Adaptation Strategy for Climate Change in Japan

- Toward Water-disaster Adaptive society -

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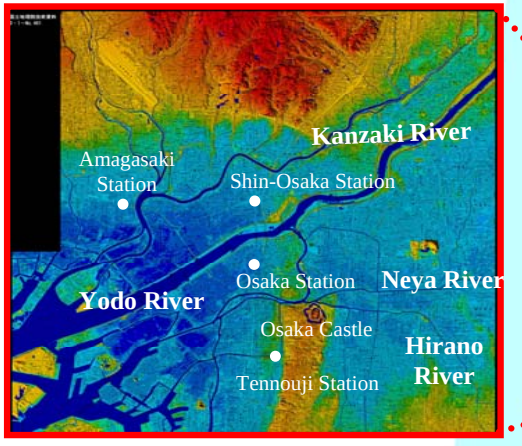
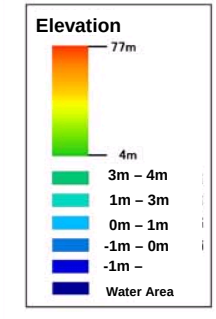
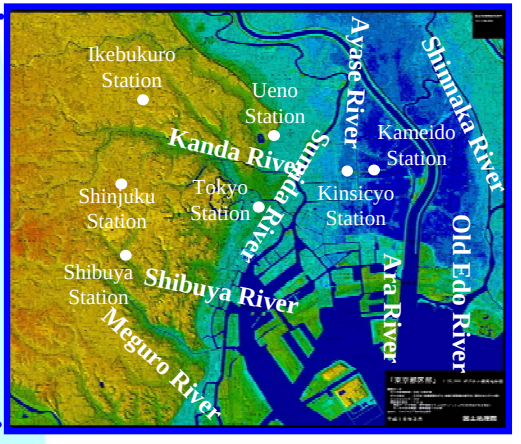
Japan is vulnerable to climate change

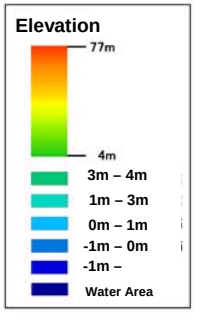
Kinki Region

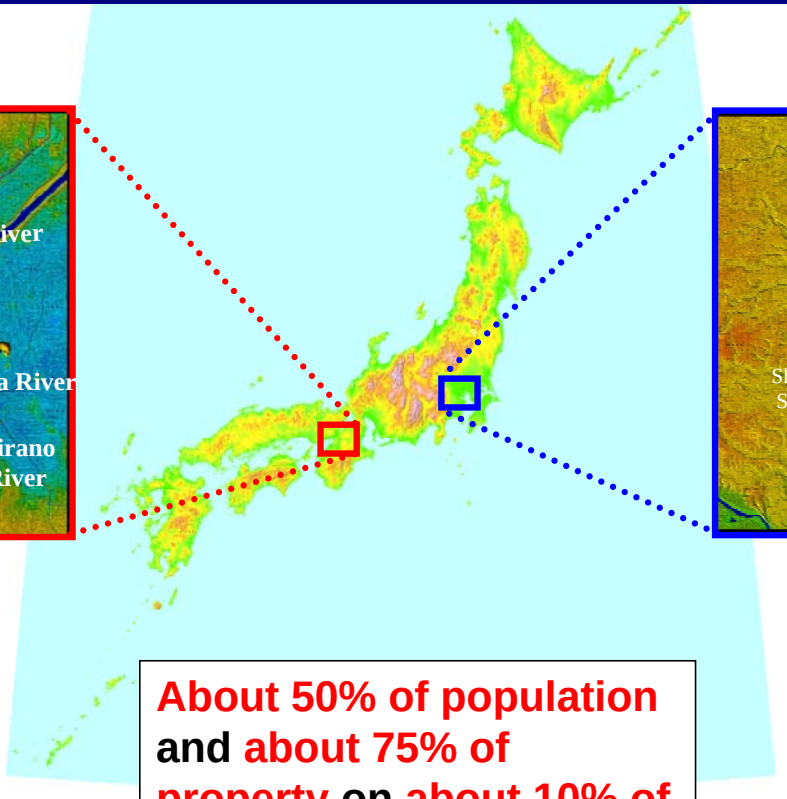




Kanto Region







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

2008 Floods in Japan

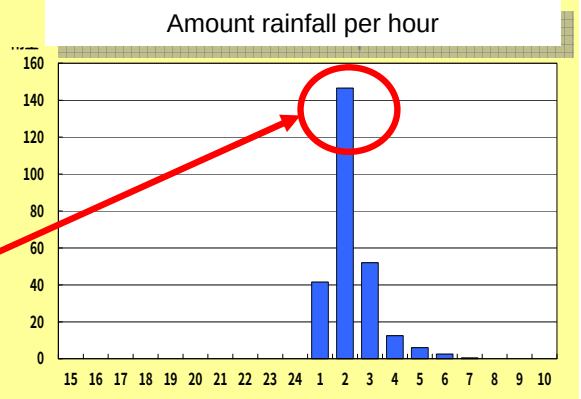
2008.7.28 Floods in Hyogo Pref.

Rapid water level rise of **134cm** in **10 minutes**

2008.8.29 Floods in Aichi Pref.

largest-ever amount rainfall per hour

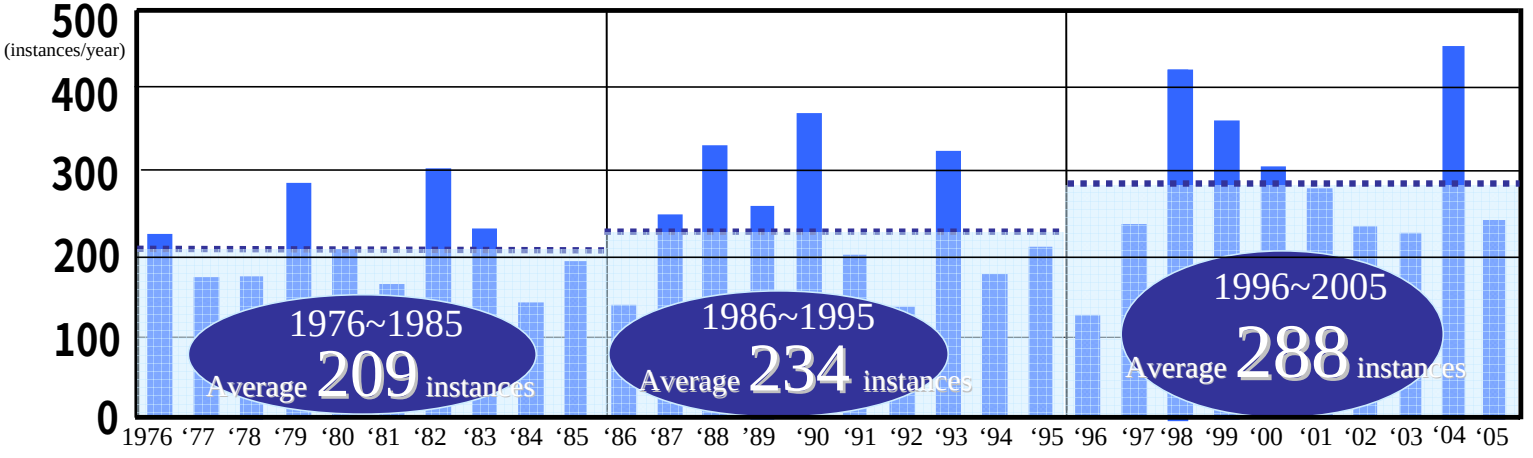
(146mm/h)



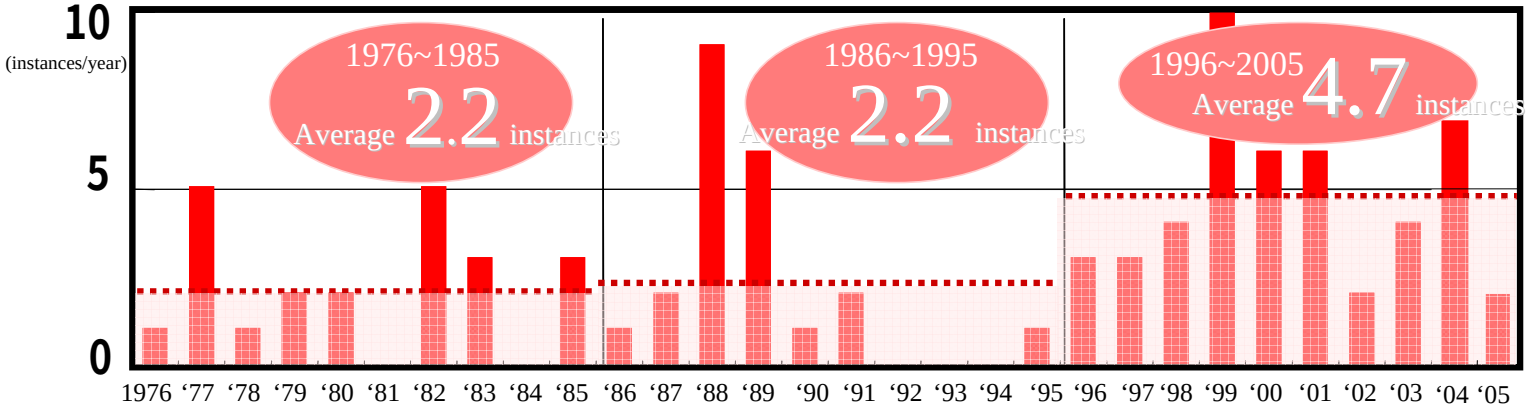
Increase of torrential rain

Annual total of hourly rainfall instances
(from approx. 1,300 AMeDAS locations across Japan)

1. Number of instances of 50 mm or more rain in an hour



2. Number of instances of 100 mm or more rain in an hour



Data from the materials prepared by the Meteorological Agency

Mechanism of global warming and climate change

Large volumes of greenhouse gas emissions cause CO_2 concentration in the air to rise and increase heat absorption, resulting in temperature rise. Thus, global warming occurs.

