

Point and Non-Point Sources of Water Pollution in Labac-Alemang Watershed, Cavite, Philippines

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ABSTRACT

Due to persistent pollution problems on the water resources of the province of Cavite, particularly on its rivers which drain to Manila Bay, this study aimed to identify and locate the point and non-point sources of water pollution in Labac-Alemang Watershed. Domestic sources and agriculture in terms of livestock and poultry were determined to be the point sources of water pollution in the watershed. The estimated contributed pollution from each of the 57 barangays within its boundaries was determined through population densities and data from municipal agricultural offices that were gathered through key informant interview. On the other hand, GIS mapping coupled with field validation was used to estimate the area of the plantation, urban areas, and rice fields in the watershed which were considered as the non-point sources. Plantation areas were found to dominate the land area, hence, assumed to contribute the most amount of pollutants.

Keywords: Labac River, Manila Bay, river water quality, river basin

INTRODUCTION

In the province of Cavite, watersheds, particularly its rivers, remain to be among the important sources of water needed for domestic, agriculture, industrial, recreational and other uses. Cavite has six major watersheds and the third largest is the Labac-Alemang Watershed, which covers a part of the upland areas of the province, particularly Tagaytay City, portions of the municipalities of Mendez, Indang, Tanza, Naic, and parts of the city of Trece Martires. A total of 57 barangays rely on the provisioning services available from the watershed that has a total drainage area of 9,086.55 ha (90.86 km²). However, as Cavite became the fastest growing and most populated province in the country with 3.68 million population in 2015 (Philippine Statistics Authority, 2016), there has been an increased rate of urbanization and industrialization in the province which threatens the sustainability of its resources. Wastewater discharges from various anthropogenic activities contribute to the pollution load of the rivers of the watershed, resulting in degraded water quality and habitat of aquatic flora and fauna.

Water pollution sources can be categorized into point and non-point sources. Point sources of

water pollution are identified sources that drain to a particular water body. These sources contribute various pollutants, especially if they do not undergo treatment. Regardless of proximity to waterways, households contribute pollution to the rivers through surface runoff, direct wastewater discharge, and sewage overflow. Furthermore, domestic sources contribute pollution load to the rivers through graywater from sinks and drains and blackwater from toilets. A usual case in the Philippines is that when a household lacks proper toilet facility and septic tank, it is most likely that wastewater is discharged directly to the nearest water body, which in the case of Cavite are drainage canals that go into the rivers. On the other hand, non-point sources come from diffuse and unidentifiable confined sources. In watersheds, these are the plantation, urban, rice field, and grassland areas.

According to Cero (2015), high levels of microbiological contamination and indicators of organic pollution were observed in the downstream section of the watershed. These pollutants, whether filtered or treated by either natural or artificial processes, eventually drain to Manila Bay, which is recognized as an important

sea resource and historical landmark of the country. In 2008, the Supreme Court of the Philippines issued a writ of continuing *mandamus* which directs 13 government agencies (MMDA, DENR, DepEd, DOH, DA, DPWH, DBM, PCG, PNP Maritime Group, DILG, MWSS, LWUA and PPA) to rehabilitate, preserve, and restore Manila Bay to SB level (recreational water class I suitable for bathing, swimming, skin diving, etc.; fishery water class I suitable as spawning areas of *Chanos chanos* and similar species) as per DENR Administrative Order No. 34 series of 1990. This stemmed from a complaint filed by concerned residents as early as 1999. In support to this, a study on the total pollution load in the Laguna de Bay-Pasig River-Manila Bay watershed, which included the 58 sub-basins that drain to the bay, was conducted by the Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), Department of Environment and Natural Resources (DENR) and Laguna Lake Development Authority (LLDA) in 2013. Results showed high levels of biochemical oxygen demand, total phosphorus, and total nitrogen from pollution emitted by the industry, domestic, agriculture, and forest sectors into the bay.

