Flood Management in Japan

“Making space for water”
in innovative ways under land limitation

JICA River Management Advisor
AKIHISA OKUDA

Flood Management in Japan

1. Japan's National Land Conditions

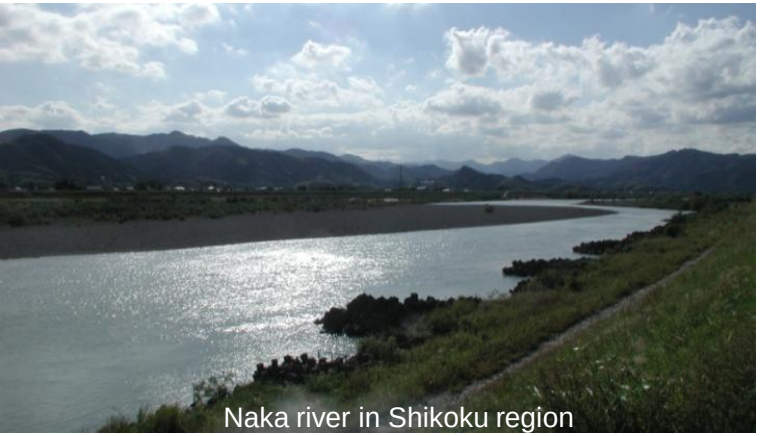
2. Comprehensive Flood Control Measures

   River Measures
   Basin Measures
   Damage Reduction Measures

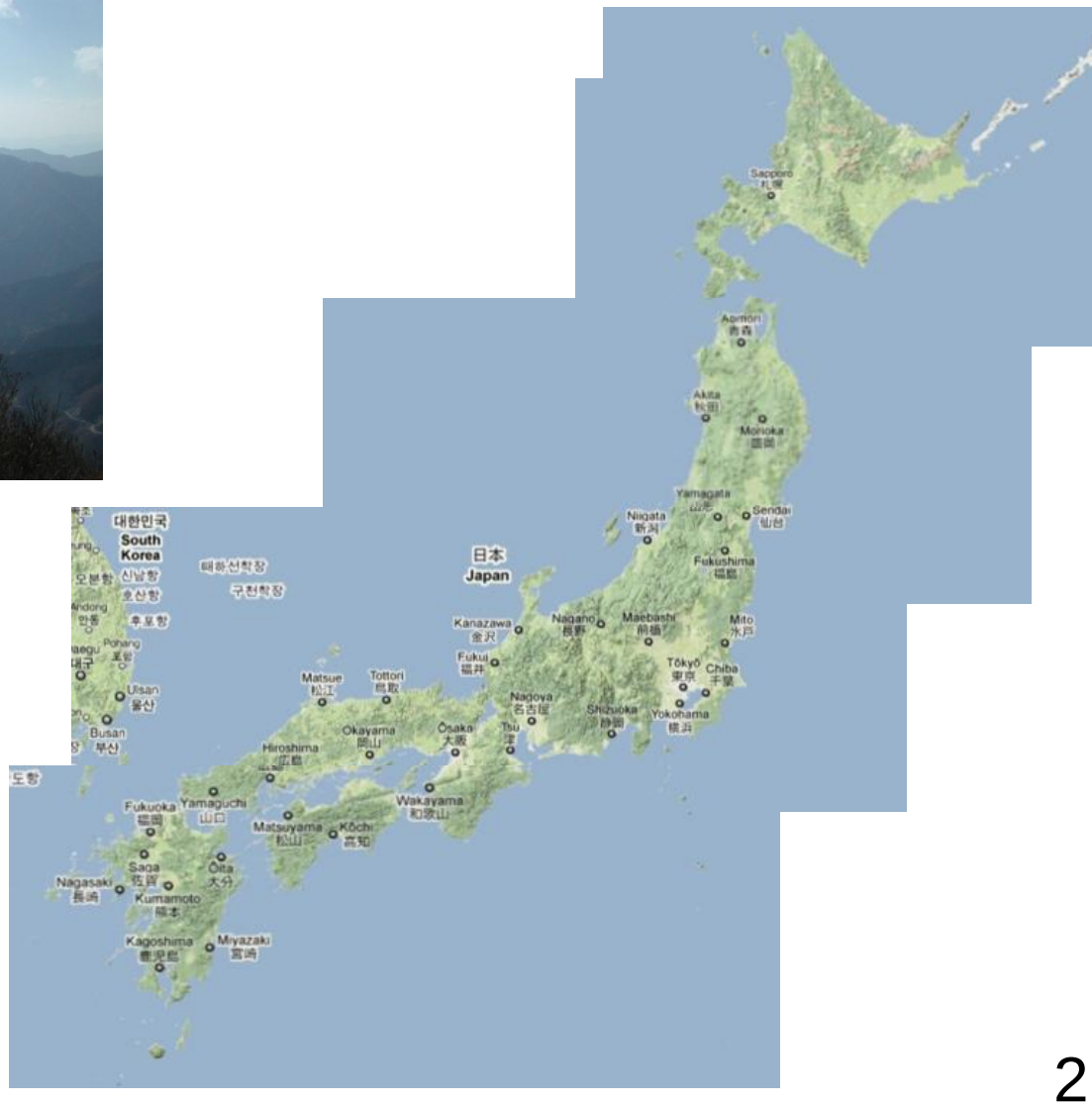
3. Recent Developments

Japan, a country of mountains

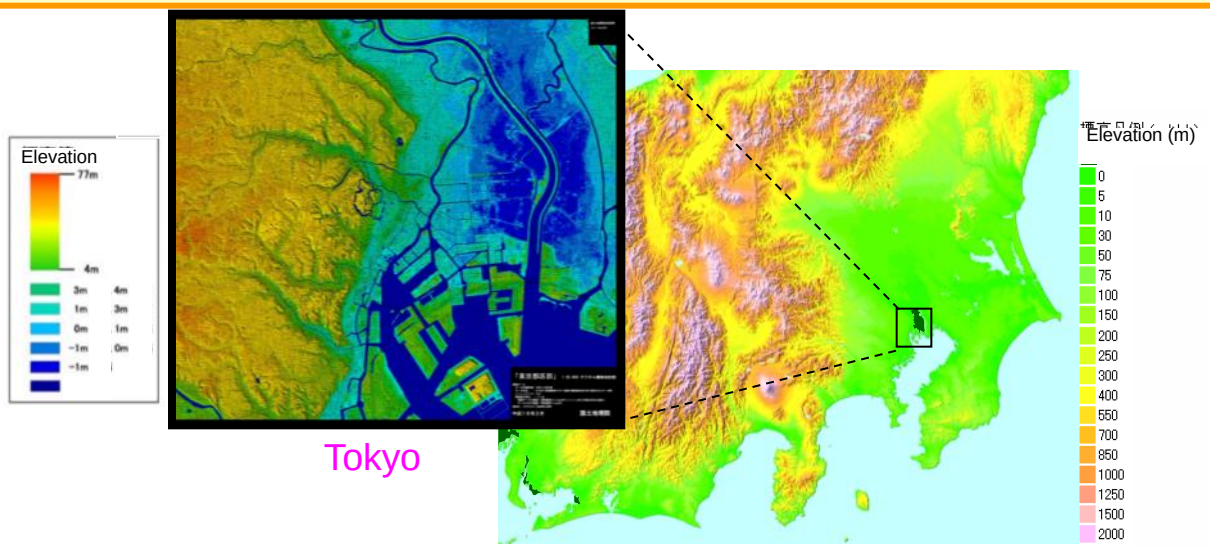
About 70% of its national land is mountainous.

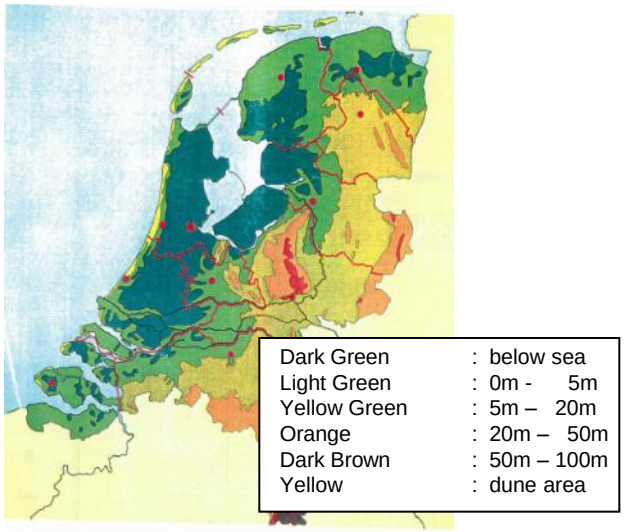


Naka river in Shikoku region



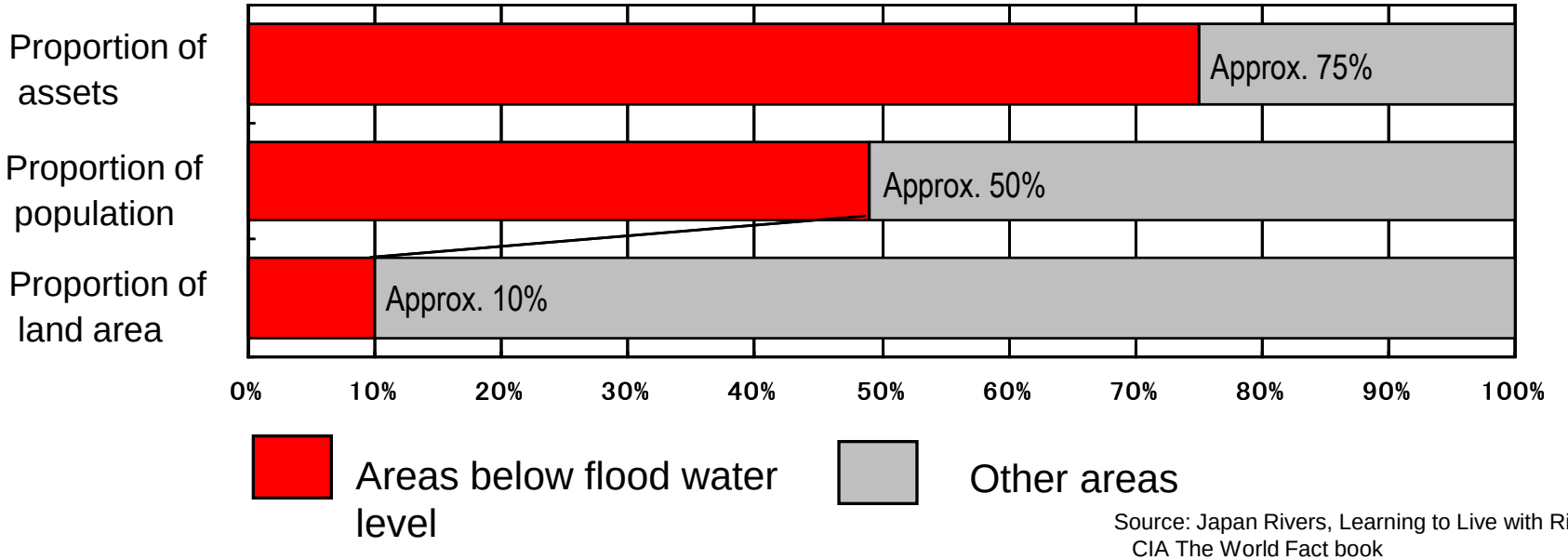
Japan and the Netherlands



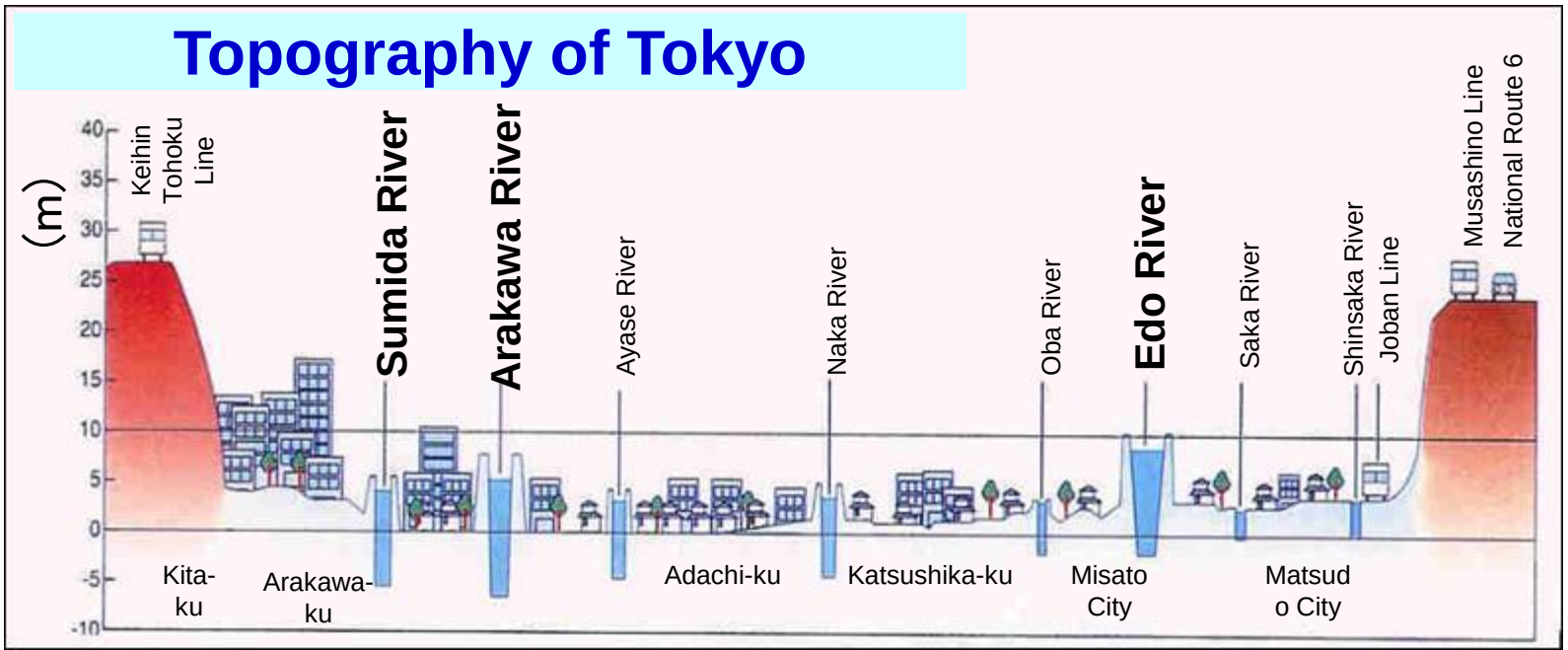


		Japan	The Netherlands
Geography		・Area：378,000km^2 ・Many short steep rivers. ・Sediment problems because of poor soil ・Flood plain area is located by alluvial fan and riverside	・Area：42,000km^2 ・Rhine River, Maas River, Schelde River as mild slope international river ・Delta and low area
		・Population：127.4 mil. (Density 337.1 /km^2)	・Population： 16.6 mil. (Density 400.4 /km^2)
	River	Name of River	Tone River	Rhine River
		Basin Area	About 17,000km^2	About 185,000km^2
		length of river	322km	1,320km
		Average bed slope	About 1/175	About 1/2,600
		largest flow discharge	17,000m^3/s(1947)	13,000m^3/s (1926)
Climate		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 ）