- Melting of glaciers, ice caps and ice sheets
- Thermal expansion of sea water
- Change in evapotranspiration
- Change in snow accumulation condition

- Sea level rise (Maximum rise: 59 cm)
- More intense typhoons
- Increase of precipitation by a factor of 1.1 to 1.3*
- More frequent heavy rains and droughts
- Earlier snow melt and reduction of discharge

- Increase of river flow rate
- Change in water use pattern

- More frequent high tides and coastal erosions
- More frequent floods
- More serious debris flow
- Higher risk of drought

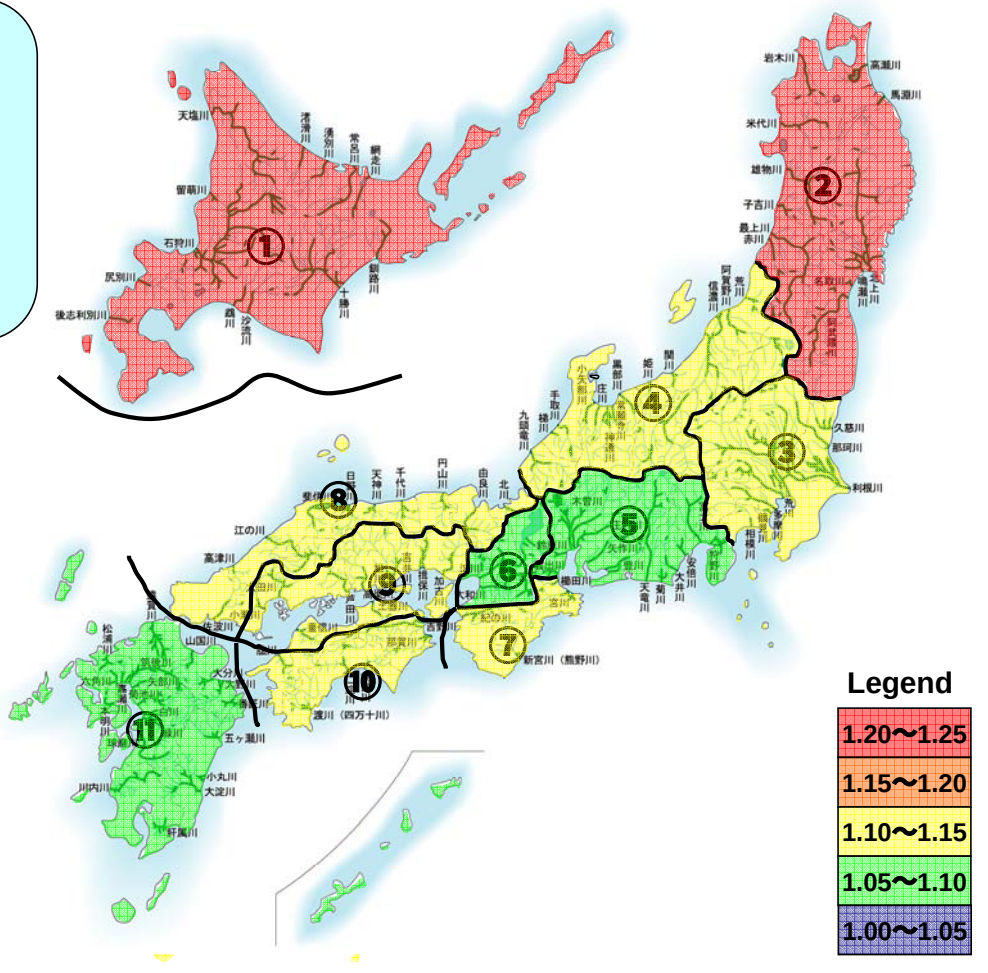
Estimation of increased rainfall in region

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

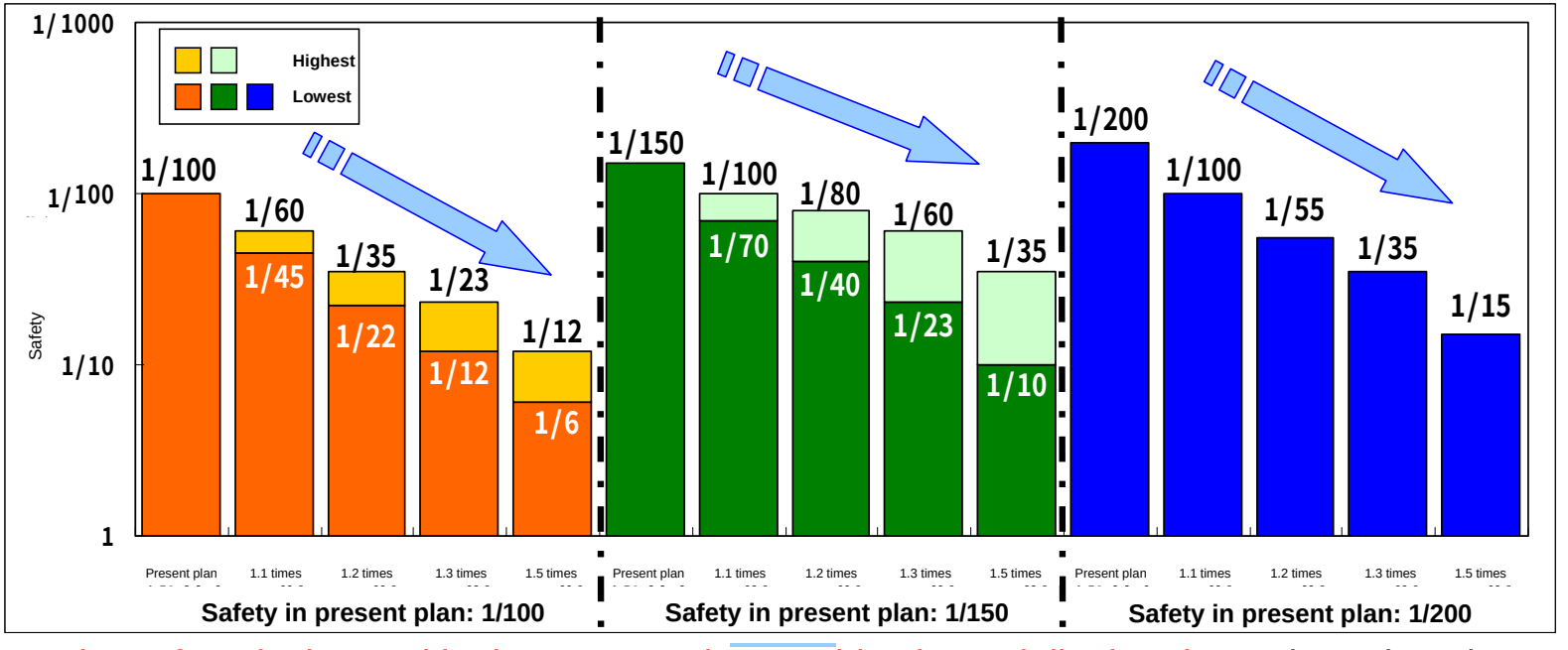
①	Hokkaido	1.24
②	Tohoku	1.22
③	Kanto	1.11
④	Hokuriku	1.14
⑤	Chubu	1.06
⑥	Kinki	1.07
⑦	Southern Kii	1.13
⑧	San-in	1.11
⑨	Setouchi	1.10
⑩	Southern Shikoku	1.11
⑪	Kyushu	1.07



Impacts of precipitation 100 years from now on safety against flood

Precipitation 100 years from now is projected to be about 1.1 to 1.3 times the present level. The highest projection may be 1.5 times.

