Climate Change and Risk Prevention

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This PPT file is provided by Prof. Dr. Hiroji Nakagawa.
Original Title is “Adaptation Countermeasures of water related disasters for Climate Change”

Note: all materials in this report were offered by
Ministry of Land, Infrastructure, Transport and Tourism (MLIT)
Japanese Government

Outline

① The visible reality of climate change

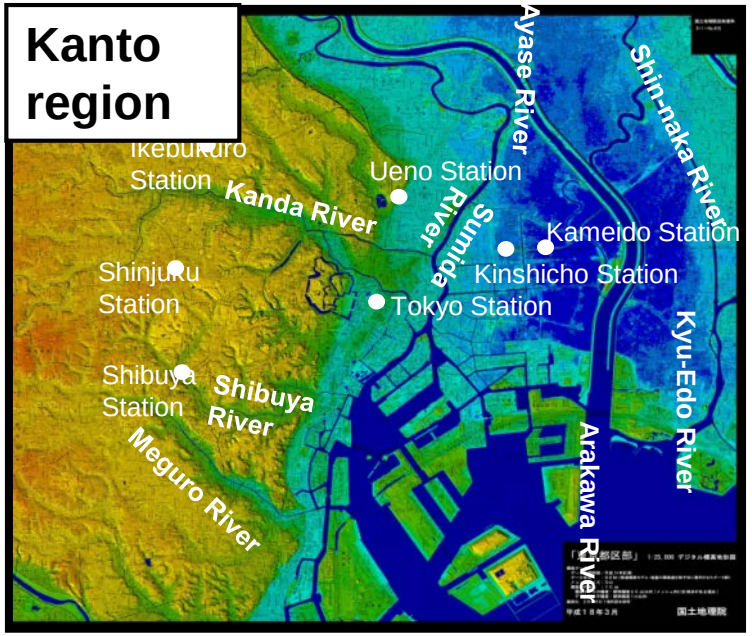
② Predictions of future climate change and its effects

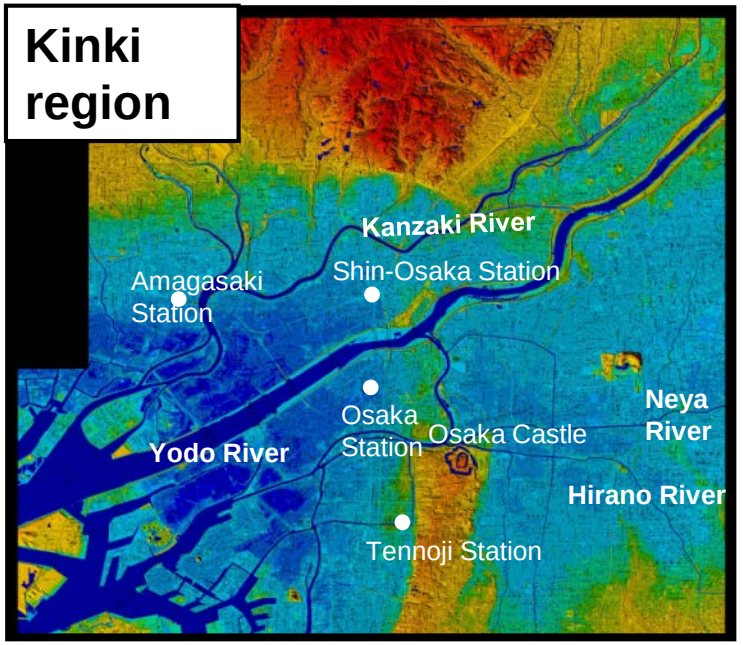
③ State of policy for responding to climate change in the field of flood damage

① The visible reality of climate change

Japanese territory weak in the face of climate change

○Many of Japan's cities are situated in places that are lower than the water level of seas and rivers.
Japanese territory is weak in the face of water damage, etc., such as major damage when banks are broken.



