

# Flood damage mitigation efforts in Japan

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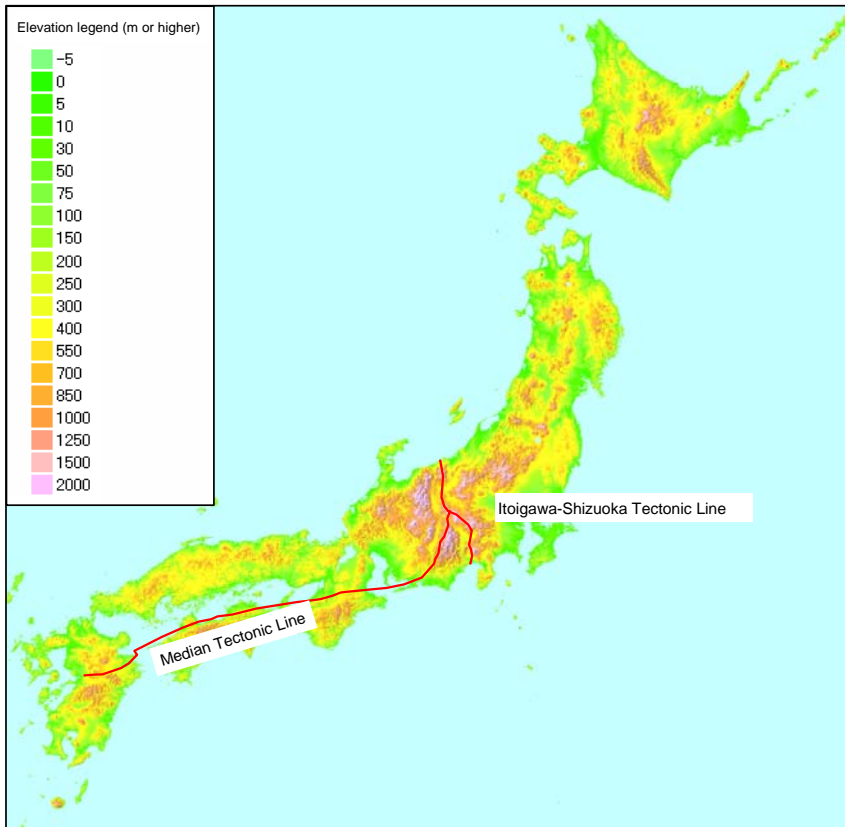
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**Ministry of Land, Infrastructure,  
Transport and Tourism (MLIT)**



**Ministry of Land, Infrastructure, Transport and Tourism**

# Natural conditions of Japan



Topography	<b>Long and slim</b> archipelago about 2,000 km long in the north-south direction
Four main islands	<b>The four main islands separated</b> by straits, and many smaller islands
Backbone mountain ranges	<b>Mountain ranges running longitudinally</b> at the center of Japan roughly divides the country into two halves.
Tectonic lines	<b>The Median Tectonic Line and the Itoigawa-Shizuoka Tectonic Line</b> run north to south across the Honshu island.
Plains	<b>Small plains</b> along the coastlines (about 14% of the total land area)
Soft ground	Most of the large cities in Japan are <b>located on weak ground</b> .
Earthquake	<b>About 10% of all earthquakes in the world</b> occur in or around Japan.
Heavy rain	<b>Rainy weather</b> (mean annual precipitation: 1,714 mm, which is about two times as much as that in the European countries); steep rivers
Snow	<b>About 60% of the country is located in snowy cold regions</b> (annual cumulative snowfall: more than 4 m in many cities).

Snowy region: The average of maximum snow depths in February is 50 cm or more.  
 Cold region: The average of mean temperatures in January is 0°C or lower.

# **1 . Basic system of measures for flood damage mitigation in Japan**

## **2 . Preparedness for major floods**

- Past major floods and state-level efforts**
- Role of the Ministry of Land, Infrastructure, Transport and Tourism**

## Disaster prevention

- River improvement
- Dam construction
- Provision of river information system
- Improvement of forecasting and warning systems
- Maintenance of rivers
- Construction of disaster prevention stations, etc.

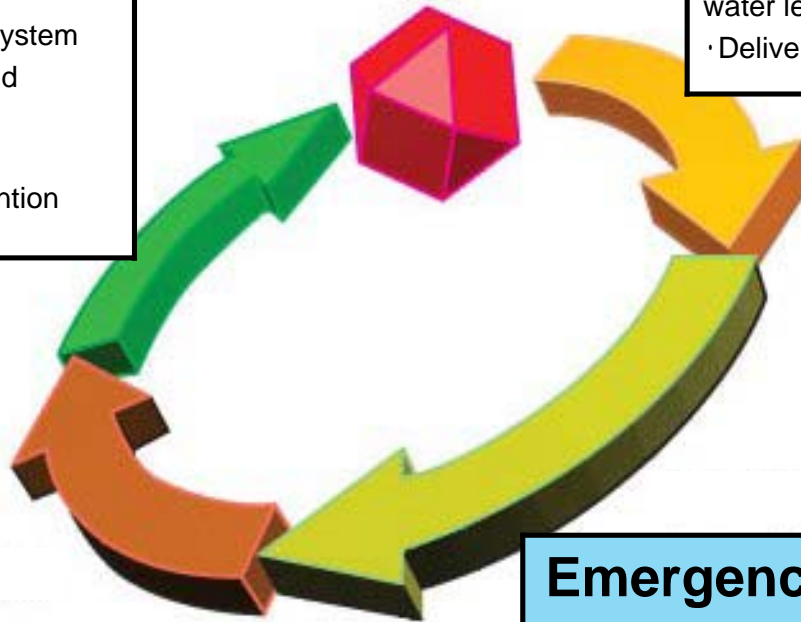
## Occurrence of flood

## Crisis response

- Patrolling rivers
- Reporting damage status
- Observing and predicting precipitation and water level
- Delivering flood warnings, etc.

## Emergency measures and restoration/recovery

- Implementing emergency restoration measures
- Implementing post-disaster recovery measures
- Restoration/recovery of affected areas



## Disaster Measures Basic Act

Establishes systems necessary for disaster prevention.

Clarifies where the responsibility for disaster prevention lies.

Stipulates basic requirements for disaster prevention planning and necessary basic disaster prevention measures such as emergency measures.

Aims to make comprehensive management of rivers so as to prevent river-related disasters such as floods and storm surges.

Aims to prepare people for floods and storm surges, protect people from them and mitigate damage due to floods and storm surges.

## River Act

## Flood Protection Act

This law aims to protect life, health and property of the people of Japan and thereby contribute to the maintenance of public order and the achievement of public welfare.

## 1. Definition of disasters

**Natural disaster:** disaster caused by anomalous natural phenomenon such as an earthquake or heavy rain

**Accident disaster:** disaster caused by a major accident such as a large-scale fire or explosion, a large-scale spill of a radioactive substance or a ship wreck involving many people

## 2. Clarification of where the responsibility for disaster prevention lies

Responsibilities of the state, prefectural and municipal governments and designated public organizations: Formulation and implementation of and cooperation concerning plans related to disaster prevention, etc.

Responsibilities of the public: Preparedness for disasters, participation in voluntary disaster prevention activities, etc.

## 3. Organization related to disaster prevention: Establishment and implementation of comprehensive disaster prevention administration

State level: Central Disaster Prevention Council, headquarters for emergency disaster control

Prefectural and municipal levels: local disaster prevention councils, disaster response headquarters

## 4. Disaster prevention planning: Establishment and implementation of systematic disaster prevention administration

Central Disaster Prevention Council: Basic disaster prevention plan

Designated administrative organizations and designated public organizations: operation plans for disaster prevention

Prefectural and municipal levels: regional plans for disaster prevention

## 5. Implementation of disaster prevention measures

The role and authority of each entity at the stages of disaster prevention, emergency response and post-disaster recovery are stipulated.



Mayors are authorized to give evacuation directions, designate warning areas, order emergency expropriation, etc. (Municipal governments are primarily responsible for disaster prevention measures.)

## 6. Fiscal and monetary measures

Principle: "Implementers Pay" principle

Exceptions: Special financial assistance from the state government to local governments in the event of an extreme disaster, etc. Act Concerning Special Financial Assistance Etc. in Case of Severe Disaster

## 7. Disaster emergencies

Declaration of a disaster emergency    *Establishment of emergency response headquarters*

Emergency measures (restriction on distribution of daily necessities, grace for payment, the adoption of emergency government ordinances regarding the acceptance of assistance from other countries)

## Purpose

- The purpose of this law is to manage rivers **in a comprehensive manner** in order to prevent disasters resulting from floods, storm surges, etc.

## River administrators

- **Class A rivers:** Minister of Land, Infrastructure, Transport and Tourism  
\* The management of designated river sections is relegated from the Minister of Land, Infrastructure, Transport and Tourism to prefectural governors.
- **Class B rivers:** Prefectural governors

**River administrators manage rivers in a comprehensive manner.**

## Major disaster response measures

- **Emergency measures in the event of flood**
  - The river administrator may use or expropriate necessary land, earth materials, bamboos, wood or other materials and use vehicles or other transportation equipment or devices, or dispose of structures or other obstacles or have people who live near or are present at the flood hazard site perform the flood protection activities.

