EVALUATION OF THE PROPOSED MANAGEMENT OPTIONS FOR LAS PIÑAS–PARAÑAQUE WETLAND PARK USING CLIMATE RISK AND VULNERABILITY ASSESSMENT AND MULTICRITERIA DECISION ANALYSIS

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Master of Environment and Natural Resources Management

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Faculty of Management and Development Studies

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ACCEPTANCE SHEET

This special problem entitled *Evaluation of the Proposed Management Solutions for Las Piñas–Parañaque Wetland Park using Vulnerability Assessment and Multicriteria Decision Analysis* is hereby accepted by the Faculty of Management and Development Studies, U.P. Open University, in partial fulfillment of the requirements for the degree Master of Environment and Natural Resources Management.

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ABSTRACT

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The Las Piñas–Parañaque Wetland Park (LPPWP) in Manila Bay is the 1st critical habitat and the 6th Ramsar site in the Philippines due to the presence of threatened species of birds and also the last mangrove frontier in Metro Manila. In 2019, it was classified as a national park under the eNIPAS Act. The government has done many conservation measures inside the LPPWP since 2007. However, the overall condition of the wetland is still unsatisfactory with a trend toward deterioration. This paper aims to assess the vulnerability of LPPWP to climate change and anthropogenic activities and recommend solutions to improve management of the LPPWP by using the combined approach of Climate Risk and Vulnerability Assessment (CRVA) and Multicriteria Decision Analysis (MCDA). CRVA characterized LPPWP's terrain using geographic information system and the baseline and projected climate using online databases and web-based online tools. Results of the CRVA showed that storm surge, tsunami, typhoons, sea-level rise, and flooding brought by climate change; and pollution, garbage deposition, and reclamation activities in the nearby areas caused by anthropogenic activities are the major threats to LPPWP. CRVA validated that the proposed solutions initially laid out in the draft Vulnerability Assessment Report prepared in 2014 are still

applicable to the current situation. Using MCDA through combined entropy method-TOPSIS approach, the proposed solutions are then scored against criteria and ranked through expert evaluation carried out by independent scientists. Top management options resulted from the MCDA include mangrove restoration, increasing density of deep-rooted trees, building additional security outpost, intensive information and education campaign, eco-tourism with an entrance fee, manual cleaning of garbage, and allowing fishing in the sustainable zone. Management options that require investment such as materials recovery facility, pollutant filtration system and construction of structural buffer walls are at the bottom of the ranking. MRF is acceptable only if done outside the protected area. The study recommends integrating into the Final Plan, currently under preparation, the top management solutions resulted from the MCDA and the additional solutions suggested by experts. It also suggests including in the Final Plan a logical framework and the missing sections in the draft Plan.

Keywords: Las Piñas–Parañaque Wetland Park, climate change, vulnerability assessment, multicriteria decision analysis, TOPSIS, national park management

Declaration

This is to certify that

i the special problem comprises only my original work towards the MENRM,

ii due acknowledgment has been made in the text to all other material used,

iii the special problem is fewer than 25, 000 words in length, exclusive of tables, maps, bibliographies, and appendices

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Chapter I.

