Flood Hazard and Risk Assessment for Climate Change Adaptations in Japan

国土交通省

Contents of Presentation

1 Current Procedures on Flood Control Planning

Current Procedures on Flood Control Planning

Basic Policy for River Improvement

Decision on safety level for flood control plan

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Selection of target rainfall events

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Simulation of flood hydrographs

↓

Decision of peak discharge for design flood

↓

Allocation of design flood to channel flows and regulations with flood control facilities

↓

River Improvement Plan

Decision of implementation plan for the next 20-30 years

Safety level for flood control in Japanese class-A rivers (Exceedance probability of target rainfall amount):

1/100: 67 river systems

1/150: 34

1/200: 8

2 Current Methods to Evaluate the Effectiveness of River Improvement Plans

◆ Concept of the Evaluation

A river project is thoroughly evaluated before its implementation. The evaluation is used to develop river improvement plans, to make a decision on whether or not to implement/continue a project, to provide explanations about a project at community meetings, etc. All evaluations proceed with the following objectives in mind:

- Increase transparency in decision-making processes
- Ensure accountability to the public
- Maximize efficiency in utilization of financial and other resources

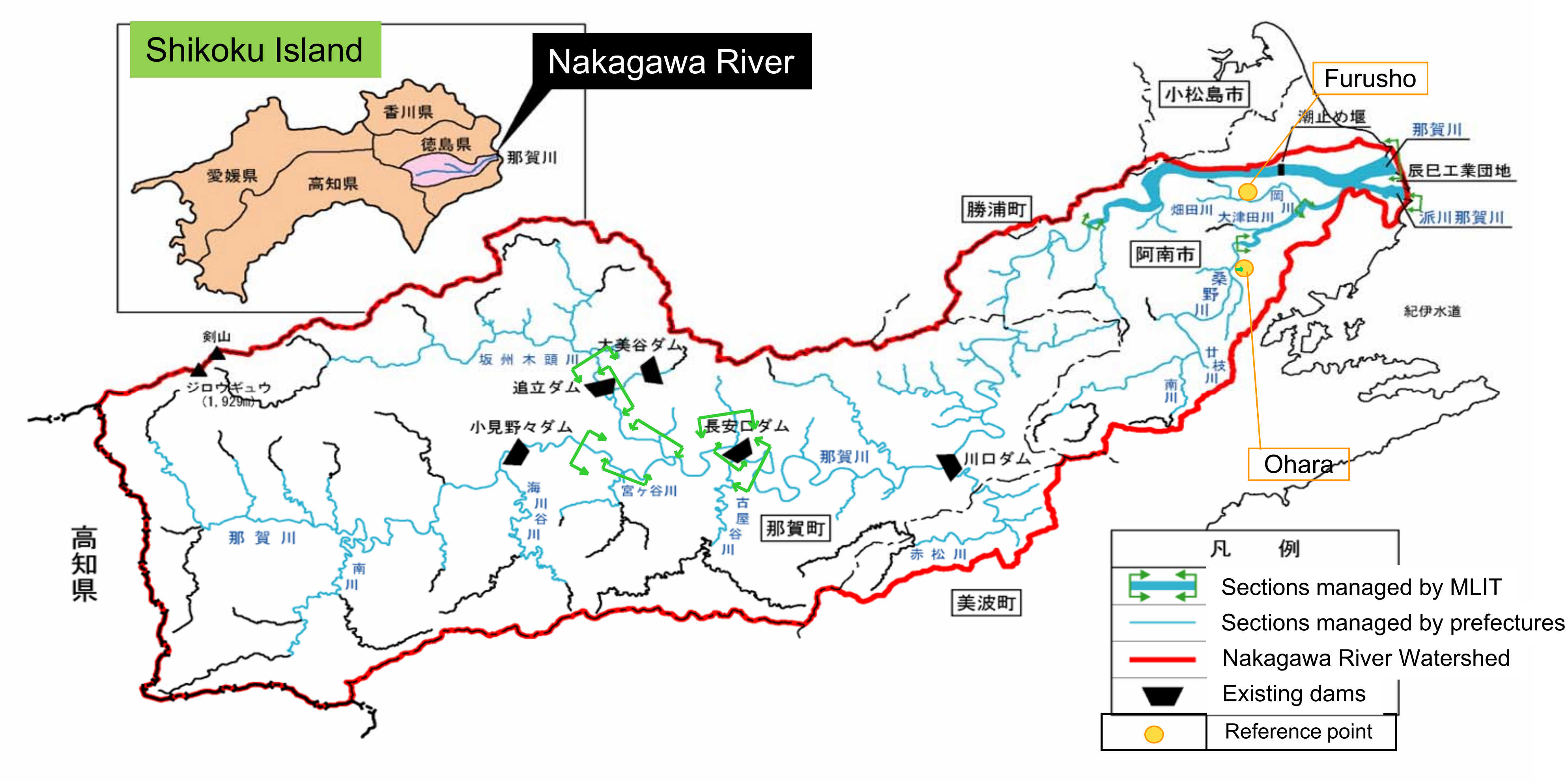
◆ Key Points of View for the Evaluation

Project evaluations are conducted in light of:

- Return on investment (cost-effectiveness analysis, etc.)
- Socio-economic conditions
- Feasibility
- Possible alternatives, etc.

※第１回河川事業の評価手法に関する研究会　資料３

The plan, based on the Basic Nakagawa River System Improvement Policy, specifies river improvement goals and project details in order to ensure comprehensive management of the Nakagawa River. Period: About 30 years



※第２回四国地方整備局事業評価監視委員会　資料11

Example of evaluating river improvement plan (Nakagawa River)

Targets of evaluation

Flood control

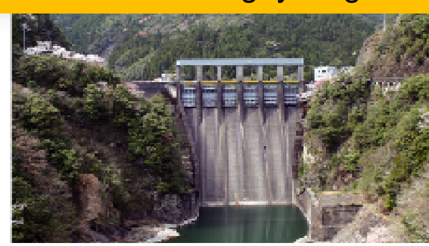
- Build levees in areas where there are none such as Fukase, Kamo and Mochii
- Improve Nagayasuguchi Dam to increase flood control and discharge capacity
- Remove sediment at the upstream entrance of Nagayasuguchi Dam reservoir to increase flood control capacity
- Review operational rules for Nagayasuguchi Dam for more effective flood control
- Tree felling and river channel excavation at points of insufficient cross-sectional flow
- Improve flood control safety in upper river basins of Nakagawa and Kuwanogawa rivers and their tributaries (prefecture managed sections)
- Enhance embankment function against water leakage and localized scouring during flooding.
- Implement measures for major earthquakes, develop disaster prevention facilities, and take countermeasures for inland flooding.

Water utilization

- Remove sediment at the upstream entrance of Nagayasuguchi Dam reservoir to increase water utilization capacity
- Use Nagayasuguchi Dam and Kawaguchi Dam for general water supply

River improvement works

Rehabilitation of Nagayasuguchi Dam



Environment

- Construct a selective intake facility for Nagayasuguchi Dam's power intake
- Move sediment removed from the upstream entrance of Nagayasuguchi Dam reservoir to downstream river channels.
- Develop an eco-friendly environment for habitat conservation (preservation of Setonofuchi, environmental mitigation and monitoring, etc.)
- Build waterfront "town squares"

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Example of evaluating river improvement plan (Nakagawa River)

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Cost-effectiveness of the Nakagawa River System Improvement Plan: B/C = 4.00
(Net present value: B – C = 200.3 billion yen)

■ Benefit:

Reduction in damage as a result of construction/improvement of levees and dams according to the river improvement plan

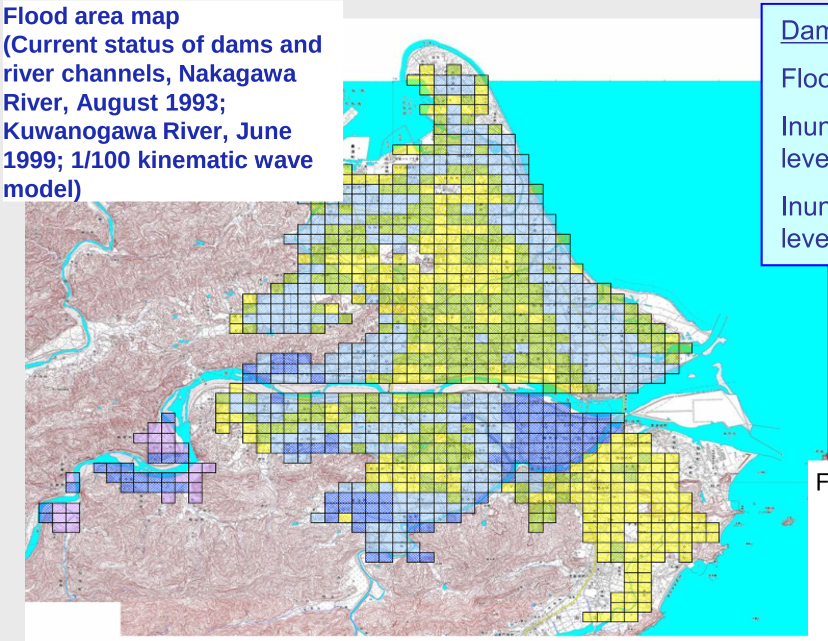
Total benefit: **Approx. 267 billion yen**

■ Cost:

Costs associated with construction/improvement of levees and dams during the river improvement plan period (about 30 years from the development of the plan)

Total cost: **Approx. 66.7 billion yen**

Flood area map (Current status of dams and river channels, Nakagawa River, August 1993; Kuwanogawa River, June 1999; 1/100 kinematic wave model)



Flood depth (m)

0.00 – 0.50	yellow
0.50 – 1.00	yellow-green
1.00 – 2.00	light blue
2.00 – 5.00	blue
5.00 –	purple

Damage

Flood area: 5,082 ha

Inundation above floor level: 10,321 houses

Inundation below floor level: 3,957 houses

Types of damage used in cost-effectiveness calculation

■ Amount of direct damage

- Damage to general assets (Houses, household articles, commercial depreciable and inventory assets, agricultural/fishery depreciable and inventory assets)
- Crop damage
- Damage to public works facilities

■ Amount of indirect damage

- Loss due to suspension of operations
- Cost of emergency measures taken by households
- Cost of emergency measures taken by businesses

Factors to Calculate Economic Losses

Classification					Effects (Damage)	Formula
Effect of damage mitigation through flood control with the river improvement plan	Direct damage	Effect of minimizing damage to assets	Damage to general assets	Housing	Damage to residential/commercial building	Amount of damage to building assets = floor area x prefecture-specified value of building per m^3 x correction coefficient x damage rate
				Household articles	Flood damage to furniture, automobiles, etc.	Amount of damage to household article assets = number of households x value of household articles per household x correction coefficient x damage rate
				Commercial depreciable assets	Flood damage to commercial depreciable fixed assets excluding land and buildings	Amount of damage to commercial depreciable assets = number of employees x value of depreciable assets per employee x correction coefficient x damage rate
				Commercial inventory assets	Flood damage to commercial inventory assets	Amount of damage to commercial inventory assets = number of employees x value of inventory assets per employee x correction coefficient x damage rate
				Agricultural/fishery depreciable assets	Flood damage to agricultural/fishery depreciable fixed assets excluding land and buildings	Amount of damage to agricultural/fishery depreciable assets = number of agricultural/fishery households x value of depreciable assets per household x correction coefficient x damage rate
				Agricultural/fishery inventory assets	Flood damage to agricultural/fishery inventory assets	Amount of damage to agricultural/fishery inventory assets = number of agricultural/fishery households x value of inventory assets per household x correction coefficient x damage rate
			Crop damage		Flood damage to crops	Amount of crop damage = area of farm land x average yield x crop price x damage rate
			Damage to public works facilities		Flood damage to public works and services facilities, agricultural property and facilities	Amount of damage to public works facilities = general assets damage x ratio of public works facilities damage to general assets damage
	Indirect damage	Effect of minimizing damage to operations	Suspension of operations	Business establishments	Suspension or interruption of production activities of affected businesses (reduction in output)	Loss due to suspension of operations = number of employees x number of days operations are suspended or interrupted x added value per person per day
				Public services	Suspension or interruption of public services	
		Effect of minimizing post-disaster damage	Cost of emergency measures	Household finance	Financial damage to affected households due to additional cost incurred for cleaning and other post-flood activities as well as the purchase of drinking water and other replenishments	Cost of emergency measures taken by households = cost of labor for cleaning + expenditure increase due to replenishing = number of households x evaluated cost of labor equivalent x number of days required for cleaning + number of households x expenditures associated with replenishing
				Business establishments	Same as financial damage to households	Cost of emergency measures taken by businesses = number of business establishments x expenditures associated with replenishing

※治水経済調査マニュアル（案）より転記

Economic Loss: Damage Ratio by Inundation Depth

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Damage ratios have been established according to inundation depth based on the findings of flood damage investigations.

