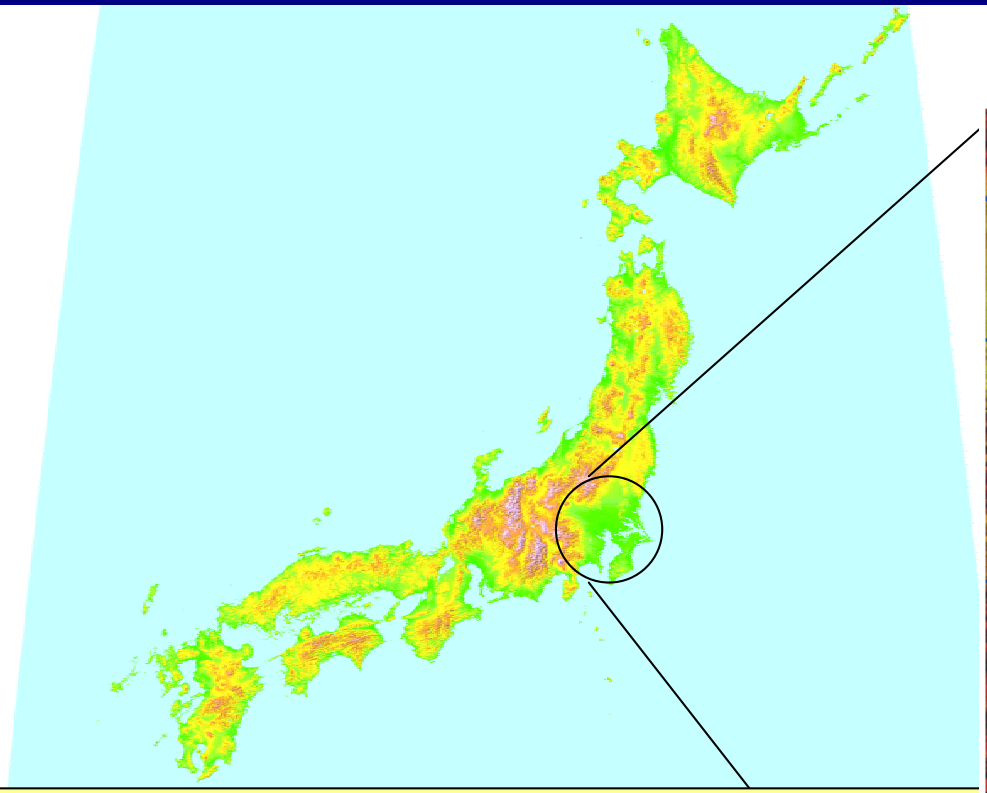
Adaptation measures related to water-related disasters to reduce the impacts of climate change due to global warming

April,2008

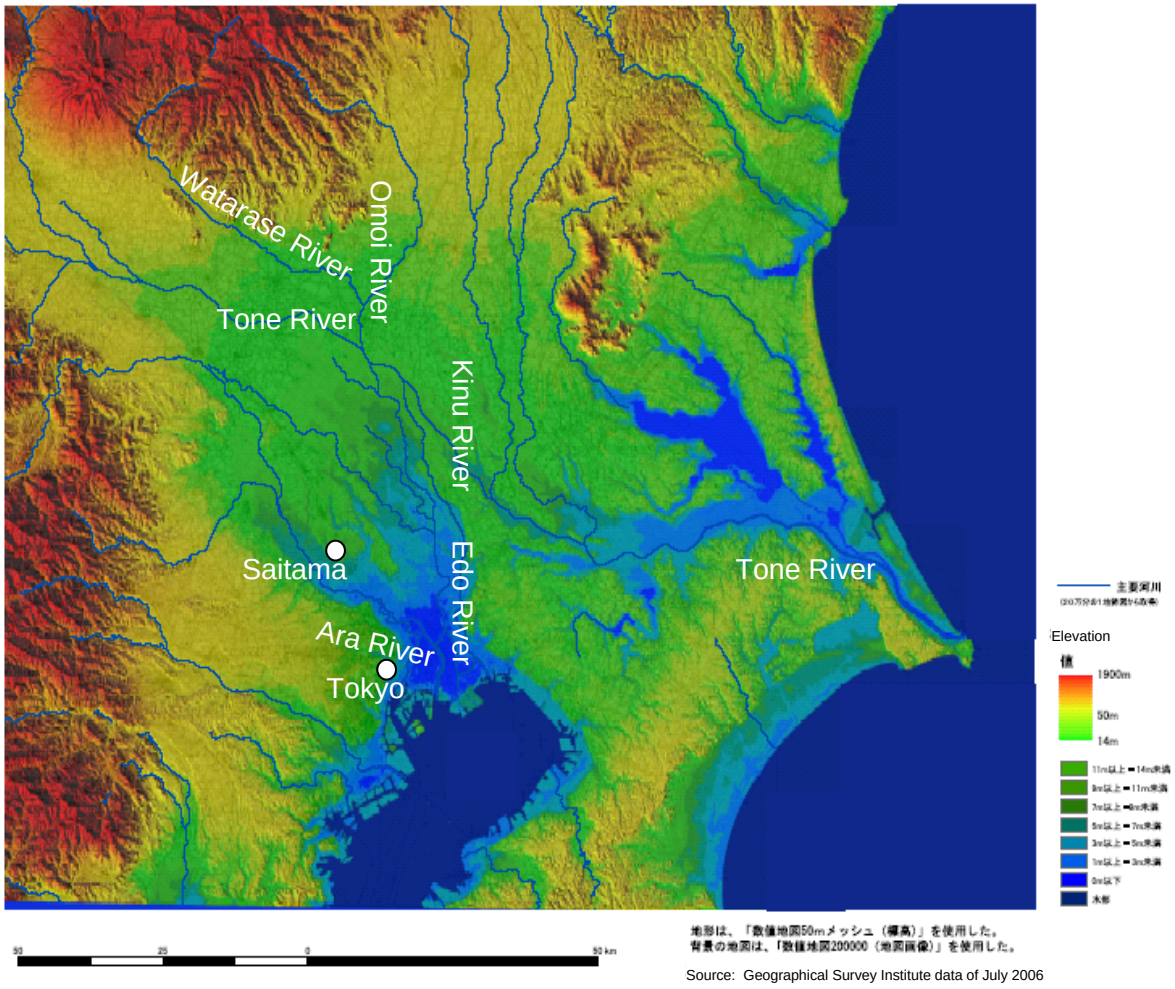
Ministry of Land, Infrastructure, Transport and Tourism

Japan is vulnerable to climate change.



(i) Land: A north-south stretch of land extending over a length of 2000 km
(ii) Four main islands: Four main islands are separated from one another by straits. There are also numerous small islands.
(iii) Backbone mountain range: Mountains run at the middle of the land.
(iv) Tectonic lines: Median and Itoigawa-Shizuoka Tectonic Lines run from north to south.
(v) Plains: Narrow plains are located along shorelines.
(vi) Weak soils: Most large cities are located on weak soils.
(vii) Earthquakes: About 10% of world's earthquakes occur in Japan.
(viii) Heavy rains: Japan is on the eastern edge of Monsoon Asian and is faced with the threats of heavy rains and typhoons. Rivers flow on steep slopes.
(ix) Snow cover: Sixty percent of land is located in snowy and cold areas.

