



Japan - the Netherlands Workshop

# Adaptation Measures for Climate Change in Japan

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River Bureau

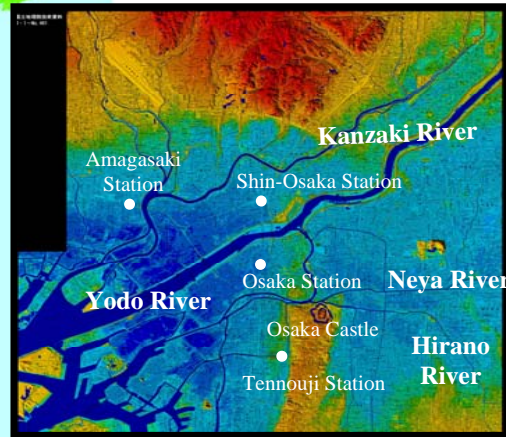
Ministry of Land, Infrastructure, Transport and Tourism, Japan



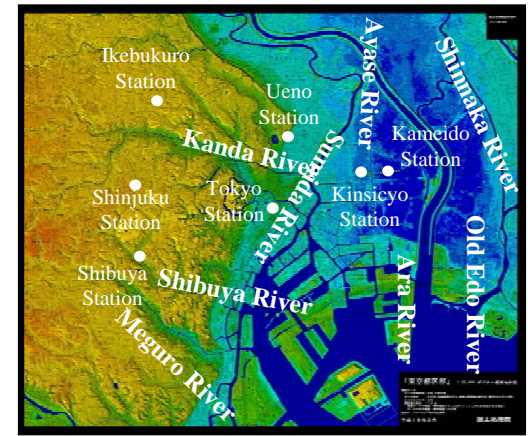
# Japan is vulnerable to climate change.

## 1. Present conditions in Japan

### Kinki Region

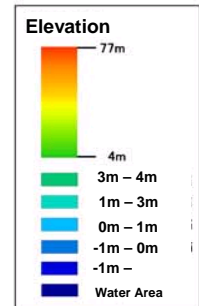


### Kanto Region



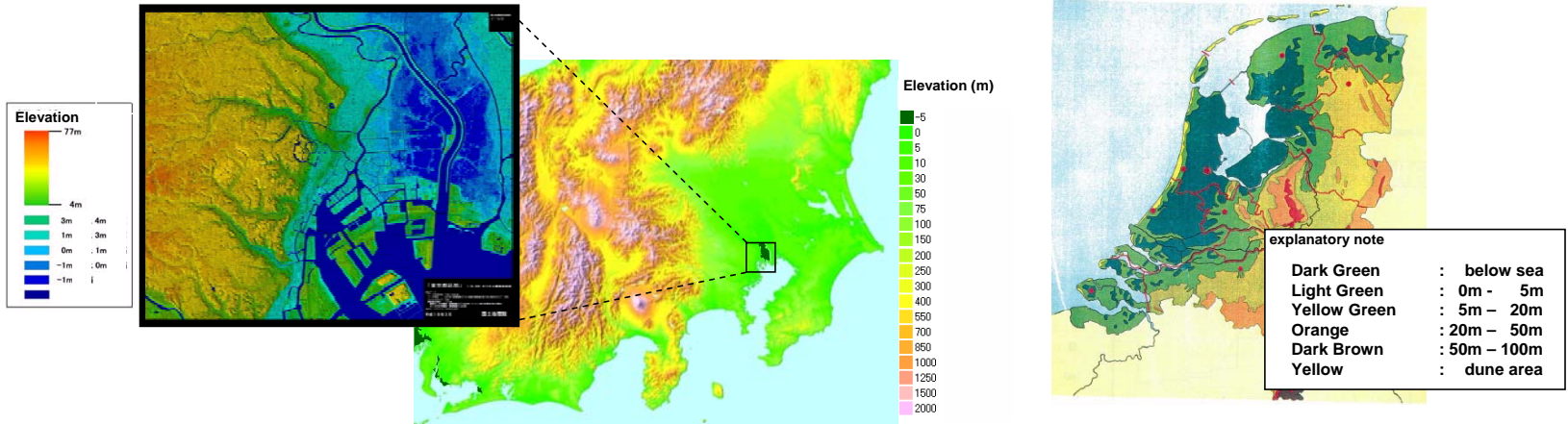
- (i) Land: A north-south stretch of land extending over a length of 2000 km
- (ii) Four main islands: Four main islands are separated from one another by straits. There are also numerous small islands.
- (iii) Backbone mountain range: Mountains run at the middle of the land.
- (iv) Tectonic lines: Median 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.