Housing: Damage Ratio by Inundation Depth

Land inclination \ Depth	Below floor level	Above floor level					Sedimentation (above floor level)	
		Less than 50 cm	50 – 99	100 – 199	200 – 299	300 cm or more	Less than 50 cm	50 cm or more
Less than 1/1,000	0.032	0.092	0.119	0.266	0.580	0.834	0.43	0.785
1/1,000 - 1/500	0.044	0.126	0.176	0.343	0.647	0.870		
1/500 or more	0.050	0.144	0.205	0.382	0.681	0.888		

Household Articles: Damage Ratio by Inundation Depth

Inundation depth	Below floor level	Above floor level					Sedimentation (above floor level)	
		Less than 50 cm	50 – 99	100 – 199	200 – 299	300 cm or more	Less than 50 cm	50 cm or more
Damage ratio	0.021	0.145	0.326	0.508	0.928	0.991	0.50	0.845

Commercial Depreciable/Inventory Assets: Damage Ratio by Inundation Depth

Assets \ Depth	Below floor level	Above floor level					Sedimentation (above floor level)	
		Less than 50 cm	50 – 99	100 – 199	200 – 299	300 cm or more	Less than 50 cm	50 cm or more
Depreciable	0.099	0.232	0.453	0.789	0.966	0.995	0.54	0.815
Inventory	0.056	0.128	0.267	0.586	0.897	0.982	0.48	0.780

Agricultural/Fishery Depreciable/Inventory Assets: Damage Ratio by Inundation Depth

Inundation depth	Below floor level	Above floor level					Sedimentation (above floor level)	
		Less than 50 cm	50 – 99	100 – 199	200 – 299	300 cm or more	Less than 50 cm	50 cm or more
Depreciable	0.0	0.156	0.237	0.297	0.651	0.698	0.370	0.725
Inventory	0.0	0.199	0.370	0.491	0.767	0.831	0.580	0.845

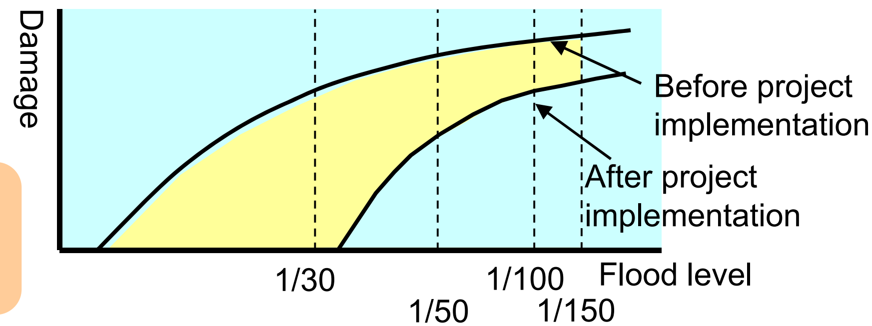
※治水経済調査マニュアル（案）より転記

Economic Loss: Calculating Expected Average Annual Damage Reduction

- Amount of damage reduction is the difference between damage before and after project implementation for a specific flood level.

> Amount of damage reduction by flood level =
> Estimated damage before project implementation – Estimated damage after project implementation

- The amount of damage reduction for each flood level is multiplied by its probability of occurrence to obtain the expected amount of average annual damage reduction.



> Expected amount of average annual damage reduction =
> Σ(Amount of damage reduction by flood level) x (Probability of occurrence)

Scale at the time of assessment E.g. 1/10

Overall stock effects of flood control project

Scale of discharge	Exceedance probability	Amount of damage: Before project implementation (1)	After project implementation (2)	Amount of reduction (3) = (1) - (2)	Interval average of damage amount (4)	Interval probability (5)	Average annual damage (4) x (5)	Cumulative total of average annual damage = Expected amount of average annual damage reduction
Q_0	N_0			$D_0(=0)$				
					$\frac{D_0+D_1}{2}$	N_0-N_1	d_1	d_1
Q_1	N_1			D_1				
					$\frac{D_1+D_2}{2}$	N_1-N_2	d_2	d_1+d_2
Q_2	N_2			D_2				
					$\frac{D_{m-1}+D_m}{2}$	N_m-N_{m+1}	d_m	$d_1+d_2+\cdots+d_m$
Q_m	N_m			D_m				

Target of river improvement plan (plan scale) E.g. 1/150

Expected amount of average annual damage reduction

※治水経済調査マニュアル（案）より作成

3. Projection of Future Climate Change

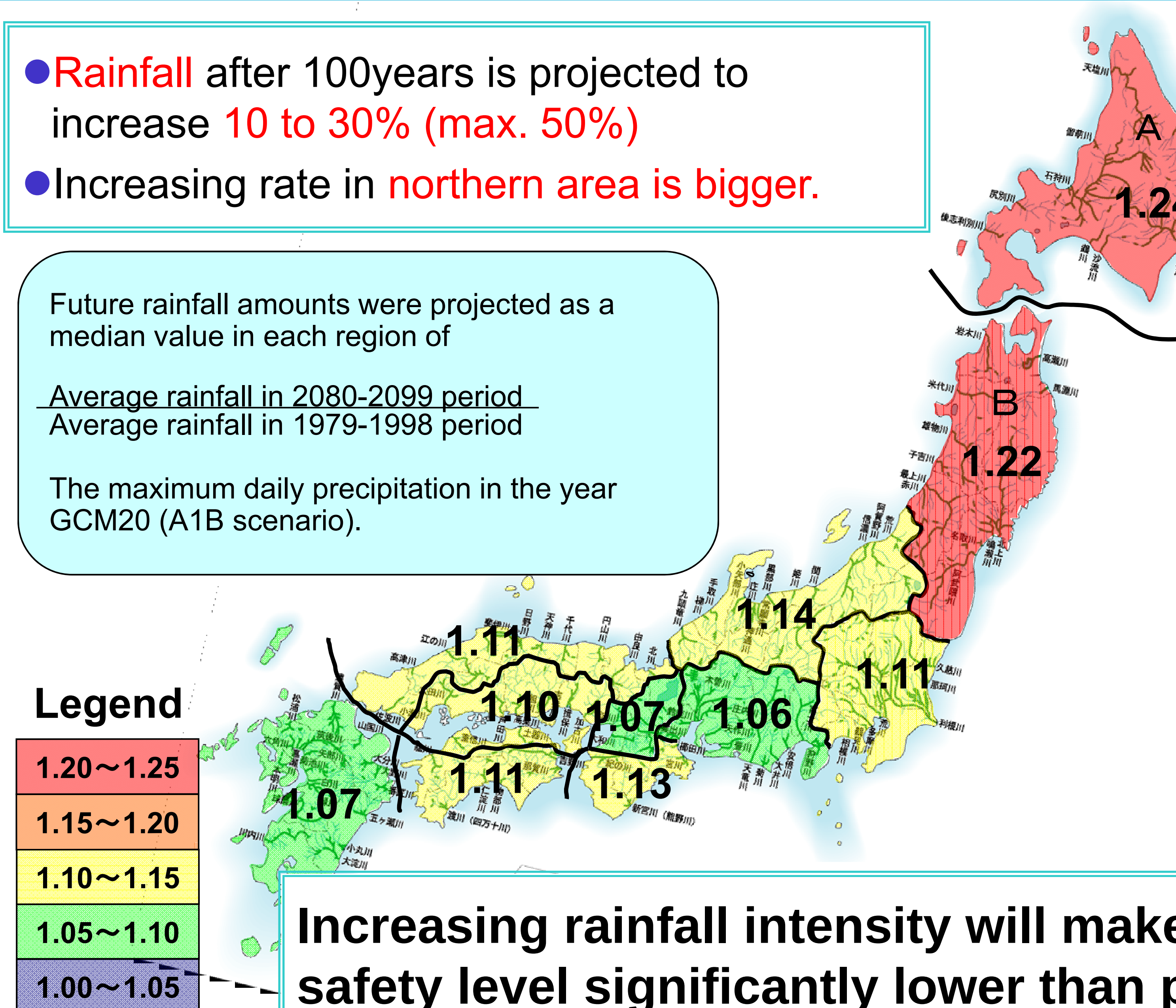
Projection of Future Climate in Terms of Extreme Events

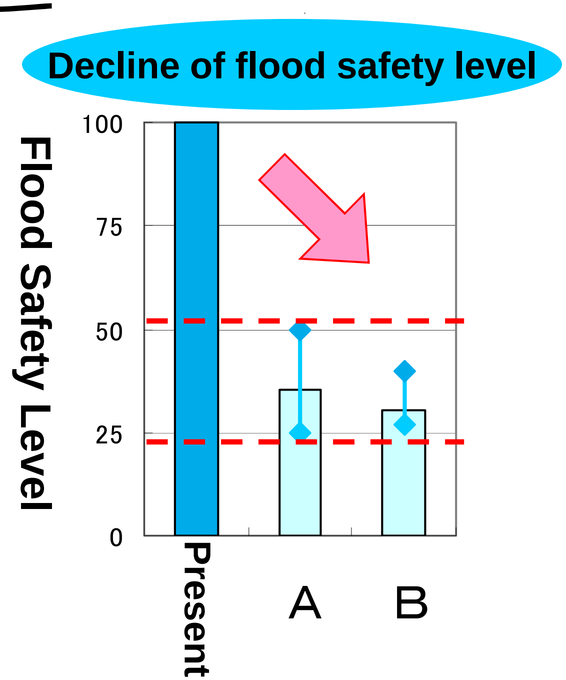
- Rainfall after 100years is projected to increase 10 to 30% (max. 50%)
- Increasing rate in northern area is bigger.

Future rainfall amounts were projected as a median value in each region of

$$\frac{\text{Average rainfall in 2080-2099 period}}{\text{Average rainfall in 1979-1998 period}}$$

The maximum daily precipitation in the year GCM20 (A1B scenario).





Increasing rainfall intensity will make the flood safety level significantly lower than present

4. New challenges in Flood Management Based on Risk Assessment

(1) Assessment of Human Damages

Life Loss Estimation (1): LIFESim Model

Source: Central Disaster Prevention Council, Report 1 from the Ninth Meeting of the Expert Committee on Large Scale Water-related Hazards

Source: Cabinet Office

1. Estimating the rate of evacuation from flooded areas

- Evacuation rates were set at 0%, 40% and 80% since the evacuation rate varies depending on the scale of flood.
- Evacuation rate was 46% on average according to Web-based survey results.

