Coastal Disaster Prevention Works in Japan

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In this paper, we will present the Japanese coastal disaster prevention policy for the 21st century. First of all, we will show the characteristics of Japan's geographic conditions and coastal disasters. The next, we will review the evolution of coastal disaster prevention policy in our country in the last 5 decades. The third, we will discuss some aspects that affect coastal disaster prevention policy in 1990's and explore a new policy in order to meet the new waves; such as an coastal engineering development, an emergence of environmental awareness, and needs for recreational use of shorelines.

Introduction

The total length of Japan's shoreline is approximately 36,000 kilometers including various peninsulas, bays and small islands; half of the country's economic and social activities is done in the coastal area. Where people and industries are concentrated along the coast, they have been suffered severe damages from coastal disasters. An appropriate coastal protection works that protect people and infrastructure from coastal disasters is urgently needed in those days. Japan organized a coastal protection by enacting Coastal Protection Act and allocating a central and local governments' roles. It also introduced long range fiscal plans to implement coastal protection works efficiently in 1970. These efforts made our land safety to some extent last fifty years. However people gradually valued a coastline as an environmental protection, recreational use as well as the economic activity. The purpose of the coastal protection is diversified by these new demands. We introduce environmentally and user-oriented coastal protection

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works as well as technically sound creditable coastal protection works to meet these new waves.

Natural and Geographic Condition of a Japan's Coastline

Japan is prone to several types of coastal disasters such as typhoons in the summer, wind waves in the winter and Tsunamis caused by earthquakes (Takayama,1997). **Figure 1** shows the major coastal disasters which run across our nation. High tides generated by the low pressure of a typhoon have caused floods in under sea level areas such as Tokyo Bay, Osaka Bay and Ise Bay. **Table 1** shows major high tide disasters and **Photograph 1** shows a high tide disaster at Yokosuka, Tokyo Bay 1996. The severe erosion caused by the wind waves is a significant problem in the coastal area that faces the Japan Sea. The disasters erode our national land by about 160 hectares each year.

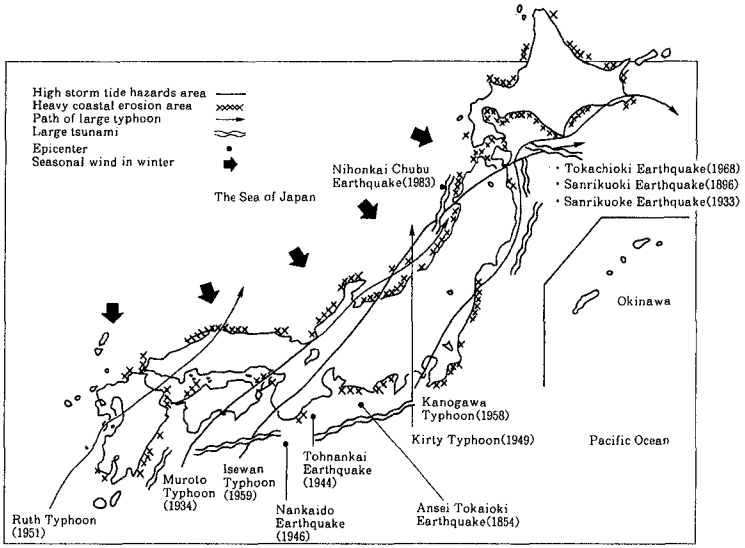


Figure 1 Characteristics of coastal disasters in Japan

Table 1 Major high tide disasters of the last 80 years

Year	Disaster region	High tide (m)	dead or missing	household missing	Typhoon
1917	Tokyo Bay	2.0	1,324	60,175	
1927	Ariake Bay	1.3	439	2,211	
1934	Osaka Bay	2.3	3,036	92,323	Muroto
1942	Suo Nada	1.7	1,158	102,374	
1945	South Kyushu	1.2	3,121	115,984	Makurazaki
1950	Osaka Bay	1.9	534	110,923	Jane
1951	South Kyushu	1.5	943	72,653	Ruth
1959	Ise Bay	2.6	5,098	156,676	Isewan
1961	Osaka Bay	2.2	200	54,782	2nd Muroto
1970	Tosa Bay	2.4	13	4,479	T 10
1985	Ariake Bay	0.8	3	589	T 13
1991	All Japan		62	170,447	T 19

Source: Nihon Kisho Saigai Nenpo (Meteorological Agency)

Photograph 1 A high tide disaster at Yokosuka 1996

Table 2 shows that Tsunamis are also a critical issue in the fjords such as Sanriku and Suruga Bay.

