環境省
Ministry of the Environment

IGES Institute for Global Environmental Strategies

LCS-RNet

# Making land-use climate-sensitive

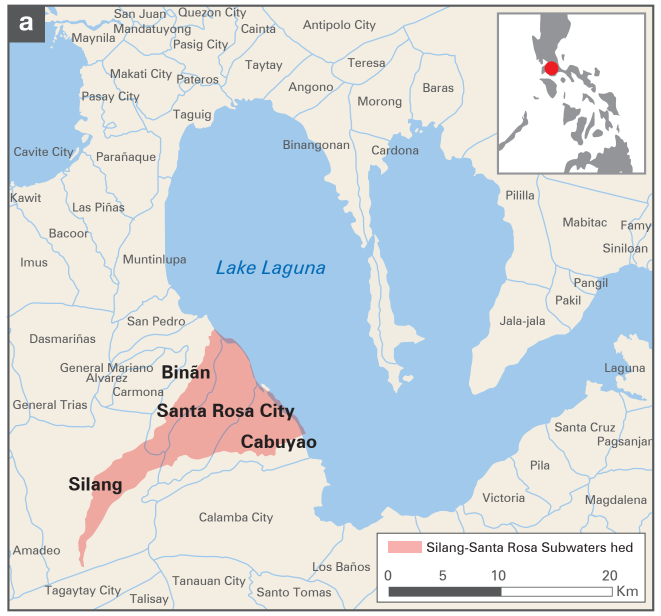
## A pilot to integrate climate change adaptation and mitigation

## Introduction

**While synergies among climate change adaptation and mitigation (CCA&M) policies clearly exist [1-3], little common understanding has been established on how to introduce CCA&M policies in an integrated manner [1, 4-7]. A holistic approach to land-use planning and management at the local level can help meet this challenge [8, 9]. To test this idea, with support from the Ministry of the Environment, Japan and the International Research Network for Low Carbon Societies, the Institute for Global Environmental Strategies and the University of the Philippines at Los Baños launched a pilot project with local governments in the Philippines in 2014. This project aims to examine the necessary conditions for integrating climate change measures – adaptation and mitigation – by improving land-use planning at the river basin level. The project spans several cities in one watershed in the Philippines and engages municipalities and government agencies.**

## Study area

The study area is the Silang-Santa Rosa subwatershed, which is located about 40 km south of Manila, the national capital, and adjacent to Lake Laguna, the largest lake in the country (Fig. 1(a)). The Silang-Santa Rosa subwatershed, one of 24 subwatersheds surrounding the lake, has a basin area of about 120 km$^2$ and accounts for 4.1% of the entire watershed of the lake [10]. Four local governments manage the Silang-Santa Rosa subwatershed, which holds a total population of about 570,000 people: the Municipality of Silang, Cavite (upriver) and the Cities of Biñan, Santa Rosa, and Cabuyao (downriver) [11] (Fig. 1(b)).



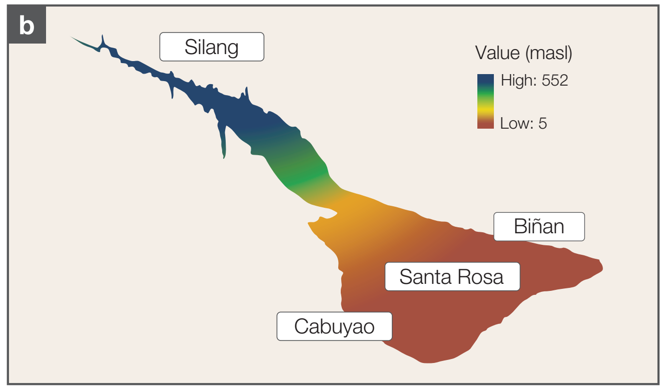




**Fig. 1.** Study area: (a) Silang-Santa Rosa subwatershed, Philippines (Source: Project); (b) Topography with municipalities located in the subwatershed (Source: Project)

## Conclusions

This pilot project is developing and testing an approach to integrate CCA&M at the local level, especially in land-use planning and management, by analyzing risks and setting out countermeasures, including utilizing ecosystem services, in a river basin context. The pilot project emphasizes the need for a holistic approach to land-use planning and management by local governments in the Philippines that incorporates climate change mitigation and adaptation strategies. Collaboration among local government agencies at the river basin / watershed level is critical to an effective response to weather-related disasters, especially flooding, which are expected to become more pronounced with climate change.

