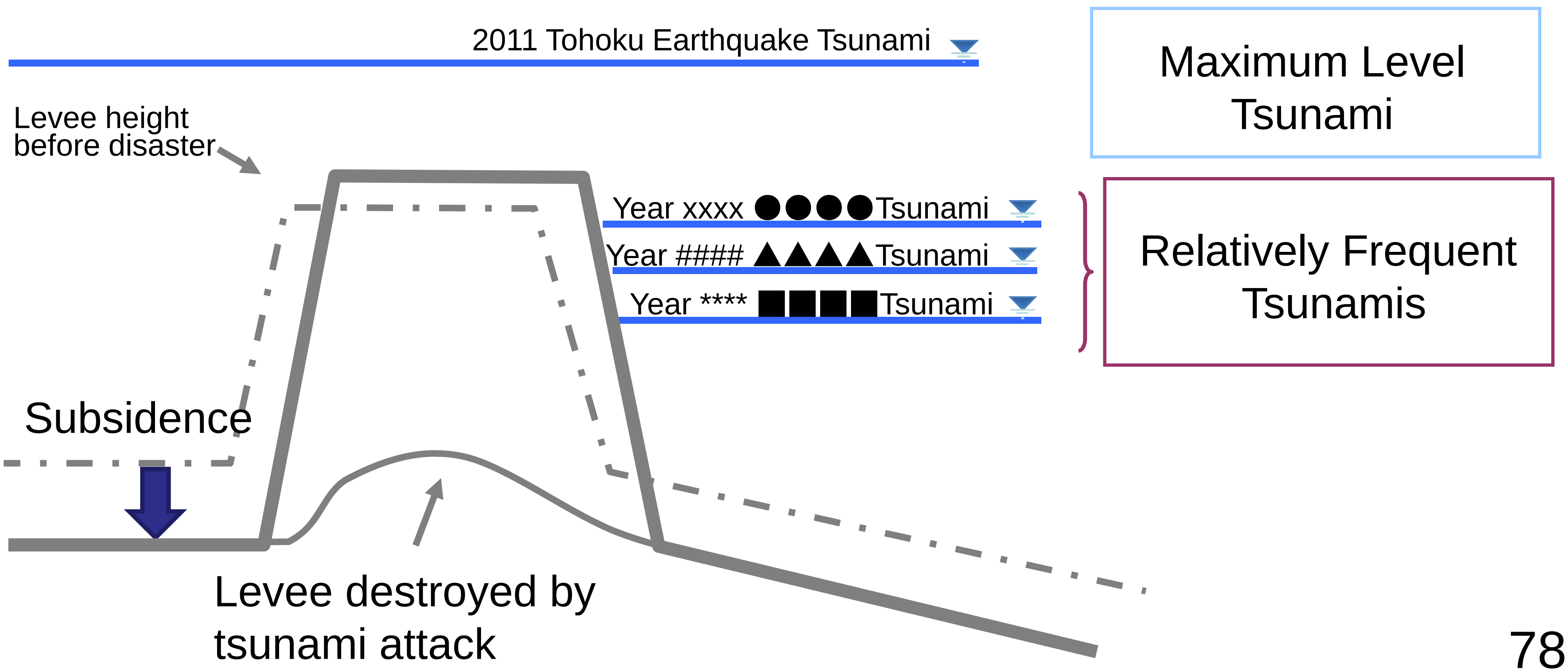
Determining the Height of Coastal Levees (1/2)

Determining Design Tsunami Level, the basis for Coastal Levee Height

For the series of coastlines and ports:

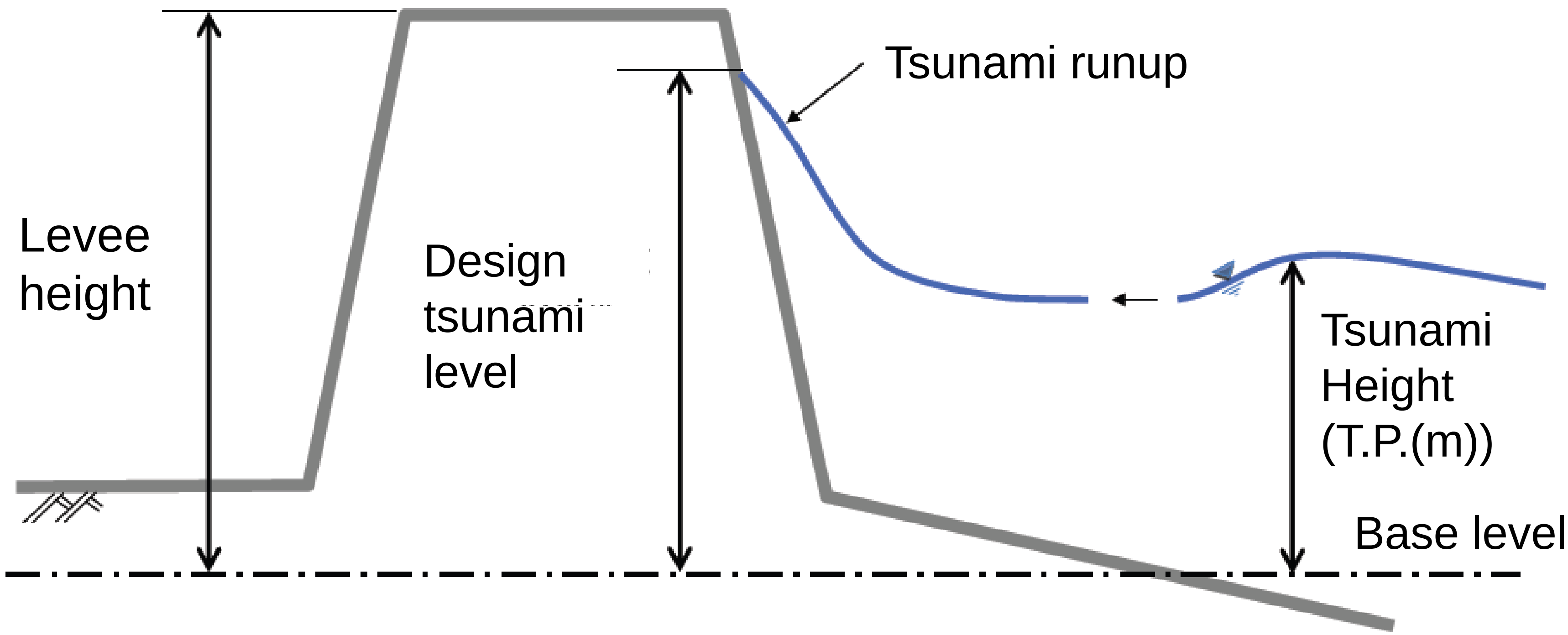
- Historical tsunami trace height records are investigated
- Conduct tsunami simulation for earthquakes with high probability of occurrence

➡ Design tsunami level is set by tsunamis occurring every several tens of years to a hundred and several tens of years



Determining the Height of Coastal Levees (2/2)

○ Levee height is set by considering the environmental aspects, economic efficiency and manageability.



Preparedness for Largest Scale Tsunami (Tsunami-Resistant City)

Outline of the Act for Tsunami-Resilient City

○In order to prevent/reduce tsunami disasters in the future, develop a standard institutional system to be utilized nationally and promote “tsunami resilient city” through “integrated prevention” incorporating structural and non-structural measures.

1. Basic Guidelines to be set by Minister for Land, Infrastructure, Transport and Tourism.
2. Tsunami Inundation Assumption to be set by Governors.
3. Promotion Plan (a plan to comprehensively promote tsunami resilient city) to be prepared by municipalities.
4. Development of tsunami adaptation structures

Prevent expansion of inundation

5. “Tsunami Disaster Security Zones” to be designated by Governors.