Impacts of precipitation 100 years from now on safety against flood

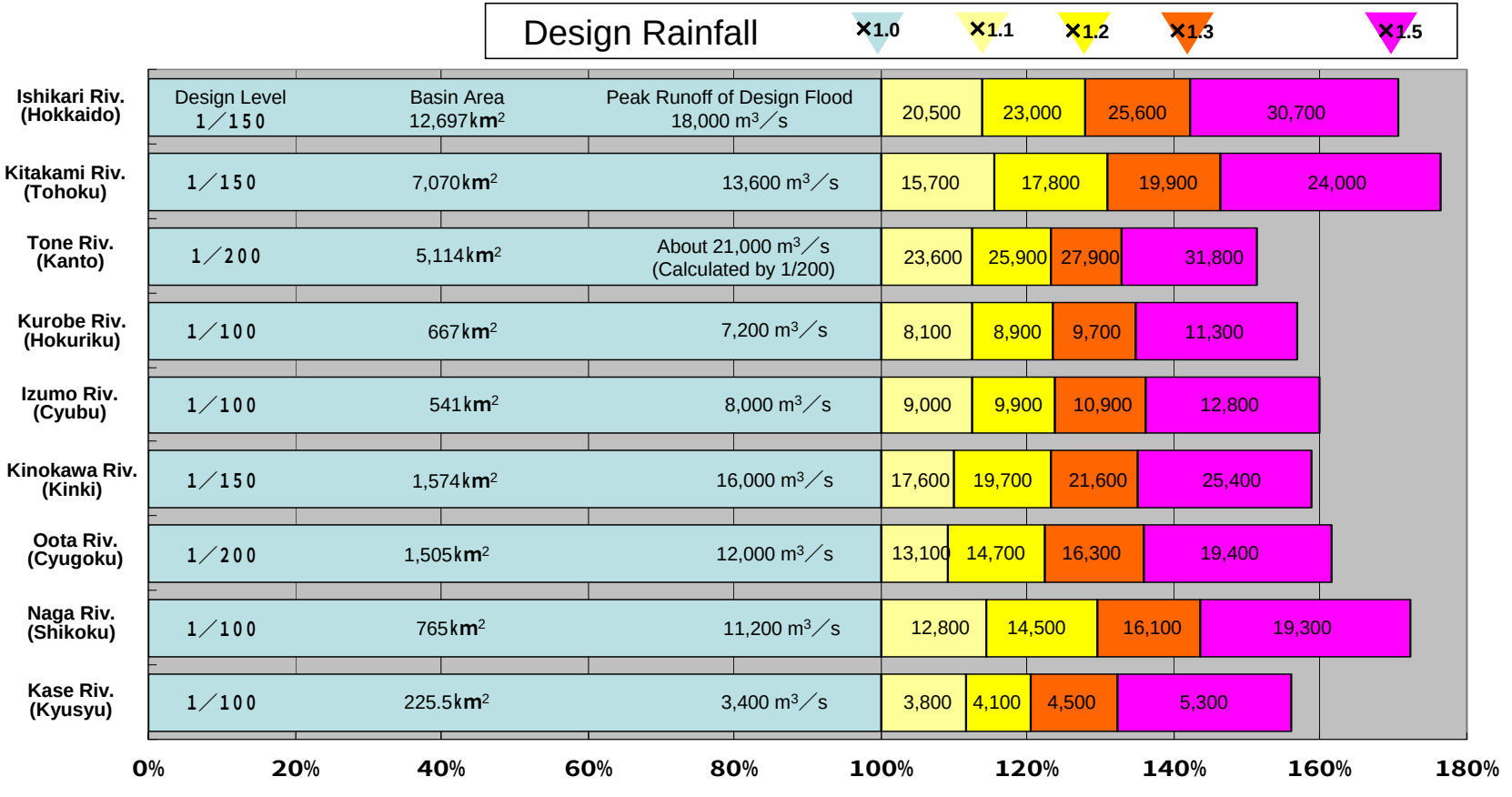


The safety designated in the present plan would substantially deteriorate based on the assumption of projected precipitation 100 years from now.

More frequent inundation and flooding

Changes of peak runoff by future rainfall

Estimations of future rainfall are about ×1.1 ～×1.5 compare to current rainfall. Peak runoff will be estimated about ×1.1 ～×1.7 compare to current peak runoff in 9 major rivers.



Frequent and more serious droughts: Deterioration of safety against droughts

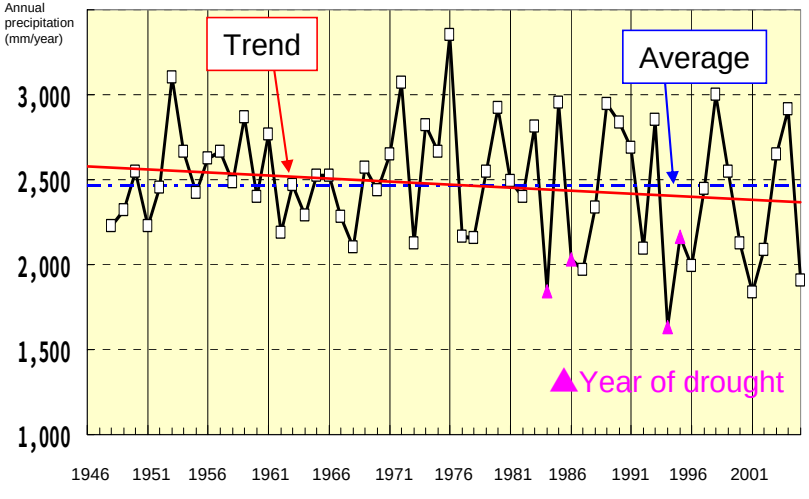
■There has been a smaller rainfall amount in recent years and the range of variation has been lower than in the late 1940s through the late 1960s when dams and other facilities were constructed.

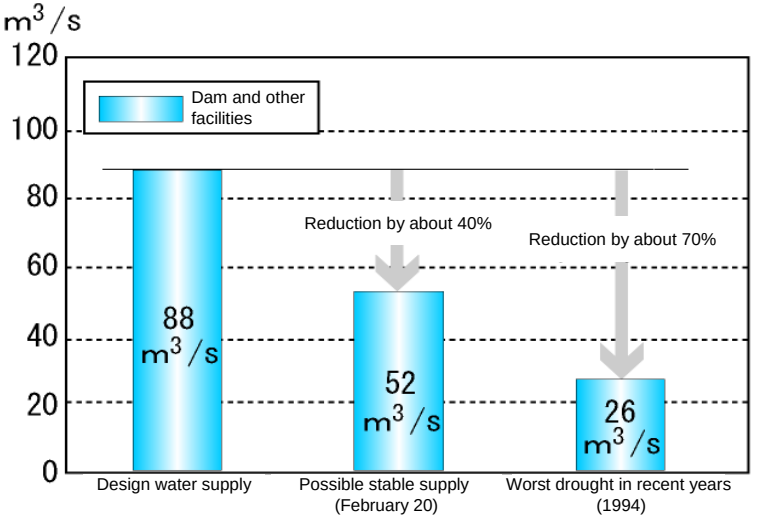
■As a result, stable water supply using dams has been decreasing.

Example in the Kiso River system

◇In recent years (in 1979 through 1998): Reduction of water supply below the design level by about 40%

◇Worst drought in recent years (1994): Reduction of water supply below the design level by about 70%



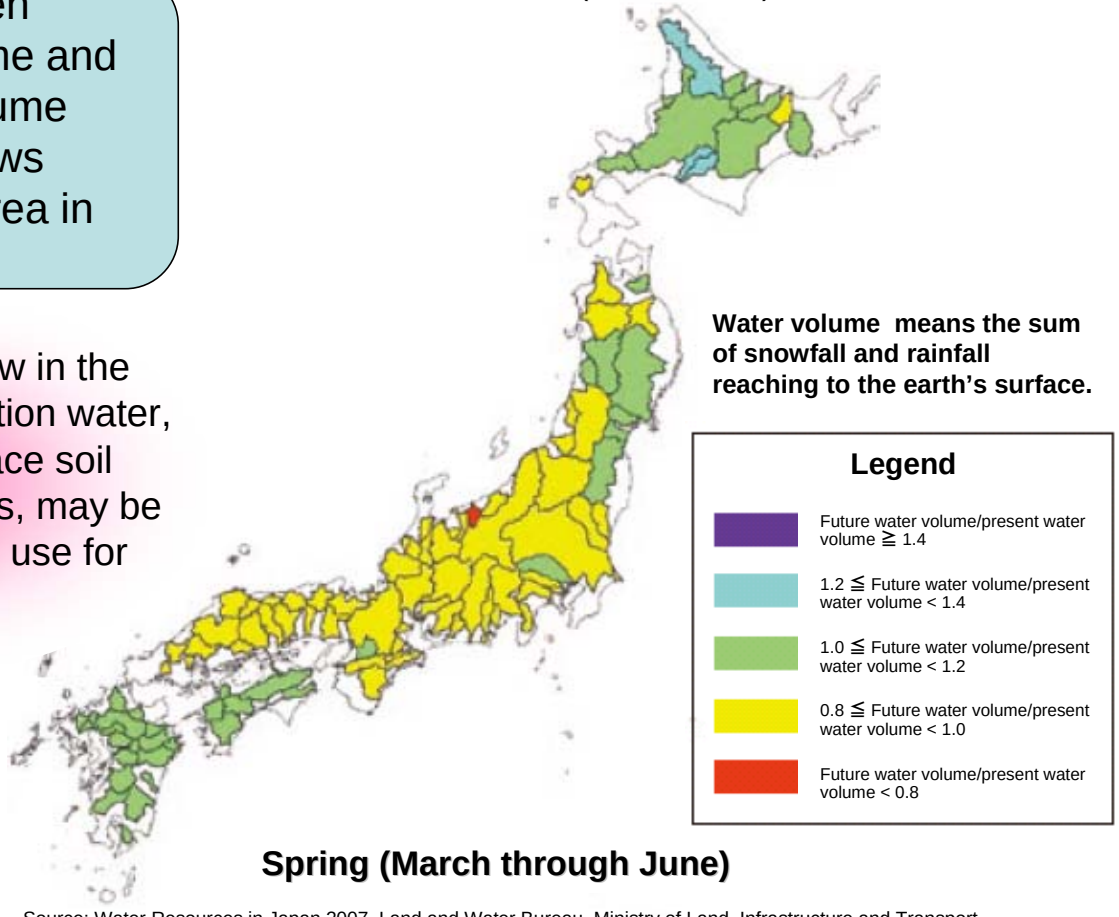


More frequent and serious droughts

Comparison between present water volume and predicted water volume after 100 years shows decrease in most area in March - June

Reduction of river flow in the periods requiring irrigation water, e.g. during the surface soil puddling in paddy fields, may be deteriorated to water use for rice farming.

