Environmental Assessment and Flood Control in the Can Gio Bay Area located in the Lower Saigon River using Numerical Simulation Models in Context of Climate Change

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（数値シミュレーションモデルを用いたサイゴン川下流域カンジオ湾の気候変動に伴う環境評価と洪水制御）

区　　分　：甲

論 文 内 容 の 要 旨

Currently, climate change is a serious issue all over the world. Especially, the Ho Chi Minh City (HCMC) is listed as one of top ten cities which will be strongly impacted by the sea level rise (SLR) resulting from the climate change. To protect the HCMC from the inundation problem, in the year 2010, the Vietnamese Government proposed the project of super sea dike with an idea to construct a sea dike in the Can Gio Bay located at the Saigon River mouth. In the project, two types of sea dike connecting the Go Cong to the Vung Tau (GCVT) and the Go Cong to the Can Gio (GCCG) were proposed to make all or a half of the Can Gio Bay a closed sea area respectively. The project is now considered to be one of probable solutions to protect the whole of the upstream HCMC area. The sea dike has a gate through which the tidal exchange occurs, however, the tidal exchange would be small and the sea dike construction together with the SLR would make a severe impact on the hydrodynamic regime and the salinity regime in the Can Gio Bay, which is considered as "Green-Lung of the HCMC" with wide mangrove forest that is respected as one of the most beautiful mangrove forests in the Southeast Asia. Assessing the impact of the SLR and the sea dike construction in the Can Gio Bay must be vital for the sustainable development of the Can Gio Bay area and the mangrove forest.

In this study, the influence of the SLR and the sea dike construction to the hydrodynamic regime and the salinity regime in the Can Gio Bay was assessed by numerical simulations based on the scenario analyses, and the impact of the SLR and the sea dike construction on the Can Gio Bay was evaluated to determine which sea dike type was suitable for both reducing the inundation in the Can Gio Bay and preserving the mangrove forest. The scenarios were set up based on the predicted SLRs in the years 2050 and 2100, two types of sea dike of the GCVT and the GCCG, three types of operating modes for the sea dike gate, and their combinations.

A horizontal two-dimensional hydrodynamic model coupled with a convective-dispersive model that combined the wetting-and-drying scheme for determining tidal flats was firstly constructed. The validation of the model was carried out by comparing the calculated results with the observed data of the water level variation, the inundated area in an actual flood event and the spatial-temporal salinity distributions that were obtained in the Can Gio Bay. The validated results showed the satisfactory performance and usefulness of constructed model for conducting scenario analyses to evaluate the impact of the SLR and the sea dike construction.

Then the influence of the SLR and the sea dike construction to the hydrodynamic regime including the inundation situation in the Can Gio Bay was evaluated by the scenario analyses using the hydrodynamic model. The scenario analyses were conducted in the period from October 20th to 30th, 2000 when a historical flood event has occurred in the HCMC. The results obtained from 27 scenarios demonstrated that the tide and the river inflow discharge from the upstream were the primary factors affecting the inundation of the Can Gio Bay. It was also shown that the sea dikes could effectively control flooding and water levels in the Can Gio Bay as well as in the central HCMC. The GCVT sea dike created two distinct areas, a closed sea area of inner Can Gio Bay which functioned as a regulating reservoir, and an open sea area of outer Can Gio Bay. The GCVT sea dike controlled water levels and reduced the inundated area better than the GCCG sea dike. The GCVT sea dike together with the operation of the gate was proved to be more effective in reducing the inundated area. However, the effectiveness of the sea dikes in reducing the water level and the inundated area came down under the 100-cm SLR in 2100, indicating that, regardless of the sea dike and the gate operation, the ability in reducing the inundated area drastically decreased in the SLR, because of the flat low-lying topography with an elevation of 1.4 m – 2.0 m in the Can Gio Bay.

Next the numerical simulations using 9 scenarios were carried out by the hydrodynamic model coupled with the convective-dispersive model to assess the impact of the SLR and the sea dike construction on the salinity regime in the Can Gio Bay and the mangrove forest. The scenario analyses were conducted in the period from November 1st to December 30th, 2017 when the field observation has been conducted in the Can Gio Bay. The results of the scenario analyses showed that the salinity in whole Can Gio Bay in the SLR scenarios markedly increased and the amplitudes of salinity oscillation decreased, because the effect of river inflow discharge became to be relatively weak comparing the tidal regime. The spatial-temporal distributions of salinity drastically changed with the layouts of the GCVT and the GCCG sea dikes, resulting in the increase or the decrease of overall salinity level in each river that formed the complicated river network in the Can Gio mangrove forest. In the case of the GCCG sea dike that divided the Can Gio Bay into a closed water area and an open sea area, the salinity tended to decrease in the closed water area and increase in the open sea area. On the other hand, the GCVT sea dike, which created two distinct areas of a closed sea area of inner Can Gio Bay and an open sea area of outer Can Gio Bay, had more noticeable change in reducing the salinity in the inner Can Gio Bay than the GCCG sea dike. The GCVT sea dike would give a strong negative impact on the Can Gio mangrove forest because the most of mangrove species thrive with higher salinity levels.

In this study, the influence of the SLR and the sea dike construction to the hydrodynamic regime and the salinity regime in the Can Gio Bay was comprehensively evaluated by numerical simulations based on the setup scenarios. The findings obtained in this study has the key contribution to the sustainable development of the Can Gio Bay and the mangrove forest.