This implies that there is a long-standing water pollution problem in the area and this can be attributed to all the pollutants coming from the water bodies and land forms surrounding it and draining into it. Therefore, Labac-Alemang Watershed is among the factors to this situation. As one of the tributaries of Manila Bay and in compliance to the *mandamus*, the rivers of the watershed must then be also rehabilitated - its quality must be improved and there should be reduction in the amount of pollutants that they contribute.

To address this, mitigating measures must be put in place to lessen the damage and prevent further degradation of the aquatic ecosystems, which can eventually affect the lives and the livelihood of the communities dependent on them. To make these measures effective, this study aimed to identify and map the specific point

and non-point sources of water pollution in the watershed to determine the actual and key contributors of pollution to the rivers of the watershed. Identifying these water pollution sources will lead to appropriate actions, policies, and programs for the protection of both the watershed and Manila Bay and for the prevention of the alteration of their current uses and the ecological services that they provide.

Key informant interview and field validation were conducted in Labac-Alemang Watershed (Figure 1) to determine the point and non-point sources

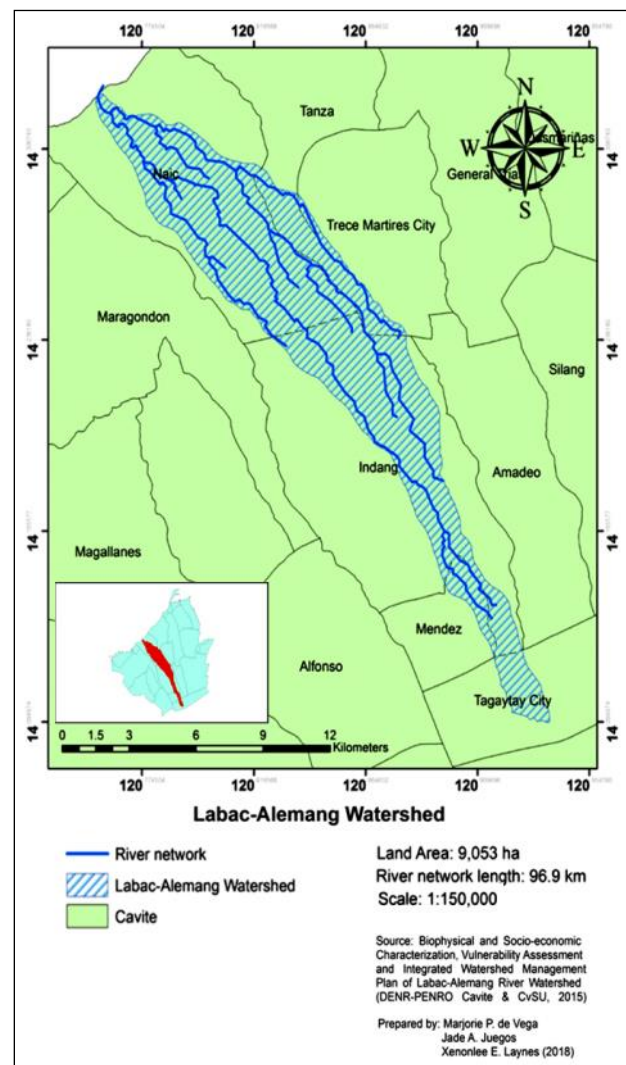


Figure 1. River network map of Labac-Alemang Watershed in Cavite, Philippines

of water pollution. The watershed covers two cities (Tagaytay City and Trece Martires City) and four municipalities (Mendez, Indang, Tanza, and Naic). Human settlements, agricultural sites (poultry and livestock) and industries were classified as point sources of pollution while forests, agricultural lands (arable lands and plantation), and urban areas were considered non-point sources.

In identifying the point sources of water pollution, officials of each of the 57 barangays within the watershed were interviewed to obtain data regarding manufacturing industries and factories, domestic population, and livestock and poultry population. The domestic sources were estimated using the population density of each barangay, multiplied by the barangay area located within the watershed. On the other hand, data on backyard and commercial farms were obtained from the Municipal Agricultural Office. The number of backyard livestock and poultry

such as cattle, goat, swine, duck and chicken was estimated using the population density of each type of animal in each barangay multiplied by the area of the barangay.