Comparison between present conditions(1979 to 1998) and future rainfall(2080 to 2099) in Class A river



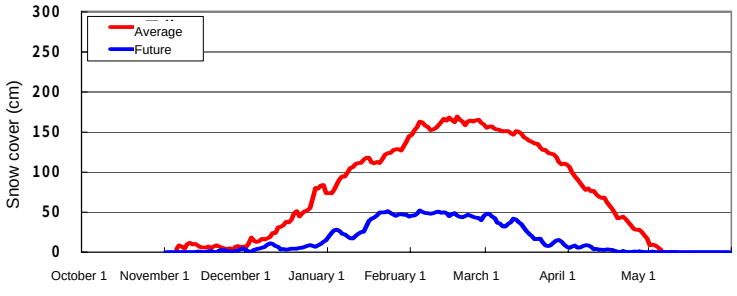
Source: Water Resources in Japan 2007, Land and Water Bureau, Ministry of Land, Infrastructure and Transport

Frequent and more serious droughts

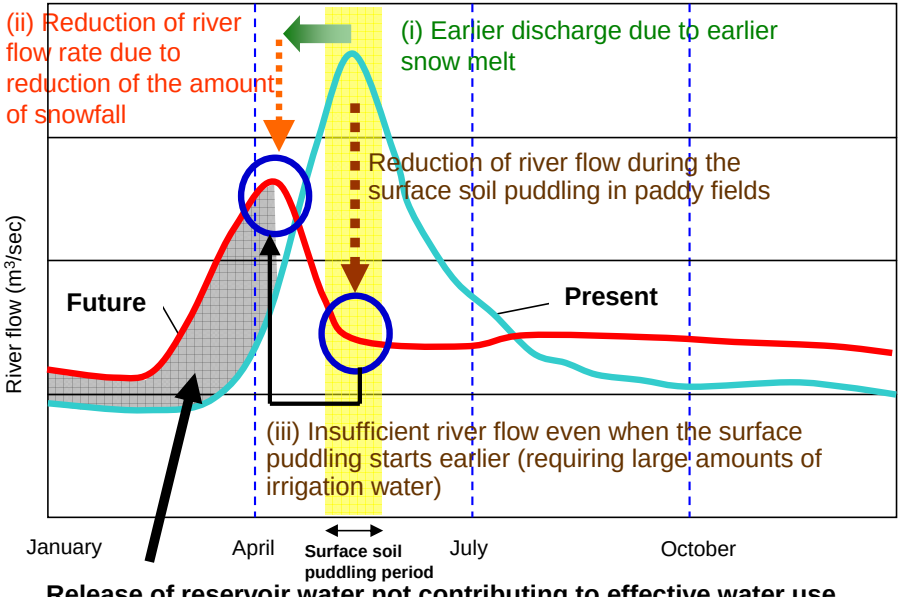
In the upper Tone River, snow cover is likely to decrease considerably. That will accompany the reduction of river flow rate in the snow melt season or in early spring.

With global warming,
(i) earlier snow melt and (ii) reduction of snowfall induce changes in river flow rate, and
(iii) earlier surface soil puddling in paddy fields is expected to cause the annual water demand pattern to change and to have serious impacts on water use.

Change in snow cover in 100 years' time due to further global warming (Fujiwara)



*Prepared by Water Resources Department, Water and Land Bureau, Ministry of Land, Infrastructure and Transport based on Regional Climatic Model (RCM) 20, a global warming prediction model, developed by Japan Meteorological Agency.

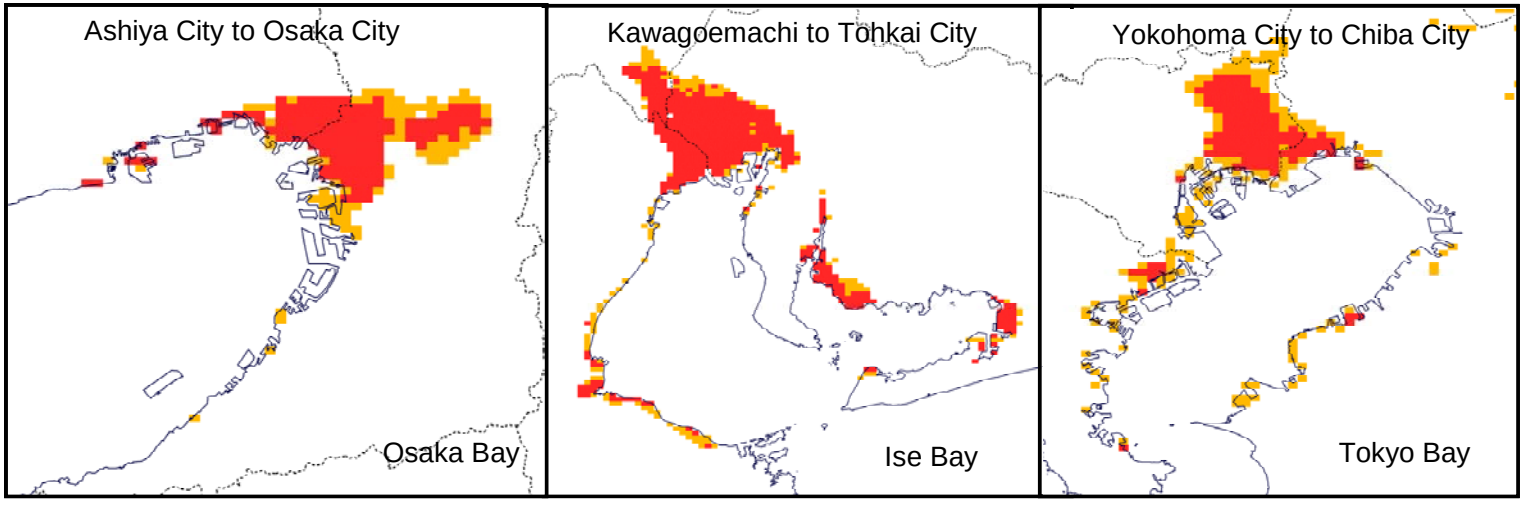


Release of reservoir water not contributing to effective water use
Where the reservoir is full, released water is not used effectively.

Source: Water Resources in Japan 2007, Land and Water Bureau, Ministry of Land, Infrastructure and Transport

Impacts of sea level rise

Increases of below-sea-level areas in three large bay areas (Tokyo Bay, Ise Bay and Osaka Bay)



Areas with flood risks due to high tides will increase.

*Prepared by the River Bureau based on the national land-use digital information.
*Shown are the areas at elevations lower than sea level shown in a three-dimensional mesh (1 km x 1 km). Total area and population are based on three-dimensional data.
*No areas of surfaces of rivers or lakes are included.
*A premium of 60% is applied to the potential flood risk area and to the population vulnerable to flood risk in the case with a one-meter rise of sea level.

	Present	After sea level rise	Rate of increase
Area (km^2)	559	861	1.5
Population (Million)	**3.88**	5.76	1.5

Basic concept of adaptation strategies

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

Basic concept for Future ideal society

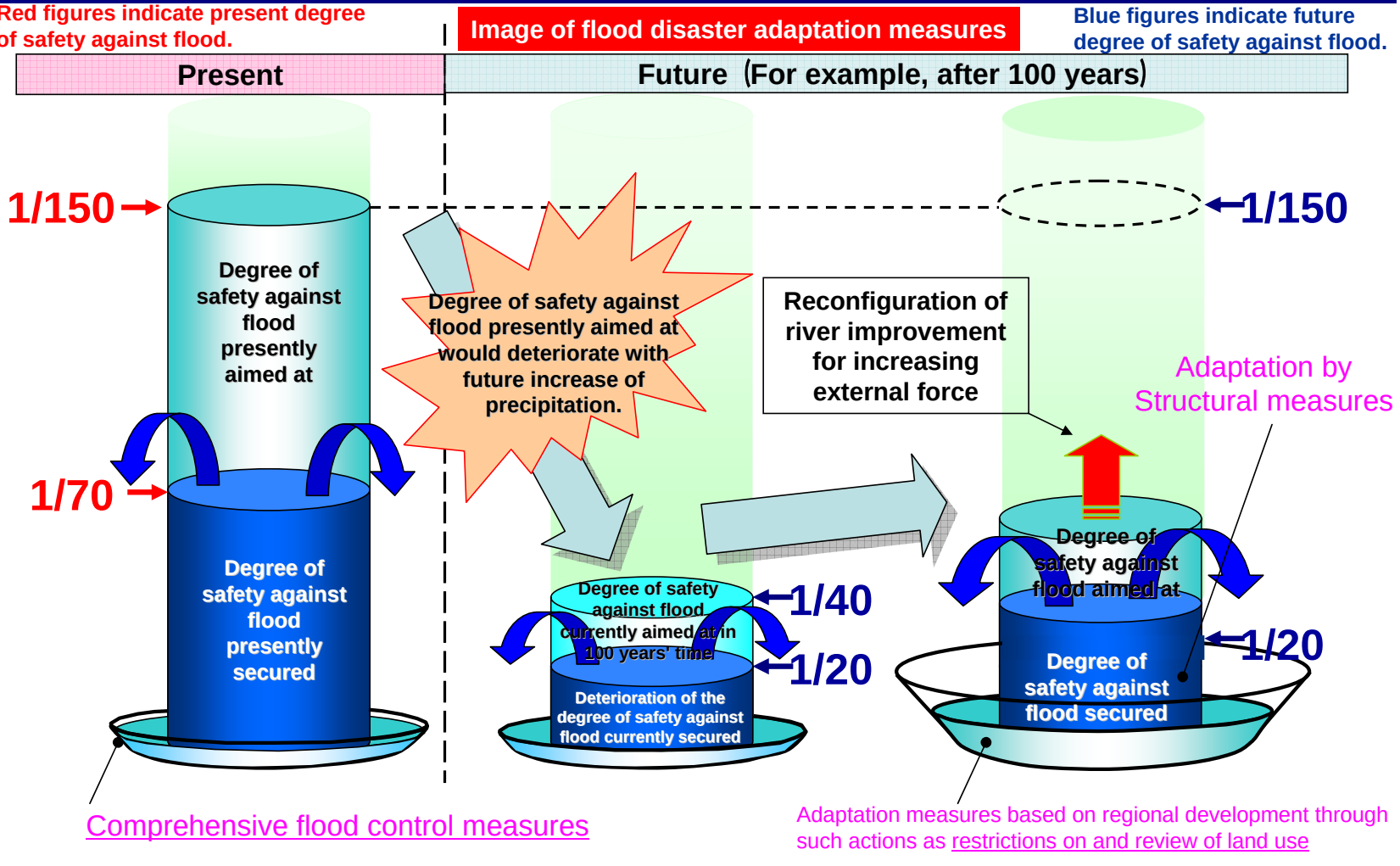
Combining mitigation and adaptation aiming at ‘’ Water -disaster adaptation society’’

