Japanese experience on Structural Measures for Flood Management

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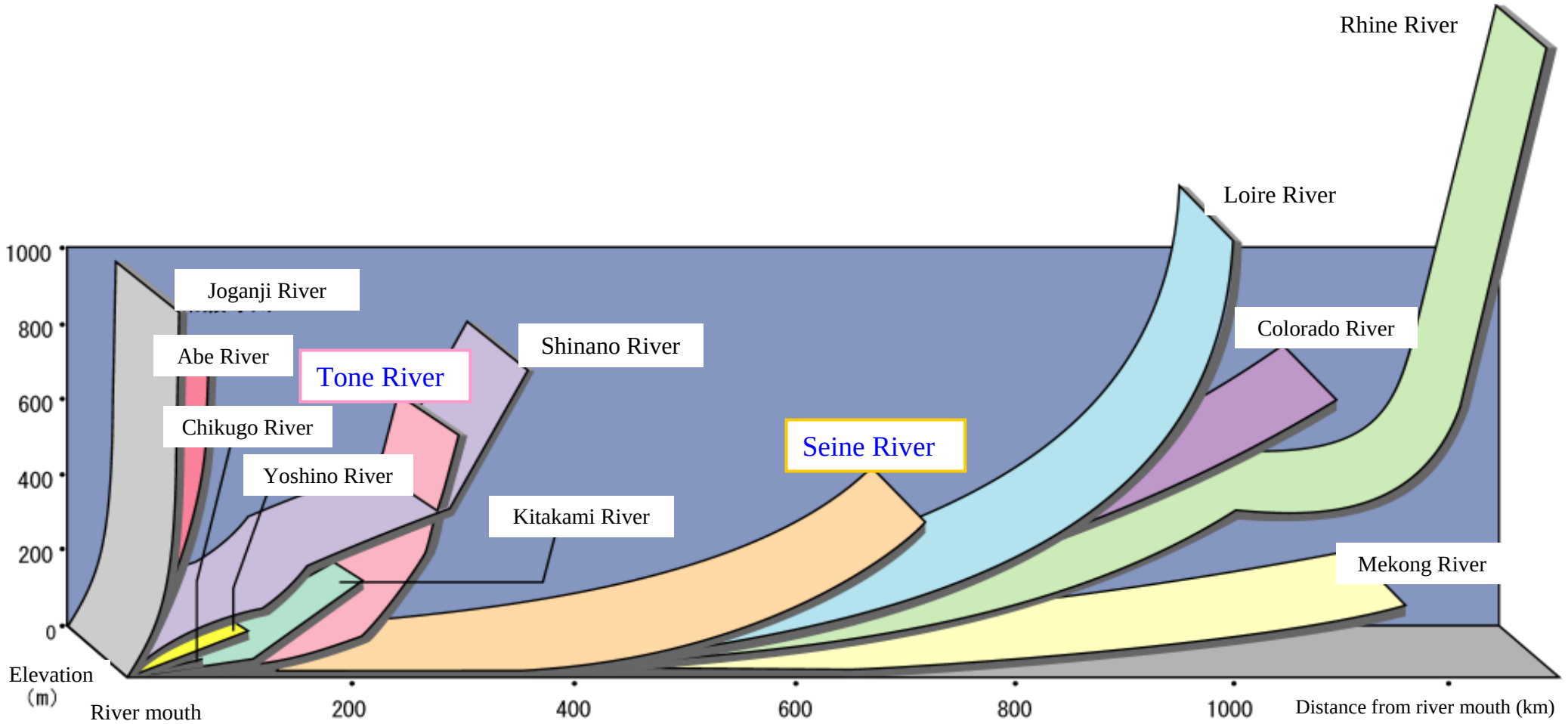
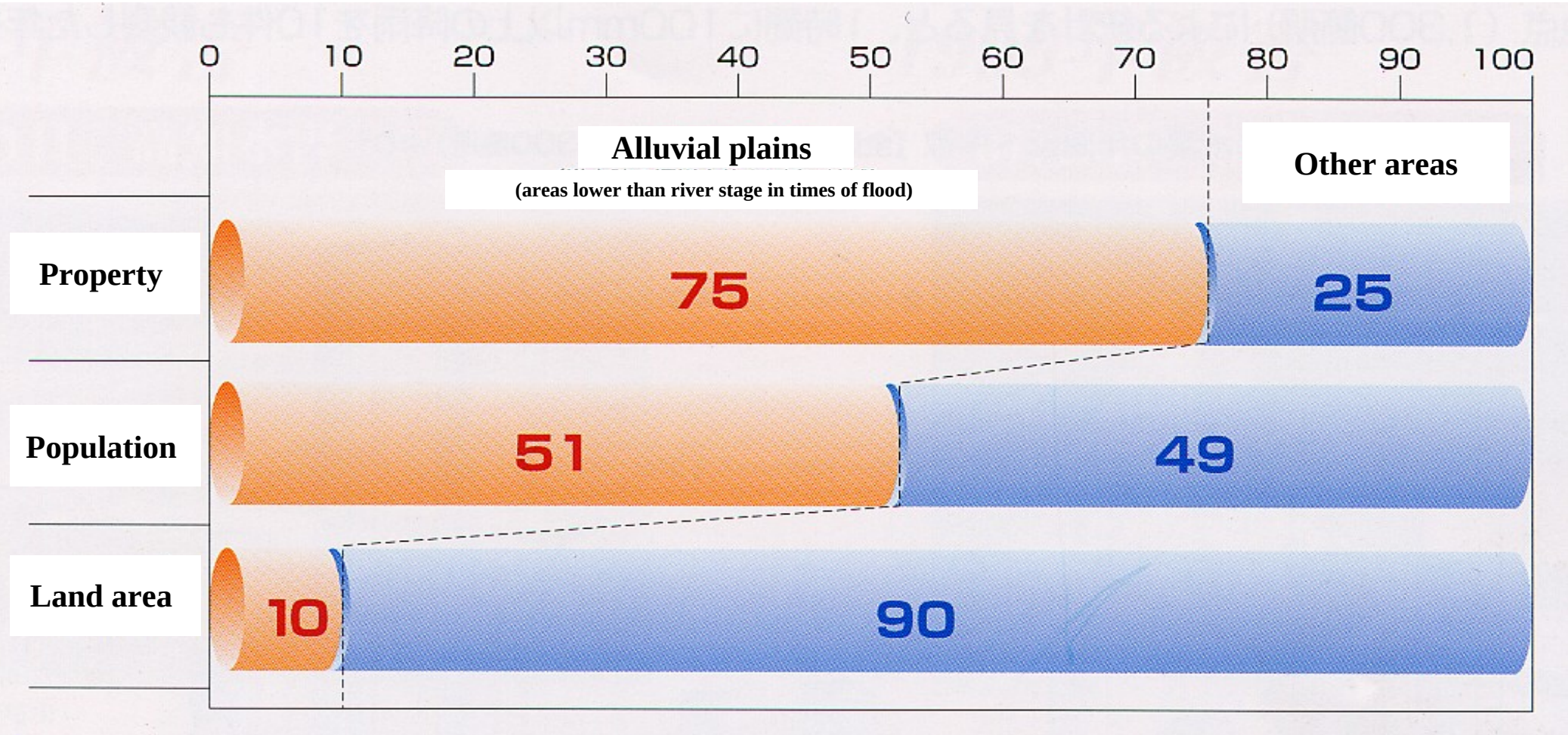
Rivers in Japan are steep.

Rivers in Japan tend to be steep, short and rapid flowing.

