

## Multiple stressors and protection efforts in highly urbanized watersheds in the Philippines

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Among developing countries in the tropics, urban stream syndrome is primarily driven by multiple environmental stressors, such as nutrient pollution and habitat degradation, due to social-economic developments in the catchment. To aid in environmental mitigation, improved conservation effort was recently set based on the Convention of Biological Diversity Aichi Target 11 that underscores global expansion of protected areas in terrestrial and aquatic environments. As such, this study aims to disentangle the overlaying effects of nutrient pollution and deforestation on benthic macroinvertebrate communities and assess the recent protection efforts in the watersheds of Laguna de Bay, Philippines. Study sites in Silang-Santa Rosa Subwatershed (13) and Marikina Watershed (16) were sampled for benthic macroinvertebrates and surveyed for environmental factors such as land cover and land use patterns, human population density (HPD), and stream physicochemistry including nutrient concentrations. Multivariate and multiple regression analyses on macroinvertebrate assemblages and environmental variables efficiently delineated sites according to degree of human impacts in Silang-Santa Rosa Subwatershed and the status of protection in Marikina Watershed. Canopy openness, HPD, conductivity, dissolved oxygen, and nutrients (total phosphorus, nitrates, ammonia) appeared to be the most important variables in predicting assemblages of benthic macroinvertebrates. This study effectively demonstrated how Silang-Santa Rosa Subwatershed's HPD and canopy openness, as proxies for human activities and deforestation, respectively, impact stream environments and the benthic communities. Furthermore, the recent establishment of Upper Marikina River Basin Protected Landscape inside Marikina Watershed was successfully used to show how freshwater protected areas are effective in combatting stream habitat destruction and biodiversity loss. Our findings timely show the crucial role of freshwater protected areas in conserving stream ecosystems from the effects of unsustainable urbanization in a developing country like the Philippines.

Keywords: Human population density, Deforestation, Freshwater protected area, Aichi Target 11, Biodiversity loss