Escape from tsunami

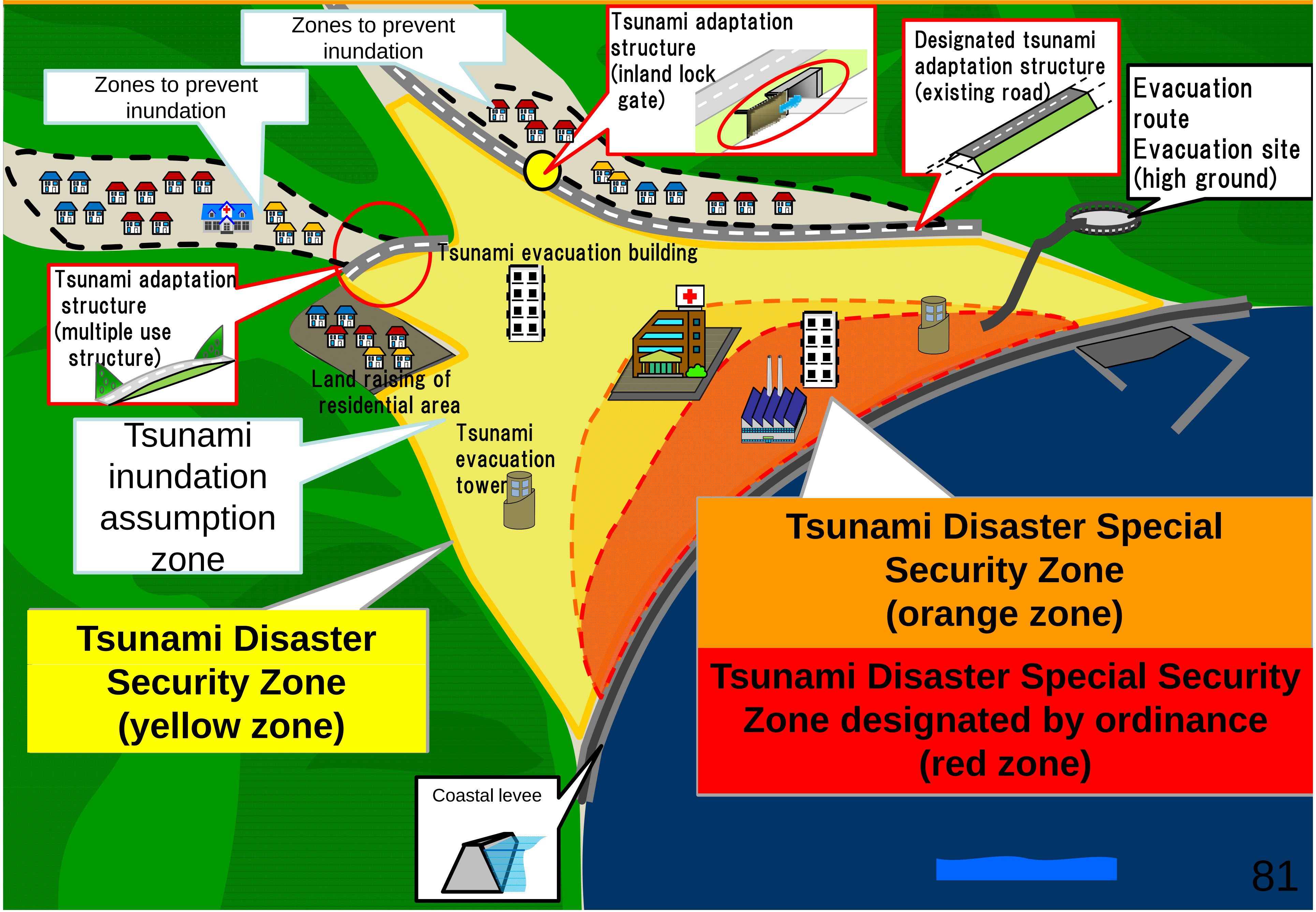
(Yellow zone: development of preparedness and evacuation procedures)

6. “Tsunami Disaster Special Security Zones” to be designated by Governors.

Avoid tsunami

(Orange and Red zone: land use regulation)

Image of Tsunami-Resilient City



Yellow Zone (Tsunami Disaster Security Zone)

Zones where residents or others have possibilities of loosing their lives or being injured by tsunamis.

