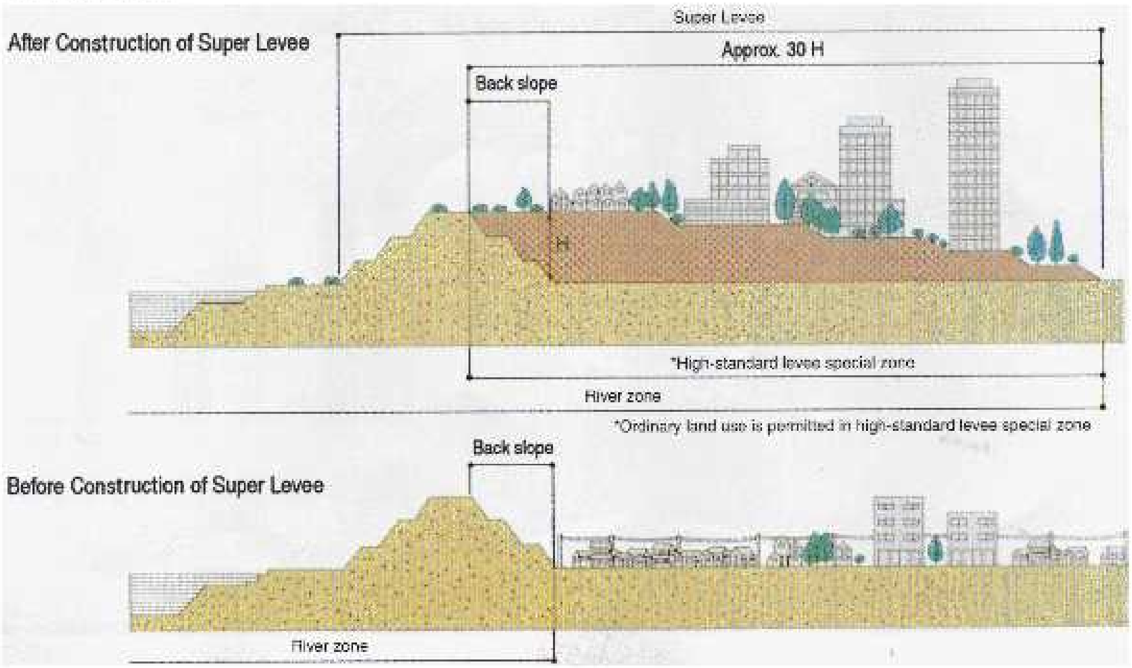
"Super levees" (High-standard levees) are the ultimate defense against a usual flood in alluvial lowlands. Super levees also provide space for a scenic and comfortable living environment.

Even in the event of an extreme flood, damage can be minimized if levees do not break. Levee failure due to overtopping can be prevented by increasing levee width. Super levees are by far wider than conventional levees. A gently sloped Super levees helps to connect the community to the river smoothly. The community side of Super levees can also be used effectively, for example as residential land and parks. Thus, Super levees can make it possible to build a safe and scenic community integrated with the river.

