Economy and Environment Program
for Southeast Asia
22 Cross Street #02-55
South Bridge Court
Singapore 048421

Phone : (65) 6438 7877
Fax : (65) 6438 4844
E-mail : hfrancisco@idrc.org.sg
Web site : www.eepsea.org

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 pollcymakers.

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

EEPSEA Policy Briefs and Research Reports are available online at http://www.eepsea.org

Responding to Sea Level Rise – A Study of Options to Combat Coastal Erosion in the Philippines

EEPSEA POLICY BRIEF • No. 2009-PB2

Sea erosion is currently affecting many coastal areas in the Philippines. Natural factors such as wind and waves are to blame, as are human activities such as coral reef destruction. The scale and impact of this problem are both expected to become more widespread due to climate change and sea level rise. Continuing urbanization and the development of more coastal →

A summary of EEPSEA Research Report No. 2009-RR2: 'Economic Vulnerability and Possible Adaptation to Coastal Erosion in San Fernando City, Philippines, by Jaimie Kim E. Bayani, Moises A. Dorado and Rowena A. Dorado, Department of Economics, College of Economics and Management, University of the Philippines Los Baños, College, Laguna, The Philippines.
Telephone: +6349-536-2505 Fax: +6349-536-2505
Email: jkbayani@yahoo.com

"a planned protection strategy is ...

communities in the country are also likely to make the situation worse.

To assess possible responses to this problem, a new EEPSEA study has investigated coastal erosion in one of the country's more developed coastal regions. It finds that this coastline is vulnerable to the impact of erosion and that, if nothing is done, the problem will cause hundreds of millions of Php worth of damage. It also finds that a planned protection strategy is the most rational approach to adopt. Such a strategy is socially and politically acceptable, justifiable from an economic perspective and also preserves the area's beaches along with the social services they provide.

The Coastal Erosion Challenge

Coastal erosion can have a serious impact on society and can destroy land, properties, infrastructure, and natural resources, such as sandy beaches. It is not surprising that huge efforts are currently being made around the world to reduce the impact of this environmental problem. Typical projects usually involve coastal protection activities. These adaptation options, however, entail large investments and can sometimes have undesirable impacts themselves. It is therefore important to carefully evaluate and assess the feasibility of any chosen option before action is taken.

This study, which is the work of a research team from the Department of Economics, at the University of the Philippines Los Baños, conducts such an assessment for the San Fernando Bay in the La Union region of the Philippines. It looks at approximately seven kilometers of the bay's coastline.

		Scenario A			Scenario B		
		Business as usual	Planned protection	Planned retreat	Business as usual	Planned protection	Planned retreat
Low	1%	237.74	462.41	(672.31)	35.61	260.27	(470.17)
	3%	110.07	169.67	(311.73)	62.34	121.94	(264.01)
	4%	81.94	114.56	(233.09)	58.20	90.81	(209.35)
	5%	63.92	82.70	(183.26)	51.93	70.71	(171.27)
	6%	51.74	63.19	(150.02)	45.60	57.05	(143.88)
	7%	27.79	30.71	(86.99)	27.31	30.23	(86.51)
	10%	16.00	17.30	(58.12)	15.98	17.28	(58.10)
	15%	237.74	462.41	(672.31)	35.61	260.27	(470.17)
Average	1%	557.89	920.77	(1,344.62)	200.69	563.57	(987.42)
	3%	258.51	372.20	(623.47)	150.11	263.79	(515.06)
	4%	192.94	259.78	(466.19)	130.80	197.64	(404.05)
	5%	151.19	191.78	(366.52)	114.72	155.32	(330.05)
	6%	123.18	148.63	(300.04)	101.33	126.78	(278.19)
	10%	69.22	74.68	(173.98)	65.88	71.35	(170.65)
	15%	43.68	45.32	(116.24)	43.27	44.91	(115.83)
High	1%	878.04	1,409.57	(2,016.93)	331.63	863.16	(1,470.52)
	3%	406.96	618.34	(935.20)	188.95	400.33	(717.19)
	4%	303.93	445.77	(699.28)	157.65	299.50	(553.00)
	5%	238.45	336.93	(549.77)	137.04	235.53	(448.36)
	6%	194.62	265.00	(450.06)	122.37	192.75	(377.81)
	10%	110.64	133.22	(260.98)	88.11	110.68	(238.44)
	15%	71.36	78.65	(174.36)	64.60	71.90	(167.60)

Net present values of adaptation strategies (in Php millions)

San Fernando Bay is a densely-populated area and it was chosen because it was identified as a place where coastal erosion is already prevalent.