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



# Japan and the Netherlands

## 1. Present conditions in Japan

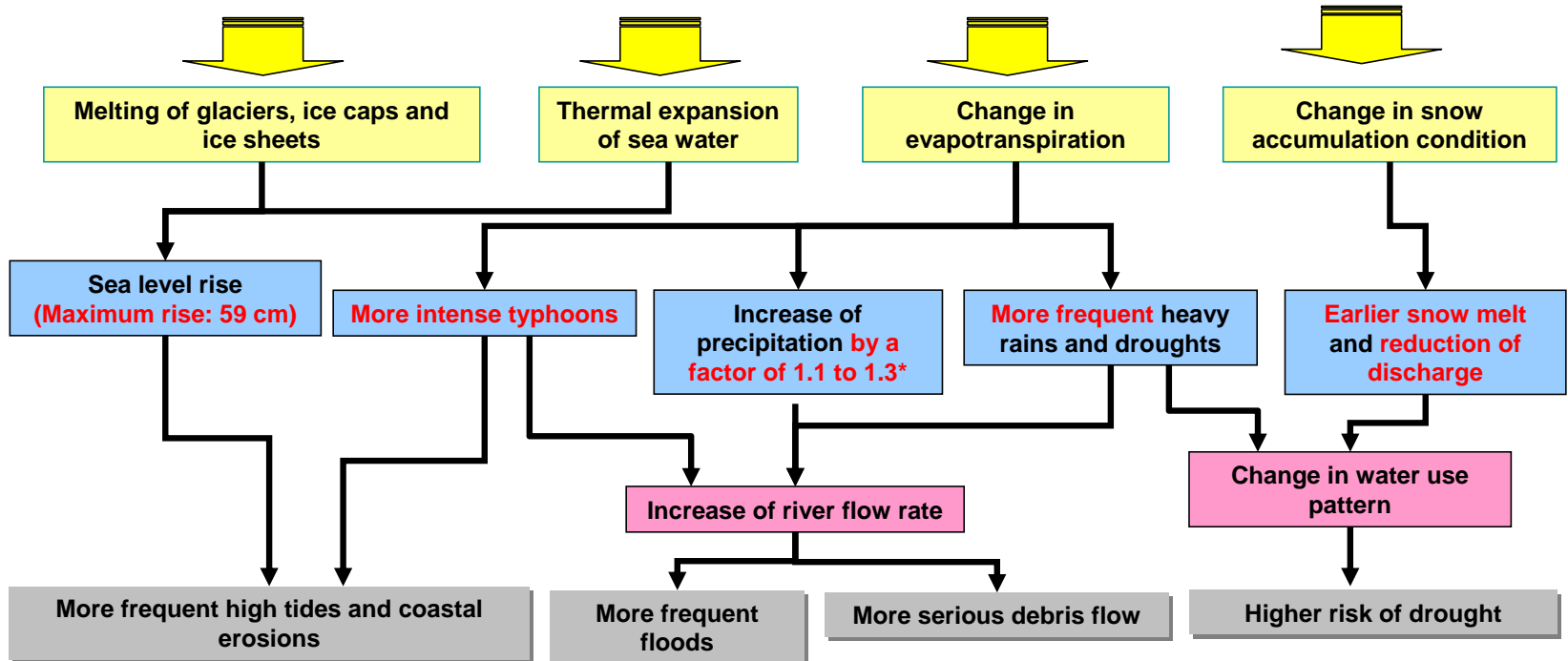


		Japan	The Netherlands
Geographical characteristics		<ul style="list-style-type: none"> <li>Area : 378,000km<sup>2</sup></li> <li>Many short steep rivers.</li> <li>Sediment problems because of poor soil</li> <li>Flood plain area is located by alluvial fan and riverside</li> </ul>	<ul style="list-style-type: none"> <li>Area : 42,000km<sup>2</sup></li> <li>Rhine River, Maas River, Schelde River as mild slope international river</li> <li>Delta and low area</li> </ul>
Profile of representative river	Name of River	Tone River	Rhine River
	Basin Area	About 17,000km <sup>2</sup>	About 185,000km <sup>2</sup>
	length of river	322km	1,320km
	Average bed slope	About 1/175	About 1/2,600
	largest flow discharge	17,000m <sup>3</sup> /s(1947)	13,000m <sup>3</sup> /s (1926)
Climate characteristics	annual mean rainfall	1,718mm	About 800mm
	100 year daily precipitation	376mm (Tokyo)	80mm (de Valdo)
	100 year hourly precipitation	94mm (Tokyo)	40mm ( de Valdo )

# Mechanism of global warming and climate change (impacts on water-related disasters)

2. Outline of the IPCC AR4 Report

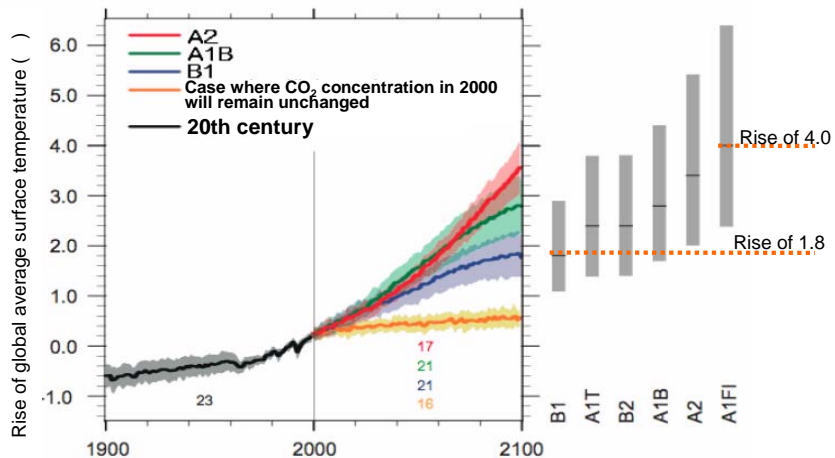
Large volumes of greenhouse gas emissions cause CO<sub>2</sub> concentration in the air to rise and increase heat absorption, resulting in temperature rise. Thus, global warming occurs.



# Rises of temperature and sea level

- Temperature is expected to rise by about 0.2 per decade in the next 20 years.
- Global average surface temperature is expected to rise by 1.8 to 4.0 in 100 years' time from now.
- Global average sea level is expected to rise by 18 to 59 cm in 100 years' time from now.
- Global warming and sea level rise will continue over several centuries even if green house gas emissions are controlled.

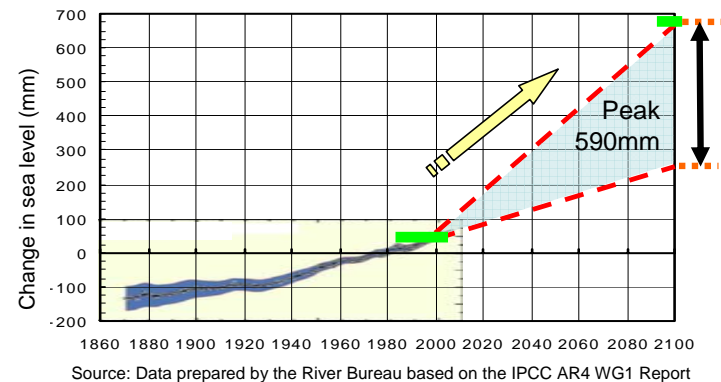
## • Average temperature



A1: High growth oriented society  
 A1FI: Dependent on fossil energy sources  
 A1T: Dependent on non-fossil energy sources  
 A1B: Emphasis on the balance among various energy sources  
 A2: Multipolarized society  
 B1: Sustainable growth oriented society  
 B2: Emphasis on regional initiatives

Source: IPCC AR4 WG1 (Working Group 1) Summary for Policymakers (Japan Meteorological Agency)  
 -Solid lines indicate rises of global average surface temperature in each scenario identified using multiple models.  
 -Shaded areas indicate the range of standard deviations of average annual temperature for each model.

## • Average sea level



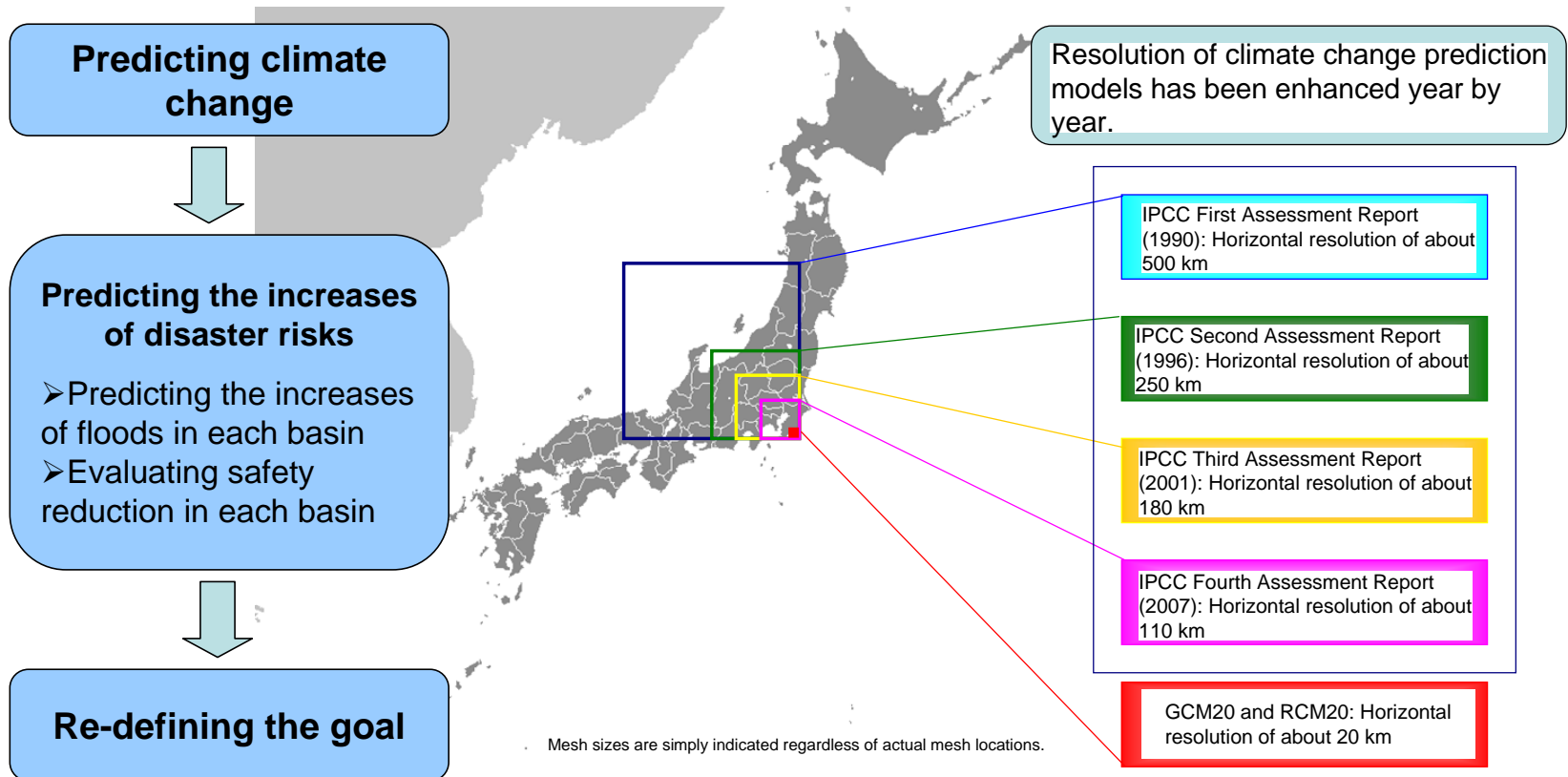
## • Rises of average temperature and sea level at the end of the 21st century