Topography of the Kanto Plains from a viewpoint of flood control



Source: Geographical Survey Institute data of July 2006

About 50% of population and about 75% of property on about 10% of land lower than water levels in rivers during flooding

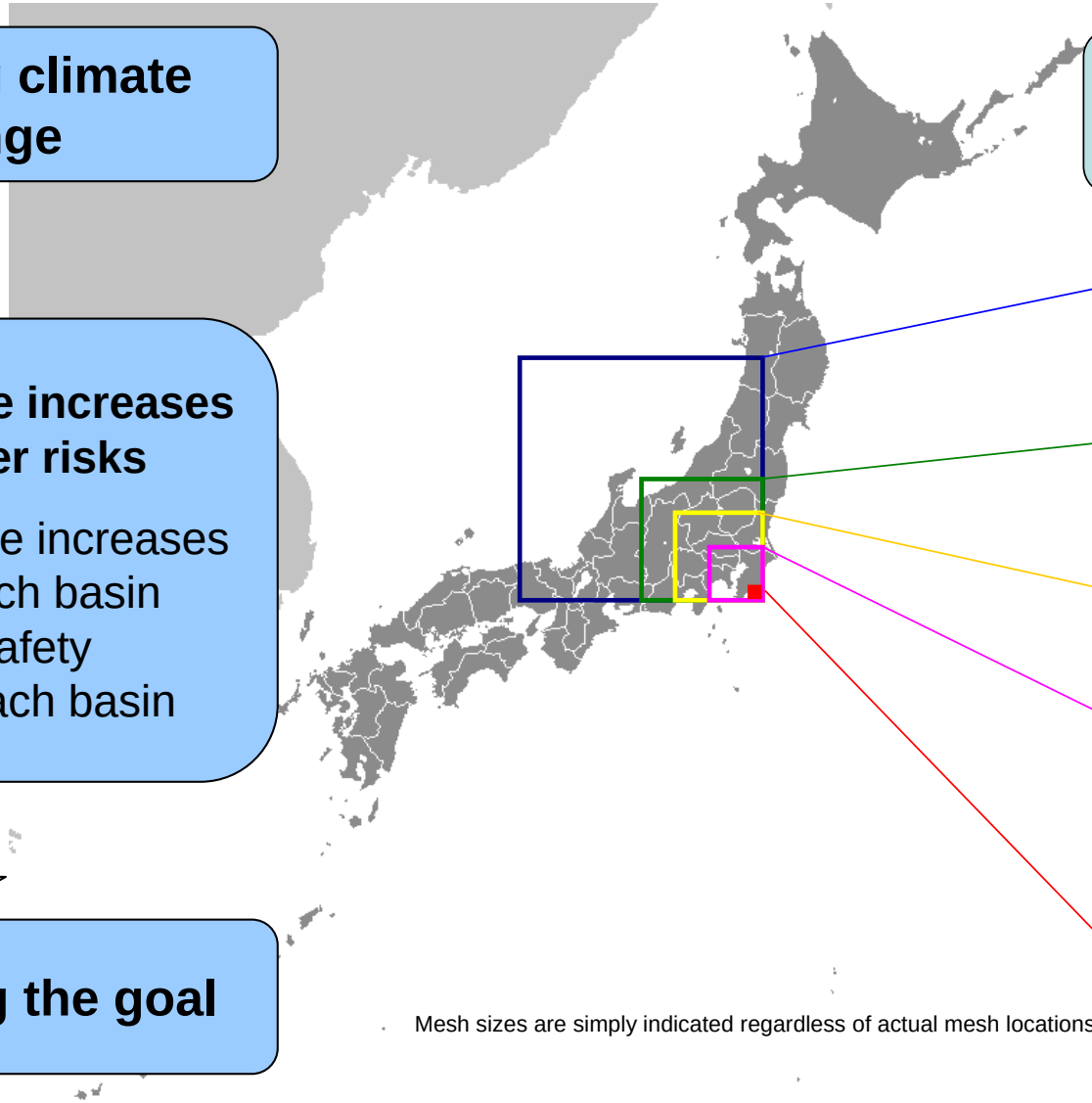
How to study adaptation measures

Predicting climate change

Predicting the increases of disaster risks

- Predicting the increases of floods in each basin
- Evaluating safety reduction in each basin

Re-defining the goal



Mesh sizes are simply indicated regardless of actual mesh locations.

Resolution of climate change prediction models has been enhanced year by year.

- IPCC First Assessment Report (1990): Horizontal resolution of about 500 km
- IPCC Second Assessment Report (1996): Horizontal resolution of about 250 km
- IPCC Third Assessment Report (2001): Horizontal resolution of about 180 km
- IPCC Fourth Assessment Report (2007): Horizontal resolution of about 110 km
- GCM20 and RCM20: Horizontal resolution of about 20 km