Table 2 Major Tsunami disasters of the last 100 years.

year	name of Tsunami	dead or missing	Residential building destroyed
1896	Meiji-Sanriku quake Tunami	27,123	10,617
1923	Kantou Daishinsai	142,807	702,495
1933	Sanriku quake Tunami	3,008	11,841
1944	Tounankai quake	998	76,139
1946	Nankai quake	1,443	68,006
1952	Tokachioki quake	32	2,230
1960	Chilean quake	139	22,693
1964	Niigata quake	26	92,012
1968	Tokachioki quake	52	19,695
1983	Nihonkai Chubu quake	104	6,359
1993	Hokkaidou Nanseioki	232	3,443

Source: Rika Nenpyou (1996)

Figure 2 indicates that the length of shoreline per land area of island nations such as Japan and the United Kingdom is relatively longer than that of peninsula nations (Korea and Italy) and continental nations (USA, France, Canada and the former USSR).

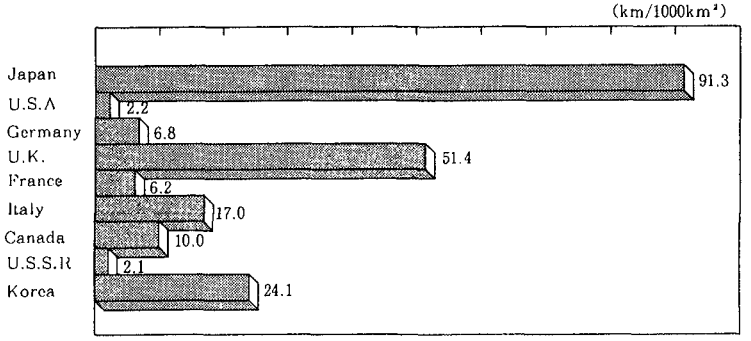


Figure 2 Comparison of coastal length per land area by nation

Figure 3 shows that population and industries are highly concentrated in the coastal municipalities. Nearly a half of nation's population and industries is found in coastal municipalities which occupy one third of the national land.

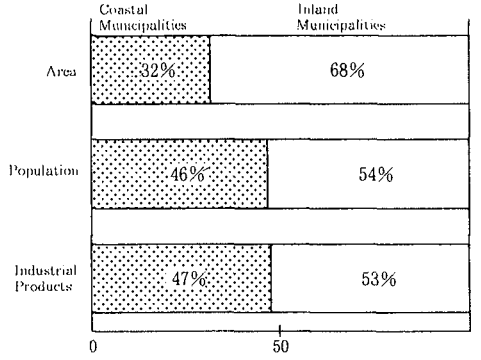


Figure 3 Comparison of coastal municipalities and inland municipalities by area, population and industrial products

The Coastal Protection Act

The protection of national land from the coastal disasters is defined to be a central government role under the Coastal Protection Act. The Act was established in 1956 to prevent coastal disasters which were very common after the W.W.II. Several coastal disasters such as those in the former chapter deteriorated our national land in those days. A coastal protection manager is responsible for coastal protection. Coastal protection is administrated by three competent Ministers depending on land use; Minister of Transport (MOT), Minister of Agriculture, Forestry and Fishery (MAFF), and Minister of Construction (MOC). MOT is in charge of sea ports and harbor areas. MAFF is in charge of agricultural areas and a fishery port areas. MOC is in charge of the rest of the coast. Under the Act, a governor can designate the coastal protection sea and land areas within 50 meters from seashore line by the due process of the law. In addition, a prefecture governor, a head of port authority or a fishery port manager manages a coast as a coastal protection manager. The manager's main task is to create a Coast Protection Facilities Plan and submit it to the Minister. He also has to register the coastal protection area and the coastal protection facilities and release this information to the public. Dredging, development or occupation of the area requires his permission. He collects a fee for all permitted activities. Those who violate the coastal protection ordinance will be fined by him. The central government supports the manager financially; up to half of investment when the manager constructs or renovates a coastal protection facility such as a dike, a jetty, a revetment or a sluice gate in the coast defense area. Each

Minister can construct or renovate the facility by himself when the coastal protection work is especially important for the national land protection when the work costs a lot, requires high technology and machinery power, or expands plural prefectures. The minister also has to show the design code of the coastal protection facility to the coastal protection managers in term of national land safety (Commission of Coastal Protection Facility Design Code ,1987). **Figure 4** shows a flow of construction or renovation of a coastal protection facility.