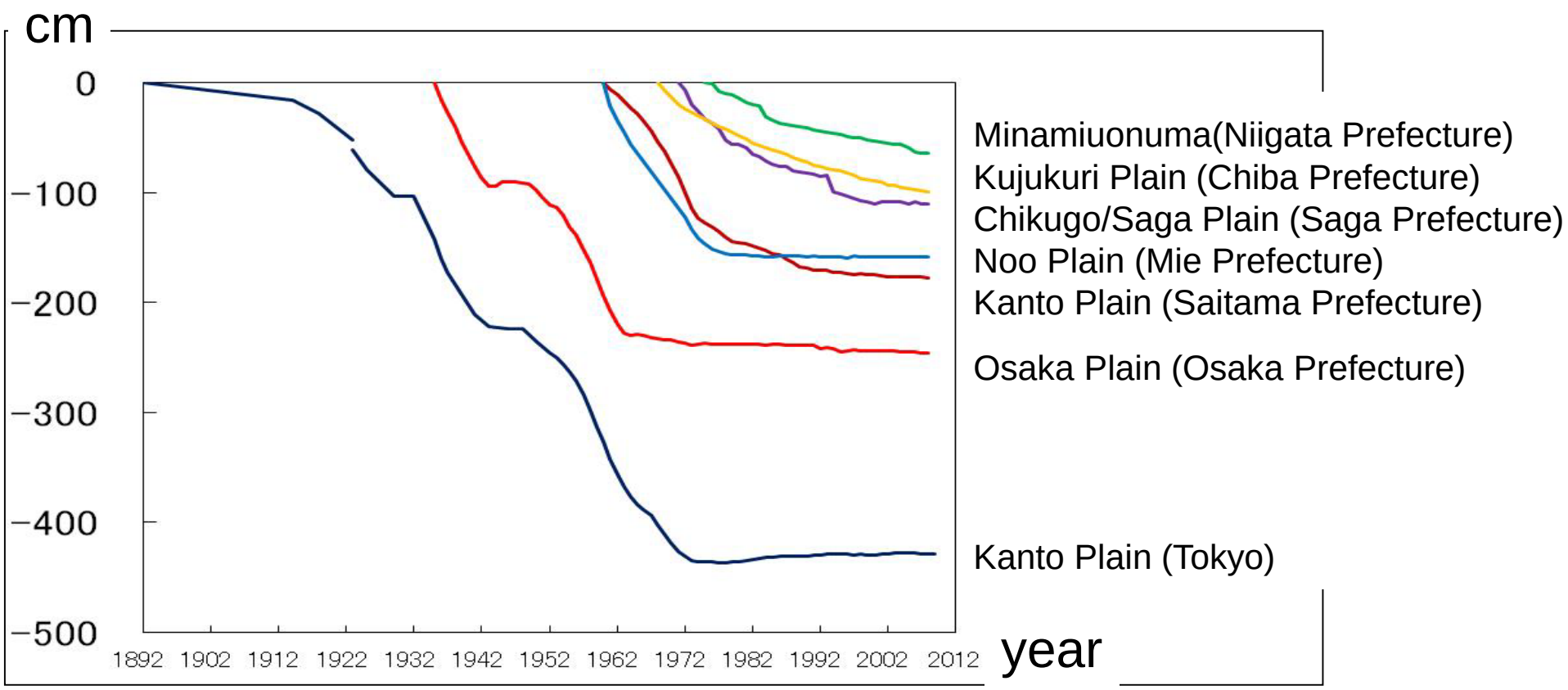


Source: Materials produced by Geospatial Information Authority of Japan

Height above sea level

- T.P. 0-1m
- T.P. -1-0m
- T.P. less than -1m
- Water part

Japanese territory weak in the face of climate change



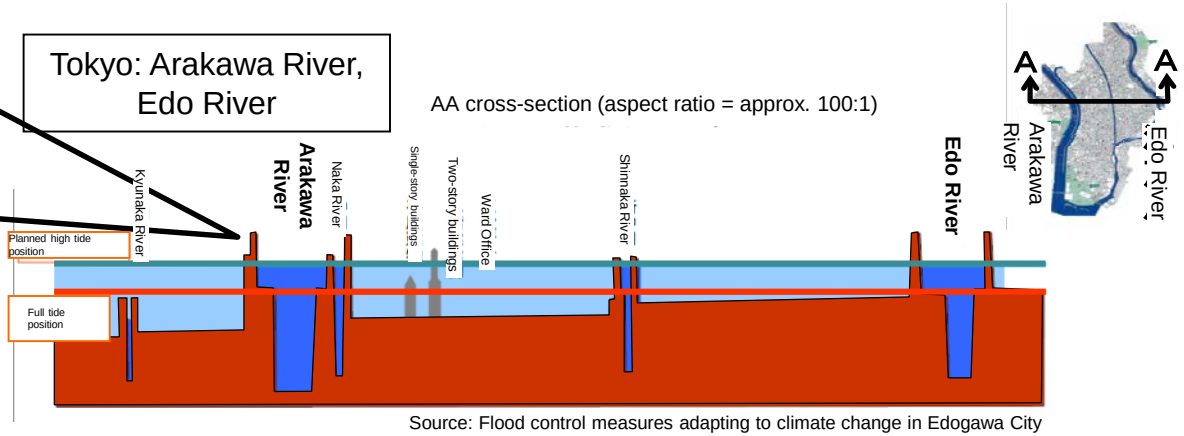
Changes in amount of land subsidence in three major bays, etc. over the years

Japanese territory weak in the face of climate change

○Many of Japan's cities are situated in places that are lower than the water level of seas and rivers.


River banks (Arakawa River)

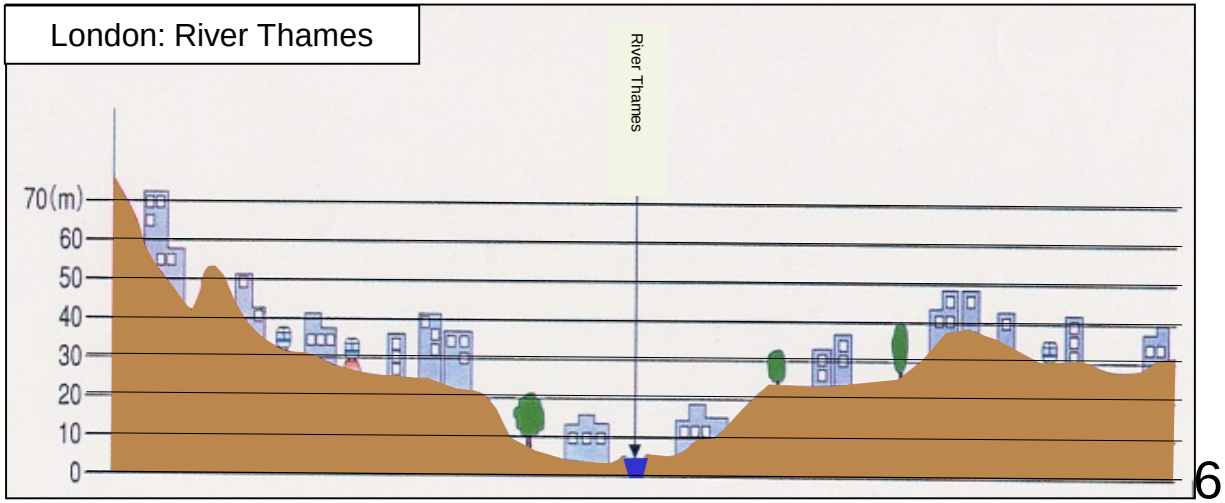
Tokyo: Arakawa River, Edo River



Source: Flood control measures adapting to climate change in Edogawa City


Along the River Thames, London

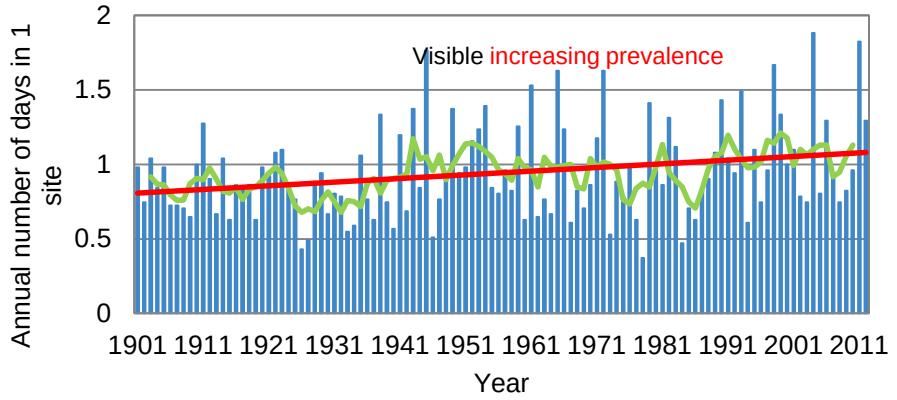
London: River Thames



Increasing prevalence of heavy rain

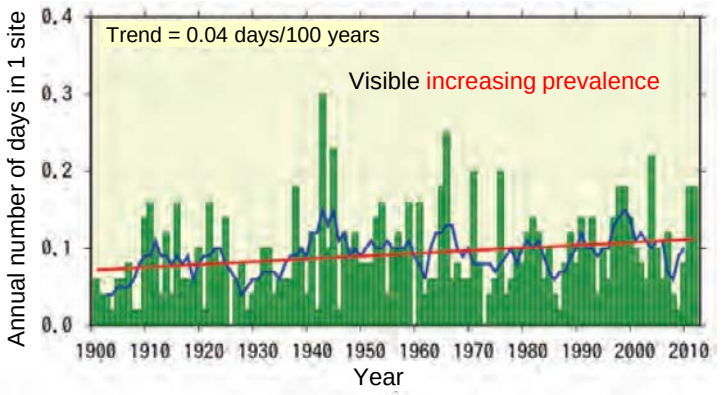
Heavy rain of 100 mm or more of daily precipitation and severe rain of 50 mm or more of precipitation per hour are being observed with increasing prevalence.

Annual number of days with 100 mm or more of daily precipitation



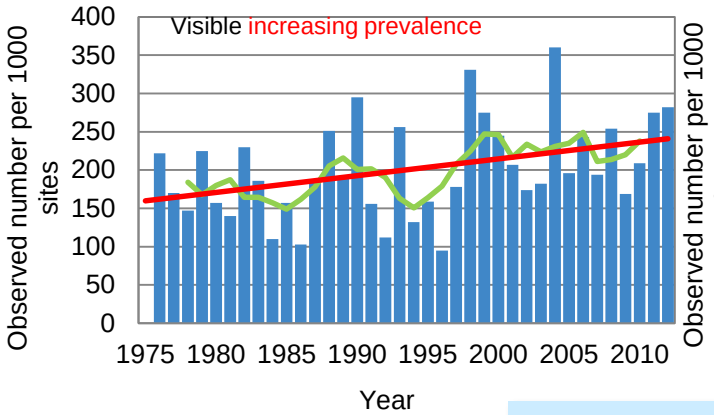
The bar graph indicates the average annual number of days with 100 mm or more of daily precipitation in 51 locations throughout the nation. The line graph indicates the 5 year moving average, and the straight red line indicates the changing prevalence.

