# Choosing Flood Adaptation Options: An Economic Assessment from the Philippines

*Strengthening local capacity in the economic analysis of environmental issues*

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 10 member countries (i.e., Cambodia, China, Indonesia, Lao PDR, Malaysia, Myanmar, Papua New Guinea, the Philippines, Thailand, and Vietnam.) It aims to strengthen local capacity for the economic analysis of environmental issues so that researchers can provide sound advice to policy makers.

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**Flooding is one of the key environmental challenges facing the province of Laguna in the Philippines. It is a problem that is expected to get worse due to the impact of climate change. However, despite the pressing nature of this crisis, a range of financial, institutional and other constraints have hampered efforts to act. There is also a lack of research to underpin the formulation of effective strategies to cope with the problem.**

**To help provide this much needed information, a new EEPSEA study looked at the impact of flooding in the Sta. Cruz River watershed (the part of the province most at risk from floods) and has identified and evaluated some economically suitable adaptation projects. The study is the work of a team led by Jaimie Kim Bayani Arias from University of the Philippines Los Baños. It finds that flooding has a massive financial impact on the study site. It also finds that local residents would be willing to pay for a technology-based early warning system, which would bring significant benefits to society as a whole. The study also assessed a number of other adaptation options applicable to the municipality of Sta. Cruz and recommends that the local government should consider financing the strengthening and modification of homes to help local people cope with floods in the future.**



A summary of EEPSEA Research Report No. 2014-RR6: 'Economic Analysis of Flood Adaptation Options in the Sta. Cruz River Watershed, Laguna, Philippines', by Jaimie Kim Bayani Arias, Vicente G. Ballaran, Jr., Ma. Emilinda T. Mendoza, Rowena A. Dorado, and Bessie M. Burgos. Comments should be sent to Jaimie Kim Bayani Arias, College of Economics and Management, University of the Philippines Los Baños, College, Los Baños, Laguna, Philippines. Email: jbarias@up.edu.ph

## The Sta. Cruz River watershed

Based on the assessment previously carried out by the study team, it was found that the municipalities of Victoria, Pila, Sta. Cruz, Calauan and Pagsanjan are the areas in the province of Laguna most vulnerable to flooding. These municipalities all belong to the Sta. Cruz River watershed. The study then calculated the cost of direct flood damage for the whole Sta. Cruz River watershed. It also identified the best flood adaptation options for the study site and finally carried out an economic analysis of the chosen adaptation options. The overall objective of the study was to identify suitable, economically efficient adaptation projects to cope with flooding along the lakeshore municipalities of the Sta. Cruz River watershed

Flood water in the area comes from upland run-offs. However, the major flood contributor in the area is Laguna Lake, the largest lake in the Philippines with a surface area of 900 km$^2$. More than 100 streams feed into the lake but it has only one outlet, the Pasig River, which drains out to Manila de Bay. It serves as the catch basin for the provinces of Laguna, Rizal, Batangas, Cavite, Quezon, and some parts of the National Capital Region. However, its water holding capacity has been declining over the years due to siltation. According to the Laguna Lake Development Authority, its depth now only averages about 2.5 m, a substantial decline from its maximum observed depth of 10 m. The map on the right shows the study site in relation to Laguna Lake.

Lakeshore barangays in the municipality of Sta. Cruz are at risk of long-term flooding, which lasts for several months. In the last five years, two long-term flood events have been reported in the area. In 2009, flooding occurred as a result of typhoon Ondoy (Ketsana) and some houses were submerged for as long as six months. The second flood event took place in 2012. This was brought about by a strong monsoon and later extended by typhoons Gener (Saola) and Ofel (Son-Tinh). The 2012 inundation lasted for between four and six months, depending on location.

These long-term floods have brought severe economic loss and inconvenience to affected households. For example, during the 2012 flood, important public buildings were submerged, including the Sta. Cruz public market, two public elementary schools and several barangay halls. A total of 8,917 houses were inundated.