	Society achieving both global environmental protection and economic development	Society achieving high economic growth dependent on fossil energy sources
Temperature rise	About 1.8 (from 1.1 to 2.9 )	About 4.0 (from 2.4 to 6.4 )
Sea level rise	Sea level rise	26 ~ 59 cm

Source: IPCC AR4 WG1 Report

# How to study adaptation measures

## 3. Impacts of heavy rains



Prepared by the River Bureau

# Areas with increased rainfall amount

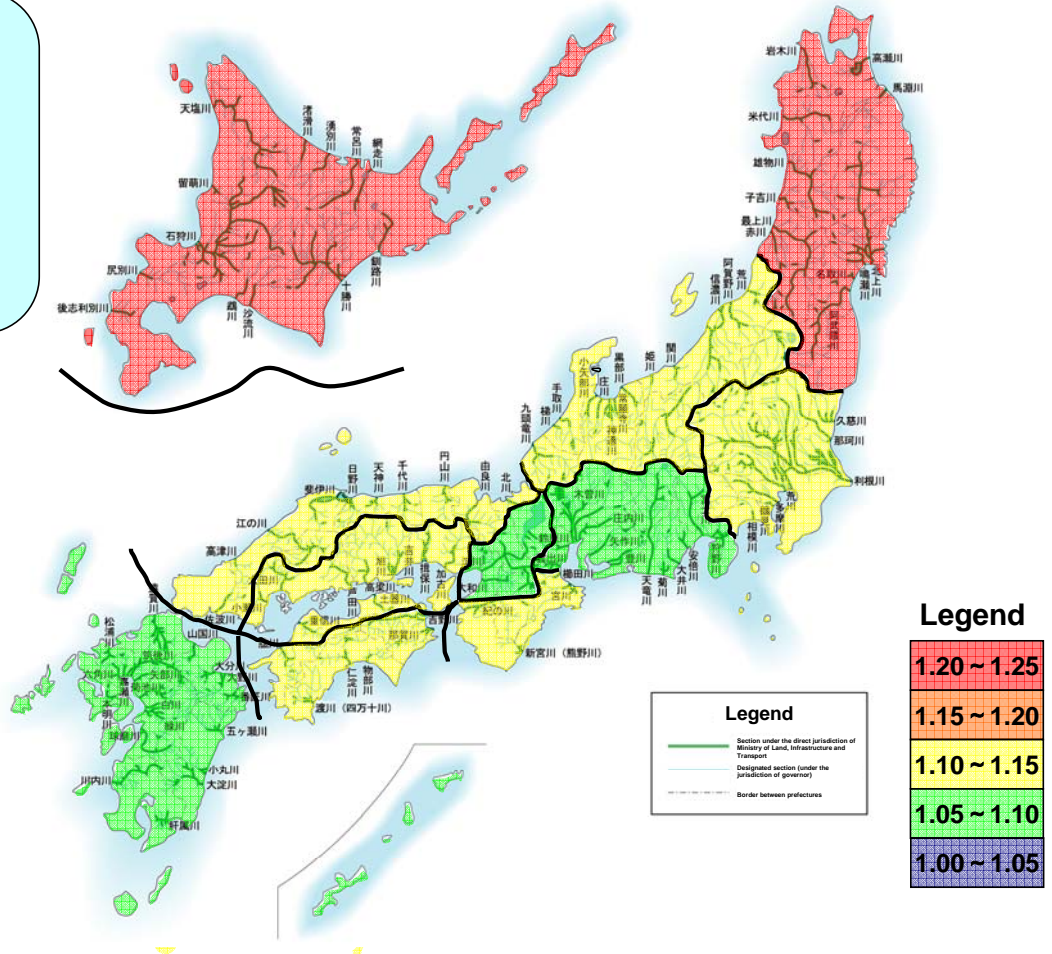
## 3. Impacts of heavy rains

Future rainfall amounts were predicted as a median value of

Average rainfall in 2080-2099 period  
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).

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



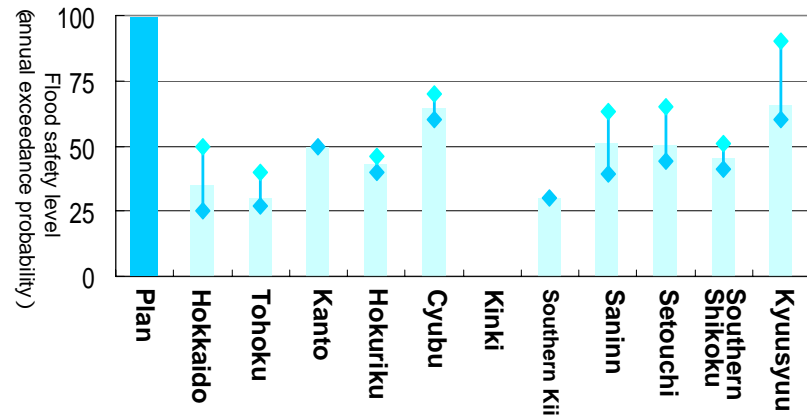
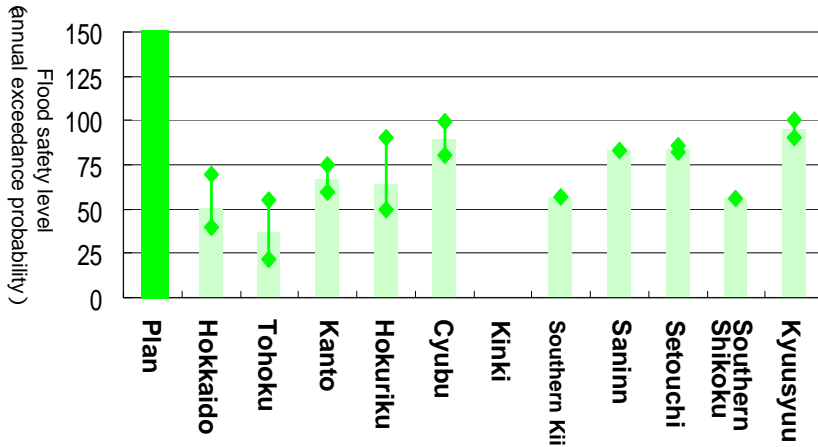
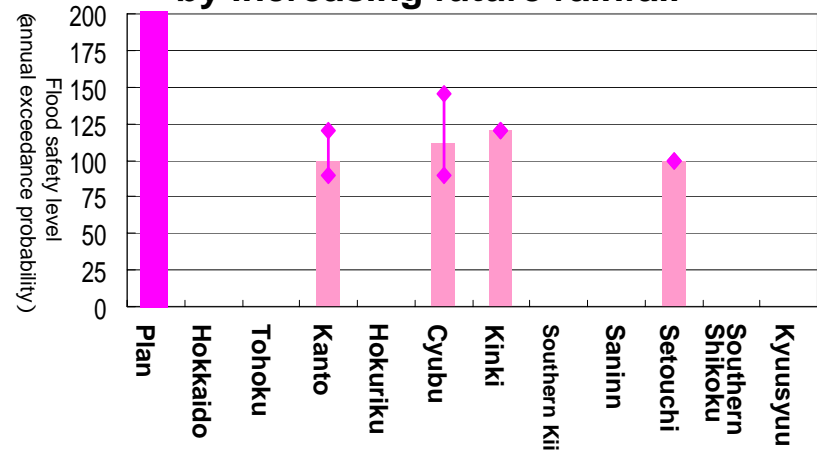
# Declining the degree of safety against flood by increasing rainfall