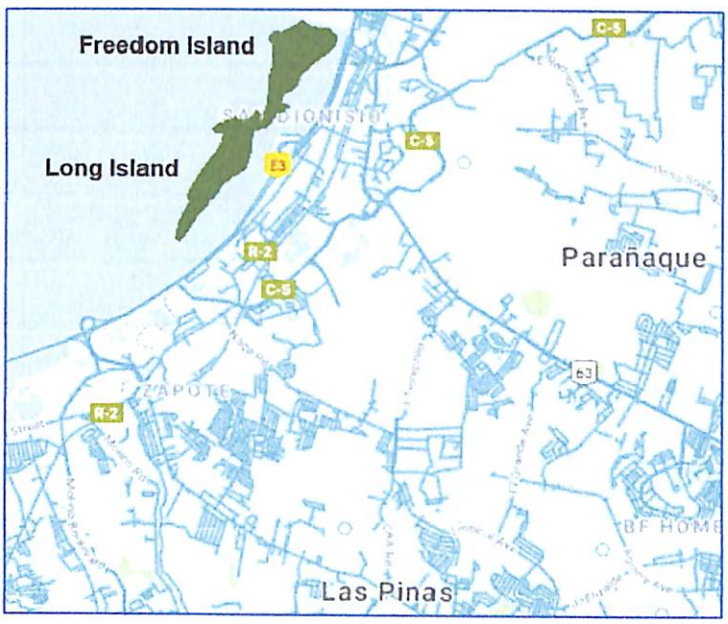
INTRODUCTION

A. Background of the Study

The Las Piñas–Parañaque Wetland Park (LPPWP), formerly called Las Piñas–Parañaque Critical Habitat and Ecotourism Area (LPPCHEA), in Manila Bay is the first critical habitat in the Philippines, an area which is known to be a habitat of certain wildlife species designated as threatened or wildlife species or subspecies considered as critically endangered, vulnerable, or rare, or at risk of extinction. Aside from being a critical habitat for migratory birds and indigenous terrestrial wildlife species, the site, considered as the last mangrove frontier in Metro Manila provides many environmental services: (i) it acts as a carbon sink and for offsetting carbon emission, (ii) as a filter of pollutants produced upstream and downstream, and (iii) as a buffer area protecting the residential, commercial areas, and other important infrastructures along with the coastal communities in Paranaque and Las Piñas from storm surges and floods. LPPWP is also an ecotourism area that provides a place for environmental education, scientific research, and nature conservation activities (e.g., birdwatching, ecotours, and nature walk).

LPPWP, with an area of 175 hectares, is composed of two islands: the Freedom Island at the northwest and the Long Island at the southwest portion (Figure 1).

Figure 1. Location map of LPPWP

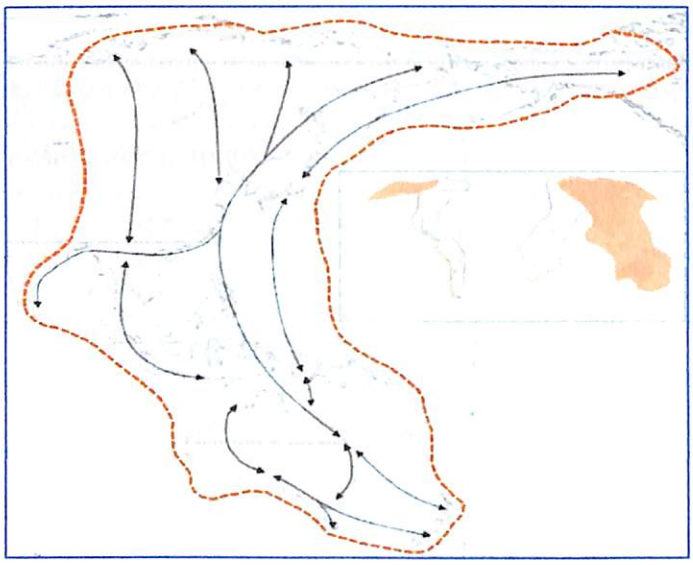


SOURCE: Google Earth, 2020.

LPPWP is a bird sanctuary with more than 85 species of birds and 12 species of mangroves. It hosts at least 5,000 migratory birds making it an important component of the East Asian–Australasian Flyway that stretches from the north in Russia, China, and Japan to South East Asia and finally to Australia and New Zealand (Figure 2). It signifies one of the most important shorebirds and waterbird migratory flyways in the world (WBCP, 2012).

LPPWP was also declared as a Ramsar site, the 6th in the Philippines, due to the presence of threatened species of birds such as Chinese Egret, rare Pied Avocet, Siberian Rubythroat, and the Philippine duck. These wild birds enhance the coastal ecosystem through the dispersal and fertilization of the vegetation, especially the mangroves, which in turn provide shelter for various insects and other wildlife that serve as food by birds and other predators.

Figure 2. East Asian–Australasian Flyway



SOURCE: BirdLife International.