Vulnerability to water hazards

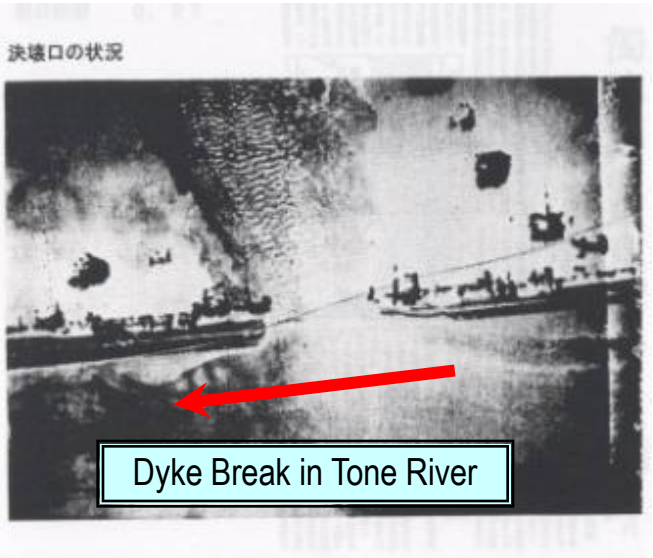


Source: Japan Rivers, Learning to Live with River
CIA The World Fact book

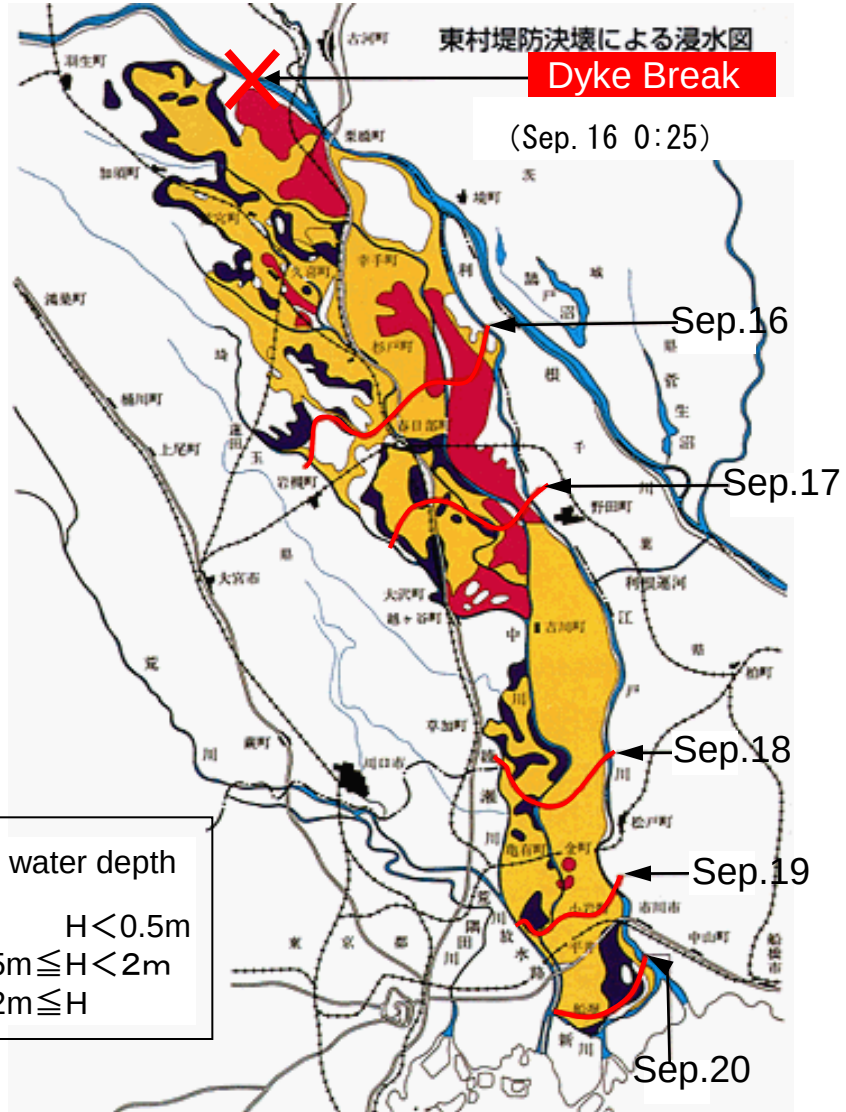


Typhoon Kathleen (1947) killed more than 1,100 people and submerged over 300,000 houses in Tokyo area.

A dike in Tone River collapsed and floods reached as far as Tokyo.



Areas inundated



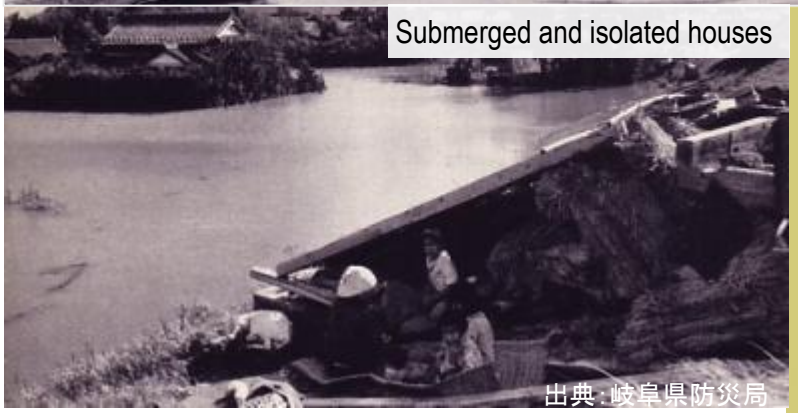
Typhoon Vera (Typhoon Ise Bay) in 1959 left 5,098 persons dead or missing, 38,921 injured, and some 1.2 million houses damaged.

* Excluding figures for the Kyushu region

- Dikes collapsed because of storm surge and river flood. Drifting woods increased casualties.
- Low-lying areas continued to be covered with water for more than 120 days.

Search and rescue efforts using boats (Yoro Town, Gifu Prefecture)

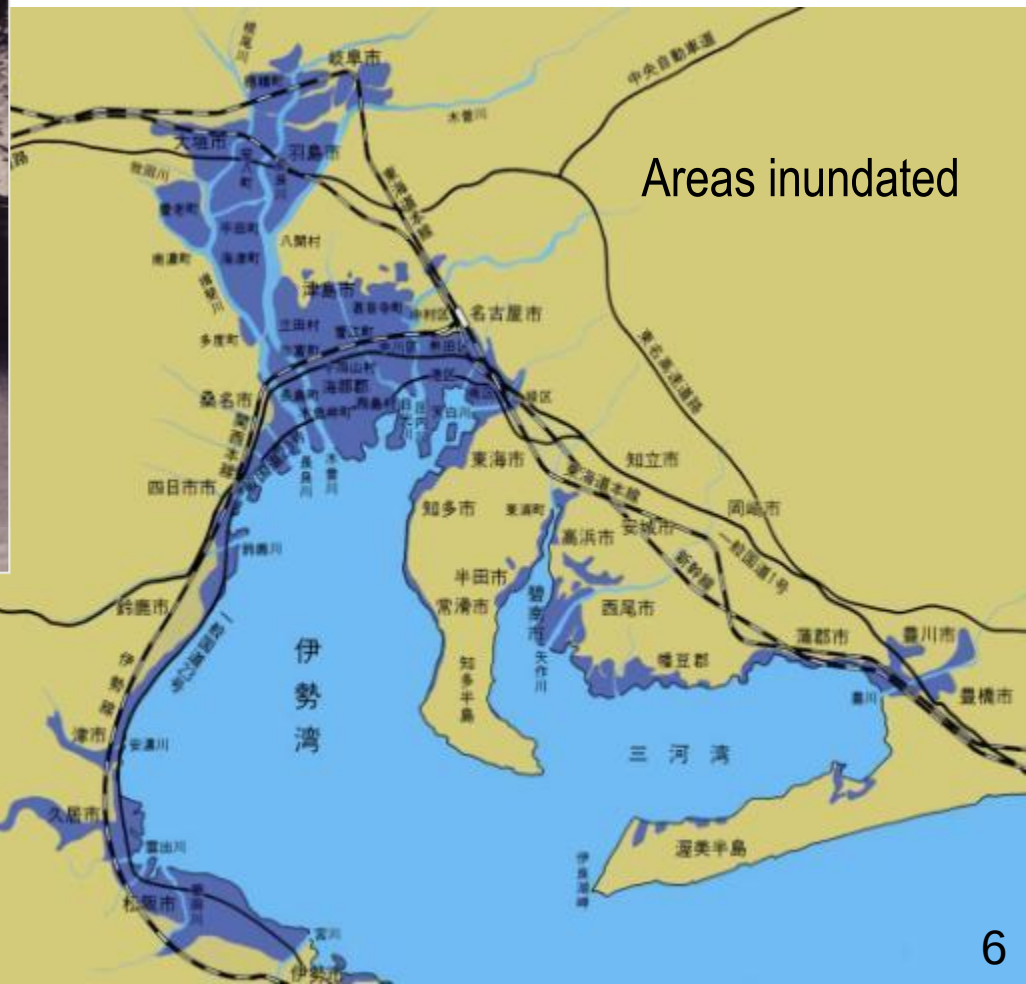
出典：岐阜県防災局



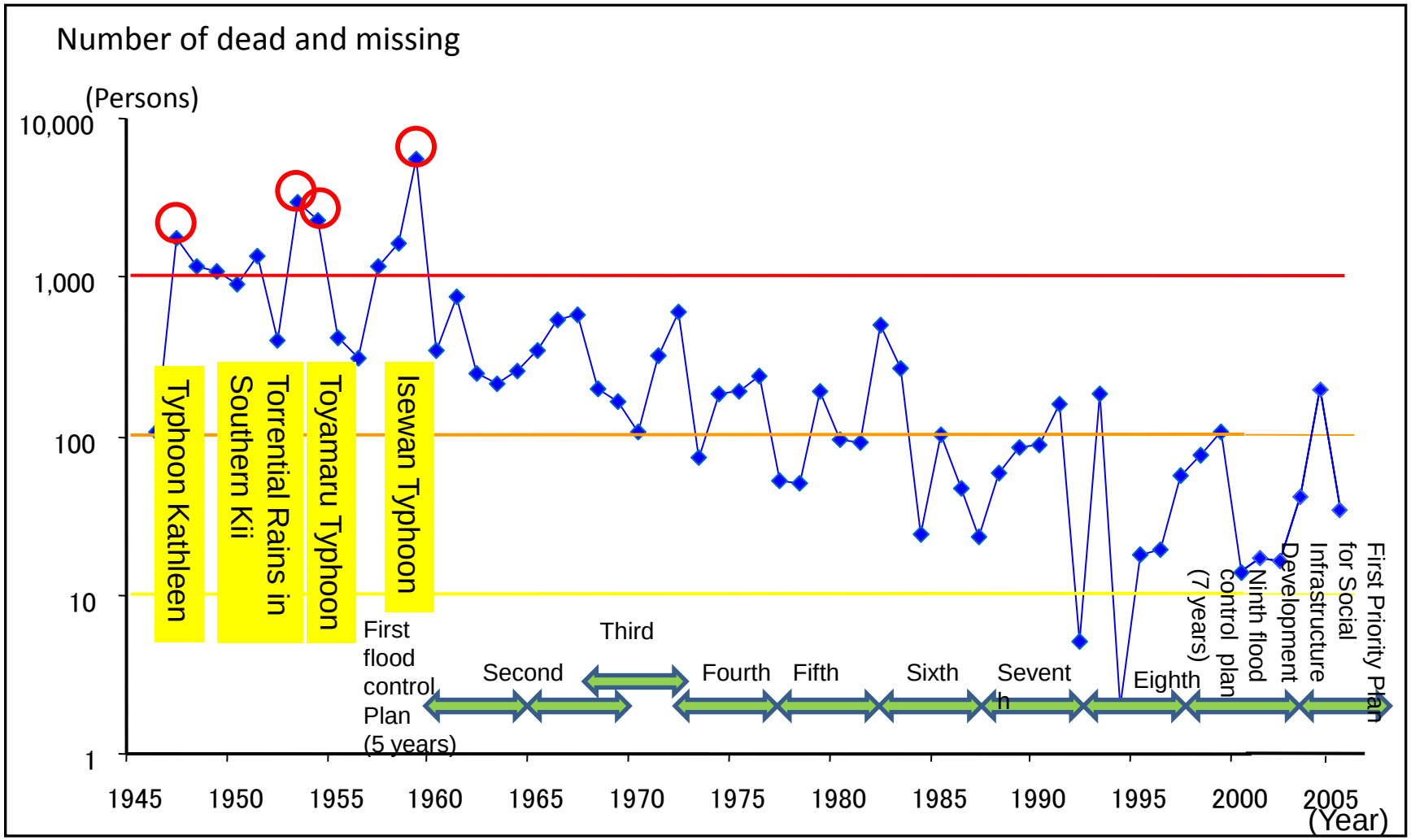
Submerged and isolated houses

出典：岐阜県防災局

Source: *Jidai ni Hikitsugu ano Kyokun Isewan Taifu* (Handing down the Lessons Learned from the Ise Bay Typhoon to the Next Generation) compiled by the Executive Committee of the 30-year Ise Bay Typhoon Project



Significant Decrease in Number of Casualties Due to Implementation of Continuous Flood Control Measures