How best to Act?

Among the factors that have been identified as contributing to coastal erosion along San Fernando Bay are sea-level rise due to tectonic movements and climate change, which is causing changes in precipitation and storminess. Other factors include land cover changes, shifting river mouth positions and human activities such as mining, the construction of seawalls and the destruction of coral reefs, mangroves and sand dunes.

In light of these problems, the general objective of this study was three-fold: First to estimate the economic vulnerability of San Fernando Bay to coastal erosion; second, to assess the value of resources, properties, structures and economic activities at risk from coastal erosion and shoreline retreat; and, thirdly, to identify and evaluate various adaptation options to address the hazard. Three adaptation strategies were evaluated: (a) a "business as usual" or hold-the-line strategy; (b) planned protection; and (c) planned retreat/relocation.

Three Adaptation Strategies

The "business as usual" framework was based on adaptation strategies that people are already putting in place. Using a survey and site visits, it was found that some of the household properties along the bay had started to be encroached by the sea, because of this, residents were adopting a 'hold-the-line strategy', employing

the most rational approach to adopt."

bulkheads or seawalls. It was therefore assumed that this type of work would continue if no other strategy were proposed. One problem with this approach is that it will lead to the loss of the beach and restrict public access to the sea.

For the planned adaptation option, it was assumed that the government would intervene and build hard (bulkheads and revetments) and soft (vegetation) protection along the coast. The goal of these interventions would be to maintain public access and preserve the beaches while at the same time protecting properties and infrastructure along the coast.

For the last option, planned retreat, it was assumed that the government would prohibit any protection activities by property owners so that the shoreline would be allowed to retreat. In the meantime, the government would gradually purchase properties situated in "risky" areas to ensure that these areas were vacated over time.

Which is Best Option?

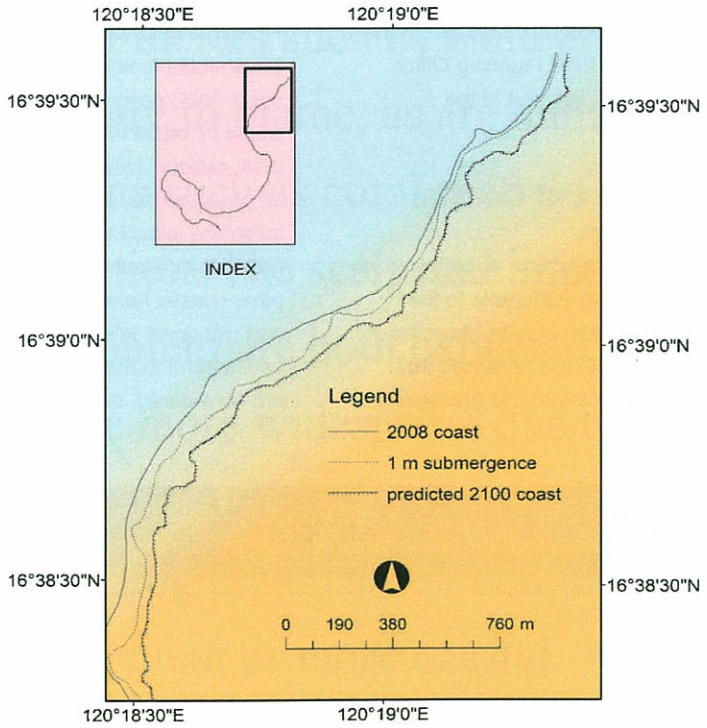
A cost-benefit analysis was carried out to see which of the three key adaptation strategies would provide the highest net present value (NPV) and so be the most economically beneficial. A number of surveys were also done with local residents and politicians to gauge awareness of coastal erosion and its effects, to identify what is currently being done to deal with the problem and to assess the acceptability and legality of the proposed adaptation options. People were also asked to state what they considered to be the most important attributes and outcomes of any erosion adaptation strategy.