The coastal lagoon was pronounced a critical habitat and ecotourism area by Proclamation No. 1412 dated April 22, 2007, to conserve and protect the wetland and the threatened migratory and local wild birds. A Management Council, composed of DENR as the Chair and representatives from the Philippine Reclamation Authority, Department of Tourism, the City Governments of Las Piñas and Parañaque, non-government organizations, and people's organizations with direct stake in the area, was created to develop the Master Plan that will provide the criteria and guide the development in and around the area according to universally established and scientific principles to ensure the protection of critical bird habitats. An Ecotourism Business Plan will also be developed to ensure sustainable tourism and management and promote environmental awareness and education in the area.

The draft Framework Plan prepared by the Management Council and

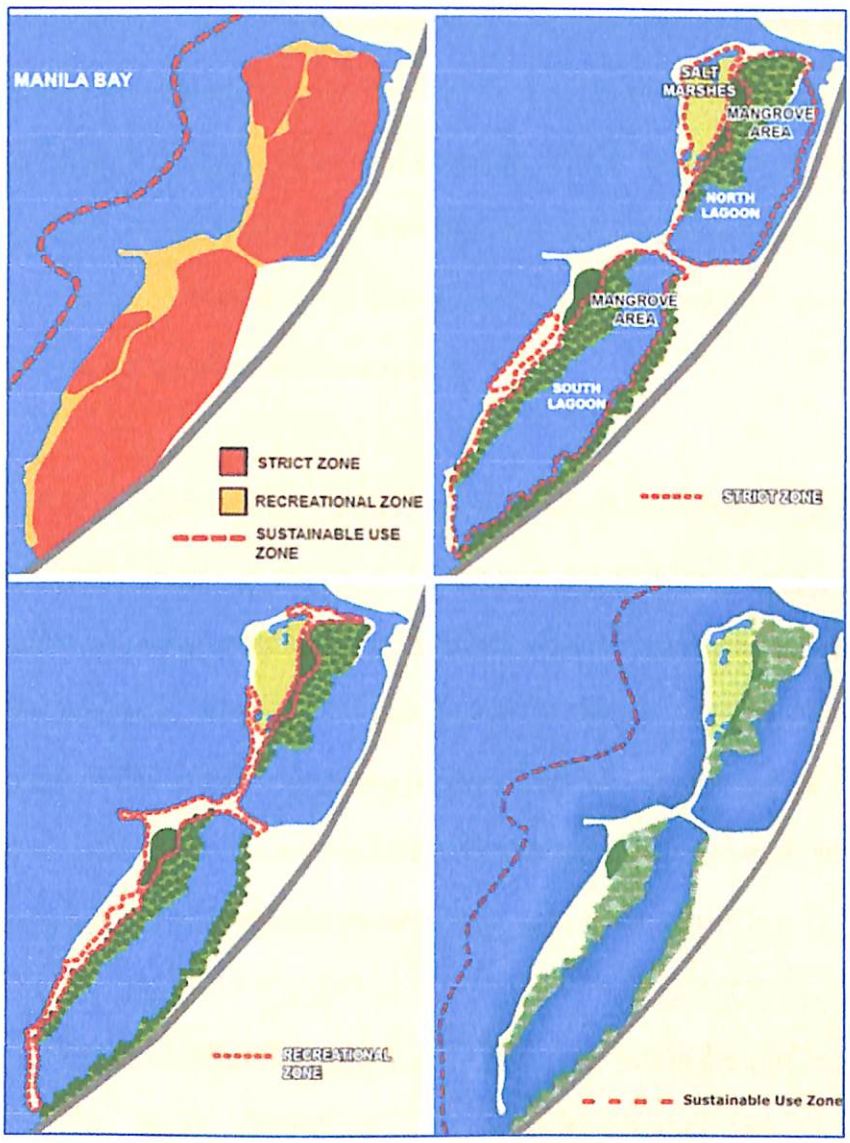
developed through consultation with various stakeholders was approved on September 13, 2012. The draft Framework Plan focuses on zoning within the protected area. A zoning plan aims to establish a coherent spatial framework that relies on systematic conservation planning to achieve the desired state for biodiversity and aesthetics/tourism objectives of the park thereby minimizing conflicts between different users of a park. There are three zones in LPPWP: strict zone, recreational zone, and sustainable use zone (Table 1 & Figure 3).

Table 1. Zoning Plans for LPPWP based on the 2014 Draft Framework Plan.