Annual number of days with 200 mm or more of daily precipitation

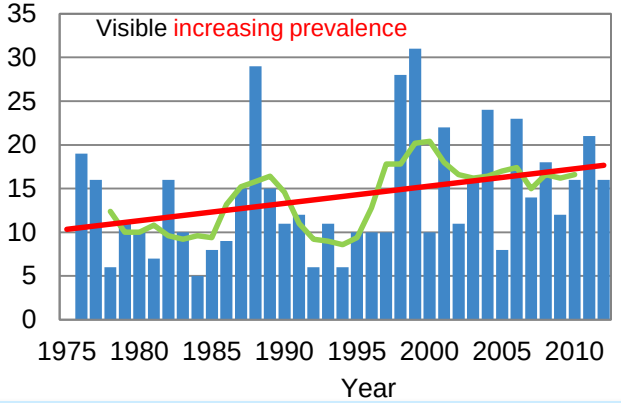


The line graph indicates the 5 year moving average, and the straight red line indicates the changing prevalence over time.

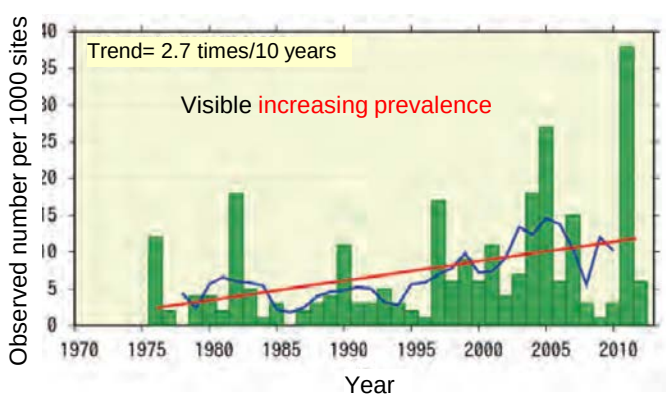
Annual number of times 50 mm or more of rainfall per hour is observed at AMeDAS site



Annual number of times 80 mm or more of rainfall per hour is observed at AMeDAS site



Annual number of times 400 mm or more of daily precipitation is observed at AMeDAS site



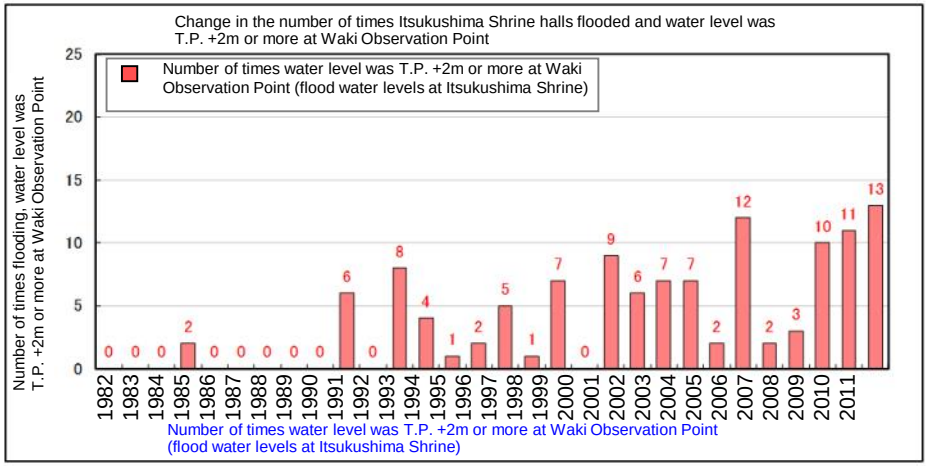
The line graph indicates the 5 year moving average, and the straight red line indicates the changing prevalence over time.

Japan Meteorological Agency (2013), Climate Change Monitoring Report 2012

Impact of global warming: Japanese case study (1)

Miyajima (Itsukushima Shrine) flooding over

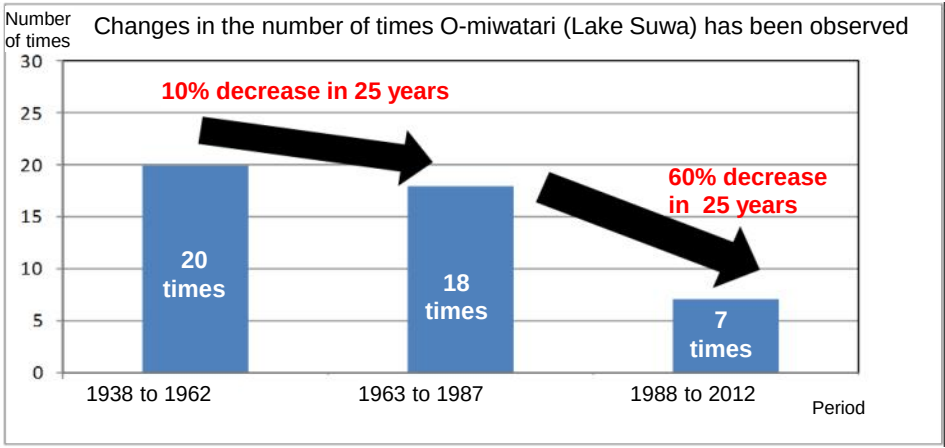
A water level of T.P. +2m or more at Waki Observation Point, which is the same level that the halls of Itsukushima Shrine flood over, was usually less than 5 times annually during the Showa period (1926 to 1989), however increased to about 10 times annually during the Heisei period (from 1989 onwards), and flooded 13 times throughout 2011. The number of times the shrine has flooded over is also increasing.



Source: "World Heritage Site: Itsukushima: Knowledge of disasters from our ancestors", Chuden Engineering Consultants

Number of times the O-miwatari phenomenon (Lake Suwa) has been observed

The O-miwatari phenomenon was observed on Lake Suwa about 20 times annually over the 25 years from the start of the Showa period (1938 to 1962), 18 times annually over the 25 years from mid to late Showa period (1963 to 1987), and 7 times over the 25 years of the Heisei period (1988 to 2012), indicating a clear downward trend.

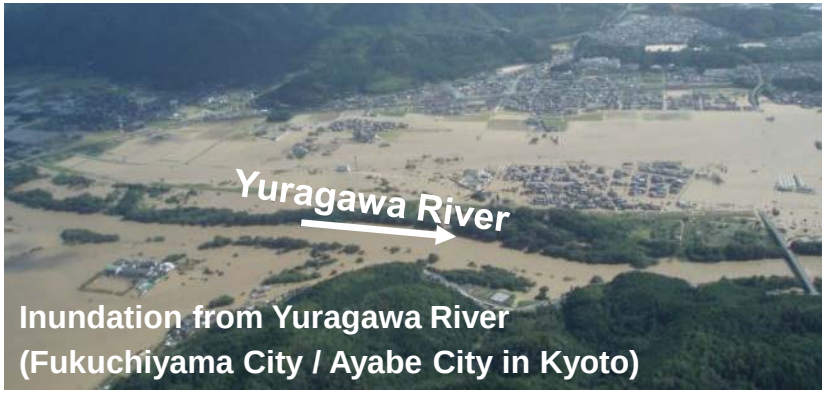


http://www.city.suwa.lg.jp/scm/dat/special/omiwatari/

Damages caused by 18th Typhoon in 2013

○ **Heavy rain due to Typhoon #18 and the front line**

Record heavy rain in Kyoto, Shiga, and Fukui Prefectures with water damages from Yuragawa River and Katsuragawa River in the Yodogawa River System.