■ **Effect of Super levees**

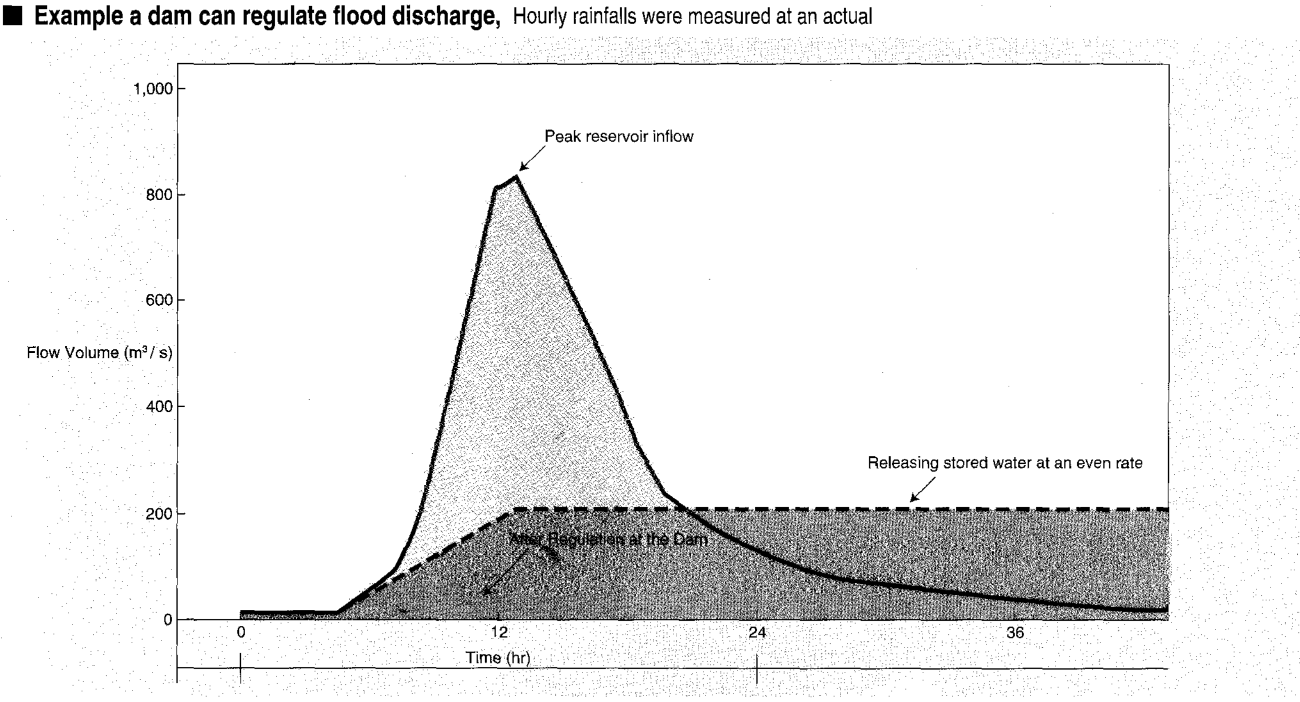


The use of dams for food control

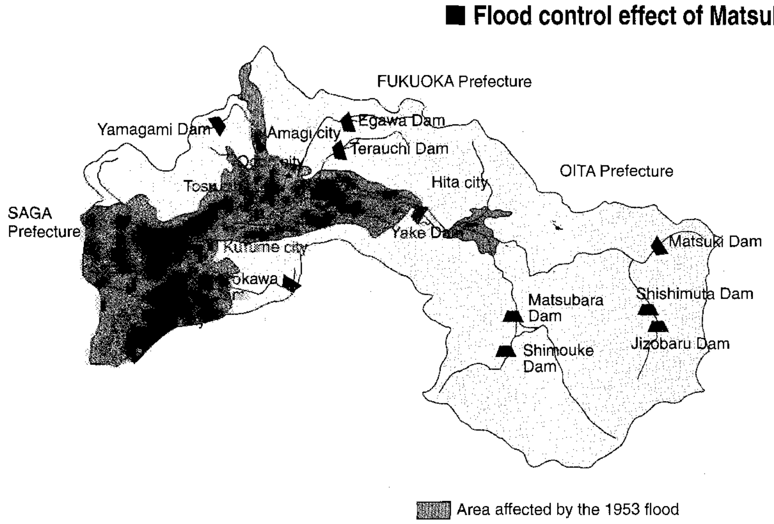
Using a dam to regulate the downstream flood discharge is one of the most effective means of flood damage mitigation.

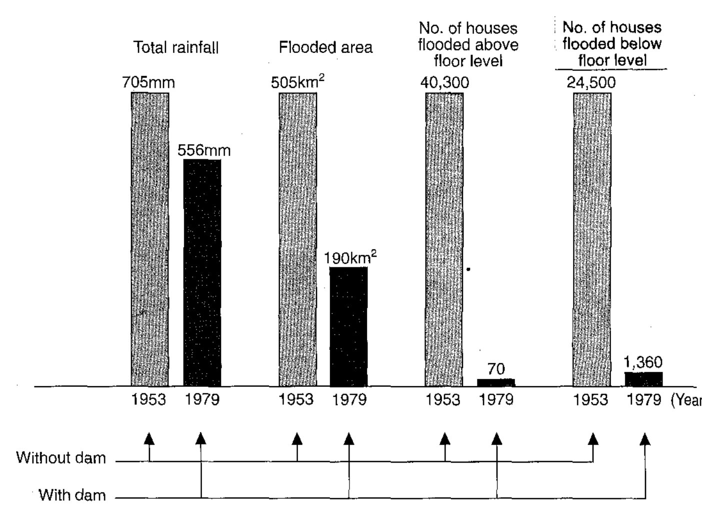
The function of a dam is to regulate the downstream flood discharge by storing storm flood only when flood discharge is high. Thus, dams reduce the peak discharge downstream and prevent a sharp increase in streamflow.