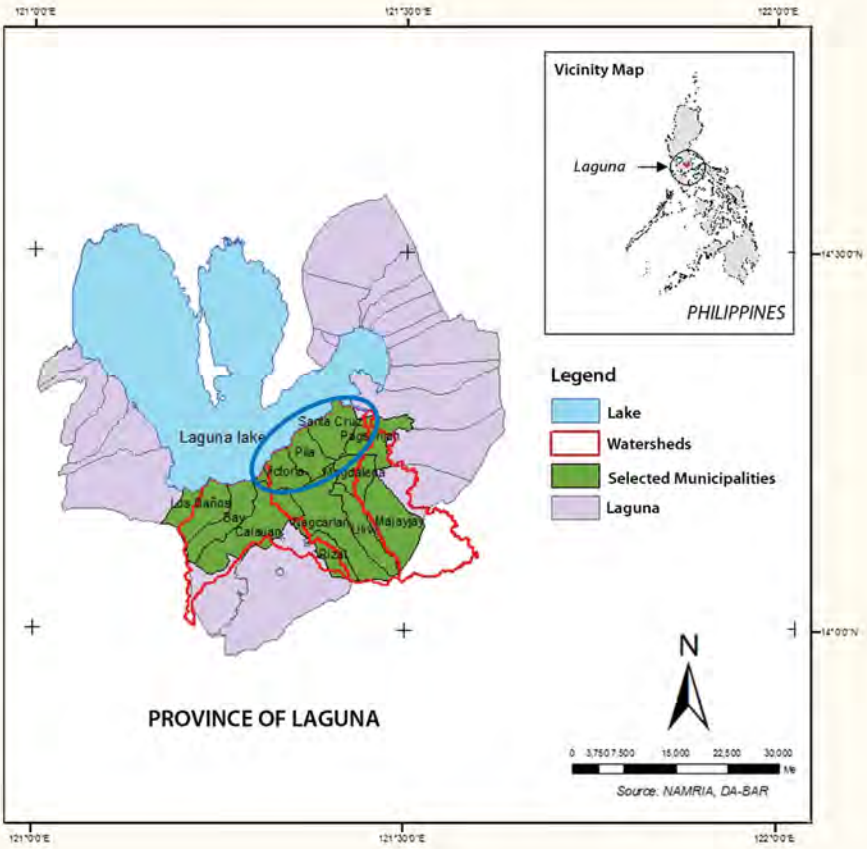
## Collecting information

A survey of 500 randomly selected households was conducted to collect data on household profiles and characteristics and on the impacts and damages caused by flooding. Focus group discussions, key informant interviews and secondary data collection were also undertaken. Secondary information collected included the municipal comprehensive land use plans, typhoon damage data, evacuation data, and building construction cost standards

This survey found that a majority (47%) of people in the study area believed that they face a risk of flooding once every five years, while 36% believed that they face no risk at all. About 4% of respondents thought that they faced a very small risk of flooding (which corresponds to a flood that occurs once every 50 to 100 years), while 7% felt that they were exposed to flooding once every 10 to 25 years

## The cost of flooding in the watershed

Market-based valuation was applied to calculate the costs of the property and asset losses from flooding. Real damage data was obtained from the 500-household survey. Damage per household was then estimated for different levels of flood height. For rice farming land, the lost net income per hectare (of a typical rice farm) was used to value the flood damages.



In this estimation, rice production cost data was sourced from existing literature, while rice yields and market prices were based on information obtained via the household survey.

The study's flood damage cost estimate per hectare for built-up land came to about PhP 410,000, PhP 215,000 and PhP 85,000 for neck-level, waist-level and knee-level floods, respectively. Rice land suffered damage worth PhP 29,600/ha for floods of 2.5 ft and above. The corresponding cost of damage resulting from floods therefore ranged from PhP 13.7 million to PhP 88.8 million for built-up lands and PhP 19.9 million to PhP 75.9 million for rice farming lands.

## Selecting adaptation options

Once flood damage costs had been calculated, the study then focused on the identification and economic analysis of adaptation options. Adaptation options were identified and selected using a rigorous series of consultations with a variety of stakeholders, including the municipal planning officers of the 12 municipalities of Laguna, and representatives from the Department of Environment and Natural Resources, partner agencies such as the Laguna Provincial Planning Development Office, and experts from academia. Field and on-site visits were undertaken to validate these insights.

Through this process, the following adaptation options were chosen for analysis: a technology-based early warning system (EWS) for the whole Sta. Cruz River watershed; and relocation, evacuation and building modification options specifically for lakeshore barangays in the municipality of Sta. Cruz.

The proposed EWS utilizes an Automated Weather System (AWS) and a Water Level Monitoring System (WLMS). If it was to be installed for the whole Sta. Cruz watershed, the information from these systems would be used to predict flooding and serve as the basis for issuing flood warnings.

Photo credit: Isagani Serrano, courtesy of the International Rice Research Institute (IRRI)

Flooding at the municipality of Sta. Cruz after Typhood Ondoy (Ketsana) in 2009.

## The benefits of the early warning system

The estimated initial investment needed to establish the EWS is about PhP 2 million (USD 50,000). This covers the acquisition and installation of the equipment, capacity building and training, and setting up of the monitoring and warning dissemination office. The annual operation cost is about PhP 1.7 million/year (USD 42,500/year).