Geographic Information System (GIS) techniques and Global Positioning System (GPS) technology were used to predict the areas that will be threatened by coastal erosion/shoreline retreat along San Fernando Bay by 2100. The year 2100 was chosen so as to capture the long-term impact of the hazard. Coastline changes are very complex and can be caused by several factors that work interactively with one another, such as coastal geomorphology, sea-level rise, past shoreline evolution, storm surges and wave action. To predict the areas at risk by 2100, the Markovian Chain Analysis and Cellular Automata Analysis were used to allow the effects of the different factors to be taken collectively.

Because the resilience of the beaches in San Fernando Bay is yet to be known, two scenarios were analyzed. The first assumed that the beaches in the study site are not resilient and would be lost as a consequence of coastal erosion/shoreline retreat (Scenario A). The second scenario assumed that the beaches are resilient and would just retreat inland (Scenario B).

Calculating Costs

In order to calculate the cost of any changes caused by coastal erosion threatened lands, threatened buildings and threatened beaches were first identified. This was done using aerial photographs from Google and spot maps collected from barangay offices.



Projected areas at risk to coastal erosion by 2100 in the upper coastal segment of San Fernando Bay

After this inventory was completed, data on property and land values were collected.

It was found that the primary natural resources at risk along San Fernando Bay are its sandy beaches. From the site visits that the research team conducted, two main uses of the beach along San Fernando Bay were identified: (a) for recreation (e.g. picnics and jogging) by nearby residents, and (b) for docking by local fishermen. If the beaches in San Fernando Bay become completely eroded, the docking services that they provide will be lost. This is expected to result in the abandonment of fishing activities in the area. Moreover, public access will be restricted and the recreational benefits that the beaches currently provide will be gone.

To estimate the recreational value of the beaches in San Fernando Bay, the study used previously estimated values for similar beaches elsewhere in the world. To approximate the economic value of docking services, the researchers calculated the net income from fishing. Secondary data from the San Fernando LGU Planning Office was used to do this part of the assessment.

The Impact of Coastal Erosion

The results of this study show that San Fernando Bay is vulnerable to the impacts of coastal erosion/shoreline retreat. By 2100, it is projected that about 300 structures, 283,085 square meters of land and 123,033 square meters of sandy beaches will be lost due to the hazard. The current value of these capital and land resources is estimated at Php 112.1 million and Php 932.5 million, respectively; while the annual benefits that the threatened sandy beaches provide are estimated at Php 4.5 million for recreation and Php 8.0 for docking services.

When the results of the cost-benefit analysis were compared, the planned protection option yielded the highest net present value (NPV) of about Php 148.63 million under Scenario A (in which beaches are not resilient) and about Php 126.78 million under Scenario B (in which the beaches are resilient). The "business as usual" option was the next best option. It would have a NPV of about Php 123.18 million under Scenario A, and Php 101.33 million under Scenario B. The planned retreat/relocation option, on the other hand, yielded negative NPV estimates.

Planned Protection Proves Its Worth

From this analysis, it is clear that the government-financed planned retreat is not a viable option to pursue because it would be much more costly than the other options. However, it should be emphasized that the analysis considers solely the impacts of coastal erosion/shoreline retreat. If the cost of other coastal hazards like tsunamis and typhoons, which can potentially cause harm to human health and life, are considered, the benefits of the retreat option may be significantly higher.

The business as usual scenario is a better economic option than planned retreat. It is also the more desirable in terms of administrative feasibility, as it would entail no investment from the government. However it has a major disadvantage: As already mentioned, if all shoreline property owners built bulkheads to protect their land, this would mean the subsequent loss of the beach resource and its services. These resources are highly valued by local people; therefore this option does not represent a popular choice.

It can therefore be concluded that among the three strategies evaluated, the planned protection strategy is the most rational option to adopt along the coast of San Fernando Bay. Not only does this strategy provide the best economic benefits, it also protects the welfare of property owners and satisfies the goal of preserving the beaches and the social services derived from using them.

This adaptation strategy, which combines hard and soft protection, is also socially feasible with 65% of the property owners saying that they would agree with its implementation. It is also politically feasible with 82% of the city government officials interviewed expressing a willingness to support the strategy. In light of these findings, the study recommends that policy makers look into this approach with a view to its implementation.

EEPSEA is administered by Canada's International Development Research Centre (IDRC) on behalf of EEPSEA's sponsors:

Sida

Canadian International Development Agency

Agence canadienne de développement international

IDRC CRDI