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Assessment of Coastal Vulnerability to Sea Level Rise in Southeast Asia: Some Management Considerations

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Introduction

- The risk potential in coastal areas of Southeast Asia is increasing, due to Global Environment Change (climate change, sea level rise, increase of frequency and intensity of extreme natural events);
- Complex and dynamic social, economic and environmental processes influence the vulnerability of coastal nations to GEC, and the ability of those affected to cope, recover and adapt;
- Hence, the interactions of these processes, their effects on human communities, and adaptation capacities must be analysed in an integrated manner;
- There are clear implications for management and governance of these coastal systems, if development of coastal areas are to be sustainable;
- Several previous assessments of vulnerabilities of human populations in coastal areas of Southeast Asia to future global change highlighted that sea level rise and climate change will affect agriculture, water and forest resources, populations and infrastructure of mega-cities;
- More recently, studies have indicated that GEC will have implications on human economic activities and wealth distribution.

Objectives

- To conduct a regional assessment of vulnerability of coastal areas in Southeast Asia to sea level rise (encompassing participating countries: Cambodia, Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam);
- To assess similarities or dissimilarities in results obtained based on natural and socio-economic country parameters, as well as mitigation / adaptive strategies;
- To develop decision making tools for management.

Methodology

- The assessment was conducted using the DINAS-COAST DIVA model (Dynamic Interactive Vulnerability Assessment), which integrates natural and social-economic variables;
- Cases were simulated using the six scenarios derived from Intergovernmental Panel on Climate Change Special Report on Emission Scenarios (IPCC SRES) storylines, and also using combinations of adaptive strategies available in the DIVA model;
- Two adaptation options for coasts under threat of sea level rise in the DIVA model: dike protection and beach nourishment, were implemented according to several pre-defined adaptation strategies;
- Analyses were conducted on a regional scale and on a per-country scale using low, medium and high regionalised sea level rise;
- Further analyses of model results were conducted using a geospatial clustering tool, LOICZ-DISCO (Deluxe Integrated System for Clustering Operations) to highlight similarities or disparities in natural and socio-economic resources, sea level rise scenarios and resulting consequences;
- Additionally, country-specific case studies were conceptualised using diagrams to highlight specific issues relating to sea level rise in the coasts.

Results and Discussion

- Results from the regional analyses indicate an overall vulnerability of coastal areas by the number of people affected by flooding, land loss and wetland inundation;
- There is a high cost to doing nothing;
- The highest migration was observed for the A2 scenario followed by the A1F1 scenario.
- Implementing adaptation measures reduced migration by 40 – 95%;
- Full nourishment (incorporating coastal cover rehabilitation) was the most cost-effective option for minimising loss of wetland areas (including coastal forests and mangroves), loss of sand and land loss (with consequent reduction in migration of populations);
- Dike protection was a better option to mitigate the number of people flooded, land loss due to submergence and costs of damage due to flooding from the sea;
- Cluster analyses resulted in Vietnam being a cluster by itself with a characteristic high coastal floodplain population, while Malaysia, Thailand and the Philippines exhibited an overall low land loss doe to submergence and a moderate net loss of wetland area;
- Cambodia and Singapore were clustered together due to a small total coastal length, and Indonesia was on its own with a high coastal population, and high coastal forest and mangrove cover.
- High land loss due to erosion, wetland loss and migration due to land loss in Vietnam and Indonesia were modelled to be effectively mitigated by beach nourishment;
- Nourishment and dike protection were equal mitigation options for Malaysia, Thailand, the Philippines and Cambodia, while dike protection was recommended for Singapore;
- In all countries, the B1 Sea Level Rise Scenario (SRS) exhibited the least amount of damage in terms of loss of natural resources and number of people flooded;
- Scenario A1T was also an acceptable alternative for Indonesia, Malaysia, Thailand and Vietnam;
- None of the adaptation strategies could effectively address the impacts of salinity intrusion.

Management and Policy Implications

- Adapting to the impacts of coastal change due to sea level rise requires engineering measures to limit damage to human populations and coastal resources;
- Application of the cost-benefit relation between beach nourishment and sea walls / dikes was country-specific and target-specific;
- The extent of impact anticipated is dependent on the underlying IPCC SRES storyline;
- On global political and governance scales, effort should be exerted towards a target of the B1 or A1Tscenarios with emphasis on reduced populations, a balanced mix of energy resources, and an increase in equity among global regions;
- Conceptual diagrams for country-specific case studies were useful in highlighting vulnerable coastal populations and natural resources.

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