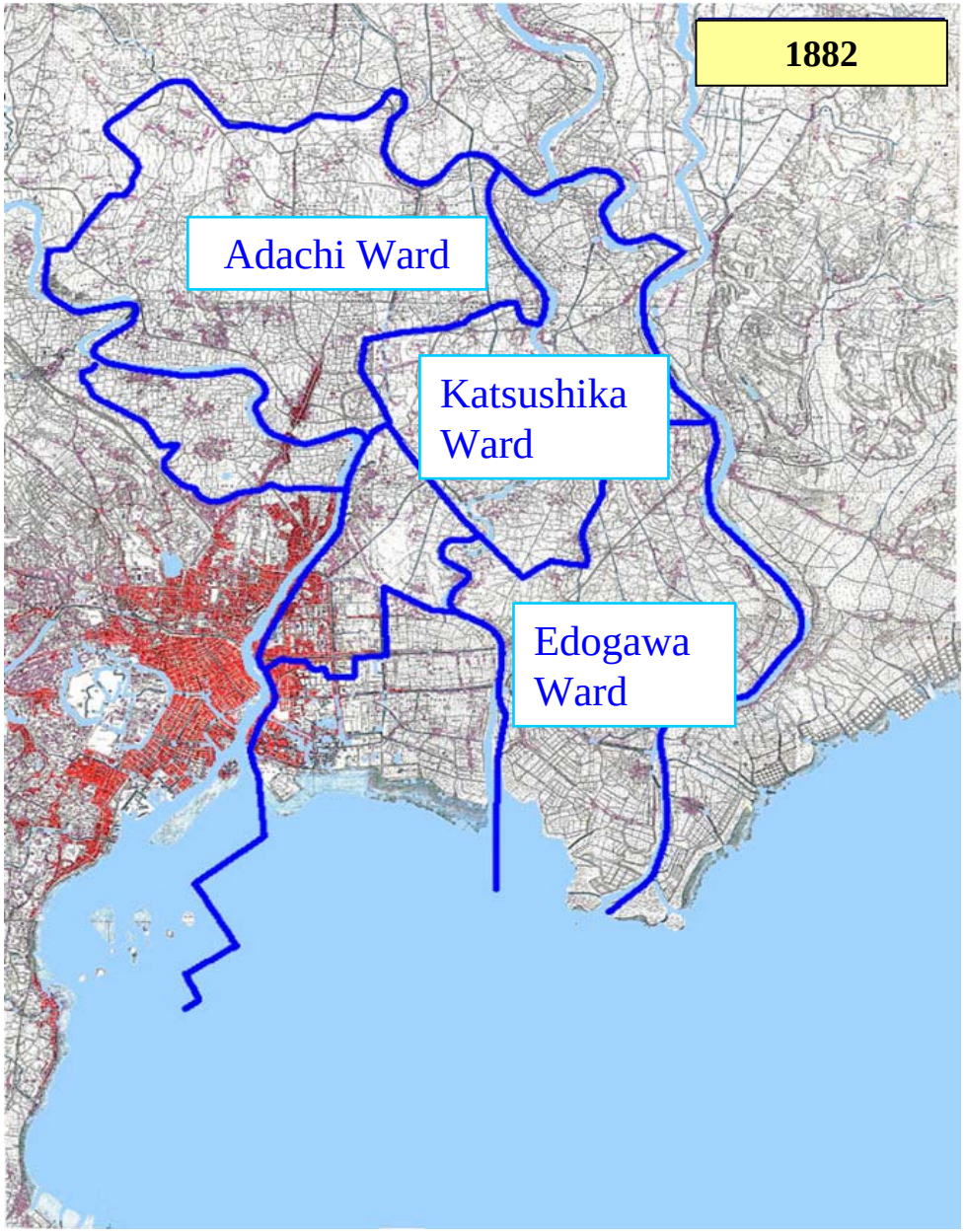


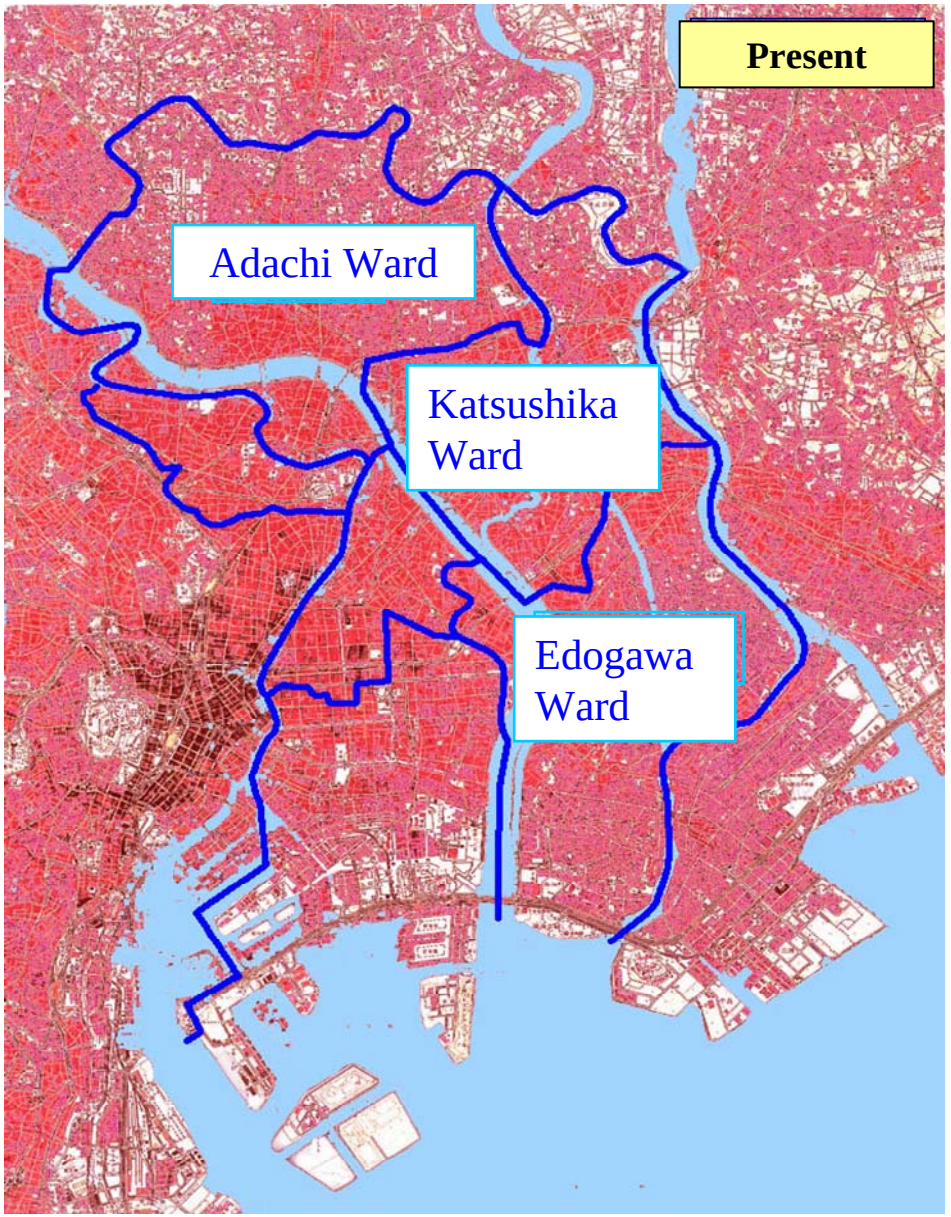
Comparison of the longitudinal profiles of rivers in Japan and other countries

Fifty percent of population and 75% of property are concentrated in floodplains accounting for only 10% of total land area.



Land use changes in the left-bank area of the Ara River Floodway in the past 100 years





Major storm and flood disaster after WWII

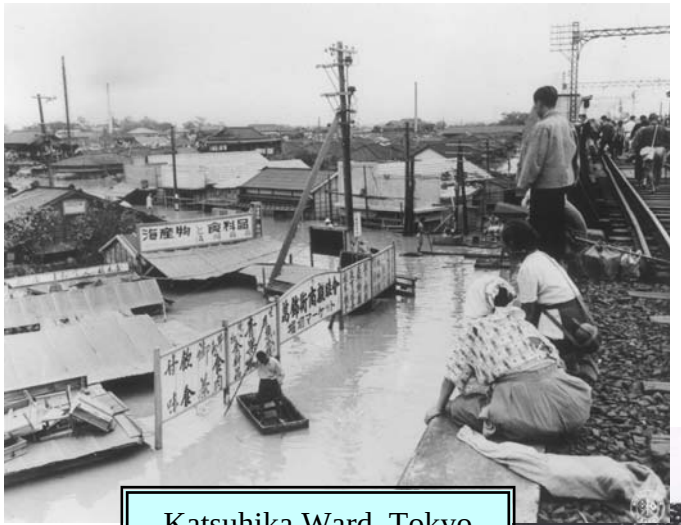
~ Typhoon Kathleen (September, 1947) ~

Number of persons killed: 1077　　Number of persons missing: 853

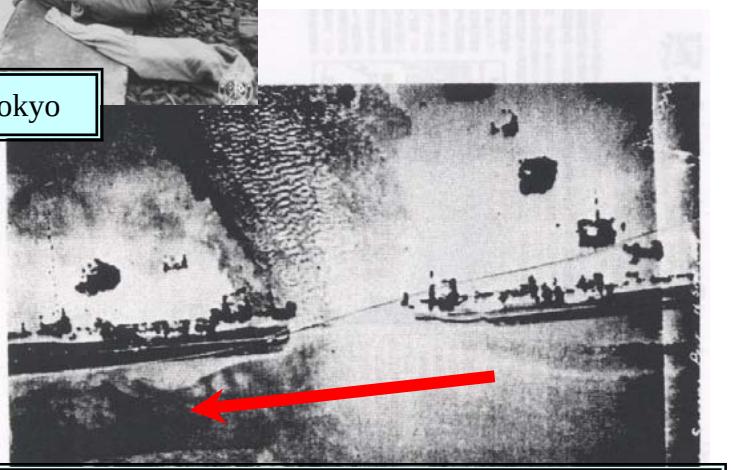
Number of persons injured: 1,547　　Number of houses completely or partially destroyed: 9,298

Above-floor-level/below-floor-level inundation: 384,743

Areas inundated by the September 1947 flood

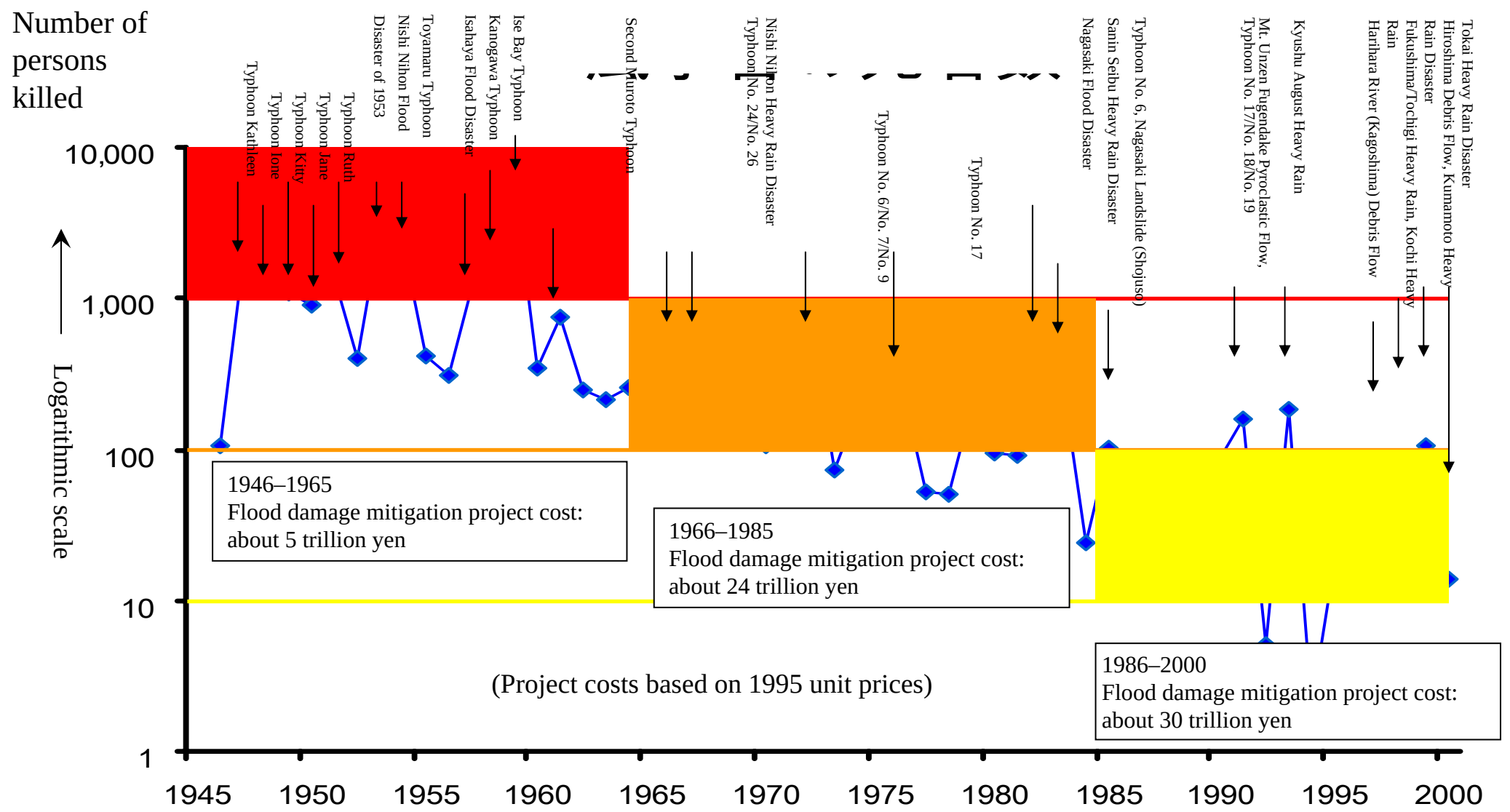


Katsuhika Ward, Tokyo



Failure of the levee along the Tone River in the Tone River System (134.5km from river mouth)

Changes in the number of persons killed by storms and floods



• The graph shows the total number of persons killed by floods, mass movements and volcanic activities.

• The death tolls are based on disaster statistics compiled by the River Bureau (1947–1952) and National Police Agency data (1953–).

• The flood damage mitigation project costs are shown as net values (calculated according to the 1995 flood damage mitigation project index) and are total amounts including the costs of the projects funded by national government subsidies. (The costs for 1946–1959, however, include the costs of flood damage mitigation projects funded by local governments alone for reasons associated with the availability of statistics.)

Prepared by Disaster Risk Management Office, Disaster Prevention and Relief Division, River Bureau (September 2001)

Construction of flood diversion channels

Kano River Floodway (Shizuoka Pref.)

Ota River Floodway (Hiroshima Pref.)

Toyo River Floodway (Aichi Pref.)