■ **Example a dam can regulate flood discharge,** Hourly rainfalls were measured at an actual



■ **Flood control effect of Matsubara and Shimouke Dams**

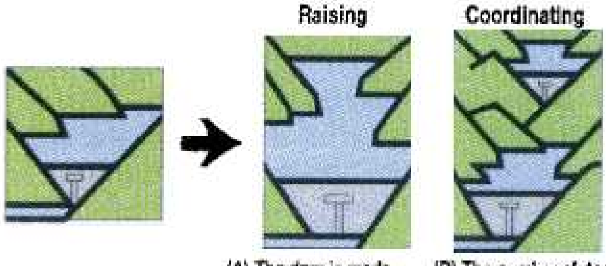




A flood in 1953 caused serious damage in the Chikugo River basin. Thanks to Matsubara and Shimouke dams completed after that flood, the damage caused by a 1979 flood was by far smaller than the 1953 damage.

Raising or coordinating existing dams may be necessary to cope with floods.

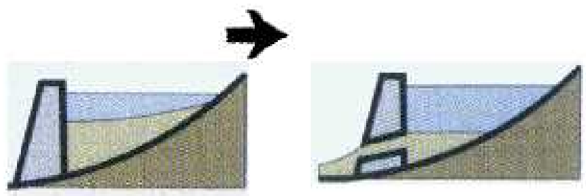
Flood control capacity of a dam can be increased by, for example, removing sediment that has accumulated in the reservoir or increasing the height of the dam. Another method of flood control is to construct another dam upstream and integrate the operation of the two dams. Thus, existing dams can be made more effective by redevelopment.



(A) The dam is made bigger to increase its storage capacity.

(B) The number of dams is increased to increase the flood control capacity

Sediment removal by use of scour pipes



Hiyoshi Dam (Kyoto)

Preventing sediment disaster

Japan is predisposed to sediment disasters.

■ **The summer of 1993 saw an outbreak of disasters throughout the country.**

In 1993 a plethora of natural disasters included the Kushiro-oki Earthquake, the eruption of Mt Unzen's Fugendake, the "blown-over tree disaster", the Hokkaido Nansei-oki Earthquake, and the so-called "August heavy rain disaster " Particularly disastrous were the heavy rains in August (including Typhoon No 13), which, by causing many debris flows and slope failures. left 71 persons dead or missing and 156 injured in Kagoshima prefecture alone. In the city of Kagoshima, about 1,000 houses were damaged, and the national highways and railways were severed at many places

Guarding against debris flows, tsunami-like waves of sediment

Large volumes of sediment moving in the form of debris flow can crush houses and farmlands instantly. In Japan, there are about 80,000 debris flow hazard sites

Huge volumes of debris loosened by the great earthquake of 1858 still remain where they were deposited in the Joganji River basin in Toyama Prefecture If washed out by a heavy rain, sediment thus produced would bury the entire Toyama Plain to a depth of about 2 meters Sediment and erosion control facilities, such as Shiraiwa Check Dam, play an important role in protecting the Toyama Plain from debris flows.

The eruption of Fugendake is still a haunting memory. Volcanically induced flow control is essential in a country where volcanoes account for about 10% of the total land.

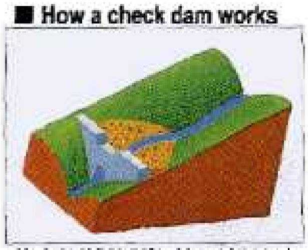
Japan is a volcanically active country. In 1990, Mt. Unzen Fugendake erupted after about 200 years of dormancy and inflicted great damage on the local community Since there are as many as 83 active volcanoes in the country, there is a need for systematic effort to control volcanic flows.