In assessing the non-point sources of water pollution, satellite images from Google Earth were used to determine the area and location of arable land, plantations, and urban areas. A land use map was generated using ArcGIS 10.2.1 and each land use type was validated in the field.

RESULTS AND DISCUSSION

Point Sources of Pollution

The point sources of water pollution in the watershed include domestic sources (population) and agriculture (backyard and commercial livestock and poultry farms). No industries currently exist within the watershed.

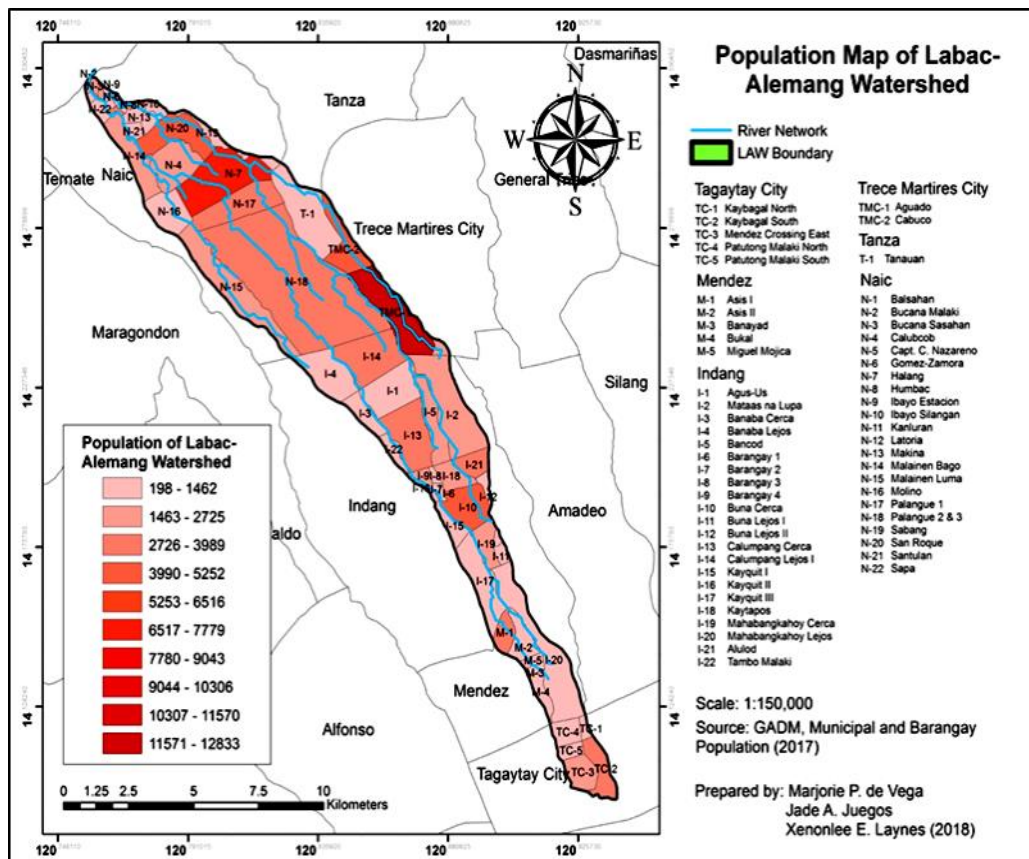


Figure 2. Population map of Labac-Alemang Watershed (2017)

Domestic sources. Domestic sources were assessed through the estimation of population in each of the 57 barangays within the watershed.

Based on population density and land area, there was an estimated population of 109,685 persons within the watershed. Barangay Aguado, which is located in Trece Martires City, has the highest population of 12,833 residents while Barangay Tambo Malaki in Indang has the lowest population of 198 residents. These were based on the most recent population data provided by the barangay for year 2017. Barangay Aguado is situated near the headwaters of one the tributary rivers of the watershed (Figure 2).