Basic direction of climate change adaptation strategies

1. Adaptation measures to achieve “Zero casualty" should be considered because ‘’Zero damage’’ from disasters is difficult.
2. In a nerve center like the Tokyo metropolitan area, intensive efforts should be made such as preventing from ceasing national function

Multiple measures for increasing in risk

3.Adaptation measures for climate change



Process of effective and efficient adaptation program

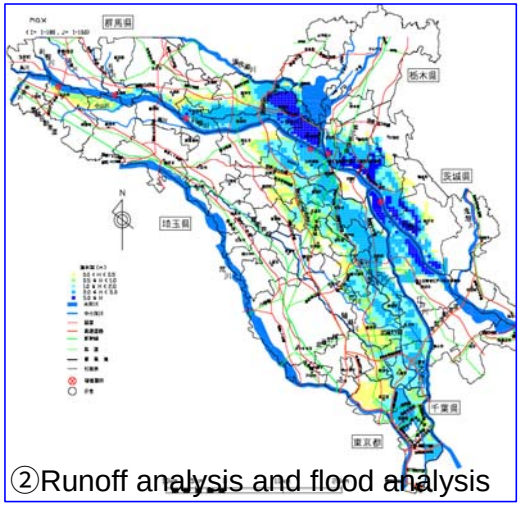
①Review of past flood

②Runoff analysis and flood analysis

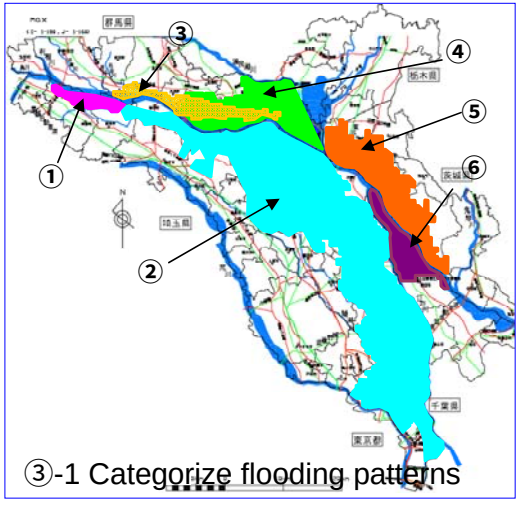
③Categorize flooding pattern in each category

④Calculate damage and effect

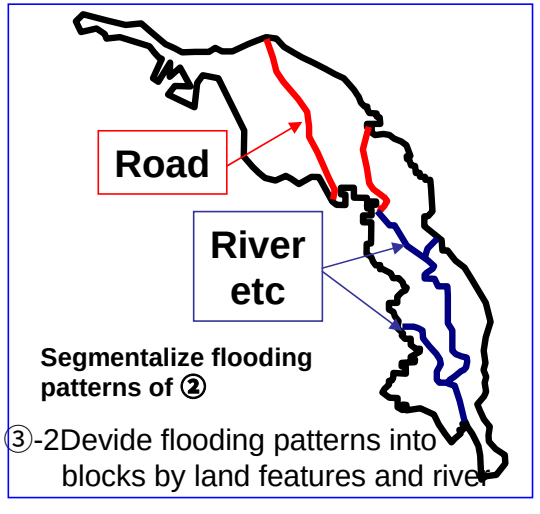
⑤Consider effective and efficient adaptation measures



②Runoff analysis and flood analysis

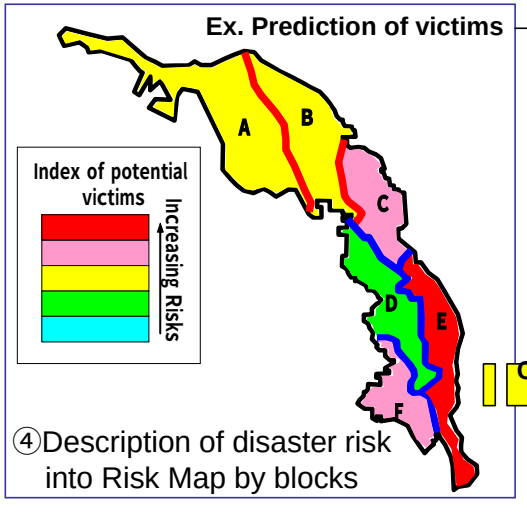


③-1 Categorize flooding patterns



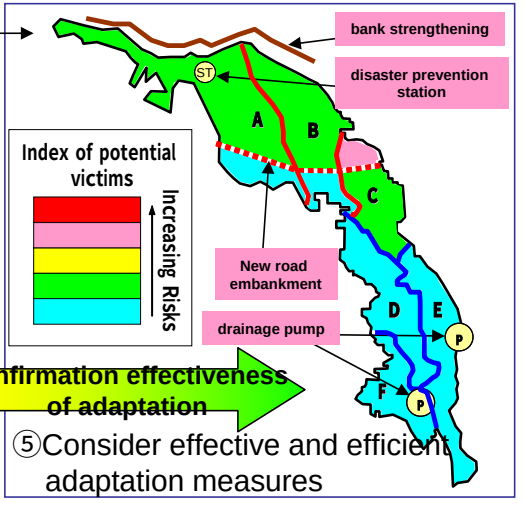
Segmentalize flooding patterns of ②

③-2Devide flooding patterns into blocks by land features and river



④Description of disaster risk into Risk Map by blocks

Confirmation effectiveness of adaptation



⑤Consider effective and efficient adaptation measures

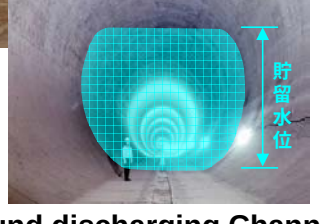
Adaptation by using structures

3.Adaptation measures for climate change

Improvement of the reliability of structures, full and long-life utilization of existing structures

Constructing new structures

Flood control (Dam)