## Role of the state government in times of emergency

### ● Directions of the Minister of Land, Infrastructure, Transport and Tourism

- In the event that a disaster has occurred or is likely to occur because of a flood, storm surge, etc. and it is deemed necessary in order to prevent or mitigate such disaster, the Minister of Land, Infrastructure, Transport and Tourism may direct the prefectural governor who performs part of the management of a Class A river in a designated section or the management of a Class B river to take necessary measures.

## Purpose

- The purpose of this law is to watch for and guard against water-related disasters caused by floods or storm surges and mitigate damage in order to maintain public safety.

## Flood protection manager

- The head of the municipal government or flood defence association that is a flood protection management organization

## Major damage mitigation measures

- Patrol of rivers, etc.
- Mobilization of flood-fighting and fire-fighting organizations
- Ordering residents, etc., to move out
- Reporting and publishing water levels
- Reporting levee breaches

## Role of the state government

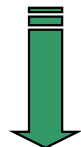
### ● Flood forecasting

#### Director-General of Japan Meteorological Agency (JMA)



- In the event of the imminence of a flood or storm surge, the Director-General of JMA informs the Minister of Land, Infrastructure, Transport and Tourism and the prefectural governors concerned of the present state.

#### Minister of Land, Infrastructure, Transport and Tourism



- Informs, jointly with the Director-General of JMA, for a class A river (excluding designated sections), the prefectural governors concerned of
  - water level or discharge if the possibility of flooding is deemed high or
  - water level or discharge, or the flood hazard area and the flood water depth if flooding has already occurred.

#### Prefectural governors

- Communicates the information received as described above to the flood protection managers and stage gauge managers.

### ● Issuing flood watch advisories

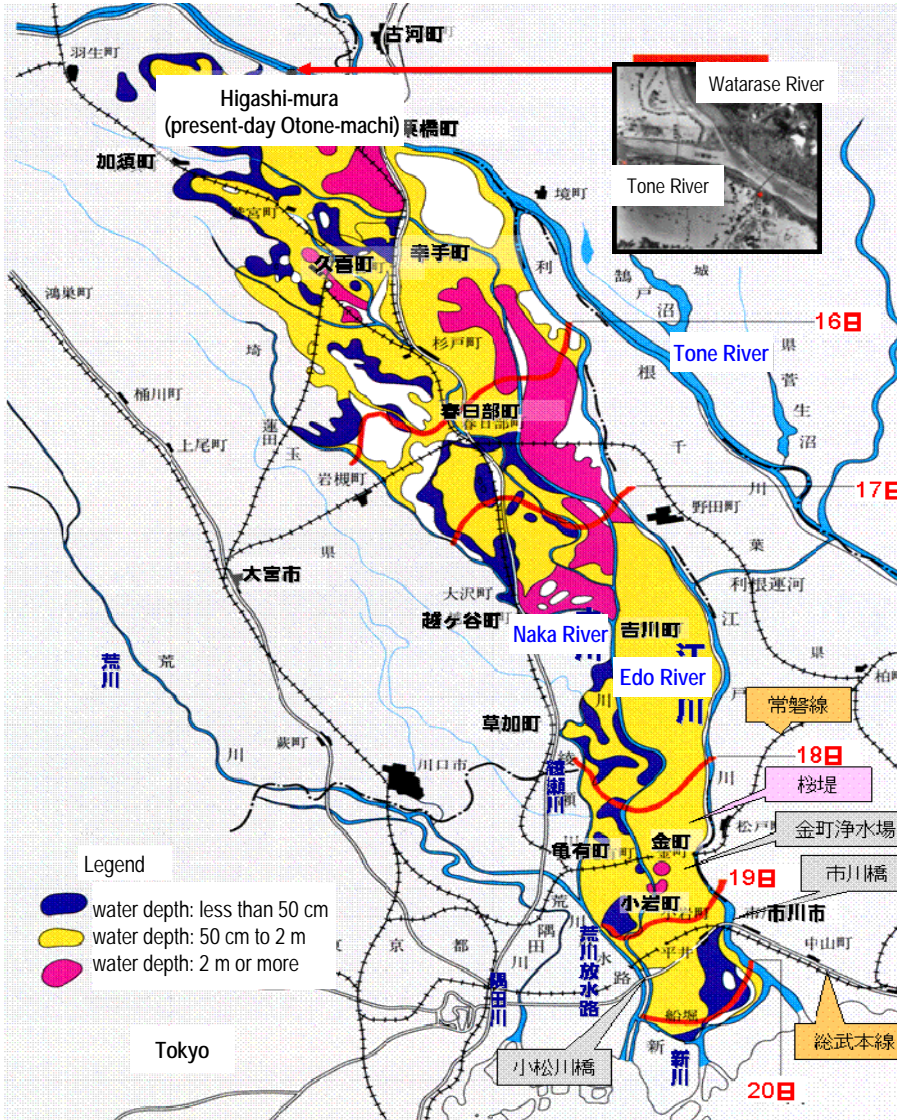


# 1. Japan's basic flood protection system

## 2. Preparedness for major floods

- Past major floods and state-level efforts
- Role of MLIT

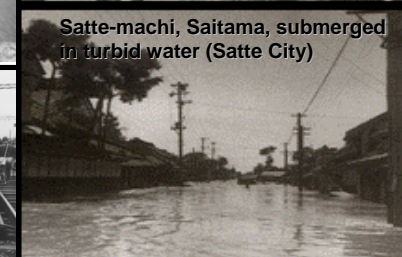
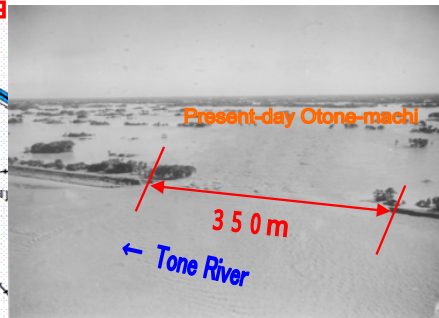
# Flood caused by Typhoon Kathleen (1947)



Inundation due to a breach in the right-bank levee of the Tone River in the Shinkawadori area in Azuma-mura (present-day Otone-machi), Saitama Prefecture

	Tokyo	Chiba	Saitama	Gunma	Ibaraki	Tochigi	Total
Dead (persons)	8	4	86	592	58	352	1,100
Injured (persons)	138		1,394	315	23	550	2,420

Number of completely or partially destroyed houses: 31,381  
House inundation: 303,160 houses  
Farmland inundation: 176,789 ha





# Storm surge caused by Ise Bay Typhoon (1959)



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Flood damage in Aichi and Mie prefectures caused by Ise Bay Typhoon

	National total	Aichi and Mie	
Number of people killed or missing	5,012	4,533	91%
Number of injured people	69,538	63,670	92%
Number of affected people	1,887,723	1,110,057	59%
Number of totally or partially destroyed houses	177,574	125,591	71%
Number of houses washed away	16,580	15,386	93%
Number of flooded houses	359,178	196,256	55%
Farmland washed away or buried	14,662hectare	6,325ha	43%
Farmland submerged	295,264hectare	89,503ha	32%
Estimated amount of damage	¥47,857,470,000	¥13,189,080,000	30%
Number of boats/ships washed away or sunk	2,481	2,069	83%

Searching a stranded house

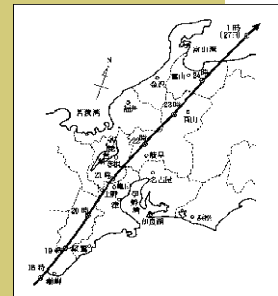
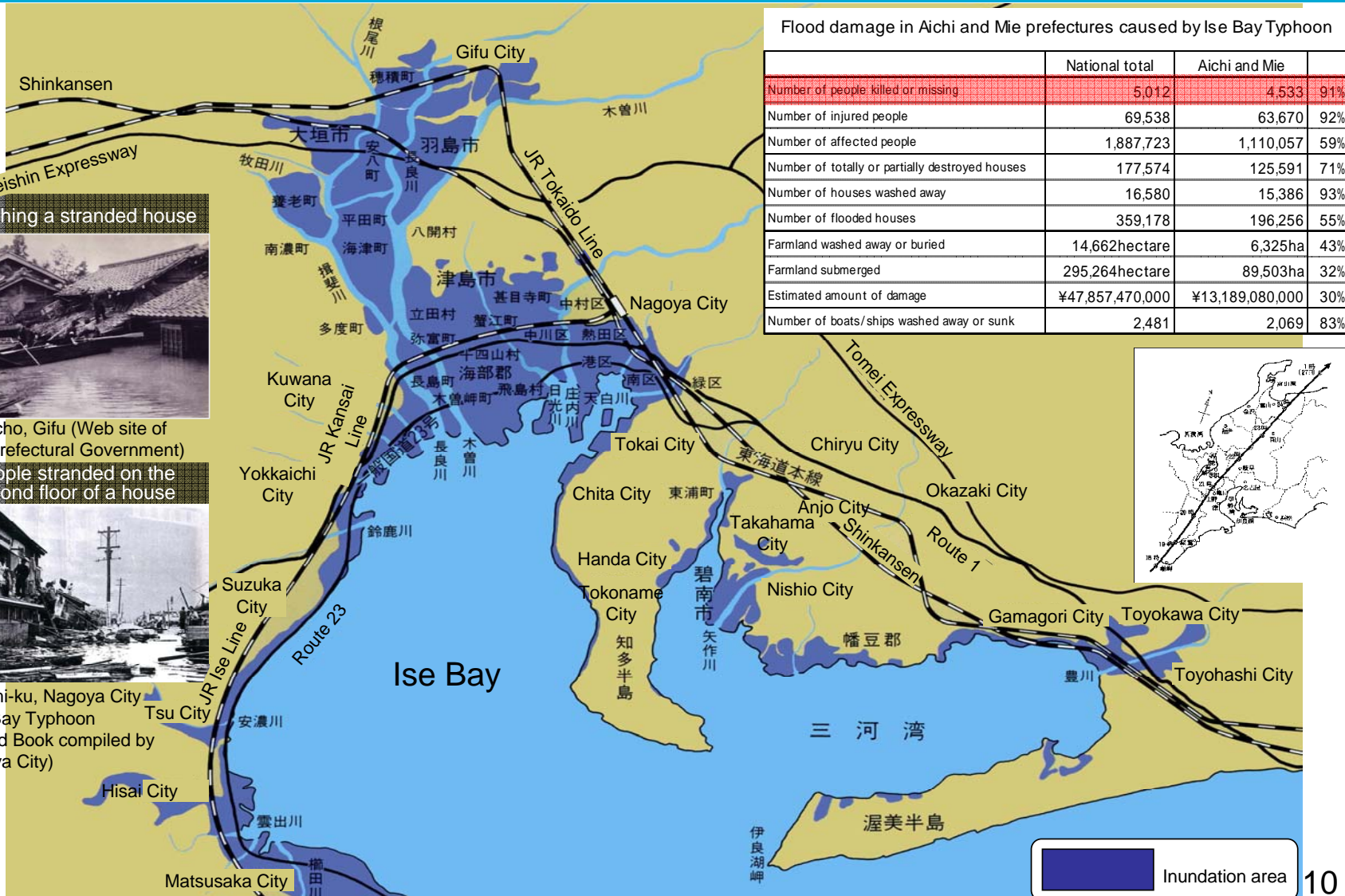