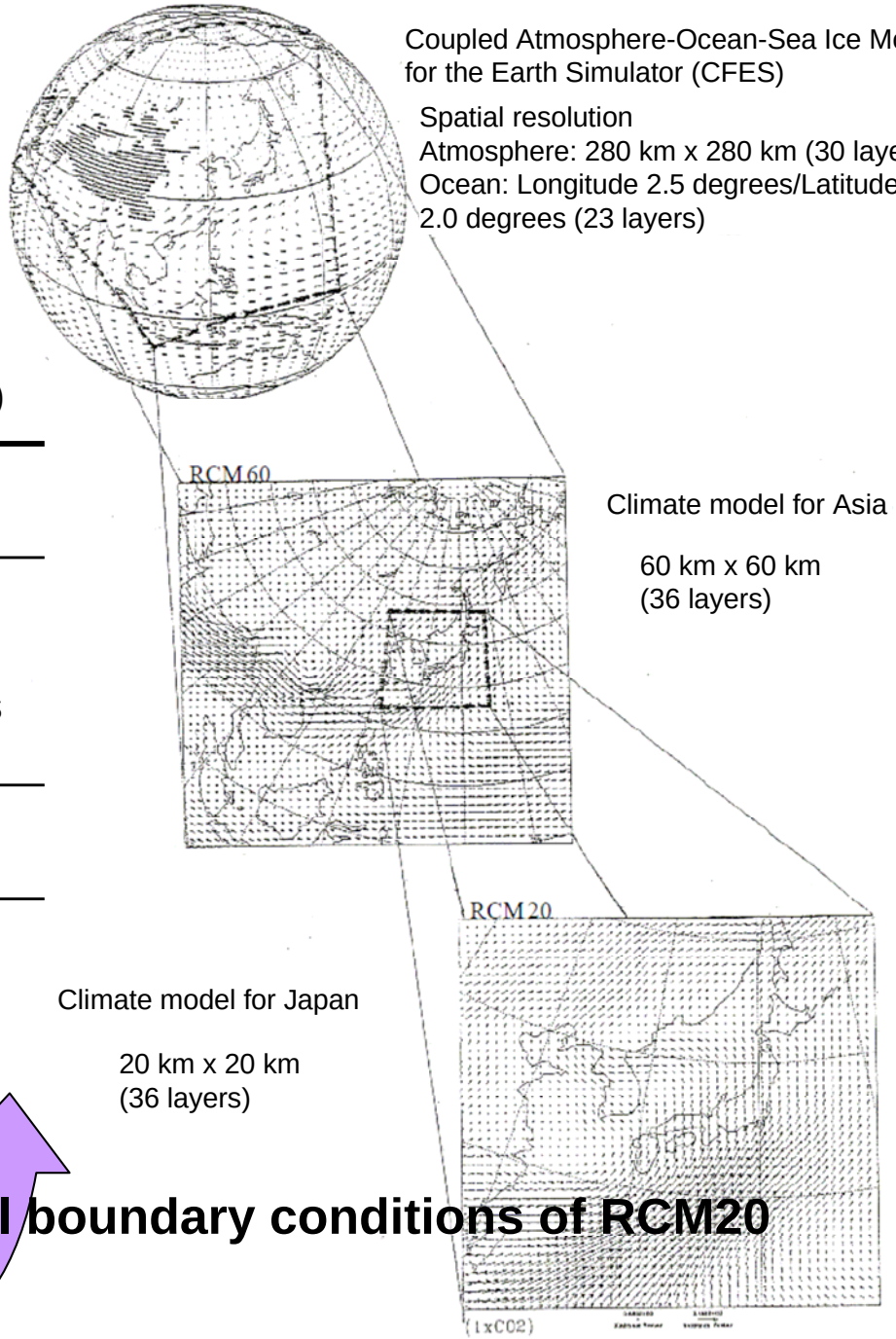
Prepared by the River Bureau

Regional Climate Models (RCM20 and GCM20)

The recently developed simulation model enables more detailed regional climate prediction.

Regional Climate Models

	GCM20 (General Circulation Model)	RCM20 (Regional Climate Model)
Areas to be Calculated	Global scale	Japan and surrounding areas
Horizontal Resolution	About 20 km Number of meshes 1920 x 960	About 20 km Number of meshes 129 x 129
Number of Vertical Layers	60 layers	36 layers
Lateral Boundary Conditions	N/A, as this is a global scale model.	Climate model for Asia



Concept of lateral boundary conditions of RCM20

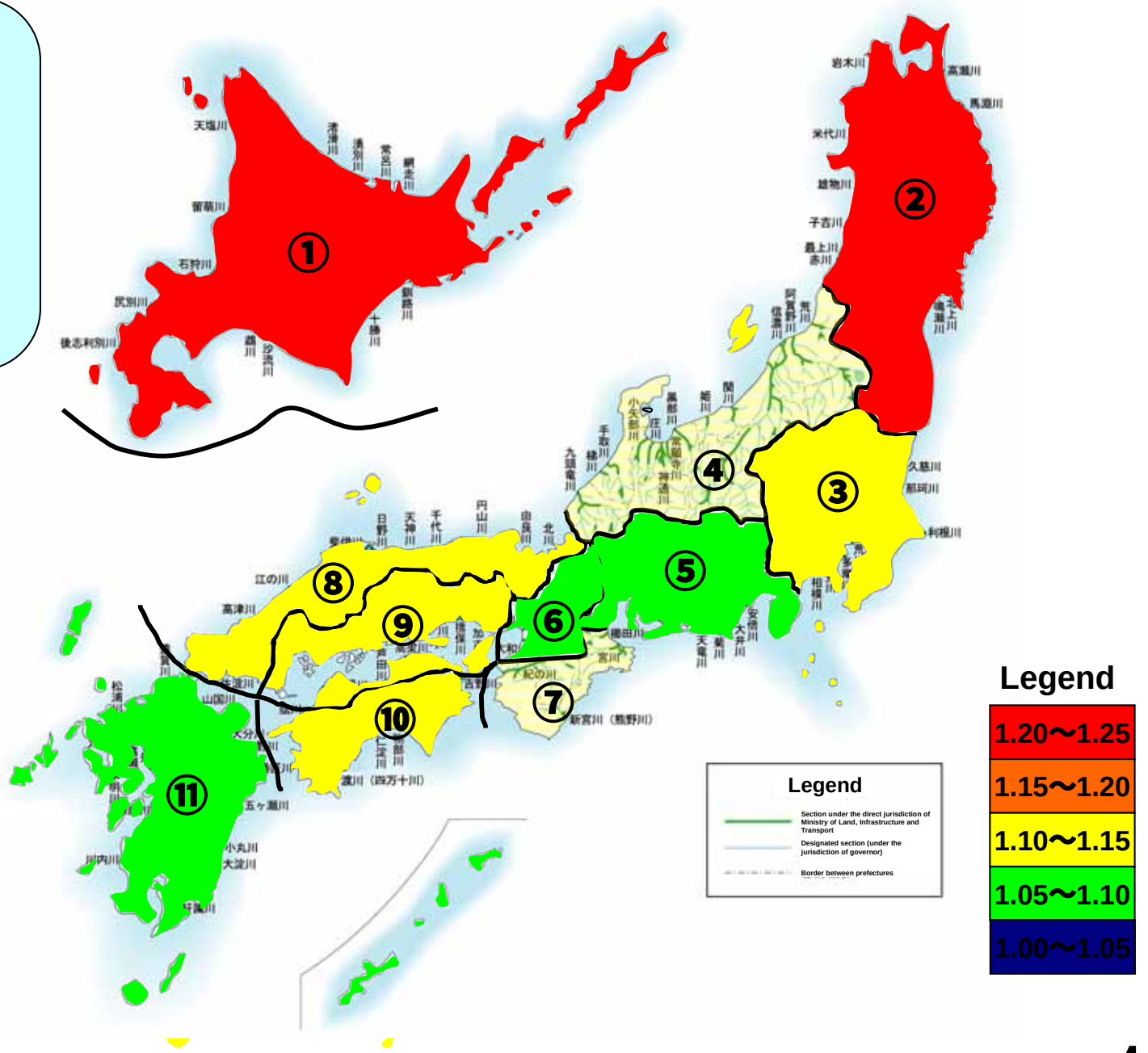
Areas with increased rainfall amount

Future rainfall amounts were predicted as a median value of

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

The above equation was obtained based on the maximum daily precipitation in the year at each survey point identified in GCM20 (A1B scenario).

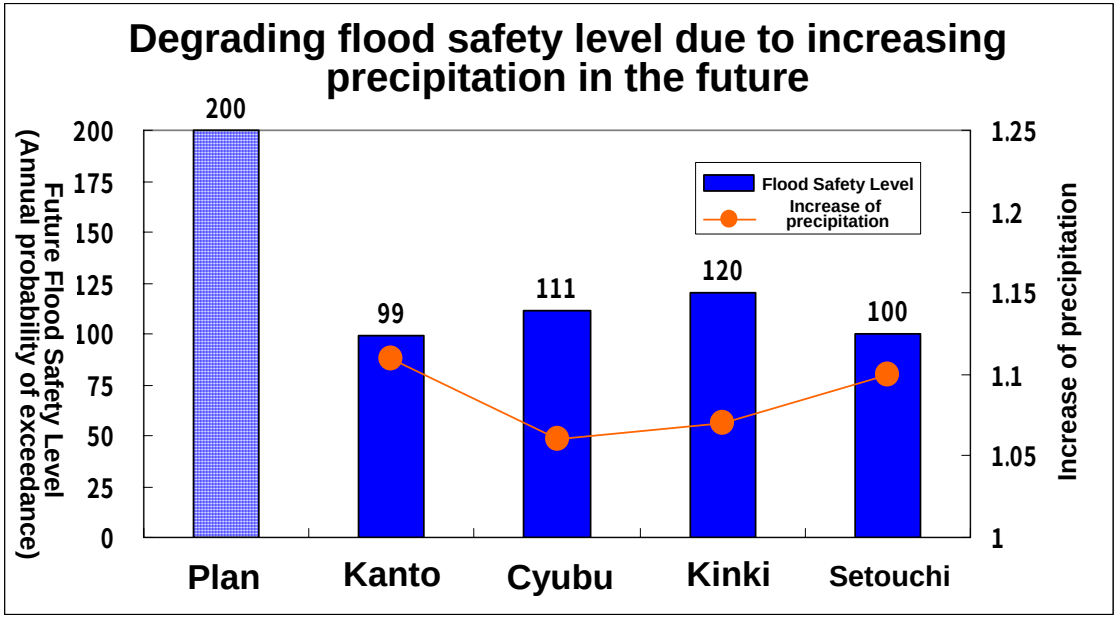
①	Hokkaido	1.24
②	Tohoku	1.22
③	Kanto	1.11
④	Hokuriku	1.14
⑤	Chubu	1.06
⑥	Kinki	1.07
⑦	Southern Kii	1.13
⑧	San-in	1.11
⑨	Setouchi	1.10
⑩	Southern Shikoku	1.11
⑪	Kyushu	1.07