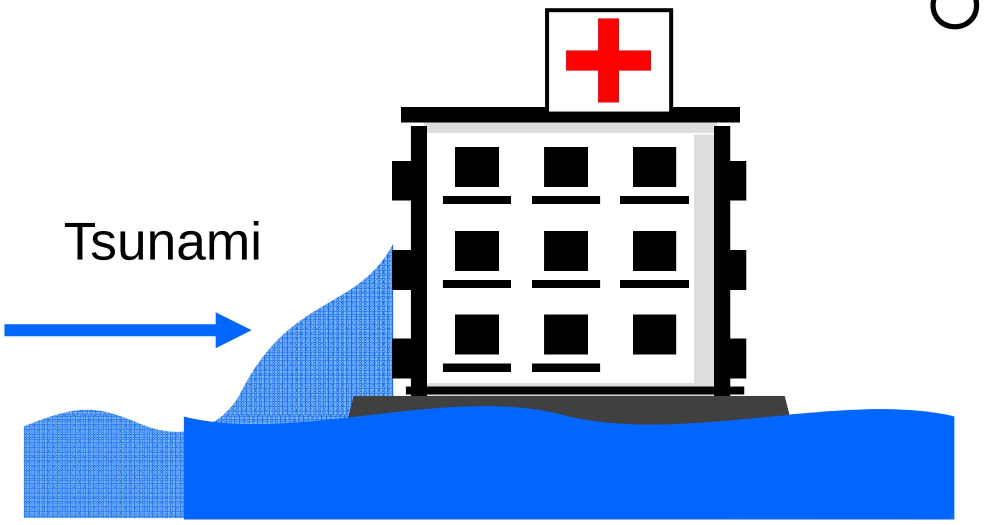
➡ Development of preparedness and evacuation procedures (Escape from tsunami)

- ○ Inclusion of tsunami preparedness/evacuation procedures (evacuation facilities/routes, tsunami evacuation drills, information delivery, etc) in the local disaster management plans for municipalities
- ○ Preparation of tsunami hazard maps by municipalities
- ○ Designation of evacuation facilities and execution of management agreements (succession effective) by municipalities
- ○ Preparation of evacuation plans or implementation of tsunami evacuation drills in underground facilities or facilities used by people who need assistance for evacuation

Orange Zone (Tsunami Disaster Special Security Zone)

Zones included in the Yellow Zone where residents or others have high possibilities of loosing lives or being injured by tsunami.

➡ Land Use Regulations (Avoid Tsunami)



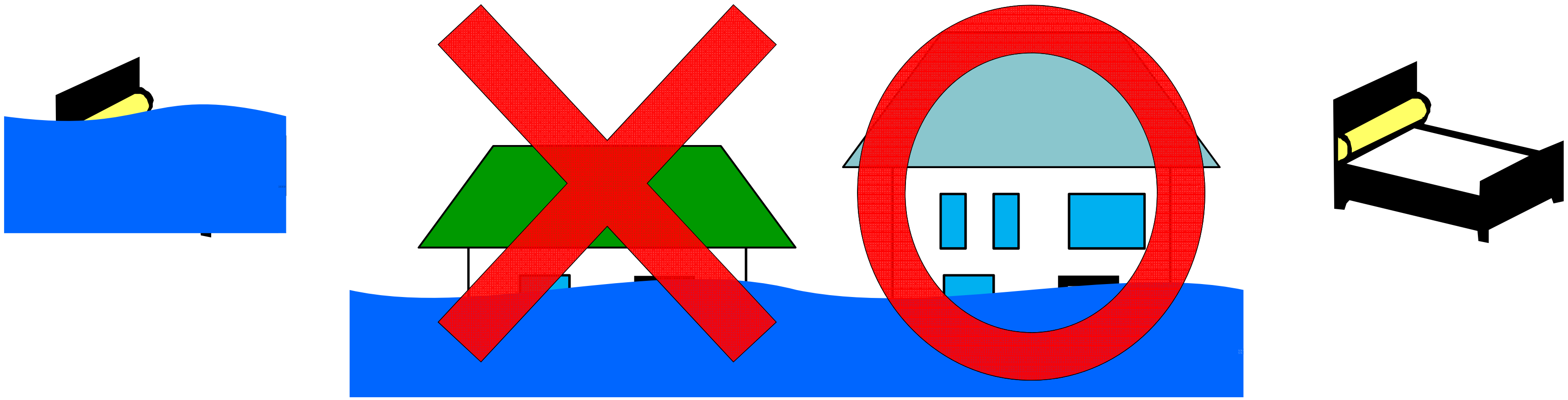
○ Hospitals and social welfare facilities

- Building or embankment structures to be safe against tsunamis
- Floor level of rooms to be above the tsunami water level

Red Zone (Tsunami Disaster Special Security Zone designated by ordinance)

Zones included in the Orange Zone where persons can not evacuate smoothly or promptly when tsunami occurs.