Yoro-cho, Gifu (Web site of  
Gifu Prefectural Government)

People stranded on the  
second floor of a house



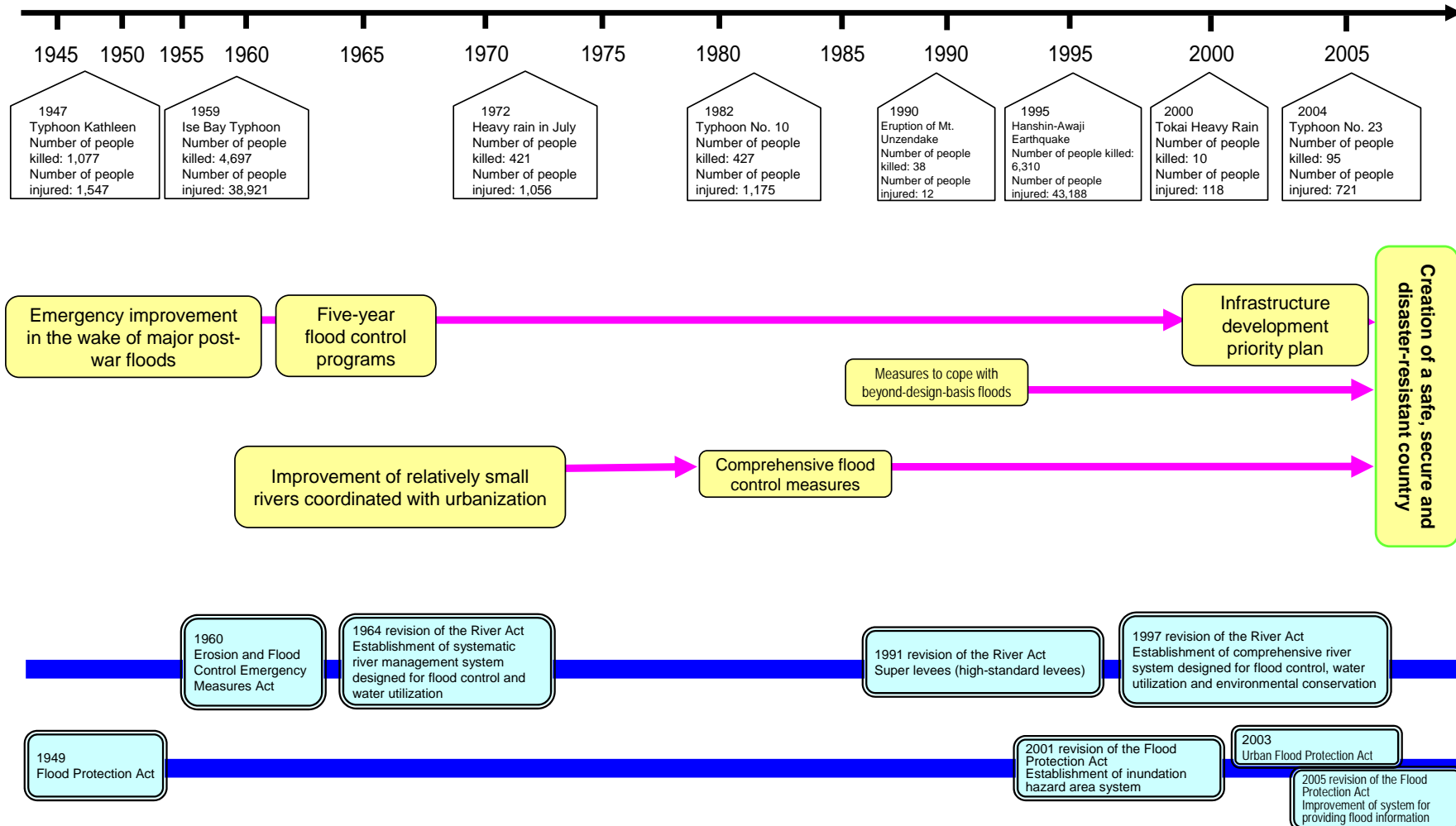
Minami-ku, Nagoya City  
(Ise Bay Typhoon  
Record Book compiled by  
Nagoya City)



# History of river improvement



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# Characteristics of flood damage in recent years

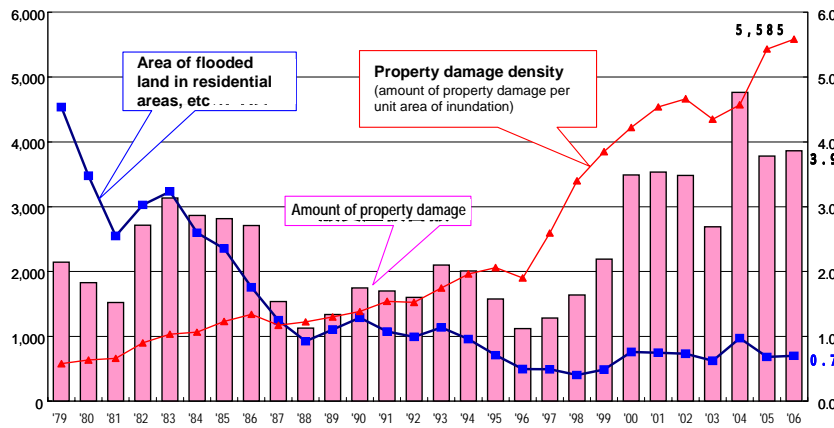
The area of inundation has decreased, but the amount of flood damage shows an increasing trend.

The amount of flood damage is on the increase.

Although the area of inundation has been on the decrease because of flood control measures, it has been showing a slightly increasing trend in recent years. Mainly because of the urbanization of flood-prone areas and the increase in flood-vulnerable property, the amount of damage has been showing a tendency to increase.

Flood damage density (10,000 yen/ha)  
Amount of property damage per ha of inundation area (2000 prices)

Property damage (100 billion yen)  
Flooded land area (10,000 ha)



- Notes:
1. Averages in the last five years
  2. The amount of property damage and flood damage density include business interruption loss.
  3. Source: 2006 Flood Statistics combined by River Bureau, Ministry of Land, Infrastructure, Transport and Tourism
  4. 2000 prices



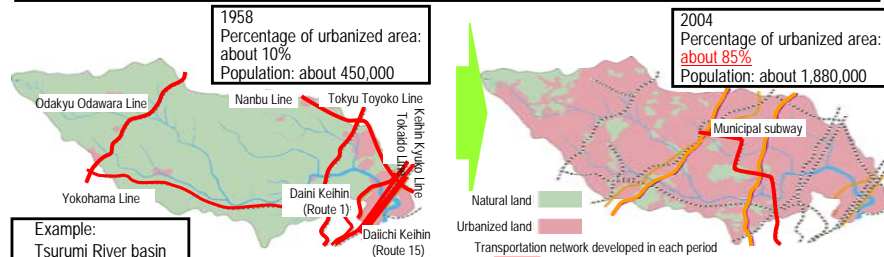
If submerged in water, even if only once, electronic appliances are rendered useless.