Evacuation rates of actual flood events[Note 1]

Event	Evacuation rate (%)
Heavy rain in Nagasaki (1982)[1]	13
Heavy rain in Tokai (2000)[2]	44
Typhoon No. 6/Kitakami River (2002)[3]	18[Note 2], 32[Note 3]
Heavy rain in Niigata/Fukushima (2004)[4]	19[Note 4], 23[Note 5], 36[Note 6]
Typhoon No. 23/Toyooka (2004)[5]	33
Hurricane Katrina (New Orleans)	Approx. 80

Web-based survey

- Conducted by the Cabinet Office and MLIT in October 2007
- Among 1,768 people living in 18 municipalities susceptible to flooding of the Arakawa River.
- The largest number of respondents said that the reason for not evacuating was because they lived high up in the building.

Note 1: Parameters for determining the evacuation rate vary depending on investigations. Evacuees include those who evacuated after flood struck and those who evacuated to a shelter located within the flooded area.
Note 2: The total number of evacuees is the number of people who responded. Note 3: The total number of evacuees is the number of households that suffered inundation above or below floor level.
Note 4: Mitsuke City, Note 5: Sanjo City, Note 6: Nakanoshima-machi

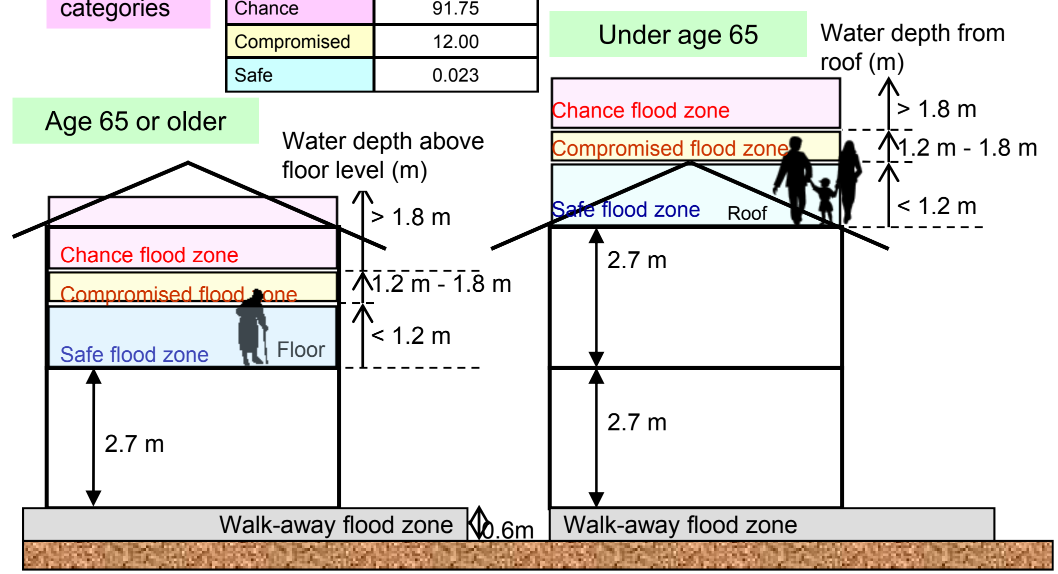
2. Estimating life loss

(1) The life loss estimation model developed by the US Army Corps of Engineers was used.
(2) Three flood zone categories were established in relation to the depth of inundation above floor level.
(3) The number of people for each category was calculated on the basis of age and the number of floors in the building where they lived, which was then multiplied by the fatality rate.

- All people over the age of 65 can move to the highest habitable level of the building.
- All people under the age of 65 can climb to a higher level such as a roof.
- People can evacuate if the water depth does not exceed 60 cm above ground surface.

Flood zone categories

	Fatality rate (%)
Chance	91.75
Compromised	12.00
Safe	0.023



Life Loss Estimation (2): LIFESim Model

Source: Central Disaster Prevention Council, Report 1 from the Ninth Meeting of the Expert Committee on Large Scale Water-related Hazards

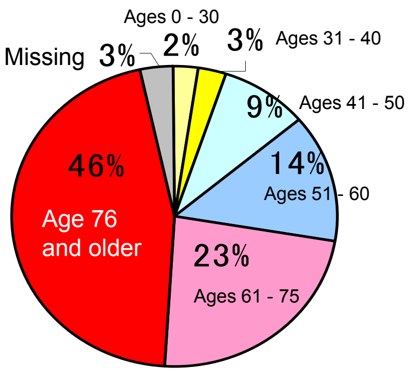
Source: Cabinet Office

3. Examining the validity of using the US model

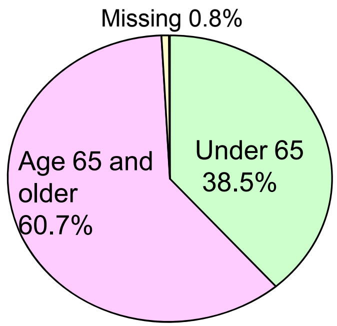
- In calculating fatalities in Japan, we made sure that the age composition, average height of people, as well as floor and building height were similar to the US model.

(1) Similar age composition in Japan and the US

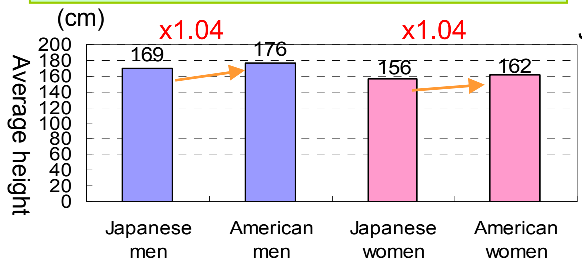
Fatalities in Louisiana (Hurricane Katrina)[8]



Fatalities/missing in 2004 flood/mudslide[9]



(2) Height difference of 4%



US: Average height of people aged 20 or older (1992 – 2000)[10]

Japan: Average height of people aged 20-79 (2005)[11]

8) Based on Vital Statistics of All Bodies at St. Gabriel Morgue (1/16/2006: Louisiana Department of Health and Hospitals); 9) MLIT River Bureau report; 10) CDC, October 27, 2004, Advance Data from Vital and Health Statistics; 11) 2005 Physical Fitness Survey, Ministry of Education, Culture, Sports, Science and Technology

(3) No major difference in floor/building height

Floor height

US model	• Floor height: 60 cm
Japan	• In addition to the thickness of foundation floor and floor boards, 34.6% of houses have a 30 – 40 cm-high foundation and 56.2% have a 40+ cm-high foundation[12]. • Floor height must measure 45 cm or more directly off the ground from the bottom of the floor (Order for Enforcement of the Building Standards Act)[13]

Building height (from floor to the highest habitable building level)

US model	• Building height: 2.7 m
Japan	• In addition to the thickness of beam and floor, the ceiling height of a habitable room is 2.3 m to 2.5 m[12]. • Ceiling height of habitable room must be 2.1 m or more (Order for Enforcement of the Building Standards Act)[13]

4. Validation of the model

- Based on a re-calculation of fatalities in Hurricane Katrina, estimated life loss was 1,086, which fell between the actual number of people killed (867) and missing persons (1,259).[7]

1) Disaster and Information Research Group, The Institute of Journalism, University of Tokyo, "Community Response to July 1982 Flood in Nagasaki, University of Tokyo Institute of Journalism, 1984; 2) Osamu Hiroi, et al., "Communication and Community Response to 2000 Heavy Rain in Tokai," The Bulletin of the Institute of Socio-Information and Communication Studies, The University of Tokyo, Vol. 19, 2003; 3) Motoyuki Ushiyama, et al., "Community Response to Typhoon 0206 and Challenges," Disaster Prevention Research Institute Annuals No. 46, 2003; 4) Osamu Hiroi, "Community Action and Communication in July 2004 Flood in Niigata/Fukushima," Research Survey Reports in Information Studies No.23, Interfaculty Initiative in Information Studies, The University of Tokyo, 163-287, 2005; 5) Isao Nakamura, et al., "Communication Problems in Flood Due to 2004 Typhoon No 23"; 6) City of New Orleans, "New Orleans One Year After Katrina," 2007; 7) US Army Corps of Engineers, "Performance Evaluation of the New Orleans and Southeast Louisiana Hurricane Protection System," Draft Final Report of the Interagency Performance Evaluation Task Force, June 2006; 12) Housing Loan Corporation/Yutakana Juseikatsuo Kangaeru Kai, *Nihon no Jutakuga Wakaru Hon*, PHP Institute, 1994; 12) Article 22 of the Order for Enforcement of the Building Standards Act

Method for predicting the number of isolated people

Source: Cabinet Office

1. Method of estimating the number of isolated persons

(1) Calculate the number of evacuees to areas outside the flood areas.
(2) As in the calculation of death toll, evacuation rates are assumed at 0%, 40% and 80%.
(3) Of the persons who did not evacuate, the population of the area flooded more than 60cm from the ground, which is the water depth more than which people are difficult to evacuate, as the number of isolated persons.

2. Evacuation is difficult when inundation depth reaches 60cm

(1) In the U.S. human damage simulation model, 60cm is adopted as the flood water depth over which evacuation becomes difficult.
(2) In the flood caused by Tokai Torrential Rain, people were rescued at the flood water depth more than knee height (about 50cm or more).
(3) According to the results of the questionnaire to the people who evacuated in the Ise Bay Typhoon, the flood water depth over which evacuation was difficult was 70cm for men and 50cm for woman. [13)]
(4) Based on the above, the flood water depth over which evacuation becomes difficult is set to 60cm.

(Reference) Flood water depth at which people were rescued for evacuation with a rubber boat or other in the flood by the Tokai Torrential Rain [14)]

Inundation depth upon evacuation	Not flooded	Ankle	Knee	Waist	Breast	Total
Number of persons	0	0	2	10	22	34

3. Method of estimating the number of evacuees

(1) Based on the assumption of the capability and number of boats available for rescuing isolated persons

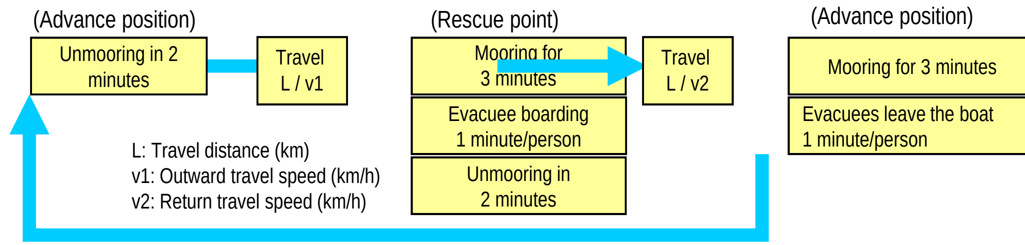
Capability and number of rubber boats *1

		Ministry of Defense	National Police Agency	Fire Defense Agency
Boarding capacity for evacuees *2		11 persons *5	2 persons	2 persons
Travel speed *3	Outward	2.6km/h	2.0km/h	2.0km/h
	Return	2.0km/h	1.2km/h	1.2km/h
Number of boats *4		about 300	about 600	about 1,000

*1 Created by Cabinet Office based on results of hearings from the National Police Agency, Fire Defense Agency, and Ministry of Defense, etc.
*2 The maximum boarding capacity for evacuees is not necessary with the fixed capacity.
*3 Speed of travel by rowing the boat is assumed because there may be many obstacles such as driftwood.
*4 The number of boats held in the Eastern Army (Ground Self Defense Force) and the Yokosuka District Fleet (Maritime Self Defense Force) for the Ministry of Defense, and in the prefectures of Ibaragi, Tochigi, Gunma, Saitama, Chiba, Tokyo, and Kanagawa for the National Police Agency and Fire Defense Agency.
*5 Reconnaissance boat (2 evacuees), another type of reconnaissance boat (3 evacuees), and river-crossing boat (23 evacuees) are included the number of boats by weight average.