The following activities have been proposed for the pilot project in 2015:

- Develop flood-risk maps taking into account future development and climate change, and identify flood damage according to different scenarios of with and without measures;
- Identify, prioritize, and design in detail measures such as zoning and watercourse management;
- Conduct cost-benefit analysis of taking measures; and
- Build and strengthen the capacity of the Integrated Watershed Management Council by creating action plans and by promoting information sharing and dissemination.

## Acknowledgement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## Weather-related natural disaster and local responses

Because of rapid urbanization and industrialization, a vast area of land in the subwatershed, especially the cities of Santa Rosa and Biñan, has been converted for industrial use in the past two decades [12]. Population growth, land-use change, and climate change have altered the water resources in the river basin in ways that have negatively impacted the availability of drinking water, public health, and food security, and are also associated with large weather-related natural disasters such as floods and landslides [11] (Fig. 2). This situation is expected to worsen with development upriver in Silang and climate change likely to exacerbate flooding downriver.

In these circumstances, local governments understand the need to manage land and other natural resources holistically [10]. Local governments in the Silang-Santa Rosa subwatershed have been revising their Comprehensive Land-use Plans (CLUPs), paying attention to both climate change and disaster risk prevention and reduction. Understanding that a coordinated response across the watershed is required, local governments have established the Integrated Watershed Management Council for the Silang-Santa Rosa subwatershed in December 2014. This is the first such council in a subwatershed of Lake Laguna.

**Fig. 2.** Floods in the Silang-Santa Rosa subwatershed from Typhoon Milenyo, September 2006
(courtesy of E.C. Creencia)

## Methodology

The methodology of the pilot project consisted of the following four steps: (i) scenario analysis, (ii) risk assessment, (iii) CCA&M measure development, and (iv) land-use plan improvement (Fig. 3). The first step, ***scenario analysis***, aimed at understanding the problems that the local governments faced in addressing natural disasters and other impacts of climate change, and also the future development and land-use that the local governments planed. Participatory rapid appraisal activities, specifically the key informant and focus group discussions and the participatory mapping, were conducted with representatives from the four local governments. About 30 officials participated in the discussions, who were in charge of urban planning, agriculture, environment, and disaster risk reduction and management. The officials were asked to draw a future land-use map as of 2025 on tracing papers overlaid on the current land-use map as of 2014. The second step, *risk assessment*, aimed to quantify the damage arising from floods due to typhoons and long periods of rain by identifying the areas, population, and structures such as infrastructure, buildings, and facilities, exposed to flood risks. Geographical information system (GIS) and remote sensing techniques were applied, and to estimate the population vulnerable to flooding in the subwatershed, a Landsat satellite image, national census population data, and a flood susceptibility map were used. The future land-use, obtained from Step one, was processed as GIS data. Step three, *CCA&M measure development*, aimed to devise possible climate actions for both adaptation and mitigation in consultation with the local governments and prioritize these actions according to their feasibility and urgency. Another focus group discussion session where a set of possible countermeasures were presented (Table 1) requested the officials to identify measures based on the needs of each local government. Further consultation then led to the identification of priority measures. Step four, *land-use plan improvement*, aimed to support local governments to strengthen their land-use and related development plans through dialogue on the recommendations generated from the previous three steps.