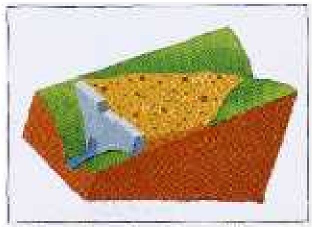
■ **Major sediment disasters and damage they caused**

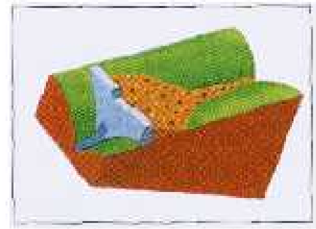
Date	Prefecture	Hard-hit areas	Cause of disaster	Damage: Dead or missing	Damage: House damage
Jul. 1967	Hyogo	Omote Rokko	Severe local rain	92 persons	746 houses
Jul 1967	Hiroshima	Kure city area	Severe local rain	88 persons	289 houses
Jul 1972	Kumamoto	Amakusa area	Severe local rain	115 persons	750 houses
Aug 1975	Aomori	Mt Iwaki	Severe local rain	22 persons	28 houses
Aug. 1975	Kochi	Niyodo River area	Typhoon No 5	68 persons	536 houses
Sep 1976	Kagawa	Shodo Island	Typhoon No. 17	119 persons	2,001 houses
May 1978	Niigata	Myokou-kogen-machi	Snowmelt	13 persons	25 houses
Oct. 1978	Hokkaido	Mt Usu area	Eruption of Mt. Usu flow	3 persons	144 houses
Jul 1982	Nagasaki	Nagasaki city area	Severe local rain	299 persons	19,447 houses
Jul 1983	Shimane	Misumi town/Hamada city area	Rainy season front	107 persons	17,600 houses
Sep 1984	Nagano	Otaki-mura	Naganoken Seibu Earthquake	29 persons	604 houses
Jul 1985	Nagano	Mt. Jitsuki	Severe local rain	26 persons	69 houses
Jul 1990	Kumamoto	Ichinomiya-machi	Rainy season front	11 persons	308 houses
Jun 1991	Nagasaki	Shimabara city	Pyroclastic flow	43 persons	179 houses
Sep 1991	Shizuoka	Shimoda city, etc	Severe local rain	4 persons	29 houses
Apr to Aug 1993	Nagasaki	Shimabara city	Pyroclastic flow	1 person	535 houses*
Jun to Sep 1993	Kagoshima city, etc	Rainy season front	Typhoon No 7 and No 13 Severe local rain, etc	141 persons	1 250 houses**

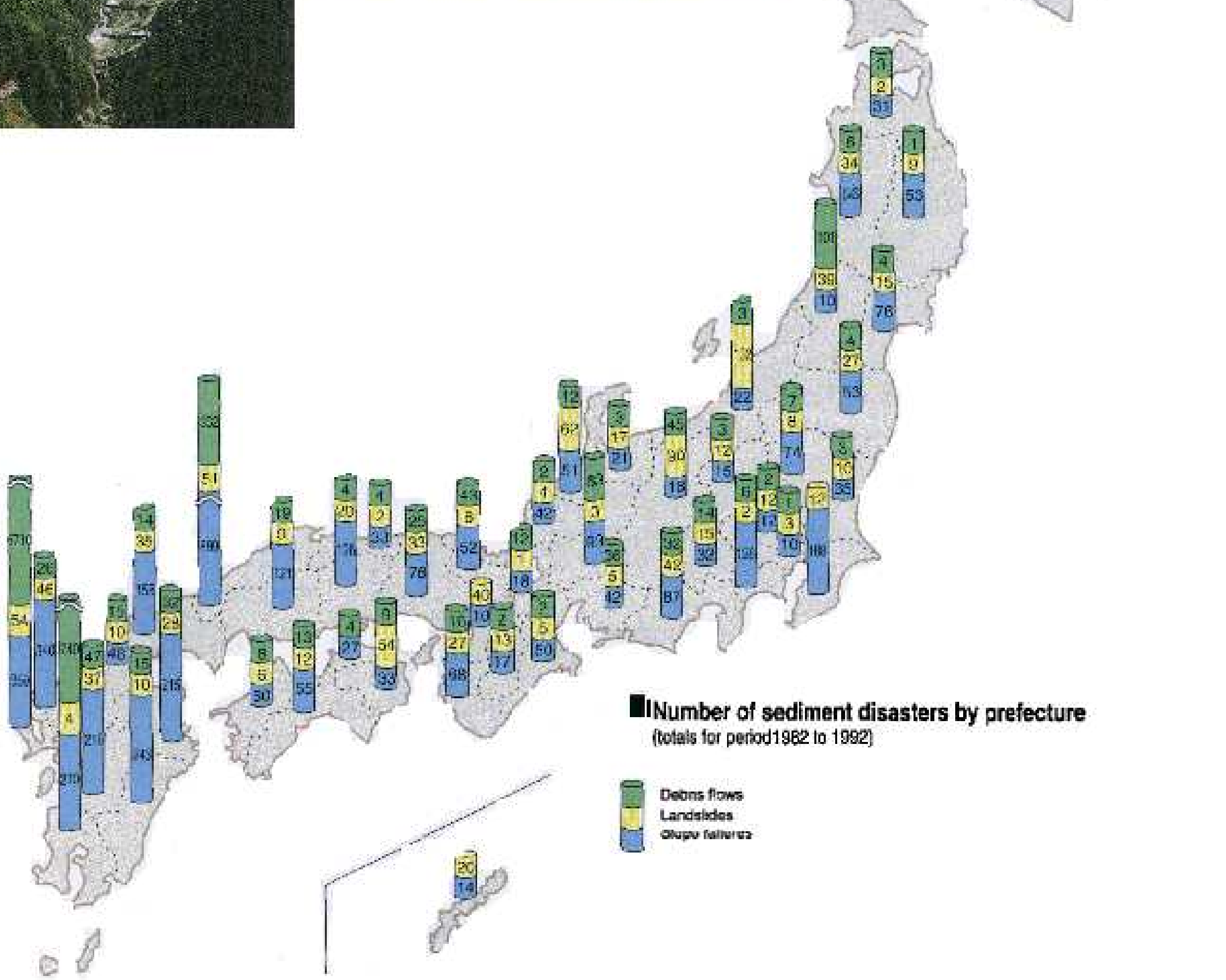
* Total, based on data released by Nagasaki prefectural disaster counter measures headquarters
** Damage caused by Mt. Unzen Fugendake is not included here