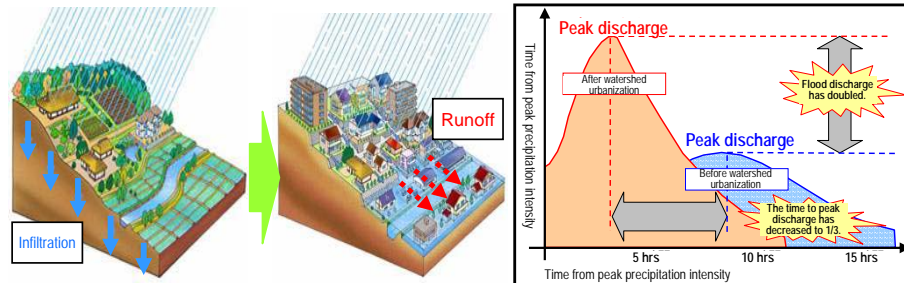
Having absorbed water, insulation materials have become useless.

Watershed urbanization causes flood risk to increase.

As a result of railway and arterial road network construction, which began around 1960, watersheds today are crisscrossed with railways and roads. The resultant urbanization has caused the water retention and detention functions of the watersheds to decline.



As runoff increases, the time to peak runoff decreases.



Increasingly intensive land use (e.g., subways, underground streets) has given rise to new types of inundation damage such as flooding of underground spaces.



Tokyo Metro's Azabu Juban Station (October, 2004)



Fukuoka municipal subway (July, 2003)



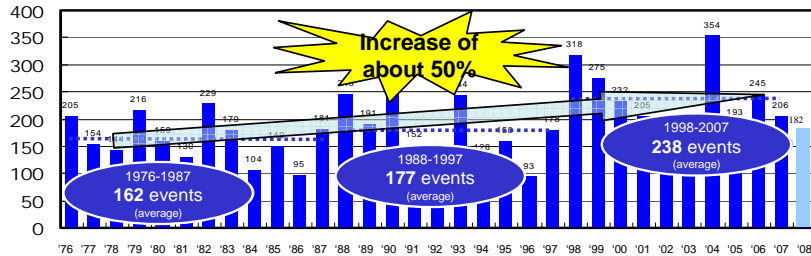
# Increasing frequency of heavy rains: The trend is expected to continue.



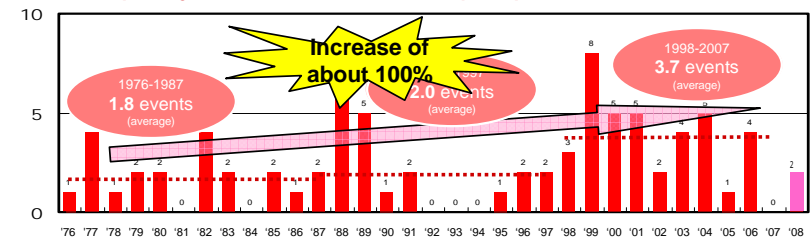
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Both hourly rainfall and daily rainfall tend to increase.

Annual frequency of 50 mm/hour or more precipitation events (per 1,000 locations)

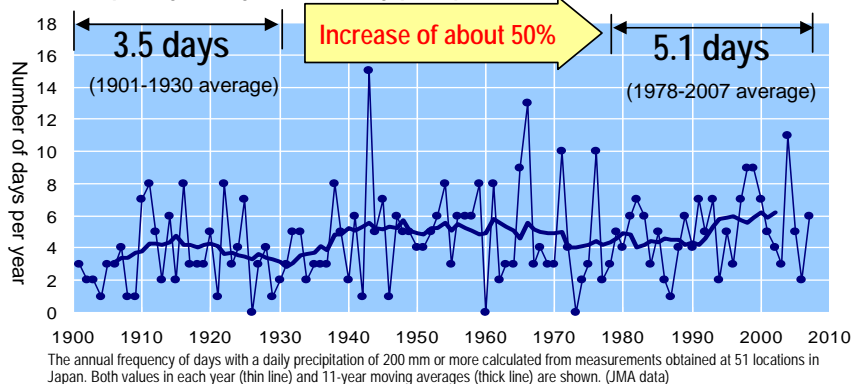


Annual frequency of 100 mm/hour or more precipitation events (per 1,000 locations)



\*The annual frequency of precipitation events with different hourly precipitations was calculated from AMeDAS data obtained from about 1,300 locations in Japan.  
\*The 2008 data are data obtained on or before September 2, 2008.

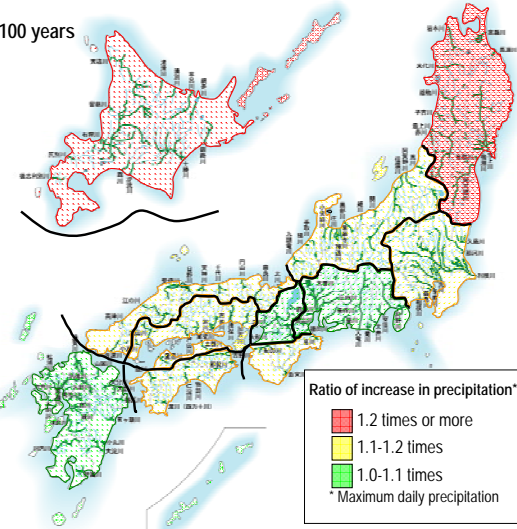
Annual frequency of days with a daily precipitation of 200 mm or more



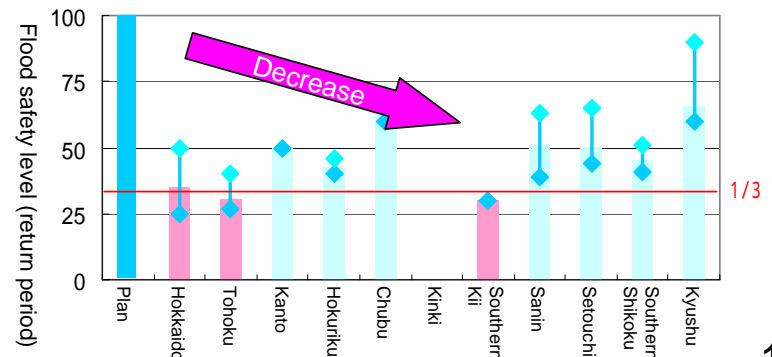
In future, **precipitation is likely to increase throughout the country.**

Projections of increase in daily precipitation in 100 years

Hokkaido	1.24
Tohoku	1.22
Kanto	1.11
Hokuriku	1.14
Chubu	1.06
Kinki	1.07
Southern Kii	1.13
Sanin	1.11
Setouchi	1.10
Southern Shikoku	1.11
Kyushu	1.07



The level of flood safety will decline because of a future increase in precipitation. For example, in some regions such as **Hokkaido and Tohoku**, the target level of flood safety of 1/100 will decrease to about 1/30 so that **the flood safety level will decrease to about 1/3 of the target level.**

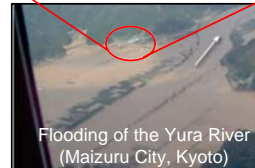
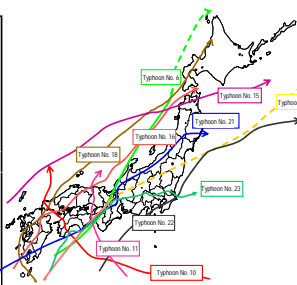
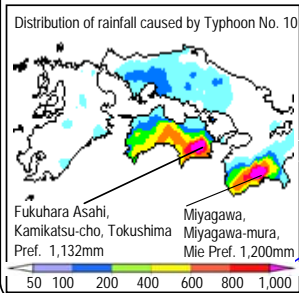


# Consecutive occurrence of major flood and mass-movement disasters

Heavy rainfall events with a total rainfall exceeding 1,000 mm have occurred almost every year mainly in Kyushu,  
causing flood and mass-movement disasters.

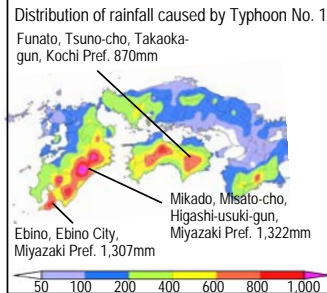
2004

- A record number (10) of typhoons made landfall in Japan (three or more times as many typhoons as in the average year). During Typhoon No. 10 (July to August), hourly rainfalls of more than 100 mm were observed in the Shikoku region. In Tokushima Prefecture, a total rainfall of more than 1,000 mm was recorded.
- The Fukui Heavy Rain (July) caused a levee breach along the Asuwa River. Typhoon No. 23 (October) caused levee breaches and overtopping along the Yura and Maruyama rivers, inflicting tremendous damage in Kyoto, Hyogo and other parts of the Kinki region.
- Fukui Heavy Rain: 4 people killed, 4,052 houses flooded above floor level, 9,674 houses flooded below floor level, etc.
- Typhoon No. 23: 43 people killed, 13,041 houses flooded above floor level



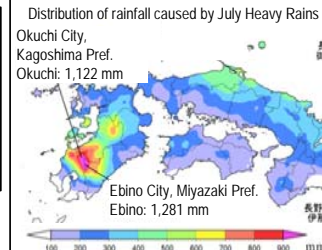
2005

- Typhoon No. 14 (Sept. 4 to 6) caused heavy rains with a total rainfall of 1,000 mm or more in southern Kyushu.
- A number of rivers including the Oyodo and Gokase rivers flooded, causing serious damage in the Kyushu region.
- In the Chugoku region, the bankful stage was exceeded in the Ota and other rivers.
- Typhoon No. 14: Kyushu region: 19 people killed, 3 people missing, 3,960 houses flooded above floor level, 5,085 houses flooded below floor level
- Chugoku region: 4 people killed, 1,678 houses flooded above floor level, 2,969 houses flooded below floor level