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   - River Measures
   - Basin Measures
   - Damage Reduction Measures
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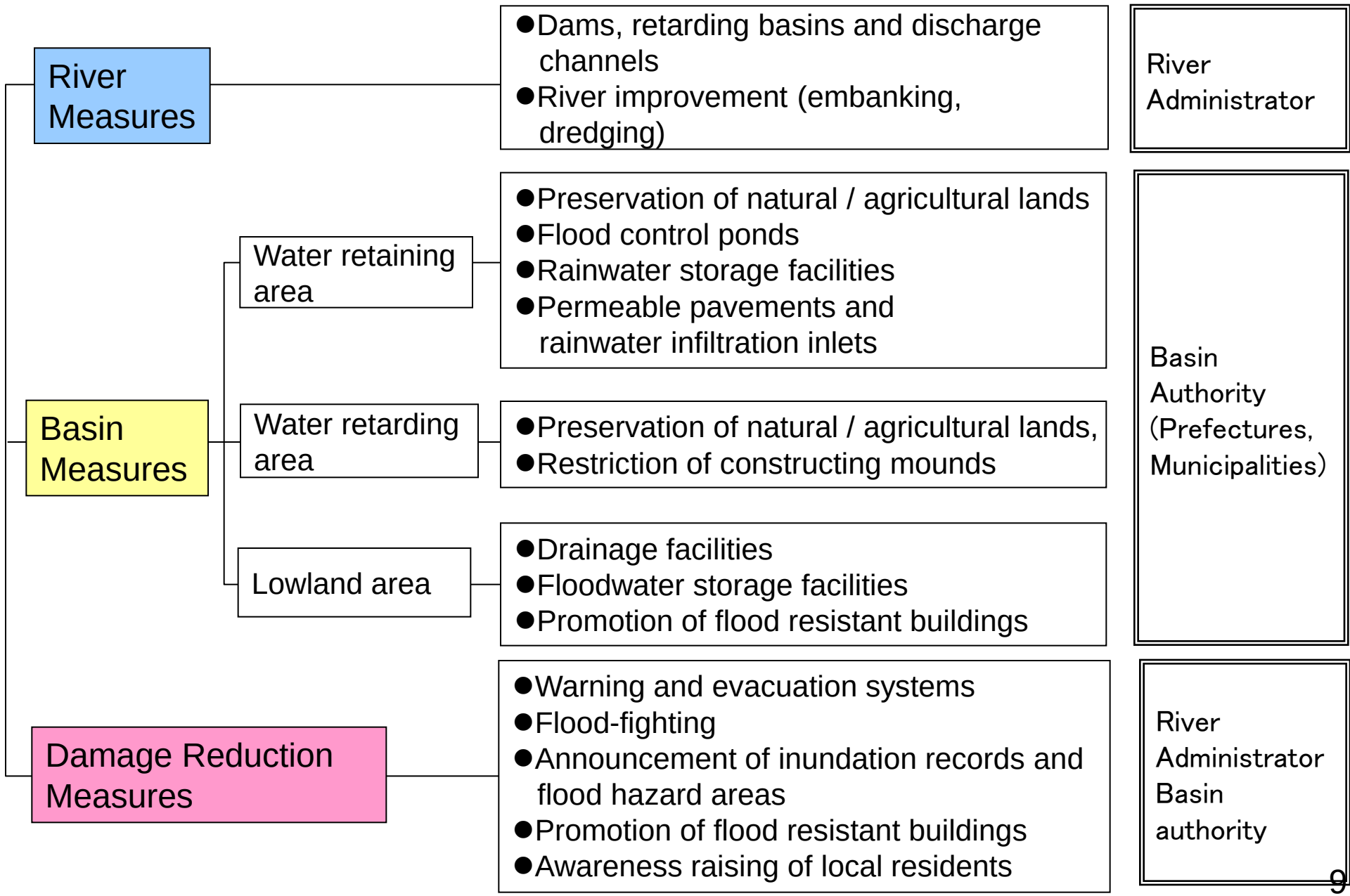
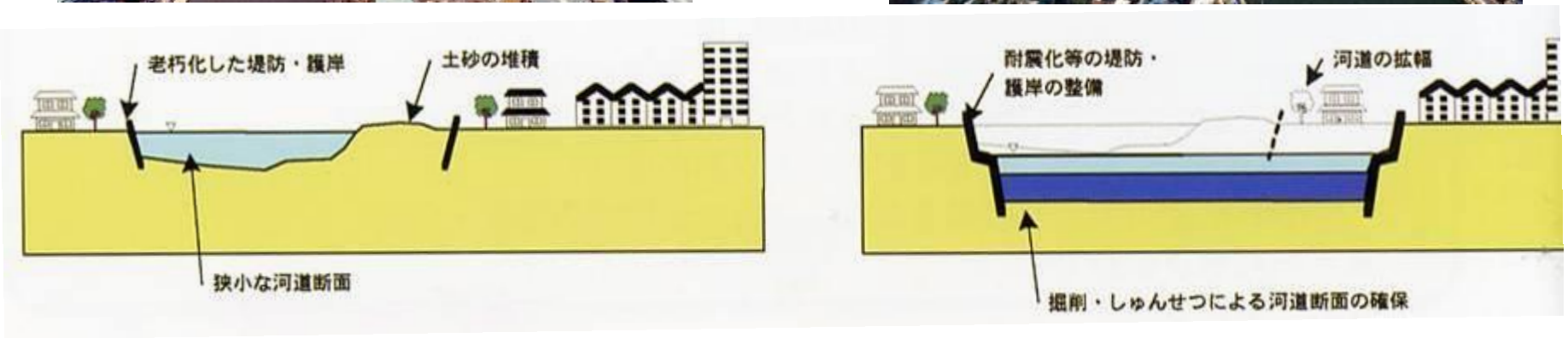
Comprehensive Flood Control Measures



River Measures

River channel improvement

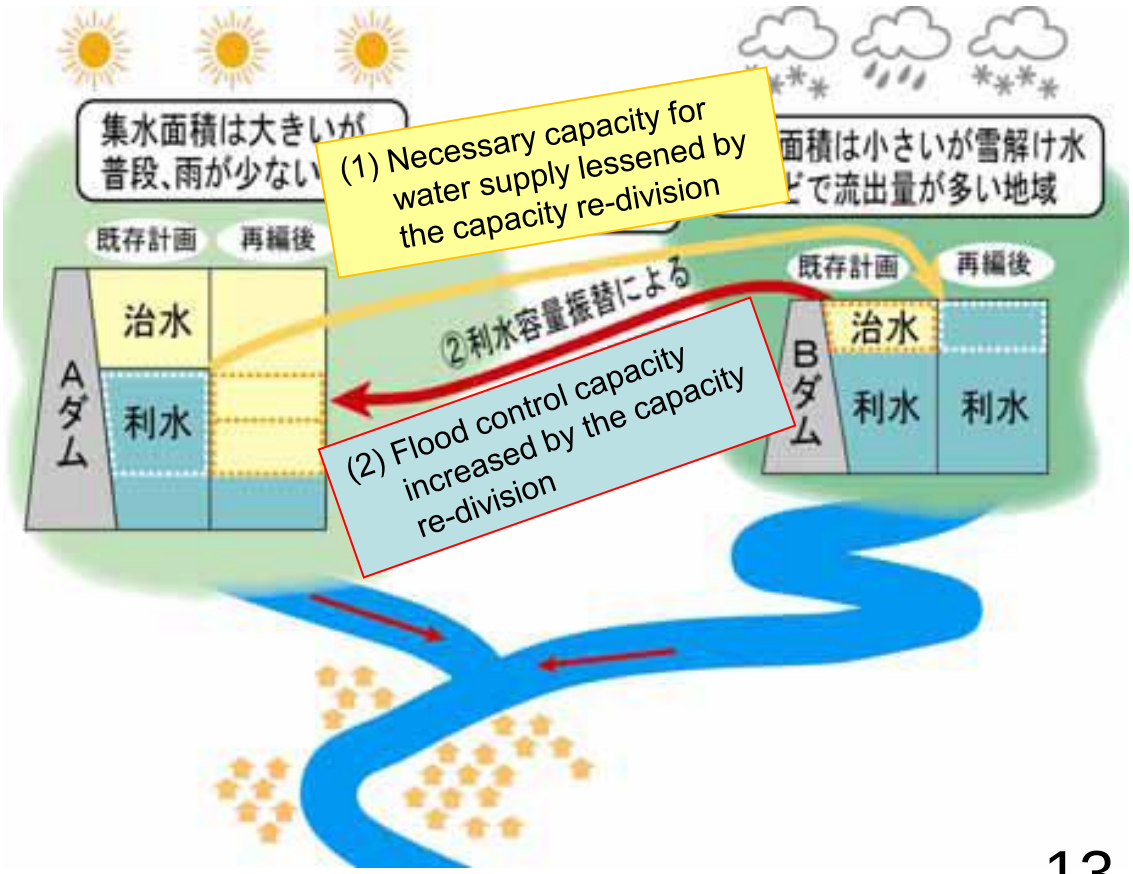


Construction of levees

Construction & Operation Improvement of Dams

Integrated operation of existing dams

Optimum capacity re-division of related dams based on present situations of dam operation, precipitation and flow characteristics of each sub basin



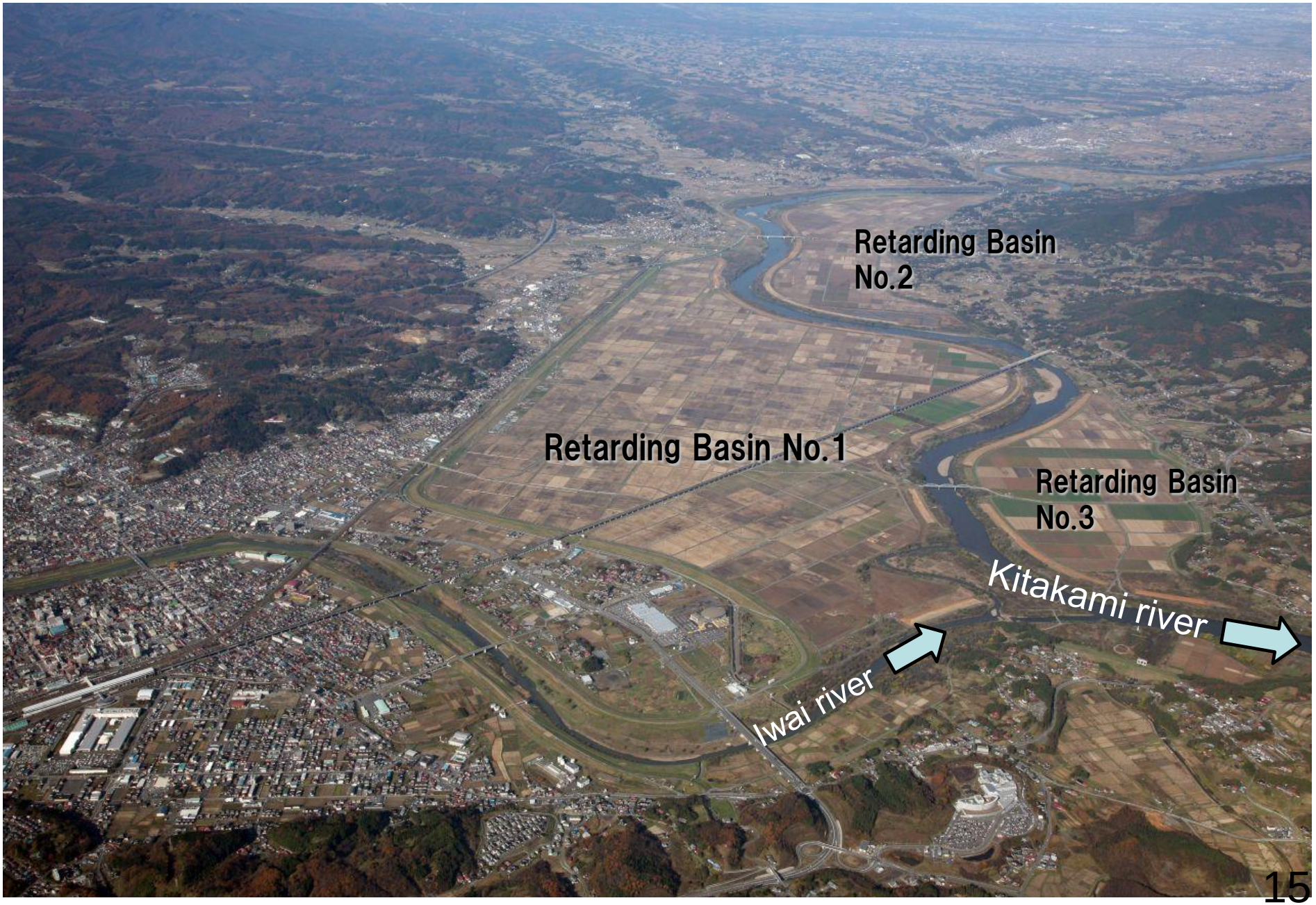
Retarding basin (Ara river)

Ara River First Retarding Basin

- ●location : Saitama City & Toda City, Saitama Pref.
  (28.8 – 37.2km from estuary of Arakawa river)
- ●Operation Start : Year 2003
- ●Area of Reservoir : 580 ha
- ●Total Capacity for Flood Control : 39 mil. m^3
- ●Valid Capacity : 10.6 mil. m^3
- ●Control volume : 850m^3/sec