Inundation from Yuragawa River
(Fukuchiyama City / Ayabe City in Kyoto)

○ **Flooding in the Kyoto City subway**

Overflow from Anshojigawa River was conveyed along Keihan railway's lines and flowed into Kyoto Municipal Subway, flooding Misasagi Station. This affected transportation, such as shutting down the municipal subway for four days.

Inundation damage in Keishin line of Keihan Railways

Inundation damage in Misasagi Station of Keihan Railways

Inundation damage in Tozai line of Kyoto Municipal Subway

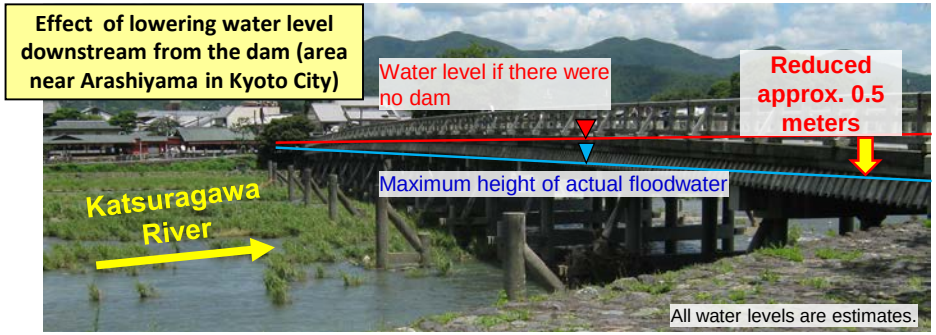
○ **Effect of dam flood control**

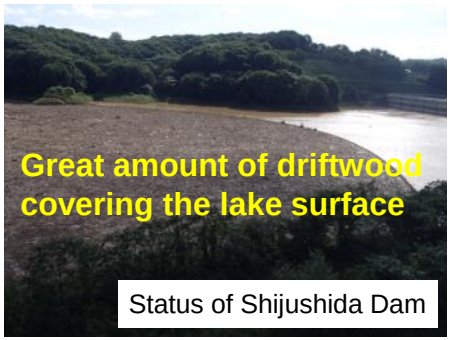
(Katsuragawa River in the Yodogawa River System – Hiyoshi Dam)

Flood adjustment at Hiyoshi Dam can **at maximum reduce the water flowing downstream by about 90%.** It is estimated that, in the area around Arashiyama in Kyoto City (near Togetsukyo Bridge), the dam **prevented extensive damage to Togetsukyo Bridge** and **virtually halved the number of inundated houses.**

(Kitakamigawa River in the Kitakamigawa River System – Shijushida Dam)

Due to the flood control at Shijushida Dam and Gosho Dam, the water level downstream was reduced and **inundation damage in Morioka City downstream was prevented.** This also contributed to reducing secondary damage due to driftwood, such as downstream flow interference and intake obstacles.



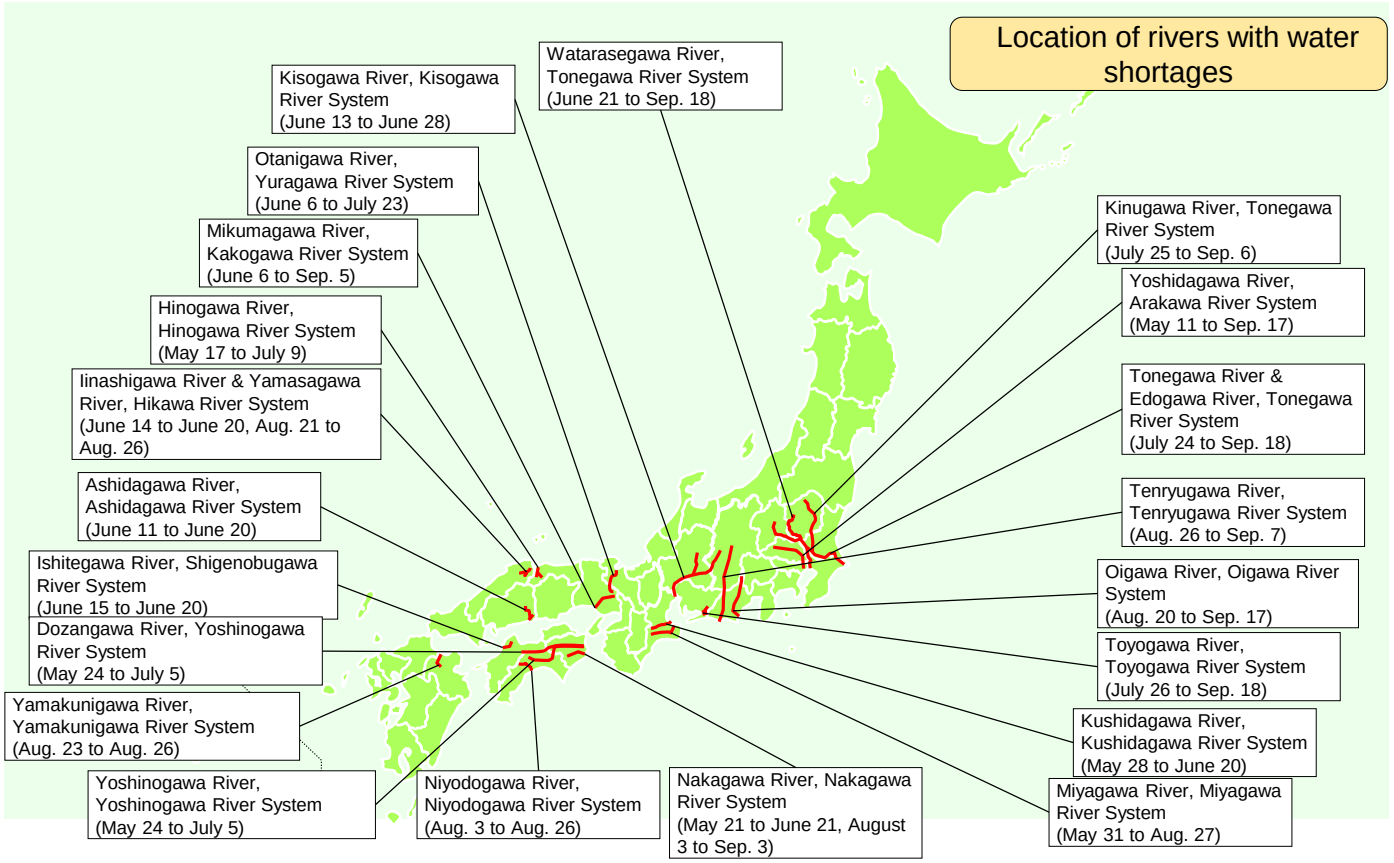


Status of Shijushida Dam

If there weren't a dam
Driftwood caught on the bridge

Water shortages in 2013

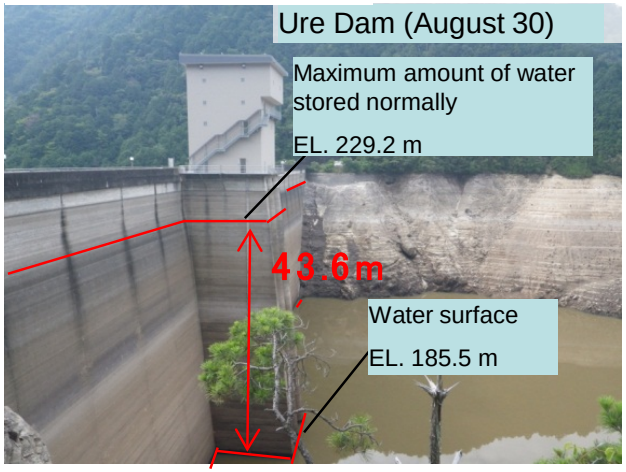
Water shortages for class A rivers occurred 18 river systems and 23 rivers throughout the nation.



