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Climate Change Driven Variations in Future Longshore Sediment Transport Rates along the Coast of Vietnam

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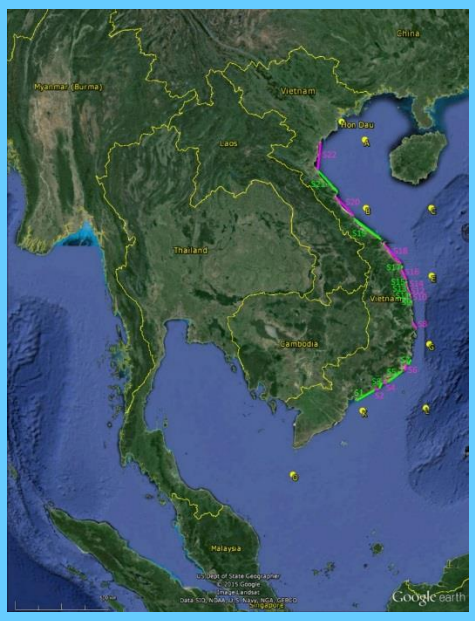

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Executive Summary

Introduction

This report presents the results of the study on Climate Change driven variations in longshore sediment transport rates along the coast of Vietnam. The 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. The coastline of Vietnam is 3,260 kilometers long and consists of 114 river mouths, 48 Bays, 12 lagoons, and 3000 islands. Impacts of changing climate in the coastal zone are already threatening people's livelihoods as well as the ecological system.

Out of the many potential climate change (CC) impacts on coasts, the one impact that has received most attention is coastline recession due to sea level rise (SLR), while little or no attention has been given to other potential coastal CC impacts. Recent sutidies has highlighted that other CC impacts may in fact override the SLR impact on coasts (Stive et al., 2009; Ranasinghe and Stive, 2009; Ranasinghe et al., 2013). One such potentially severe CC impact that has not been sufficiently investigated is the *coastal response to CC driven variations in offshore wave characteristics.* Since longshore sediment transport is a direct function of breaking wave height and direction, assessment of CC on the longshore sediment is now possible for the Vietnamese coast due to a recent study of "Climate Change driven variations in the wave climate along the coast of Vietnam" funded also by Ministry of environment and infrastructure of the Netherlands. Changes in longshore sediment transport rates will determine the coastline evolution in medium to long term time scales (i.e. 1 -100 years) and spatial scales (i.e. 1 - 100 km).

Objective

The main objective of this study is to evaluate the impact of climate change on the large scale longshore sediment transport rates along the coast of Vietnam.

Methodology

Wave characteristics are the most important input data for the calculation of longshore sediment transport. The previous study on "Climate Change driven variations in the wave climate along the coast of Vietnam" compared the present (1981 -2000) and the future (2081 - 2100) offshore wave climate at several locations along Vietnam coast using downscaled output from two global climate models (ECHAM and GFDL).

In the present study, the 1981 -2000 and 2081 - 2100 offshore wave climate derived from the aforementioned study are used to determine the nearshore wave climate for both time slices for 22 different coastline sections along the coast of Vietnam (Figure E-1). This was done by using the spectral wave model SWAN model. The nearshore wave climate for the present time slice (1981-2000) is used as the input to the GENESIS model to estimate annual average longshore sediment transport at these 22 coastline sections. These model estimates were verified with reported longshore sediment transport rates as far as possible. The verified GENESIS model was then forced with the nearshore wave climate for 2081-2100 to estimate future climate change modified longshore sediment transport along the Vietnam coast.

Figure E-1 Locations of 22 selected coastal sections along the Vietnam coastline.

Results

The computed results indicate that the volume and direction of longshore sediment transport along the coast of Vietnam is rather variable. For present conditions, the annual average results from ECHAM and GFDL wave climate at 22 costal sections are found to be in the range of 11,000-2,748,000 m^3/year in total gross transport and 1,400-1,426,000 m^3/year in net transport in a northerly direction (at coastal section S2, S4 and S18-S21) and 35,000-2,740,000 m^3/year in net transport in a southerly direction (at coastal section S1, S3, S5-S17 and S22). For future conditions, the annual average results at the 22 costal sections are in the range of 10,000-3,403,000 m^3/year in total gross transport and 2,000-1,569,000 m^3/year in net transport in a northerly direction (at coastal section S4, S9, S18-S21) and 500-3,174,000 m^3/year in net transport in a southerly direction (at coastal section S1-S3, S5-S8, S10-S17 and S22).

The estimated results of longshore sediment transport rates for the present (1981-2000) and future (2081-2100) show significant changes in net longshore sediment transport rates along the coast of Vietnam, with upto 0.5 million m^3/year increase in the net transport rate at some locations. Such large changes in longshore sediment transport rates can lead to significant future variations in the position and orientation of the Vietnamese coastline.