How a check dam works


Sediment has not yet been trapped.


Sediment has been trapped to capacity.


Trapped sediment has been gradually carried downstream.

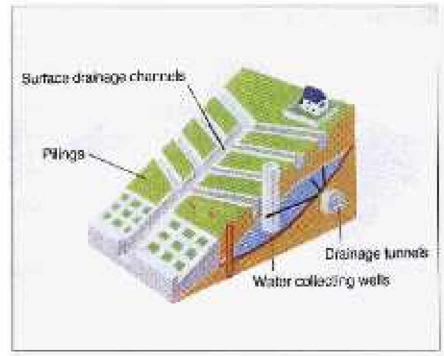


Number of sediment disasters by prefecture

(totals for period1982 to 1992)

Preventing sediment disaster

Heavy soils moving downslope carry houses and farmlands away. Measures must be taken to guard against landslides.

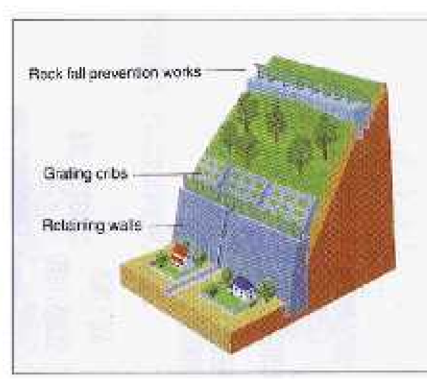


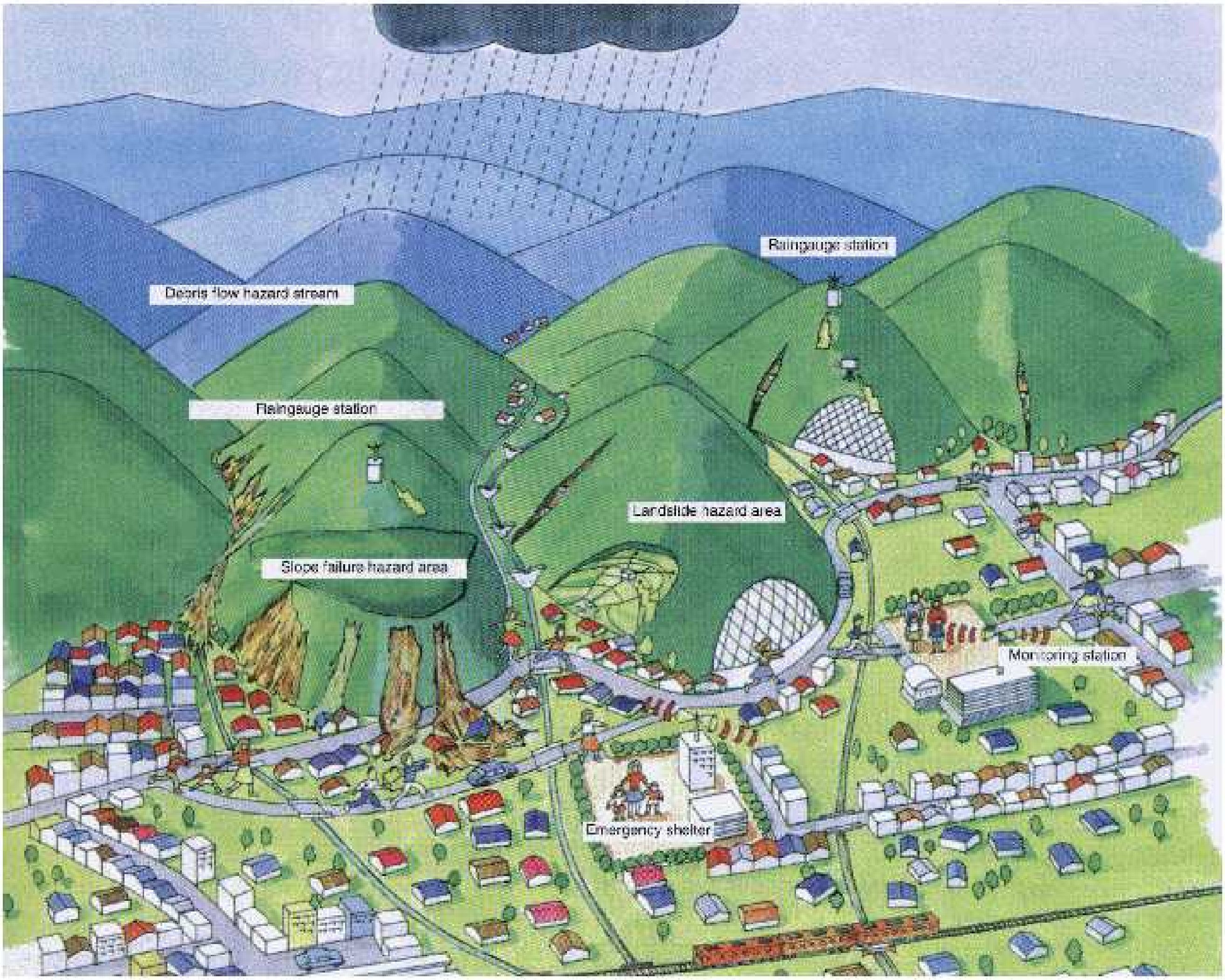
Landslides could be disastrous in that they could not only bury houses, farmlands, railways, or roads, but also cause secondary disasters by damming rivers with sediment. Another characteristic of landslides is that they tend to recur on the same slopes. In Japan, there are more than 10,000 landslide hazard areas

A waterfall-like cascade of soil and rock fragments suddenly tumbles. Safeguard measures must be designed carefully because slope failure often occurs in developed areas.