## 3. Impacts of heavy rains

Impact for flood safety level by changing rainfall after 100 years

Region	Future flood safety level(annual exceedance probability)					
	1/200 ( CurrentPlan )	1/150 ( CurrentPlan )		1/100 ( CurrentPlan )		
		Number of river system		Number of river system		Number of river system
Hokkaido	-	-	1/40 ~ 1/70	2	1/25 ~ 1/50	8
Tohoku	-	-	1/22 ~ 1/55	5	1/27 ~ 1/40	5
Kanto	1/90 ~ 1/120	3	1/60 ~ 1/75	2	1/50	1
Hokuriku	-	-	1/50 ~ 1/90	5	1/40 ~ 1/46	4
Cyubu	1/90 ~ 1/145	2	1/80 ~ 1/99	4	1/60 ~ 1/70	3
Kinki	1/120	1	-	-	-	-
Southern Kii	-	-	1/57	1	1/30	1
Saninn	-	-	1/83	1	1/39 ~ 1/63	5
Setouchi	1/100	1	1/82 ~ 1/86	3	1/44 ~ 1/65	3
Southern Shikoku	-	-	1/56	1	1/41 ~ 1/51	3
Kyusyu	-	-	1/90 ~ 1/100	4	1/60 ~ 1/90	14
<b>All Japan</b>	1/90 ~ 1/145	7	1/22 ~ 1/100	28	1/25 ~ 1/90	47

### Declining the degree of safety against flood by increasing future rainfall



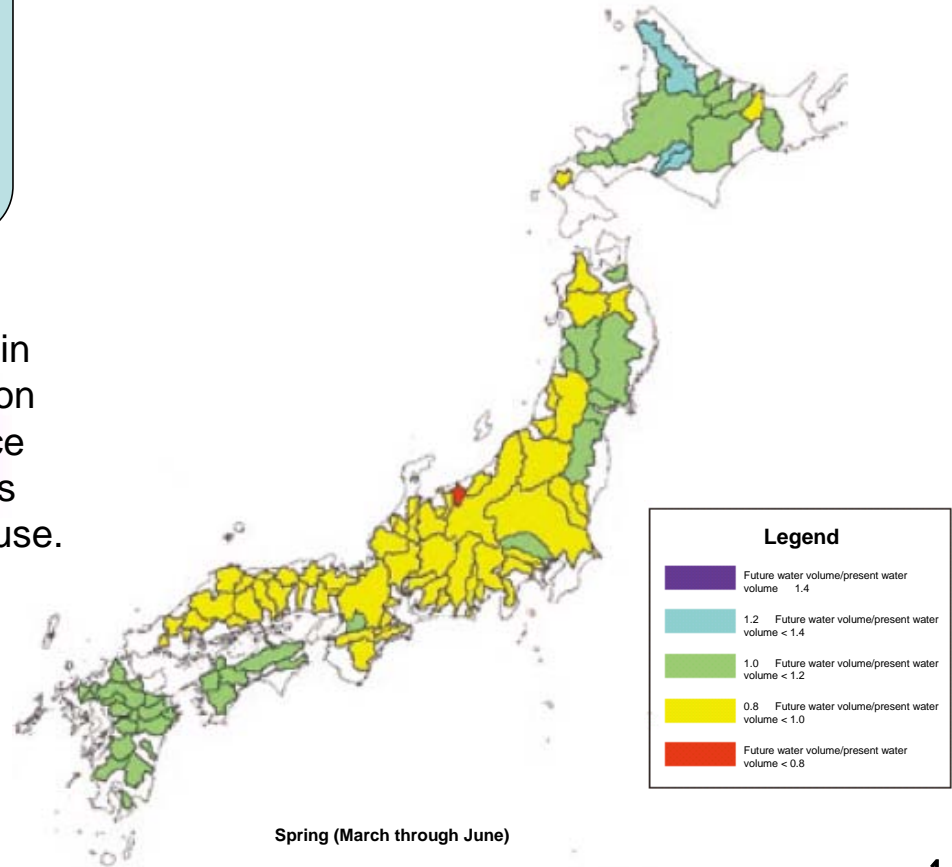
Circled number is number of calculated river system



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

Reduction of river flow rate in the periods requiring irrigation water e.g. during the surface soil puddling in paddy fields may be detrimental to water use.

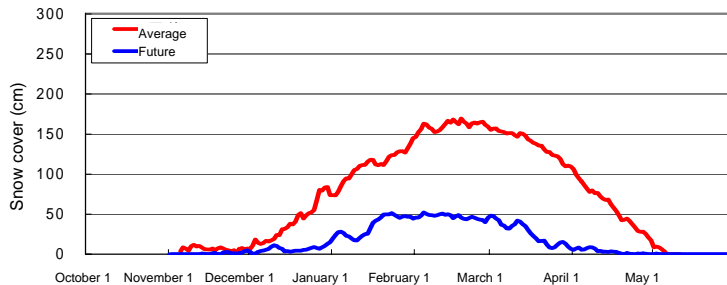
Comparison between present conditions(1979 to 1998) and future rainfall(2080 to 2099) in Class A river