The results are summarized in Table E-1. The magnitude of the change and its foreseen effect on the coastline emphasizes the urgent need for detailed coastal morphological studies and quantitative risk assessments at sensitive coastal areas along the coast of Vietnam. This appears to be particularly the case in the vicinity of Danang (coastal sections 17, 18 and 19) due to the large projected future changes in longshore sediment transport direction and magnitude in this area, with an additional 875,000 m^3 of sand being transported away from this area per year.

Table E.1 Changes in net sediment longshore sediment transport due to climate change at 22 coastal sections along the Vietnam coastline.

Coastal section	Description
S1	The net longshore sediment transport is toward the south at present and will remain towards the south upto 2100. The magnitude of net annual transport **increases** by 62%, in the order of 30,000 m3/yr
S2	There is no dominant direction of net longshore sediment transport in this section it will remain the same upto 2100 but with more tendency toward the south. The magnitude will **decrease** with about 7% in order of 1,000 m^3/year in the southerly direction
S3	The net longshore sediment transport is toward the south at present and will remain towards the south upto 2100. The magnitude of net annual transport **increases** by 34%, in the order of 125,000 m3/yr
S4	There is no dominant direction of net longshore sediment transport in this section it will remain the same upto 2100 but with more tendency toward the south. The magnitude will **decrease** with about 28% in order of 2,000 m^3/year in the southerly direction
S5	The net longshore sediment transport is toward the south at present and will remain towards the south upto 2100. The magnitude of net annual transport **increases** by 50%, in the order of 122,000 m3/yr
S6	The net longshore sediment transport is toward the south at present and will remain towards the south upto 2100. The magnitude of net annual transport **increases** by 37%, in the order of 113,000 m3/yr
S7	The net longshore sediment transport is toward the south at present and will remain towards the south upto 2100. The magnitude of net annual transport **increases** by 40%, in the order of 78,000 m3/yr
S8	The net longshore sediment transport is toward the south at present and will remain towards the south upto 2100. The magnitude of net annual transport **decreases** by 30%, in the order of 145,000 m3/yr
S9	There is no dominant direction of net longshore sediment transport in this section it will remain the same upto 2100 but with more tendency toward the north. The magnitude will **increase** with about 240% in order of 162,000 m^3/year in the northerly direction
S10	The net longshore sediment transport is toward the south at present and will remain towards the south upto 2100. The magnitude of net annual transport **decreases** by 7%, in the order of 80,000 m3/yr
S11	The net longshore sediment transport is toward the south at present and will remain towards the south upto 2100. The magnitude of net annual transport **decreases** by 22%, in the order of 155,000 m3/yr
S12	The net longshore sediment transport is toward the south at present and will remain towards the south upto 2100. The magnitude of net annual transport **decreases** by 30%, in the order of 176,000 m3/yr
S13	The net longshore sediment transport is toward the south at present and will remain towards the south upto 2100. The magnitude of net annual transport **increases** by 16%, in the order of 434,000 m3/yr
S14	The net longshore sediment transport is toward the south at present and will remain towards the south upto 2100. The magnitude of net annual transport **decreases** by 23%, in the order of 131,000 m3/yr
S15	The net longshore sediment transport is toward the south at present and will remain towards the south upto 2100. The magnitude of net annual transport **increases** by 9%, in the order of 170,000 m3/yr
S16	The net longshore sediment transport is toward the south at present and will remain towards the south upto 2100. The magnitude of net annual transport **decreases** by 15%, in the order of 105,000 m3/yr
S17	The net longshore sediment transport is toward the south at present and will remain towards the south upto 2100. The magnitude of net annual transport **increases** by 23%, in the order of 460,000 m3/yr
S18	The net longshore sediment transport is toward the north at present and will remain towards the north upto 2100. The magnitude of net annual transport **increases** by 45%, in the order of 290,000 m3/yr
S19	The net longshore sediment transport is toward the north at present and will remain towards the north upto 2100. The magnitude of net annual transport **increases** by 10%, in the order of 124,000 m3/yr
S20	The net longshore sediment transport is toward the north at present and will remain towards the north upto 2100. The magnitude of net annual transport **increases** by 15%, in the order of 170,000 m3/yr
S21	The net longshore sediment transport is toward the north at present and will remain towards the north upto 2100. The magnitude of net annual transport **increases** by 20%, in the order of 113,000 m3/yr
S22	There is no dominant direction of net longshore sediment transport in this section it will remain the same upto 2100 but with more tendency toward the north. The magnitude will **increase** by about 60% in order of 5,000 m^3/year in the northerly direction