Underground discharging Channel

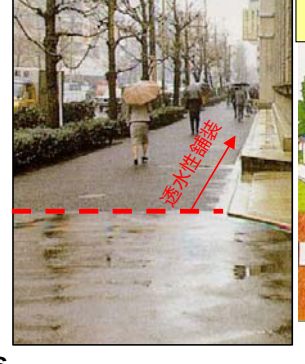
High standard embankments

Storage facilities

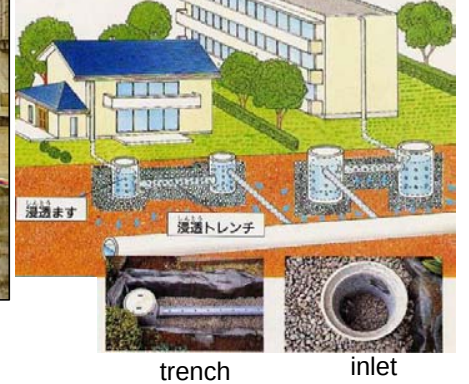
usual

flooded

Permeable pavement



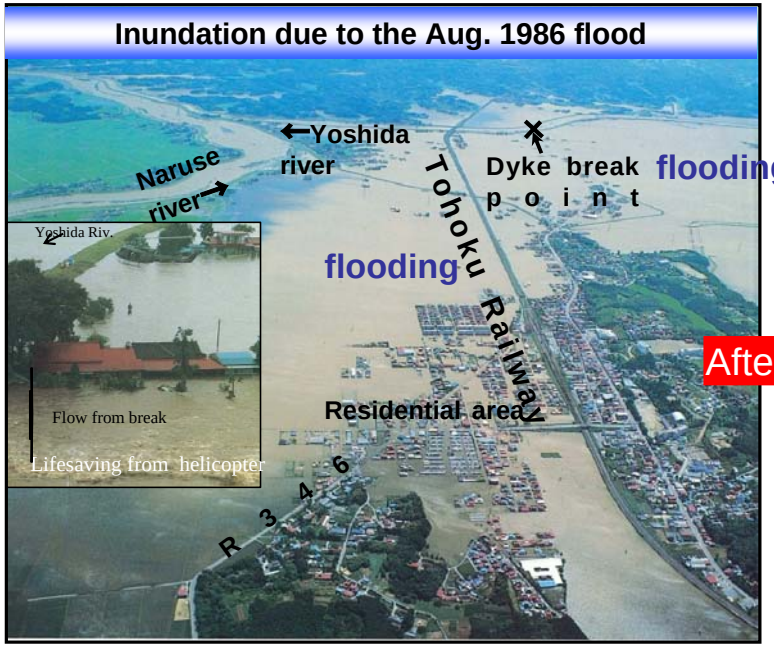
Infiltration trench and inlet



trench inlet

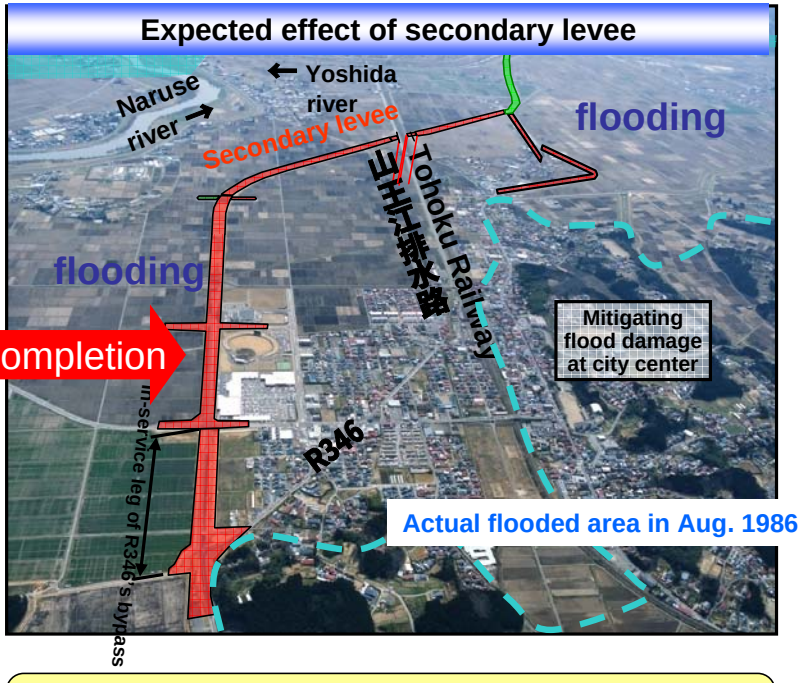
Structure construction in river basins: floodwater control with secondary levees

Floodwater control with secondary levees to prevent expansion of a damaged area



Due to 4 break points, 3,060ha was flooded, 1,510 houses were flooded above the floor level, and some parts of the area stayed under water up to 12 days.

After completion



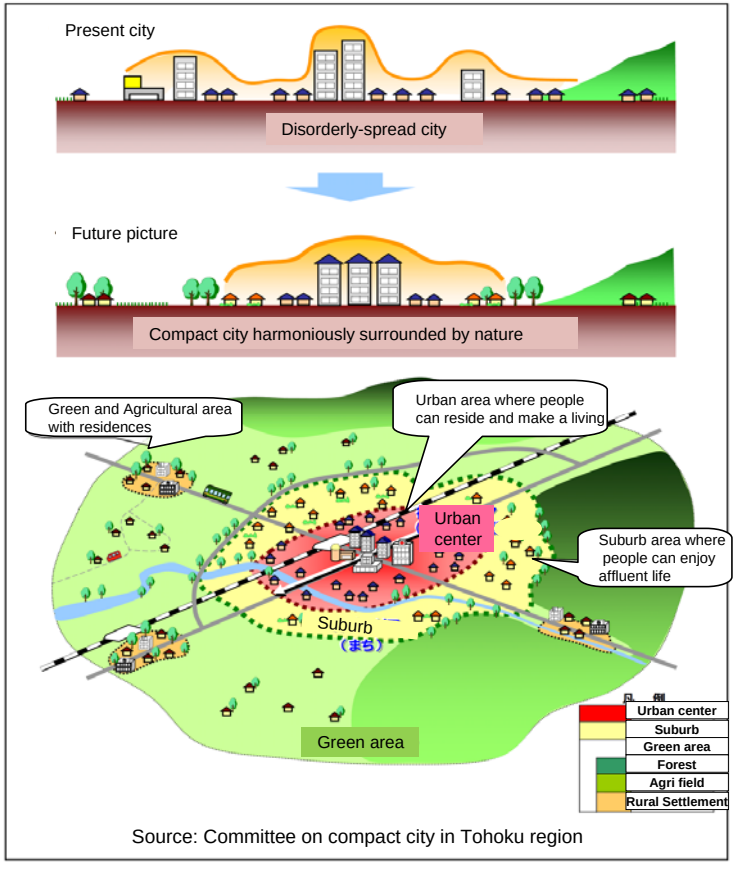
This secondary levee is under construction in coordination with road construction.

A new concept for urban development：Compact community easier to implement flood control measures

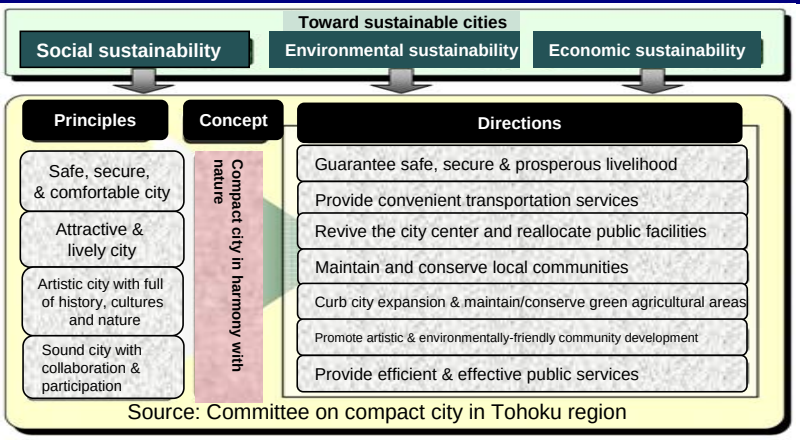
3.Adaptation measures for climate change

Compactly-built residences provide better energy efficiency and easier environment for flood control projects

■ **Conceptual figure of compact city for present small and medium cities in Tohoku region**



Source: Committee on compact city in Tohoku region



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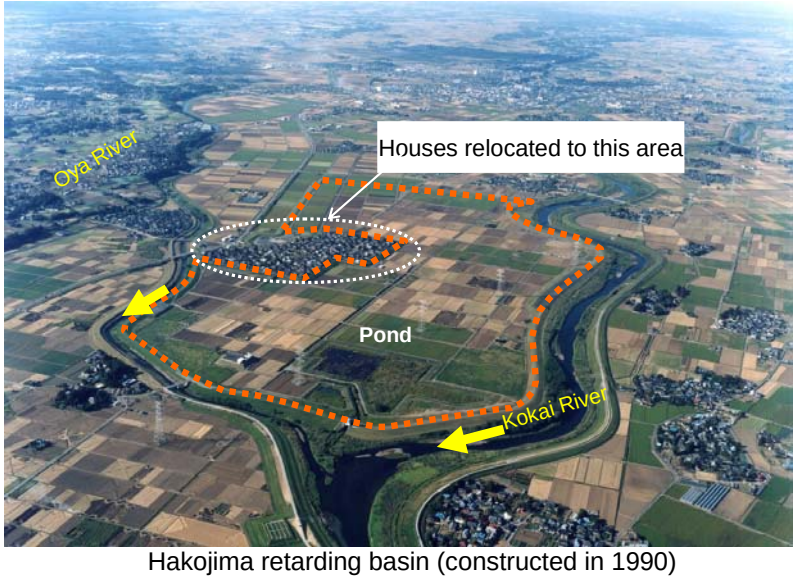


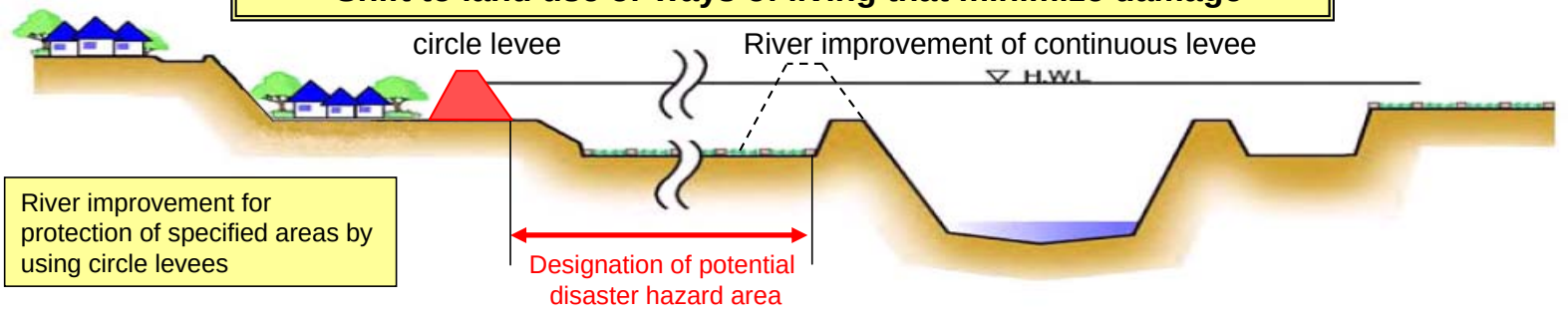
Hakojima retarding basin (constructed in 1990)