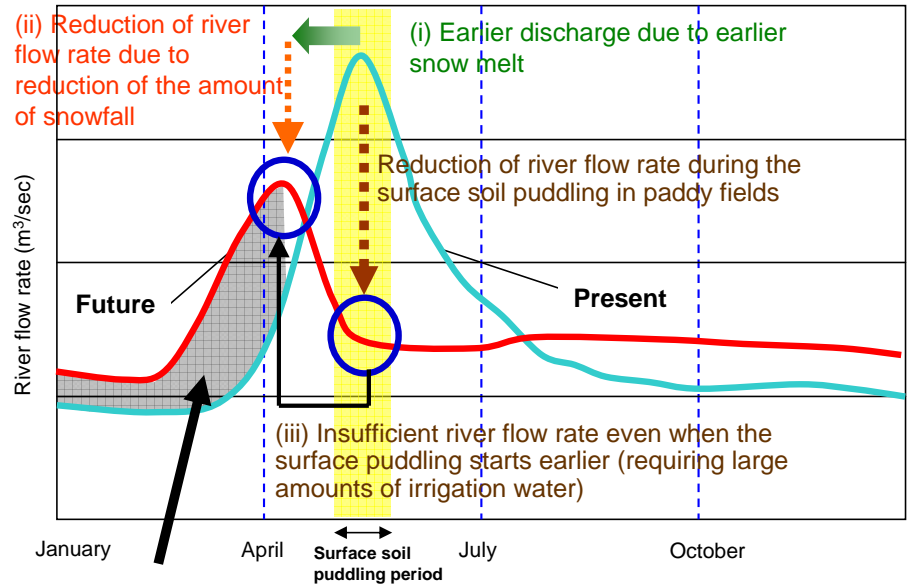
In the upper Tone River, snow cover is likely to decrease considerably. That will accompany the reduction of river flow rate in the snow melt season or in early spring.

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.

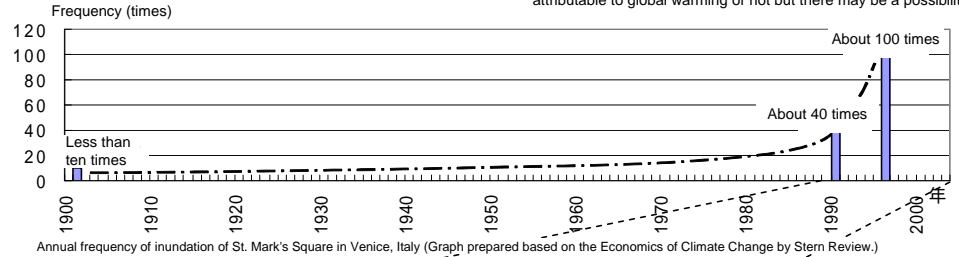
# Impacts of sea level rise: Increase of areas below sea level, and of risks of inundation due to high tides

## 5. Impacts of sea level rise

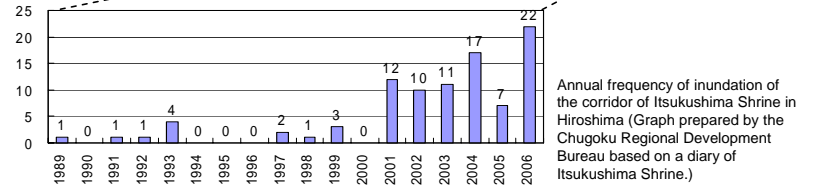
### Increase of risks of inundation due to high tides

\*At present, it is not clear whether the increase of inundation risk is attributable to global warming or not but there may be a possibility.

-St. Mark's Square in Venice was flooded with water less than ten times a year at the beginning of the 20th century. Ground settlement and climate change later caused the frequency to increase to about 40 times a year by 1990 and to as many as **100 times a year in 1996**.  
-There is also a report of 250 times of inundation a year in 2006.



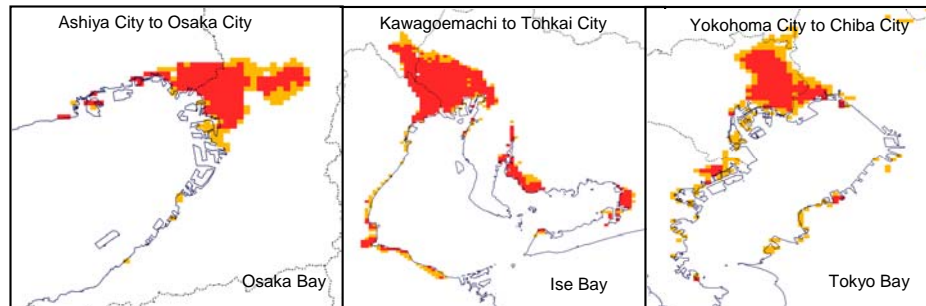
The corridor of Itsukushima Shrine in Hiroshima was inundated in water less than five times a year in the 1990s. It was flooded about ten times a year in the 2000s. The frequency was **22 times a year in 2006** and is still increasing.



### 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.**

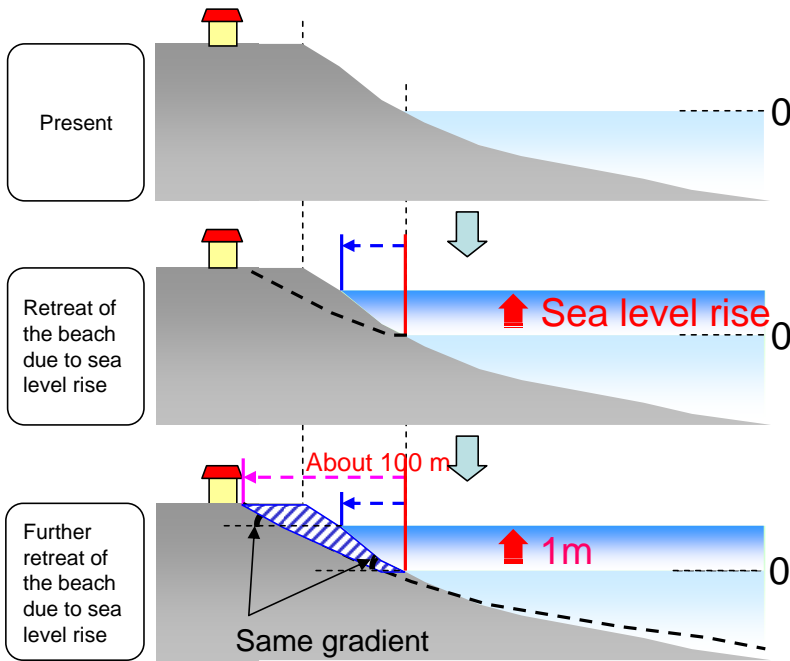
	Present	After sea level rise	Rate of increase
Area (km <sup>2</sup> )	577	879	1.5
Population (in tens of thousands of people)	404	593	1.5



\*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.

# Impacts of sea level rise: Retreat or loss of beaches

## 5. Impacts of sea level rise



Coastal erosion in the Majuro Atoll of the Marshall Islands (Masaaki Nakajima, May 2001)

Source: Japan Center for Climate Change Actions

Sea level rise (m)	0.3	0.65	1
Average distance of beach retreat	30.55	65.4	101.04
Percentage of eroded area	56.6	81.7	90.3

Prepared by the River Bureau based on the "Assessment of impacts of sea level rise on sandy beaches"

With sea level rise, the beach tries to achieve a stable gradient, so the shoreline retreats by a margin larger than the sea level rise.

With a one-meter rise of sea level, beach retreats by about 100 m. About 90% of beaches in Japan are vulnerable to erosion.

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

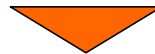
➡ Frequent and serious high tides and coastal erosions

-Wider range of variation of rainfall intensity and change of river flow regime

➡ Frequent and serious droughts



Combining CO<sub>2</sub> 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.