Zoning	Description
Strict zone	Mangrove areas, salt marshes, and mudflats. Public access is strictly limited in this zone as its objective is for habitat restoration and biodiversity enhancement.
Recreational zones	Freedom Island and Long Island (except for the mangrove areas and lagoons) Visitors have free access to this area. It consists of (i) a visitor's center/administration office, eco-lodge, food stalls and parking areas, and (ii) bird watching, and research facilities, including an education center.
Sustainable zones	Reserved for use and access of local communities for livelihood development purposes. Fishing, shellfish collection, and other low impact economic activities will be allowed.

SOURCE: Draft Framework Plan for LPPWP, 2014

Figure 3. Zoning scheme for LLPWP



SOURCE: Draft Framework Plan for LPPWP, 2014.

In 2018, the LPPWP was further reclassified and legislated as a national park. In May 2019, the Implementing Rules and Regulations for R.A. 7586, or the National Integrated Protected Areas System (NIPAS) Act of 1992, as amended by R.A. 11038, or the Expanded NIPAS (ENIPAS) Act of 2018, was finalized and listed the LPPWP as a protected area within the classification of

national park. Expanded NIPAS defines national parks as lands of the public domain classified as such in the Constitution which include all areas under the NIPAS, primarily designated for the conservation of native plants and animals, their associated habitats, and cultural diversity. Under the International Union for Conservation of Nature (IUCN), national park is under Category II, which is primarily managed to protect natural biodiversity and at the same time, promote opportunities for education and recreation.

LPPWP is quite complex as it is situated inside an urban area, which is subject to urban edge effects and threatened by flooding, encroachment, intensification of urban development, and affected by solid waste, water, air, and noise pollution. It is also challenging to infuse nature into a built environment. At the same time, urban protected areas provide opportunities for urban people to experience nature and increase their awareness of ecological connections and concern for nature (Worboys & Trzyna, 2015).

As of 2020, the Final Management Plan for LPPWP is still not completed, and the zoning within LPPWP is not yet implemented. The 2014 draft Framework Plan is used by the Protected Area Supervisors (PASu) and other LPPWP staff to manage the site. Currently, entry to LPPWP is only allowed for photography, ecotours, nature walk, birdwatching, company social responsibility, outreach and community work activities, cleanup activities, and research. A permit from DENR to be secured seven days before a visit is needed to gain access to the site for the above activities.

B. Significance of the Study

Being part of the Manila Bay, LPPWP lacks the barriers that stand between the islands and the seas, which makes it vulnerable to climate change impacts such as sea-level rise, tropical cyclones, and extreme rainfall events. LPPWP is also surrounded by three rivers – on the north by Parañaque River, Zapote River on the northeast, and on the south by Las Piñas River. Aside from these three rivers, Manila Bay is drained by seven major rivers from 26 catchments. This makes the LPPWP highly vulnerable to anthropogenic activities such as improper waste disposal since all pollutants coming from these rivers end up in it. It is also located near densely populated areas, which poses major threats to its existence including illegal human encroachment, garbage deposition, poaching, and destruction of mangroves. It is also threatened by the proposed reclamation projects in Manila Bay.

To address the above risks from climate change and anthropogenic activities, a Vulnerability Assessment Report was prepared by DENR staff and consultants for the LPPWP which laid out options for its management. However, the Vulnerability Assessment report is already outdated, having been developed in 2014. There is also only a small section discussing climate change since the report focuses on threats due to anthropogenic activities. The report itself recommends that the potential impacts of climate change on the LPPWP should be monitored regularly.

The first part of this study sought to complement and update the 2014 Vulnerability Assessment report by conducting a Climate Risk and Vulnerability Assessment (CRVA) to have more comprehensive and up-to-date information on climate hazards and associated risks and vulnerabilities of LPPWP. Based on the results of CRVA, the study assessed the applicability of the potential management options, initially recommended in the draft Vulnerability Assessment report for LPPWP, in the current situation.