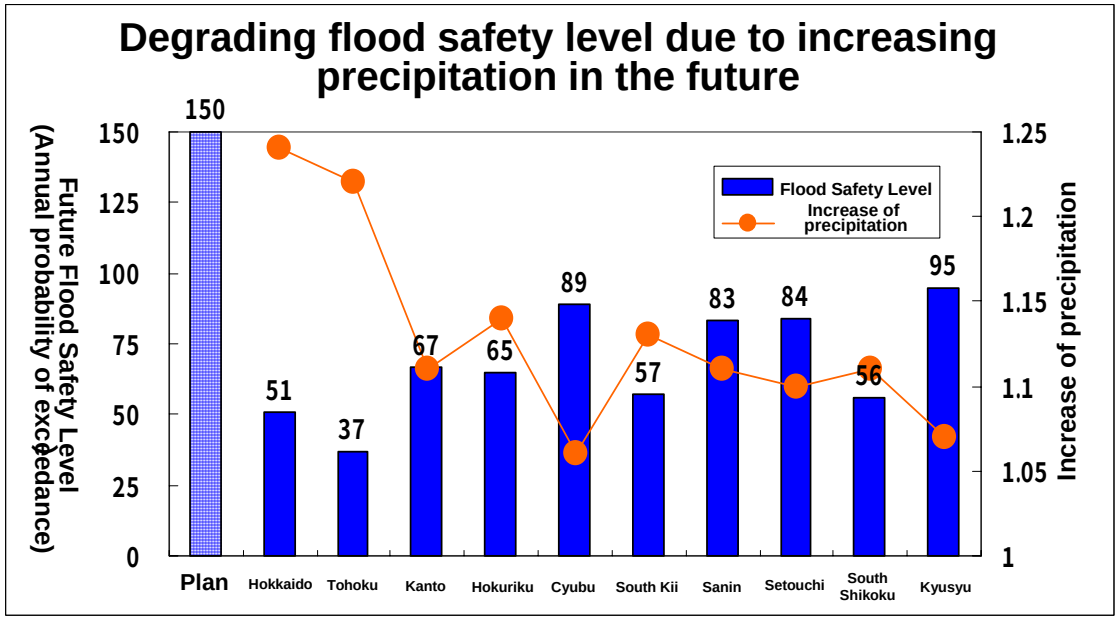


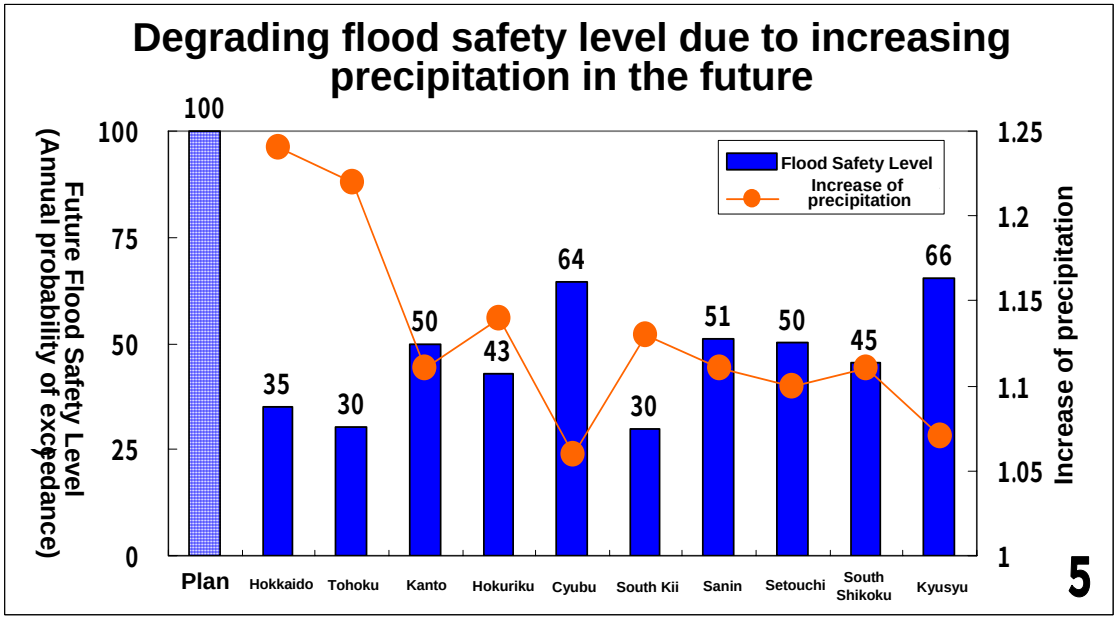
Degrading flood safety level due to increasing precipitation in the future

Region		Future increase in precipitation	Future Flood Safety Level (Annual probability of exceedance)					
			1/200 (Current Plan)	Number of River Basin	1/150 (Current Plan)	Number of River Basin	1/100 (Current Plan)	Number of River Basin
①	Hokkaido	1.24			1/51	2	1/35	8
②	Tohoku	1.22			1/37	5	1/30	5
③	Kanto	1.11	1/99	3	1/67	2	1/50	1
④	Hokuriku	1.14			1/65	5	1/43	4
⑤	Cyubu	1.06	1/111	2	1/89	4	1/64	3
⑥	Kinki	1.07	1/120	1				
⑦	Southern Kii	1.13			1/57	1	1/30	1
⑧	Sanin	1.11			1/83	1	1/51	5
⑨	Setouchi	1.10	1/100	1	1/84	3	1/50	3
⑩	Southern Shikoku	1.11			1/56	1	1/45	3
⑪	Kyusyu	1.07			1/95	4	1/66	14

※ 82 River Basins calculated flood safety level







Climate change adaptation measures (against water-related disasters)

Climate change due to global warming is expected to induce the following phenomena in coastal and low-lying areas.
-More frequent heavy rains and more intense typhoons
⇨ Frequent and serious flood and sediment disasters
-Sea level rise and more intense typhoons
⇨ Frequent and serious high tides and coastal erosions
-Wider range of variation of rainfall intensity and change of river flow regime
⇨ Frequent and serious droughts

Combining CO_2 reduction measures (mitigation measures) with global warming control measures (adaptation measures) is important to further reduction of the risks of climate change.

○Basic direction of climate change adaptation measures

1. Adaptation measures to achieve "zero victims" should be considered because providing full protection from disasters is difficult.
2. In a nerve center like the Tokyo metropolitan area, intensive efforts should be made such as preventing the central government from ceasing functioning to minimize the damage.