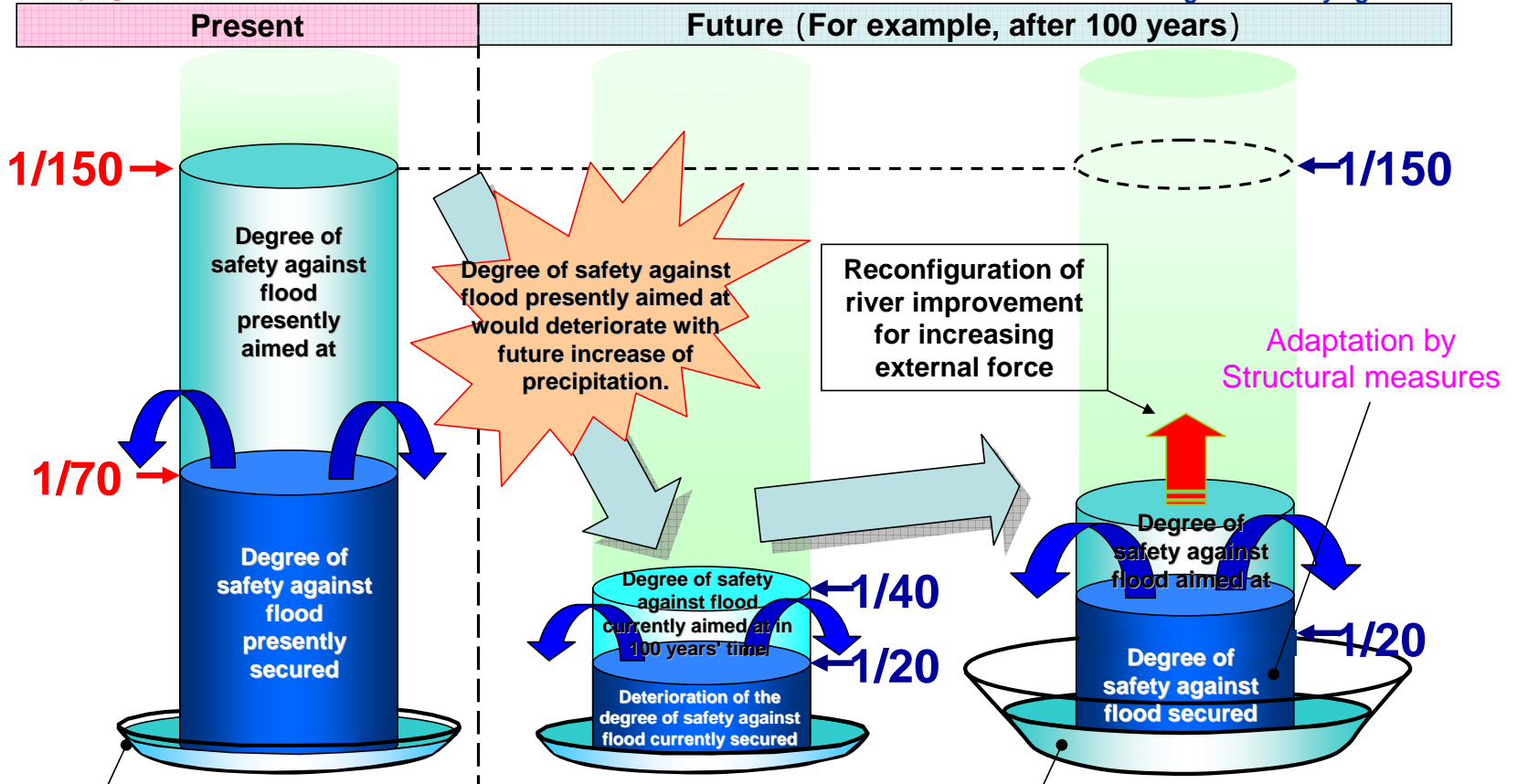
To provide protection from frequent floods expected to be caused by climate change due to global warming, flood control policy should include measures in the basin partially allowing inundation in addition to conventional flood control measures.

# Image of adaptation measures in future

6. Japan's response to climate change

Red figures indicate present degree of safety against flood.

Blue figures indicate future degree of safety against flood.

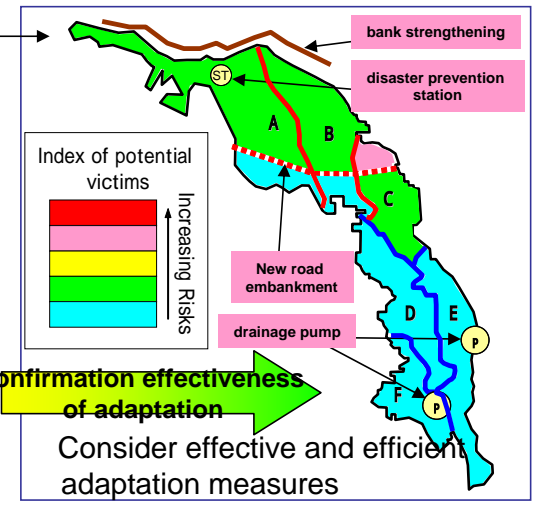
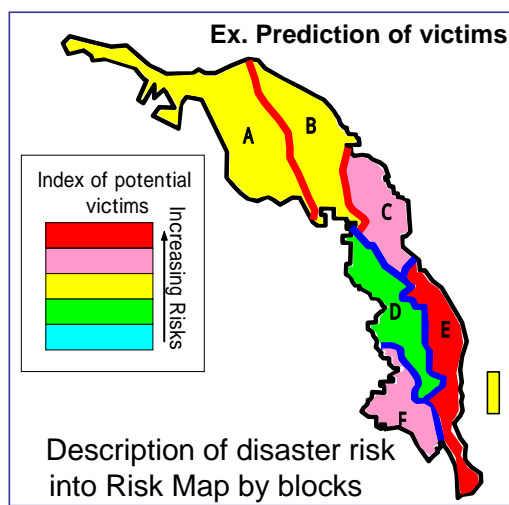
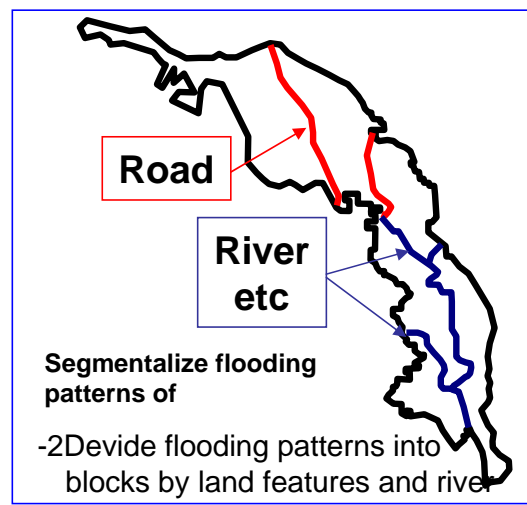
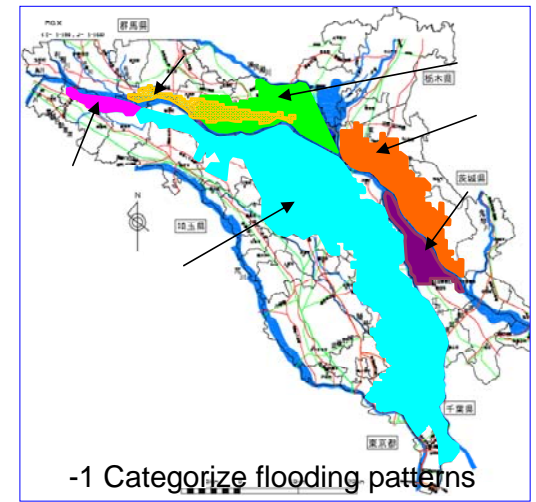
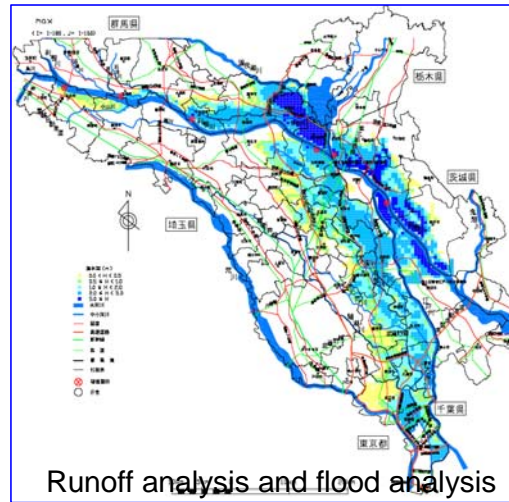
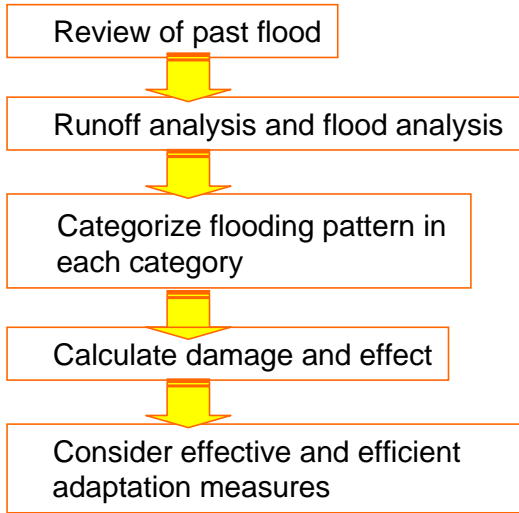


