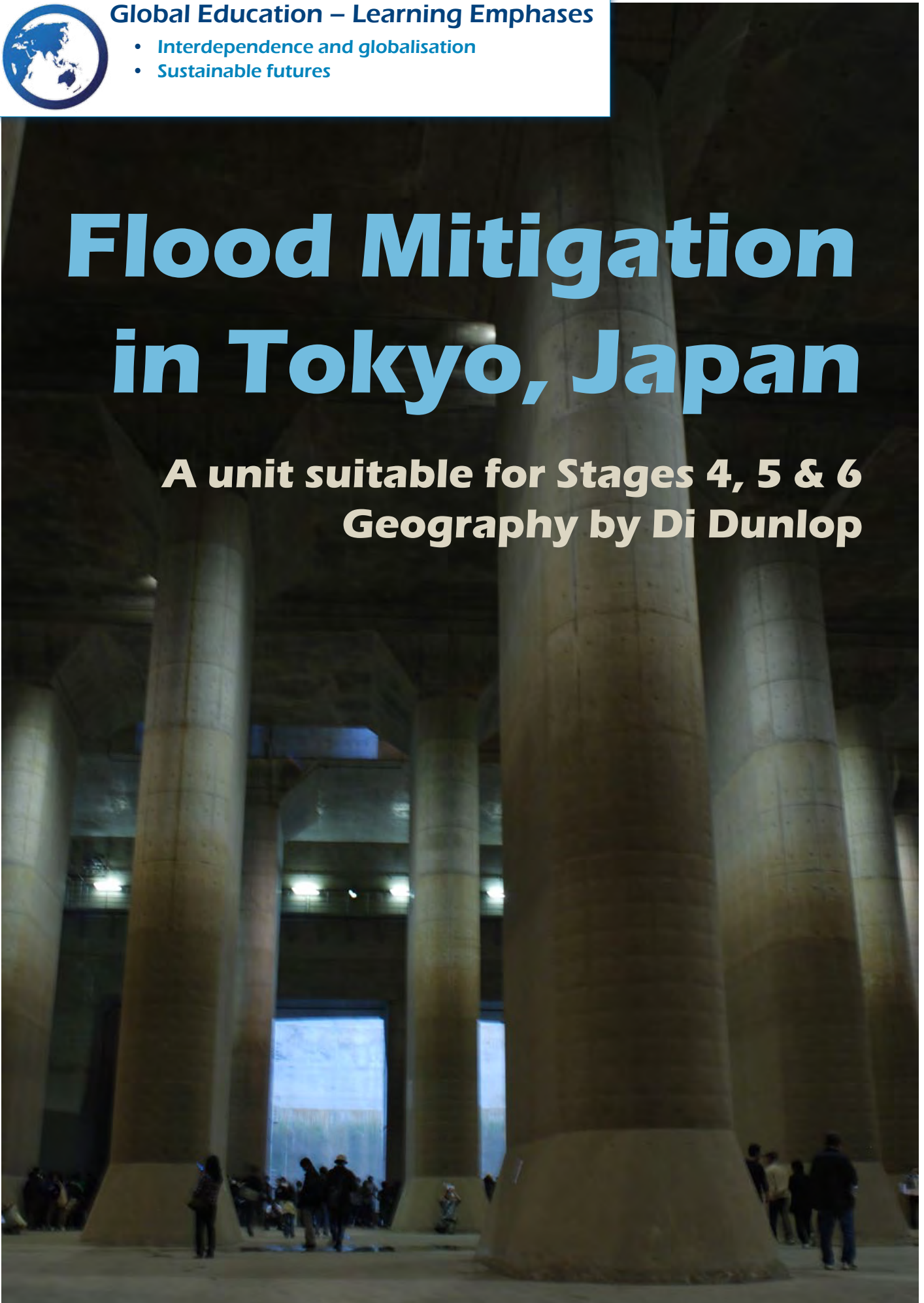




- Interdependence and globalisation
- Sustainable futures

Flood Mitigation in Tokyo, Japan

**A unit suitable for Stages 4, 5 & 6
Geography by Di Dunlop**



The cathedral-like Tokyo metropolitan area underground flood discharge tunnel, excursion 2008. Source: Wikimedia Commons