(2) Calculate the number of evacuees by multiplying the number of persons to be rescued per boat / hour by the number of boats and the number of activity hours

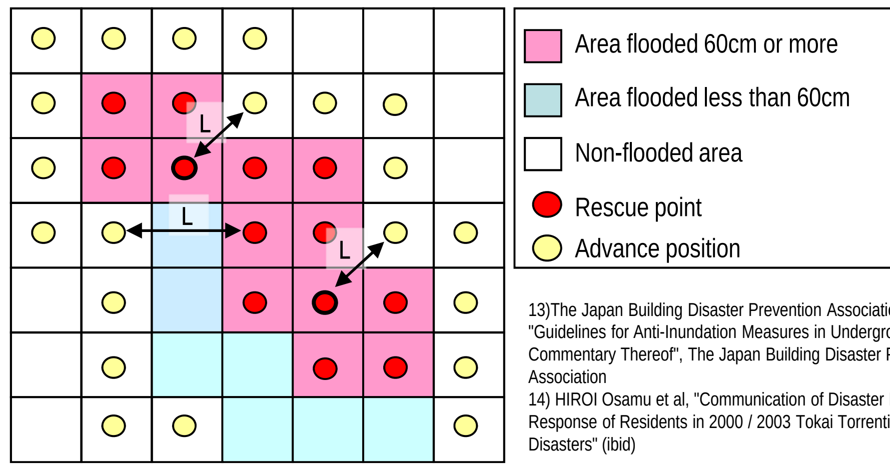
Cycle of rescue



Number of evacuees (person/day)
= Number of persons to be rescued per boat / hour (persons / hour-boat) x Number of boats x Activity time (hours / day)
Number of persons to be rescued per boat / hour (persons / hour-boat)
= Boarding capacity for evacuees (persons/boat) / Time of 1 cycle (hours)

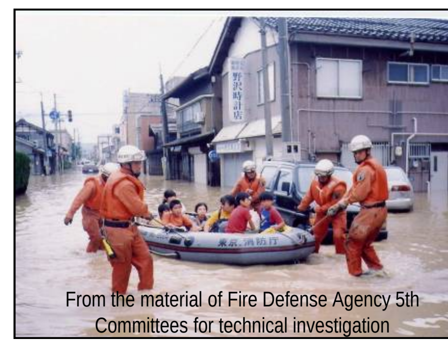
Travel distance of boats

For the travel distance from the advance position to the rescue point, the average distance from each rescue point to the nearest unflooded area (except for area surrounded by the flooded areas) is used.



13)The Japan Building Disaster Prevention Association, June 2002, "Guidelines for Anti-Inundation Measures in Underground Space and Commentary Thereof", The Japan Building Disaster Prevention Association
14) HIROI Osamu et al, "Communication of Disaster Information and Response of Residents in 2000 / 2003 Tokai Torrential Rain Disasters" (ibid)


From the material of Ministry of Defense 7th Committee for technical investigation

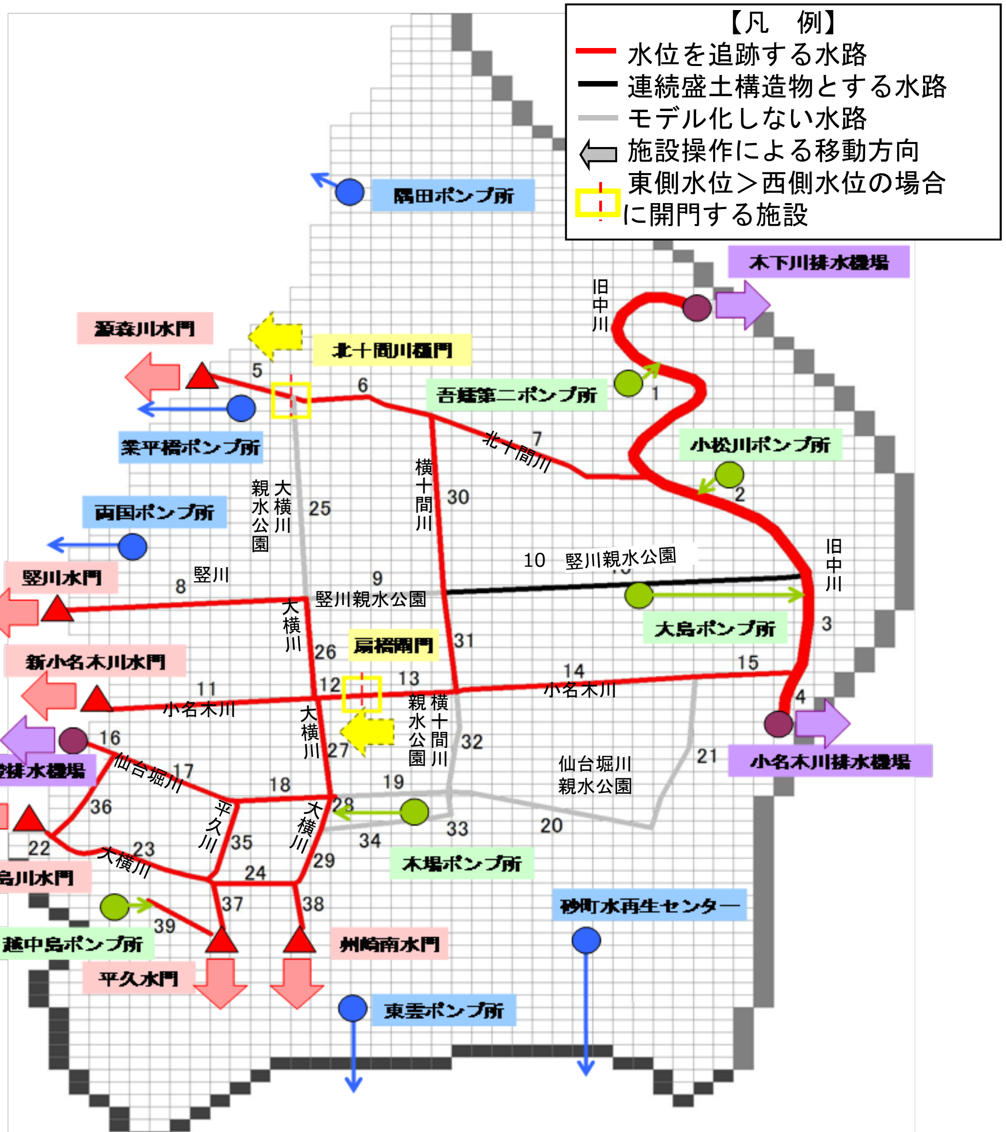

From the material of Fire Defense Agency 5th Committees for technical investigation

4 .(1)　　　- Case Study -

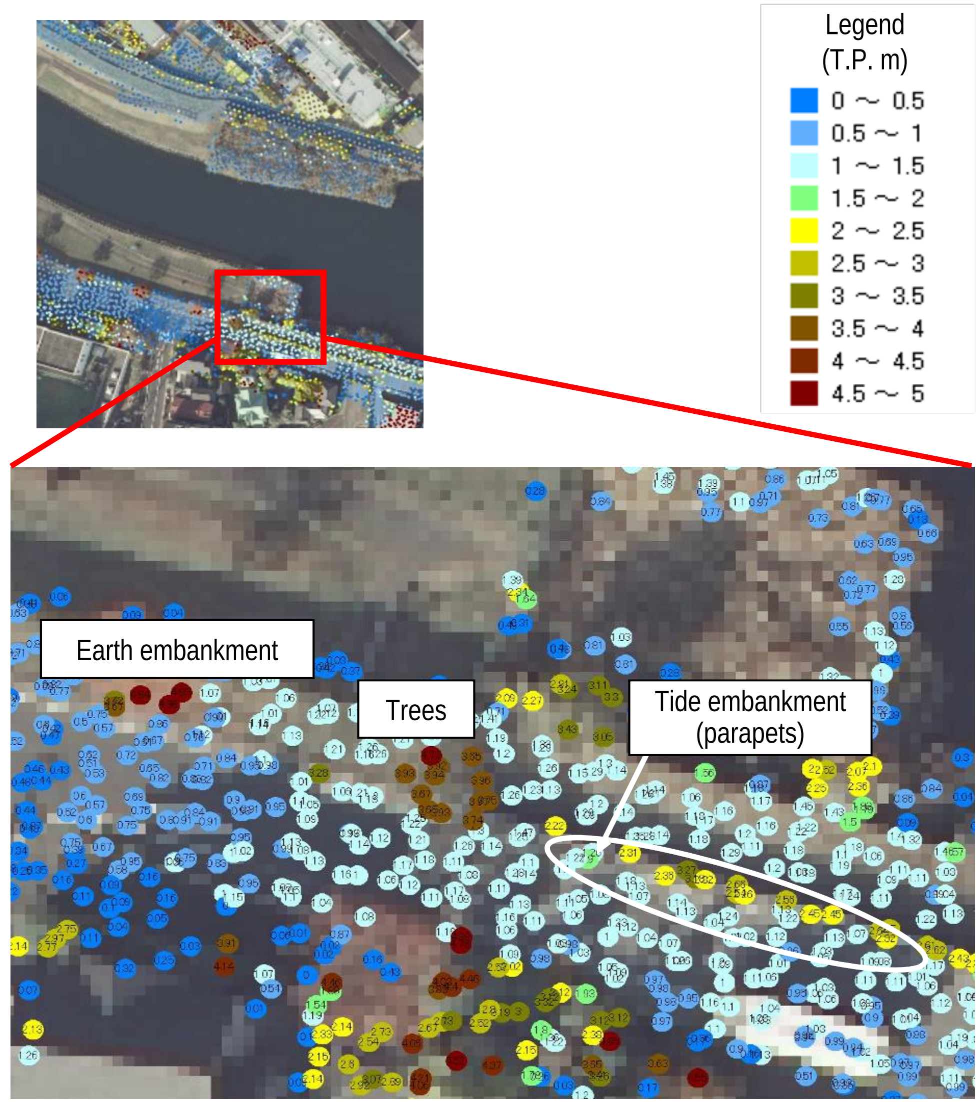
Building a model for rivers in the Koto delta

Source: Cabinet Office

Based on laser profiler (LP) data and the results of field surveys, the drainage calculation model with rivers (canals) in the Koto delta was built.