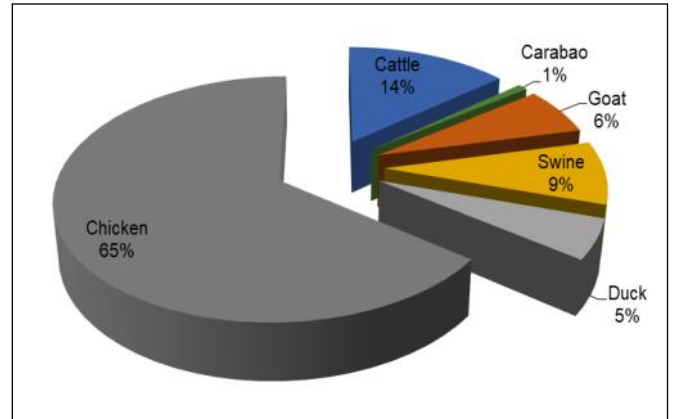


Figure 3. Percentage of backyard animals in Labac-Alemang Watershed (2017)

Backyard animals. The most commonly raised backyard animal in the watershed is chicken (65%), followed by cattle (14%), and swine (9%) (Figure 3). The barangays with the highest

estimated number of backyard animals are Palangue 2 & 3 at Naic, Cavite. Two barangays have no backyard farms (Gomez - Zamora in Naic and Tanauan in Tanza) (Figure 4).