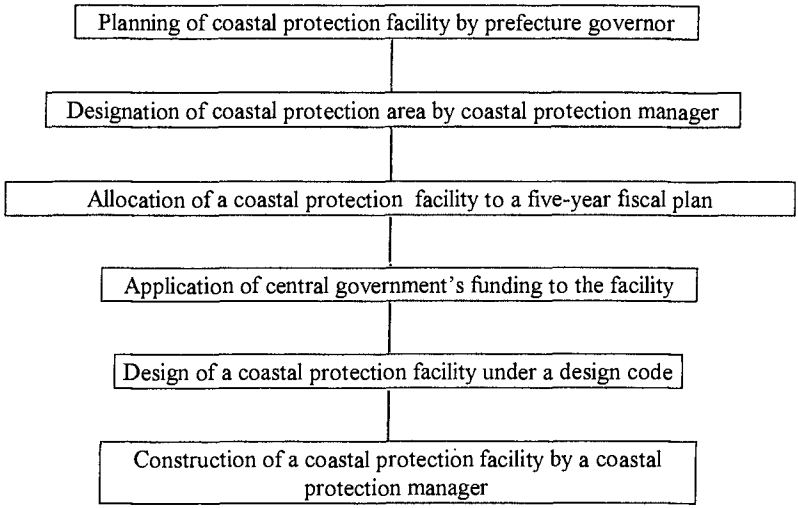


Figure 4 A flow of construction of a coastal protection facility

Evolution of Coastal Protection Work

The Ministers and coastal protection managers were previously not able to perform coastal protection work sufficiently due poor economic conditions. The construction of coastal protection facilities was urgently required in the 50's and the beginning of the 60's. For example, 4,700 people and 150,000 houses were lost by the Ise Bay Typhoon in 1959. The Congress requested the central government to allocate sufficient funds for coastal protection. Hence, the government introduced a long range fiscal plan to implement the annual investment efficiently and effectively in 1970. The aim of the plan is considered to be an administrative purpose to implement the investment efficiently and effectively, rather than legislative obligation of investment. **Table 3** shows a summery of the coastal protection work investment from 1970 to 2002.

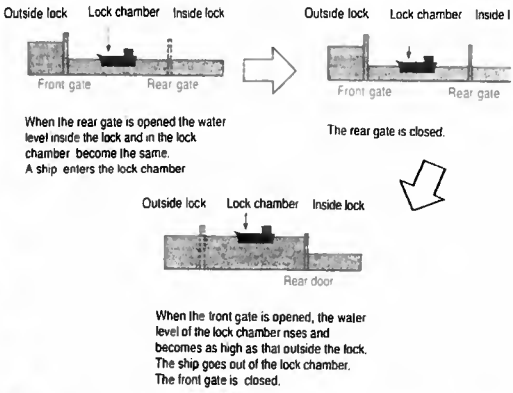
Table 3 A Summary of the Coastal Protection Work Investment

Fiscal plan	1st	2nd	3rd	4th	5th	6th
Fiscal year	1970-74 75	76-80	81-85	86-90	91-95	96-02
Investment	260.4 73.0	561.3	673.8	822.6	1151.4	1340.0

(billions yen)

The Ministers and the managers quickly introduced low cost protection facilities and directed half of the budget to the densely populated and under water areas such as Tokyo bay, Osaka bay and Ise bay. **Figure 5** shows the coastal protection works at under sea level area in Osaka Bay.