There are over 80,000 slope failure hazard areas in Japan, and more than 6 million people live in those areas. Mainly because of urbanization, the numbers living in slope failure hazard areas have increased in recent years.

Slope failure occurs very fast, and it often claims more victims than other types of sediment disasters if it occurs in a populated area. It is therefore necessary to design preventive facilities carefully.





Prevention of sediment disasters requires a comprehensive approach encompassing both structural and nonstructural measures.

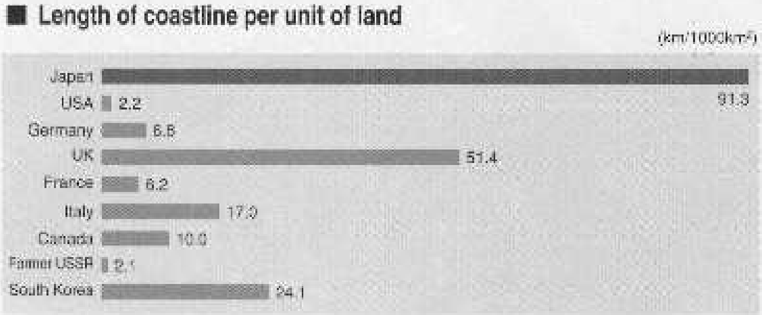
In order to prevent sediment disasters, it is necessary to organize a comprehensive set of measures combining various sediment and erosion control facilities and warning and evacuation systems For example, comprehensive set of preventive measures to safeguard a river basin may include hillside slope rainforcements to prevent sediment runoff from collapsed slopes, inspection dams to control sediment runoff, and channel works to prevent scouring of the river banks and beds with, and may also establish a warning system to detect signs of imminent debris flows