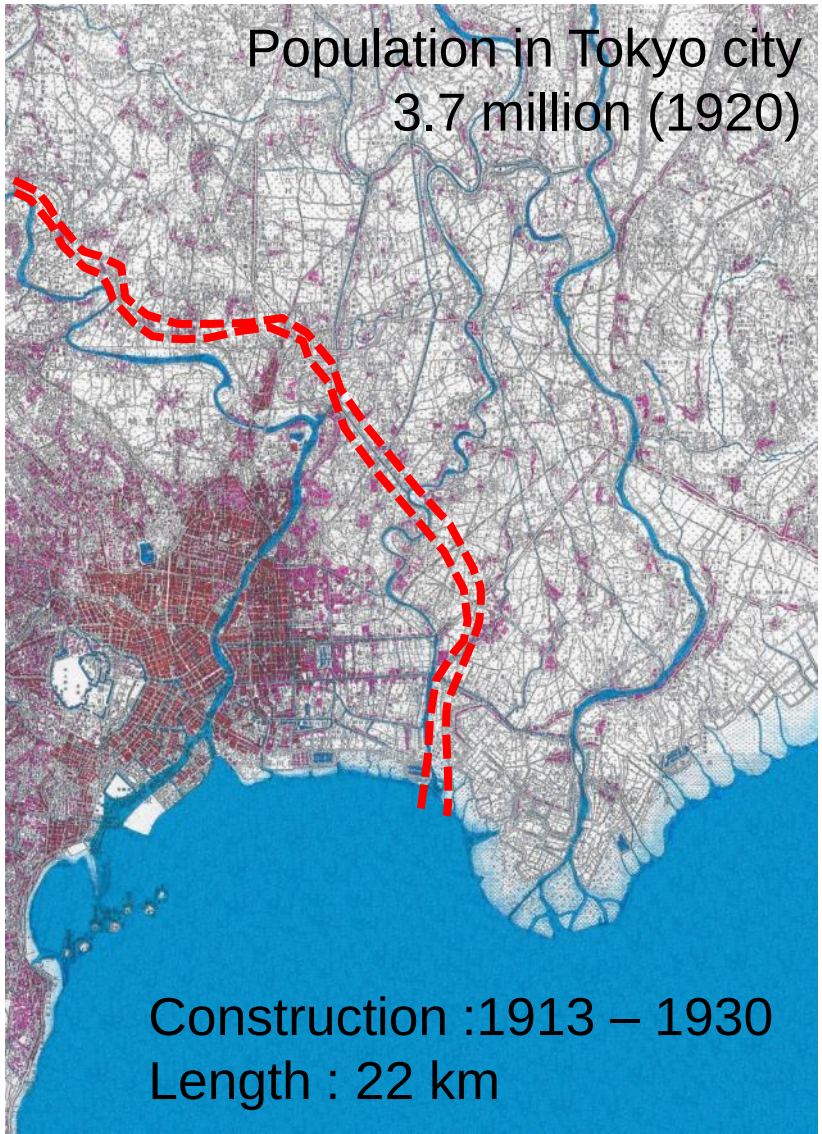
Photo by Arakawa Upstream River Office

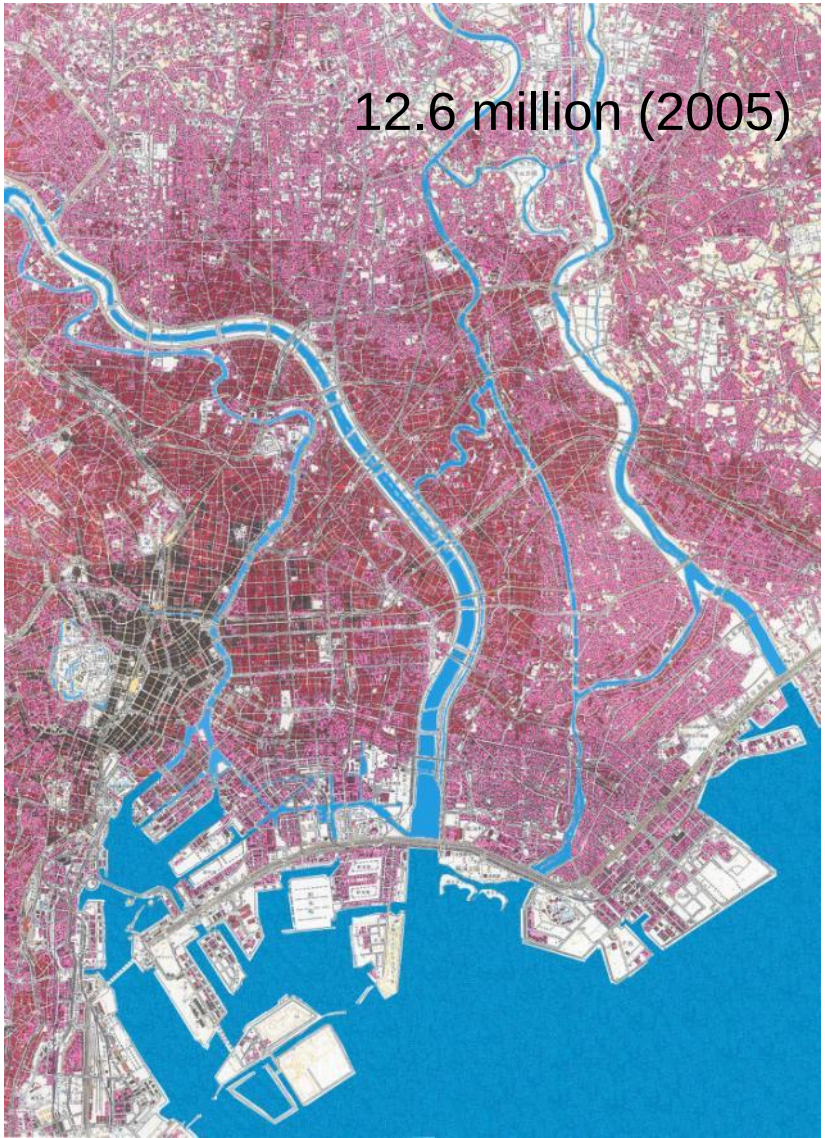
Retarding basin (Kitakami river)



Discharge channel (Ara river)

For the Ara River running through Tokyo, a floodway was constructed following the great flood of 1910.

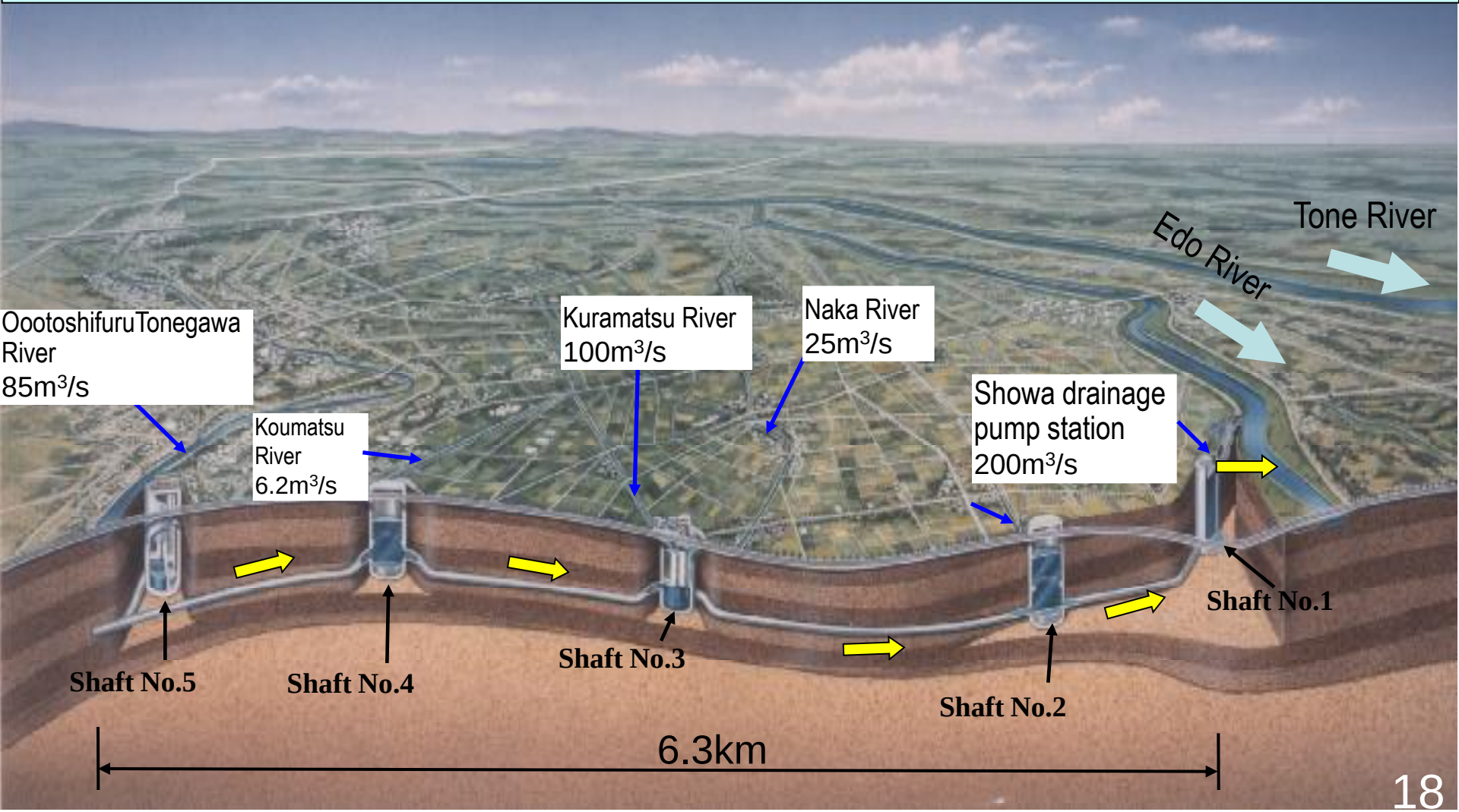




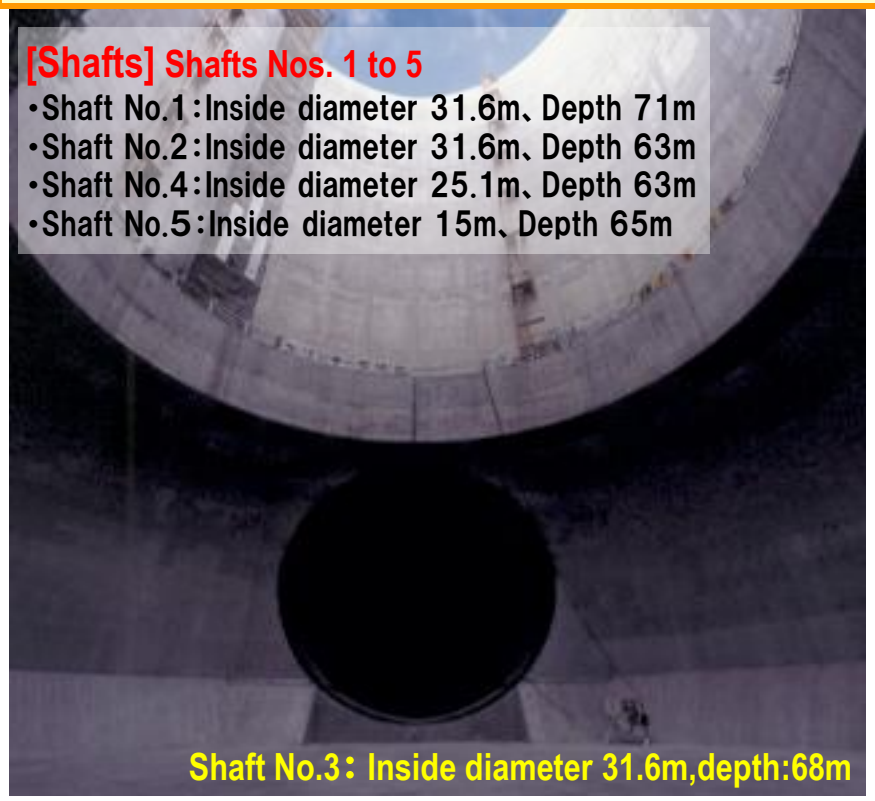
Discharge Channel (Hii river)

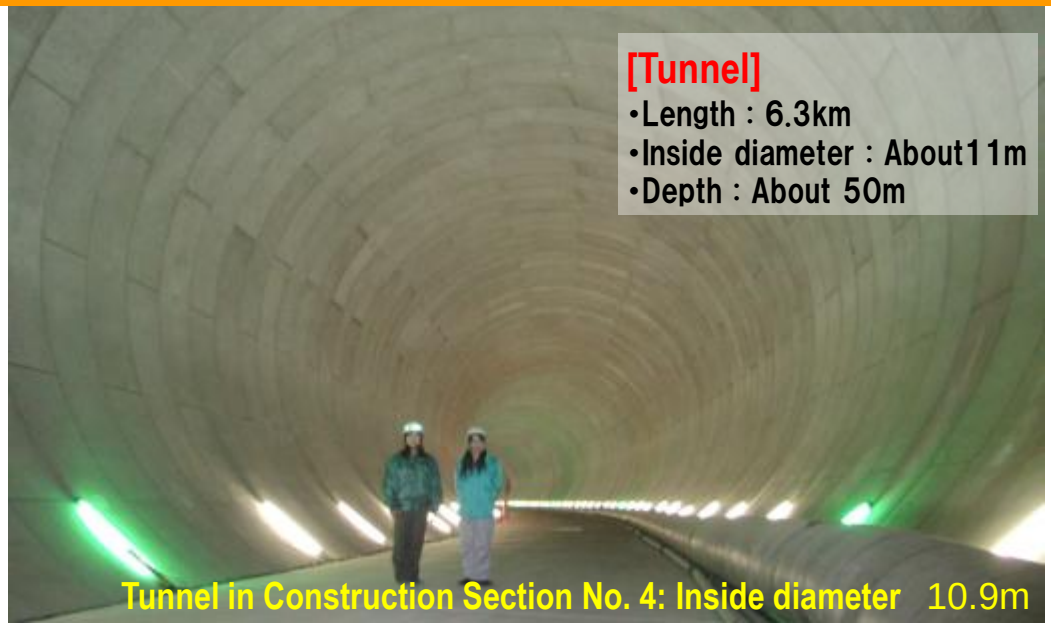
Underground discharge tunnel (Outer metropolitan area)

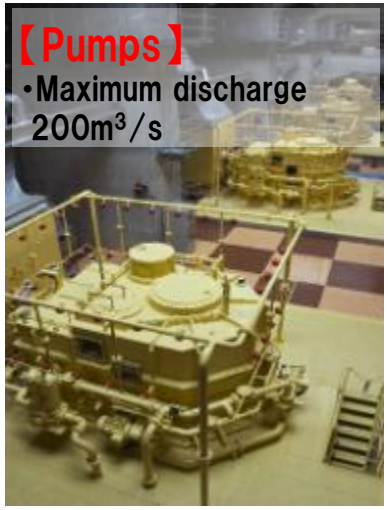
The floodway was constructed to drain floodwater in low-lying Naka river basin (suburban Tokyo), where frequent inundation caused severe damage.
Due to the land restriction, the floodway was build underground.

