

caused by storms, the study assessed the impact of five storm scenarios in which storms would occur once every 4, 10, 20, 50 and 100 years. Four flood scenarios were also assessed in which floods would occur once every 2, 10, 50 and 100 years. To overcome the uncertainty in estimating the impacts of relatively random events such as storms, floods and salinity, a simulation analysis using Crystal Ball® was applied to these uncertain variables. The economic damage due to each storm or flood event was calculated using the World Bank's 2010 projections and data from the Vietnam Central Committee for Flood and Storm Control (CCFSC).

The Impact on Agriculture and Aquaculture

To get the information needed for the cost benefit analysis, a wide range of socio-economic data was collected. 233 rice farmers and 79 aquaculture farmers (who culture *Macrobrachium rosenbergii*) were interviewed. Data was collected on issues such as production areas, yields, inputs (labor, fertilizer, chemicals, food, etc.) and investments. This information was used in order to estimate lost productivity due to the effects of salinity.

In order to ascertain the impact of salinity on rice yield, the sample of farmers was split into two. One

sample was from the Cang Long and Cau Ke areas, which are mostly unaffected by salinity. The other sample was from Duyen Hai and Cau Ngang areas, where farmers have to cope with salinity and seawater intrusion. A similar approach was taken to assess the impact of salinity on aquaculture. Forty two aquaculture farmers in Cang Long district (a salinity-free area) and 37 aquaculture farmers in Duyen Hai district (a salinity-affected area) were interviewed.

Which Dyke System is Best?

As previously outlined, once they had been measured, the value of losses caused by storms, floods and salinity were used to calculate the benefits that the dyke systems would bring (over a period of 100 years). The results show that the dyke systems would provide significant protection against storms and floods. In the case of salinity, annual rice and aquaculture productivity losses avoided would be USD 331.25 per ha and USD 915 per ha respectively.

The results show that dyke options four and five would provide the highest level of benefits, totalling USD 23,875 million each, and that option one would provide the lowest benefit, of USD 18,797 million. Overall, the larger in scale the dyke system, the higher the potential benefits it could bring. In general, the dyke options that could be built in stages would incur lower costs

than the alternative options that would be built to full height from the start.

Revising the National Dyke Upgrade Program

As the benefits provided by all the dyke options are significant, it is clear that policymakers should consider them all. However, the study recommends that the most appropriate route to take would be to initially construct the small-scale dyke systems that could be enlarged at a later date.

The study concludes that, if the proposed sea dyke options in this report are taken into consideration, the existing national sea dyke upgrading program will need to be revised towards a concrete sea dyke system with a century-long lifespan – rather than a working life of 2020-2030, as is currently the case.

The study also notes that it only focused on the economic valuations of storms, floods and salinity. Other factors, such as the cost/value of loss of life, the cost/value of wetland protection and the cost/value of planting mangrove forest to protect dykes were not calculated in the CBA analyses. Therefore, in any future sea dyke-related studies, the author recommends that these important factors should be taken into account.



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The Economy and Environment Program for Southeast Asia (EEPSEA) was established in May 1993 to support training and research in environmental and resource economics across its 9 member countries: Cambodia, China, Indonesia, Laos, Malaysia, Papua New Guinea, the Philippines, Thailand, and Viet Nam. Its goal is to strengthen local capacity for the economic analysis of environmental problems so that researchers can provide sound advice to policymakers.

EEPSEA Policy Briefs summarize the key results and lessons generated by EEPSEA supported research projects, as presented in detail in *EEPSEA Research Reports*.

Protecting Vietnam from Sea Level Rises – an Assessment of Concrete Sea Dyke Options

EEPSEA POLICY BRIEF • No. 2011-PB13

Vietnam is one of the five countries in the world that will be most seriously affected by sea level rises as a result of global climate change. Now a new EEPSEA study has looked at how the country should protect itself from this steadily developing challenge. To do this, the study assessed five different concrete dyke options for the development of Vietnam's sea dyke protection system.