Coastline protection

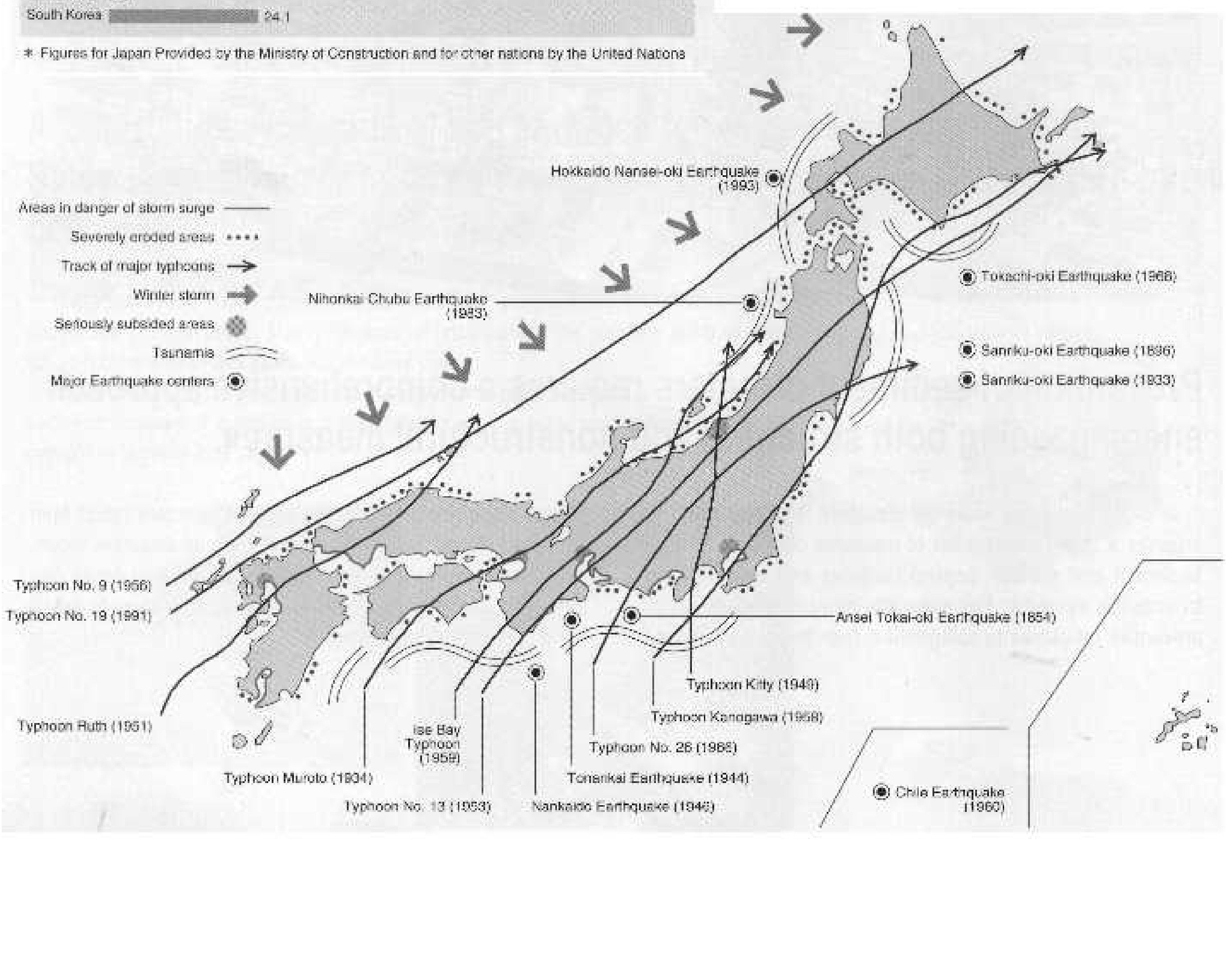
The coastline of Japan is disproportionately long for its land. Severe natural conditions, such as earthquakes, typhoons, and heavy winter waves, make the Japanese coastline all the more vulnerable to natural disasters.

