Integrating climate change adaptation and mitigation for land-use planning in the Philippines: A participatory, watershed-level approach

Introduction

Climate change adaptation and mitigation (CCA&M) policies should be developed in an integrated manner to maximize their effectiveness [1–3]. There is relatively little common understanding, however, as to how to best achieve this in practice [3–7]. At the local level, holistic approaches to land-use planning and management have the potential to help meet this challenge [8,9]. For example, conservation and restoration of natural ecosystems can reduce both the cause (greenhouse gas emissions) and potential impacts (e.g. stronger typhoons) of climate change. Based on this idea, the Institute for Global Environmental Strategies (IGES) and the University of the Philippines Los Baños (UPLB) – with support from the Japanese Ministry of the Environment and the International Research Network for Low Carbon Societies – launched a project in the Philippines in 2014. This project engages local governments as well as regional/national agencies (including the Laguna Lake Development Authority) in the Philippines, and aims to examine the necessary conditions for integrating climate change adaptation and mitigation measures into the land-use planning process at the watershed level. The project started with four local governments in one watershed (Silang-Santa Rosa watershed) in the year 2014, and it now spans 16 municipalities in five watersheds bordering the lake (Figure 1).

Project news

- Project wins "Dubai International Award for Best Practices to Improve the Living Environment" (http://www.dubaiaward.ae/p/award-winners/2017#).
- Local government unit forum entitled "Climate-smart land-use planning for a sustainable and resilient Laguna de Bay basin" organized by Laguna Lake Development Authority/IGES in October 2018; attended by more than 30 cities and municipalities.
- Project report[11] cited in latest IPCC assessment, "Global Warming of 1.5°C".

Study area

This project covers the Silang-Santa Rosa, San Cristobal, San Juan, Los Baños, and Pila-Victoria watersheds surrounding the Laguna de Bay lake, the largest lake in the Philippines (Fig. 1). This area is located around 40 - 60 kilometers south of Manila, the national capital, and has a total population of approximately 1 million. Generally, the watersheds in the study area located closer to Manila, particularly the Silang-Sta. Rosa and San Cristobal watersheds, are rapidly urbanizing, while those farther from Manila are still predominantly agricultural areas, as can be seen in the recent land-use map in Figure 1.

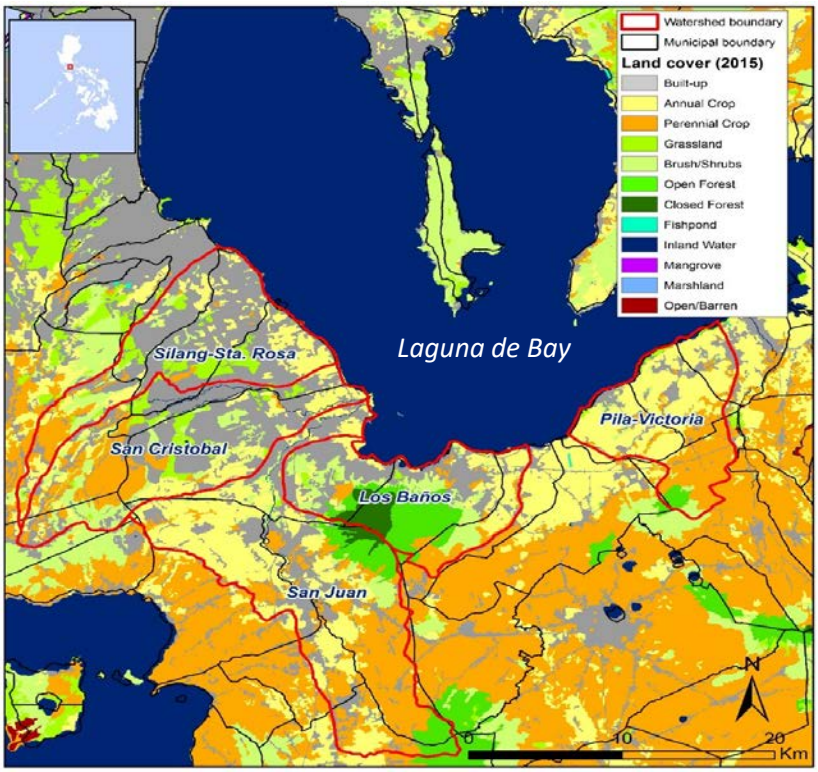

Fig. 1. Study area watersheds, and current (2015) land-use/land cover map (courtesy of NAMRIA). Manila is located in top left corner of the map.