Adaptation measures in step with local community development

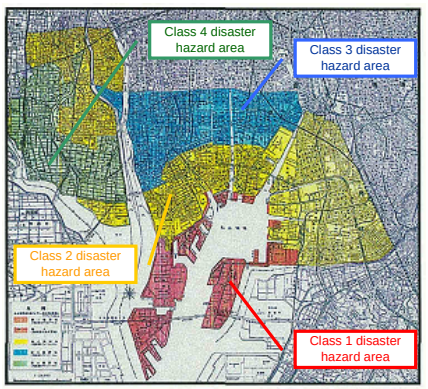
3.Adaptation measures for climate change

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

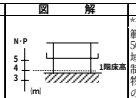
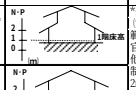
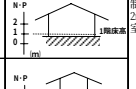
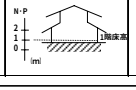


Restrictions on land use by designating potential disaster hazard areas



Example of Nagoya city

Sample ordinance restrictions (Nagoya City)

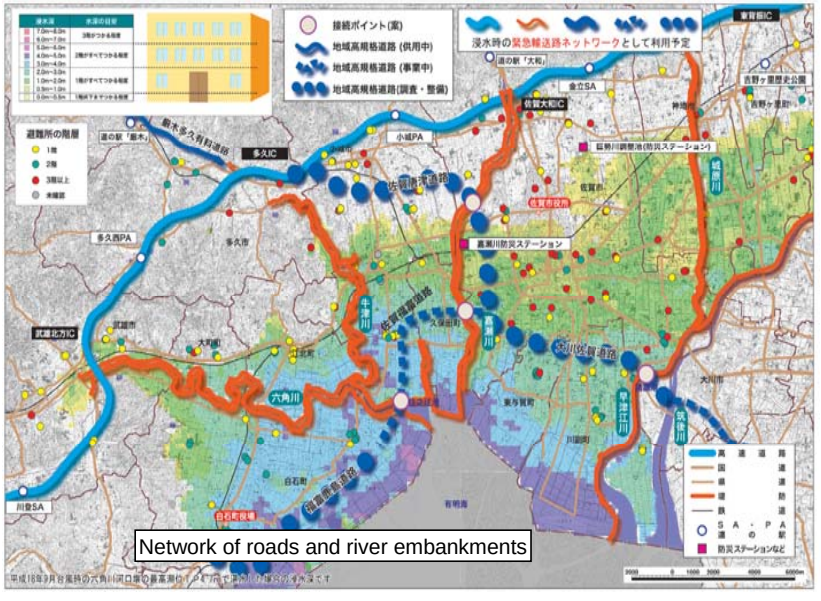
		1階の床の高さ	構造制限	図解	
第1種区域	市街化区域	N・P (+) 4m以上	木造禁止		*建築物の建築禁止 範囲…海岸線・河岸線から50m以内で市長が指定する区域 制限…居住室を有する建築物、病院及び児童福祉施設等の建築禁止 木造以外の構造で、居住室等の床の高さをN・P (+) 5.5m以上としたものについては建築可能
第2種区域	市街化区域	N・P (+) 1m以上	2階以上に居室設置 緩和：延べ面積が100㎡以内のものは避難室、避難設備の設置による代替可		*公共建築物の制限 ：第2種～第4種区域 範囲…学校、病院、集会場、官公署、児童福祉施設等その他これらに類する公共建築物 制限…1階の床の高さN・P (+) 2mかつN・P (+) 3.5m以上の居室設置
第3種区域	市街化区域	N・P (+) 1m以上	――		
第4種区域	市街化調整区域	N・P (+) 1m以上	2階以上に居室設置		

Shift to community planning resistant to inundation

Adopting pilotis to prevent damage to buildings during a flood

Adaptation measures with emphasis on crisis 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

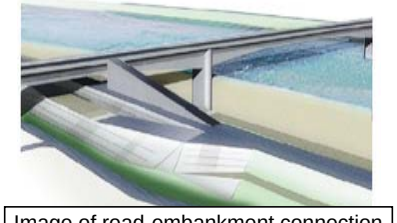


Image of road-embankment connection

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	Staff of Regional Development Bureaus and Offices
Wide-area infrastructure force (rivers, roads, sediment control, ports, etc.)	Engineers of National Institute for Land and Infrastructure Management and Public Works Research Institute
Sewerage system force	Technical support group (engineers)
Building land force	Private sector construction organizations (operators of equipment) (Contract/ agreement)
Buildings force	Coordination
	Staff of local public entities

Activities
-Investigation of damage
-Quick repairing
-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 with emphasis on Preparedness

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.