**Fig. 3.** Methodology

## Results

In the scenario and risk analyses, the pilot project has identified the area and population likely to be affected by flooding and examined plausible impacts as further development and climate change are materialized. Fig. 4 (a) shows land-use of the Silang-Santa Rosa subwatershed in 2014 and indicates flood-prone zones. Most of the upriver area is either agricultural land or green space, while downstream areas are mostly developed but do hold some agricultural and unused land. In stark contrast, as Fig. 4 (b) illustrates, about 80-90% of the land in the subwatershed will have been converted for residential and commercial use by 2025. Farmland and forests will only remain in midstream and downstream areas. It is expected that flood damage – observed already in approximately half of the subwatershed (the area surrounded by the red line in Fig. 4(a)) and affecting about 100,000 people – will be aggravated by planned massive land conversion, which will increase the runoff coefficient (i.e. the percentage of rainfall that appears as stormwater run-off from a surface) (Fig. 5). The number of disaster victims and the economic damage that they suffer will increase as a result of increased flooding in terms of area, frequency, depth, and/or duration.

With support of the pilot project, under step three (CCA&M measure development), local governments have started devising climate change measures. These include a wide range of measures, as indicated in Table 1, from structural measures such as the construction of dikes and water storage to non-structural measures relevant to land-use policies, building codes, and ecosystem service enhancement. Some of the measures address adaptation and mitigation at the same time, and could provide non-climate benefits in terms of disaster risk reduction, livelihood creation, and improved health. These measures include the introduction of green space, green building, and afforestation and reforestation.