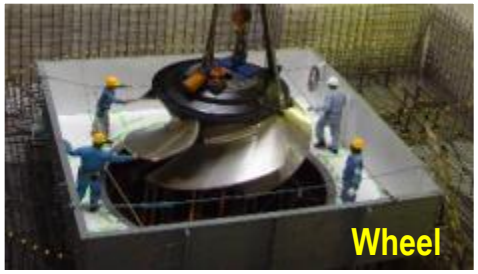


Underground discharge tunnel (Outer metropolitan area)





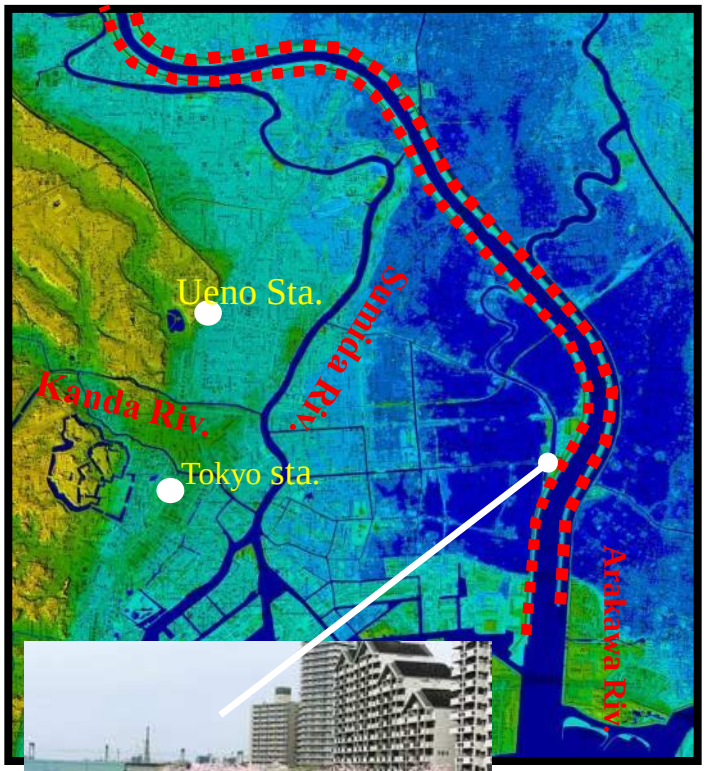




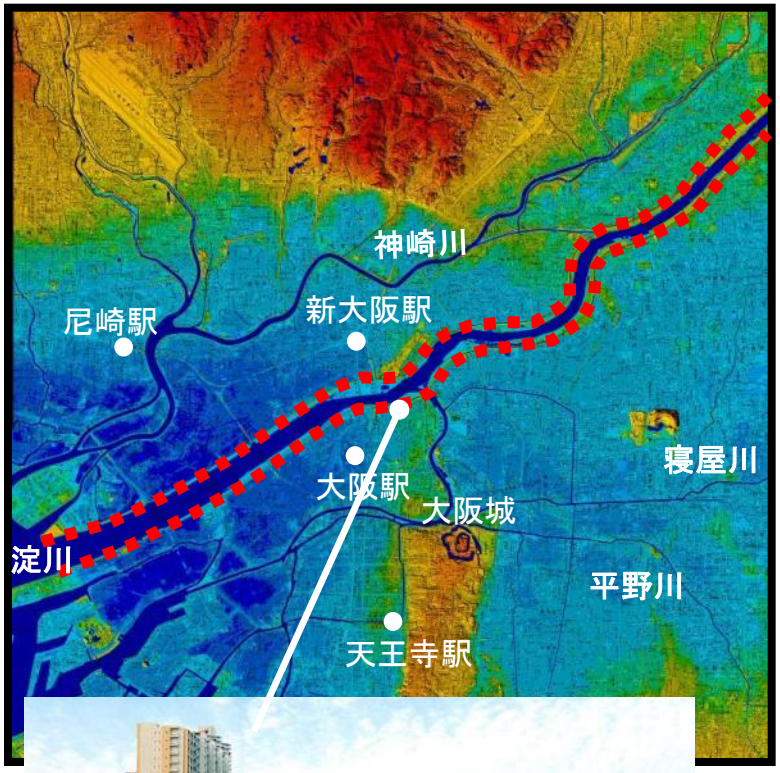
写真：江戸川河川事務所提供

Super Levees to avoid a catastrophic disaster

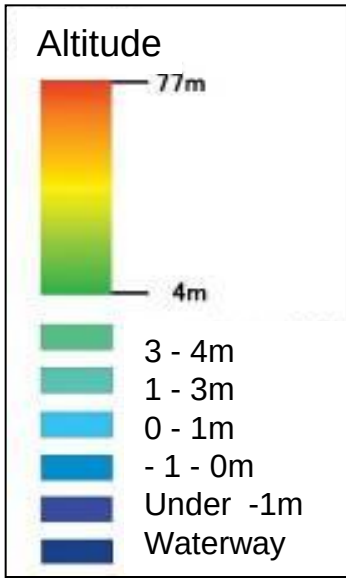
High-standard levees are build in order to prevent catastrophic damage due to dyke breach in low-lying highly urbanized areas, such as Tokyo and Osaka.



Komatugawa Area, Arakawa



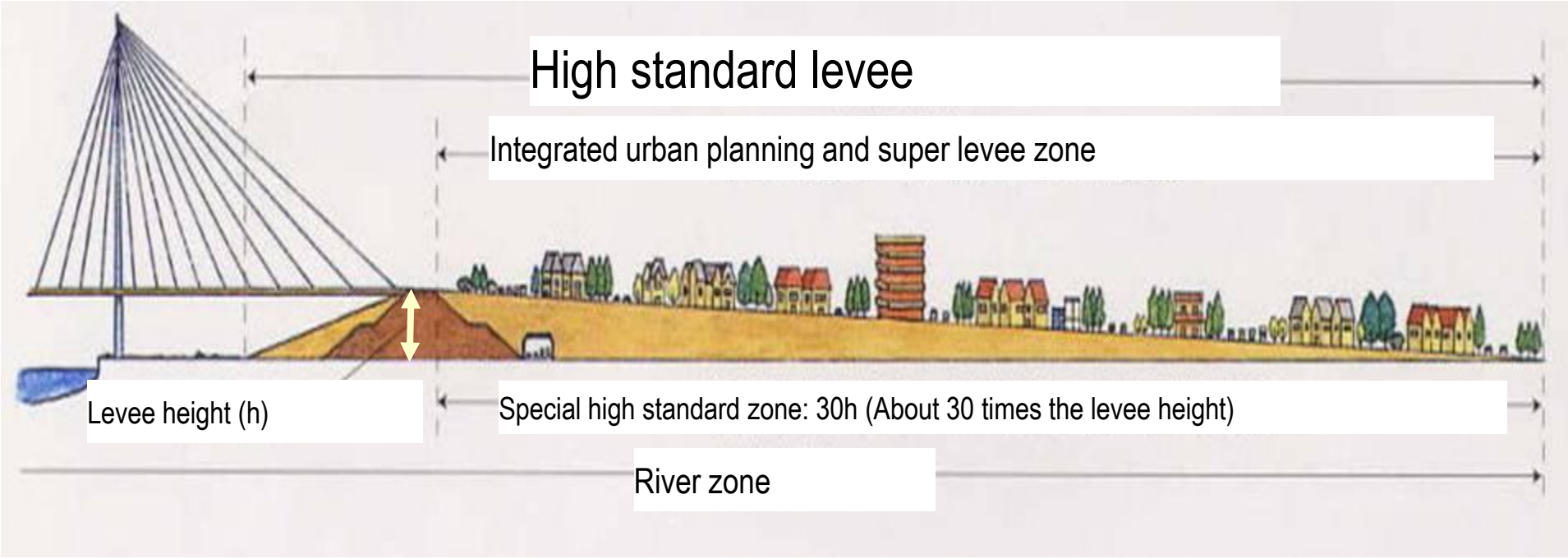
Iganishi Towmk Yodo



Super Levees (effects of disaster reduction)

With their extreme width, built in tandem with urban renovation projects, super levees can withstand

1) Overtopping flow,
2) Seepage during floods,
3) Earthquake (liquefaction and landslides).



Super Levees (effects of urban landscape, environment)

Super levees can enrich urban environment by creating open public spaces along the river.

Arakawa River and Shinden districts in Adachi City

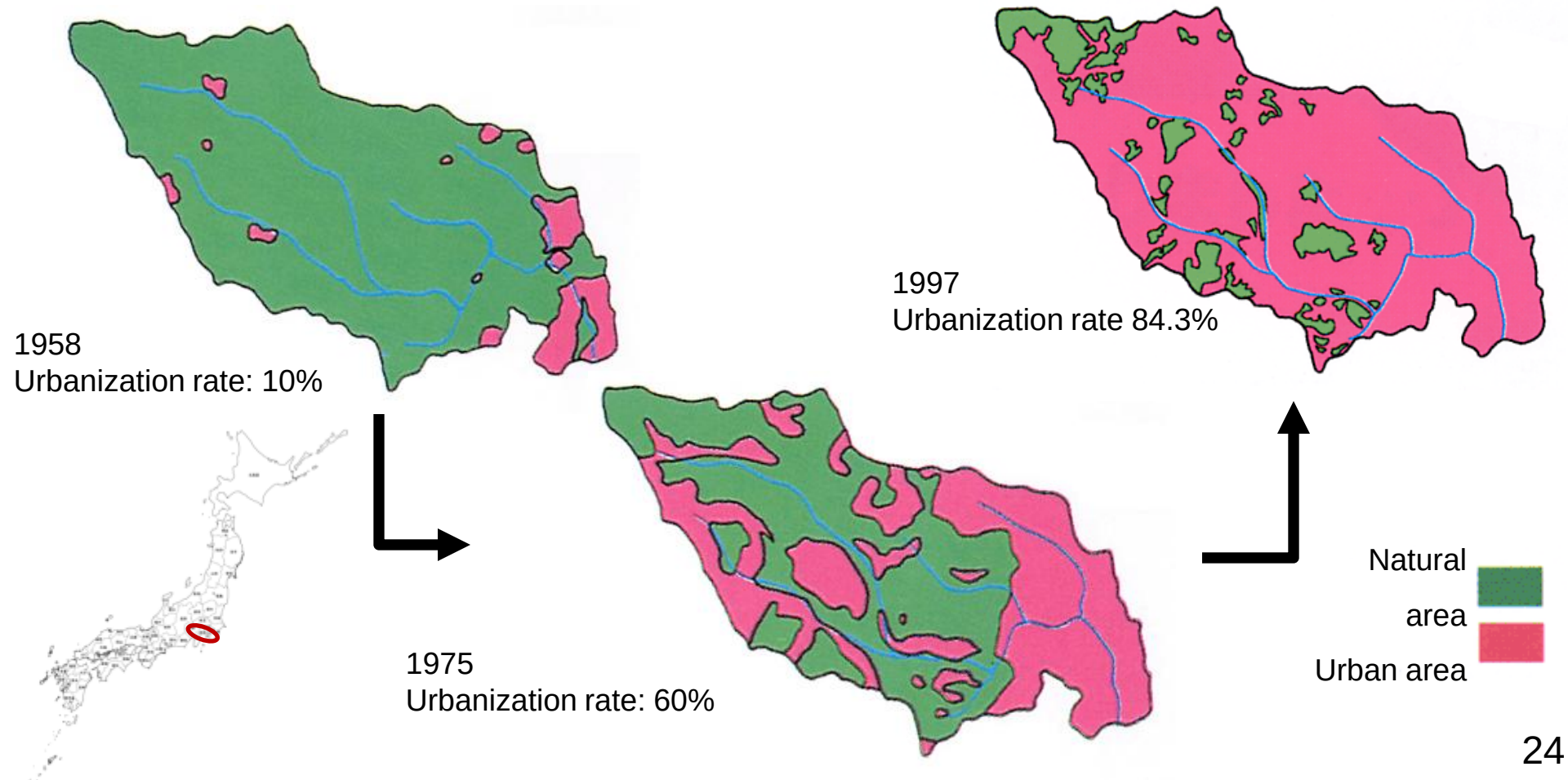
写真：荒川下流河川事務所提供

Basin Measures

The background for the introduction of “Basin Measures”

Due to the rapid increase of population, plateaus and hilly areas near large cities were developed rapidly on a large scale.

Tsurumi River (Tokyo and Kanagawa Pref.)

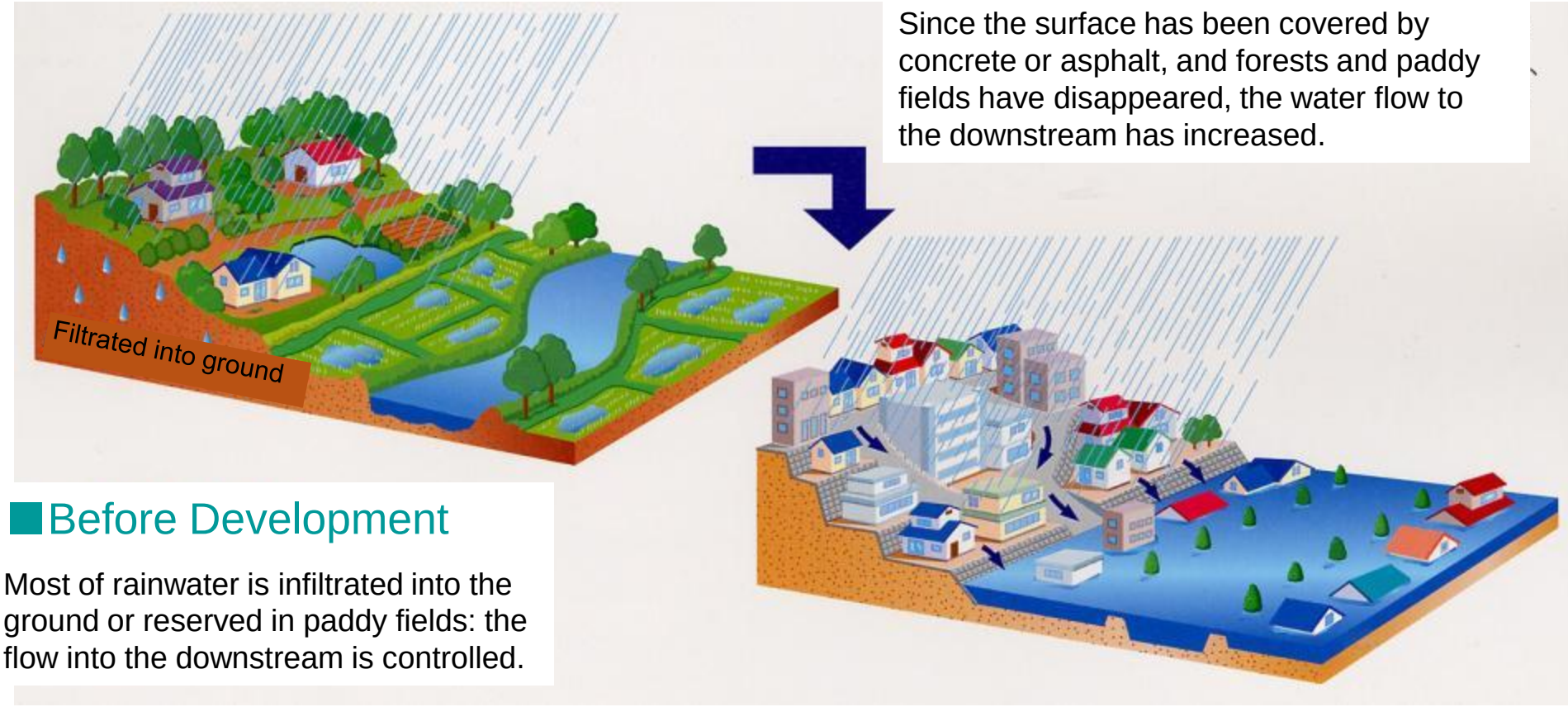


The background for the introduction of “Basin Measures”