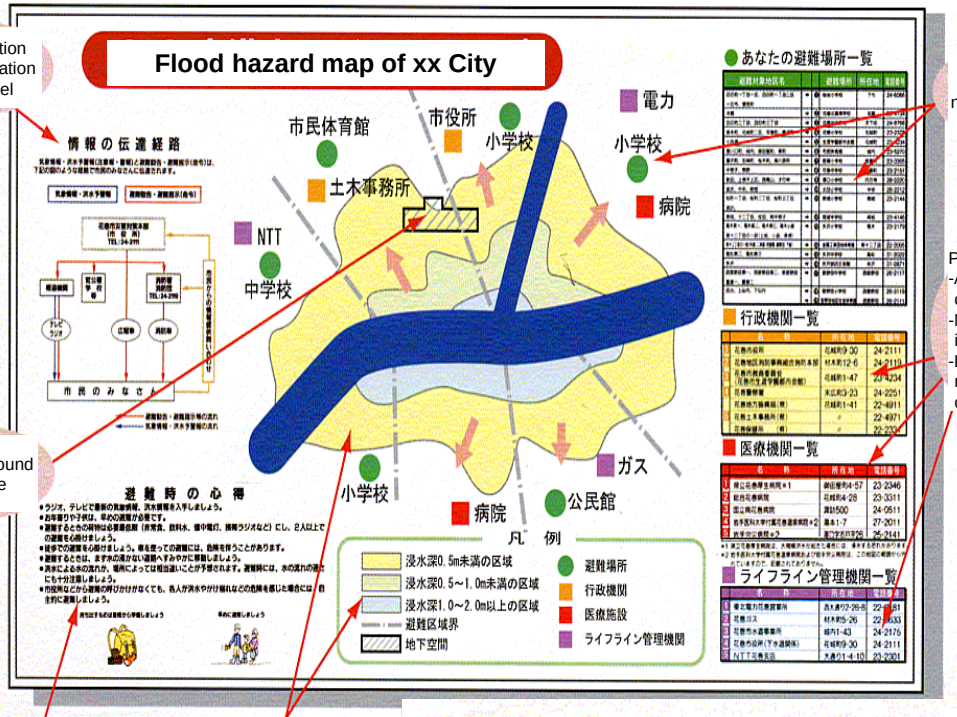


Image of a flood hazard map

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

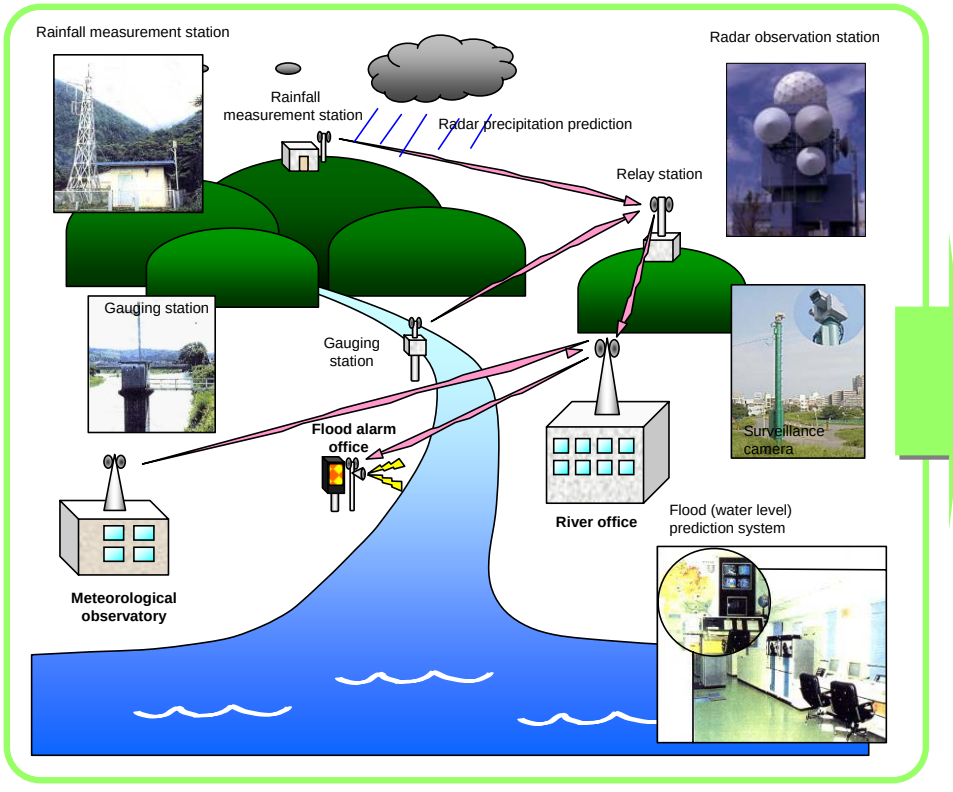
Toyooka City, Hyogo Prefecture

Easily recognizable signs

Adaptation measures with emphasis on Preparedness

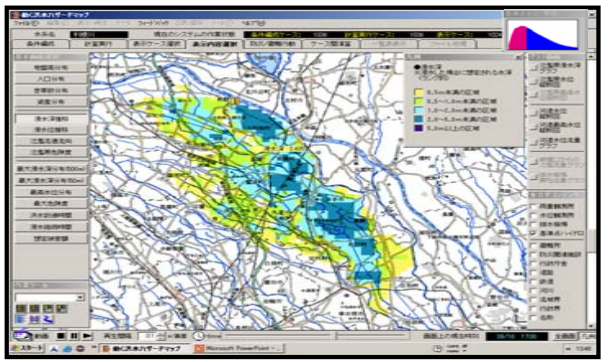
Share real-time information

- 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

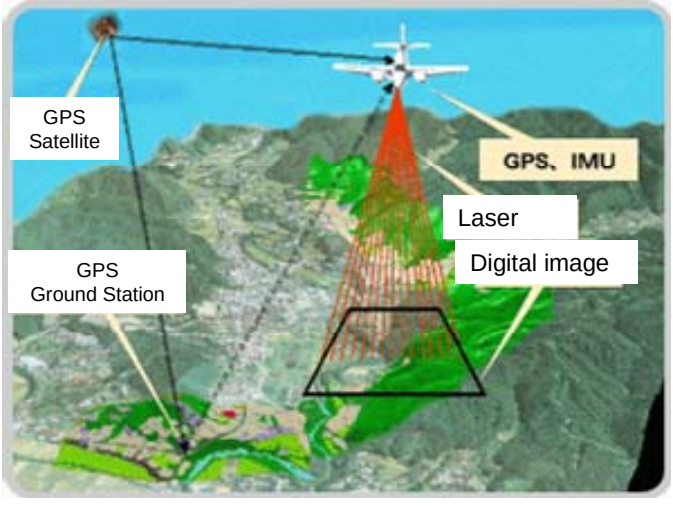


Floodwater prediction through real-time simulation

Adaptation measures by Advanced Technology
Utilization of Aerial Laser Survey

Aerial Laser Survey is a surveying technology of three-dimensional digital terrain data. For surveying, laser pulse are radiated from aviation, and analysis of reflected laser pulse from ground surface.

Terrain data such as figure of cross section of flood prone area can be obtained by this survey.



Advantage point

Preciseness

Elaboration of inundation analysis

⇒More elaborate inundation area can be obtained by detailed terrain data such as roads, railways and embankments.

⇒Identification of effective countermeasures about inundation, such as prevention inflow to underground arcade by accuracy inundation height

Swiftness

Quick investigation on natural disaster damage

Specification

Accuracy

Standard Deviation 25cm

(Optec 3100DC, AGL2000m)

※Depend on Equipment, height

Adaptation measures by Advanced Technology
Aerial Laser Survey Utilization for Adaptation measures

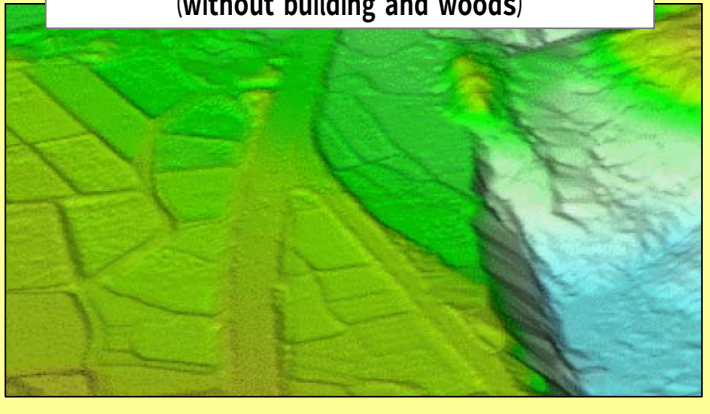
Improvement of inundation analysis by using Aerial Laser Survey Data

Utilization of various adaptation measures

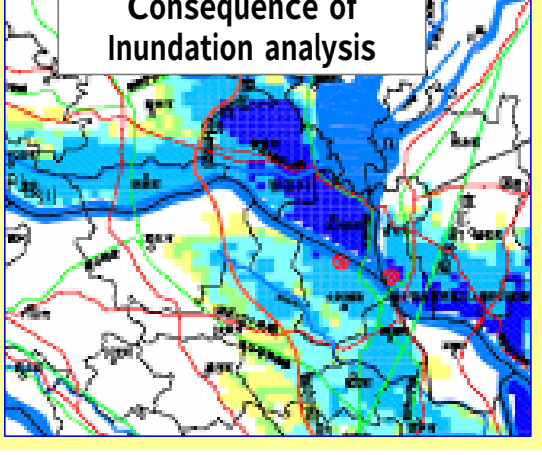
- Evaluation of disaster risks which is increasing by climate change
- Regulation of land-use and Building restrictions
- Improvement of Water bar and Storage facility
- Formulation of crisis management plan

e.t.c

three-dimensional digital terrain data
(without building and woods)



Consequence of
Inundation analysis

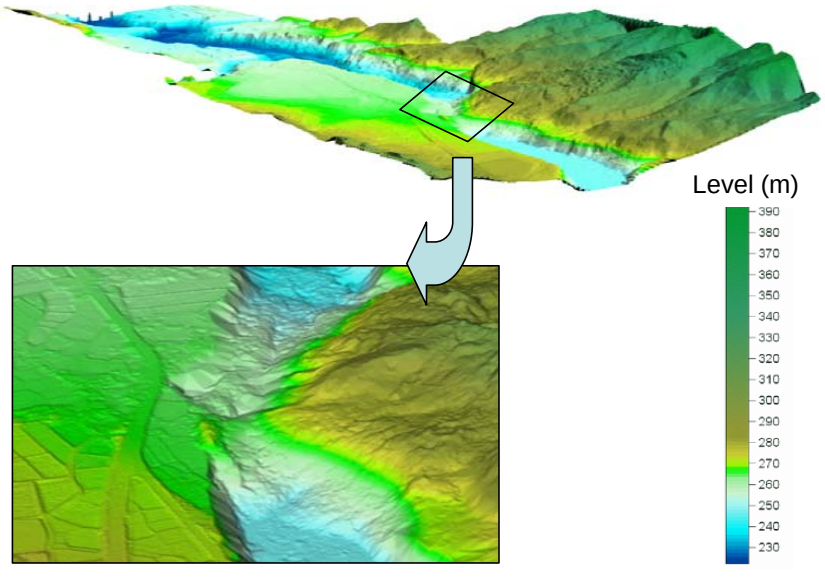


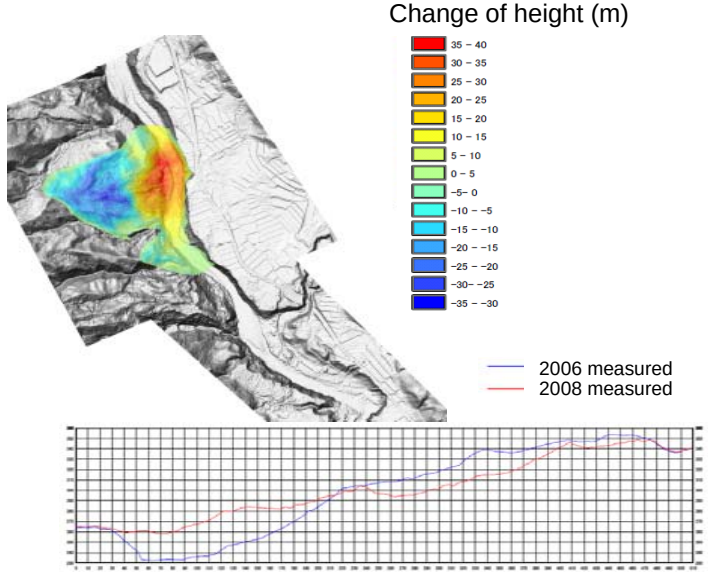
(C.f.) Earthquake damage investigation by using Aerial Laser Survey

Landslide dams Lake were built in several places by the Iwate-Miyagi Nairiku Earthquake in 2008. Aerial Laser Survey Data was used for consideration on finding appropriate countermeasures. Aerial Laser Survey can be useful in the case of difficult situation to approach the damage area.

◎ Understanding of landslide dams lake by three-dimensional digital terrain data

◎ Measuring deformation volume compared with before-and-after on earthquake





Conclusion

①Prioritized investment to disaster prevention

- ✓Investment prioritize areas related to disaster prevention for limitation of available capacity

②Clarification of priority and Planning of road map

- ✓Drawing up short-term, middle-term, long-term policy by [selection and concentration] as meaning of clarification of prioritized policy.
- ✓Planning the road map by assessment of disaster risk every term.

③Adoption adaptive approach

- ✓Adopting adaptive approach of revising road map in response to future observation and cumulative knowledge

④New technical development and contribution to the world

- ✓Contributing to the world by transferring of new technology and Japanese expertise, policy, technology

⑤Participatory approach

- ✓Participatory approach is necessity. Informing to be understood easily to citizens.