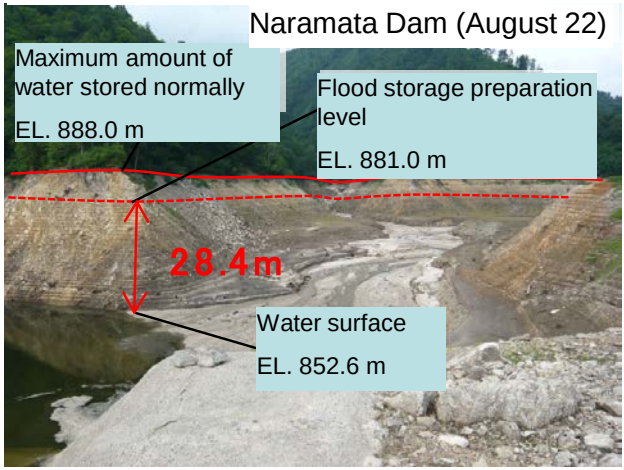
[Main water restrictions]

River name	Water restrictions			Rate of maximum water restrictions
	From	~	To	
Tonegawa River & Edogawa River, Tonegawa River System	July 24	~	Sep. 18	Domestic- 10%, Industrial- 10%, Agricultural- 10%
Toyogawa River, Toyogawa River System	July 26	~	Sep. 18	Domestic- 28%, Industrial- 40%, Agricultural- 40%
Yoshinogawa River, Yoshino gawa River System	Aug. 2	~	Sep. 4	Domestic- 50%, Industrial- 50%, Agricultural- 50%, Unused 100%

Toyogawa River Dam



Tonegawa River Upstream Dam



①Summary of the visible reality of climate change

- Many of Japan's cities are situated in places that are lower than the water level of seas and rivers.
- Observed Heavy rainfall are increasing.
- Damages caused by Typhoon are increasing.
- Water shortages occurred in 18 river systems and 23 rivers in 2013.

② Predictions of future climate change and its effects

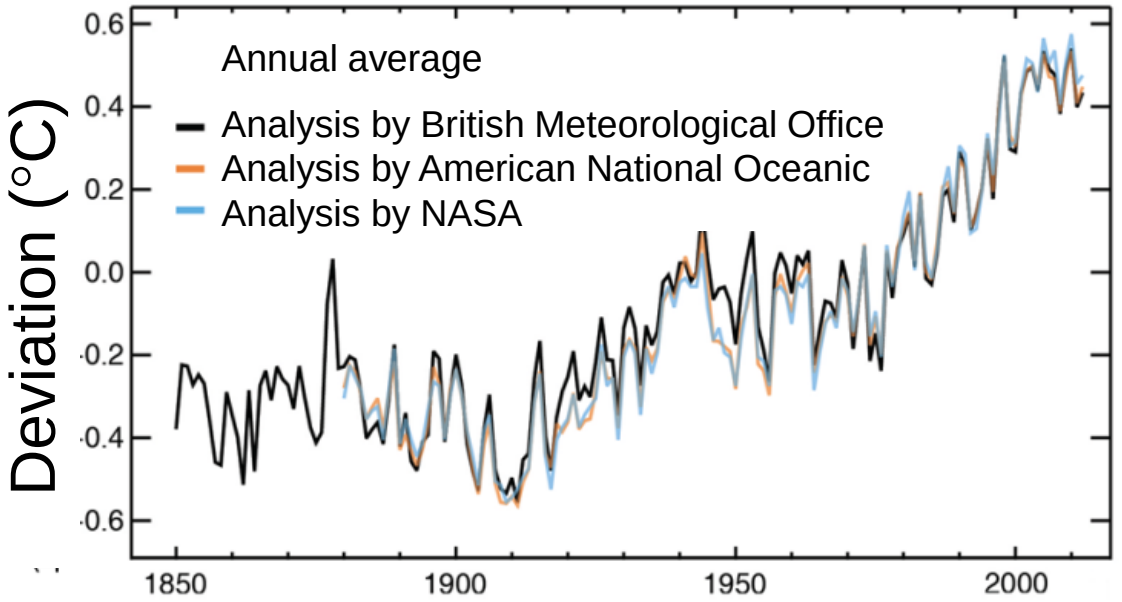
Main contents of the first taskforce report released in Sep. 2013

[Observed realities and reason for warming]

◆There's no room to doubt the warming of climate systems.

◆Human activity is the main reason for warming

Change in global land temperature over the years



Change in global average temperature from 1950 to 2100 (Compared to average from 1986 to 2005)

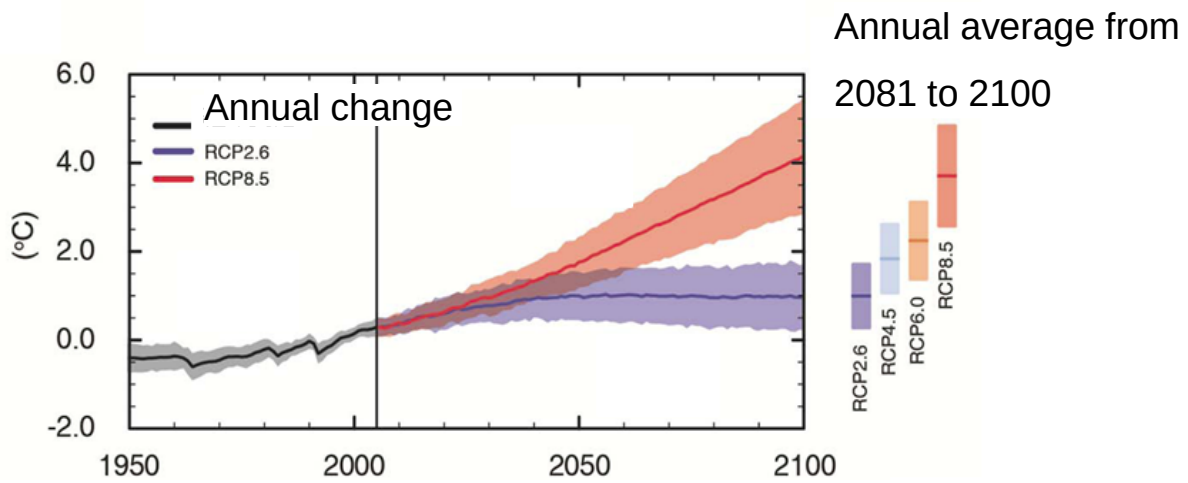
Main contents of the first taskforce report released in Sep. 2013

[Prediction]

◆By the end of the 21st century, the average global temperature will rise by 0.3 to 4.8°C

◆The average global ocean level will rise by 0.26 to 0.82 m.

◆In the mid-latitude areas, extreme rainfall will become stronger and more frequent.



(Source: created by Japan Meteorological Agency based on IPCC 5th Assessment Report)

Major Risk reported by IPCC in Mar. 2014

- Risk of sea level rise and coastal storm surge damage
- Risk of flood damage to major cities
- Risk of failed infrastructure due to extreme weather events
- Risk of disease and death to citizens in urban areas, due to heat waves
- Threatened food security due to rising temperatures and droughts etc.

Threats to water posed by global warming

Temperature is increasing as a result of emission of large quantities of greenhouse gas into the atmosphere, where the concentration of these gases has increased and absorbed more heat. Sea water levels are also rising due to this phenomenon.