Construction of flood retarding basins

Ichinoseki Detention Basins

Maehori area protected by Ishinoseki Detention Basin System

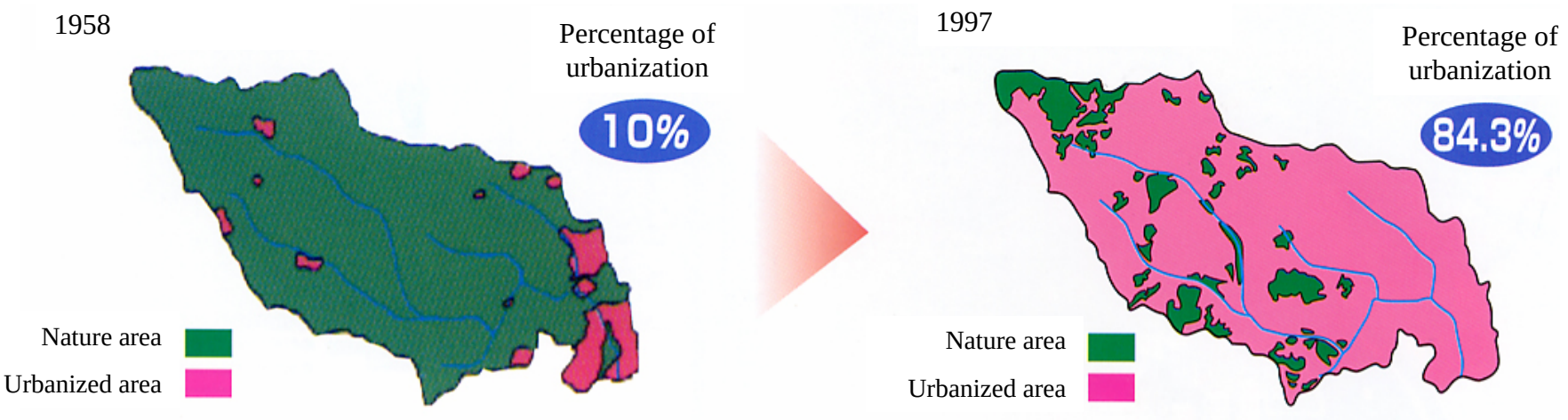
Ichinoseki Detention Basin System (Iwate Pref.)

Ueno Detention Basin System (Mie Pref.)

Urbanization

Rapid development since the second half of the 1950s has caused many river basins to be mostly urbanized.

Example: Tsurumi River Basin (drainage area: 235 km^2)



Population: 379,000

Urbanized land area: 23.5 km^2

Population: 1,820,000

Urbanized land area: 196 km^2

Example of urban flood damage

Urban rivers run very low in ordinary times. In times of heavy rains such as typhoons, however, stormwater is concentrated quickly, and the resultant runoff and overtopping impair urban functions and cause the inundation of underground streets. This type of damage is characteristic of urban floods.

Kanda River in ordinary times (Tokyo)

Kanda River in flood during Typhoon No. 11 in 1993

Comprehensive Flood Control Measures

So as to enhance flood-control-safety-level in urban areas, it is necessary to implement comprehensive measures, such as the measures for river basin, damage alleviation measures, improvement of sewerages and the like other than river improvement.

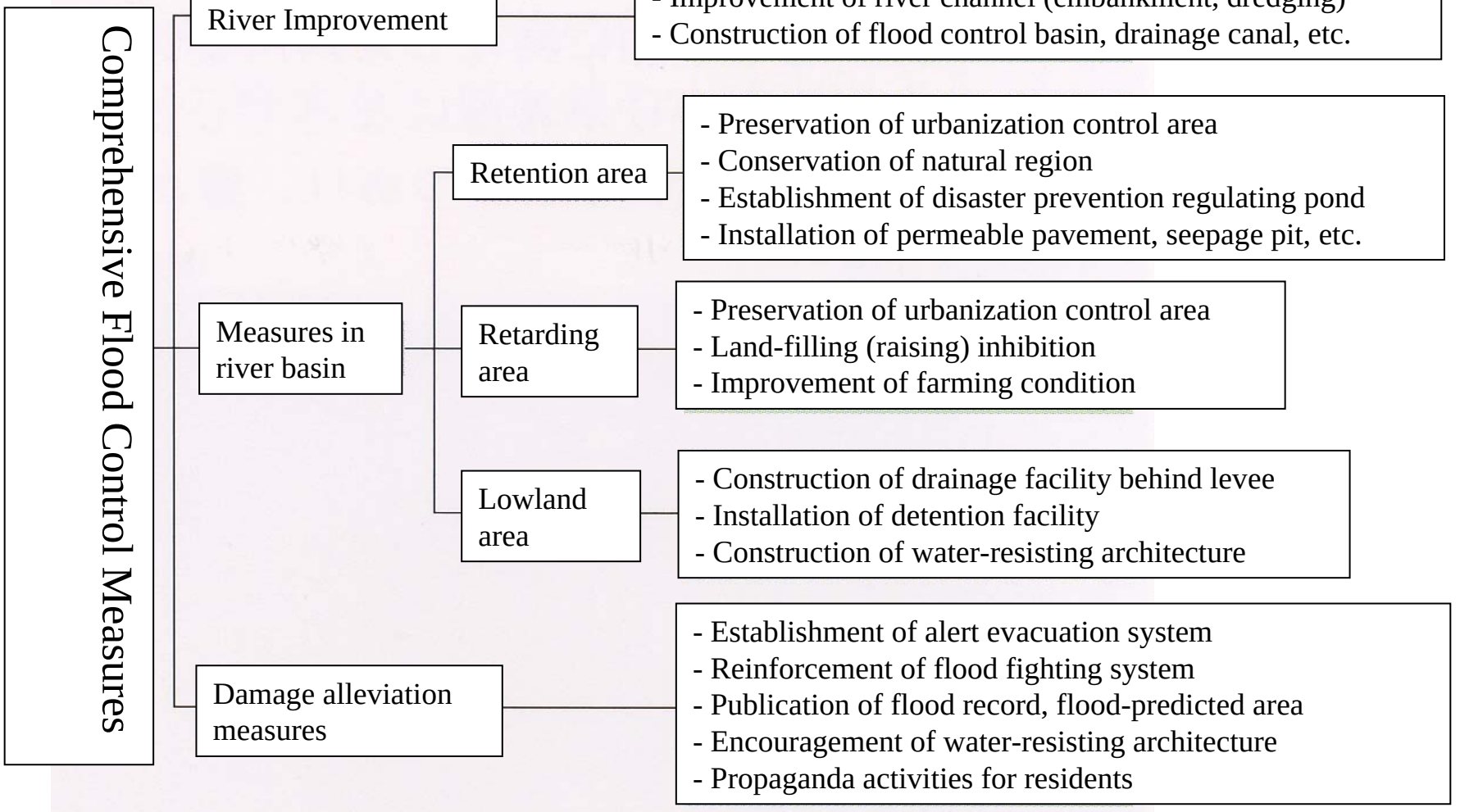
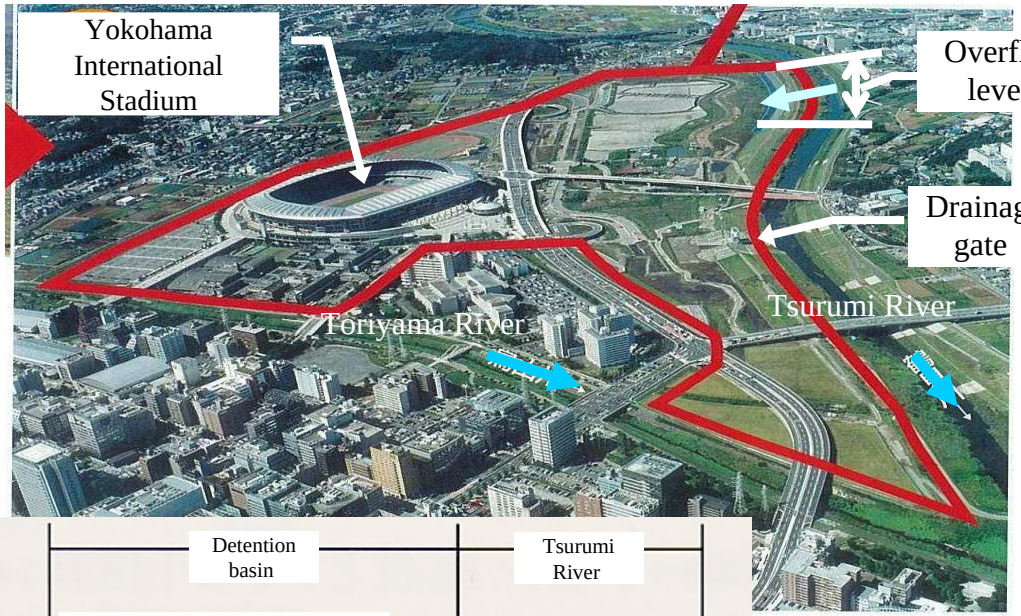
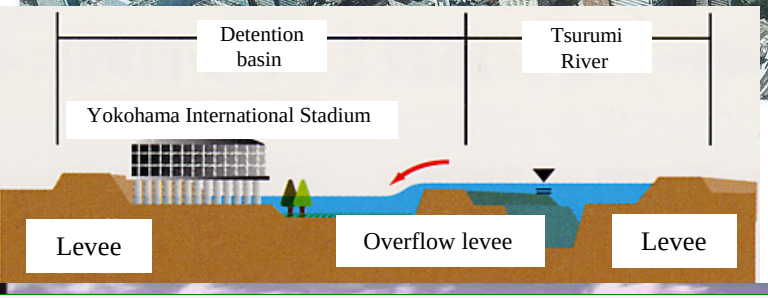


Figure of comprehensive flood-control measures system

Tsurumi River Detention Basin and Loop Road No. 7 Underground Detention Basin

Tsurumi River Detention Basin



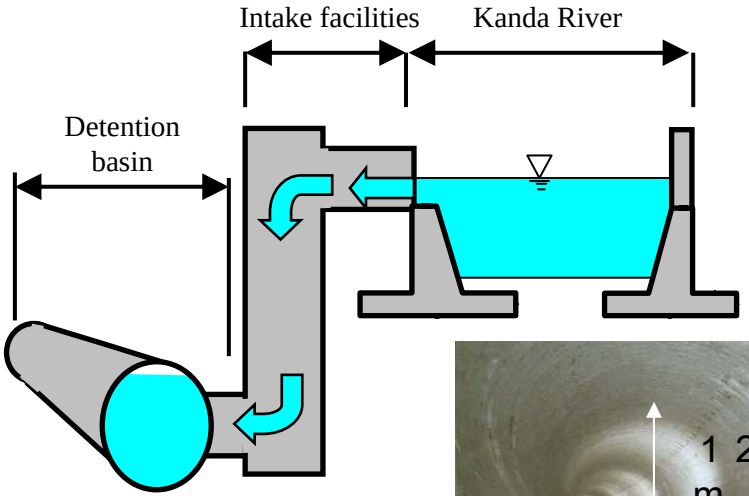


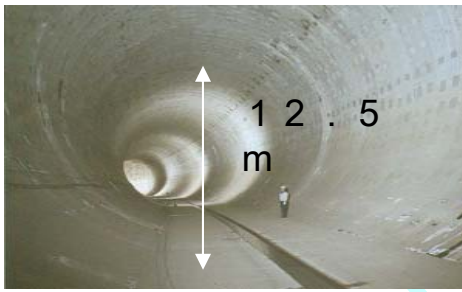
About 1,250,000 m³ of inflow due to Typhoon No. 22 in October 2004
Downstream water level lowered by up to 1.5 m