Progress of urbanization heighten the risk of flood on low grounds

After Development

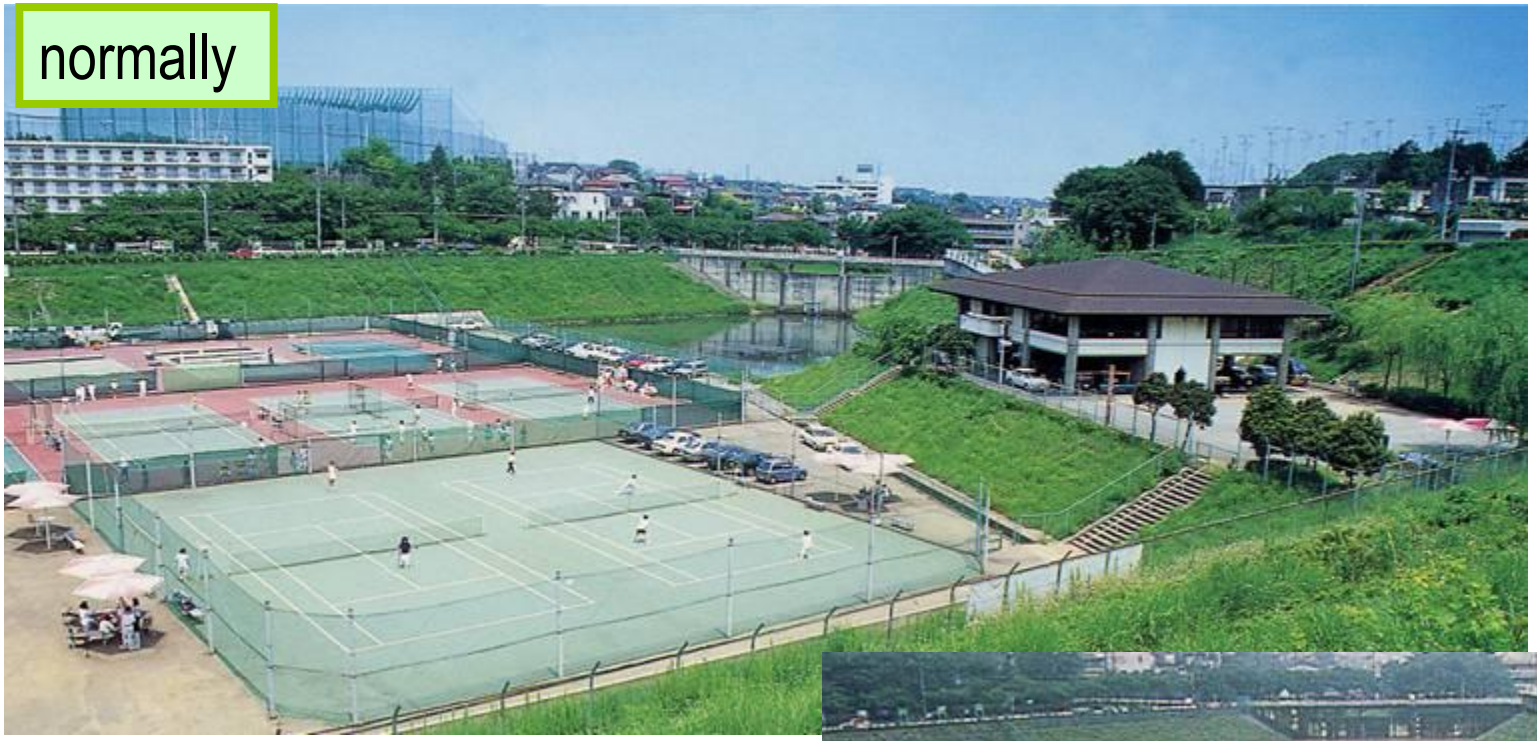
Since the surface has been covered by concrete or asphalt, and forests and paddy fields have disappeared, the water flow to the downstream has increased.



Before Development

Most of rainwater is infiltrated into the ground or reserved in paddy fields: the flow into the downstream is controlled.

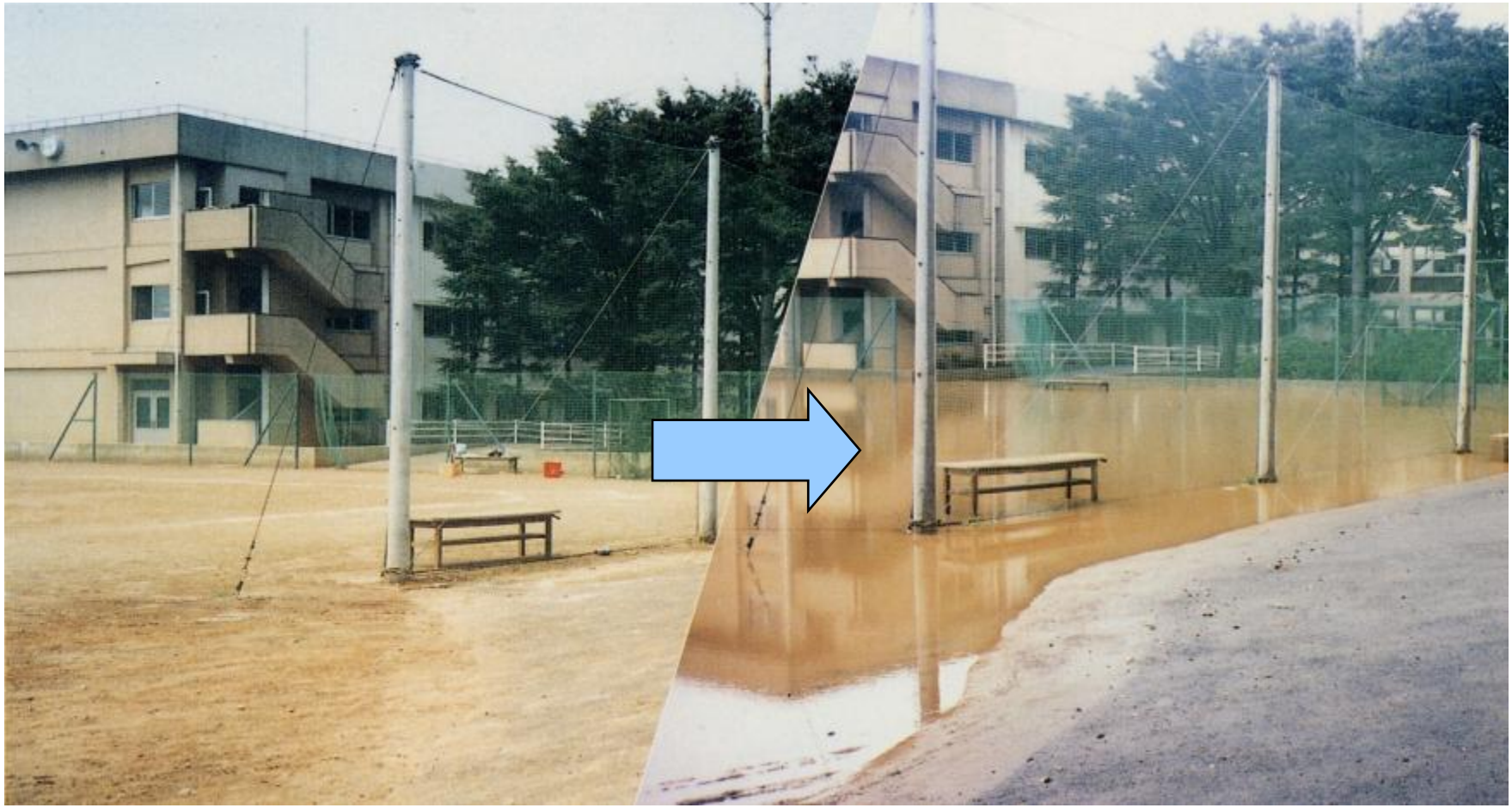
Flood control ponds



Kirigaoka reservoirs
(Tsurumi river)

Rainwater storage facilities

Storing rainwater in a schoolyard



normally

flooded

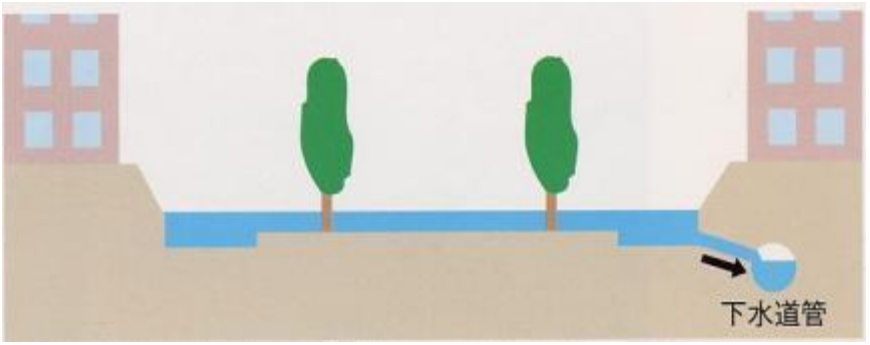
Permeable pavements

permeable pavement

permeable tile pavement

Tokyo

Rainwater storage between buildings in apartment complexes



Infiltration facilities

Seepage pits・Seepage trench

Damage Reduction Measures

Increase of Damage Potential due to Urbanization

Flood damage in Fukuoka City (June, 1999)
A city with approximately 1.5 million people.

Urban area were flooded with some 1 meter high

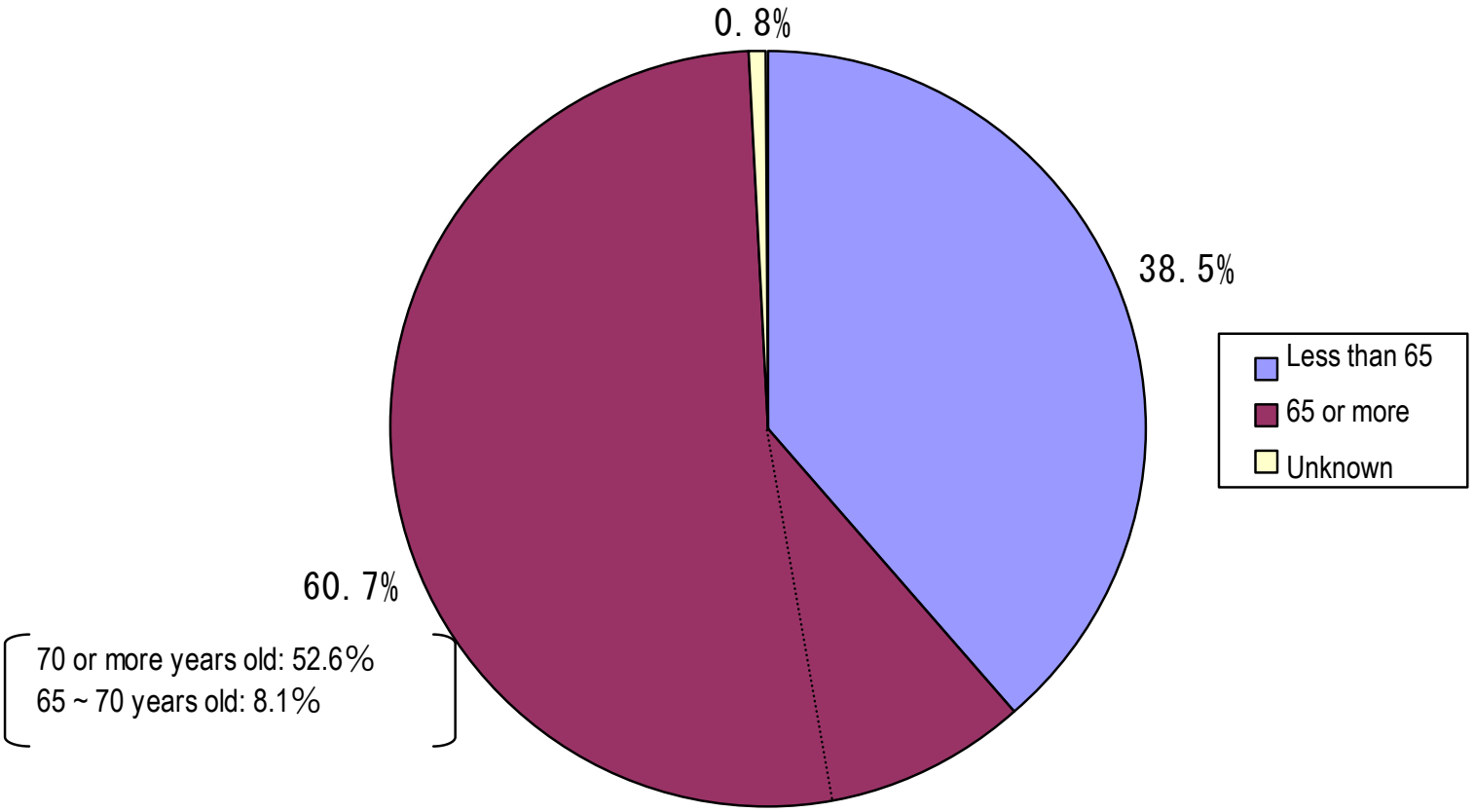
Submergence at the underground facilities in urban areas

Oct.2004
Azabu-juban Sta.
(Tokyo metro)

Jul. 2003
Hakata Sta.
(Fukuoka municipal subway)