➡ Land Use Regulations (Avoid Tsunami)



○ Residential houses

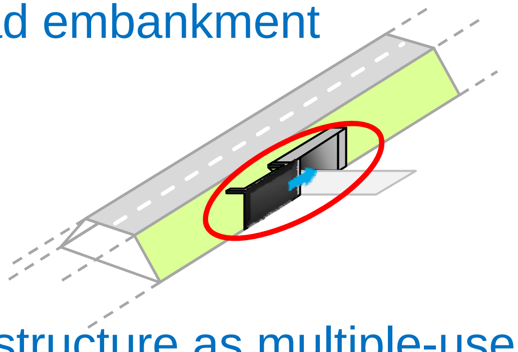
- Building or embankment structures to be safe against tsunamis
- Floor level of rooms or rooftop where persons can evacuate to be above the tsunami water level

Development of Tsunami Adaptation Structures
(Prevent inundation expansion)

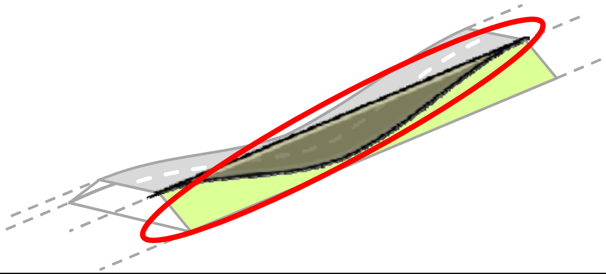
○ Tsunami Adaptation Structures
Such structures as embankment structures, inland lock gates, protective walls or breast-walls built and managed by governors or mayors based on the tsunami inundation assumptions in order to prevent or mitigate human damages caused by tsunami disaster.

Schematics of Tsunami Adaptation Structure

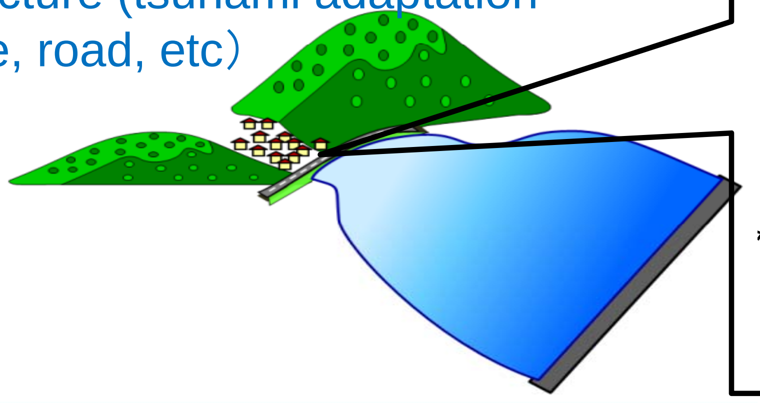
○ Installation of inland lock gate to existing road embankment

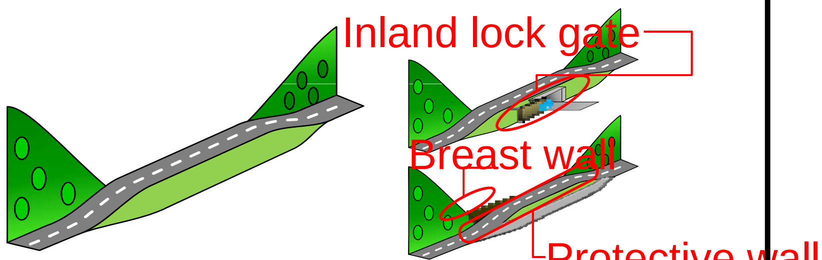


○ Installation of breast-wall to existing road embankment



○ Embankment structure as multiple-use infrastructure (tsunami adaptation structure, road, etc)