Tsurumi, right bank, 14.8km from river mouth, upstream of overflow levee

Total detention volume: about 1,250,000 m3

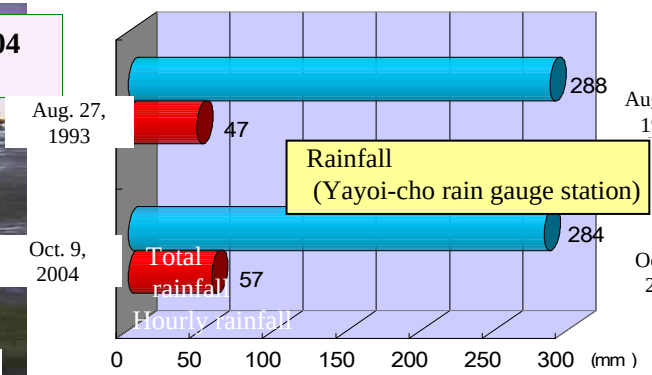
Kanda River Loop Road No. 7 Underground Detention Basin

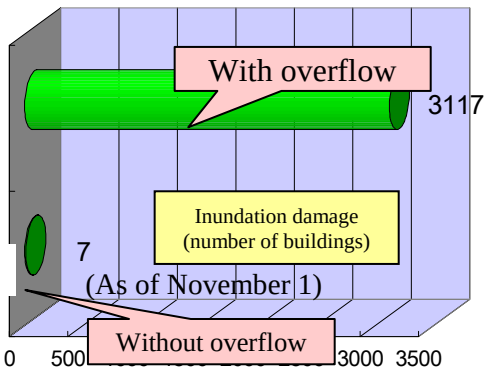




Comparison between Typhoon No. 11 of August, 1993, and Typhoon No. 22 of October, 2004 (Kanda River)

Similar rainfalls, but by far smaller damage because of underground detention





Stormwater detention ponds and infiltration facilities

Regulating reservoir

Construction of regulating reservoir

Example of use as a multipurpose facility

In ordinary times

Kirigaoka Regulating Reservoir (Tsurumi River)

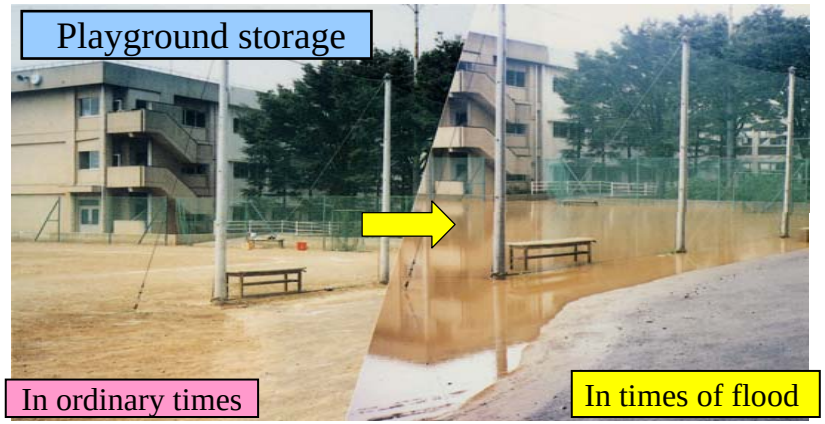
In times of flood

Example of biotope creation

Construction of permeable pavement, infiltration pits, etc.

Construction of stormwater retarding facilities

Playground storage



In ordinary times

In times of flood

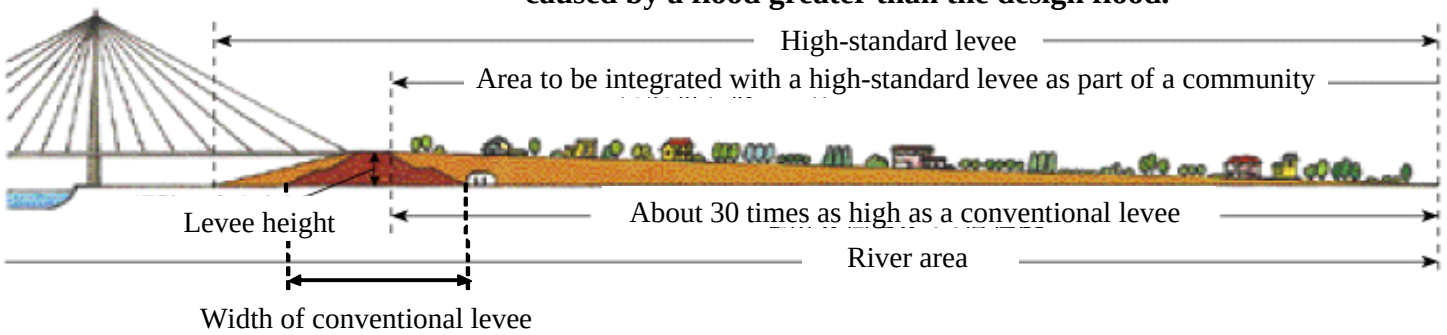
Permeable pavement

Infiltration pit, infiltration trench

Construction of high-standard levees ("super levees")

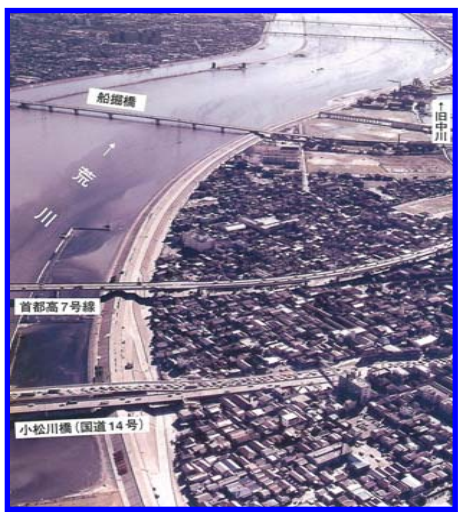
High-standard levees

A high-standard levee is an embankment designed as part of a community to prevent destructive damage resulting from a levee break caused by a flood greater than the design flood.

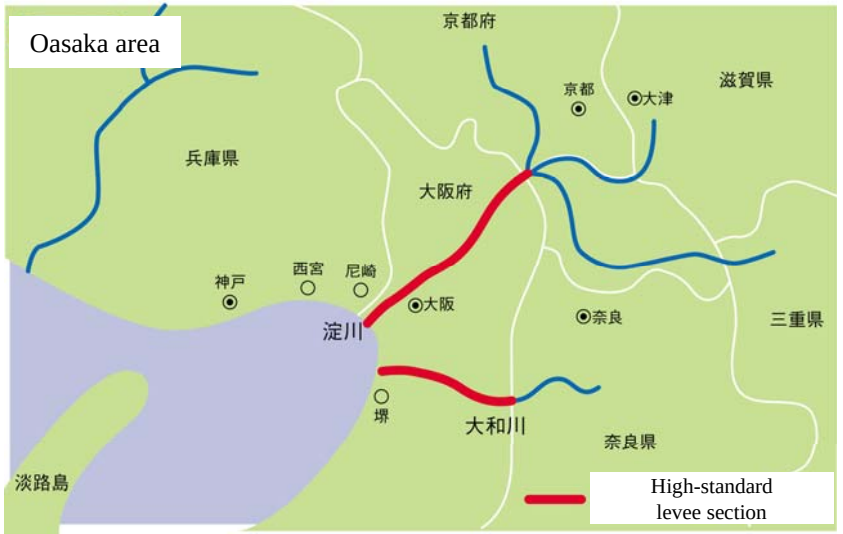


Ara River (Komatsukawa area)

High-standard levee projects are integrated with urban redevelopment projects to make efficient use of limited space in built-up areas.



Construction of high-standard levees ("super levees") along the Yodo River



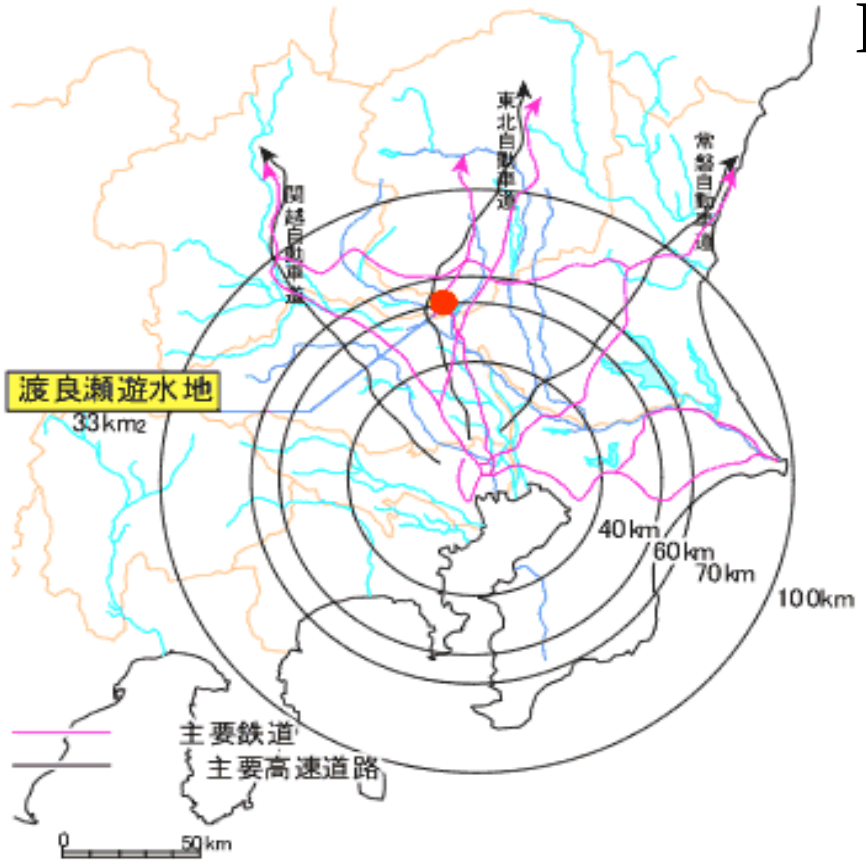
○Large former factory site

Yodo River (Torishima area)
Before levee construction

○Construction of public housing complexes, etc., to make Effective use of waterfront