Increase of vulnerability due to the aging population

Most of fatalities and missing (60%) are aged persons

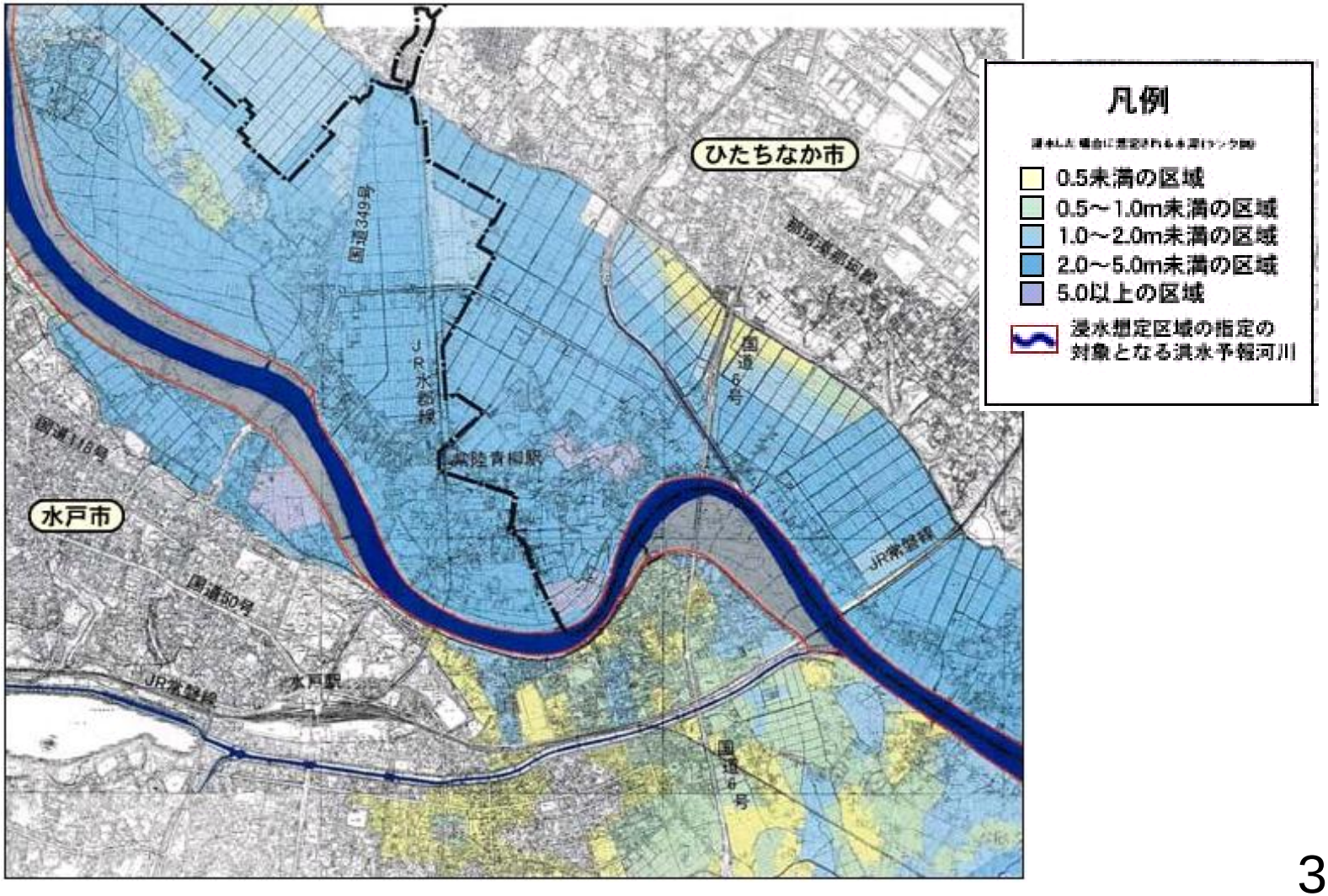


Notes: 1. The graph above totals the 145 fatalities and missing caused by the flood and landslide disasters out of the 232 fatalities and missing caused by main typhoons and flood disasters.

2. We classified the victims according to the ages and main causes of death or missing based on the Fire Agency disaster information. For the unknown parts, we refer to the newspapers and the results of the hearing survey conducted by the government research group, some explanations are added by the River bureau and classified.

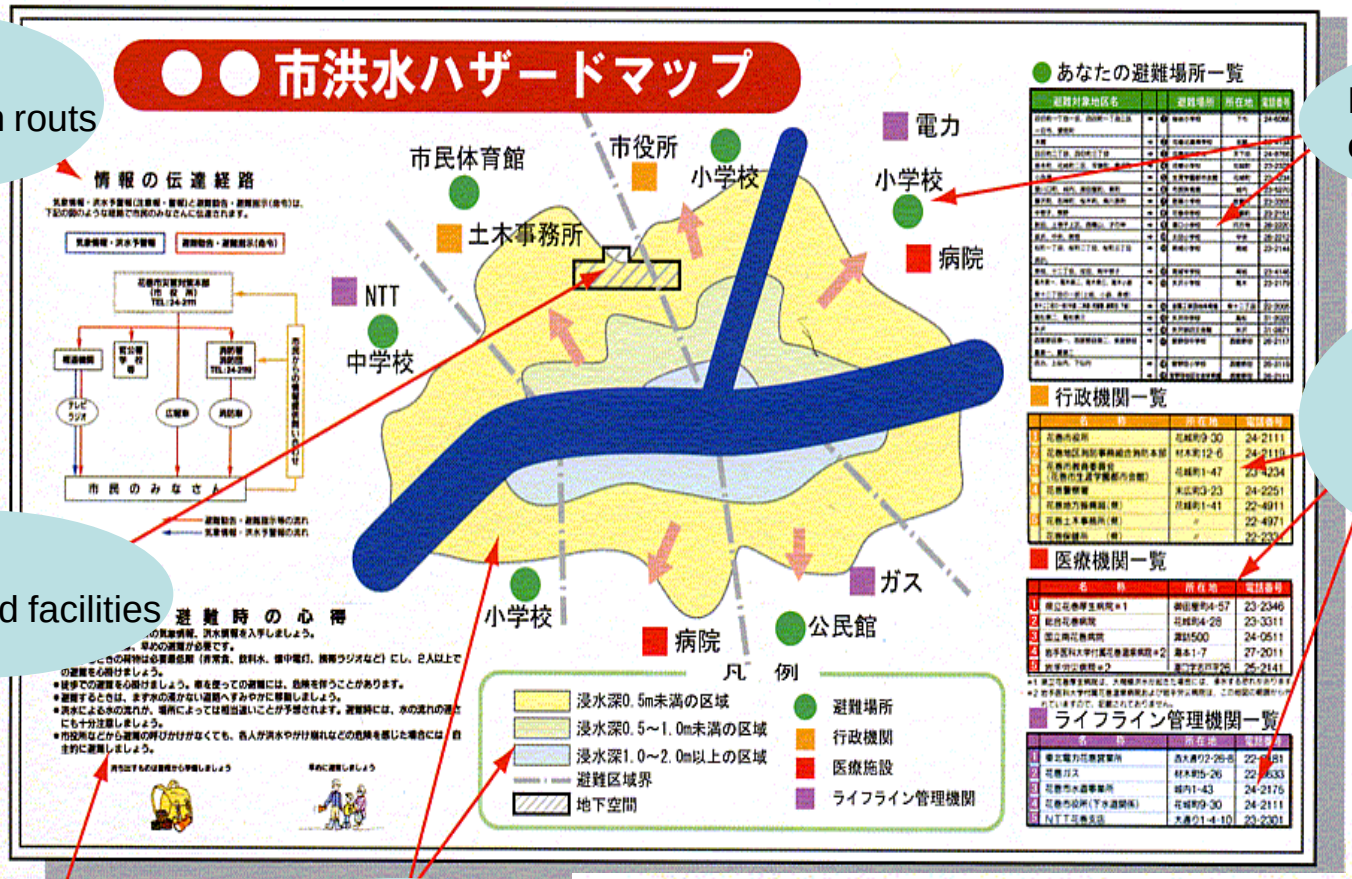
Designation and publication of flood-prone areas

Based of the article 14 of the flood-fighting Act, river administrators (MLIT and prefectural governments) designate areas that may be inundated in the event of flooding as flood-prone areas.



Preparation and dissemination of flood hazard maps

Based on the article 15 of the flood-fighting Act, municipalities prepare and disseminate flood hazard maps to residents on the basis of flood- prone area maps.



Information transmission routs

Names, locations of evacuation sites

Contact information (government offices, hospitals, public utilities)

Location of underground facilities

Tips, things to bring when evacuating

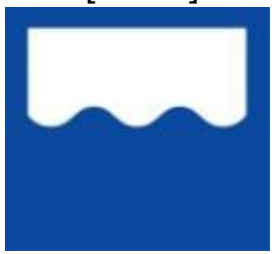
Designated flood-prone area and expected depth

Indication of Flood Hazards in Town

Flood-related symbols

JIS Z8210:2006

[Flood]



This symbol indicates that the area concerned may be affected by floods.

[Evacuation site (building)]

This symbol shows a safe building that provides a shelter when a disaster occurs.

Provision of river information

Provision of river information by MLIT in real time, 24hours a day, 365 days a year.

Nationwide data are measured and sent by telemetry

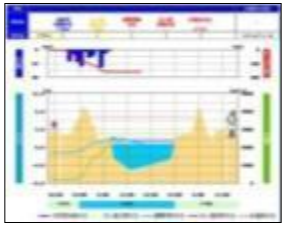
Data are collected, processed and edited into an easy-to-use form and transmitted

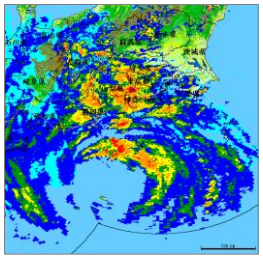
Sent to users

Collection
Data from 17,300 stations nationwide every 10 minutes.

Processing • Editing
Into easily understood tables, graphs, maps, diagrams etc.

Transmission
(Information by time/location provided as needed)





River manager

Municipalities

State depts.

Provision of River information by mobile phone

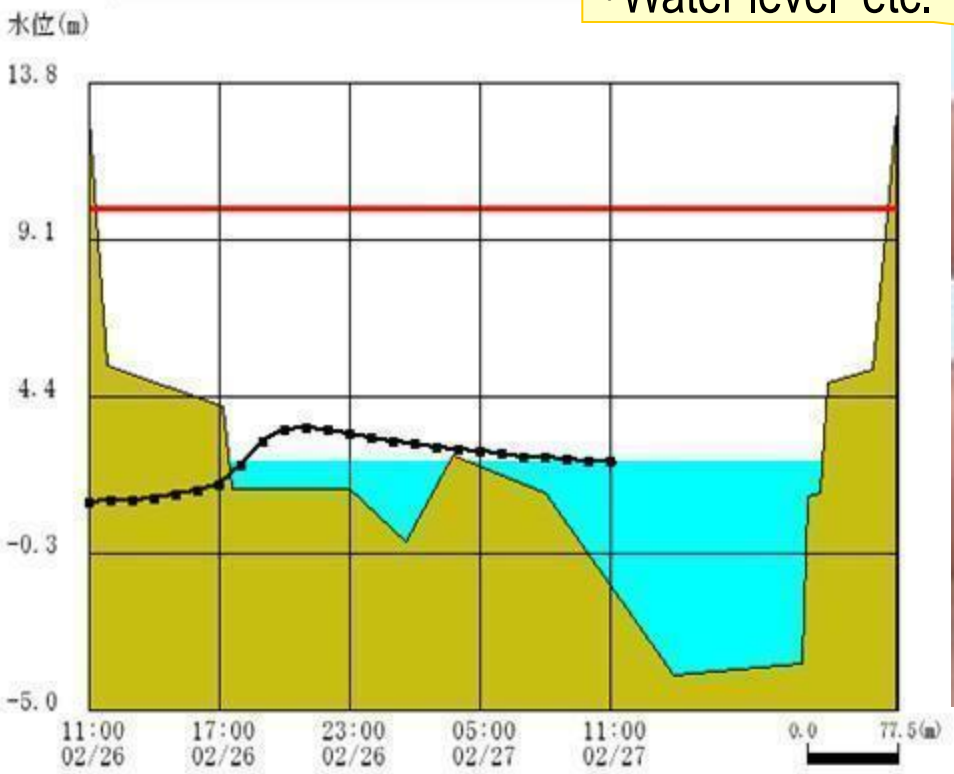
Information provided on the internet

観測所別水位グラフ

計画高水位	10.0
危険水位	—
特別警戒水位	—
警戒水位	—
指定水位	—

水系名	吉野川
河川名	吉野川
観測所名	高瀬橋
所在地	徳島県名西郡石井町藍畑

年月日時分	水位(m)
2006/02/27 11:00	**
10:00	**
09:00	**
08:00	**
07:00	**
06:00	**
05:00	**
04:00	**
03:00	**
02:00	**
01:00	**
2006/02/26 24:00	**
23:00	**
22:00	**
21:00	**
20:00	**
19:00	**
18:00	**
17:00	**
16:00	**



※この情報は速報値であり、検定済データではありません。

Information provided to mobile phones

Contents
- Precipitation by hyeto meter
- Precipitation by radar rain gages
- Water level etc.

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Occurrence of Heavy Rain with Hourly Rainfall of over 100 mm

Damage caused by torrential downpour in Chugoku and Northern Kyushu districts in July 2009

○ Hourly rainfall of 116 mm (Fukuoka city, Fukuoka pref. (Hakata))
○ Hourly rainfall of 72.5 mm (Hofu city, Yamaguchi pref. (Hofu))
○ Damage caused by debris flow, etc. in Northern Kyushu and Chugoku districts
Deaths: 31
Houses flooded above floor level: 2,152, Below floor level: 9,285

※H21.9.3現在（消防庁発表）

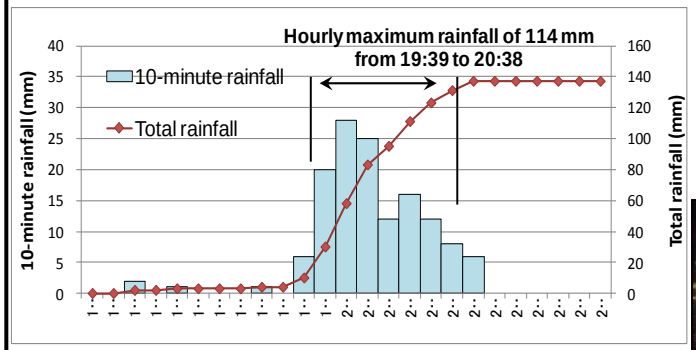
福岡県大野城市乙金
（九州縦貫自動車道）
被災状況

山口県防府市
（特別養護老人ホーム）
被災状況

Damage caused by "guerrilla downpour" in Itabashi Ward, Tokyo on July 5, 2010

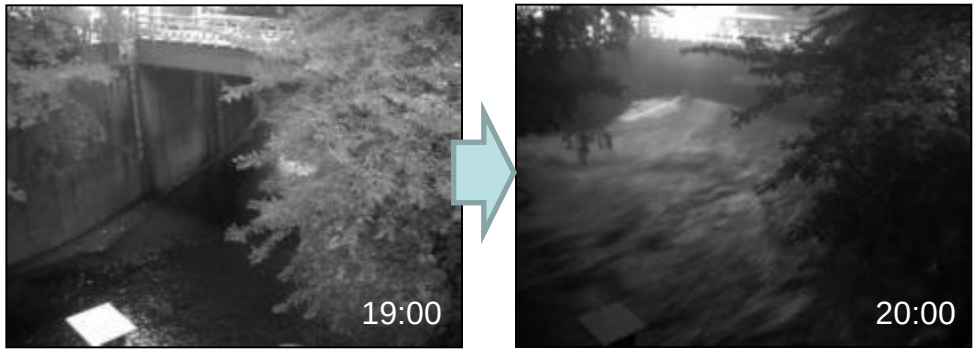
○ Hourly rainfall of 114 mm (Itabashi Observation Station (Shakujii River Basin))
○ Hourly rainfall of 82 mm (Aogishi Bridge Observation Station (Zanbori River Basin))
○ Shakujii River flooded, causing inundation damage in Itabashi.
Houses flooded above floor level: 58, Below floor level: 50

※数値は速報値



Itabashi
Observation Station

Water level rose by 3.45 m in 10 minutes from 19:50 to 20:00.



