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Climate Change Adaptation through Storm Surge Protection: A Case Study in Osaka Bay

〇Yuedi Zhou

Global climate change has already had observable effects on the environment. As the global temperature will continue to rise for hundreds, the land temperatures are also increasing, accompany with the stronger typhoon, which leads to much considerable storm surge risk, especially in Japan. The temperature in Japan is about to rise from 3.4 to 5.4 till 2100 centigrade, according to the Japan Meteorological Agency. The inundation loss in Osaka Bay with current structural facilities protection will achieve more than 1600 billion Japanese yen at the end of the century.

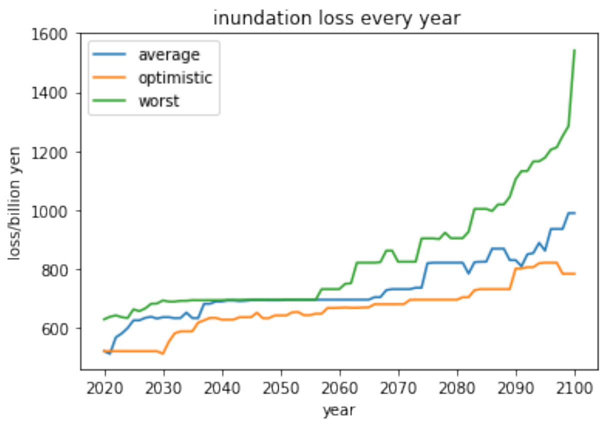

Figure. Inundation loss per year in Osaka bay with current facilities protection.

Several policy makings of facilities adjustment have been designed and assured to be implemented by the government. In Osaka Bay, the seawall adjustment will include the elevation of the seawall, L1/L2 seismic retrofit and strengthening measures. The three main river gates will be reconstructed with a roller gate design instead of the old visor format. However, the structural measures to protect the coastal area so far in Osaka bay are lacked combination with the latest simulation and adjustment in an extended period. It is necessary to figure out how the decision could influence the current state and how the new adjusted facilities could play the desired role for the coming decades.

Aiming at protecting the lives and properties, this paper proposes a methodology based on the Markov Decision Process to find long-term alongshore solutions under the limited government budget in Osaka Bay. Firstly, this research could help identify the relation between the storm surge loss and temperature, gives an explicit risk estimation based on various temperature states. Based on the assumption with temperature and typhoon central pressure and the simulation results between central typhoon pressure and storm surge impact, we could derive a direct impression on how the influence gets worst intuitively. Secondly, as reflected in the adjustment with the height of the seawall and river gate, the methodology includes all the possible assemble of height modification at a particular time point in the upcoming years. The comparison of the differences could derive the optimal adaptive strategies assemble to achieve the minimum cost, including expected loss from storm surge inundation and construction cost. By applicating the simulation in the RCP 8.5 scenario, the results of seawall adjustment show that the inundation loss could be reduced at most by elevating two meters. The river gate has also been proved that the MDP model could lead to the optimal results achieving the minimum cost.

The methodology applied in climate change adaptation introduces a new perspective to evaluate the efficiency of specific measures and could be improved by including more strategies not limited in the seawall and river gate. The combination of the MDP model with future storm surge and inundation simulation could strengthen the severe impacts caused by climate change, play the role of reference with policy-makings, and promote implementation for the government in the long run.