After levee construction

Watarase flood Retarding Basin



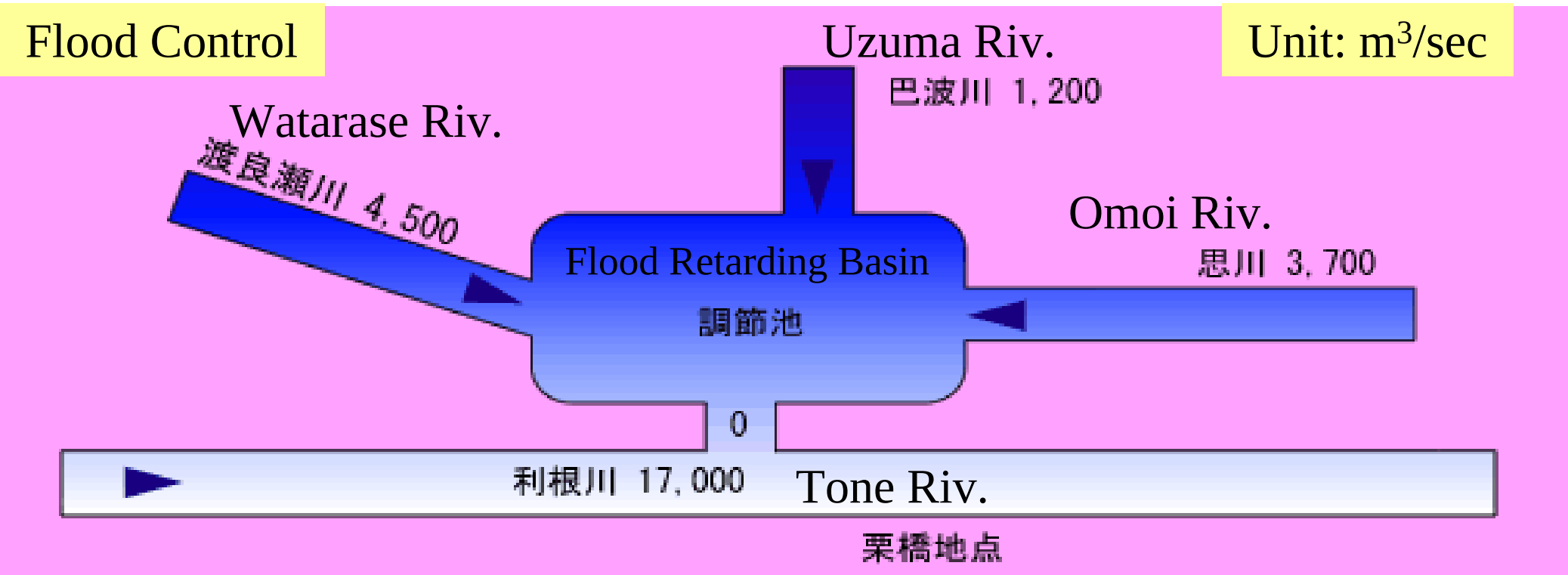
Multi-purpose reservoir
- flood control
- water supply
(domestic & maintenance)

Specification of Watarase Flood Retarding Basin and Reservoir

- Watarase Flood Rerarding Basin
  - Total area 33 km^2
  - Total flood control volume 200 x $10^6 m^3$
- Watarase Multi-Purpose Reservoir (Yanaka Res.)
  - Surface area 4.5 km^2
  - Total volume of reservoir 26.4 x $10^6 m^3$
  - Flood control volume 10.0 x $10^6 m^3$
  - Water level during flood period (July 1 ~ September 30) 11.5 m (YP) (3.0 m deep)
  - High water level 15.0 m (YP) (6.5 m deep)

Flood Control by Watarase Flood Retarding Basin (1)

The Watarase Flood Retarding Basin cuts all the inflows (9,400m^3/s) from the Watarase River to the Tone River during its peak event.



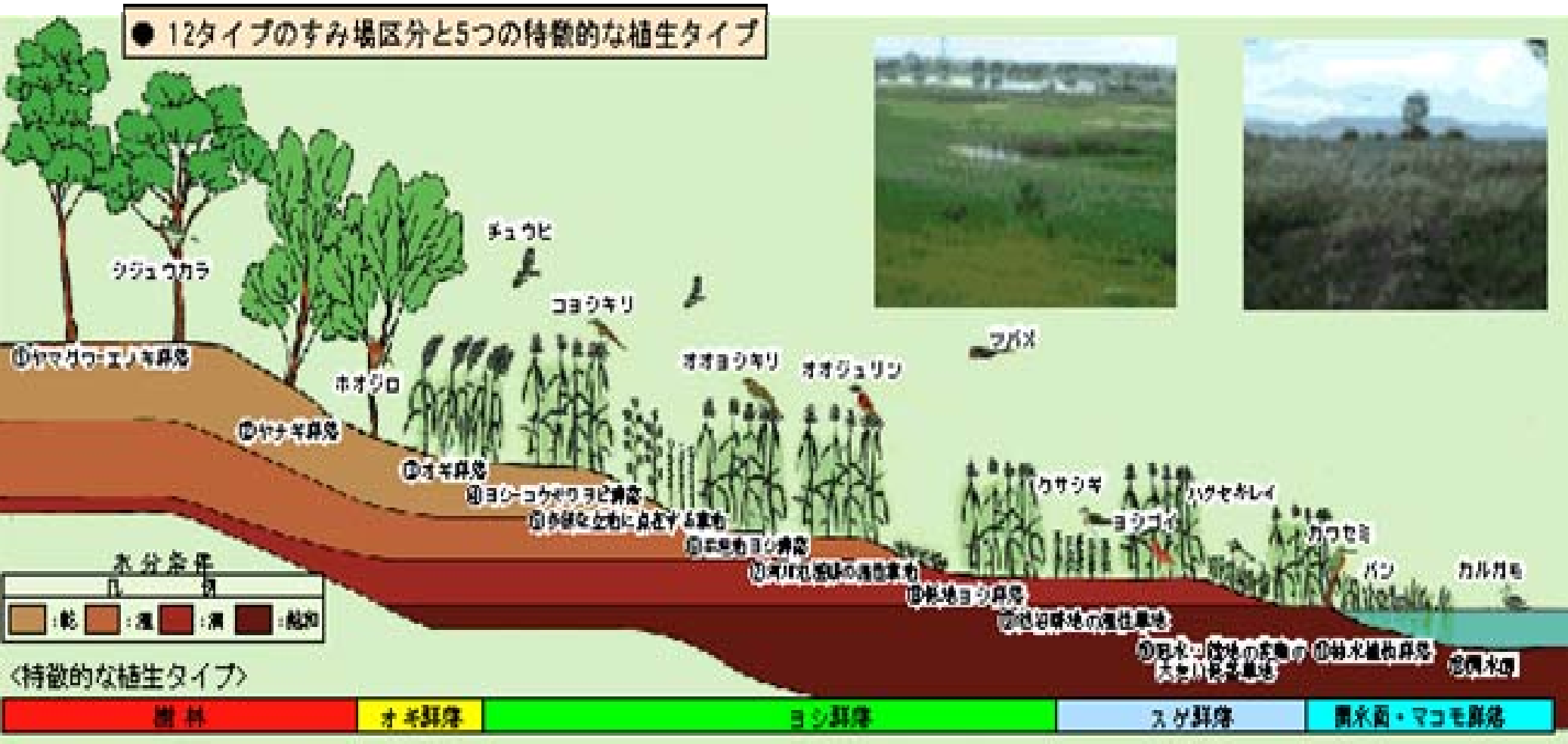
Flood Control by Watarase Flood Retarding Basin (2)

Date	Peak discharge at the Kurihashi point of the Tone River (m^3/s)	Max. overflow into Watarase Flood Rerarding Basin from the upstream (m^3/s)	Total stored flood volume (× 10^3 m^3)
Sep., 1972	6,780	148	240
Oct., 1982	11,120	370	1,808
Sep., 1982	11,610	1,150	3,335
Oct., 1991	6,550	323	658
Oct., 1998	5,660	435	846
Sep., 1998	10,430	1,890	6,333
Oct., 1999	6,980	95	517
Aug., 2001	5,900	24	50
Sep., 2001	8,000	1,140	5,800

Water Augumentation by Watarase Reservioir

Year	Replenishment (10^4 m^3)	Year	Replenishment (10^4 m^3)
1990	1,520	1997	3,260
1991	0	1998	1,710
1992	660	1999	1,490
1993	140	2000	2,420
1994	900	2001	2,210
1995	1,710		
1996	1,390	Total	17,410

Natures in Watarase Flood Retarding Basin



Forest Eulaliagrass Nutsedge Wild rice

Change of River Law revision

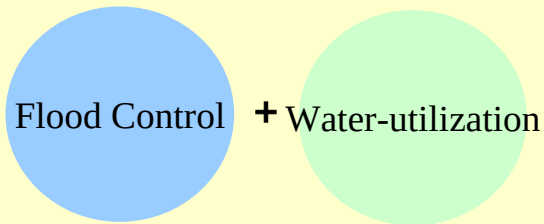
Meiji 29 (1896)

Establishment of modern river system

Showa 39 (1964)

Development of systematical system of flood control and water-utilization

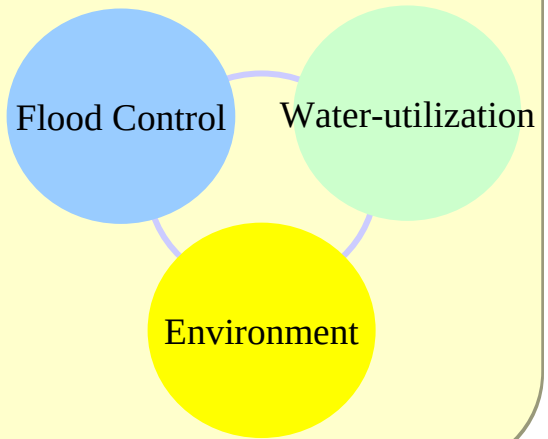
- Introduction of integrated management of river systems
- Development of regulations concerning water-utilization



Heisei 9 (1997)

Development of integrated river system including flood control, water-utilization and river environment preservation

- Development and preservation of river environment
- Introduction of a river development planning system responding to local opinions



New planning system reflecting opinion of local people

Old System

Basic Plan for the Implementation of Construction Works

River Works

Contents ⇒Basic Policy, Design Flood, Design Flood Discharge etc.
Main contents of river works

Draw up the basic plan draft of works operation

Determination of the basic plan of works operation

Reflection

River Council
(Class A river system)

New System

Fundamental River Management Policy

River Improvement Plan

River Works and Maintenance

Contents ⇒ Basic Policy
Design Flood, Design Flood Discharge etc.