Change of water level in Shakujii River

提供：日本気象協会、板橋区ホームページ

Occurrence of Heavy Rain with Total Rainfall of over 1,000 mm

2005

- Total rainfall of over 1,000 mm due to Typhoon No.14 (Southern Kyushu)
- Oyodo and Gokase Rivers overflowed their banks

	Chugoku Region	Kyushu Region
Deaths	4	19
Houses flooded above floor level	1,678	3,960
Houses flooded below floor level	2,969	5,085

大淀川の氾濫
（宮崎県宮崎市）

上椎葉地区の土石流（宮崎県椎原村）

2006

- Total rainfall of over 1,200 mm due to torrential downpour in July
- Sendai and Komenotsu Rivers overflowed their banks

	Torrential downpour in July
Deaths	5
Houses flooded above floor level	899
Houses flooded below floor level	2,674

下手仲間地区の土石流
（鹿児島県菱刈町）

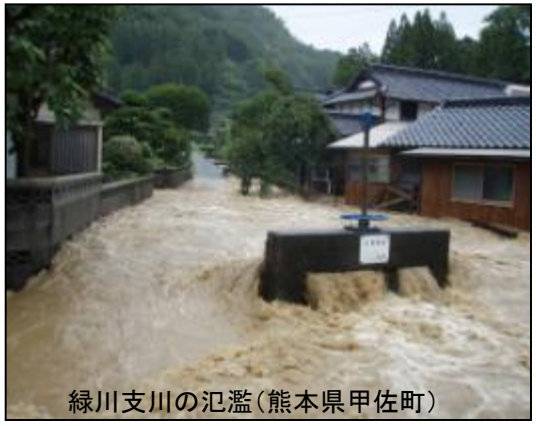
川内川の氾濫による家屋損壊（鹿児島県さつま町）

2007

- Total rainfall of over 1,000 mm due to Typhoon No.4
- Midori River caused inundation damage

	Typhoon No.4
Deaths	3
Houses flooded above floor level	169
Houses flooded below floor level	1,152

緑川の氾濫（熊本県甲佐町）

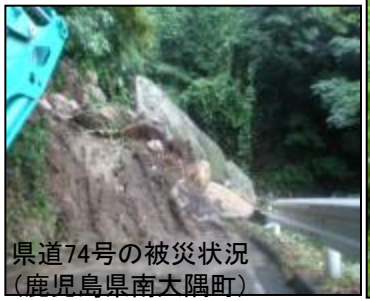


緑川支川の氾濫（熊本県甲佐町）

2010

- Total rainfall of over 1,200 mm due to torrential downpour on seasonal rain front in July
- Slope failure occurred in Kagoshima Prefecture, etc.

	Seasonal rain front, etc
Deaths	12
Houses flooded above floor level	1,921
Houses flooded below floor level	3,821



県道74号の被災状況
（鹿児島県南大隅町）

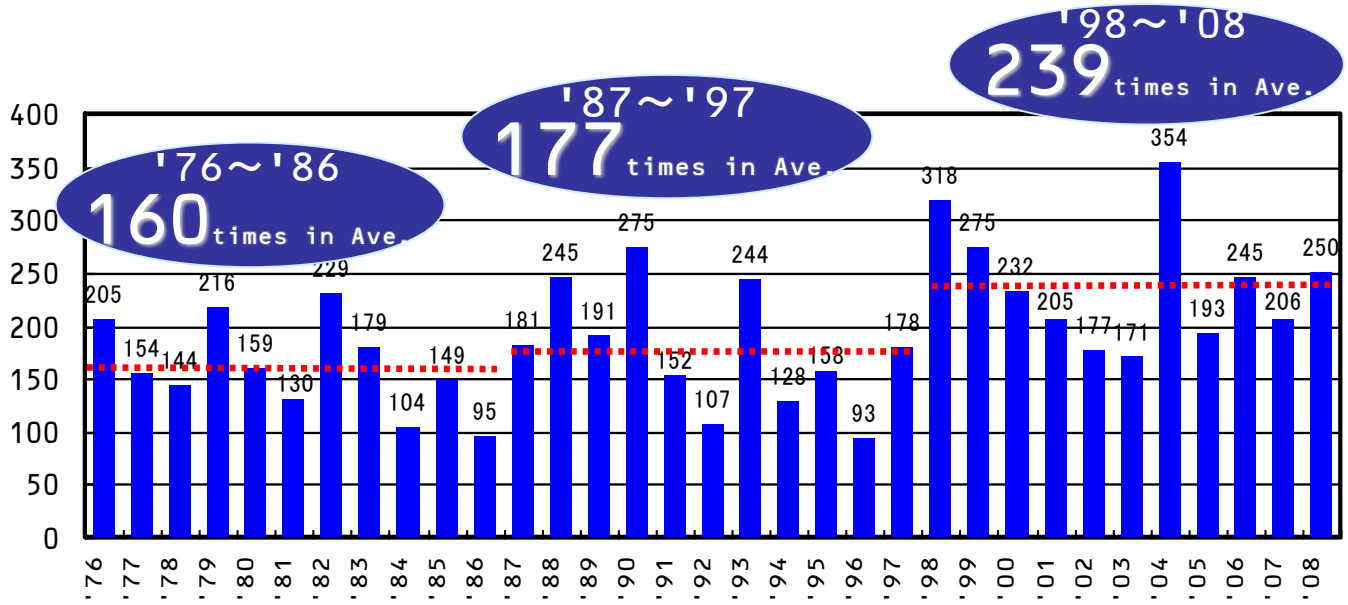
がけ崩れによる家屋損壊（鹿児島県さつま町）

Increase of intense rainfall

Occurrence of hourly rainfall over 50mm is significantly increasing

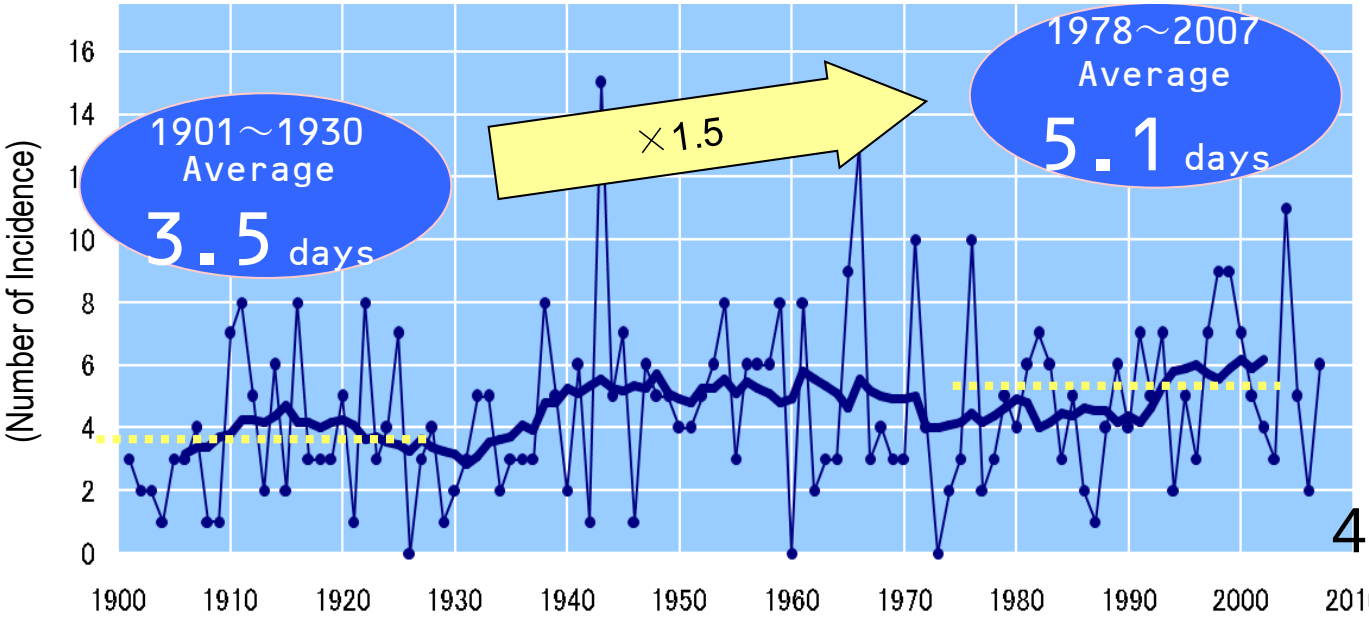
- The annual number of occurrence of over 50mm/hr precipitation
- Analyzed with 1,300 national AMEDAS spot data
- Per 1000 spots

Source: JMA



Number of days with rainfall over 200mm is increasing

(observation value of 51 spots nationwide)



Source: JMA

"Climate Change Adaptation Strategies to Cope with Water-Related Disasters Due to Global Warming"

Policy Report by the Panel on Infrastructure Development, MLIT, June, 2008

Recommendation

Multiple implementation of **"Basin Measures"** to counteract the growing external forces in addition to **"River Measures"** where the principal emphasis is placed on coping with a certain design discharge through river channel improvement and the construction of flood control facilities.

Those policies in river basins involve

(i) flood control facilities such as retarding basins,

(ii) runoff control facilities such as regulating reservoirs and rainwater storage and infiltration facilities,

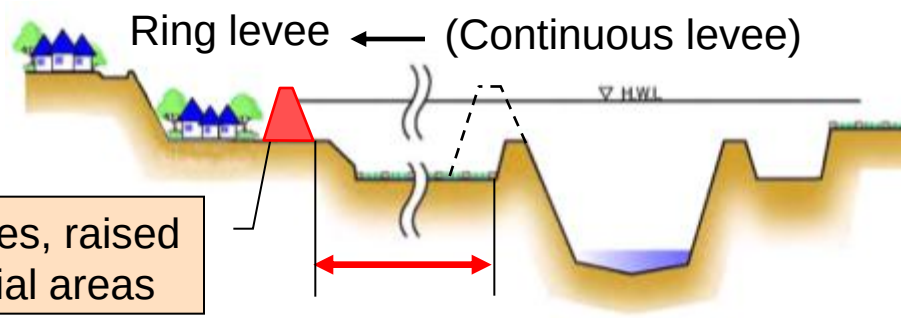
(iii) the use of setback (secondary) levees, ring dikes, roads and railroad embankments to prevent the spread of flood water

and should be applied **with proper consideration of the mode of local land use**.

Flood control measures in concert with land use

An ordinary method
(takes long time to complete)

Application of more flexible methods



Ring levees, raised residential areas

Designated as “disaster hazard zone”
(bylaw based on the Building Standards Act)

Example (Ring Levee along Omono River)

“Basic guidelines for Nature-oriented river works”
October 2006

1) Preserve or create the environment for the inhabitation, growth, bleeding of natural life, which rivers inherently have.

2) Preserve or create the diversity of river landscapes

3) Consideration for harmonization with lives, history and cultures of each region

“Basic guidelines for Nature-oriented river works”
October 2006

Utilization of the characteristics and mechanism of river environment

1. Preserve or create the environment for Inhabitation, growth, bleeding of natural life, which rivers inherently have.

   e.g. creation of the transition zone (ecotone)

2. Preserve or create intricate geomorphologic features by utilizing works of rivers themselves.

   e.g. riffles and pools, riverside forest

“Basic guidelines for Nature-oriented river works”
October 2006

Utilization of the characteristics and mechanism of river environment

3. Ensure space to allow for the works of rivers.

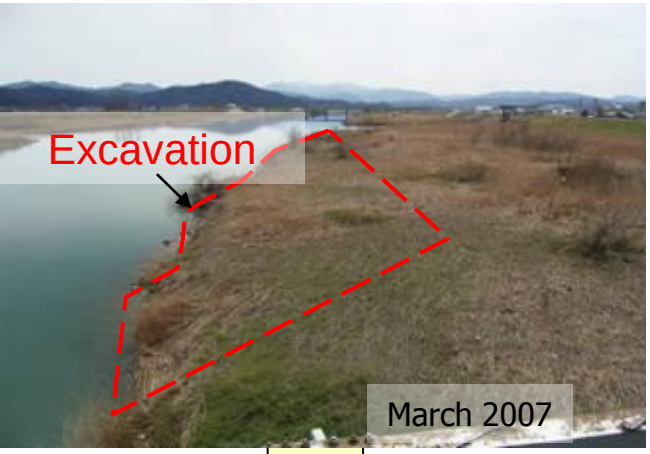
e.g. Large river width to promote formation of a good water route
Disturbance of river and land by floods

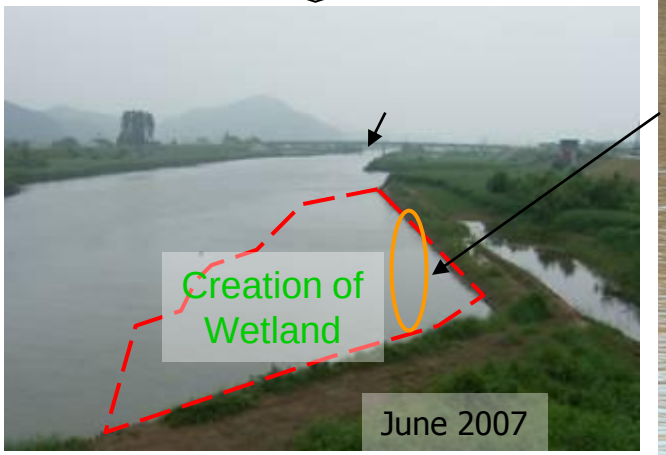
4. Preserve and restore river continuity

e.g. fish ways

5. Enrich river landscape

Maruyama river in Hyogo Prefecture





Combination of flood control works and creation of wetland

After a devastating flood in 2004, river excavation was implemented.
The work contributes to both increase flow capacity and creation of wetlands for storks.

Umeda river in Yokohama City

2007

When the river was widened to increase flood capacity, a meandering channel alongside a hill was preserved.

Flood Management in Japan

Characteristics

- Consistent Basin- based comprehensive flood management plans, according to respective characteristics of basins
- Combination of various “Hard (structural)" and “Soft (non-structural" measures
- Innovative measures to under the constraints due to the land limitation

In the face of the Climate Change…

- Further development is needed to “make space for water” through the utilization of limited land.

Dank u zeer veel.

Kereppu (Krib) groyne in Kiso river,
Introduced by Johannis de Rijke in Meiji era