The EWS project was then evaluated using benefit-cost analysis (BCA). BCA is a method by which the impacts of a project are systematically identified, quantified and monetized to determine the net benefit of the project. Using a discount rate of 15%, the net present value of the EWS was estimated to be about PhP 330 million (USD 82.5 million). The project's benefit-cost ratio was calculated to be 33, while its estimated internal rate of return would be more than 3,000%. These positive findings further validate that the proposed EWS project should be implemented for the whole Sta. Cruz River watershed.

Study results also indicate that respondents in the study site are willing to pay for this technology-based EWS. The estimated mean willingness-to-pay (WTP) was between PhP 127 and PhP 152/household per month. Male respondents were found to have a higher likelihood of saying 'yes' to paying for the project.

## Assessing the three adaptation options for Sta. Cruz

Focusing on the lakeshore barangays of the municipality of Sta. Cruz that are exposed to long-term flooding, the three adaptation options identified – relocation, evacuation, and building modification – were assessed using cost-effectiveness analysis (CEA). This method was chosen because it would have been difficult to monetize or even directly attribute the benefits of the relocation option and the evacuation option.

The proposed relocation option would provide households with core shelters made from concrete and plywood, each of which would have its own toilet and sewerage facility. A 4.6-hectare land already owned by the municipal government would be used. The costs associated with this option would include the cost of acquiring the additional 15 ha

**Table 1.** Costs and cost-effectiveness of the adaptation options

| Options | Capital outlay | Annual operational and maintenance cost | Present value of cost (PhP) (15% discount rate, 25 years) | Incremental cost-effectiveness ratio (ICER) |
|---|---|---|---|---|
| Relocation | 551,940,000 | 120,000 | 552,955,698 | 447,902 |
| Evacuation | 377,519,000 | 3,101,500 | 400,669,058 | 340,413 |
| Building modification | 279,814,900 | 685,100 | 284,928,589 | 279,342 |

needed, construction costs and livelihood support in the form of a one-off payment for the relocated families. Rent for the existing owned land is also included; this is the opportunity cost associated with income that could have been earned if the land was put to other productive use, e.g., agricultural production.

The proposed evacuation center option would also be constructed in the available lot owned by the municipal government. Following international standards of 3.5 $m^2$/person, the three-story center would have a total area of about 29,750 $m^2$. Costs associated with the evacuation option would include 85% of construction costs (as the building is intended to be multi-purpose and includes recreation and storage facilities for use when there are no evacuees), the costs of transporting households to and from the evacuation site, communications, maintenance, and property flood damage costs.

The proposed building modification option would involve improving the resilience of existing house structures to flooding. The project would require money to be diverted from relocation or evacuation efforts to directly assist households in at-risk areas to modify or improve their houses. Since most houses in the area are concrete, modification would entail building a second floor, rather than raising houses on stilts. Since ground-floor bathrooms are not usable during floods, floating toilets would also need to be provided.

## Which is the best option?

When the three options were compared, the study found that the highest capital outlay would be required for relocation (about PhP 552 million), followed by evacuation (about PhP 377.5 million), and building modification (about PhP 279.8 million). The annual operational and maintenance costs would be about PhP 0.12 million for relocation, PhP 3.1 million for the evacuation center, and PhP 0.68 million for building modification (Table 1).

Compared with the other options analysed, the relocation option was deemed to be the most effective in terms of ensuring zero casualties during disasters. However, it is clear that it would require a large capital outlay and would be difficult to implement because people can be reluctant to leave their homes.

Hence, to determine which option is best, it is necessary to compare the Incremental Cost-Effectiveness Ratio (ICER). Results of the CEA reveal that building modification is the most cost-effective option among the three with an ICER of 279,342. This is followed by evacuation (ICER of 340,413), while the least cost-effective option is relocation (ICER of 447,902) (Table 1). Hence, the study recommends that the local government consider financing building modification.

However, it also recommends that more in-depth study is needed on the indirect costs associated with all the proposed projects.

It is intended that the output of this research be used to assist Laguna local government craft an adaptation project proposal for submission to various funding agencies. In addition, it is suggested that the estimates of direct flood damage costs can be used as input for studies that will look into the benefits of flood mitigation projects, such as lake dredging. Hence, it is hoped that this study will be relevant, not only because of its contribution to the existing body of knowledge about flood adaptation, but also due to its direct impact on communities.

**MALAYSIA:** WorldFish headquarters, Jalan Batu Maung, Batu Maung, 11960 Bayan Lepas, Penang
**Tel:** +60 4 626 1606
**Fax:** +60 4 620 2263

**PHILIPPINES:** WorldFish Philippine Country Office, SEARCA Building, College, Los Baños, Laguna 4031
**Tel:** +63 49 536 2290 loc. 196

**Email:** admin@eepsea.net

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