Draw up the basic plan draft of works operation

Determination and publication of the plan

opinion

Social capital improvement Council
(Class A river system)
Prefectures' River Council
(Class B river system)

The case that the prefecture has its River Council

Contents⇒ Goal of River Development
Contents of River Works and River Maintena

Original plan

opinion

opinion

Academic expert

Reflection of opinions of local people (Hearing)

Draw up the basic plan draft of works operation

opinion

Governor of a local authority

Determination and publication of the plan

Straightened and concrete-lined river channel

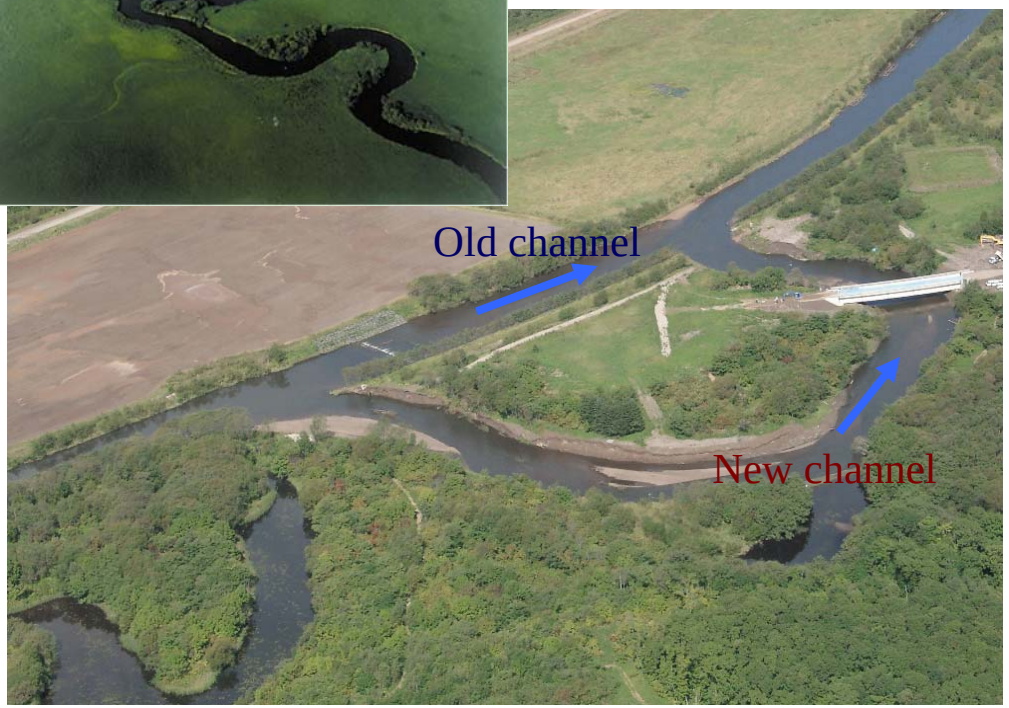
Example: Moizari River (Hokkaido)

Before (photographed in October 1989)

After (photographed in July 2003)

Meander restoration

Loss of meanders in the Ishikari River due to river improvement projects (Hokkaido)



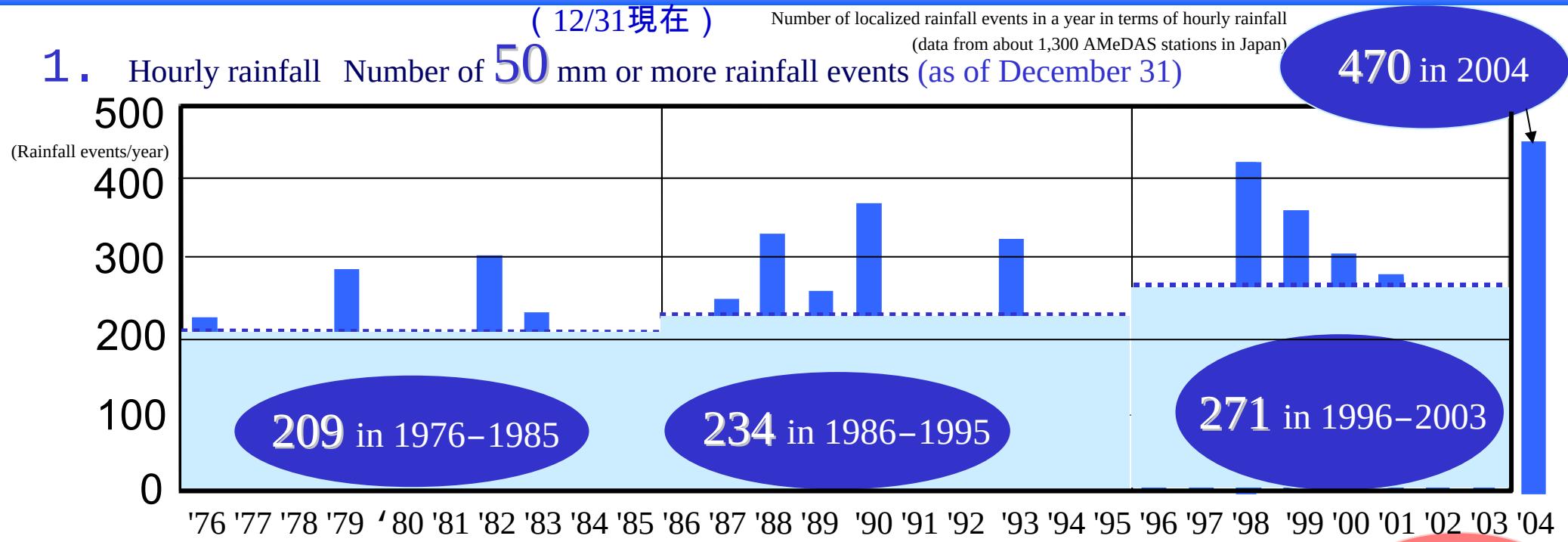
Restoration of meanders in the Shibetsu River (Hokkaido)

Increasing frequency of localized heavy rains

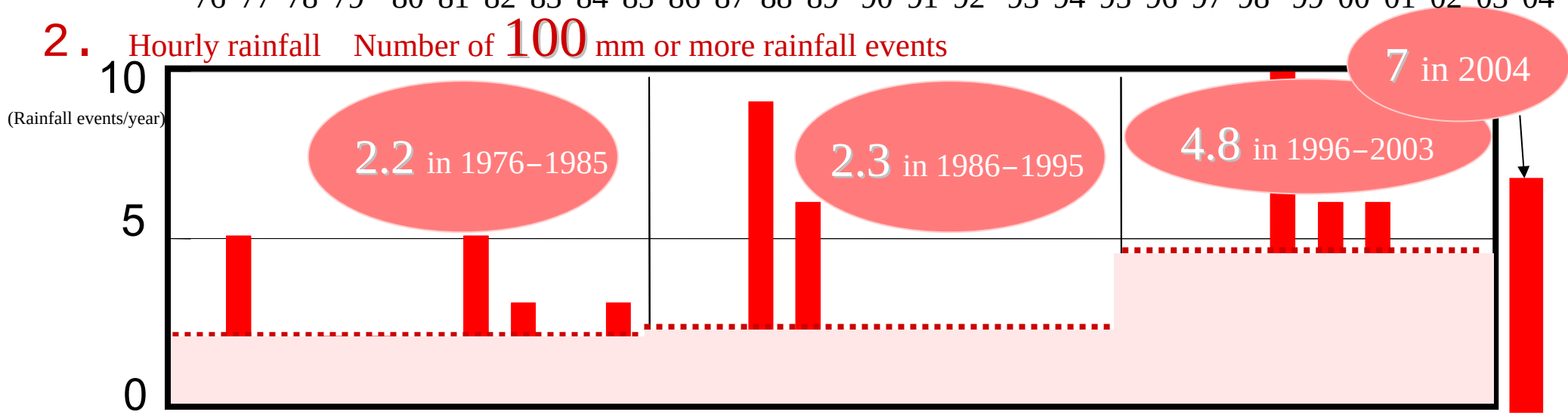
（12/31現在）

Number of localized rainfall events in a year in terms of hourly rainfall
(data from about 1,300 AMeDAS stations in Japan)

1. Hourly rainfall Number of 50 mm or more rainfall events (as of December 31)



2. Hourly rainfall Number of 100 mm or more rainfall events



Tokai-storm Flood (September 2000)

Inomori-cho, Tenpaku-ku, Nagoya (in ordinary times)

During inundation (September 12, 2001)

Inundation of underground streets and other spaces characteristic of urban environment

Subway Hakata Station during localized heavy rain in July 2003

Subway Azabu-juban Station during Typhoon No. 22 in October 2004

Inundation of basement in Shinjuku in July 1999

豪雨 地下室を襲う

点検の65歳が水死

階段から雨水、脱出できず

関東地方は21日午後、雷を伴う激しい雨に見舞われた。東京都内では急な浸水のため地下室でお年寄りが水死し、神奈川県相模原市でも落雷で1人が死亡した。洪水による地下室での水死は福岡県で起きたばかりで、国でも対策の検討を始めた矢先だった。また、交通機関も大幅に乱れ、首都圏では約16万人の足を直撃した。

21日午後4時ごろ、新宿区西落合3、無職、跡部倫孝さん(65)方の地下1階倉庫で、跡部さんが道路から流れ込んだ雨水でおぼれた。約1時間半後に消防隊員らに救助され、近くの病院に運ばれたが、間もなく死亡した。

警視庁戸塚署などの調べでは、跡部さん方は4月に新築した地上4階地下1階建て。1階を貸し、2階から上に跡部さん一家5人が居住、地下1階を物置にしていた。跡部さんは雨が激しくなった午後4時ごろ、浸水を心配して「様子を見に行く」と言い、エレベーターで物置に降りた。

しかし、戻ってこなかったため家族が様子を見に行くと、エレベーターが地下1階で止まり、建物の前の道路も冠水していたという。物置は広さ約33平方㍍で、道路から直接下りる階段があり、その階段に雨水が流れ込んだ。階段側のドアを開いた瞬間、室内に流れ込んだらしい。室内は一時高さ2㍍近くまで浸水、消防隊員が着いた時も膝の高さまで浸水していた。