○To provide protection from frequent floods expected to be caused by climate change due to global warming, flood control policy should shift from the conventional approach for ensuring safety only in rivers to the addition of measures in the basin such as the one allowing inundation.

Basic direction of adaptation measures: Zero victims

Directions of adaptation measures

○ Define how to deal with increasing external forces using facilities.
Facilities-based adaptation measures will be taken such as the improvement of reliability, effective use or prolonging of lives of existing facilities and the construction of new facilities.

○ Set the level of protection according to the magnitude of the external force beyond the capacity of facilities.

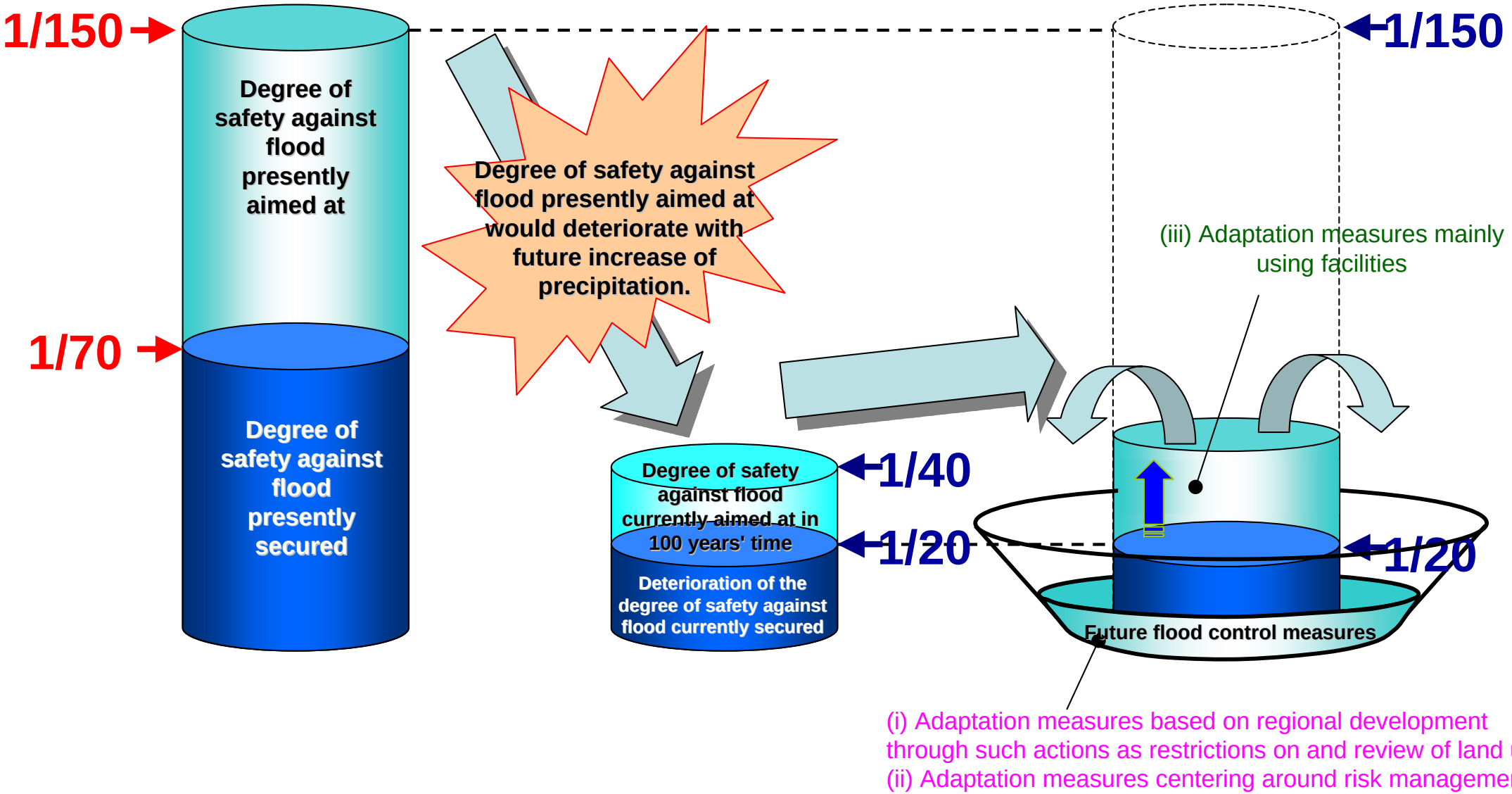
○ Determine adaptation measures accordingly to minimize damage.

1) Adaptation measures based on regional development through actions including the restrictions on and review of land use, such as a review of land use and ways of living and guidance in planning of inundation-resistant communities.
2) Adaptation measures based on risk management such as the development of a wide-area support system during a disaster, and studies of escape, relief and salvation, and restoration and rehabilitation activities.

Limitations of adaptation measures

Red figures indicate present degree of safety against flood.

Blue figures indicate future degree of safety against flood.

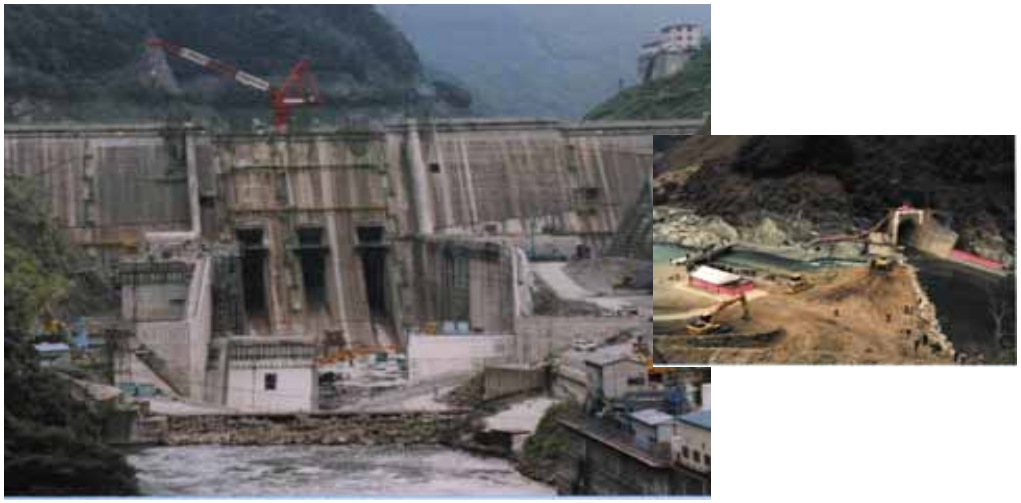


Facilities-based adaptation measures

Development of new facilities including the construction of new embankments, widening of river channels and construction of flood-regulating dams; and maximum use of existing facilities

Development of new facilities

Development of a river channel



Construction of a flood-regulating dam

Effective use or prolonging of the life of an existing facility (removal of sediment from an existing reservoir)

Example: Yokoyama Dam

Facilities-based adaptation measures

Improvement of reliability, effective use, use for multiple purposes and prolonging of lives of existing facilities

Improving the reliability of an existing facility (a coastal facility)