The second part of this study aimed to contribute to the decision-making and finalization of the Management Plan for the future management of the LPPWP by conducting a multicriteria decision analysis (MCDA), wherein the validated potential management options in part 1 were used as alternatives to be scored against management criteria. The set of alternatives involves several interests and objectives such as conservation of the critical habitat, subsistence fishing, and tourism. As highlighted by the draft Framework Plan, looking at the issue from the conservation perspective only will limit the range of opportunities for the area to merely a bird and wildlife sanctuary and will not benefit the broader segments of society. Thus, an MCDA, taking into account the area's ecological, sociopolitical, and economic impacts will help determine the best management solutions among the set of alternatives.

C. Objectives

The primary objectives of the study were: to assess the vulnerability of LPPWP to climate change and anthropogenic activities, to evaluate the proposed management solutions and climate change mitigation and adaptation measures for LPPWP, and propose recommendations for the finalization of the Management Plan for improved management of the LPPWP as a national park. The secondary objectives were to:

(i) characterize the terrain using geographic information system, and calculate the baseline climate and projected climate of the LPPWP using online databases;

(ii) map the climate risks and hazards to LPPWP using web-based online tools to complement the 2014 Vulnerability Assessment;

(iii) validate the management options identified in the 2014 Vulnerability Assessment report, and if necessary, adding other options proposed by experts, and identifying experts' position concerning these options;

(iv) conduct MCDA to assess the proposed management solutions for the improvement of the management of LPPWP; and

(v) recommend integrating into the Final Management Plan for LPPWP the best management solutions resulted from the MCDA.

Chapter II.

REVIEW OF RELATED LITERATURE

LPPWP is an urban protected area recently classified as a national park with the primary objective of protecting natural biodiversity. Vallejo (2012) found that LPPWP, as an artificial reclaimed habitat, supports the highest species diversity and number in Manila Bay likely due to various habitats ranging from sandy beaches, mudflats, mangroves, and estuaries. The said study supports the preservation of the habitat that has likely important ecological and scientific value. It also described the training and capacity building conducted for DENR staff on basic taxonomy and species identification, sampling strategies, and statistical analysis; and recommended some ecosystem restoration strategy to preserve the coastal habitat, with a particular focus on mudflat restoration in LPPWP. Meanwhile, the Ecosystems Research and Development Bureau of DENR conducted a study to develop a technology using selected bacteria in enhancing the degradation of plastic wastes collected in LPPWP.

Another objective of LPPWP as a national park is to promote educational opportunities. Several universities are conducting research studies on LPPWP since it is the nearest nature laboratory in Metro Manila. Some of these studies relate to mangrove forestry, wildlife management, ecology, botany, and biology. Ocampo et al. (2015) surveyed the mollusks along the intertidal zone of LPPWP and found that 22 out of 34 mollusk families were found to be the major source of the birds' nourishment. Gabriel and Salmo (2014) and Hallare et al. (2015) studied the efficiency of *Avicennia marina* in phytoaccumulating the heavy

metals in LPPWP. Cabal and Duzon (2016) isolated and identified fungal endophytes from the leaves of the mangrove *Avicennia sp.* Meanwhile, Onza et al. (2017) conducted molecular identification and phylogenetic analyses of Streptomyces sp. isolates using the 16S rRNA Gene. In 2014, Balangue listed the number of students from various schools who researched LPPWP, which averages to around 200 students per year from 2011–2014.

LPPWP's continued provision of the above services is challenged by pollution and urban development since it is in a vicinity close to an urban area. Beltran-Cruz et. al (2017) assessed the water surface quality in the area and found that samples taken from Las Piñas River and South Lagoon were the most polluted. Vallejo et al. (2019) analyzed the relationship between environmental quality on invasion potential in Manila Bay and hypothesized that pollution-driven events either prevent or facilitate biological invasion. With regards to urban development, De Leon et al. (2017) focused on implications of land-use change processes to urban protected area management and found that land-use conflicts are due to the competing ecosystem services derived by stakeholders and lack of coordination between land use planning and protected area management. Mercado (2018) analyzed governance of urban wetland including existing laws and regulations and how institutional arrangement affects the level of coordination among actors and found gaps due to unclear delineation of roles and responsibilities and undocumented agreements. LPPWP was also included in the publication by the United Nations University in 2014 with the main findings that (i) there is a lack of coordination among entities working on biodiversity, (ii) key documents and spatial data were

missing, and (ii) the site is threatened by waste and water pollution and a large project to reclaim the area for development.