- Fusion of ice from glaciers and the South Pole, etc.
- Thermal expansion of ocean water
- Increasing amounts of evapotranspiration
- Decline in amount of snowfall

- Increasing sea levels
- Stronger typhoons
- Changes to amount of rainfall
- Increasing frequency of torrential rain and water shortages
- Acceleration of melting of snow, and decline in flow rate

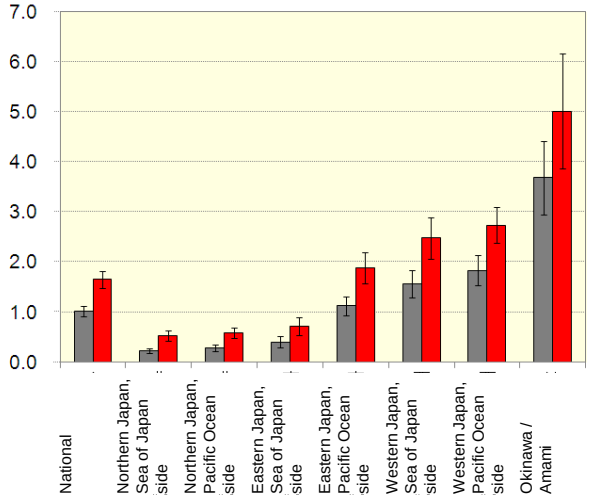
- Increased river flow rates
- Changes to patterns of water use

- Storm surges and coast erosion
- Increase of floods
- Intensification of landslide disasters
- Increased risk of water shortages

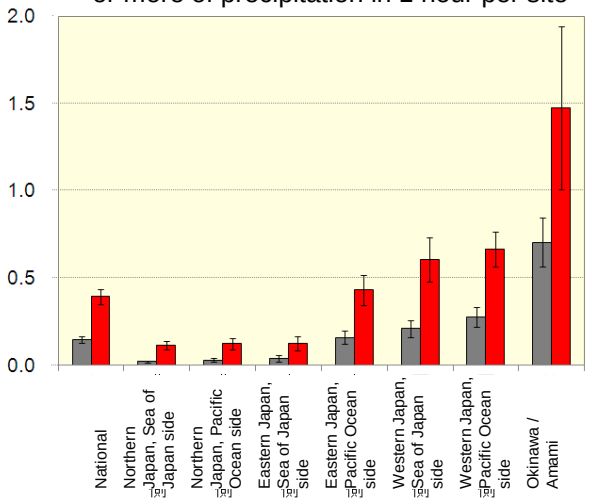
Implementing detailed prediction about Japan at the end of the 21st century (JMA)

Heavy rain and short-term heavy rain will become **more frequent** throughout the nation, and precipitation due to heavy rain will increase in virtually each season and region.

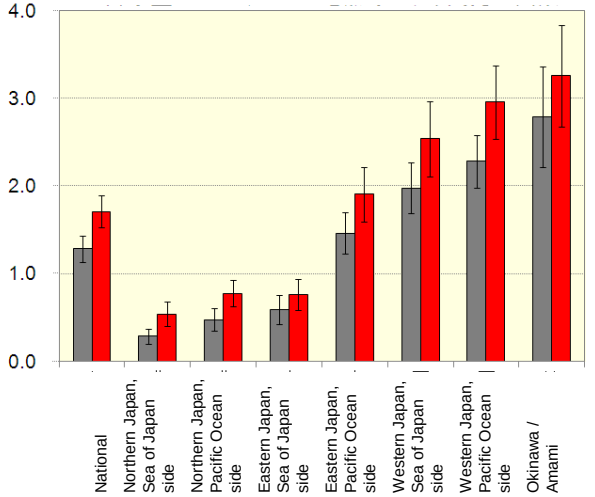
Annual number of occurrences with 30 mm or more of precipitation in 1 hour per site



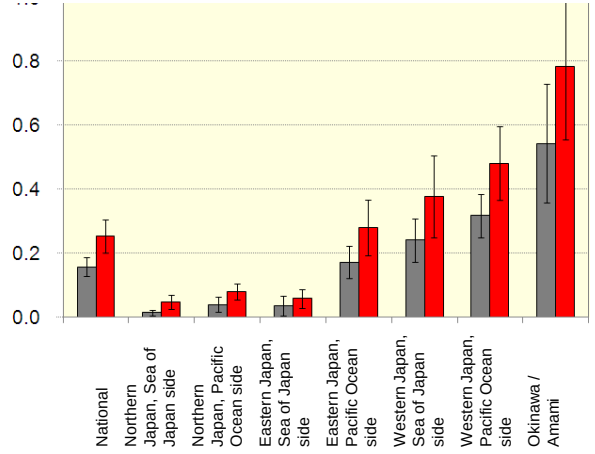
Annual number of occurrences with 50 mm or more of precipitation in 1 hour per site



Annual number of occurrences with 100 mm or more of daily precipitation per site



Annual number of occurrences with 200 mm or more of daily precipitation per site



This indicates the change between the current weather (1980 to 1999) and future climate (2076 to 2095) according to the SRES A1B scenario using NHRCM5km. The bar graph indicates the number of occurrences per site for current weather (gray) and future weather (red) with the vertical line indicating standard deviation for each year.

Future changes in annual number of occurrences

	30 mm or more per hour	50 mm or more per hour	100 mm or more per day	200 mm or more per day
National	0.63	0.25	0.43	0.09
Northern Japan, Sea of Japan side	0.31	0.09	0.26	0.03
Northern Japan, Pacific Ocean side	0.30	0.10	0.30	0.04
Eastern Japan, Sea of Japan side	0.32	0.09	0.18	0.02
Eastern Japan, Pacific Ocean side	0.76	0.27	0.44	0.11
Western Japan, Sea of Japan side	0.91	0.40	0.56	0.14
Western Japan, Pacific Ocean side	0.91	0.39	0.67	0.16
Okinawa / Amami	1.33	0.77	0.47	0.24

This indicates the increase (decrease) in annual occurrences. If the change is above the standard deviation for current weather, it is colored blue- if it is not statistically significant with 90% reliability, it is colored gray.

Global Warming Projection Volume 8, Japan Meteorology Agency (2013)
http://www.data.kishou.go.jp/climate/cpdinfo/GWP/index.html

③ State of policy for responding to climate change in the field of flood damage

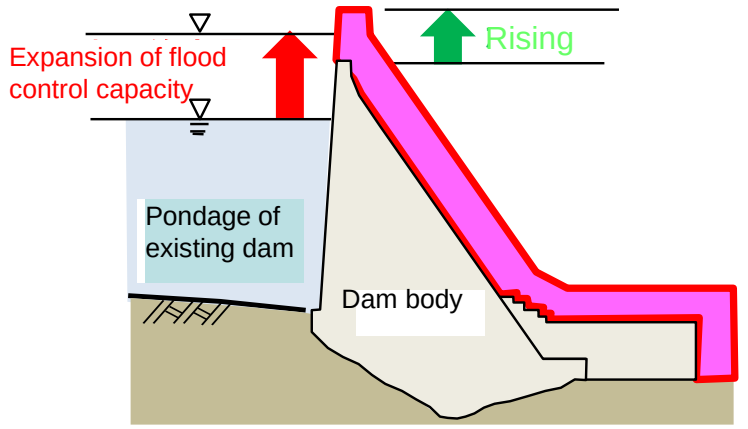
Adaptation policy for facilities (Maintaining flood control facilities)

Building new facilities, maintaining/improving safety of existing facilities, thorough use of existing facilities

