Conclusions

The pilot project is developing and testing an approach to integrate CCAM 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.

Acknowledgement

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References:

10. WPPPhilippines, Santa Rosa watershed: Managing water resources in urbanizing landscapes. 2011.

Contact Information
Research and Information Office, Global environment Bureau, Ministry of the Environment, Japan
Natural Resources and Ecosystem Services, Institute for Global Environmental Strategies (IGES)
Tel: 046-855-3880   E-mail: rei-info@iges.or.jp
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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 in Santa Rosa and Binan, has been converted for industrial use in the past two decades [1]. 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 disasters such as floods and landslides [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 [3]. 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.

Methodology

The methodology of the pilot project consisted of the following four steps: (i) scenario analysis, (ii) risk assessment, (iii) CCAM measure development, and (iv) land-use plan improvement. 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 planned. 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, CCAM 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.

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 food 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 (CCAM 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.

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
- Strait law enforcement.

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

<table>
<thead>
<tr>
<th>Category</th>
<th>Measured category</th>
<th>CCM</th>
<th>CCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecosystem-based, integrated watershed management</td>
<td>Maintenance and improvement of watershed protection function (flood alleviation, water retention ability of ecosystem)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flood-tolerant, environment-conserving building</td>
<td>Strengthened building codes in high-risk areas (e.g., embankment, high-floored housing)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved land-use</td>
<td>Development control in high-risk areas: drought and water management, water storage, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flood-tolerant, environment-conserving building</td>
<td>Improved drainage; storm and wastewater management; water storage, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved land-use</td>
<td>Improved drainage; storm and wastewater management; water storage, etc.</td>
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</tbody>
</table>

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

Fig. 3. Methodology.

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).