消防隊員はエレベーターの天井を破り、ポンプ車などで排水、物置の防火扉付近に倒れていた跡部さんを発見した。

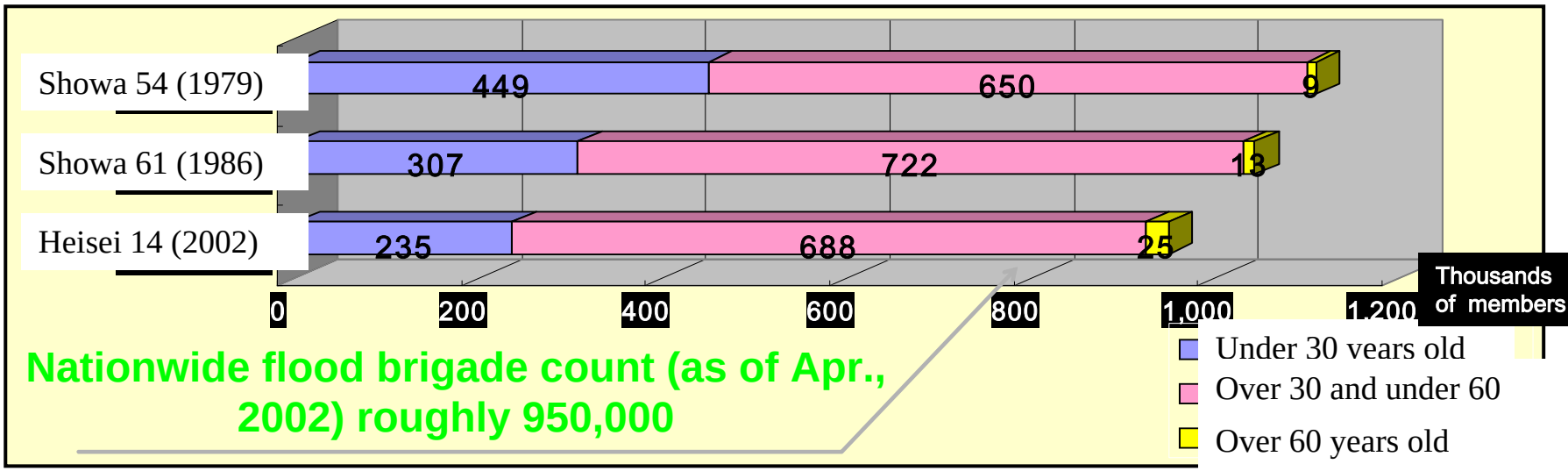
また、午後4時40分ごろ、

天井近くまで浸水し家具などが散乱した地下1階の倉庫＝東京都新宿区西落合で21日午後6時すぎ、竹内幹写す

雨水が流れ込んだ地下1階への階段＝東京都新宿区西落合で21日午後6時すぎ、竹内幹写す

Inundation of basement during Fukuoka Flood of June 1999

Flood Fighting Corps and Flood-Fighting Activity

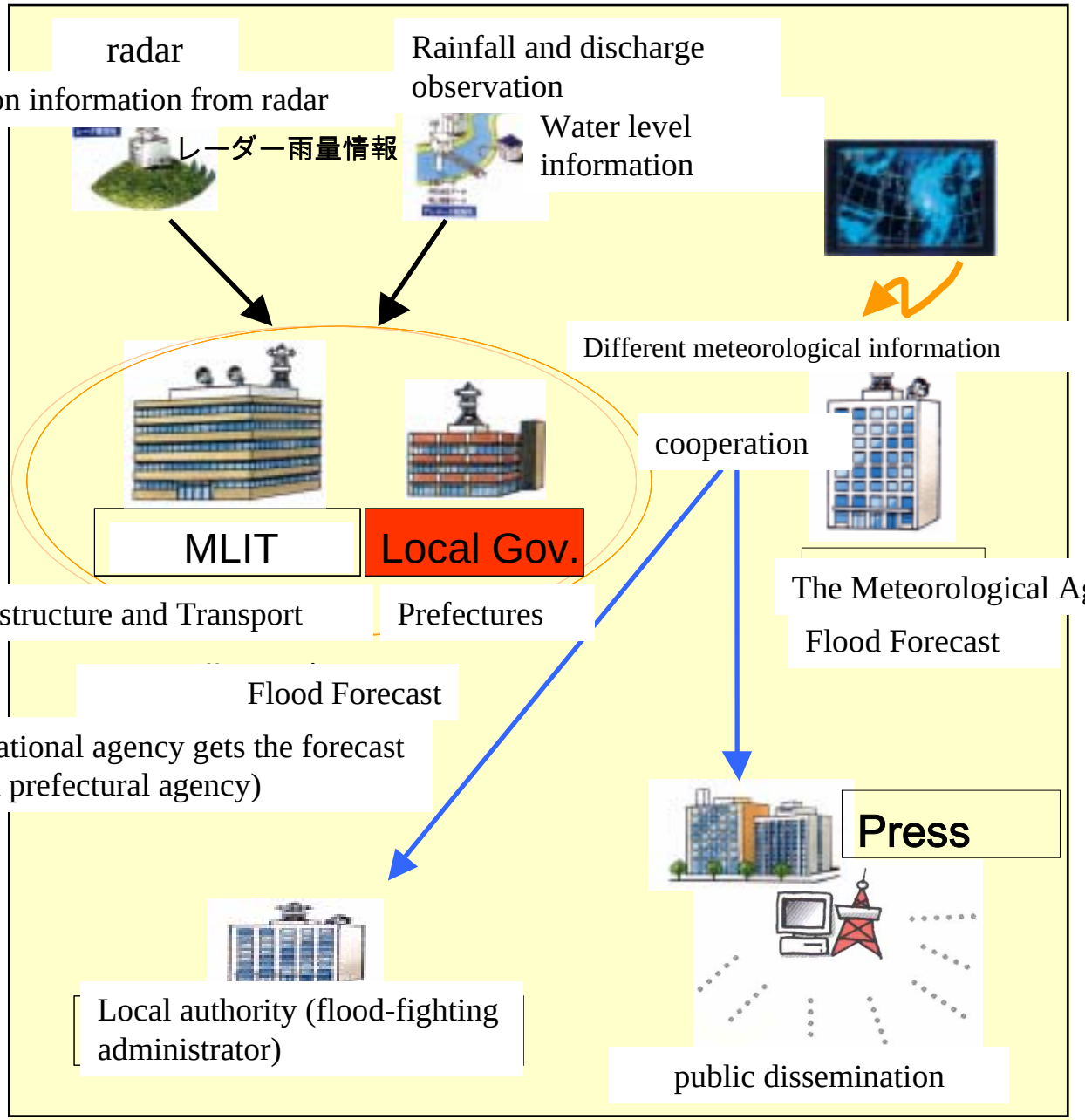


Change of flood-fighting corps counts and age composition

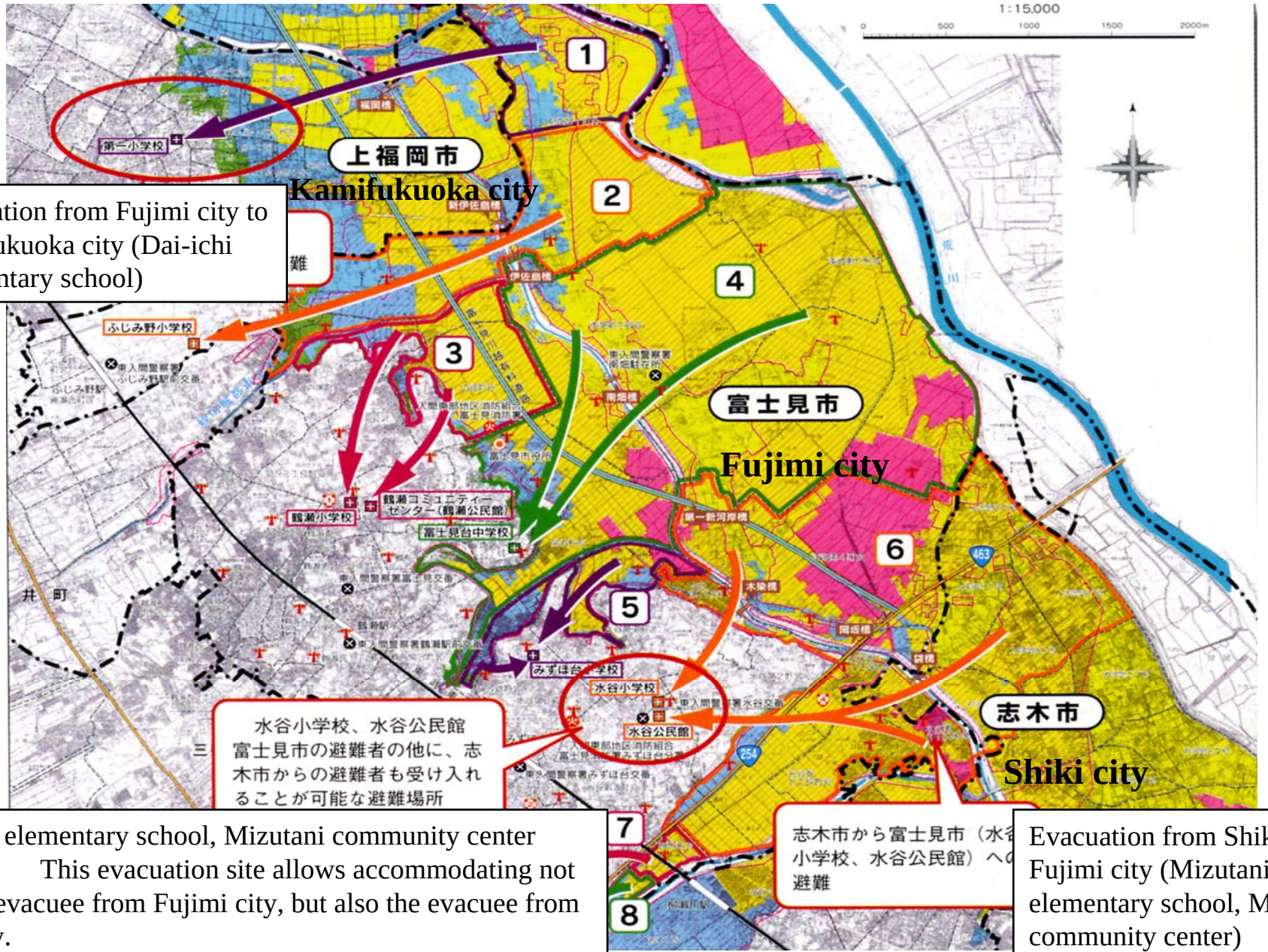
Activities of Flood-Fighting Corps

Hooping Method

Flood forecasting and warning system in Japan



A case of flood hazard map development – Fujimi city, Saitama Pref.



Evacuation from Fujimi city to Kamifukuoka city (Dai-ichi elememtary school)

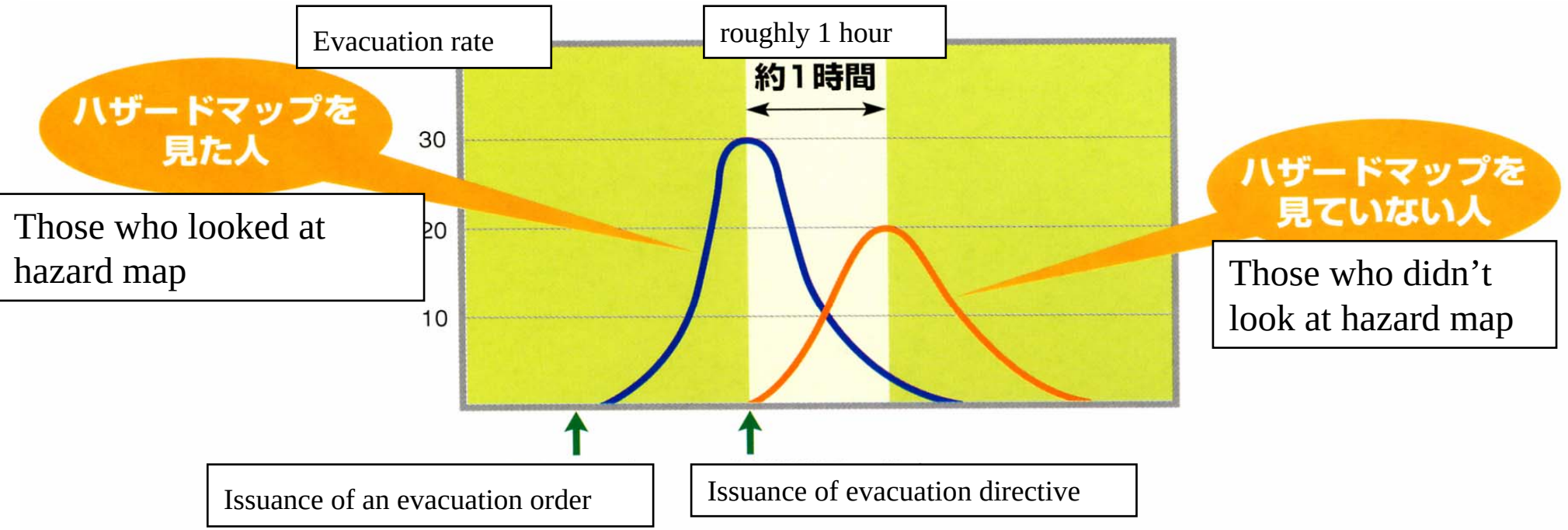
Mizutani elementary school, Mizutani community center

This evacuation site allows accommodating not only the evacuee from Fujimi city, but also the evacuee from Shiki city.

Evacuation from Shiki city to Fujimi city (Mizutani elementary school, Mizutani community center)

Benefit of flood hazard map

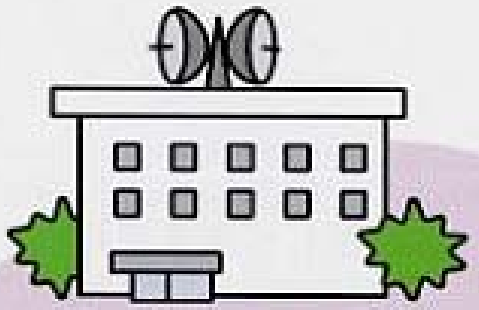
In a downpour disaster in Koriyama-focused area occurred in the end of August, 1998, a hazard map showed an effect that evacuation beginning time was brought forward.