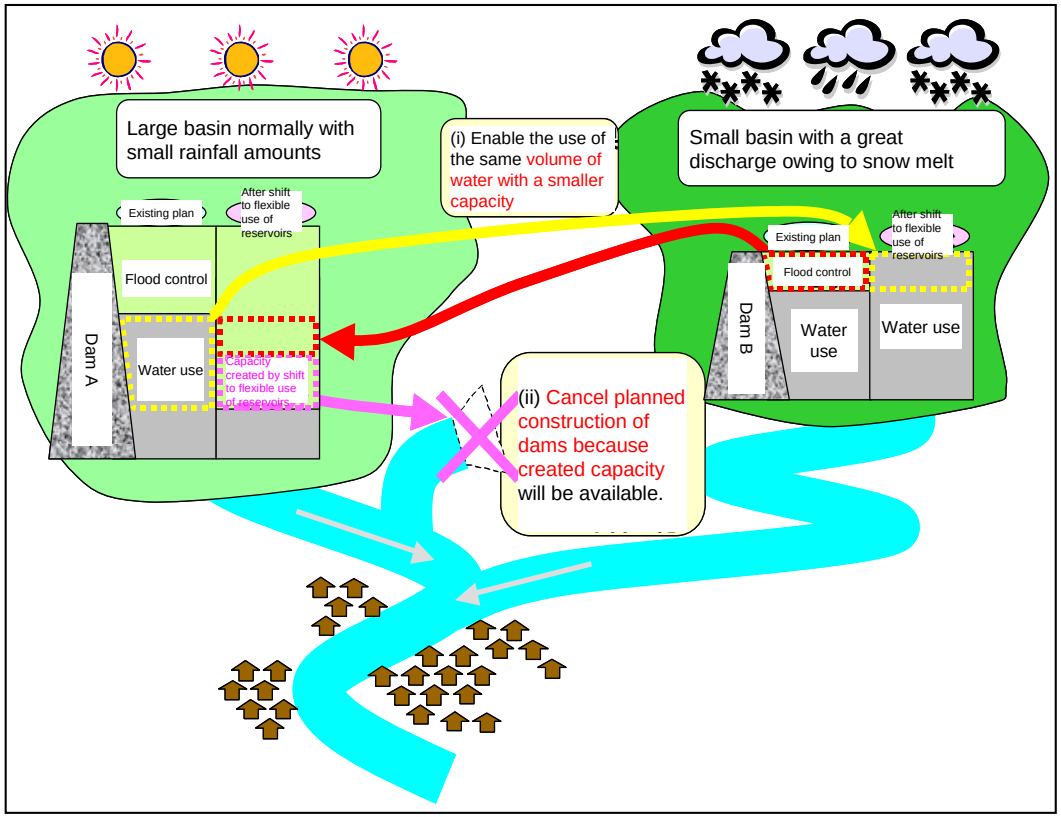
Before improvement

Revetment with deteriorated concrete

After improvement

Revetment with increased thickness

Effective use of existing facilities (flexible use of reservoirs)



Flexible use of reservoirs

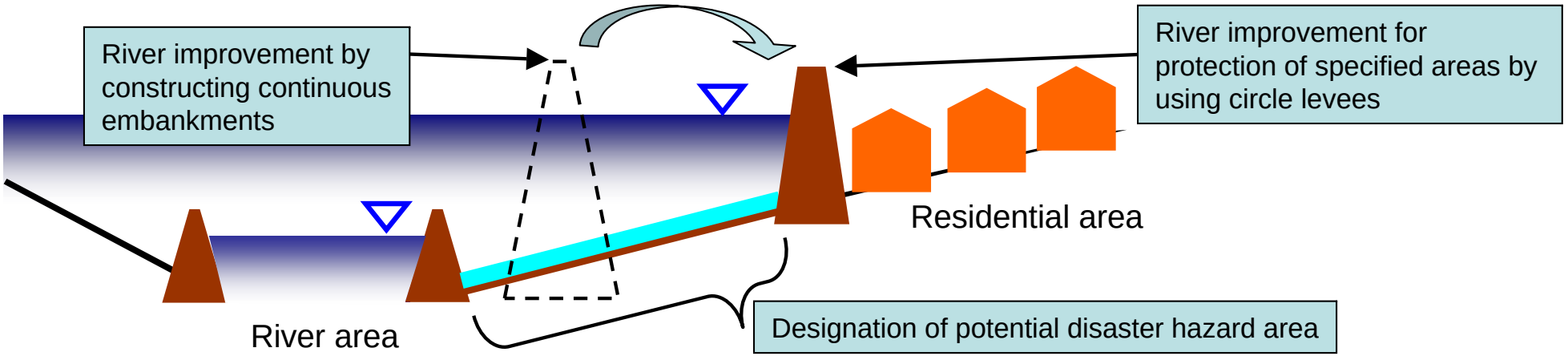
- Use the capacity for water use of the existing reservoir for controlling floods
- Flexible use of combined capacity of existing and newly constructed reservoirs

Increase the effectiveness for flood control and safety against floods

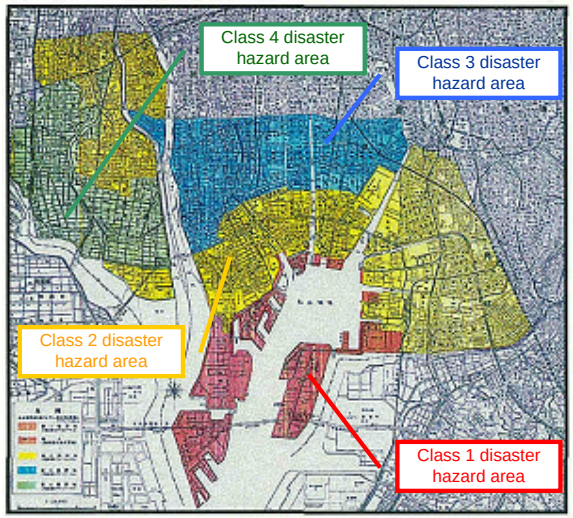
Adaptation measures based on regional development through such actions as restrictions and review of land use

Response to floods that cannot be dealt with by facility-based measures, through land use or community development allowing inundation.

Shift to land use or ways of living that minimize damage

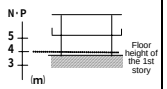
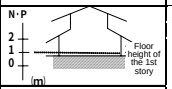
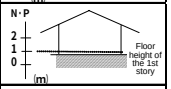
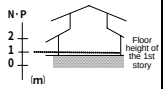


Restrictions on land use by designating potential disaster hazard areas



Map of disaster protection zones in the waterfront area of Nagoya

Sample ordinance restrictions (Nagoya City)