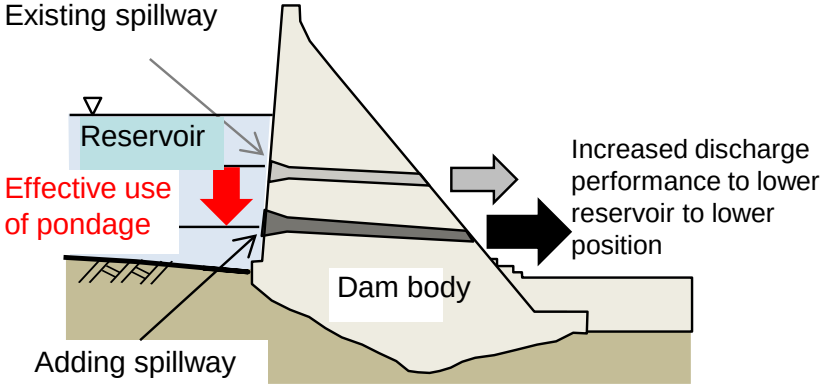
Maintenance of anti-flood pond

Maintenance of flood control facilities (underground retention basin)

Expanding flood control capacity by rising existing dams



Effective use of pondage by adding spillways to existing dams

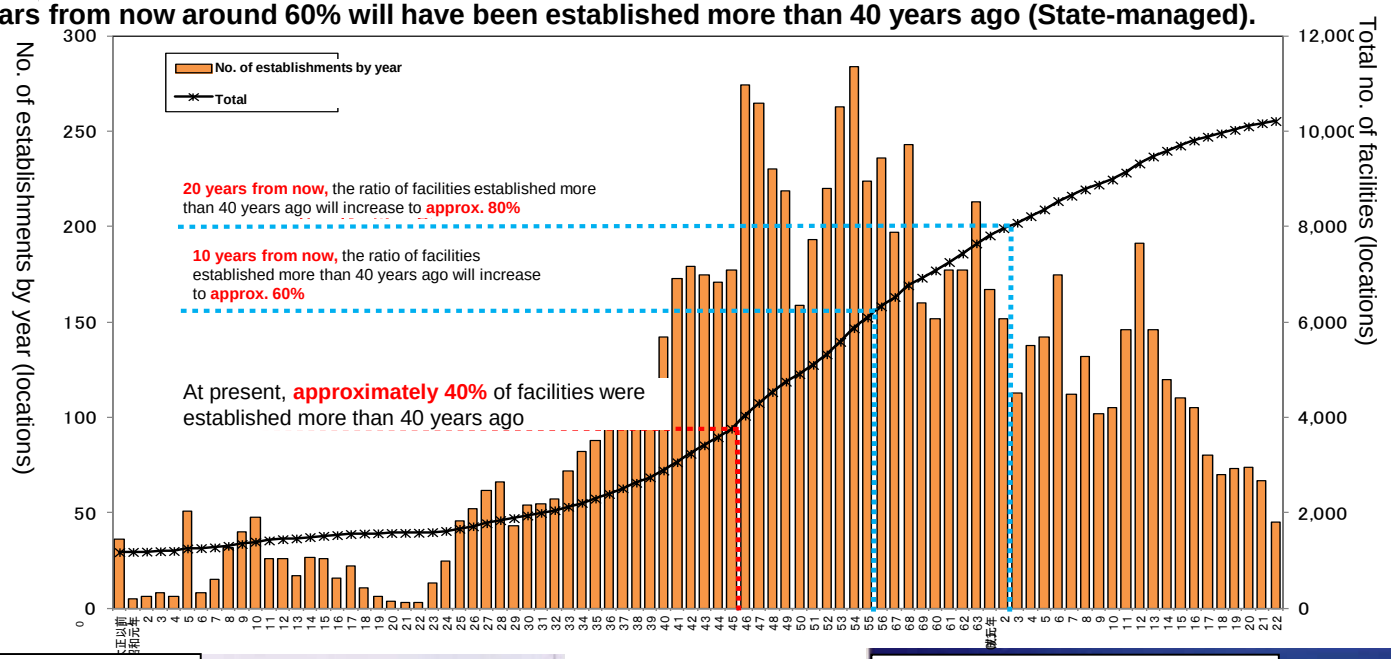


Dam regeneration

Adaptation policy for facilities (improvement of reliability of river control facilities)

Systematic operation and maintenance will be required in order to avoid centralization of renewal investment, such as by performing facility safety inspections and evaluations as well as preventive control towards long operating life.

At present approximately 40% of river control facilities were established more than 40 years ago, while 10 years from now around 60% will have been established more than 40 years ago (State-managed).



Before countermeasures

River dike where concrete has deteriorated

After countermeasures

River dike subject to measures against deterioration using barriers

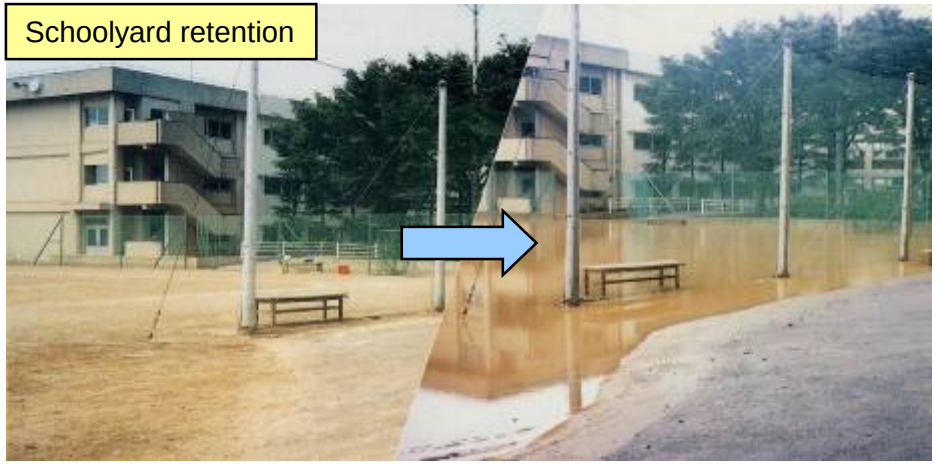
Adaptation policy for facilities (promotion of facilities for rain water retention, permeation, and flow control)

