THE STUDY OF THE EFFECT OF VEGETATION ON STORM WAVE BASED ON NUMERICAL MODELING APPROACH: PABUK STORM SURGE CASE STUDY

Chatuphorn Somphong, Kasetsart University, chatuphorn.s@ku.th
Napat Silapasuwan, Kasetsart University,napat.sil@ku.th
Karntapong Numnual. Kasetsart University, karntapong.n@ku.th

INTRODUCTION

At the midday of Friday 4th January 2019, the tropical storm 'Pabuk' hit Pak Phanang districts, Nakorn Sri Thammarat Province, Thailand. The 75-mph storm-induced a wave peak of 4.2m and brought significant property damage to the local people. There were reports of the many coastal villagers who were affected by storm-induced flooding near the river mouth area and storm surge at the shore which left watermarks and sand/mud depositions (Figure 1). In the past, in this area, there had been controversial issues regarding the construction of non-eco-friendly detached breakwaters which locals questioned about the Environmental Impact Assessment (Saengsupavanich, 2012). This storm event proved the insufficiency of the shore protection performance of the mentioned structures. Therefore, new alternatives for storm protection should be invented.

Lately, there has been a growing number of analyses and studies of the effectiveness of habitats as natural defenses worldwide. Nature-based Solutions (NBS) projects also report benefits ranging from reductions in storm damage to reductions in coastal structure costs (Narayan et.al., 2016).

Coastal habitats (e.g., mangrove, seagrass) have significant potential for reducing wave heights that vary by habitat and site. For this matter, this study attempts to investigate the effect of the seabed vegetation (seagrass) on storm wave dissipation through numerical simulations.

Figure 1 - The revetments at Pak Phanang beach drowned under the sand deposition, leading to question their capability to protect the coasts in extreme conditions.

METHOD

Similar to Unguendoli et.al., 2023, this study implemented XBeach (Roelvink et.al., 2009), a two-dimensional depth-averaged (2DH) model that can apply the surfbeat mode which is usually used for storm conditions. Xbeach is also capable of simulating wave dissipation and flow interaction due to vegetation. The domain is composed of a 4km-long and 3km-offshore section of Pak Phanang beach (Figure 2). The grid is composed of 228 cells in the longshore direction and 201 cells in cross shore direction. The resolution of the grids varies from 20m to 5m (Figure 3). The bathymetry was acquired from the General Bathymetric Chart of the Oceans (GeBCO19). The model was calibrated and validated with the radar observation data of 10-minute significant wave height from Geo-Informatics and Space Technology Development Agency (GISTDA), Thailand, and hourly water level from the Marine Department at Pak Phanang water gate station.

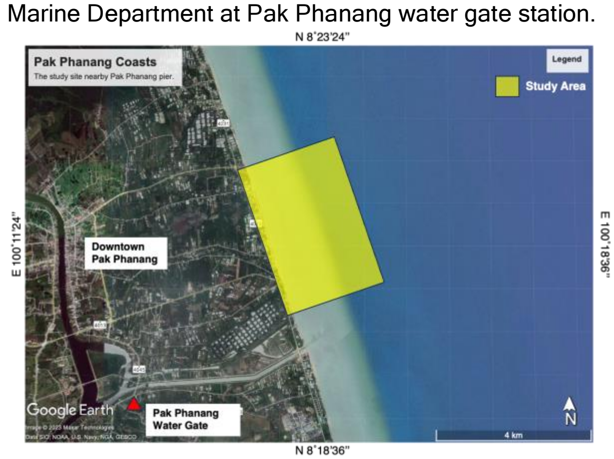

Figure 2 - Study site, Pak Phanang beach, Pak Phanang Village and Pak Phanang Water Gate

PRELIMINARY RESULTS

The effect of seabed vegetation was evaluated by the significant wave height with and without. The percentage wave attenuation (att) was evaluated with Eq. (1):

$$att = \frac{H_{sim,\ ref} - H_{sim,\ veg}}{H_{sim,\ ref}} \times 100 \quad (1)$$

where $H_{sim,\,ref}$ = wave height without seagrass and $H_{sim,\,veg}$ = one with seagrass. The wave heights were derived from the center nodes of each seagrass zone (Figure 4). With the existence of the proposed seagrass plantation, the average wave attenuation is approximately 26-46%. It also reduced the storm peak by an average of 33%.

CONCLUDING REMARKS

This study presents one of the NBSs in the role of coastal protection at one of the most controversial sites in Thailand's coasts. The results suggest the existence of seagrass could help reduce the severeness of the extreme waves. The impact of seabed vegetation is found to cause wave dissipation by 46%. In the full presentation, the effects of seagrass with the existing structures in the area (seawalls and revetments) will be presented for more realistic and reliable results. The variation of seagrass zone patterns will also be demonstrated. The feasibility of the vegetation plantation policy and other possible alternatives such as artificial reefs in Pak Phanang will be investigated and discussed in the final presentation.