The study is the work of Vo Thanh →

A summary of EEPSEA Research Report No. 2011-RR13: 'Adaptation Behavior to Sea Level Rise in the Vietnamese Mekong River Delta: Should a Sea Dyke be Built?' by Vo Thanh Danh, School of Economic and Business Administration, Can Tho University, Can Tho City, Vietnam.
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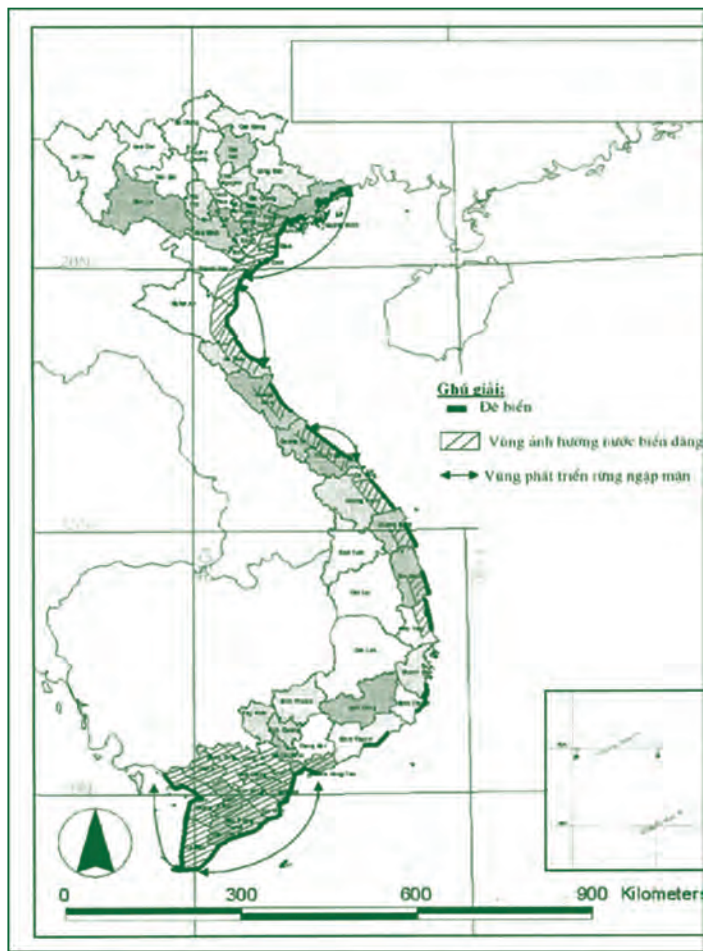


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“all the dyke options should be considered”



A map of the sea dyke system in Vietnam

→ Danh from the School of Economic and Business Administration, Can Tho University, Can Tho City, Vietnam. It finds that, although a concrete sea dyke system would be more expensive than the existing sea dyke program, such a system would bring significant economic benefits and protect large areas of agricultural land from storms, flooding and salinity. The study makes specific recommendations for the size of dykes that should be built and outlines how the existing national sea dyke upgrading program should be revised.

The Sea Level Challenge facing Vietnam

Sea level rise presents a serious challenge to Vietnam. Projections carried out by the Vietnamese Ministry of Natural Resources and Environment (MONRE) show that (compared to 1980-1999) sea levels in Vietnam will rise by between 30 cm and 33 cm by the middle of this century and by between 74 cm and 100 cm by the century’s end. According to the MONRE’s forecasts, such sea level rises could inundate between 15,000-20,000 km² of Vietnam’s Mekong Delta (VMD). They could also completely submerge nine of the Delta’s 13 provinces.

Vietnam currently has a sea dyke and salinity control dam system in

place. The dyke system in the VMD is 1,400 km long, with nearly 620 km of sea dykes. Most of these dykes were constructed many years ago. The system is mostly constructed out of earth and, although it is constantly maintained and repaired, it is often breached by storms and high tides. Moreover, some of the VMD’s provinces simply do not have enough sea dykes to prevent seawater intrusion.

For example, in January 2008, at Hiep Thanh commune, in the Duyen Hai district of Tra Vinh province, a combination of a high tide and the monsoon caused a 120-meter-long earth-built sea dyke to collapse. As a consequence seawater encroached on nearly 1,000 ha of agricultural land. In recent years, mainland seawater intrusion has occurred on a large scale in Ca Mau, Soc Trang, Ben Tre, and Tra Vinh provinces.