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Motivation for this project

Rapid urban sprawl from Metro Manila has led to the conversion of vast areas of land from agricultural/agroforestry areas to built-up land-uses (residential, commercial, and industrial areas) in recent years [10]. These built-up areas tend to have high rainfall runoff rates compared to vegetated areas, which can result in more flooding and reduced groundwater recharge. Indeed, land-use change and climate change (more frequent heavy rains) have affected the water resources (e.g. water quality and water availability) in this area and increased the risks of climate-related disasters like floods [11] (Figure 2).

This project aims to support local governments with the implementation of local CCA&M initiatives and plans, so-as to reduce the negative effects of future land-use changes and climate change. Specifically, the project provides scientific information to the local governments, which is the result of a participatory scenario analysis and risk assessment procedure.

Figure 2. Floods after Typhoon Milenyo (2006), courtesy of E.C. Creencia (top). Informal settlements located in highly flood-vulnerable areas (bottom)

Overview of the project methodology, results, and policy impact

The methodology of this project consists of the following four steps: (i) scenario analysis, (ii) risk assessment, (iii) CCA&M measure development, and (iv) land-use plan improvement (Figure 3) [11].

The ***scenario analysis*** step aims at understanding the problems that the local governments face in terms of natural disasters, water quality, and climate change, as well as the future land-use plans of the city/municipality. Participatory rapid appraisal activities including key informant interviews, focus group discussions, and participatory land-use mapping, are conducted with representatives from each local government. For the participatory mapping, the government officials produce a map of the land-use changes expected to occur over the next decade (until ~2025-2030) by sketching the future land conversions on a (poster-sized) sheet of tracing paper overlaid onto the current land-use map. This information is later digitized and georeferenced using Geographical Information Systems (GIS) software. Fig. 4. Shows some examples of the methods and results of this procedure.

Figure 3. Project methodology.

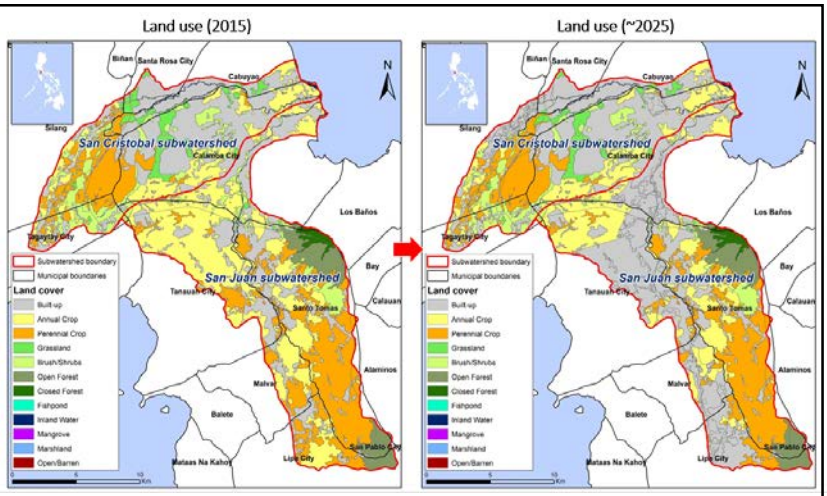

Figure 4. Participatory mapping activity conducted with local government officials (top). Current and future land-use maps in GIS format, generated by digitizing the participatory mapping result (right).