Flood Mitigation in Tokyo, Japan

.This unit is a result of a programme on the ABC 'Catalyst' – <http://www.abc.net.au/catalyst/stories/4112766.htm>

Tokyo is Japan's capital city and is home to some 35 million people[The Greater Tokyo Area], this is 28% of the total population of Japan. The Region is located on an alluvial floodplain with Tokyo Bay on one side[1.5 .million Tokyo residents live below sea level]. There are eight major rivers that flow through the Tokyo Basin including the Sumida River: the whole area is prone to flooding.

Flooding is a major concern for many reasons:

- four season weather cycle which includes typhoons,
- frequency of earthquakes which can trigger tsunamis,
- change in rainfall patterns are due to climate change[total precipitation is decreasing, but the amount falling at any one time is increasing],
- rising sea level is an issue for such low-lying land,
- 'heat island' effect of the vast Tokyo urban area,
- increasing temperatures,
- increased frequency of droughts,
- water table is decreasing and causing land subsidence, and
- water use is expected to increase.

Japan has a long history of managing river diversions and flooding. Tokugawa Ieyasu [the Shogun who united Japan in 1600] ordered river diversions including one to the ocean instead of flowing through Tokyo[it took three generations to complete it, it was finished by his grandson, Iemitsu.]

In 1947, Typhoon Kathleen devastated parts of Tokyo when the Tonegawa broke its banks [31,000 homes were destroyed and 1,100 people died]. During the 1950's and 1960's there were heavy typhoons and wet



A worker points to the wall of a section of the Furukawa reservoir project being built in central Tokyo on 7 Aug 2014. When completed in 2016, the 3.3-km-long subterranean reservoir will be able to hold 135,000 cu. meters of water, enough to fill 54 Olympic-size swimming pools. Source: Japan Times (http://www.japantimes.co.jp/life/2014/08/17/environment/tokyo-combats-flood-threats-second-mammoth-reservoir/#.VNA73SxK_KE)

seasons that destroyed much of the city. At the same time, huge amounts of groundwater were extracted due to the rapid industrialisation and urbanisation of the Tokyo Region. The area sank between 60 and 70 cms that only increased the fear of flooding. From 1949 onwards, Japan introduced laws to deal with flood control, erosion and emergencies that resulted.

The Tokyo Waterworks has incorporated policies on climate change and the implementation of mitigation measures. They have built solar-powered water filtration plants, hydraulic power stations run by renewable energy sources and reduced leakages from the system.

To cope with the floods and 'guerrilla storms,' the Government has built a coordinated, massive structure under the city. Tokyo is criss-crossed by many canals and rivers and the channel walls are now concrete and each has massive levees on either side. The First Sluice Gate was built in 1924, but much larger ones have now been built to cope with the 50% increase in rainstorms in the last century. These storms can deliver 100mm in an hour [Tokyo's Average Annual Rainfall is 1,530mm.] The discharge from these rivers and canals has doubled in the last one hundred years. Locks have been built to assist in diversion and flood mitigation as there is much less land to absorb the water as a result of urbanisation.