Lock Facility on Amagasaki, Nishinomiya and Ashiya Port Coasts



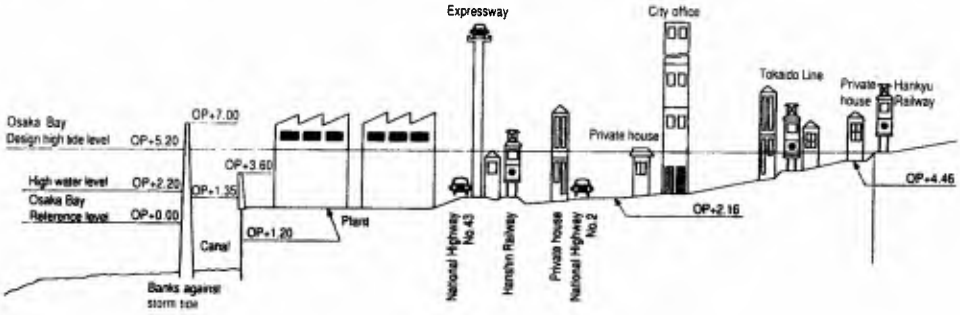


Figure 5 Coastal protection work under sea level area (Osaka Bay)

The damages inflicted by the coastal disasters might be mitigated to some extent with these rapid investments. However these facilities need high cost maintenance or even replacement since they deteriorated easily by tidal fluctuations and wave forces. The high crowns of the embankment and revetment have also prevented people from seeing water and accessing the beach, and the numbers of concrete blocks has messed up the seashore landscape. Furthermore, In the 70's environment protection movement became very popular. In the 80's people gradually conceived an especial value of the coastal zone such as recreational activities, richness of wildlife, amelioration of polluted water, and so on. The growing awareness of the importance of environment has influenced coastal protection policy (Coastal Protection Study Group,1995).

The 6th Seven-year Fiscal Plan For the 21st Century

The Cabinet established the 6th five-year fiscal plan with 1300 billion Yen (U.S. $10.8 billion when U.S. $1.00=120 Yen) in 1996. The coastal protection managers designated the 16,000 kilometer coastal protection area within the total 35,000 kilometer Japan's shoreline. According to a current study, 11 million people are living along the coastal protection area or behind it. However only 41% of the 16,000 kilometer coastal protection area is protected by the coastal protection facilities. More than 3.5 million people still live in fear of floods. **Table 4** shows that the range of protected area rate would be expected to increase to 48% in the 2000 years under the new fiscal plan.

Table 4 Coastal Protection Plan

	Present (1996)	**Seven-year plan (2002)**	**Final (2010)**
Defense Length (total 16,000 km)	**41 %**	**48%**	**70%**
Defense Population (total 11millions people)	**7.5 millions**	**8.8 millions**	**11 millions**
Defense Area (total 430 thousands ha)	**210,000 ha**	**260,000 ha**	**350,000 ha**
Erosion speed (present 160ha/year)	**160 ha/year**	**140 ha/year**	**+/- 0**
Length of Seismic Reinforcement (total 400km)	**-**	**200 km**	**400 km**
Integrated coastal protection configuration	**1,100 km**	**1,600 km**	**3,000 km**

The plan also has two goals; first, the ministries will speed up their coastal protection works and construct technically sound creditable coastal protection facilities. Next, the ministries will not only maintain the environmental standards but also promote the coastal wildlife preservation and user-oriented coast.

Technically Sound Creditable Coastal Protection Facilities

In order to produce a safe coast, the ministries are preparing three methods of defending the coast. The first method is to introduce an integrated coastal protection configuration consisting of offshore banks, beach fills, and gentle slope revetments. **Figure 6** shows that the configuration can weaken even the extraordinary strong wave forces with these serial facilities while an ordinary revetment is prone to suffer critical functional damage (Katoh,1994). Furthermore the configuration can expect town's local high amenity and the beach access.

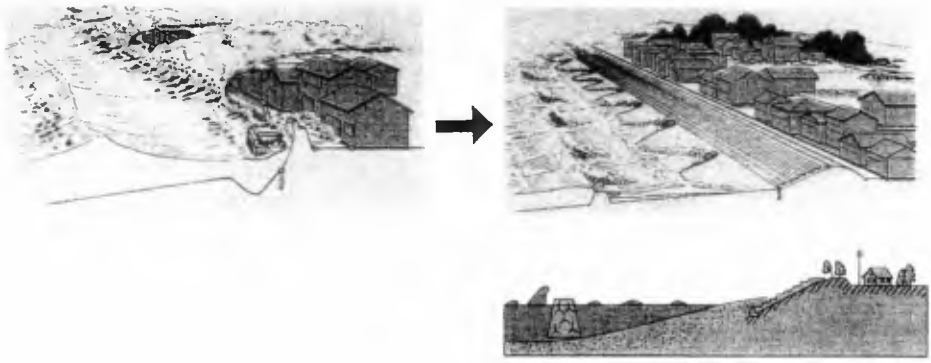
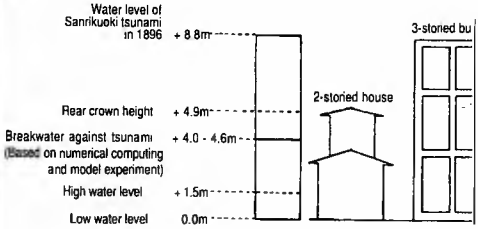