Establishment of rain water retention and permeation facilities

Normally

During flood

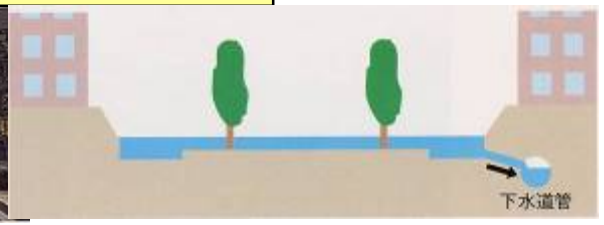
Schoolyard retention



Leaching well/infiltration trench

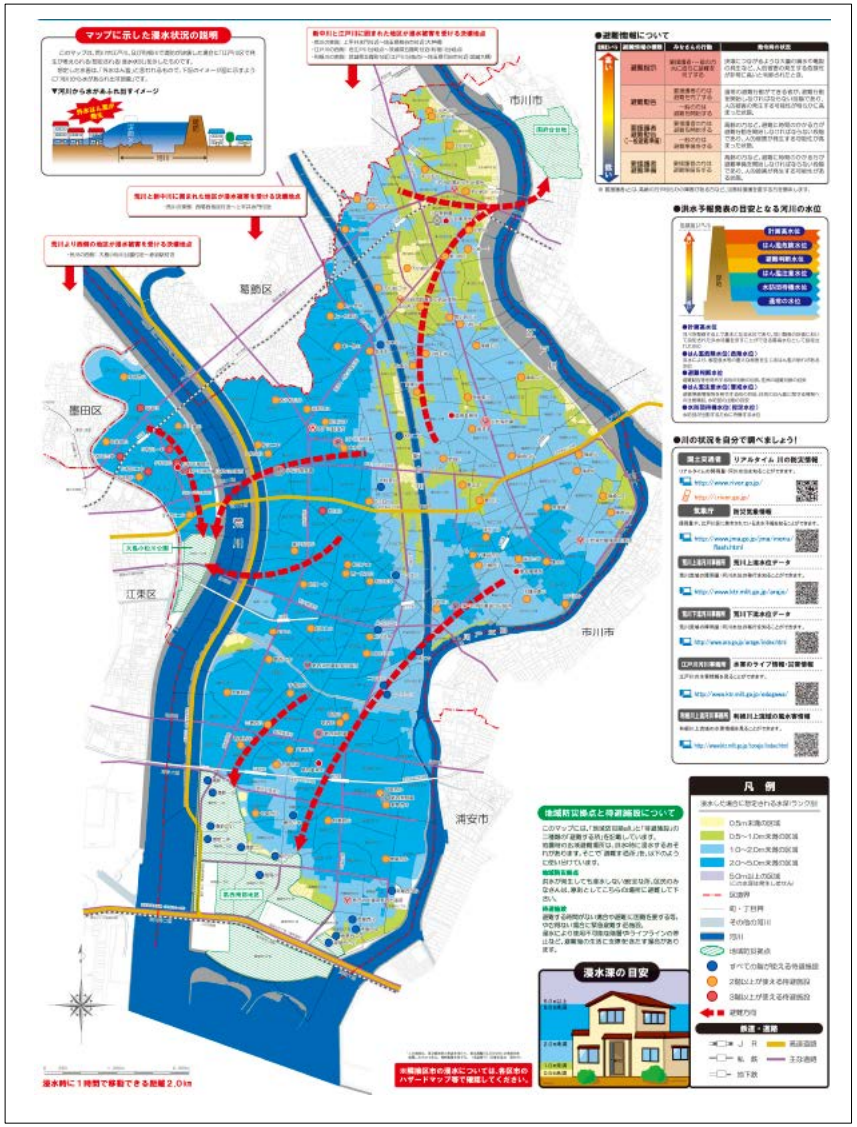
Permeable pavement

Retention between buildings



Adaptation policy focusing on crisis management support (promotion of software countermeasures)

Sharing of information in advance regarding water damage risk



Creation of hazard map

Hazard maps for each town

Adaptation policy focusing on crisis management support

(Maintaining and using XRAIN (Ministry of Land, Infrastructure, Transport and Tourism's X-band MP radar network))

XRAIN (X-band MP radar network of the MLIT), which can transmit localized rainfall in virtual real-time, began test operation in July of 2010. It will construct an observation system with 35 locations throughout the nation by September of 2013. Not only does it help with river management and disaster prevention activities, it also increases the accuracy of flooding/inundation predictions. In addition, it provides observation data to a wide variety of research and private agencies and is already used in academic-industrial research and development or by municipalities and private companies. They are continuing to promote the diversification and advancement of its use.

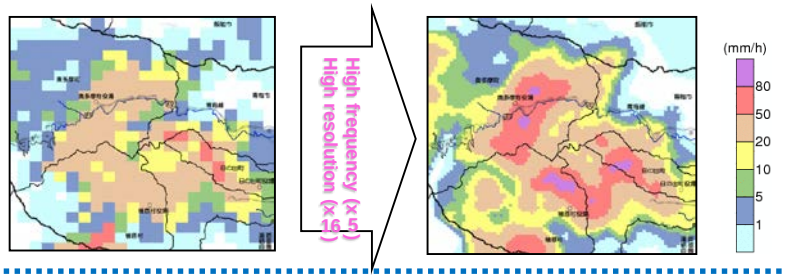
Characteristics of XRAIN

[Current radar] (C-band radar)

- Minimum observation area: 1 km mesh
- Transmission frequency: 5 minutes
- Time required after observation for transmission: 5 to 10 minutes

[XRAIN]

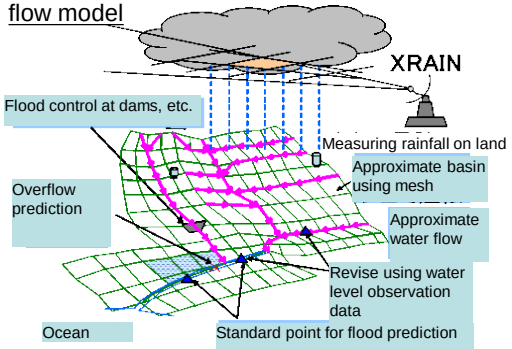
- Minimum observation area: 250 m mesh
- Transmission frequency: 1 minute
- Time required after observation for transmission: 1 to 2 minutes



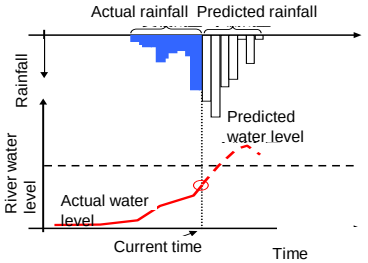
Higher accuracy for flood predictions

XRAIN's observed rainfall data is used in predicting floods and aims to improve the accuracy of those predictions.

Flood prediction using distribution-type flow model

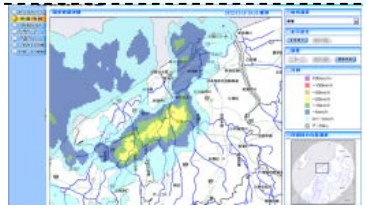


Information for water level prediction



Real-time transmission – Use in applications

XRAIN's rainfall information is transmitted in real-time on the web. The private sector is developing applications, and it is widely used

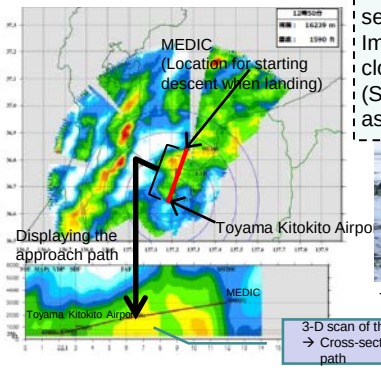


Web transmission (MLIT)

Smart phone application (Japan Weather Association)

Use in assisting airplane aviation

XRAIN (X-band MP radar rainfall information of MLIT)



3-D scan of the clouds
→ Cross-section view of the airplane's approach path

XRAIN observation data is used to improve the service rate* at Toyama Airport during winter. Improved the prediction accuracy of gaps between clouds to contribute to improved service rate.
(Service rate: Rate at which planes land at take off as planned)

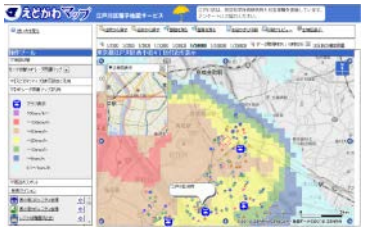
Toyama Airport during winter

Providing weather information to the pilot (at the airplane company)

(Toyama Prefecture)

Use by community municipalities (Edogawa Ward)

The "Edogawa Map", an electronic map service on the web, is performing a social experiment which publicizes maps that overlay XRAIN's observed rainfall.



National Research Institute for Earth Science and Disaster Prevention, Edogawa Ward

End