Section division of rivers inside Koto Delta



Estimation of the embankment amount using the laser profiler

Differences in the submergence condition depending on the operation of drainage facilities (⑤ Koto delta stagnant flood)

Source: Cabinet Office

- If drainage facilities do not work, areas in which about 860,000 people live would remain flooded one week after dikes break.
- If drainage facilities work, it would take about 5 days before drainage is completed

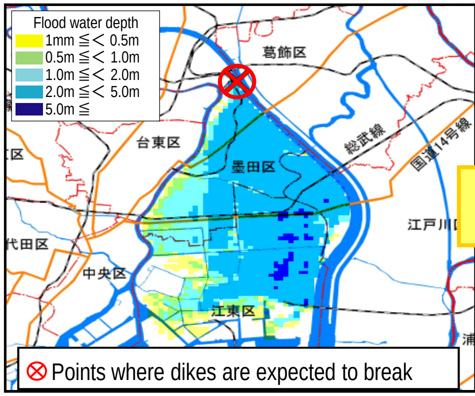
Once every 200 years

Assumed place of dike break: In Sumida City

Case 1: No pump operation; no fuel supply; no floodgate operation; no pumper truck available; once every 200 years

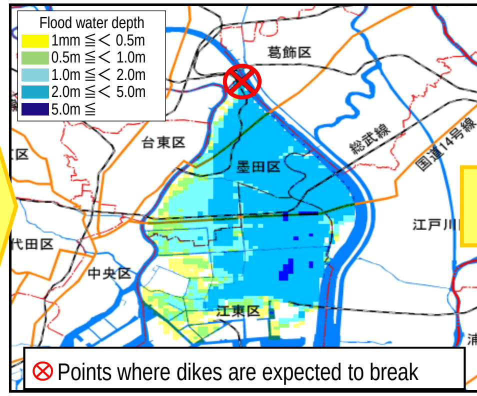
1 day (24 hours) after dike break

Population in flooded areas: Approx. 900,000 persons



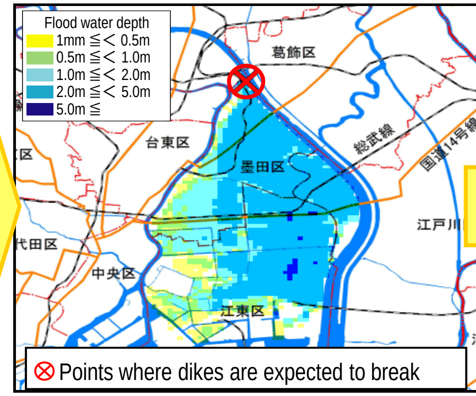
2 days (48 hours) after dike break

Population in flooded areas: Approx. 880,000 persons



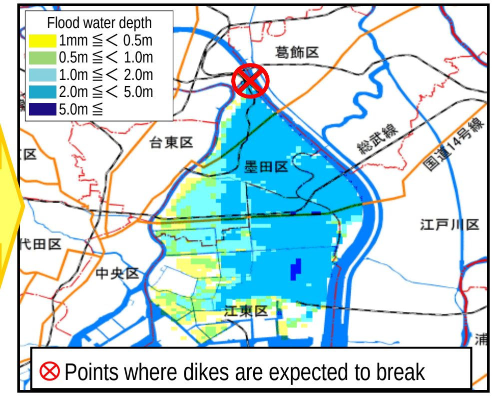
3 days (72 hours) after dike break

Population in flooded areas: Approx. 870,000 persons



1 week (168 hours) after dike break

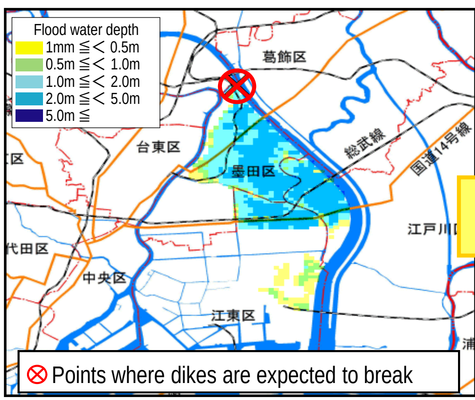
Population in flooded areas: Approx. 860,000 persons



Case 8: Pumps are operated; fuel is supplied; floodgates are operated; pumper trucks are available; once every 200 years

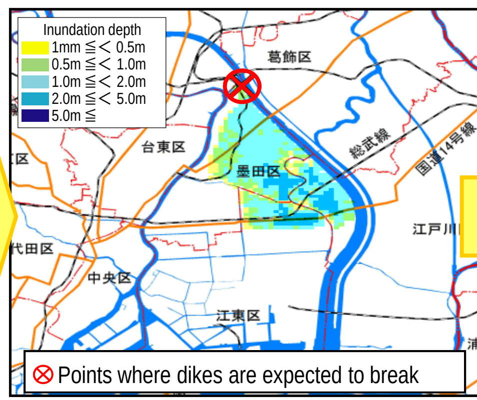
1 day (24 hours) after dike break

Population in flooded areas Approx. 560,000 persons



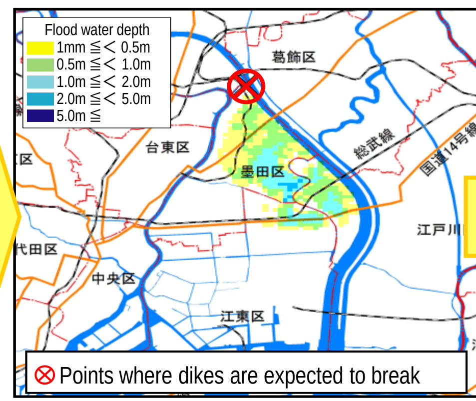
2 days (48 hours) after dike break

Population in flooded areas Approx. 330,000 persons



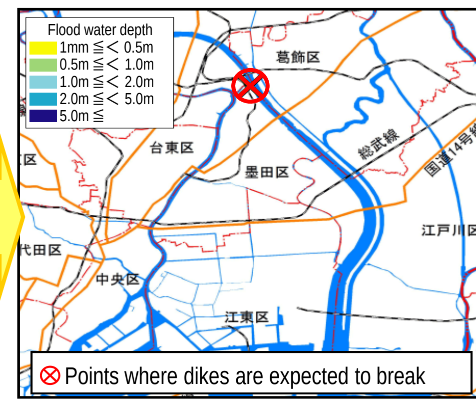
3 days (72 hours) after dike break

Population in flooded areas Approx. 170,000 persons



1 week (168 hours) after dike break

Population in flooded areas Zero



Death toll by municipality (Case 1: ⑤ Koto delta stagnant flood)

Once every 200 years

Death toll

Case 1: No pump operation; no fuel supply; no floodgate operation; no pumper truck available; once every 200 years

Assumed place of dike break : In Sumida City

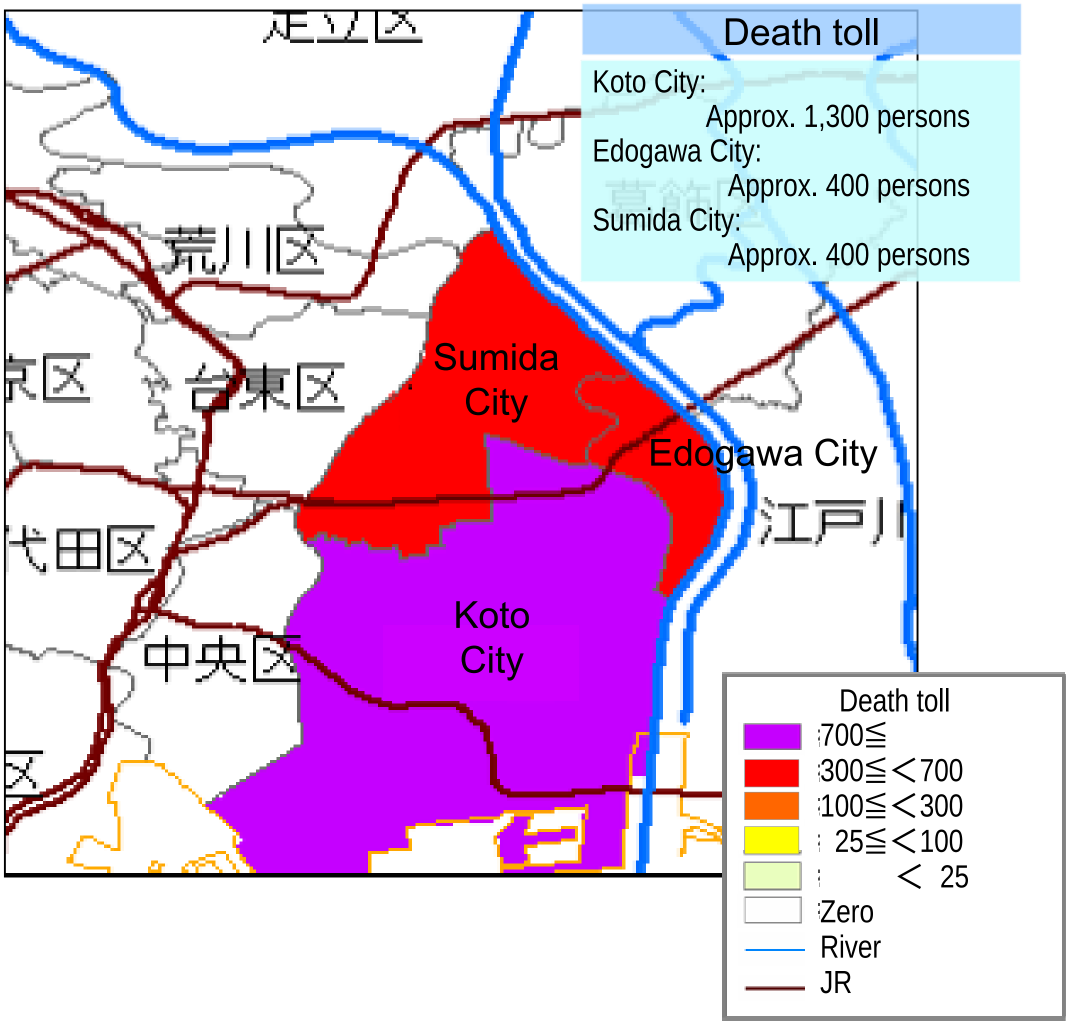
In the case of the evacuation rate being at 40%

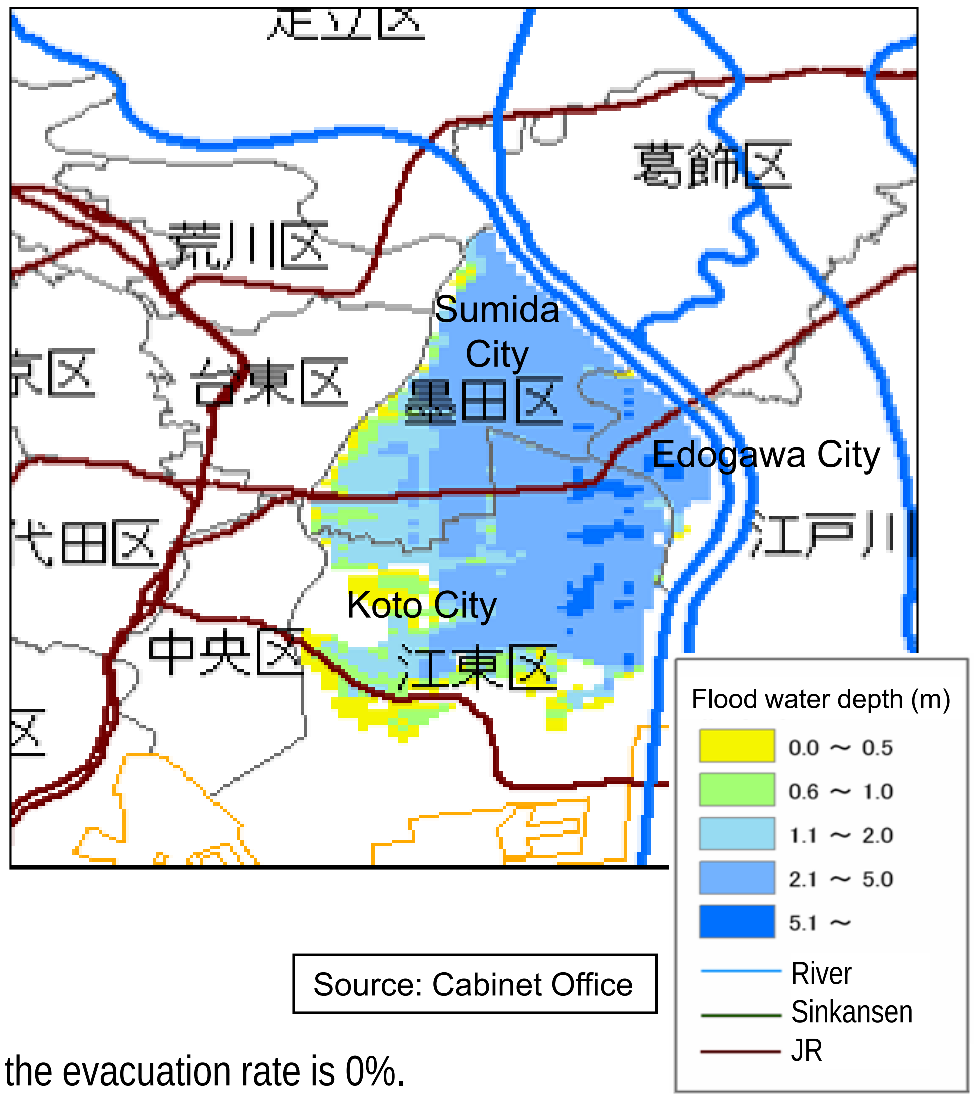
Death toll: Approx. 2,100

Maximum flood water depth

Death toll

Koto City: Approx. 1,300 persons
Edogawa City: Approx. 400 persons
Sumida City: Approx. 400 persons





Source: Cabinet Office

Note: Listed the municipalities where the death toll is 10 or more when the evacuation rate is 0%.