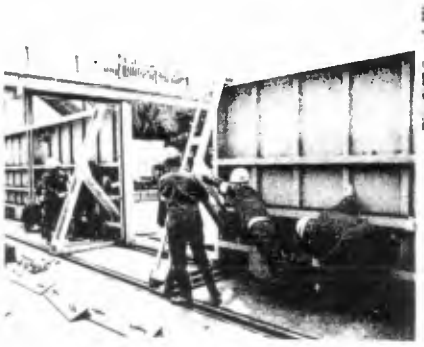
Figure 6 An integrated coastal protection configuration

The second method is to appropriate countermeasure against aearthquake. MOT checked all the facilities after Hanshin-Awaji earthquake which took place in January 1995. It found that some facilities constructed in the 60's had not been applied the seismic code properly. The code established in the 60's also needed to be revised. According to Ministers' investigation, at least 400 kilometer-length facility requires seismic reinforcement. Tsunamis also generated by earthquakes and caused severe damage on a densely populated fjord area. **Photograph 2** shows a breakwater would keep a harbor calm and break tsunami energy out. A coastal protection manager cooperates with a port authority to construct a breakwater in the fjord area.



Photograph 2 A breakwater which has both function of defending a tsunami and of keeping the harbor calm (Kamaishi Port, Sanriku Region)

Finally, an automatic gate draw system and integrated disaster information system are introduced. There are many water/ land gate in a coastal protection area. It requires a huge labor and time to open/shut the gate. **Photographs 3** shows that the system network between an inland control room and gates. The control room monitors the area for earthquakes, tsunamis and high tide information 24 hours in a day and operates the gates by a remote control. The system enables a quick response to the unpredictable tsunamis and free from manual labor on operating a gate.



A manual work on opening a gate
(Port of Nagoya)

An automated gate draw system
(Port of Tokyo)

Photographs 3 An automated gate draw system and integrated information system

Environmentally Oriented and User Oriented Coastal Protection Works

The coastal protection manager is obliged to keeps his balance between coastal protection and coastal environment preservation owing to increase of environmental awareness. He is going to manage it by managing these conflicts rather than choosing either of them. A coast has rich but vulnerable wildlife resources. Environmentally oriented facilities such as an artificial reef, a tide pool, plantation and a beach should be considered when a coastal protection facility is designed and constructed on a coast. The facility has less impact to the coastal ecology than that we used to or ameliorate coastal environment. The artificial reef can cultivate sea weed and fish habitation. The tide pool also can keep water clean or bring rich oxygen into the water. The plantation can produce woods and supply a good atmosphere in the coast. The wild-life oriented beach can also become a sanctuary for endangered species such as red-turtles and

horseshoe crabs. **Photograph 4** shows that an artificial beach is also one of the best amenities to attract people to a coast. The purpose of beach replenishment is to defend a coast from disasters as well as to produce a recreational area where people can enjoy marine activities, bathing and sightseeing. The construction of pedestrian parkways, benches, trees as well as barrier-free facilities would enable elderly and handicapped persons to approach the coast easily.

Photograph 4 An artificial beach and bathing (Port of Utsumi, Ise Bay)

CONCLUSION

All the public work including coastal protection work is strictly required its efficiency and productivity in our country owing to the nation's fiscal deficit right now. We reviewed our coastal protection's institution and showed our policy for the next decade. We always question to ourselves; what the people expect on coastal protection work? is it worth to invest on an artificial beach instead of an reinforced concrete revetment under the tight budget condition? whether a central government or local government should have a responsibility on coastal protection? and who should fund coastal protection work ? . It will be great pleasure for us to exchange information on this matter over the world.

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