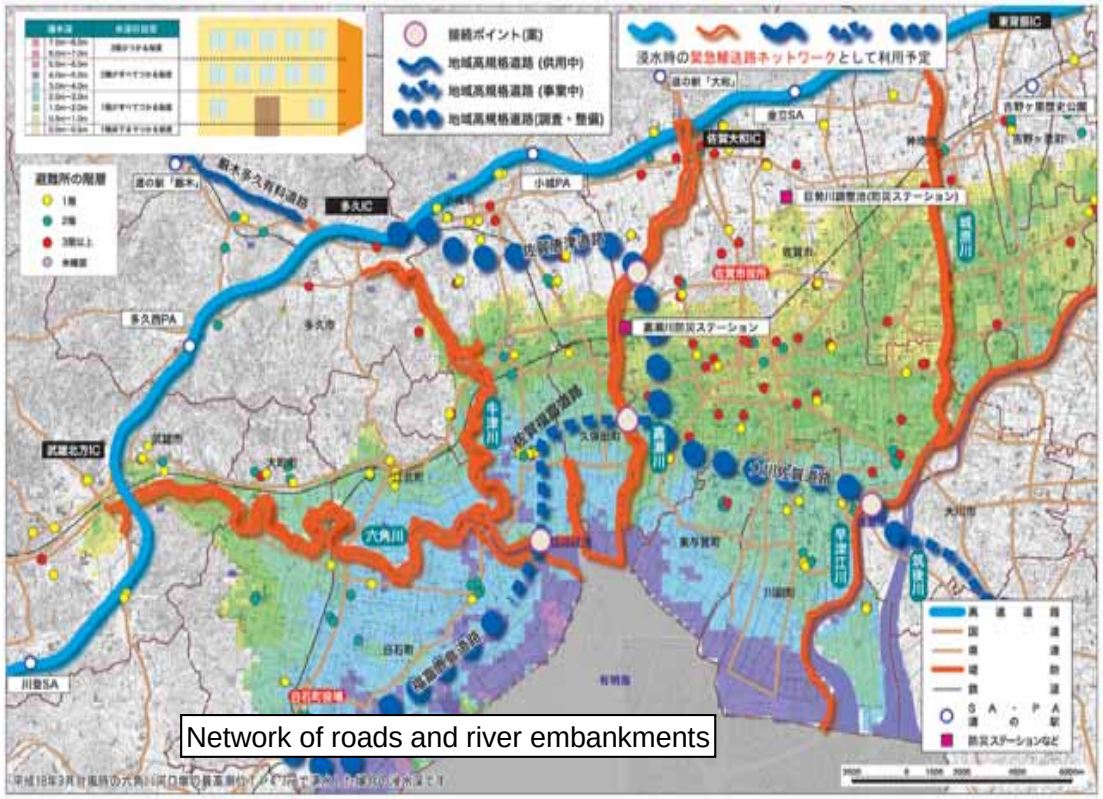
		Floor height of the 1st story	Structural restriction	Illustration	
Class 1 zone	Urbanization promotion area	N·P (+) 4m or more	Wooden structure is prohibited.		*No buildings shall be constructed. Scope --- Areas designated by the mayor the distance from which to any shore line or riverbank line is not longer than 50 meters. Restriction --- Any building having one habitable room or more, hospital, welfare facility for children, and the like shall not be constructed. Any building of non-wooden construction may be constructed, provided that the height of the floor of any habitable room, etc. is not less than N·P (+) 5.5m or more.
Class 2 zone	Urbanization promotion area	N·P (+) 1m or more	Any habitable room shall be located on the second story or higher. Relaxation: For a building with a total floor area no more than 100m², the aforementioned restriction may be replaced with the provision of an evacuation room and evacuation equipment.		*Restriction on public buildings (Classes 2 to 4 zones) Scope --- Schools, hospitals, assembly halls, public offices, welfare facilities for children, and other public buildings similar thereto. Restriction --- The floor height of the 1st story shall be N·P (+) 2m and any habitable room shall be located at a height of N·P (+) 3.5m or higher.
Class 3 zone	Urbanization promotion area	N·P (+) 1m or more	———		
Class 4 zone	Urbanization control area	N·P (+) 1m or more	Any habitable room shall be located on the second story or higher.		

Shift to community planning resistant to inundation

○Adopting pilotis to prevent damage to buildings during a flood

Adaptation measures centering around risk management

Building of a wide-area disaster prevention network that connects embankments, roads on the dry river bed for emergency traffic and elevated roads to wide-area disaster prevention bases.



Network of roads and river embankments

Inundation of Route 34 during a flood in July 1990

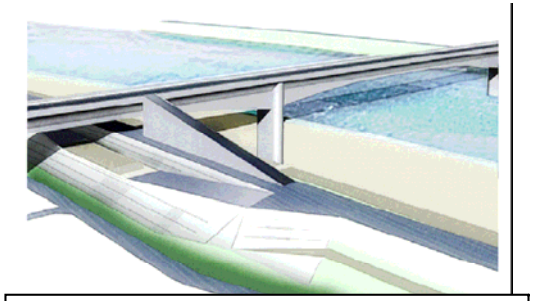


Image of road-embankment connection

Reinforcement of actions in the initial stages of a disaster for minimizing damage and restoring infrastructure early, and enhancement of an organizational setup to achieve the goal

Technical Emergency Control Force (TEC-FORCE)

TEC-FORCE

Organizational setup

- Field support center
- Wide-area infrastructure force (rivers, roads, sediment control, ports, etc.)
- Sewerage system force
- Building land force
- Buildings force

- Staff of Regional Development Bureaus and Offices
  - Engineers of National Institute for Land and Infrastructure Management and Public Works Research Institute
  - Technical support group (engineers)
  - Contract/agreement: Private sector construction organizations (operators of equipment)

Coordination

- Staff of local public entities

Activities
-Investigation of damage
-Quick fix
-Prediction of degree of damage risk
-Planning of control measures
-High-level technical guidance
-Assistance in reconstruction

Drainage pumping vehicle

Disaster control helicopter

Adaptation measures based on risk management

Share preliminary information concerning the degree of flood risk

Water levels in built-up areas in the past floods are indicated on the hazard map.

Information dissemination channel

Underground space

Hints on escape and necessities

Potential inundation areas and depths of inundation

Locations and names of shelters

Points of contact
-Administrative organizations
-Medical institutions
-Lifeline systems management organizations