Death toll by municipality (Case 8: ⑤ Koto delta stagnant flood)

Once every 200 years

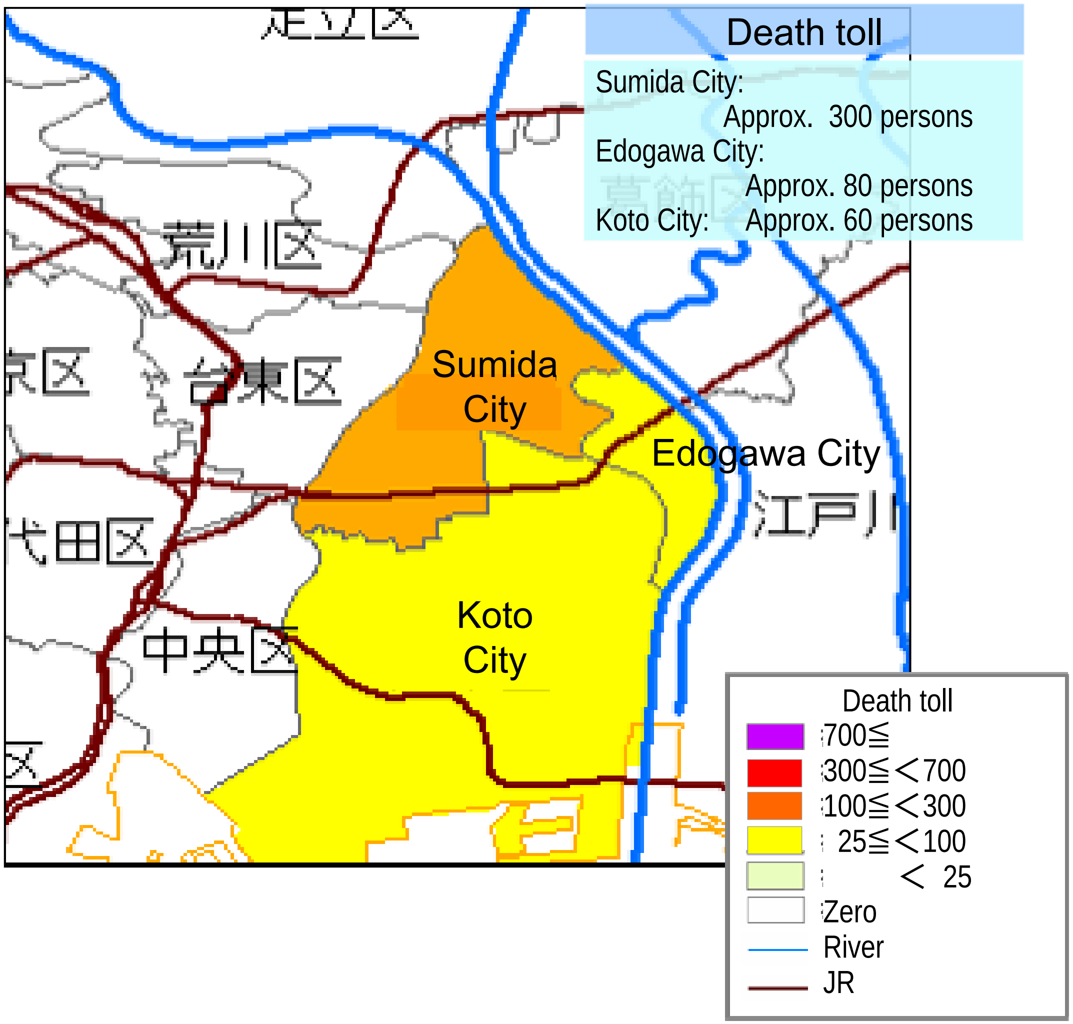
Death toll

Case 8: Pumps are operated; fuel is supplied; floodgates are operated; pumper trucks are available; once every 200 years

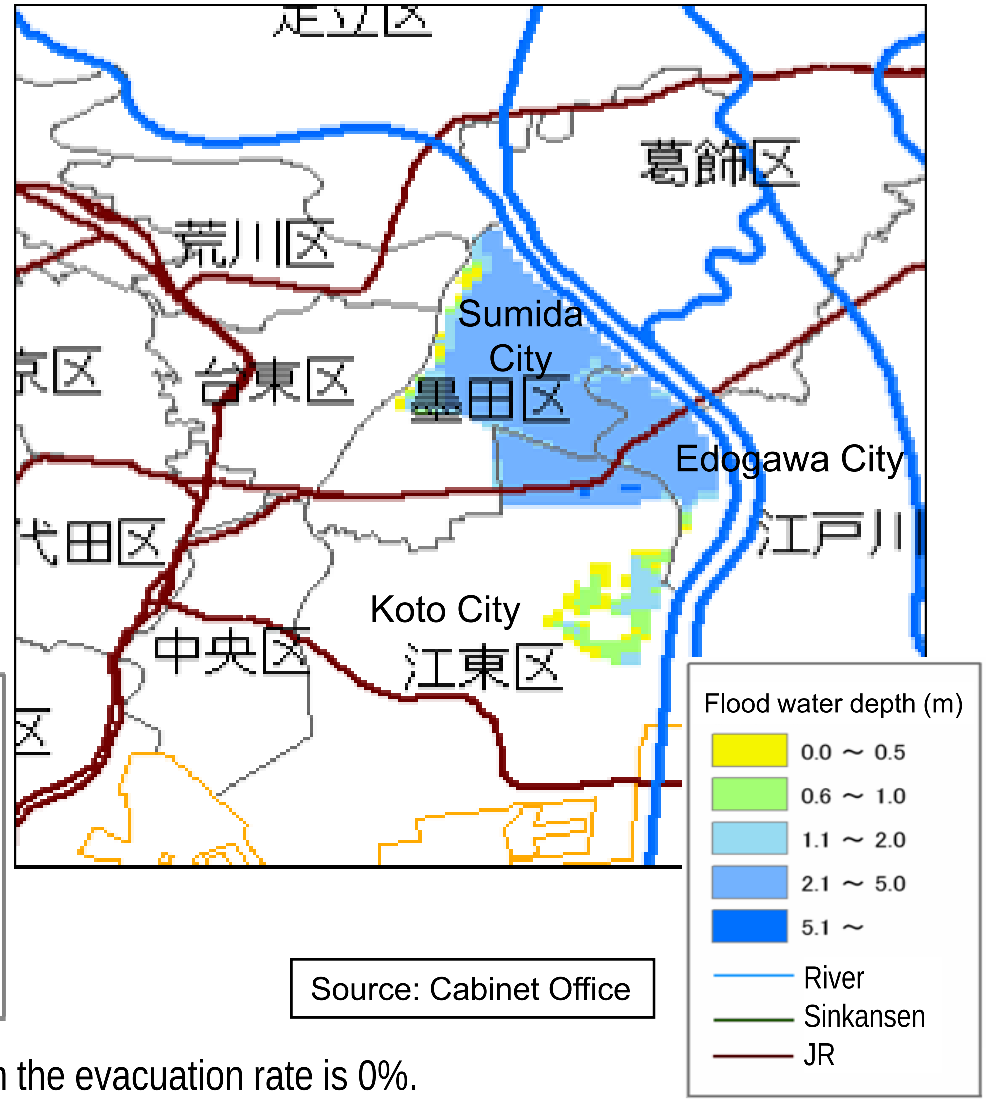
Assumed place of dike break:
In Sumida City

In the case of the evacuation rate being at 40%

Death toll: Approx. 500



Maximum flood water depth

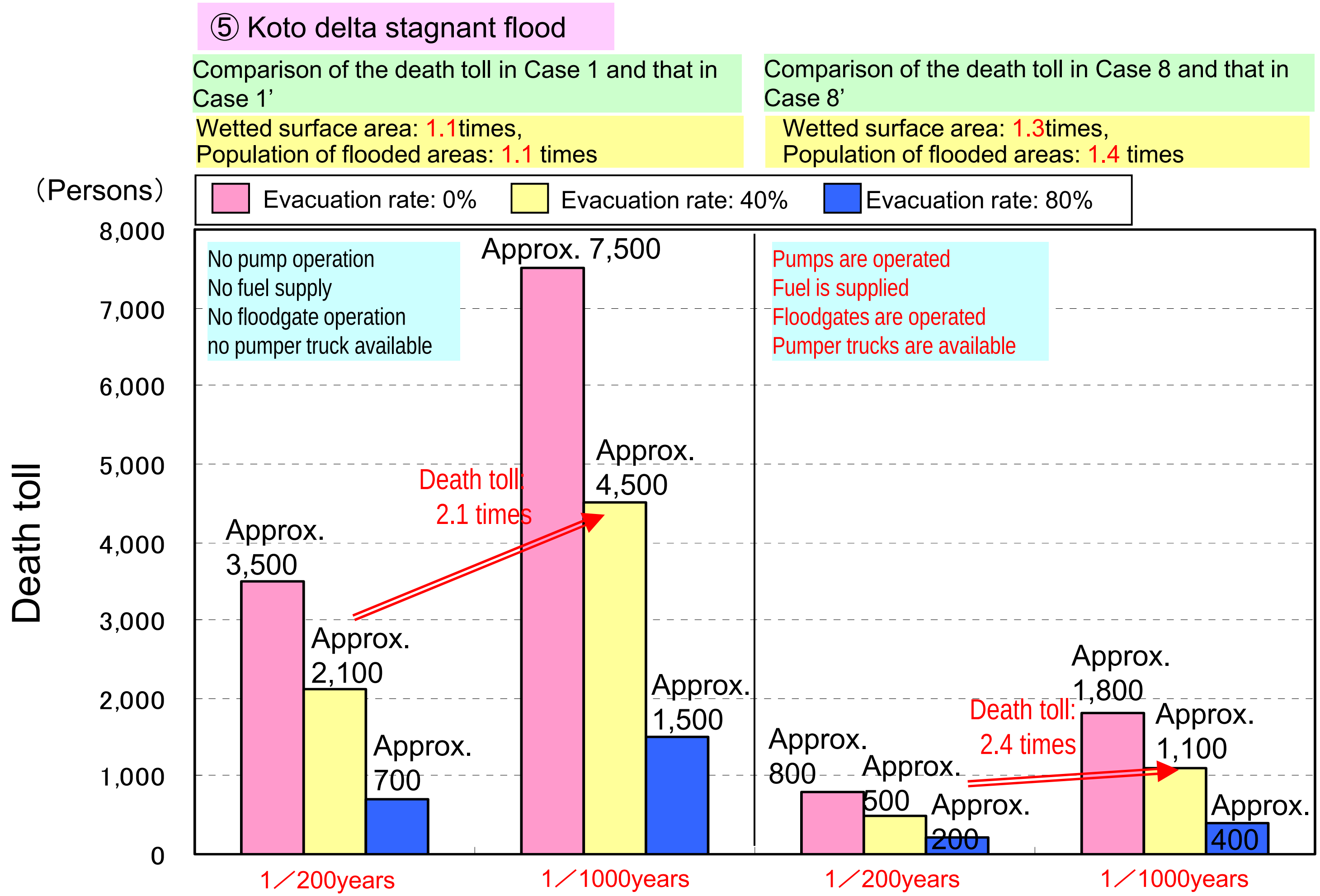


Source: Cabinet Office

Note: Listed the municipalities where the death toll is 10 or more when the evacuation rate is 0%.