The total length of the Japanese coastline is about 34,500 km. This is approximately equal to the circumference of the earth. Under severe natural conditions including earthquakes, typhoons, and heavy winter waves, the Japanese coastline is very vulnerable to natural disasters, such as tsunami, storm surge, high waves, erosion, and subsidence. Coastal erosion is particular serious throughout the country. About 2,400 hectares of land have been lost in the past 15 years.

■ Length of coastline per unit of land



* Figures for Japan Provided by the Ministry of Construction and for other nations by the United Nations



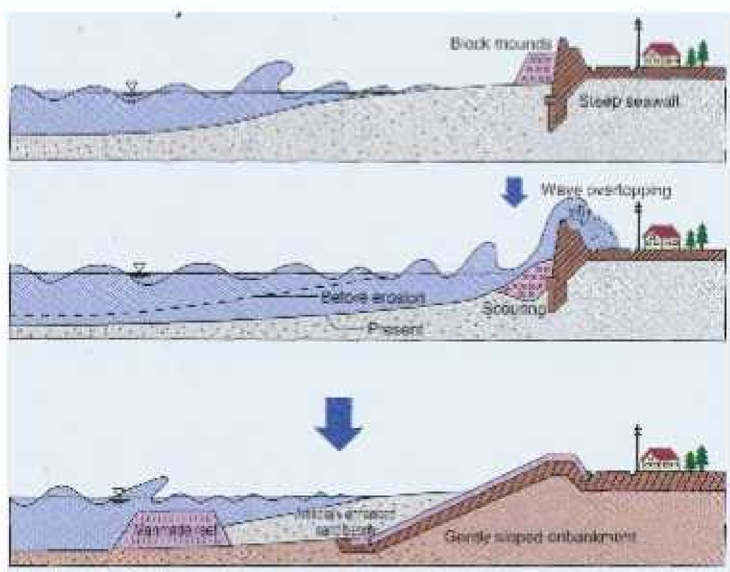
■ **Erosion and accumulated land**
(compiled over about 15 years)

	Eroded area (hectares)	Accumulated area (hectares)
Hokkaido	1,321	631
Aomori	182	94
Akita	153	43
Yamagata	65	43
Iwate	8	9
Miyagi	73	52
Niigata	221	121
Fukushima	85	73
Ibaraki	114	178
Chiba	249	127
Tokyo	36	79
Kanagawa	37	28
Shizuoka	21	43
Toyama	26	16
Ishikawa	38	28
Fukui	100	19
Aichi	40	25
Mie	51	28
Wakayama	13	20
Kyoto	10	12
Osaka	1	17
Hyogo	36	83
Tottori	130	42
Shimane	89	19
Okayama	31	5
Hiroshima	79	3
Yamaguchi	55	10
Ehime pref.	53	24
Kagawa	21	20
Tokushima	28	11
Kochi pref.	78	75
Fukuoka	3	10
Saga pref.	3	1
Nagasaki	134	22
Kumamoto	7	3
Oita pref.	90	8
Miyazaki	95	46
Kagoshima	284	144
National total	4,605	2,210

Promote Integrated Coastal Protection System to prevent disasters considering recreational use and environment.

In various parts of Japan, coastal areas had been protected mainly by steep seawall's and block mounds. However, continuous coastal erosion has resulted in severe damage to these facilities through scouring and wave overtopping. This is why the Integrated Coastal Protection System has been developed. This system is a combination of several measures , such as gently sloped embankments , artificially enhanced sand beaches, and artificial reefs. This not only improves durability against high waves and erosion, but also enhances scenic, and recreational aspects.

■ **From Linear Coastal Protection System to Integrated Coastal Protection System**



Disaster recovery

Emergency response is an important component of flood control measures.

In the event of a disaster, emergency measures are taken to minimize damage and the damaged facilities are restored. Disaster recovery projects can broadly be classified into two groups.

Disaster recovery projects and augmented recovery projects. In disaster recovery projects, the predisaster condition is restored. In augmented recovery projects, which are undertaken when simple restoration is not enough because a similar heavy rainfall event is expected to cause recurrence of a disaster, restoration work out includes unaffected areas, in accordance with permanent measures based on a set plan. Also restoration is carried out taking account of cost performance, and the surrounding environment of the river systems in mind. Disaster recovery is as important as preventive measures.

Seki river (Niigata prefecture)