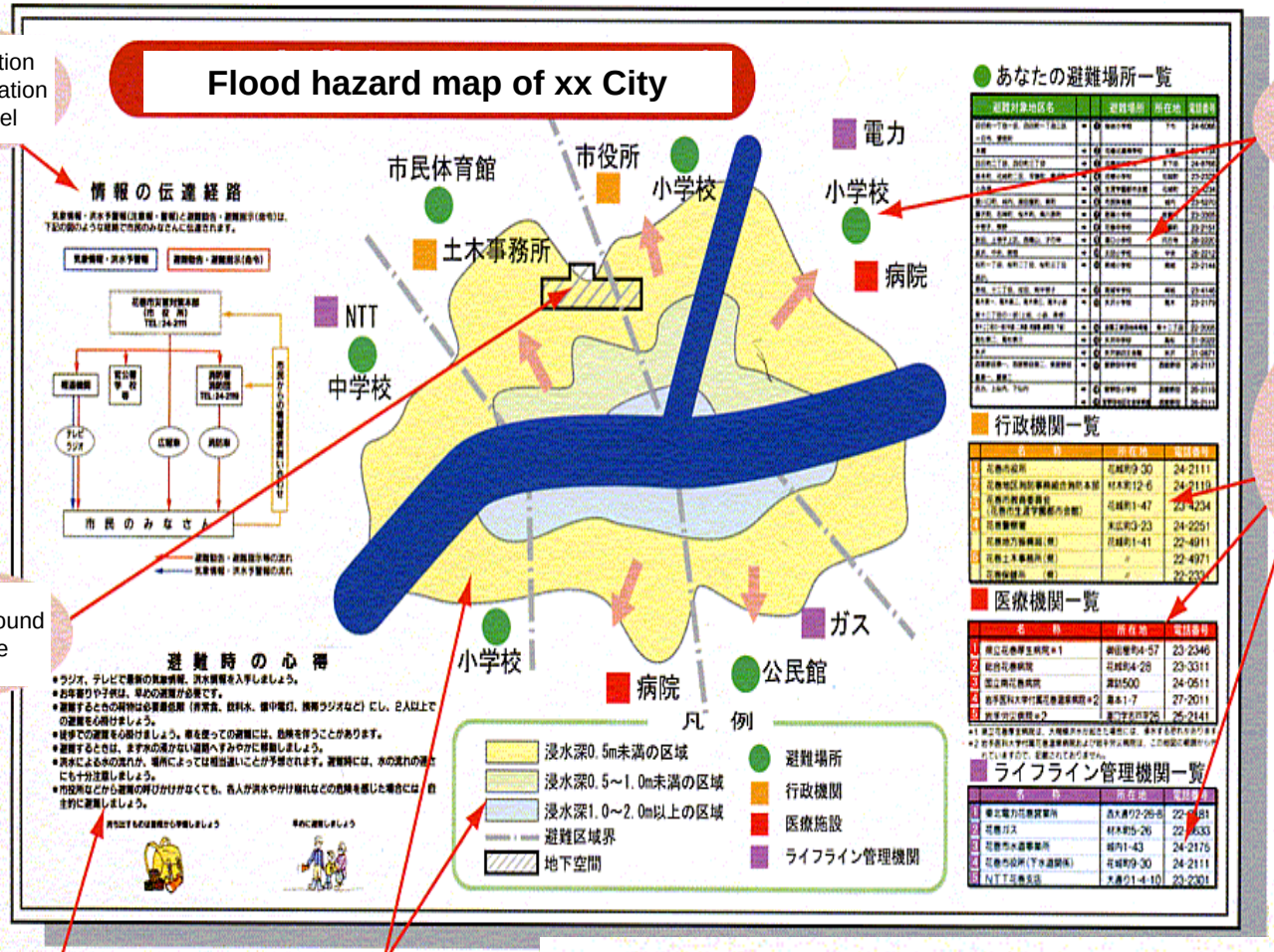


Image of a flood hazard map

Toyooka City, Hyogo Prefecture

Flood

Embankment

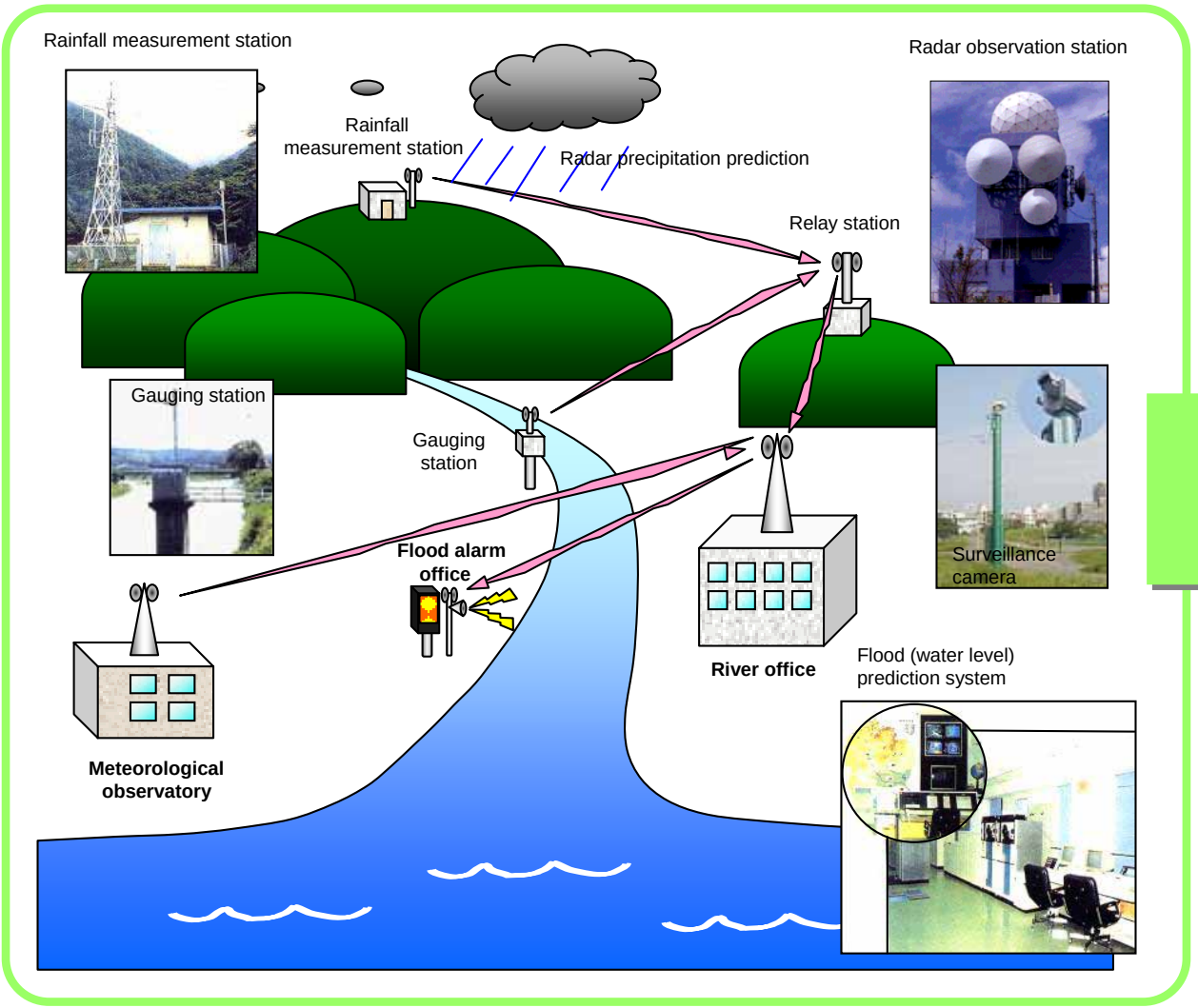
Shelter (building)

Easily recognizable signs

Adaptation measures based on risk management

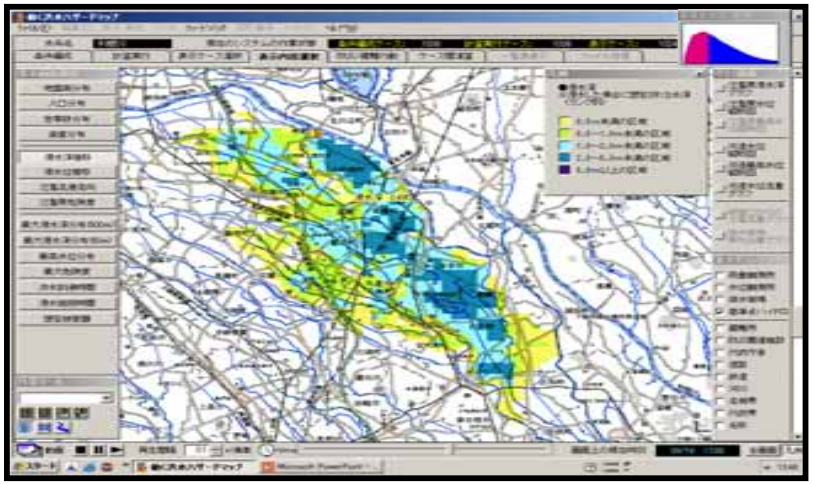
Share real-time information

- Provision of rainfall amounts and water levels real-time via cellular phone, the Internet or local disaster prevention radio
- Flood forecasting through real-time simulation



Information provision via cellular phone or personal computer

Delivery of an image to a TV screen



Floodwater prediction through real-time simulation