No.B-10.4.1 Study on Impact Evaluation Technique and Vulnerability Assessment to Japan, South-Eastern Asia, and Coral Islands

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Abstract To clarify the response of coastal disaster-prevention systems against sea level rise, we have carried out the research containing two objectives with different approaches. One is the analysis on "chains of affecting path" of the impact. Quantitative trace was applied along the paths. The other is the research on impact evaluation techniques and ideas which will be accumulated through vulnerability assessment case studies for Japanese coast, Chinese coast and Tongatapu Island. Vulnerability assessment was conducted under the IPCC common methodology.

Key Words sea level rise, vulnerability assessment, coastal zone, South-Eastern Asia, Coral Islands

1.Research Objective

Various natural forces which affect on the coastal areas will be changed due to the global warming. Human life, assets and socio-economic activities in coastal lowlands are protected by the disaster-prevention systems and facilities. Response of the disaster-prevention systems on the sea level rise and climatic changes was studied.

Vulnerability assessment under IPCC common methodology was also conducted for the coast of Japan, Tenjin City in China and Tongatapu Island in Kingdom of Tonga. This assessment can evaluate the magnitude of the potential effect of sea level rise along coasts and the values necessary to protect.

2.Research Method for Facility Response

Sea level rise and climatic change will first alter the coastal natural forces such as wind waves, tides, storm surges and other physical phenomena. These forces will change their magnitude or characteristics as they approach to the shallow coast due to hydraulic shoaling effects. Then, at coastal area, these modified forces affects the coastal facilities. The dose-response chains are arranged in event-tree diagrams. Tracing the chain in the event-tree map, we can understand the diversion of sea level rise. As shoaling processes can be described quantitatively by formula or design figures, then we can estimate the effect of the sea level rise on the coastal facilities numerically with assigning sea level rise scenario.

3.Result for Facility Response

Drainage system and other facilities were chosen for effect estimation

due to sea level rise. Assigning the graphical configuration, rainfall, storm surge, pump capacity, inner water-surface capacity and other necessary conditions, we calculated the change of the inner water level with sea level scenario. After comparing some model calculations, we found that the drainage system with less marginal capacity easily responds the changes of the outer conditions including sea level rise. We can call these system vulnerable. marginal capacity for drainage systems is controlled by such geographic parameters as the catchment area/inner water surface area ratio as well as the system magnitude itself.

4.Research Method for Vulnerability assessment of Coasts

Comparing the coastal land level and sea level, we can estimate the area at risk for inundation. For coastal inundation, sea level for spring high water level and storm surge were considered. Several sea level rise scenario were assigned. Population at risk and assets at risk were also estimated by the overlaying the coastal map with land use data and population distribution data. Remote sensing technique is very useful for land use analysis. Geographical Information System (GIS) is a very powerful means for map overlaying.

5.Result of Vulnerability assessment

Result for the Tongatapu Island is shown as Table-1. In the table, 'values at loss' expresses the values inundated at spring high tide, where 'value at risk' shows the values inundated at storm serge attack with spring high tide. After the sea level rise of 1m, affected population increases in number and almost half of the total population will exposed to the risk of inundation.

Table-1 Values at loss and at risk at Tongatapu Island for sea level rise

Impact categories	Present Situation (0.0m)	SLR 1 (0.3m)	SLR 2 (1.0m)
1. Values at loss			
- Land area (km2)	0	3.1(1.3%)	10.3(3.9%)
- Residence area (km2)	0	0.7	2.2
- Population to be affected	0	2,700(4.7%)	9,000(14.2%)
2. Value at risk			
- Land area (km2)	23.3(8.8%)	27.9(10.6%)	37.3(14.1%)
- Residence area (km2)	4.9	5.9	7.6
- Population to be affected	19,880(31.3%)	23,470(37.0%)	29,560(46.6%)

* Percentages of affected areas and populations are based on the total values of the Tongatapu Island.

6.Discussions

Two types of approach was applied for evaluating the coastal vulnerability. For the coasts in developing countries, special consideration for the lack of geographic information or social statistic data should be paid. For the coastline with some protection, combination of the two approach is required.

references

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