Comparison of the death toll caused when dikes break due to floods that occur at a probability of once every 200 years with that of deaths caused when dikes break due to floods about 30% larger in volume (ones that occur at a probability of once every 1,000 years) (Koto delta stagnant flood)

- In the case of floods with water retained in the Koto delta, comparison of the case in which dikes break due to a flood that occurs at a probability of once every 200 years with the one in which dikes break due to a flood 30% larger in volume (one which occurs at a probability of once every about 1,000 years) indicates that the submerged area and the population in flooded areas in the latter case would be 1.1-1.4 times as large, but that due to a greater flood water depth, the death toll would increase substantially, to 2.1-2.4 times as high.



Source: Cabinet Office

1/200 years flood: Average rainfall in the basin: about 550mm/3 days, Flood flow: about 14,000 m3/s (Iwabuchi Water Gate (upstream) Gauging Station)

1/1000 years flood: Average rainfall in the basin: about 680mm/3 days, Flood flow: about 18,000 m3/s (Same as above)

(Note) Wetted surface area and population in flooded areas cover the areas to be affected by flood from the bank collapse site. (Flood from the overtopping site is excluded since the depth of flooded water in overtopping is often shallow, which causes few fatalities) The death toll also includes fatalities in areas of overtopping flood.

Changes in the number of isolated people after rescue efforts (evacuation rate: 40%[Note 1]; ⑤ Koto delta stagnant flood)

Source: Cabinet Office

Once every 200 years

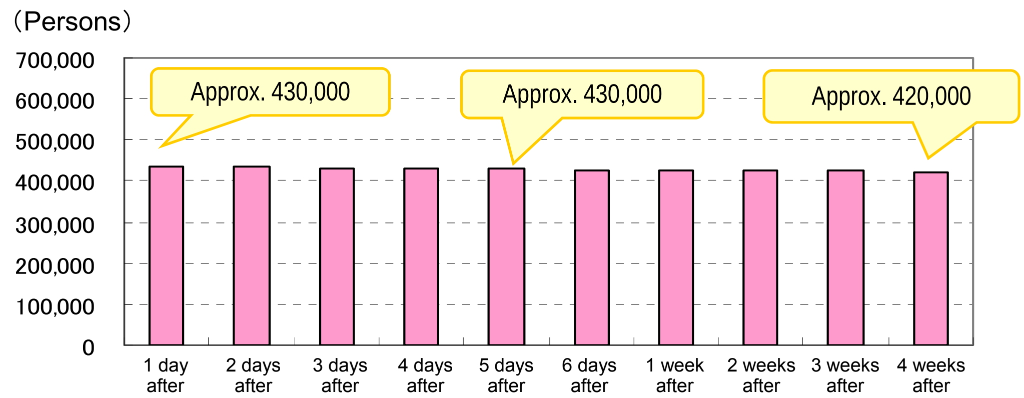
Number of isolated people

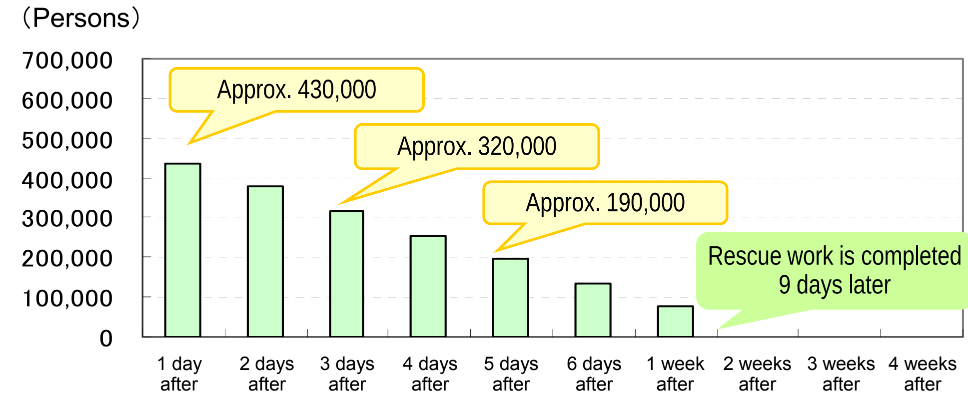
- If police office, fire and disaster management office, and Self-Defense Force make rescue efforts for 12 hours a day[Note 2], rescue work is completed 9 days after dikes break if drainage facilities do not work and 3 days if all drainage facilities work.

Case 1:

No pump operation; no fuel supply; no floodgate operation; no pumper truck available; once every 200 years

Number of isolated people when rescue efforts are not made → Number of isolated people when rescue efforts are made for 12 hours during the daytime

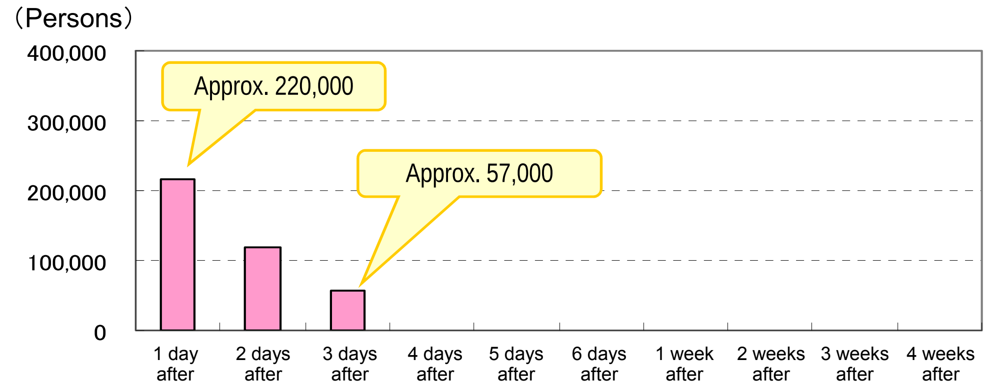


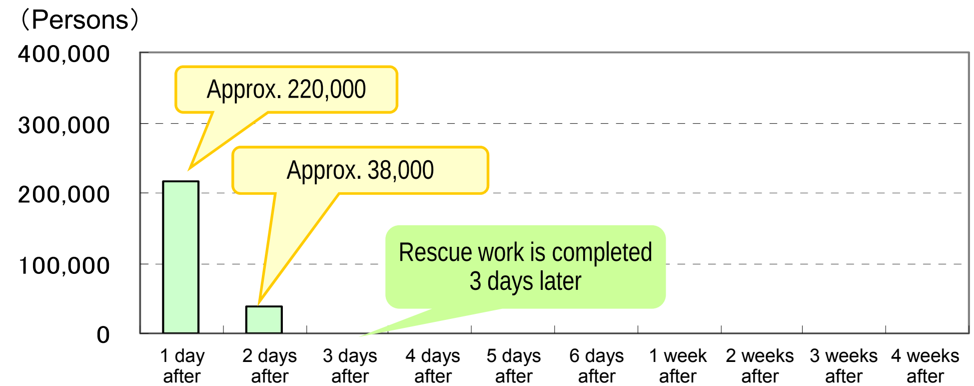


Case 8:

Pumps are operated; fuel is supplied; floodgates are operated; pumper trucks are available; once every 200 years

Number of isolated people when rescue efforts are not made → Number of isolated people when rescue efforts are made for 12 hours during the daytime





* 1: Note: The evacuation rate of 40% adopted in this material does not necessarily mean that this rate is typical in any municipality. Evacuation rates may substantially vary according to the content of various information that communicates the urgency of flood and timing to provide such information, timing and method of issuing evacuation advisory, preparedness at ordinary times such as preparation of flood hazard maps and implementation of evacuation drills, etc.

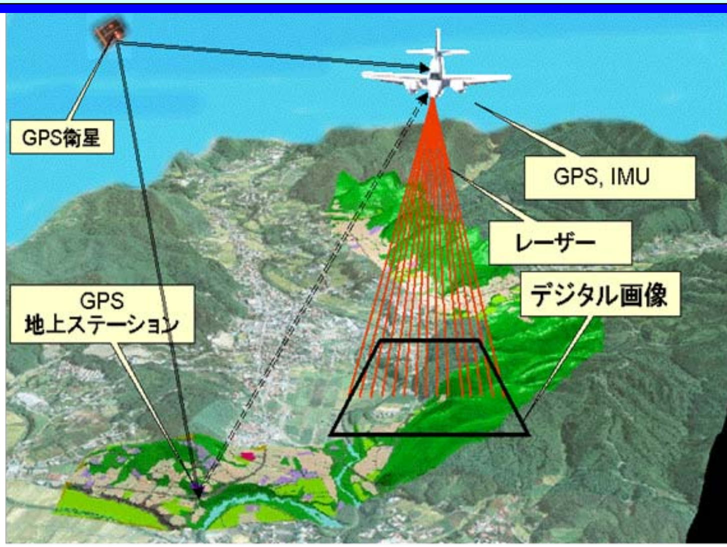
*2: Assumed rescue operations using the boats held in the prefectures of Ibaragi, Tochigi, Gumma, Saitama, Chiba, Tokyo, and Kanagawa, Tokyo Fire Department, and the Metropolitan Police Department for the National Police Agency and Fire Defense Agency and boats held in the Eastern Army (Ground Self Defense Force) and the Yokosuka District Fleet (Maritime Self Defense Force) for the Ministry of Defense (1,900 boats in total).