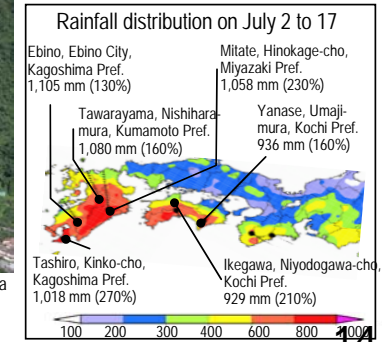
2006

- In parts of the Kyushu region, total rainfalls in seven days from July 18 to July 24 of more than 1,200 mm were recorded. The Sendai and Komenotsu rivers flooded, causing serious damage in southern Kyushu.
- A strong bai-u front in July remained stationary over a large area including the Kyushu and Hokuriku regions, and the heavy rains induced by this front caused floods in many areas.
- July Heavy Rains: 5 people killed, 899 houses flooded above floor level, 2,674 houses flooded below floor level



2007

- Typhoon No. 4 (July 2 to 17) caused a total rainfall of more than 1,000 mm in the Kyushu region. Rainfalls more than two times as much as the monthly average were recorded in many areas.
- The Midori and other rivers flooded to cause tremendous inundation damage in many areas.
- Typhoon No. 4: 3 people killed, 169 houses flooded above floor level, 1,152 houses flooded below floor level



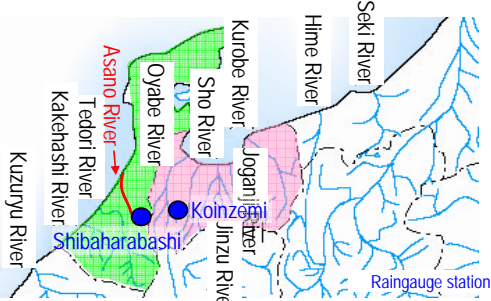
# Damage caused by localized heavy rains

## Flood damage in 2008

The heavy rains on July 28, 2008, and at the end of August brought about localized heavy rains with an hourly rainfall of more than 100 mm and caused inundation damage in many parts of the country.

### Damage caused by the flooding of the Asano River in July, 2008, in Ishikawa Prefecture and Nanto City in Toyama Prefecture

Hourly rainfalls of **132 mm** and **114 mm** were recorded at the Koinzemi raingauge station (Nanto City) and the Shibaharabashi raingauge station (Kanazawa City), respectively.



\* Koinzemi raingauge station (MLIT)

\* Shibaharabashi raingauge station (Ishikawa Pref.)



Driftwood accumulated at the Asanogawa Bridge (Kanazawa City)

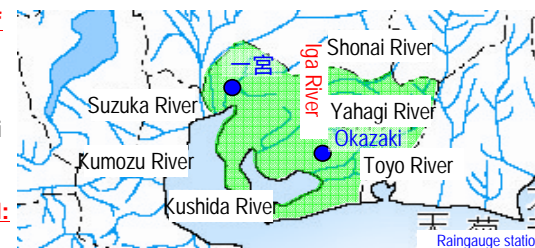


Two houses partially destroyed by a landslide (Nanto City)

In Kanazawa City, the flooding of the Asano River left 507 houses flooded above floor level and 1,476 houses flooded below floor level. A total of 55 landslides occurred in Ishikawa and Toyama prefectures, causing damage to 20 houses.

### Flood damage in Okazaki City, Aichi Prefecture, caused by the heavy rains at the end of August, 2008

A record **hourly rainfall of 146.5 mm (previous record: 55 mm)** was observed at the Okazaki raingauge station (Okazaki City, Aichi Pref.), and another record **rainfall of 120 mm (previous record: 76 mm)** was observed at the Ichinomiya raingauge station (Ichinomiya City, Aichi Pref.).



Inundation in Iga-cho, Okazaki City

In Okazaki City, 620 houses were flooded above floor level, and 705 houses were flooded below floor level.



# 1. Japan's basic flood protection system

## 2. Preparedness for major floods

- Past major floods and state-level efforts
- Role of MLIT

## Emergency status

- In the case where an organization such as a regional development bureau has moved to the emergency status and serious damage has occurred or may occur
- In the case where extensive windstorm or flood damage is almost certain to occur and in any of the following cases:
  - (a) The likelihood of occurrence of a levee breach in a particular river section is high or such a breach has already occurred and the occurrence of extensive damage is thought likely.
  - (b) Extensive damage due to a storm surge is almost certain to occur, judging from the magnitude, intensity, course and speed of a typhoon and tide level and other information.
  - (c) Extensive damage due to mass movement, etc., has occurred and the occurrence of further damage due to mass movement, etc., is thought likely.
  - (d) Serious human suffering or property damage other than those mentioned above has occurred or may occur.

## Alert status

- An organization such as a regional development bureau has moved to the alert status.
- Transportation facilities that could affect many passengers have been damaged because of the approach, landfall or other behavior of a typhoon.

## Watch status

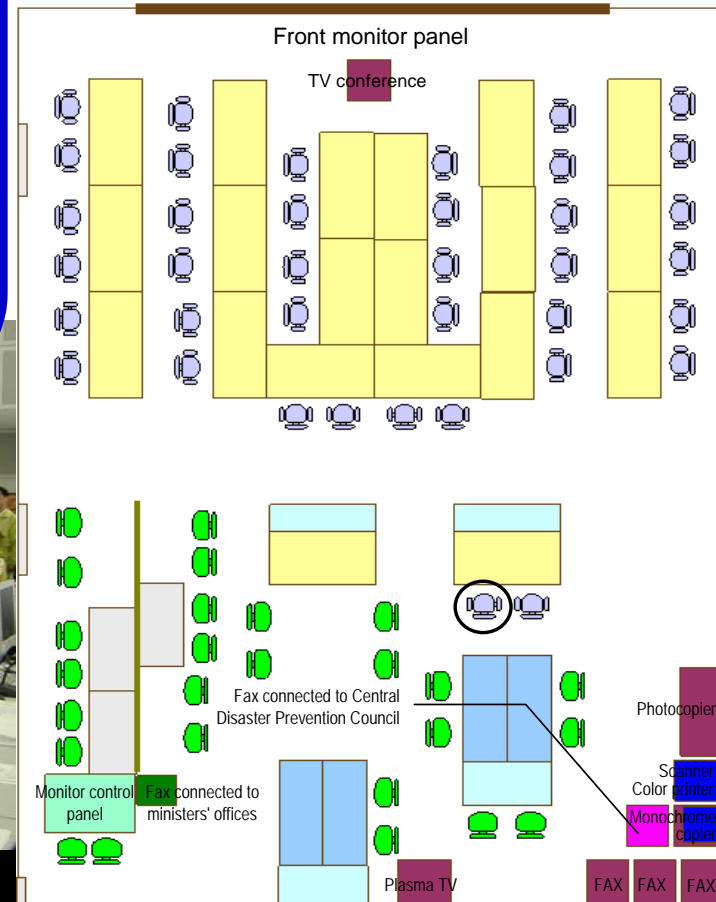
- An organization such as a regional development bureau has moved to the watch status.
- Transportation systems in two or more prefectures have been rendered inoperable because of the approach, landfall or other behavior of a typhoon.

- Mobilizing leaders, staff members and related department members
- Observing and distributing meteorological information, site images, etc.
- Collecting and sharing information (integrating damage information)
- Exchanging information with ministers' offices, other ministries and agencies, local departments, etc.
- Providing information to the public
- Regional assistance, assistance to local governments



MLIT's disaster prevention center

## 14th floor, Building No. 2



# MLIT's response to a major emergency (state level response to the 2004 flood (Typhoon No. 23))



Ministry of Land, Infrastructure,  
Transport and Tourism

On October 20, 2004, Typhoon No. 23 caused serious damage in Hyogo Prefecture and the northern part of Kyoto Prefecture. River levees were breached at several locations. For the MLIT-managed Maruyama River, where flood damage was particularly severe, temporary restoration works were carried out with the assistance of nearby regional development bureaus in order to guard against future flooding. Temporary restoration works at two sites were completed in five days.