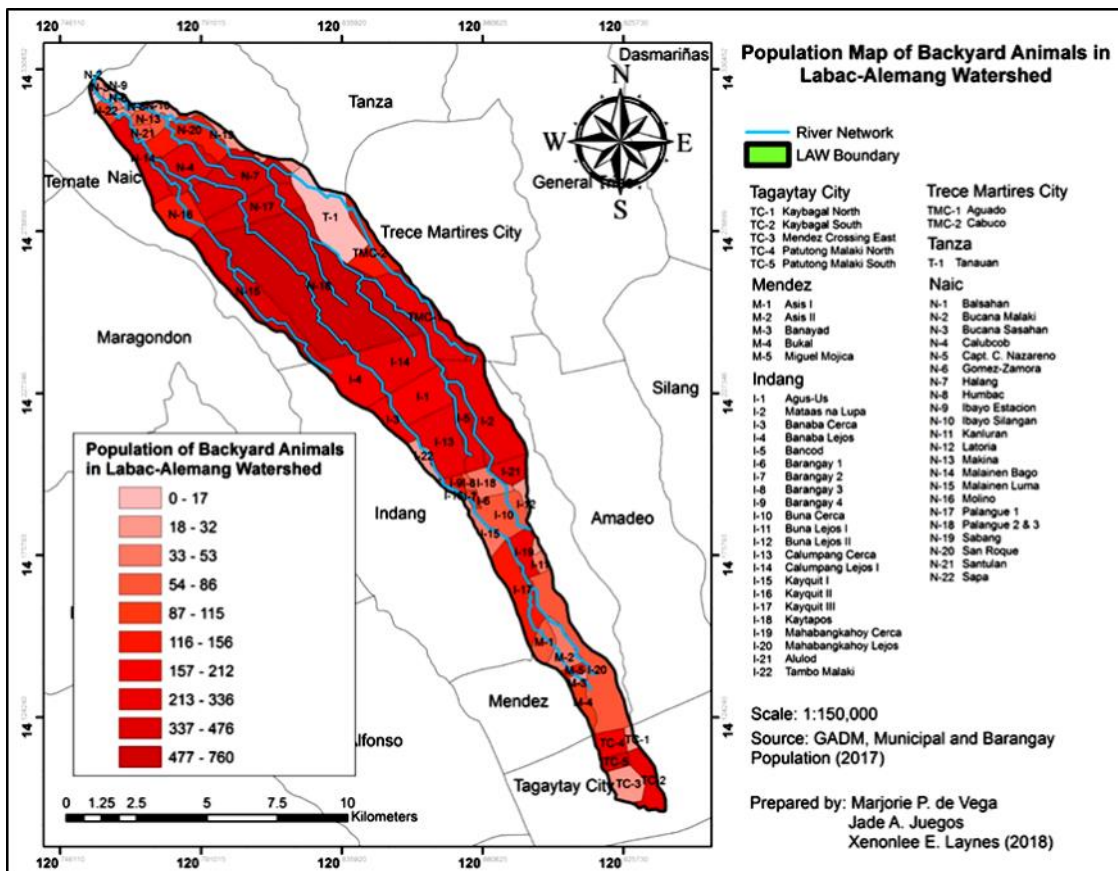


Figure 4. Population map of backyard animals in Labac-Alemang Watershed (2017)

Commercial farms. There are 21 identified commercial farms in the watershed: 12 poultry farms, seven piggeries, one duck farm, and one mixed livestock farm (Figure 5). The largest poultry farm is located in Barangay Palangue 3, Naic while the poultry farm with the least number of heads is in Barangay Kayquit 3, Indang. The piggery farm with the most number of heads is located in Barangay Aguado, Trece Martires City while the farm with the least number of heads is in Barangay Buna Cerca, Indang. The duck farm identified is located in Naic. A state university that is also located within the watershed has a mixed livestock farm that raises a number of cattle, swine, goat, chicken and duck. Out of these 21 commercial farms, seven were identified to have their own sewage treatment facility. Furthermore, these farms are also

located near the rivers at approximately 3-441 m from the stream, which suggest where their wastewater is discharged.

Gamefowl farms. There are 15 game fowl farms identified in the watershed: 12 are in Indang and three are in Naic (Figure 6). The largest farm is in Barangay Palangue 3, Naic while the smallest farm is in Barangay Calumpang Cerca, Indang. These farms are situated at approximately 13.3-385 m away from the river channel.

Non-Point Sources of Pollution

Non-point sources come from diffuse and unidentifiable confined sources. In the watershed, these are the plantation, urban, rice field, and grassland areas. Their land area was based on