comprehensive flood control etc

- (i) Adaptation measures based on regional development through such actions as restrictions on and review of land use
- (ii) Adaptation measures centering around risk management

# Process of effective and efficient adaptation program

## 6. Japan's response to climate change

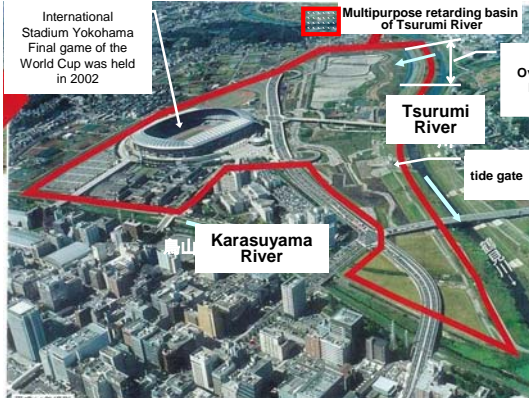


# Adaptation by using structural method

6. Japan's response to climate change

Improvement of the credibility of structure, effective and multipurpose and long-life utilization of existing structure

## Improvement structure



Multipurpose retarding basin of Tsurumi River



flood control (Dam)



River improvement of Tsurumi river

## improvement of the credibility of structure (ex Coastal protection)

Before



aging revetment by deteriorated concrete



After



Rehabilitation of aging revetment by setting up anterior wall

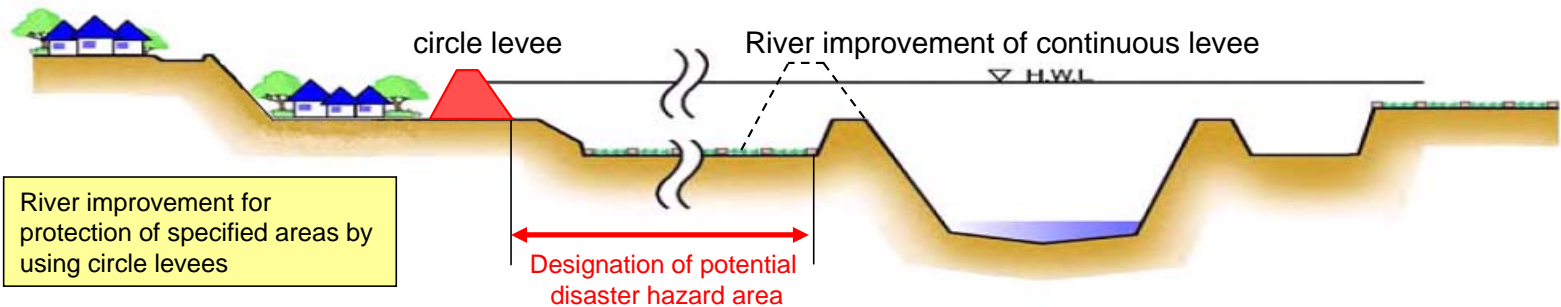


(i) Adaptation measures based on regional development through such actions as restrictions and review of land use

6. Japan's response to climate change

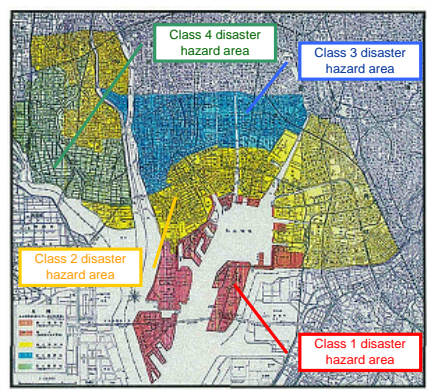
Response to floods that cannot be dealt with by facility-based measures, through land use or community development allowing inundation.

Shift to land use or ways of living that minimize damage



River improvement for protection of specified areas by using circle levees

Restrictions on land use by designating potential disaster hazard areas



Sample ordinance restrictions (Nagoya City)

	1階の床の高さ	構造制限	図解	解説
市種区域	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
市種区域	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
市種区域	N・P(+) 1m以上			
市種区域	N・P(+) 1m以上	2階以上に居室設置		

名古屋市臨海部防災区域図

Shift to community planning resistant to inundation

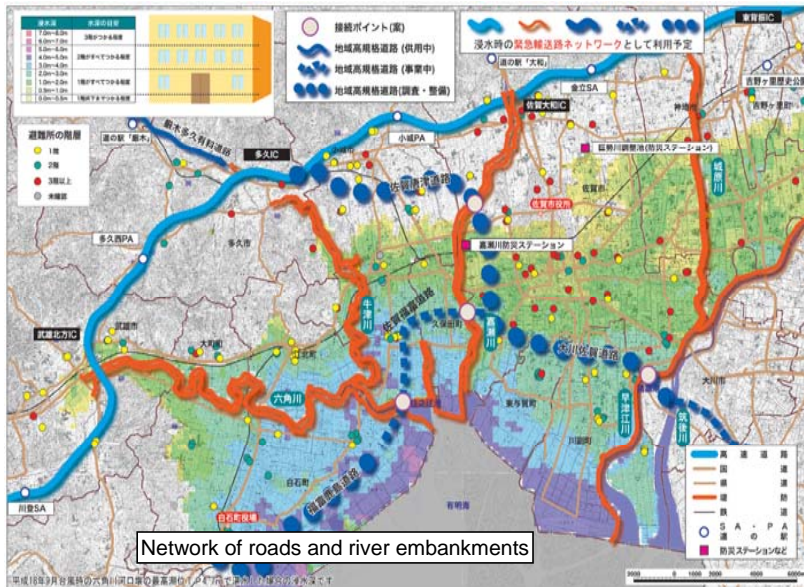


Adopting pilots to prevent damage to buildings during a flood

## (ii) Adaptation measures centering around risk management

## 6. Japan's response to climate change

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.