## Levee breaches along the Maruyama River (2 locations)



**Torii Bridge**  
Levee damage  
Levee breach site: around 5.4 km point on the left bank of the Izushi River



Experts were dispatched to Toyooka City, etc. (steep slope sites)



Site visit by MLIT Minister  
Kazuo Kitagawa



**Tachino Bridge**  
Levee damage  
Levee breach site: around 13.2 km point on the right bank of the Maruyama River



Inundation in the city of Toyooka



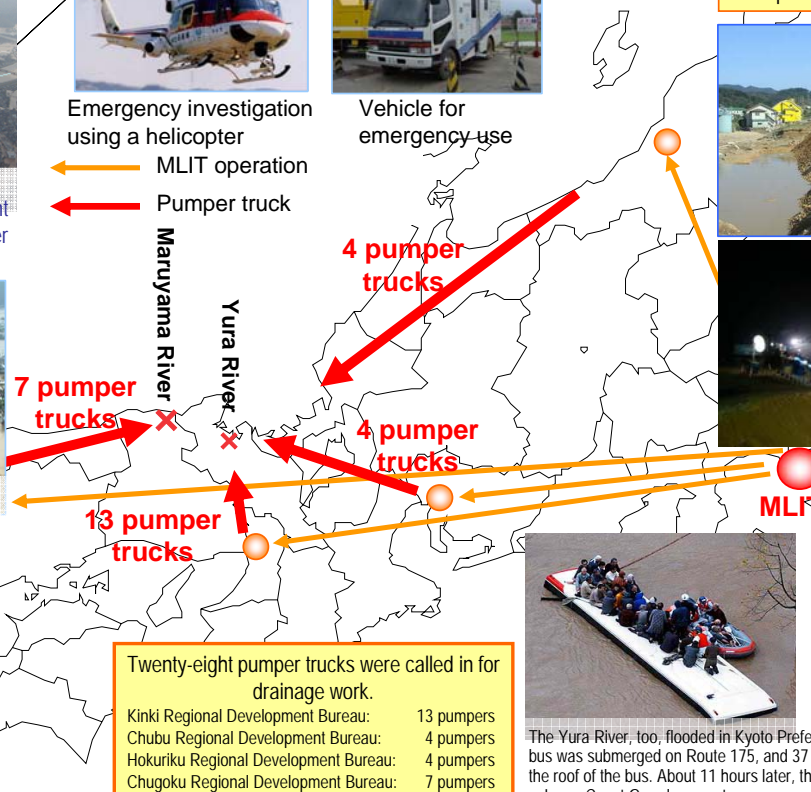
Twenty-eight pumper trucks were called in from around the country



Emergency investigation using a helicopter



Vehicle for emergency use



Around-the-clock work for temporary restoration of levees



The Yura River, too, flooded in Kyoto Prefecture. In Maizuru City, a tour bus was submerged on Route 175, and 37 passengers were stranded on the roof of the bus. About 11 hours later, the passengers were rescued by a Japan Coast Guard rescue team.

Temporary restoration of the MLIT-managed river sections (two levee breach sites) were completed in five days with the assistance of nearby regional development bureaus. The levee breaches in the sections managed by Hyogo Prefecture (four sites) were smaller than the breach sites in the MLIT-managed sections, but the temporary restoration of the four breached sections took 17 days.



To cope with the flooding of the Kariyata and Ikarashi rivers managed by Niigata Prefecture, pumper trucks and mobile lighting systems were dispatched not only from within the region covered by the Hokuriku Regional Development Bureau but also from the Tohoku, Kanto and Chubu regional development bureaus.

## Dispatched emergency equipment

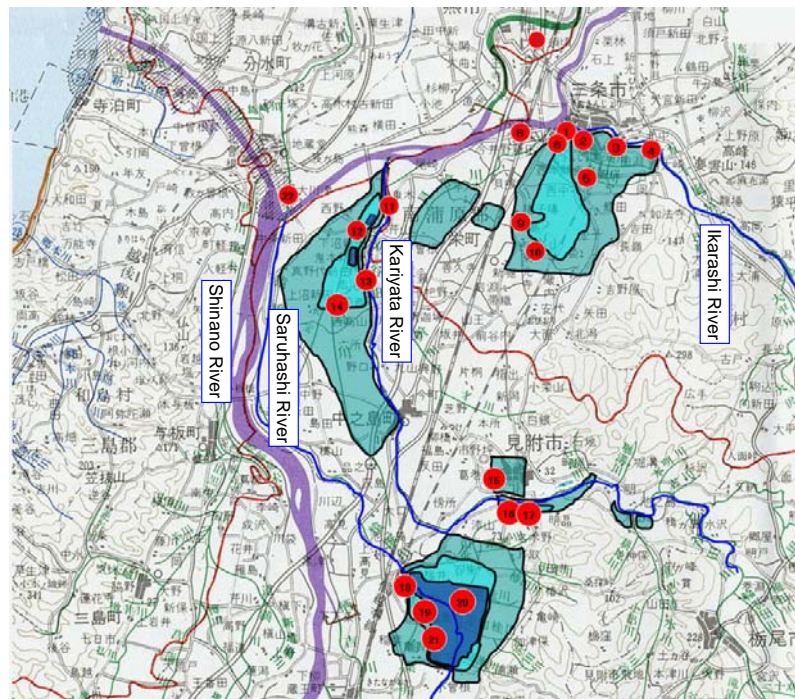
Pumper truck	36 units
Breakdown	
Hokuriku Regional Development Bureau	20 units
Tohoku Regional Development Bureau	5 units
Kanto Regional Development Bureau	8 units
Chubu Regional Development Bureau	3 units
Mobile lighting system	17 units
Breakdown	
Hokuriku Regional Development Bureau	11 units
Tohoku Regional Development Bureau	3 units
Kanto Regional Development Bureau	3 units
Satellite communications vehicle	1 unit
Mobile command vehicle	2 units
Standby support vehicle	3 units
Ku-SAT	4 units
Portable helicopter TV receiver station	1 unit
Truck-mounted drain cleaning machine	1 unit
Truck-mounted roadside gutter cleaning machine	1 unit



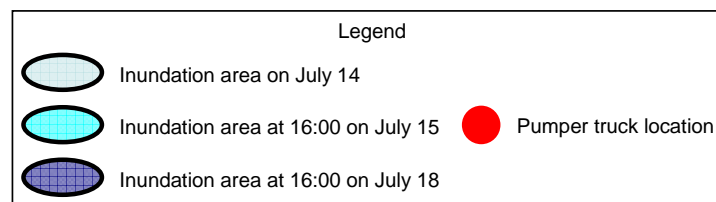
Pumper truck in action



Nighttime work using a mobile lighting system



Inundation areas and pumper truck locations



## Inundation damage mitigation by use of pumper trucks

### 12 municipalities in Niigata Prefecture

(Sanjo City, Mitsuke City, Nagaoka City, Nakanoshima-machi, Sakae-machi, Niigata City, Gosen City, Tsubame City, Mishima-machi, Bunsui-machi, Tagami-machi, Koide-machi)

### 3 municipalities in Fukushima Prefecture

(Kitakata City, Aizubange-machi, Shiokawa-machi)

# MLIT's assistance to local governments in case of emergency

## Assistance process flow

Prevention of further spread of damage in the affected area and early restoration and recovery



Timely and effective support and assistance to local governments, etc.



Dissemination of information on options for support and assistance to local governments, etc., in the affected area

## Assistance options

Providing images, maps, information, etc. (e.g., providing images of the affected area)	Shelters, relief goods, etc. (e.g., providing shelters, using "Michi no Eki" (stopovers along national roads))
Risk evaluation, etc. (e.g., inspection of mass movement risk sites)	Housing (e.g., assistance for the construction of temporary housing)
Damage survey (e.g., assistance for damage surveys, disaster prevention expert assistance for surveys)	Post-disaster restoration (e.g., technical assistance for post-disaster restoration)
Support (e.g., lending emergency vehicles, dispatching experts)	Recovery (e.g., assistance for recovery planning, assistance for tourism campaigns)

Adopted by MLIT's disaster prevention council on June 27, 2005

## Currently available emergency resources

### Mobile command vehicle



### Emergency helicopter



### Portable image transmission system: Ku-sat




### Satellite communications vehicle



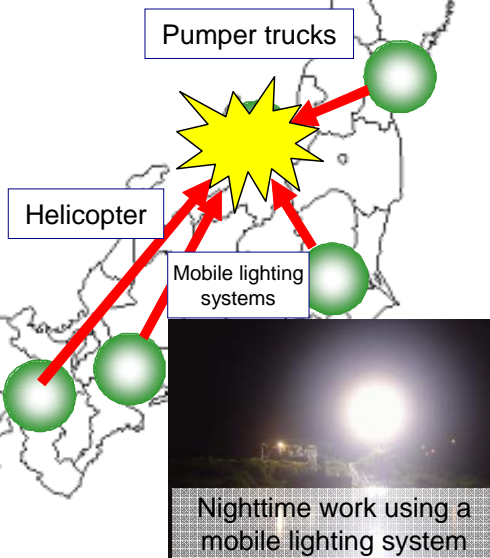
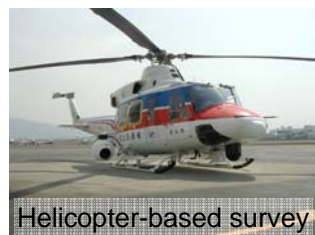
### Mobile lighting system



## Support system for Niigata-Fukushima Heavy Rains in 2004

 Occurrence of a major flood

 Regional development bureau



## Purpose

- Prompt collection of information on the state of damage in a major natural disaster and early restoration of the affected area
- Smooth and timely provision of technical assistance to local governments, etc.

## Activities

- Prompt collection of information on the state of damage
- Early restoration of infrastructure
- Faster initiation of response activities
- Intensive response by a team of experts
- Improvement and strengthening of technical guidance concerning restoration measures
- Prevention of secondary damage
- Sophisticated technical guidance related to damage sites
- Emergency measures (planning and implementation)
- Risk level prediction (judgment on evacuation)
- Other emergency response measures
- Coordination of emergency transportation

## TEC-FORCE member appointment status

- Personnel of MLIT, regional development bureaus, district transport bureaus, National Institute for Land and Infrastructure Management, etc.

Total: 2,563 members (as of October 1, 2008)

**Necessity of regional support system**



# Activities of TEC-FORCE

The TEC-FORCE was dispatched after the Iwate-Miyagi Nairiku **Earthquake (from June 14, i.e., the day of the earthquake, to July 22)** and the Iwate-ken Engan Hokubu **Earthquake (from July 24, i.e., the day of the earthquake, to July 29)** to investigate the affected areas, provide guidance on restoration methods, take secondary damage prevention measures.

