UNESCO-IHE
Institute for Water Education

Climate Change Driven Variations in the Wave Climate along the Coast of Vietnam

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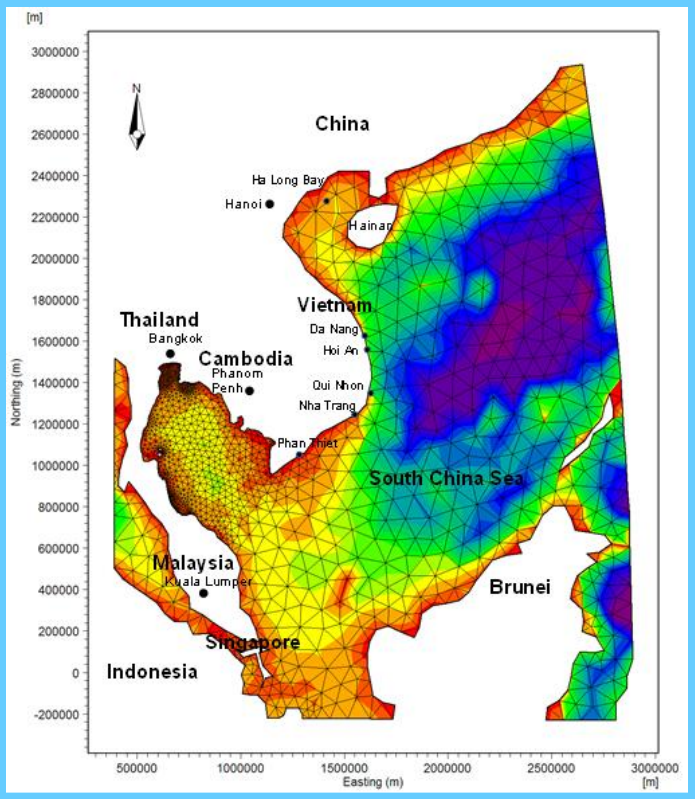

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Executive Summary

Introduction

This report presents the results of the study of the Climate Change Driven Variations in the Wave Climate along the Coast of Vietnam. This project was funded by Ministry of environment and infrastructure of the Netherlands.

Vietnam has been identified by the International Panel on Climate Change (IPCC, 2007, 2014) as one of the countries that might be most affected by climate change. In particular the Mekong and the Red River deltas, with their extremely high population density in low lying areas, are severely threatened by sea level rise and anticipated increases in the frequency and intensity of typhoons and storms. The coastline of Vietnam is presently severely eroded and mangrove forests are reduced in area and density by severe storms and sea level rise.

Changes in regional wave climate, in response to climate change driven variations of atmospheric circulation, are of interest from many different perspectives, particularly in the coastal zone. Significant change in wave climate due to climate change in turn will affect the coastal morphology, coastline position and orientation and the efficacy of coastal structures.

To this date, no study has been carried out to determine the effect of climate change on the offshore wave climate along this coast. The present study was undertaken to address this knowledge gap.

Objective

The main objective of this study is to determine the effect of climate change on the offshore wave climate along the entire coastline of Vietnam.

Methodology

In this study, a third generation numerical wave model forced with future projected wind data from selected Global Circulation Models (GCMs) is used to simulate the future offshore wave climate along Vietnam coast.

A MIKE21 model was setup for the South China Sea and the Gulf of Thailand. Results were subjected to detailed analysis at 14 locations along the coast of Vietnam (Figure E-1).

The model is forced by NCEP/CFSR winds (benchmark simulation) and climate model derived winds with 2 GCMs (GFDL CM 2.1 and ECHAM5), that had been downscaled by CSIRO's Cubic Conformal Atmospheric Model (CCAM) at 0.5° x 0.5° resolution. The model is validated by running hindcast simulations for the1981 to 2000 time slice (i.e. present condition) and comparing model results with wave data from the ship observations at two locations, Hon Dau and Hon Ngu and with ERA-40 wave data at three locations, Point B, Point E and Point K (Figure E-1). The mean significant wave height, wave period and wave direction from simulations with NCEP/CFSR, ECHAM and GFDL wind input for the 1981 - 2000 time slice showed very small differences. Thus the model was considered sufficiently validated. Subsequently, the model was used to simulate the future time slices 2041 - 2060

and 2081 - 2100 forced with downscaled winds from GFDL CM 2.1 and ECHAM5 for the high end A2 climate change scenario (comparable to RCP 8.5 in IPCC 2013).