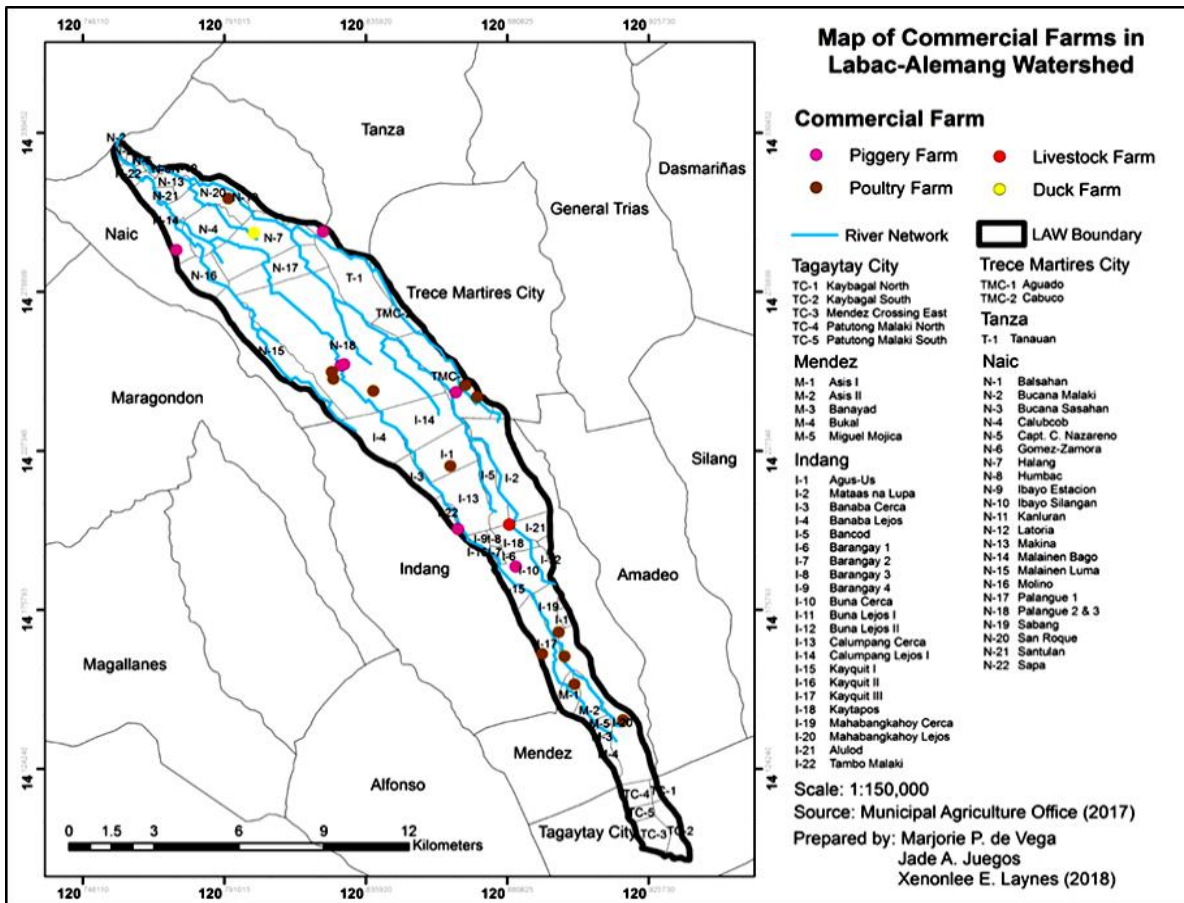


Figure 5. Location of commercial farms in Labac-Alemang Watershed (2017)

Table 1. Land use of Labac-Alemang Watershed (February 2018)

LAND USE	AREA (ha)	PERCENTAGE (%)
Plantation	4,320.53	47.55
Grassland	2,850.89	31.37
Urban Area	1,056.00	11.62
Rice Field	859.13	9.45
TOTAL	9,086.55	100.00

the generated land use map of the watershed which was validated in the field. Labac-Alemang Watershed has a total area of 9,086.55 ha. Plantation accounted for almost half of the watershed, followed by grassland, urban areas and lastly, rice fields (Table 1).

Most of the land areas in the watershed are devoted to plantations except for the lowlands of Naic, where rice is grown. Mono-cultured plantations and mixed orchards of banana, coconut, pineapple, mango, chayote and coffee can be found. The area of rice lands was reported to be decreasing yearly due to problems