The key to flood mitigation working in Tokyo is the Metropolitan Outer Area Underground Discharge Channel, the largest stormwater-drain in the world. It aims to reduce the damage caused by regular flooding by diverting river overflow by underground tunnels. It took thirteen years to build at a cost of \$3 billion. This engineering wonder is the length of two football fields and breaks the momentum of the water as it flows down from the channels. The Edo River overflows



Typhoon Kathleen, 1947 at Koiwa. Source: Wikimedia Commons

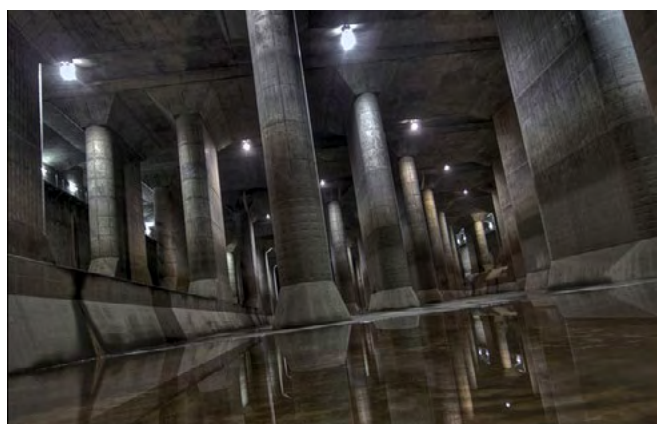
Flood Mitigation in Tokyo, Japan



Nerve center: Tetsuya Shimazu, an official in the Tokyo Metropolitan Government's rivers department, mans the consoles in its emergency operations room. PHOTO: TOMOKO OTAKE, Japan Times (http://www.japantimes.co.jp/life/2011/10/16/general/unseen-fight-to-save-tokyo-from-floods/#.VNA6qixK_KE)

up to twelve times a year [2013]. There are 6.3 km of tunnels underground and connect five watercourses to the main river that overflows into five giant cylinders that create an underground river fifty metres below the city. This system is powered by turbines and the stream flows at 200 cubic metres per second. Since its construction, the flood damage in Tokyo has fallen by 50%. From 2014, Japan intends to spend 1 trillion yen on nation-wide disaster prevention including the strengthening of levees. This massive project was completed in 2009 but the first parts were started in 1920.

A useful source is the Paper delivered by TOSHIYUKI ADACHI [Director of the River Planning Division,



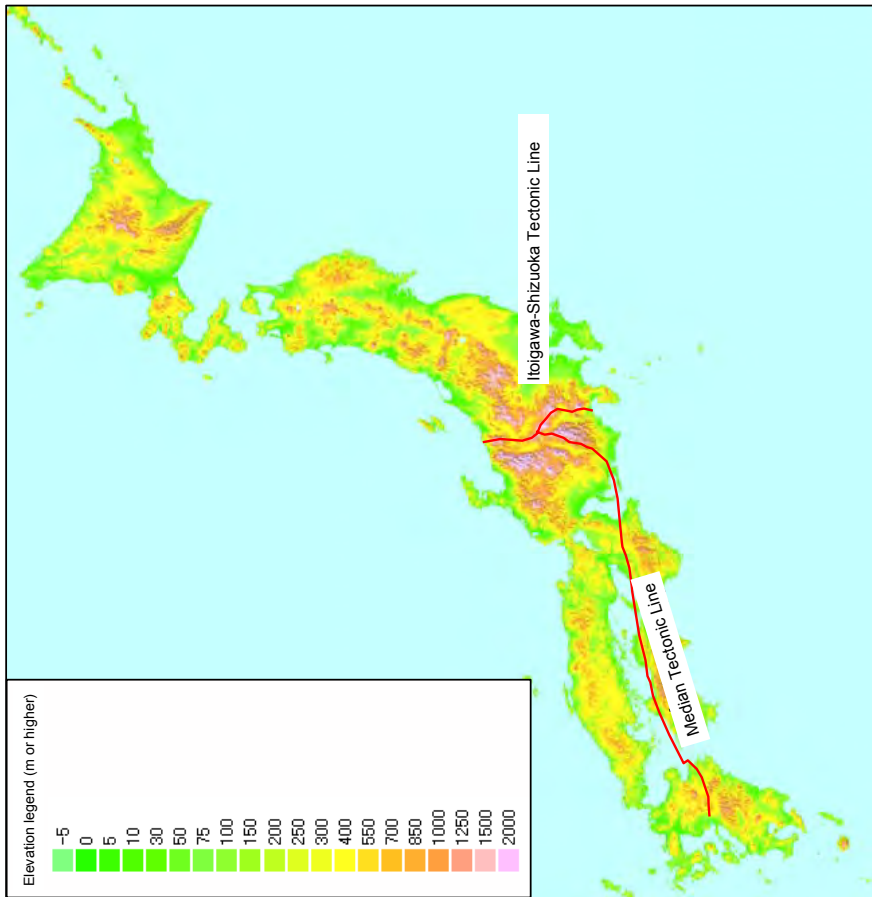
The massive pillars of the Tokyo metropolitan area underground flood discharge tunnel. Source: Wikimedia Commons