4. New Challenges in Flood Management Based on Risk Assessment

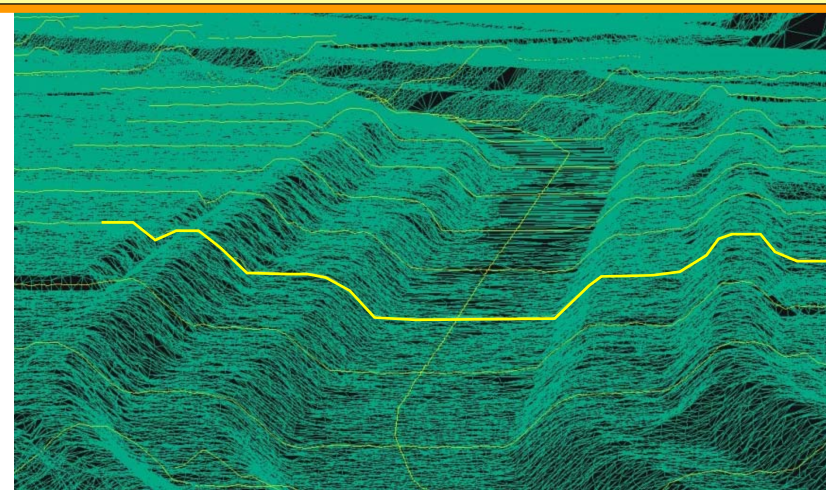
(2) Assessment of Safety Level against Flood for Small-and-Medium-Scale Rivers Managed by Local Governments with Detailed Topographic Data

Assessment of Safety Level against Flood at Small-and-Medium-Scale Rivers with Detailed Topographic Data

3D topographic data acquisition
(Airborne Laser Survey)

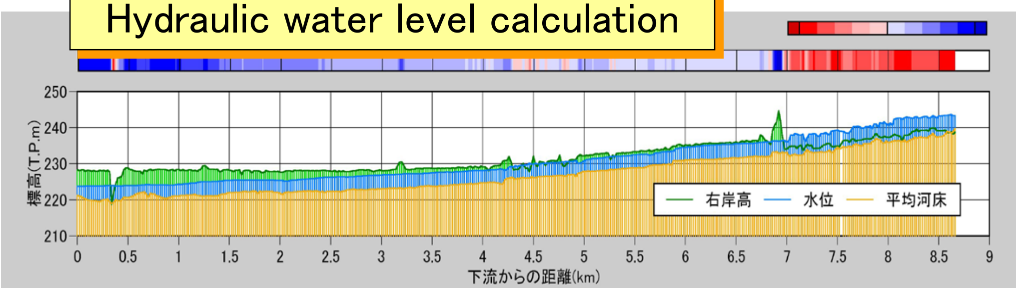


Delineation of cross sections of river channels

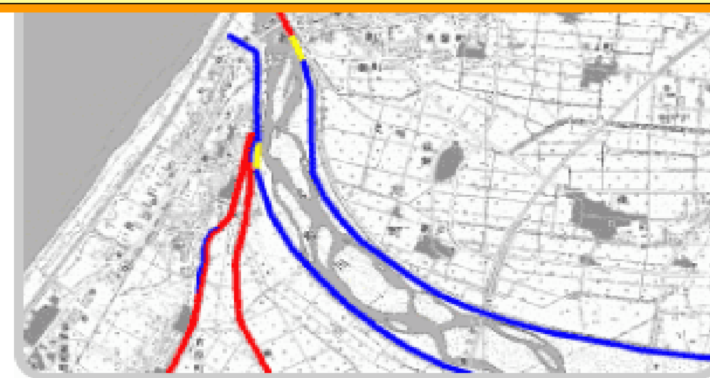


Hydrologic flood runoff calculation

Hydraulic water level calculation

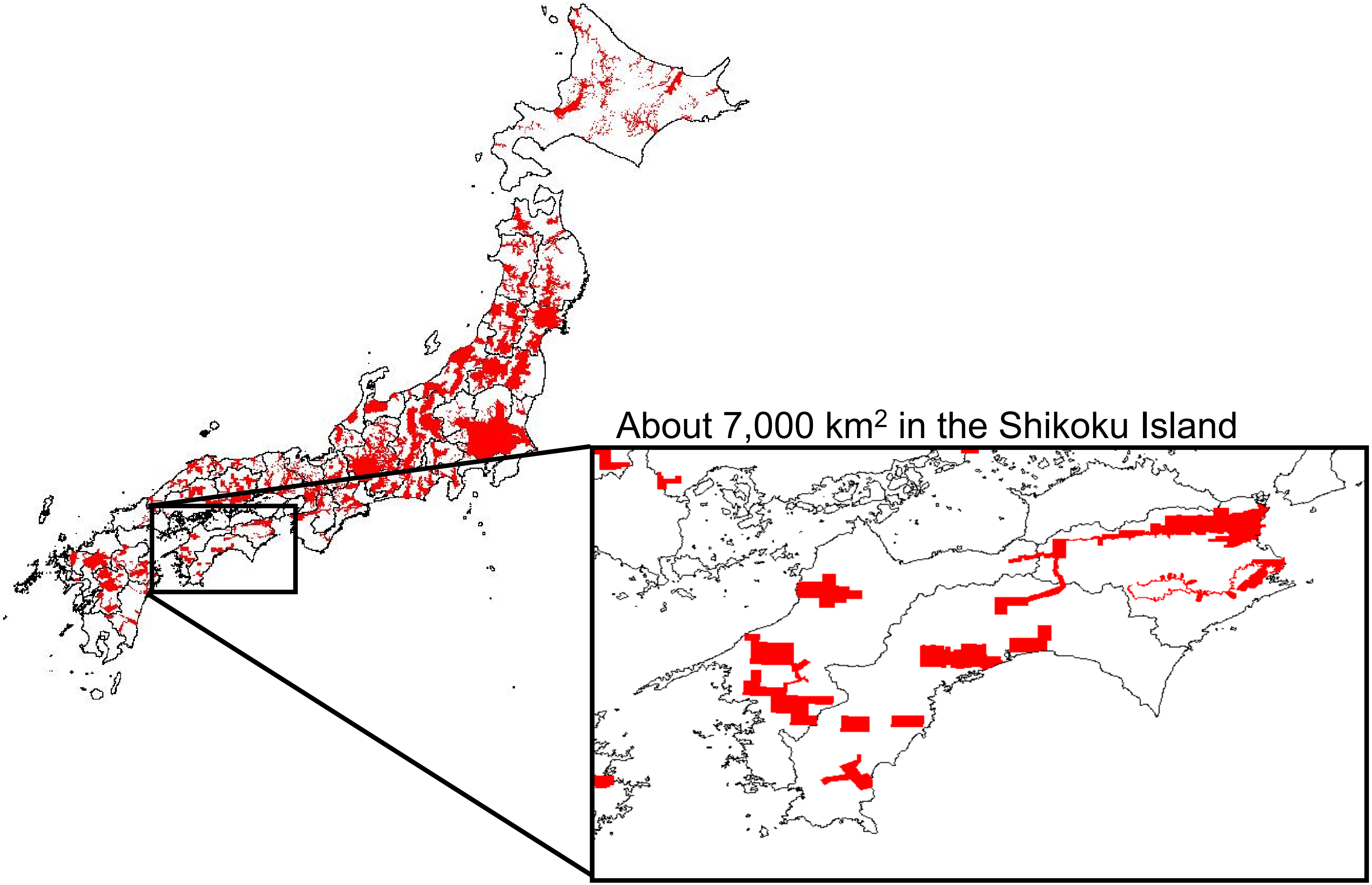


Evaluation of flow capacity of each section of small-and-medium-scale rivers



Range of Airborne Laser Profiler Observations

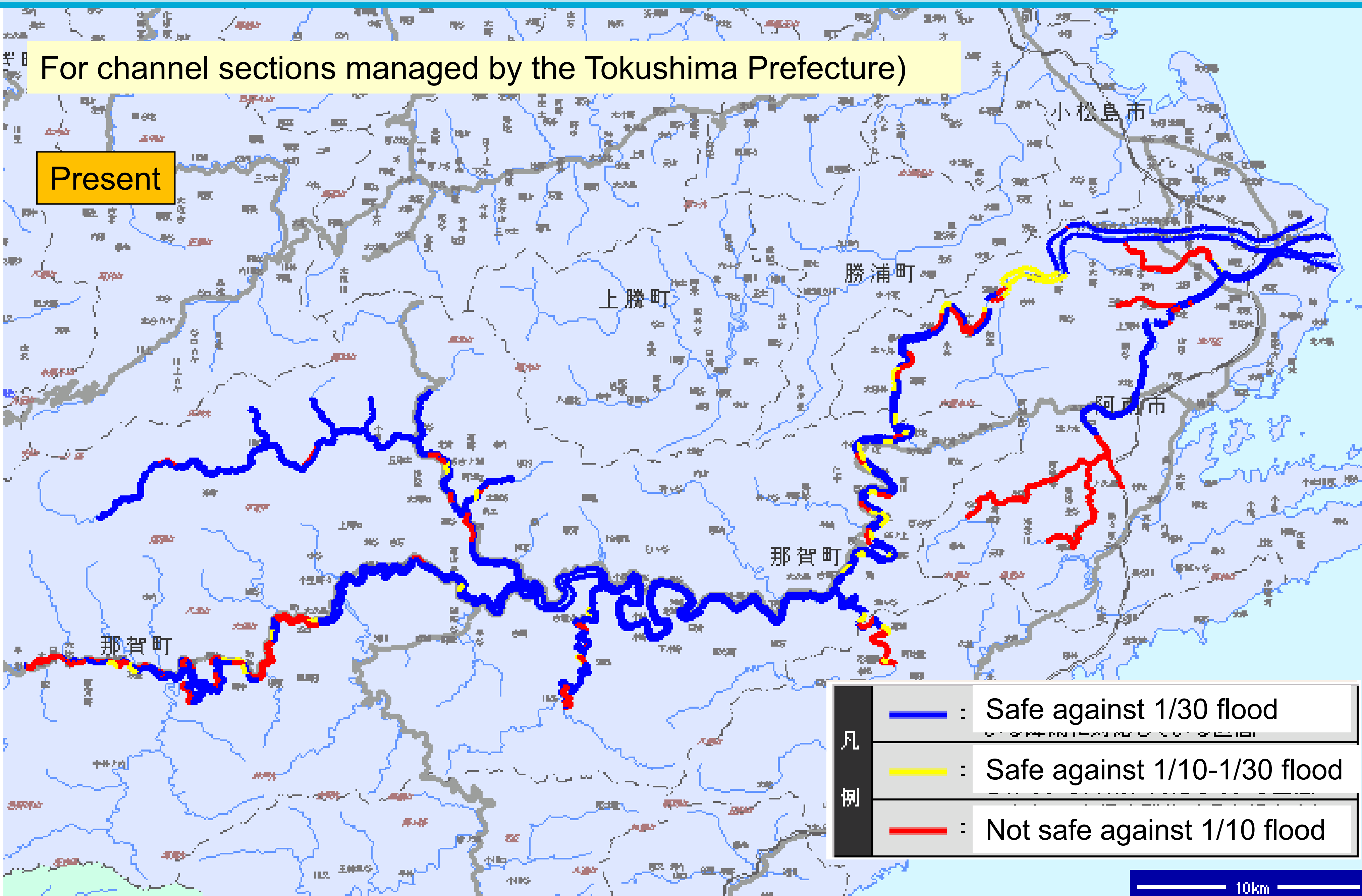
Effective observational area is about 80,000 Km^2 in total
(about 120,000 km^2 including mountainous areas)



4 . (2) - Case Study -

国土交通省

Evaluated Safety Level against Flood in Nakagawa R. (Present status)



5. Summary

1. Current Status of Flood Risk Assessment in Japan

Economic damages have been estimated in the case of the evaluation of the effectiveness of river improvement plans through cost-benefit analysis.

2. New challenges in Flood Management Based on Risk Assessment

1) Assessment of Human Damages and the Key Facilities' Damages and Their Effects in Large-Scale Rivers

Human damages (death toll, isolated people) and the ones of key facilities and their effects were evaluated for some large-scale rivers. The results have been used for designing crisis-management plans in case of large-scale floods

2) Assessment of Safety Level against Flood for Small-and-Medium-Scale Rivers with Detailed Topographic Data

Nationwide observations of detailed topography in flood-prone areas with airborne laser profiler were conducted. The observational results have been used to evaluate flood safety level of sections of small-and-medium-scale rivers managed by local governments for the implementation planning of river works.