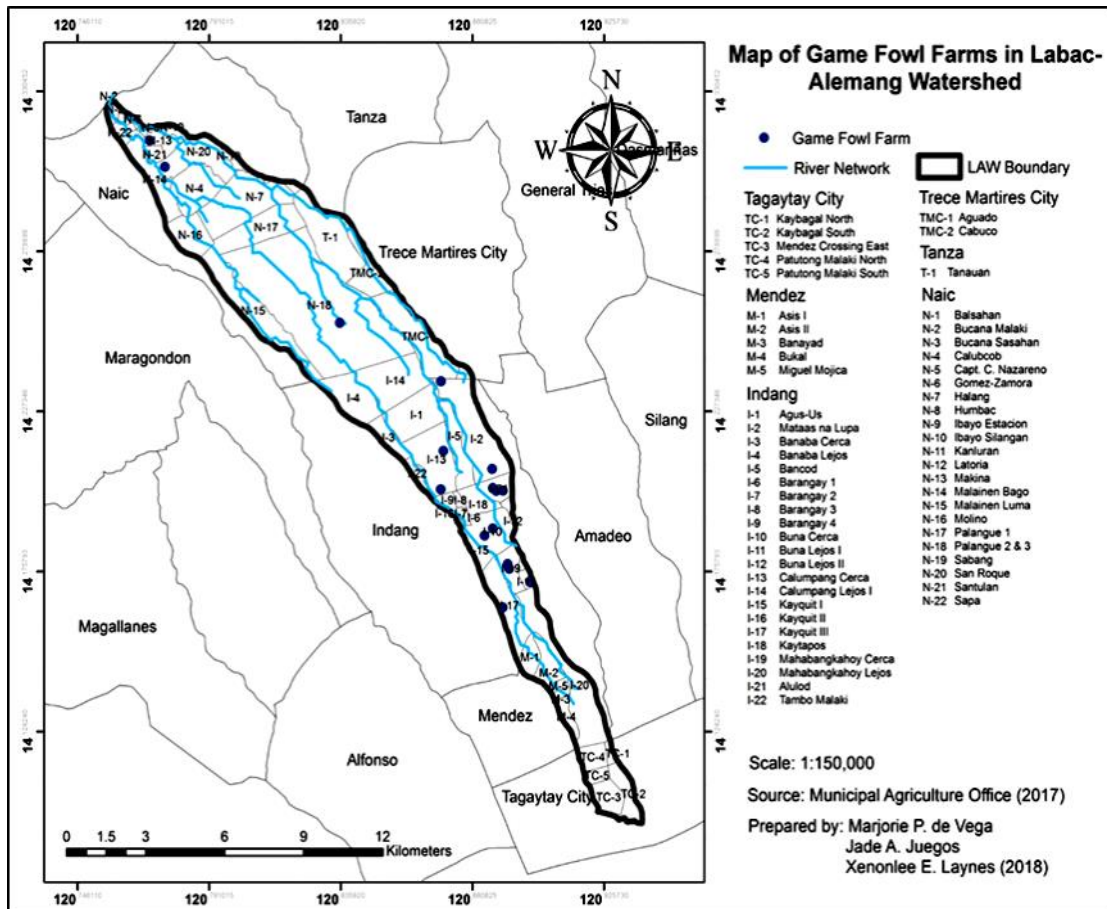


Figure 6. Location of game fowl farms in Labac-Alemang Watershed (2017)

in irrigation and conversion to commercial areas. In terms of urban areas, the watershed has a relatively low portion compared with the other watersheds in the province. The municipality with the largest urban area within the watershed is Indang and most of the urban areas are centralized in the town proper (Figure 7).

Grasslands in the province are usually those that are abandoned and not used for productivity purposes, hence, assumed not to contribute pollutants. Meanwhile, surface run-off from plantations contributes soil to the nearest water bodies, which can result to siltation or sediment pollution, especially if the river banks are already eroded and lacking of vegetation that can

naturally filter sediments and other pollutants before water enters the stream. Fertilizers and pesticides that were used in agricultural areas, such as rice fields, that contain harmful chemicals can also degrade the quality of the rivers and even cause health problems if the rivers are used for drinking and bathing by the communities.

On the other hand, urban areas also contribute pollution to rivers through surface runoff. This happens especially when the streets are polluted with solid wastes that go to canals during heavy rains and flooding events, which eventually reach the waterways.