The second step of the methodology, ***risk assessment***, involves estimating the impacts of the planned land-use changes, as well as climate change, on flood risk (e.g. flood extent and number of people affected) and water quality. For this, various hydrological models (HEC-HMS, HEC-RAS, and WEAP) are used. Figure 5 shows an example of flood risk and water quality assessment results, while more detailed explanations of the risk assessment methods and results can be found online at project website: https://www.iges.or.jp/en/natural-resource/ad/pwlm.html

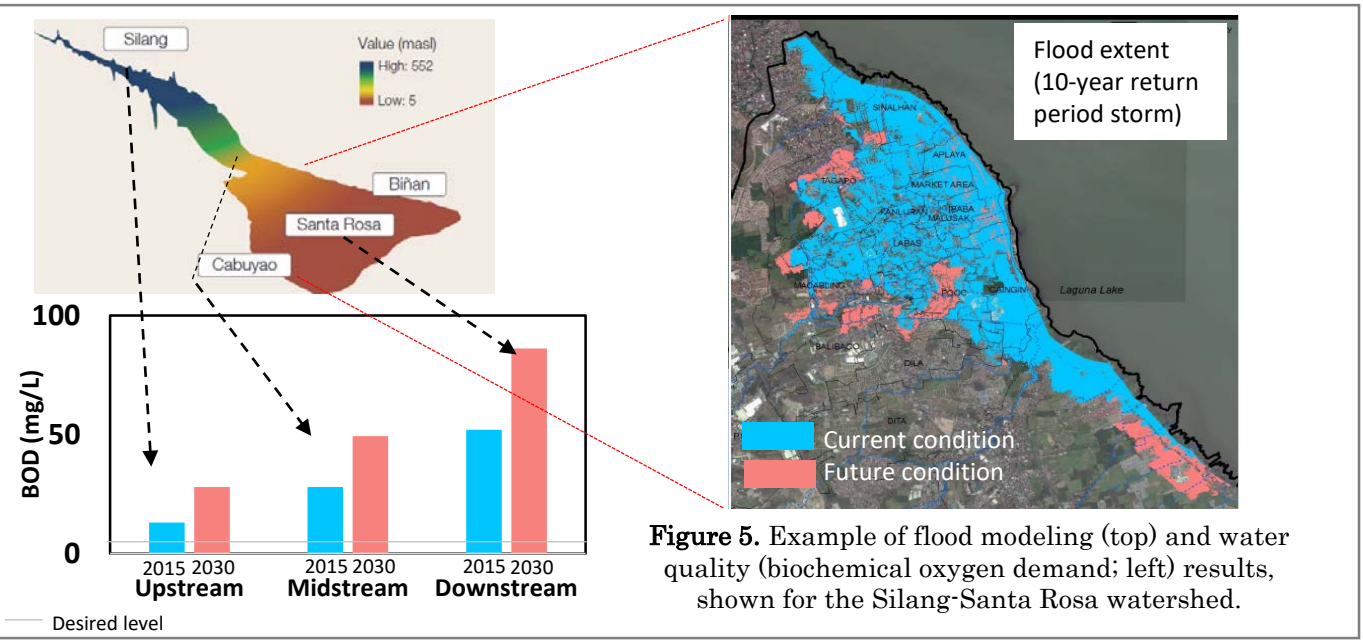

Figure 5. Example of flood modeling (top) and water quality (biochemical oxygen demand; left) results, shown for the Silang-Santa Rosa watershed.

Step three, ***CCA&M measure development***, aims 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 requested the officials to identify measures based on the needs of each local government. Further consultation then led to the identification of priority measures (Table 1) .

Table 1. Priority countermeasures for CCA&M identified by local governments in different watersheds.