## Activity results

Iwate-Miyagi Nairiku Earthquake:	<b>515 vehicle-days, 1,499 person-days</b>
Iwate-ken Engan Hokubu Earthquake:	<b>4 vehicle-days, 381 person-days</b>



Advance team (helicopter-based survey)



Telecommunications team



MLIT

Blocked river channel

Specialized technical guidance team (river channel blocking)



## Clarification of goal: Working toward "zero victims"

Complete protection from increasingly severe floods, etc., is difficult to achieve.

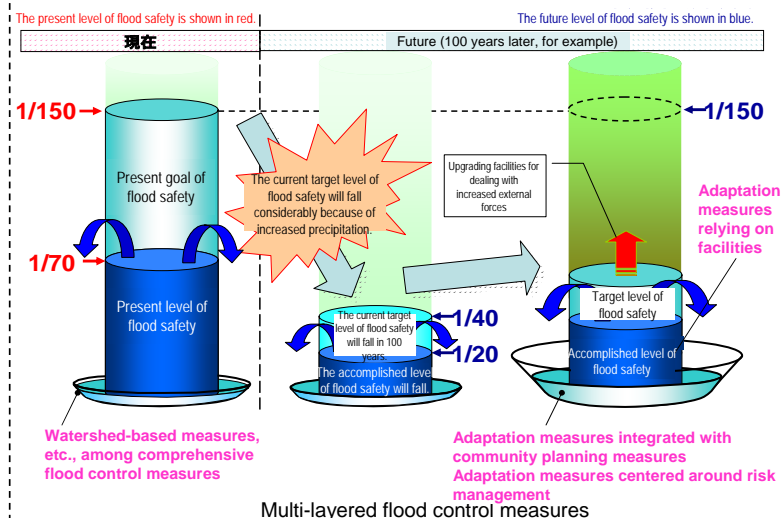
- Studies are conducted on ways to achieve **"zero victims."**
- In the areas where key state functions are concentrated, priority measures such as **measures to prevent complete impairment of the state functions** are taken.



## Measures to cope with growing external forces

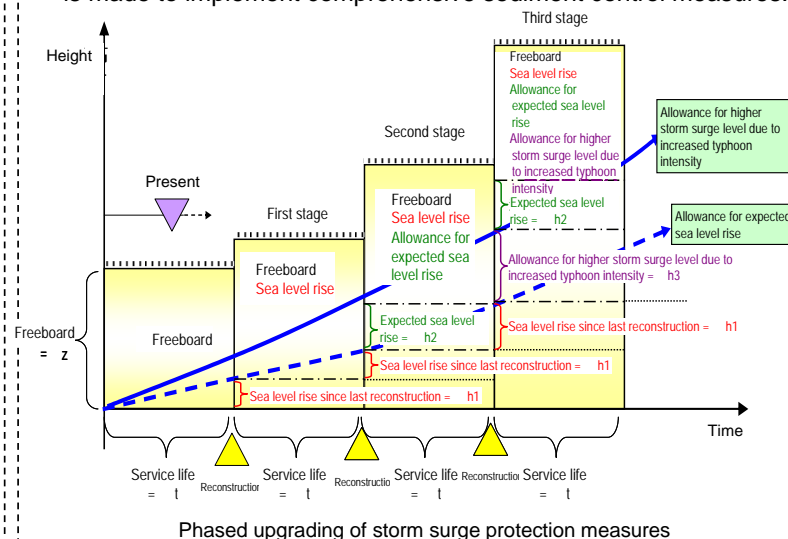
### (Multi-layered flood control measures)

- In addition to the flood control measures designed to ensure safety from the design-basis discharge, watershed-based measures are also taken to ensure safety from growing external forces.



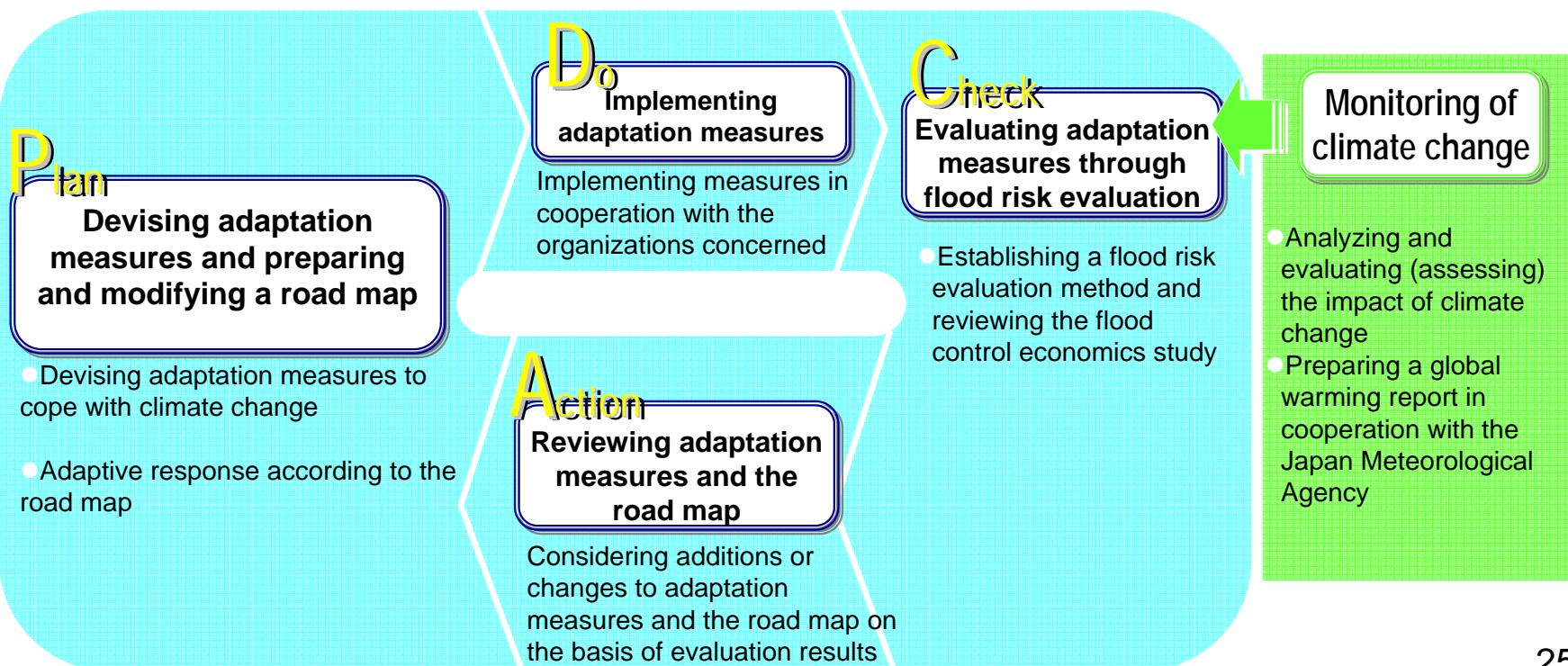
### (Phased safety measures against storm surges and upgraded measures against ongoing coastal erosion)

- In order to ensure safety from storm surges, coastal structures are raised when, for example, they are reconstructed to guard against growing external forces.
- From the viewpoint of protection from ongoing coastal erosion, effort is made to implement comprehensive sediment control measures.



- A road map indicating the procedures for adaptation measures is prepared, taking the impact of climate change into consideration.
- The potential disaster risk of the watershed under consideration is evaluated by monitoring the present state of climate change and predicting the future state.
- The evaluated disaster risk is shared in the watershed to consider adaptation measures to be taken and reflect the findings on the road map.
- Adaptation measures to be taken are prioritized according to the degree of necessity, and effort is made to achieve mainstreaming of climate change adaptation.

## River improvement plan adapted to cope with climate change



# Example of flood risk analysis

## Concepts of flood risk analysis associated with different phenomena

River flooding due to typhoon-induced heavy rains or torrential downpours and inundation due to localized heavy rains are different phenomena that require different zoning approaches for flood risk analysis.