Upgrading the Sea Dyke System

In 2009, the Government launched an ambitious sea dyke upgrade program from central Vietnam to the south of the country (Quang Ngai to Kien Giang). This program will run until 2020. This program’s main objective is to establish a robust sea dyke system that can adapt to the impacts of a future rise in sea level. However, despite this work, the dyke system from the centre of Vietnam to the south will still be predominantly made of earth.

Many commentators think that, because the VMD is at such risk from sea level rises, it needs a large concrete-based sea dyke system, similar to that in the Netherlands. However, opponents of this idea argue that such a sea dyke system will require billions of USD of

investment and will not be effective. An alternative ‘coping strategy’ is proposed. This combines moving people from affected areas during a natural disaster and putting in place measures to help people adapt to life in coastal areas affected by sea level rises.

Are Concrete Dykes Worth the Investment?

To see whether a concrete sea dyke system represents a viable policy direction for Vietnam, Vo Thanh Danh conducted an economic valuation of five concrete dyke options for the VMD. He compared the options against a base scenario of “no concrete sea dyke system”.

Option one comprised a small, two-meter-high concrete dyke; options two and three were medium in scale, at three meters high; and options four and five were large in scale, at four meters in height. Option one would be able to cope with a storm of a severity that occurs, on average, once every 20 years; options two and three would cope with a storm of a severity that occurs once every 50 years; and options four and five would cope with a storm of a severity that occurs once every 100 years.

Option 3 and option 5 were designed to be constructed in two phases: an initial investment would be made in a

small-scale dyke (two meters in height), but the dyke’s main body would be constructed on a medium or large scale so that, at a later stage, the dyke could be heightened. It was assumed that the lifespan of the dyke in option one would be 50 years. The lifespan of the other dyke options was set at 100 years.

The Study Area: Tra Vinh Province

Tra Vinh Province was chosen as the study area for this assessment. Tra Vinh lies between two big rivers: the Co Chien and Hau rivers. Along the side of these two rivers there is a dyke system consisting of sea dykes and river dykes. The province’s natural area measures 223,000 ha and the seashore has a length of 65 km. The entire coastal area of Tra Vinh is affected by high tides and seawater intrusion. Salinity and seawater intrusion begins during the dry season, starting in December and continuing until April/June. More than 90% of the total agricultural land area of 90,000 ha suffers from seawater intrusion.

The study used the risk Cost Benefit Analysis (CBA) framework to assess the dyke options. The risk-CBA framework was used because the effects of climate change are uncertain. The relative attractiveness of the alternatives was worked out using an Expected Net Present

Value (ENPV) calculation. The baseline data for this assessment came from Tra Vinh Province’s socio-economic development master plan.

To calculate the cost of the dyke options, three cost components were taken into account: construction costs, maintenance costs and dyke-heightening costs. To calculate the benefit of the different dyke options, the study assessed the economic damage that would be avoided because of the protection offered by each dyke system. It was clear that the dyke systems would provide protection against two types of damage: (1) losses from storms and floods sustained by houses, infrastructure such as roads, electricity supplies, water connections, destroyed crops, etc., and (2) the avoidance of productivity losses due to salinity.

The Impact of Storms

In the VMD storms are not an annual weather phenomenon. However, when storms do happen, they usually cause large losses. The problems they cause are likely to get worse as global climate change projections suggest that, in the future, storms will be stronger and will move further to the south of the country.

To estimate the economic losses

Dike options	Storm losses avoided	Flood losses avoided	Salinity losses avoided	Total benefit
Option 1	10,509.2	7,192.8	1,094.6	18,796.7
Option 2	11,759.6	8,721.1	1,094.6	21,575.3
Option 3	11,759.6	8,721.1	1,094.6	21,575.3
Option 4	12,789.3	9,991.0	1,094.6	23,874.9
Option 5	12,789.3	9,991.0	1,094.6	23,874.9

Present values of the benefits of the different dyke options (discount rate = 3%, units: million USD)