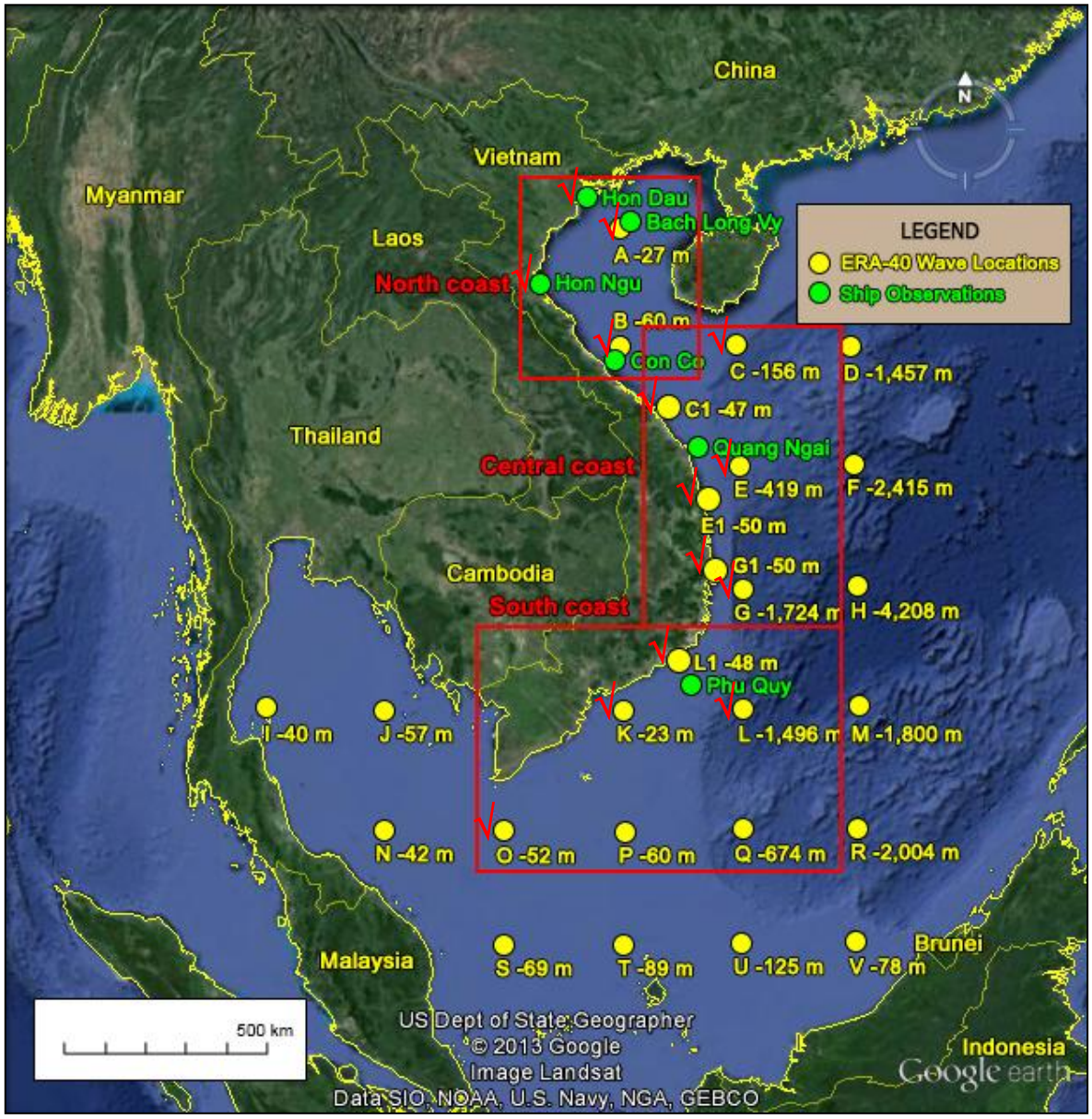

Figure E-1. Offshore locations along the Vietnam coast at which the effect of climate change on the wave climate was analysed (shown by red tick sysmbols).

Summary Results

Future mean significant wave height under the effect of climate change along the North coast of Vietnam is projected to be smaller by about 8 cm (compared to the present) with slightly longer wave periods (increase of 0.20 s), while future wave direction is projected to shift towards the south (clockwise) by less than 4 degrees. Along the central coast, future mean significant wave height is projected to slightly increase by 5 cm, wave period to increase by less than 0.08 s and wave direction is projected to shift to the south (clockwise) by less than 6 degrees. Along the South coast of Vietnam, the future mean significant wave height is projected to slightly increase by 7 cm with longer wave period (increase of 0.16 s) and future

wave direction is projected to shift towards the north (counter-clockwise) by less than 8 degrees.

The spatial distribution of the future mean significant wave height showed decreases of wave height along the North coast (Stations Hon Dau, Hon Ngu, A and B) of less than 8 cm and increases of wave height along the South coast (Station G, G1, K, L, L1 and O) of less than 4 cm. The spatial distribution of future mean wave period showed increases of less than 0.20 s along the North coast and less than 0.20 s along the South coast. The spatial distribution of future wave direction showed a clockwise rotation of wave direction (rotation towards the south) of less than 8 degrees along the North coast (Station Hon Dau, Hon Ngu, A and B) and the Central coast (Station C, C1, E and E1). On the other hand, future wave direction is projected to rotate counter clockwise (rotation towards the north) along the south coast (Station G, G1, K, L, L1 and O) by less than 8 degrees.

The most significant future potential change in the mean wave climate along the Vietnam coast is therefore the projected changes in wave directions, leading to a zone of wave direction divergence in the vicinity of Danang. This could result in longshore currents and sediment transports that diverge in this area, potentially leading to unprecedented rates of coastal erosion and coastline recession in the vicinity of Danang.