Inundation of Route 34 during a flood in July 1990

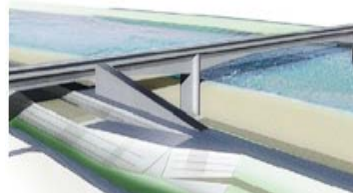
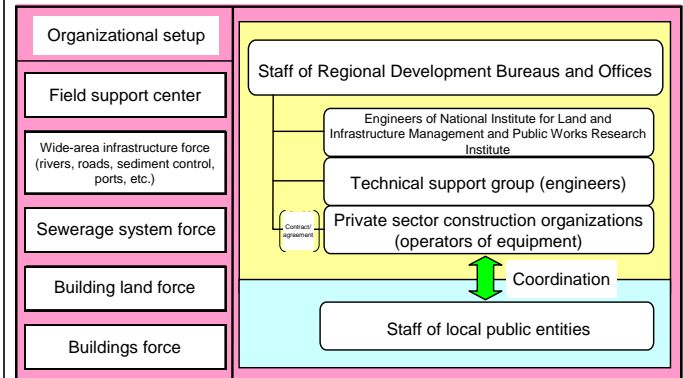


Image of road-embankment connection

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)



#### Activities

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



# Adaptation measures based on risk management

## 6. Japan's response to climate change

### 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**

情報の伝達経路

**Underground space**

避難時の心得

- ラッシュ、ラッシュで避難の危険増大、洪水発生を入手し、早急な避難が必要。
- 避難する際の荷物には避難袋、防災食、飲料水、懐中電灯、携帯ラジオなどにし、2人以上での避難を心がけよう。
- 避難する際の荷物には避難袋、防災食、飲料水、懐中電灯、携帯ラジオなどにし、2人以上での避難を心がけよう。
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**Hints on escape and necessities**

### Flood hazard map of xx City

**Potential inundation areas and depths of inundation**

**Locations and names of shelters**

**あなたの避難場所一覧**

避難場所名称	避難場所	所在地	電話番号
市役所	避難場所	市役所	042-234-1111
市民体育館	避難場所	市民体育館	042-234-1111
小学校	避難場所	小学校	042-234-1111
中学校	避難場所	中学校	042-234-1111
公民館	避難場所	公民館	042-234-1111
病院	避難場所	病院	042-234-1111
電力	避難場所	電力	042-234-1111
ガス	避難場所	ガス	042-234-1111

**行政機関一覧**

行政機関名称	所在地	電話番号
市役所	市役所	042-234-1111
市民体育館	市民体育館	042-234-1111
小学校	小学校	042-234-1111
中学校	中学校	042-234-1111
公民館	公民館	042-234-1111
病院	病院	042-234-1111
電力	電力	042-234-1111
ガス	ガス	042-234-1111

**医療機関一覧**

医療機関名称	所在地	電話番号
市立市民病院	市立市民病院	042-234-1111
市立市民病院	市立市民病院	042-234-1111
市立市民病院	市立市民病院	042-234-1111
市立市民病院	市立市民病院	042-234-1111
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**ライフライン管理機関一覧**

ライフライン管理機関名称	所在地	電話番号
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市立市民病院	市立市民病院	042-234-1111
市立市民病院	市立市民病院	042-234-1111

**Points of contact**

- Administrative organizations
- Medical institutions
- Lifeline systems management organizations

Toyooka City, Hyogo Prefecture

**Shelter (building)**

Flood

Embankment

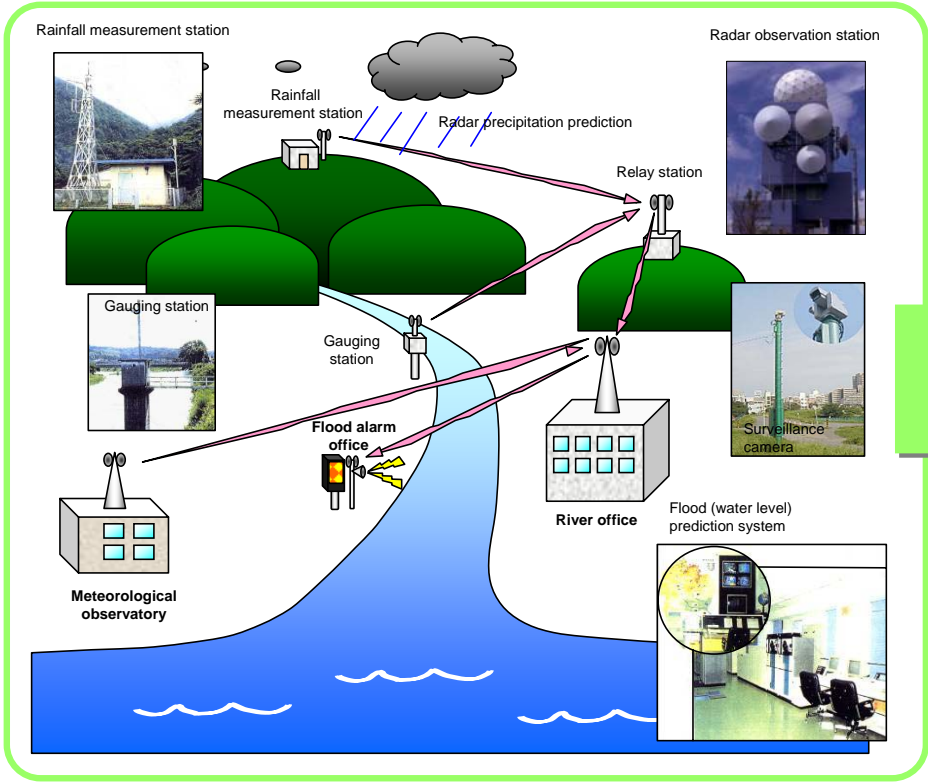
Shelter (building)

**Easily recognizable signs**

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### Share real-time information

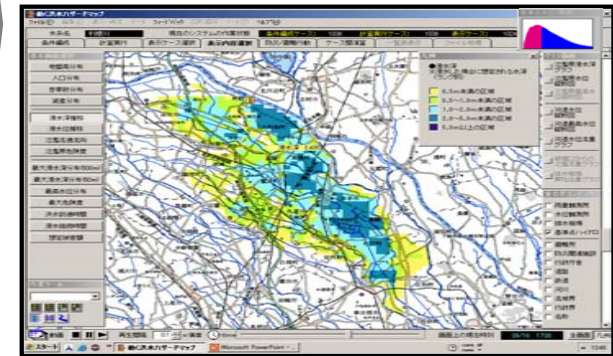
- Provision of rainfall amounts and water levels real-time via cellular phone, the Internet or local disaster prevention radio
- Flood forecasting through real-time simulation



Information provision via cellular phone or personal computer



Delivery of an image to a TV screen



Floodwater prediction through real-time simulation

### Prioritized investment to disaster prevention

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

### Clarification 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.

### Adoption adaptive approach

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

### New technical development and contribution to the world

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

### Participatory approach

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