River Bureau, Ministry of Land, Infrastructure, Transport and Tourism] at the Fifth U.S-JAPAN Conference on Flood Control and Water Resource Management in June, 2009. (www.mlit.go.jp/river/basic_info/english/pdf/con_09_0.pdf)

ACTIVITIES

- Find a map of Honshu and mark in Tokyo, Tokyo Bay, Sumida River. Shade in the alluvial plain.
- Explain the following words and terms: levee, alluvial plain, tsunami, heat island, groundwater, typhoon, industrialisation, urbanisation, guerilla storms, flood mitigation, climate change.
- Explain why flooding is an issue for the city of Tokyo.
- Outline the steps that have been taken in the past to deal with the regular flooding.
- Why are these measures no longer sufficient?
- Outline and discuss the reasons for these changes to the environment.
- Research Cyclone Kathleen and describe the changes that were implemented as a result.
- Explain why the Metropolitan Outer Area Underground Discharge Channel was needed.
- What role do levees play in the infrastructure to minimise flood damage.

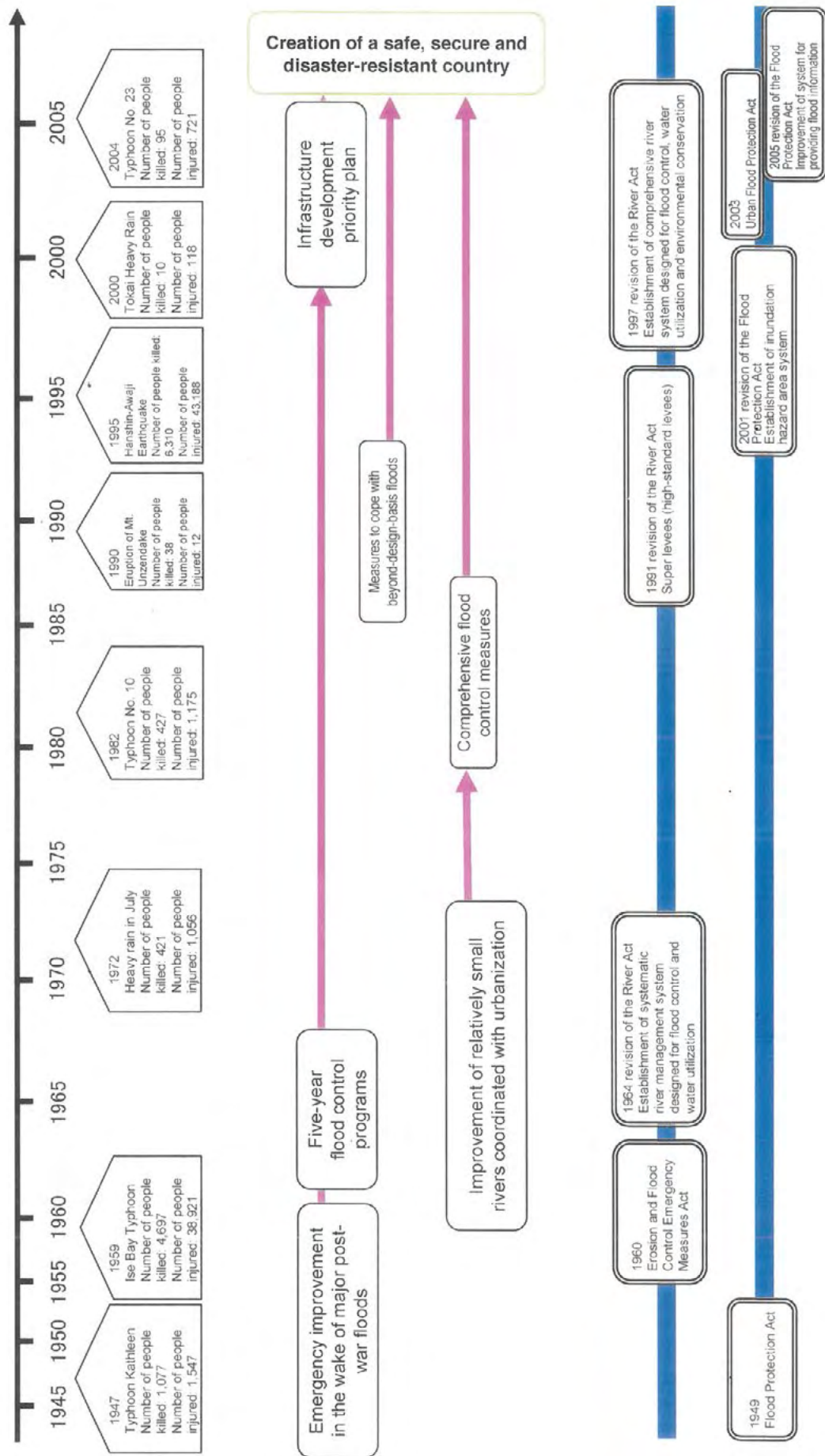
①Topography	Long and slim archipelago about 2,000 km long in the north-south direction
②Four main islands	The four main islands separated by straits, and many smaller islands
③Backbone mountain ranges	Mountain ranges running longitudinally at the center of Japan roughly divides the country into two halves.
④Tectonic lines	The Median Tectonic Line and the Itoigawa-Shizuoka Tectonic Line run north to south across the Honshu island.
⑤Plains	Small plains along the coastlines (about 14% of the total land area)
⑥Soft ground	Most of the large cities in Japan are located on weak ground .
⑦Earthquake	About 10% of all earthquakes in the world occur in or around Japan.
⑧Heavy rain	Rainy weather (mean annual precipitation: 1,714 mm, which is about two times as much as that in the European countries); steep rivers
⑨Snow	About 60% of the country is located in snowy cold regions (annual cumulative snowfall: more than 4 m in many cities).



※ Snowy region: The average of maximum snow depths in February is 50 cm or more.
Cold region: The average of mean temperatures in January is 0°C or lower.