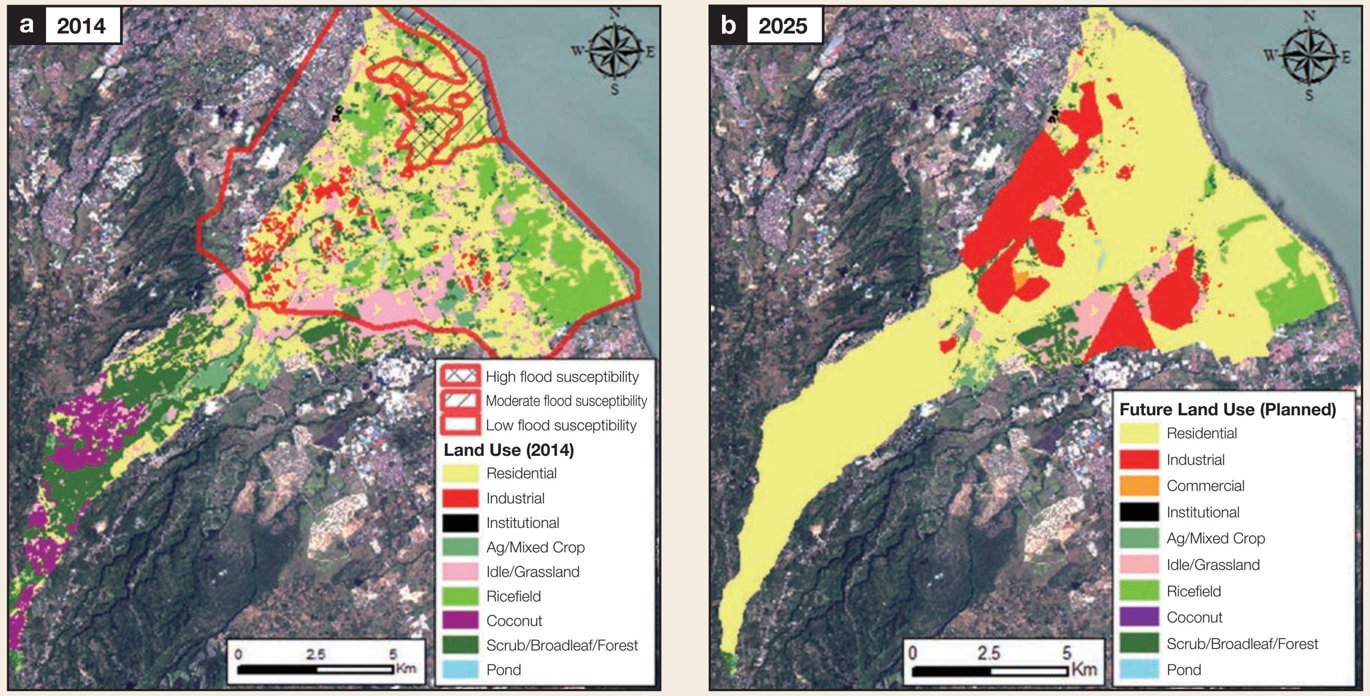


**Fig. 4.** Land-use in the Silang-Santa Rosa subwatershed: As of (a) 2014; (b) 2025 (Source: Project).

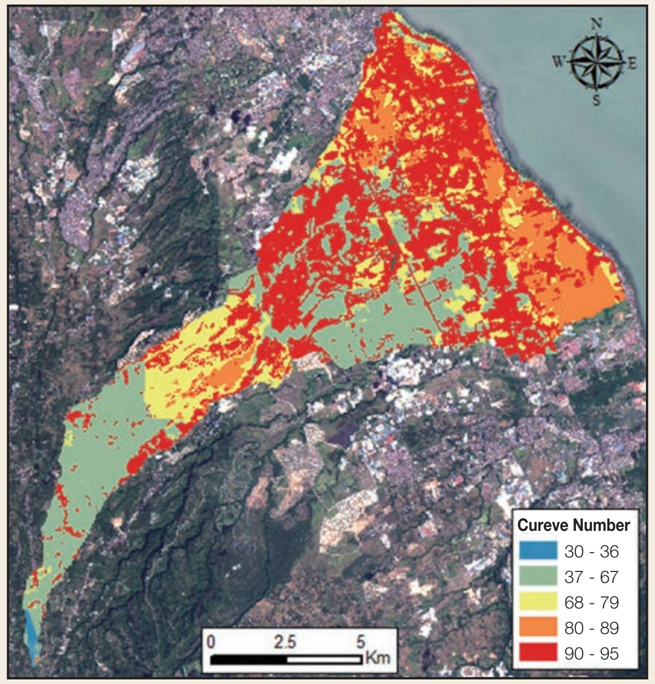


**Fig. 5.** Run-off coefficient of the Silang-Santa Rosa subwatershed in 2014
(Source: Project)

From those listed in Table 1, the local governments have created a preliminary list of priority measures, considering the necessity and feasibility of each measure based on available data and information. These are:

- Strengthened zoning, development control, and building codes;
- Riverbank reinforcement, dredging, and river cleaning;
- Information dissemination and public awareness;
- Run-off mitigation;
- Introduction of green space, green building, and urban agriculture;
- Relocation of informal settlers; and
- Strict law enforcement.

**Table 1.** List of possible measures for climate change mitigation (CCM) and adaptation (CCA)

| Category | Measures | CCM | CCA |
|---|---|---|---|
| Engineered and built-environment options | Flood levees, sea walls, and coastal protection, etc. | | ● |
| | Improved drainage; storm and wastewater management; water storage, etc. | | ● |
| Improved land-use | Development control in high-risk areas | | ● |
| | Green space, urban greening | ● | ● |
| Flood-tolerant, environment-conscious building | Strengthened building codes in high-risk areas (e.g., embankment, high-floored housing) | | ● |
| | Roof greening, green building | ● | ● |
| Ecosystem-based, integrated watershed management | Maintenance and improvement of watershed protection function (flood alleviation, water retention ability) of ecosystem: | | |
| | Development control in upriver areas | | ● |
| | Afforestation & reforestation | ● | ● |
| | Watercourse management (e.g., riverbank reinforcement, dredging, river cleaning) | | ● |
| | Change in varieties and cultivation methods of agricultural products to prevent soil runoff | | ● |

(Source: IPCC[1])