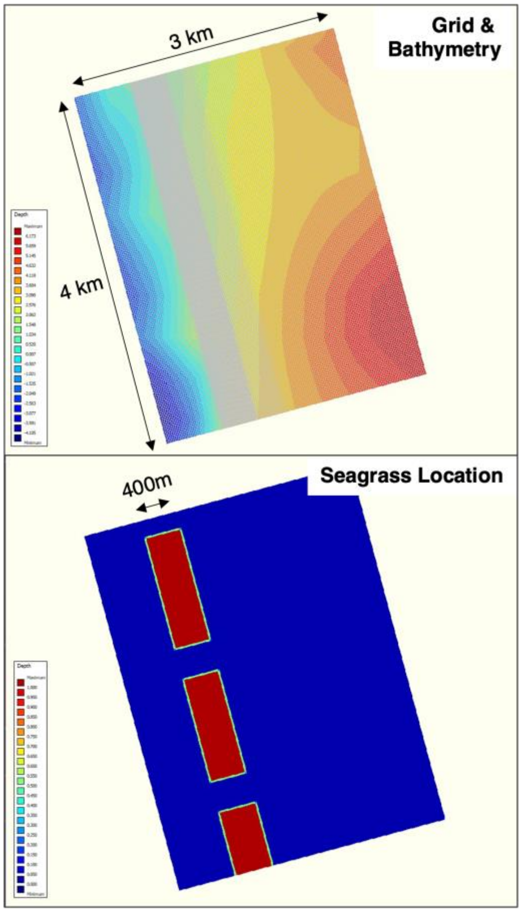

Figure 3 – The domain setup. The top picture shows the 4km x 3km domain and the bathymetry with the depth varying from 5m (inland elevation) to -7m (depth). In the bottom picture, the red zones represent the seagrass setup dimensions of 400m width and 800-1200m length.

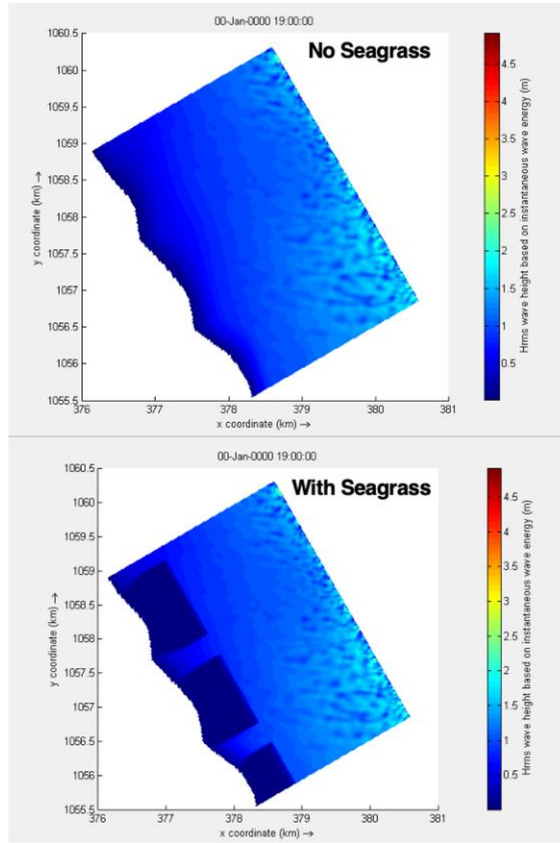

Figure 4 – The root-mean-square (or RMS) wave height (H_{rms}) without seagrass condition (top) and with seagrass condition (bottom)

REFERENCES

Narayan, Beck, Reguero, Losada, van Wesenbeeck, Pontee (2016): The Effectiveness, Costs and Coastal Protection Benefits of Natural and Nature-Based Defences. PLoS ONE 11(5): e0154735.

Roelvink, Reniers, van Dongeren, van Thiel de Vries, McCall, Lescinski (2009): Modelling storm impacts on beaches, dunes and barrier islands. Coastal Engineering, ELSEVIER, 56, 1133-1152.

Saengsupavanich (2012): Ocean & Coastal Management Unwelcome environmental impact assessment for coastal protection along a 7-km shoreline in Southern Thailand. Ocean and Coastal Management, ELSEVIER, 61, 20-29.

Unguendoli, S., Biolchi, L. G., Aguzzi, M., Pillai, U. P. A., Alessandri, J., & Valentini, A. (2023). A modeling application of integrated nature-based solutions (NBS) for coastal erosion and flooding mitigation in the Emilia-Romagna coastline (Northeast Italy). Science of the Total Environment, ELSEVIER, 867(12), 161357.