### Analysis

Tasks performed in inundation-prone area mapping and hazard mapping

#### Typhoon-induced heavy rain, torrential downpour

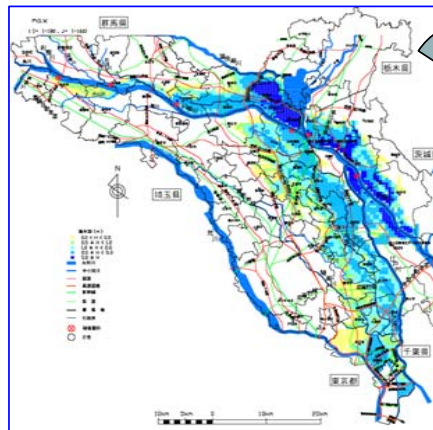
- Review of past floods
- Runoff analysis and inundation analysis
- Zoning into inundation blocks

(tasks that are usually not performed for inundation-prone area mapping)

#### Torrential downpour, localized heavy rain

- Review of inundation damage records
- Inundation simulation
- Zoning into drainage areas and flooding areas

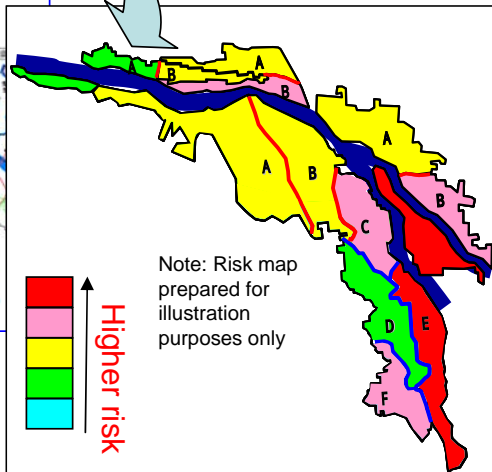
(tasks that are usually not performed for inundation-prone area mapping)



#### Runoff analysis and inundation analysis

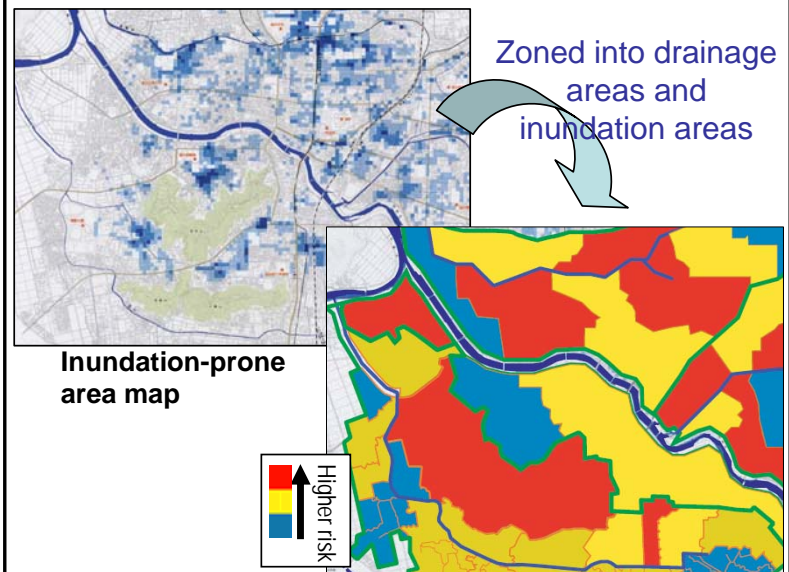
Source: Data prepared for the fifth session of the Special Board of Inquiry on Measures against Major Floods

#### Classification of inundation patterns



Note: Risk map prepared for illustration purposes only

Risk map (prepared for illustration purposes only)



#### Zoned into drainage areas and inundation areas

#### Inundation-prone area map

Risk map (prepared for illustration purposes only)

# Example of flood risk analysis

## Road mapping by use of flood risk evaluation



Ministry of Land, Infrastructure,  
Transport and Tourism

A road map indicating the adaptation measures to be taken and procedures to be followed for different types of inundation and different blocks is prepared and shared within the watershed.

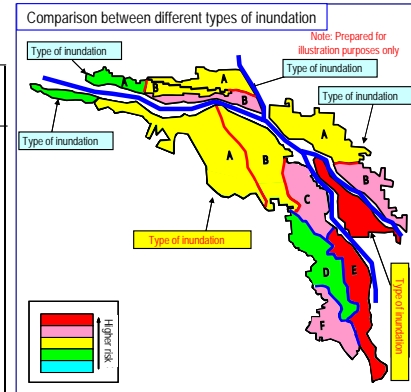
Road map (typical example)

	Type of inundation	Block	Place name	Present damage risk	Target level of damage risk 30 years later	Planned facilities	Facility plan (1-10 years)	Facility plan (11-30 years)	Watershed goal
Right bank	Type of inundation	A	AAA Town, BBB City	Green	Green				Improvement measures are taken in order to lower the risk level of each block 30 years later by at least one level.  (If the goal mentioned in is not achieved) Nonstructural measures are upgraded so that the safety level of higher-flood-risk blocks can be raised.
	Type of inundation	A	CCC Town, DDD City	Yellow	Blue	Levee reinforcement			
						Road embankment			
						Disaster prevention station			
		B	EEE Town, FFF City	Yellow	Green	Levee reinforcement			
						Road embankment			
		C	GGG Town, HHH City	Pink	Green	Road embankment			
						Flood control reservoir			
		D	III Town, JJJ City	Green	Blue				
		E	KKK Town, LLL City	Red	Green	Drainage pump			
Left bank		F	MMM Town, NNN City	Pink	Yellow	Drainage pump			
	Type of inundation	A	OOO Town, PPP City	Red	Green	Levee reinforcement			
						Drainage pump			
	Type of inundation	A	QQQ Town, RRR City	Green	Green				
		B	SSS Town, TTT City	Yellow	Yellow	Flood control reservoir			
	Type of inundation	A	UUU Town, VVV City	Yellow	Blue	Levee reinforcement			
		B	WWW Town, XXX City	Pink	Yellow	Drainage pump			
	Type of inundation	A	YYY Town, ZZZ City	Yellow	Blue	Levee reinforcement			
		B	AAA Town, BBB City	Pink	Yellow	Drainage pump			



: area that satisfies certain conditions in connection with nonstructural measures for disaster resistance enhancement

Examples: the existence of a system for achieving evacuation in 30 minutes after receiving notice, the implementation of neighborhood associations' disaster prevention drills



### Problems (tasks)

1. Finding ways to evaluate the level of safety
2. Identifying and developing evaluation items and methods needed to measure the degree of achievement of such goals as "zero victim" and "the prevention of paralysis of the central functions of the state"
3. Finding ways to evaluate various risks comprehensively

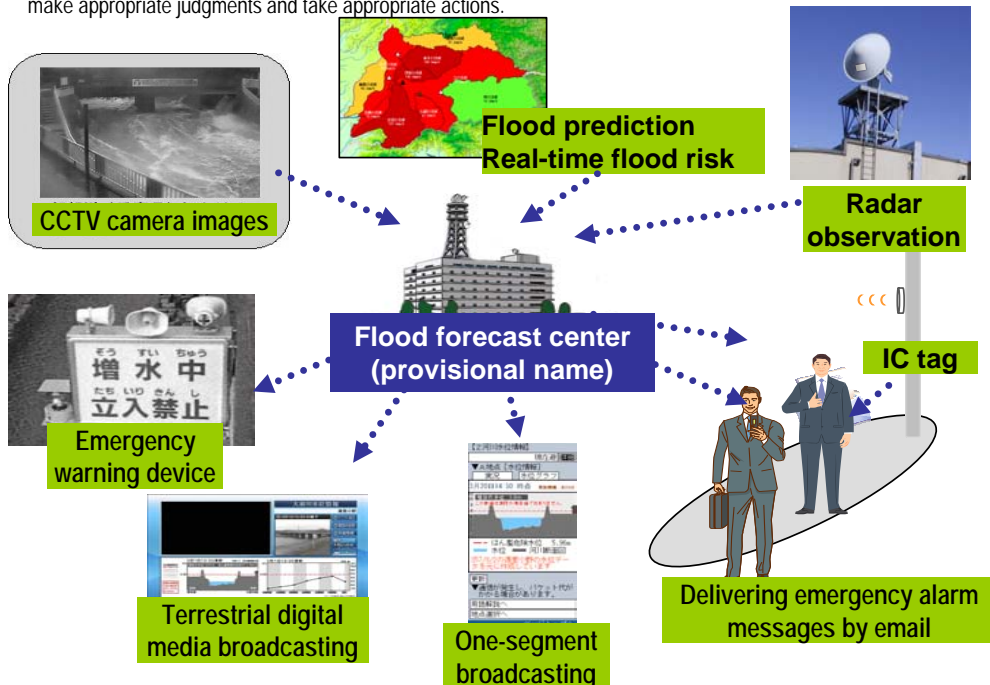
# Establishment of flood forecast centers (provisional name)

In order to achieve the "zero victim" goal in the face of increasingly intense floods and localized heavy rains caused by climate change, **flood forecast centers (provisional name) will be established** in regional development bureaus to strengthen risk management measures in, for example, monitoring floods and providing information to municipal governments, the mass media, etc.

Flood forecast centers are to perform such tasks as climate change monitoring, flood risk evaluation and the development of an advanced flood prediction system.

## Strengthening flood-monitoring and information-providing capability

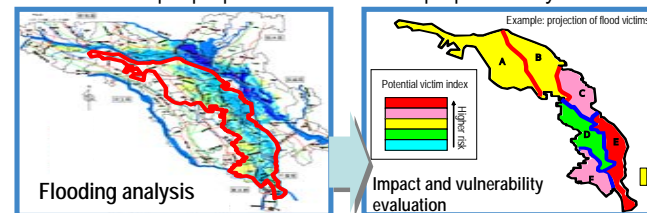
- High-accuracy weather radar systems and flood prediction systems are used for flood monitoring and information is provided by use of a variety of means of communication in order to better help municipal governments and the public make appropriate judgments and take appropriate actions.



## Climate change monitoring and flood risk evaluation

- The effects of increases and intensification of floods caused by climate change on people's daily life and the socio-economic conditions are identified through climate change monitoring and flood risk evaluation.

Example prepared for illustration purposes only



## Development of an advanced flood prediction system

- With the aim of proper risk management consistent throughout the watershed, a flood prediction system for estimating flood distribution patterns, flood risk including landslide flooding risk, real-time flooding patterns, etc., will be developed.