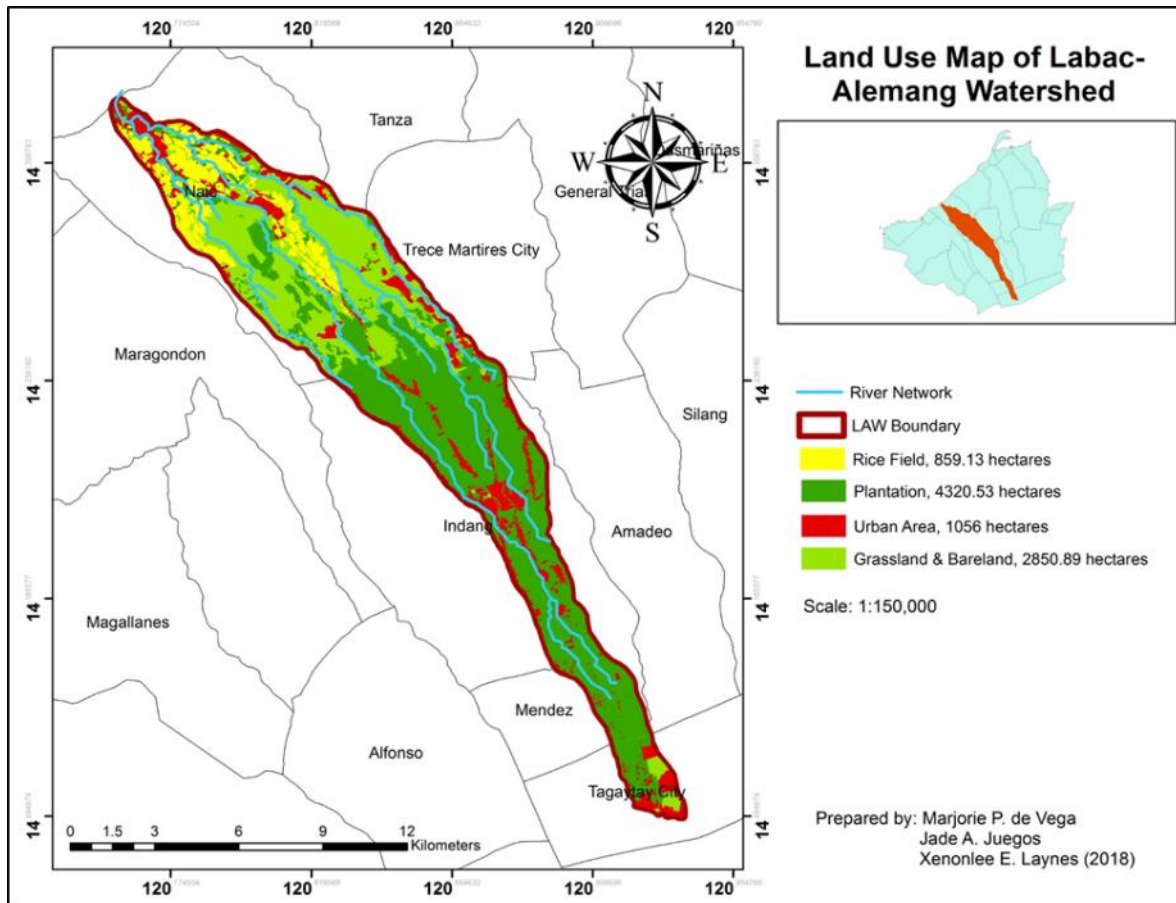


Figure 7. Land-use map of Labac-Alemang Watershed (2018)

CONCLUSIONS

Labac-Alemang Watershed is an important resource of the province of Cavite. However, as the province progressed, it is inevitable that there have been more anthropogenic sources that contribute various forms of pollutants to the environment, which lead to different forms of problems such as water pollution. The point sources of water pollution in the watershed include domestic sources (households and settlements), agricultural sources (livestock, poultry, and gamefowl farms) while the non-point sources are the plantations, grasslands, urban areas, and rice fields. These sources can contribute organic, nutrient, sediment, and microbiological pollution to the waters leading to their deterioration that, when left unaddressed, can lead to severe damages to the aquatic ecosystem and the available ecosystem services to which the two cities and four municipalities in the watershed are dependent on. Proper mitigating measures must be placed, particularly in heavily populated areas and in the areas where high pollution loads are expected to come from, such as Barangay Aguado in Trece Martires City, and Barangays Palangue 2 & 3 in Naic, to reduce their negative contribution to the environment.

RECOMMENDATIONS

Based on the results of the study, it is recommended that the local government units and concerned parties, such as the communities and farms, do their part to address or lessen the pollution load that they contribute through the following interventions: sewage treatment, re-planting activities on riparian zones of the rivers to help increase natural filtration, water recycling activities, and other environment-friendly waste disposal practices. On the other hand, to improve this study, a more thorough inventory of pollution sources, particularly backyard farms, will help improve the data and eventually, the estimation of pollution load, which is equally necessary in identifying effective mitigating measures.

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