Flood Mitigation in Tokyo, Japan

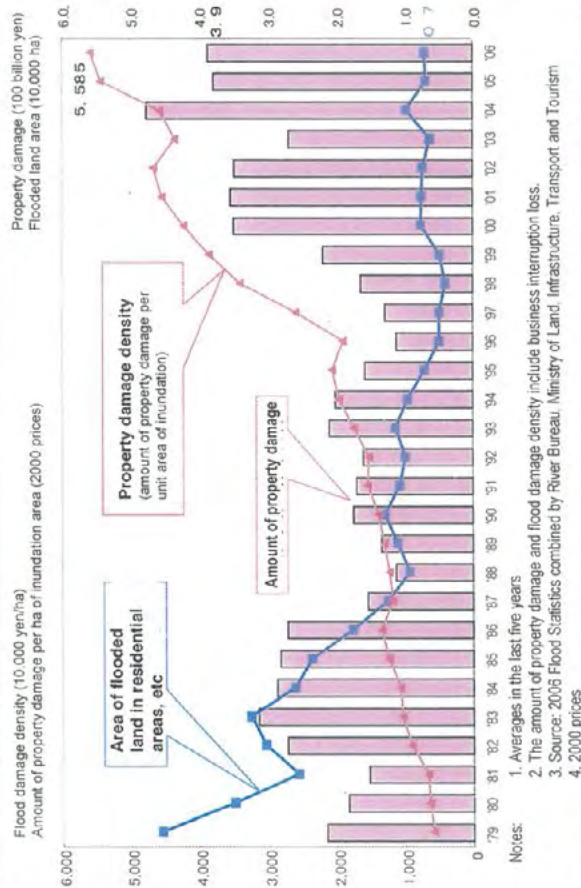
History of river improvement



Characteristics of flood damage in recent years

The area of inundation has decreased, but the amount of flood damage shows an increasing trend.

The amount of flood damage is on the increase.
—Although the area of inundation had been on a **slightly increasing trend in recent years**, mainly because of the urbanization of flood-prone areas and the increase in flood-vulnerable property, **the amount of damage has been showing a tendency to increase**.



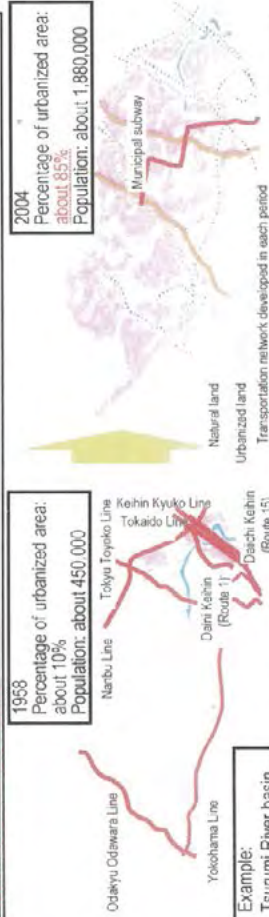
If submerged in water, even if only once, electronic appliances are rendered useless.



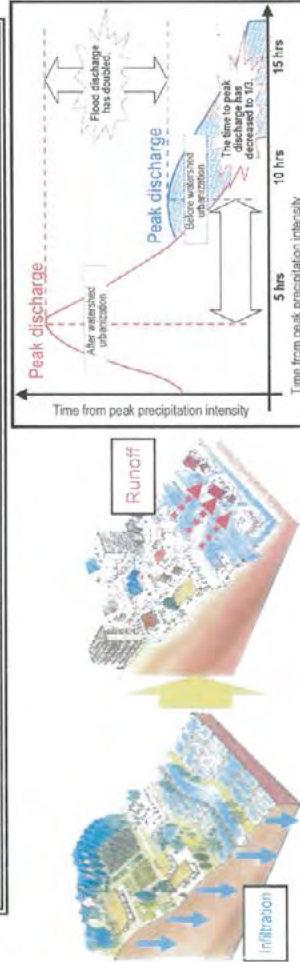
Having absorbed water, insulation materials have become useless.

Watershed urbanization causes flood **risk to increase**.

As a result of railway and arterial road network construction, which began around 1960, watersheds today are crisscrossed with railways and roads. The resultant urbanization has caused the **water retention and detention functions of the watersheds to decline**.



As runoff increases, the time to peak runoff decreases.



Increasingly intensive land use (e.g., subways, underground streets) has given **rise to new types of inundation damage** such as flooding of underground spaces.