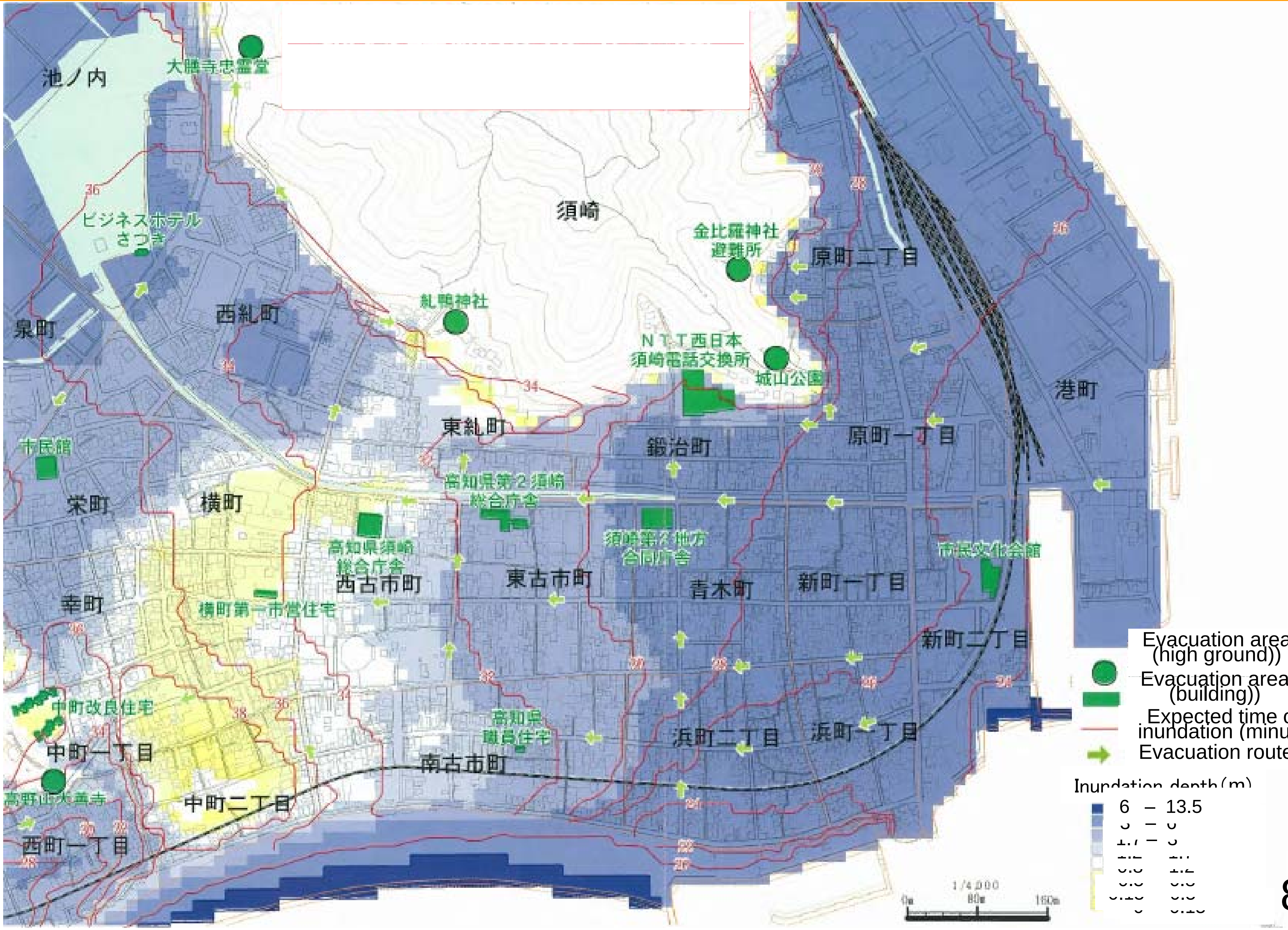




* Build barriers by embankment

* Install lock gate or protective walls as necessary

Making and publishing Hazard Map



Designating Tsunami Evacuation Building

Constructing Evacuation Route

Conducting Evacuation Drill