Developed using a research report of Prof. Katada's Laboratory,

Department of Technology, Gunma University

Disaster information provision for underground space user



Local authority
(flood-fighting administrator)

Disaster information provision for the administrators in underground mall, etc.

Underground space

Evacuation order **Evacuation order**

避難勧告 避難勧告

Emergency exit

Emergency exit

● Measure Law against Flood Damages at Specific Urban Rivers (Heisei 15 (2003), Law Number77)

The urban river basins, in which severe flood disasters have occurred or there is a possibility of them and prevention of flood damage by river works is difficult due to the proceed of urbanization, are designated as specific urban rivers and specific urban river basins. In order to promote flood damages measures for prevention at these specific urban river basins, we make basin flood measure plans and set up the development of facilities for water storage and infiltration and other plans by river managers.

In recent years, many flood damages occurred at urban river basins.

•Urban areas have been suffered many flood damages like Tokai flood in 2000.
•Due to heat-island phenomenon and other reasons, local heavy rainfalls have happened often. So the possibility of flood damages increases.
•There are also problems that detention ponds are filled for housing land developments.

•Though severe flood disasters have occurred and there is a possibility of them, due to urbanization, it is difficult to prevent flood damages by developing river channels or flood control dams.

Urban river basins need the flood damage measures by new scheme.

•Flood damage measures made by river managers, sewerage managers and local authorities in association are effective.

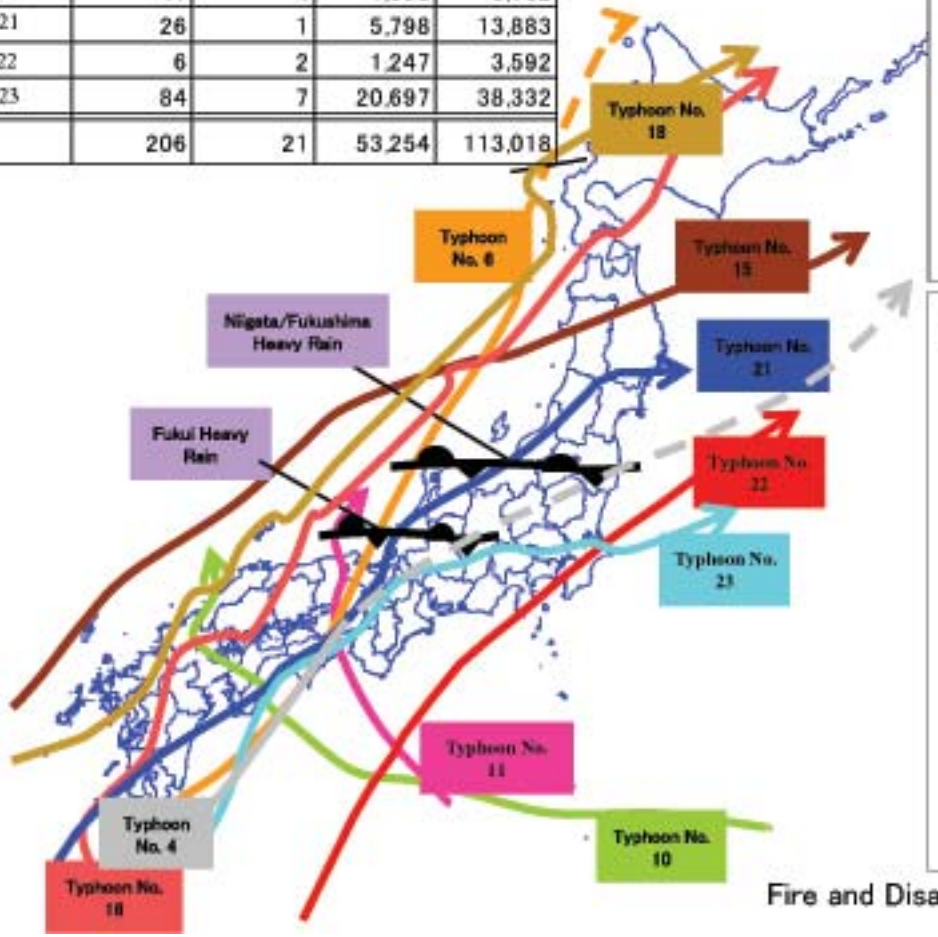
	Structural Measures	Non-Structural Measures
Measures for River Water Floods	**River Law (Prevention Measures against Floods in Advance)** Flood Measures by River Channels, Dams and so on ・Development of facilities of water storage and infiltration (River Managers)	**Flood-Fighting Law (Measures when Floods occur)** Designation of flood predicted areas (Only river water floods at flood forecast designated rivers are targeted.)
	Designation of specific urban rivers and specific urban river basins (Minister of MLIT, Governor of Prefectures)	New Law Designation of flood-predicted urban areas (Targeting river water floods and landside water inundations)
	Making a "Basin Flood Measure Plan" for comprehensive flood control measures (River Managers, Sewerage Managers, Governor of Prefectures and Municipality)	・Obligations to set facilities of water storage and infiltration against disturbance in rainfall infiltration ・Obligations to inform about landfill works of detention ponds and advise required measures ・Conclusion of management agreements by local authorities
Measures for landside water floods	Obligations to attach functions of water storage and infiltration to drainage equipments (ordinance) / Cost burden by other public groups / Drainage and treatment of sewage **Sewerage Law**	Permission of Development **City Planning Law**

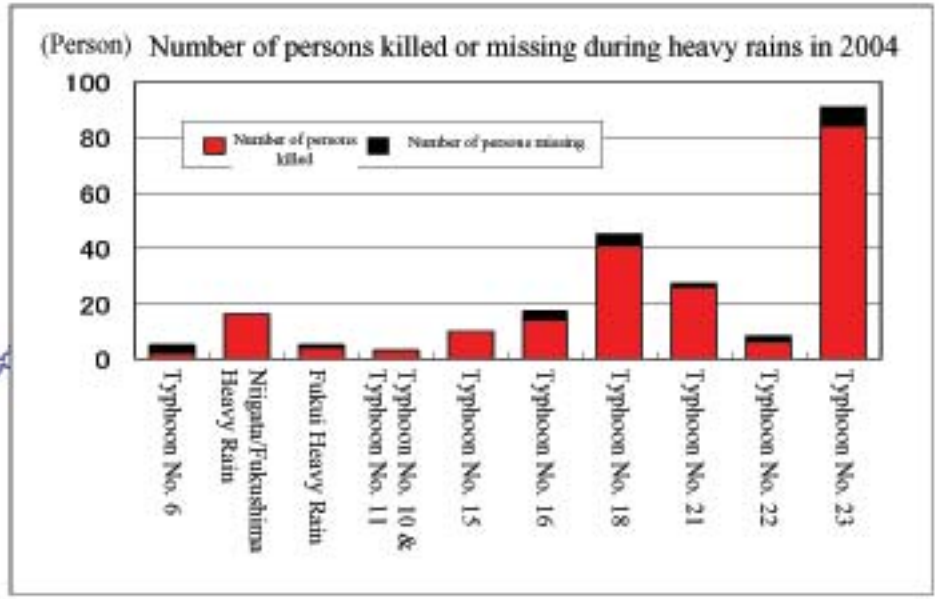
Damage and suffering caused by heavy rains in 2004

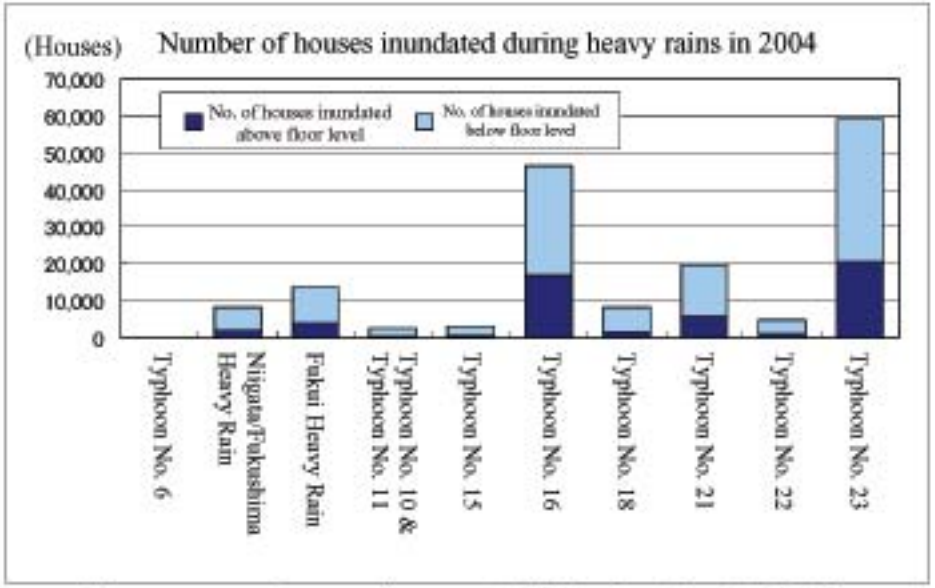
The year 2004 saw an unprecedented number of rain-induced disasters, including 10 typhoons hitting Japan, the most on record in a year.

Damage and suffering caused by heavy rain in 2004

Rainfall event	No. of persons killed	No. of persons missing	No. of houses inundated above floor level	No. of houses inundated below floor level
Typhoon No. 6	2	3	1	41
Niigata/Fukushima Heavy Rain	16	0	2,149	6,208
Fukui Heavy Rain	4	1	4,052	9,674
Typhoon No. 10 & Typhoon No. 11	3	0	218	2,420
Typhoon No. 15	10	0	695	2,339
Typhoon No. 16	14	3	16,799	29,767
Typhoon No. 18	41	4	1,598	6,762
Typhoon No. 21	26	1	5,798	13,883
Typhoon No. 22	6	2	1,247	3,592
Typhoon No. 23	84	7	20,697	38,332
Total	206	21	53,254	113,018







Fire and Disaster Management Agency data, as of 16:30, October 28, 2004

Preparation for Establishment of International Center for Water Hazard and Risk Management under the auspices of UNESCO (tentative name)

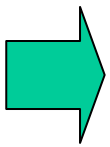
In details, please refer to
http://www.unesco.pwri.go.jp/en/index_e.htm

MEXT RR2002 Project (2002-2006)

Model Development for the Prediction of Water-Resource Change due to Natural Variation and Human Modification in the Asia Monsoon Region

(Project Leader: Prof. Kuniyoshi TAKEUCHI, Yamanashi Univ.)

- Prediction by developing a model to restore past data
  - lack of past data: restoration and reconstruction of data
  - identify the change process in the past: climate, use of lands such as forest, water utilization for agriculture, artificial infrastructure



International Conference on
Advances in Integrated Mekong River Management
25 – 27 October 2004, Vientiane

International Workshop on Flash Flood Disaster Mitigation in Asia - Understanding Current Situations and Identifying Future actions

Date: **February 28 to March 4, 2005**
Venue: **Public Works Research Institute, Tsukuba, Ibaraki, Japan**
Organized by: **Public Works Research Institute (PWRI), Japan**
Sponsored by:
Public Works Research Institute (PWRI)
Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan
and
World Meteorological Organization (WMO)

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