1. Zoning enhancement **To reduce natural hazards/climate change impacts and sequester CO2**
● Enforce development controls in areas highly susceptible to flooding, and maintain as much vegetation as possible. ● Strengthen building codes in high-risk areas to mandate measures such as the construction of floodwalls and the introduction of elevated flooring. ● Devise a relocation plan for informal settlers who reside in flood-prone areas. ● Where forest and/or agricultural land is converted to residential or commercial areas, mandate runoff mitigation measures such as tree planting, green parking design, water-permeable paving, and vegetated roofs. ● Take actions for the strict enforcement of zoning ordinances. ● Harmonize land-use among the local governments to manage the river basin as a whole to address climate-related disasters such as flooding downstream by collective planning of the development upstream. ● Acquire land in potential evacuation sites and construct evacuation center ● Prepare areas for livestock and vegetable planting in upland areas.
2. River rehabilitation **To increase water quality and water routing capacity of rivers (e.g., through reforestation, river cleanup, dredging, and riverbank reinforcement)**
● Regular river cleanup ● Protection and improvement through replanting of endemic and indigenous plant species ● Proper zoning and land use planning/implementation ● Rehabilitation of easement and riverbanks ● Construction of slope protection along riverbanks ● Control encroachment of settlements in easement areas ● Dredging of sediments ● Solid and liquid waste management ● Planting of endemic and indigenous plant species ● Improvement of drainage ● Construction of retention pond/Small Water Impound Storage System (SWISS) ● Develop early warning system of flooding ● Regular sampling and chemical and biological analyses of surface and ground water in designated water bodies, river systems and deep well sites
3. Capacity development **To build and strengthen the ability of local government to design and implement climate actions**
● Needs assessments (NA) on climate change adaptation and mitigation (CCA&M) and disaster preparedness and management: Develop survey/assessment instrument to determine the needs for training and public awareness activities; Conduct the NA. ● Development of campaign materials and training modules for CCA&M and disaster preparedness and management ● Conduct of trainings and events to increase awareness and preparedness

Step four of the project methodology, ***land-use plan improvement***, aims to support local governments to strengthen their land-use and related development plans through dialogue on the recommendations generated from the previous three steps. The City of Santa Rosa was the first city in our study area to complete this fourth step, having improved its "Comprehensive Land Use Plan" and developed "Local Climate Change Action Plan" in 2018 (Fig. 6) based on the identified land-use change/climate change impacts and countermeasures. As one specific example, their "Comprehensive Land Use Plan" now states that the flood-affected area shall be designated as "a predominantly low intensity development area which at the same time, according to the IGES study, shall be subjected to measures designed for CCA&M" [14].

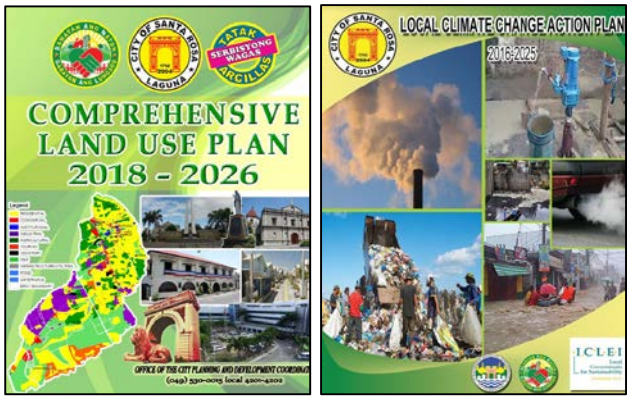

Fig. 6. City of Santa Rosa's "Comprehensive Land Use Plan" and "Local Climate Change Action Plan", both approved in 2018.

Conclusion and further extension

This project has been developing and testing an approach to integrate CCA&M at the local level, especially for land-use planning and management. The approach involves: scenario analysis, risk assessment, identification of priority CCA&M measures, and mainstreaming of these CCA&M measures into local policies and plans. The project has been focusing on the flood risk and water quality impacts of land-use change and climate change, but in the future we plan to consider other impacts including habitat loss/degradation and the well-being of local people, as these different factors are all interlinked. Land-use planning taking into account these interlinkages between various environmental, social and economic factors is also important for helping local governments to contribute to achieving to the Sustainable Development Goals (SDGs) at local, national, and global levels.

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Fig. 7. Photo of local government unit forum (left), local community in the midstream area of the Santa Rosa river (right).

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