Tokyo Metro's Azabu Juban Station (October, 2004)



Fukuoka municipal subway (July, 2003)

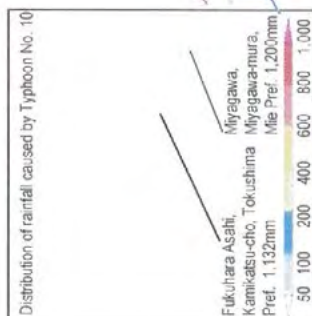
Flood Mitigation in Tokyo, Japan

Consecutive occurrence of major flood and mass-movement disasters

Heavy rainfall events with a total rainfall exceeding 1,000 mm have occurred almost every year mainly in Kyushu, causing flood and mass-movement disasters.

2004

- A record number (10) of typhoons made landfall in Japan (three or more times as many typhoons as in the average year). During Typhoon No. 10 (July to August), hourly rainfalls of more than 100 mm were observed in the Shikoku region. In Tokushima Prefecture, a total rainfall of more than 1,000 mm was recorded.
- The Fuku Heavy Rain (July) caused a levee breach along the Asuwa River. Typhoon No. 23 (October) caused levee breaches and overtopping along the Yura and Maruyama rivers, inflicting tremendous damage in Kyoto, Hyogo and other parts of the Kinki region.
- ◆ Fuku Heavy Rain: 4 people killed, 4,052 houses flooded above floor level, 9,674 houses flooded below floor level, etc
- ◆ Typhoon No. 23: 43 people killed, 13,041 houses flooded above floor level



2006

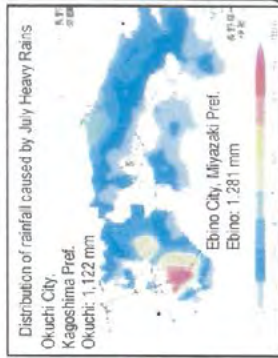
- In parts of the Kyushu region, total rainfalls in seven days from July 18 to July 24 of more than 1,200 mm were recorded. The Sendai and Komenotsu rivers flooded, causing serious damage in southern Kyushu.
- A strong bai-u front in July remained stationary over a large area including the Kyushu and Hokuriku regions, and the heavy rains induced by this front caused floods in many areas.
- ◆ July Heavy Rains: 5 people killed, 899 houses flooded above floor level, 2,674 houses flooded below floor level



Sendai River
(Satsuma-cho, Kagoshima)

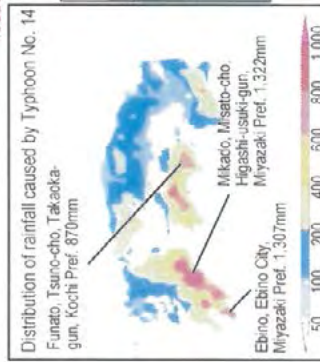


Debris flow in the
Shimodenakama area
(Hishikari-cho, Kagoshima)



2005

- Typhoon No. 14 (Sept. 4 to 5) caused heavy rains with a total rainfall of 1,000 mm or more in southern Kyushu.
- A number of rivers including the Oyodo and Gokase rivers flood, causing serious damage in the Kyushu region.
- In the Chugoku region, the bankful stage was exceeded in the Ota and other rivers.
- ◆ Typhoon No. 14: Kyushu region:
19 people killed, 3 people missing, 3,960 houses flooded above floor level,
5,085 houses flooded below floor level
Chugoku region:
4 people killed, 1,678 houses flooded above floor level, 2,969 houses flooded below floor level



Flooding of the Oyodo River
(Miyazaki City, Miyazaki)



Debris flow in the Kamishiba
area (Shiba-son, Miyazaki)

2007

- Typhoon No. 4 (July 2 to 17) caused a total rainfall of more than 1,000 mm in the Kyushu region. Rainfalls more than two times as much as the monthly average were recorded in many areas.
- The Midori and other rivers flooded to cause tremendous inundation damage in many areas.
- ◆ Typhoon No. 4: 3 people killed, 169 houses flooded above floor level, 1,152 houses flooded below floor level



Flooding of the Midori River
(Kosa-machi, Kumamoto)



Debris flow in the Futagawa area
(Tarumizu City, Kagoshima)

