B-10 (5) Risk Prediction for Coastal Area and Goal Setting for Protection Options

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Abstract Sea level rise due to global warming will bring sever impact of inundation, salt intrusion, erosion or other disasters to the coastal low lands. Japanese coast was selected for a case of the impact to highly protected coastal area. Lowlands at river mouths in Asia and a coral island in Pacific Ocean were also selected for the vulnerability study on developing coasts under Asian monsoon climate.

Key Words Coastal Vulnerability, Risk, Asian Coast, Islands, Low Land

1.Introduction

Sea level rise(SLR) due to global warming will bring sever impact of inundation, salt intrusion, erosion or other disasters to the coastal low lands. World Vulnerability Assessment by Delft Hydraulics indicated that one of the most vulnerable areas is south and south-eastern Asia. Considering the discussions at the IPCC Eastern Hemisphere Workshop on Sea Level Rise and Coastal Vulnerability at Tsukuba in August,1993, we conducted vulnerability research for Asian coasts and Pacific Coral Islands. At the same time, highly utilized coasts like Japanese one will also have their own weakness to SLR. 'Protection' is an inevitable option there. Vulnerability and impact assessment for the protection system is also tried.

2.Vulnerability for protection systems in Japan

Coastal distribution of the area-at-risk and population-at-risk due to SLR was estimated over the nationwide. As cities are developed and population accumulated along inner bays and inland sea, impact is estimated larger for inner bay coasts than coasts along outer sea. Especially, on flat lands facing to the three biggest inner bays (ie. Kantoh Flat on Tokyo Bay, Noubi Flat on Ise Bay and Osaka Flat on Osaka Bay), both are- and pupulation-at-risk increase drastically after SLR. These coasts are protected at present by hard facilities like seawalls and drainage systems.

For the disaster prevention system along inner bays, the most critical event for designing protection facilities such as seawalls and pumping stations is often the high surge due to typhoon attacks. Numerical experiments were conducted to estimate the effects of SLR and climatic changes on the maximum water level in inner bays by typhoon attacks. Effects on the drainage capacity of pumping stations were also examined by the hydraulic calculations based on both SLR and the rain fall provided by a typhoon.

For high surge, maximum water level after SLR is expected as the static sum of the high surge magnitude at present and SLR, if the typhoon magnitude and the pressure depth remain the same. Effect of the magnitude and pressure

depth is significantly larger than that of the SLR itself. Increase of magnitude and pressure depth by 10%, sometimes/at some places, makes double the amplitude of maximum water level above L.W.L.

For drainage capacity, a pumping station with larger inner water surface comparing to the catchment area (area ratio: 1%) is estimated to be effected very small by the SLR. But, a pumping station with narrow inner water surface (area ratio: 0.1%) is strongly effected by the hydraulic-head increase due to SLR in the outer sea. Maximum water level in inner water increase rapidly by precipitation in the catchment area. Increase of the strength of rain fall by 10%, or shortening of the flushing time by urbanization, gives drastically larger impact on inner water level than that of SLR. Proper management of water circulation in the urban area and wise use of the inner water surface seem important for the redundancy against coastal inundation.

Accordingly, protection facilities such as seawalls and pumping stations will decrease in their protection function by SLR. But, effects on the function will be more severe by the changes of extreme climate (typhoon magnitude and strength) and urbanization than SLR itself.

For the coastal disaster prevention facility like breakwaters and revetment, change of the failure probability or the safety factor was examined. Small facility at shallower water was found more sensitive to SLR than large facility at deeper area. For the natural morphology along the outer coast, the area of erosion of sandy beach was estimated by modified Bruun Rule. After 30cm SLR, the estimated are of erosion would be 120km2, which is around 60% of the present total sandy beach and is equivalent to the area disappeared by erosion in the past 70 years.

For Hard Protection, raise of the crown height will be most economy counter measures so long as the magnitude of SLR is limited. But safety is not the only one requirement by the society to the coast. We could find various combinations of facilities for maintaining good cooperation with coastal environment and amenity as well as safety improvement.

3.Vulnerability for Asian Coast

Judging from the geomorphology data, large coastal impact was expected in Bangladesh, Cambodia, Vietnam, and Papua New Guinea. But, land use is widely varied from paddy fields with high population density to natural rain forests. Though similar geomorphological vulnerability is expected for Bangladesh and Papua New Guinea, socioeconomic impacts are quite different between them.

Impact for the river delta lowlands was studied from the view points of water surface level and sediment deposition. Chaopuraya River in Thailand and Pearl River in Southern China were chosen for our research. Water level of the large river with slow bedslope was related statistically with strength of precipitation. Sediment deposition area was found to move upward in the river as sea level increases. Climatic change may amplify the water level rise in large rivers not only by SLR itself but by sedimentation on the river bed and increased precipitation.

Tongatapu Island is selected as a case of the vulnerability study for coral islands. This island usually receives a few cyclone attacks in February and March. Coral leaf and coral pond protect high waves. Morphological sounding shows that coral community has as high capacity of growth as it can catch up with the SLR, if the surrounding environment remains appropriate. So, at

first, neglecting the change of wave height/wave force due to SLR, we tried to estimate the increase of are- and population-at-risk after SLR. The Cyclone 'Isaac' (1982) was chosen for the reference. High surge of 2.8m was made by this cyclone, and inundated 23km2 along the coast on this island. With the cyclone attack after 1m of SLR, area-at-risk and population-at-risk are estimated as 40km2 and 30,000pop.(based on 1986 census), respectively. These are almost 15% of total area and 50% of total population in the island.

In this island, population pressure to the coast becomes sever recently. Residential area is extending toward the coral pond and urbanizing rapidly. This type of social change might strengthen the vulnerability against the fluctuation of the climate.

4.Conclusions

We conducted vulnerability research for Asian coasts and Pacific Coral Islands. Vulnerability and impact assessment for the hard protection system is also tried for Japanese coasts as an example.

Impact of Typhoons and Cyclones would be amplified by the SLR and Climate Change. Social and economic change due to urbanization and population increase might strengthen the impact along coasts. On the other hand, SLR changes the pattern of water and soil supply in the delta through the hydraulic change of the river flow and mud transport. This change would enforce community to alter agricultural production and village life.

Risk of disaster, especially risk of coastal inundation, would increased in magnitude by SLR/Climate Change along the inner bay and inland sea of Japan. Among various protection system, small facilities at shallower sea are expected more vulnerable. Climate Change as well as urbanization might provide sever impact to the coastal low lands. Comprehensive countermeasure is necessary to be discussed.

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Detailed data and discussions on the coastal vulnerability reserch can be seen in the "Data Book of Sea-Level Rise" issued by CGER, NIES (address: 16-2, Onogawa, Tsukuba, Ibaraki, 305 JAPAN). Please refer the last reference book in the list below.

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