As an urban protected area, LPPWP requires special management. IUCN Urban Protected Areas report in 2014 provides profiles and best practice guidelines that can be adapted by protected area managers. In the Philippines, the available reports which are good references in preparing the LPPWP management plan are the Manila Bay Sustainable Development Master Plan and Manila Bay Situation Atlas 2018 since LPPWP is part of Manila Bay. For LPPWP, the only available reports specifically focusing on management solutions are those prepared by DENR in developing the Framework Plan. The Framework Plan was developed based on the Ecological Profile, Species Inventory, and the Vulnerability Assessment Report prepared for LPPWP. The Vulnerability Assessment Report prepared by Dr. Balangue in 2014 assessed the vulnerability of LPPWP to water pollution and the vulnerability of avian habitat to potential destruction by anthropogenic activities given the habitat requirements and island stability factors. The Vulnerability Report recommended solutions to improve management of LPPWP, which were revalidated in this study and were evaluated by experts to select the best management options for the area using multicriteria decision analysis.

The use of multicriteria decision analysis (MCDA) is increasing in environmental management due to the high degree of complexity and uncertainty in this area. MCDA is also used in selecting adaptation solutions to address climate change. Davies et. al (2013) suggested that MCDA provides a

valuable decision-support tool, particularly for aiding negotiation toward management compromise and innovation. Garmendia and Gamboa (2011) mentioned that the use of MCDA tools in combination with participatory approaches provides a promising framework for integrating multiple interests in natural resource management and proposes a compression process to reduce the set of social preferences through cluster analysis. Karjalainen et al. (2013) developed an analytic-deliberative approach to assess restoration options by combining the ecosystem services framework with the interactive MCDA approach. Knights et al. (2014) state that decision-makers must consider the environmental, social, and economic costs and benefits in deciding whether to implement a management action and proposes a stepwise process of decision-making under uncertainty. These studies underline the importance of MCDA as a decision support system for environmental managers and stakeholders.

In the Philippines, there is also an increasing trend in recent years on the use of MCDA in decision making. MCDA was used in selecting composting as a waste management strategy in Bacoor (Louis, 2007), addressing traffic congestion in the Philippines (Bongo, 2016), in establishing criteria for landfill siting (Regalado et al., 2017), identifying opportunity areas for development of new aquaculture-related research (Araneda et al., 2018), selecting hydropower locations in Iligan City (Badang, et al., 2018), analyzing suitable sites for Diversion Dams in Quezon (Baltazar et al., 2019), flood-risk assessment for Davao Oriental (Cabrera et al., 2020), and assessing the implementation of the nuclear plant (Peñaranda, 2020), which suggest a growth in the applications of MCDA in decision making particularly in environmental management areas.

Chapter III.

METHODOLOGY

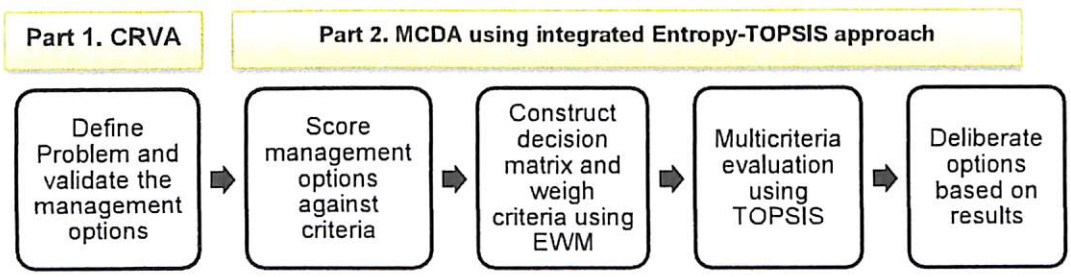
A. Research Framework

A combined approach of climate risk and vulnerability assessment (CRVA) (Part 1) and multicriteria decision-making analysis (MCDA) (Part 2) was used in selecting management options for LPPWP. CRVA assessed and validated the applicability of the proposed management options listed in the 2014 Vulnerability Assessment Report for LPPWP to the current climate scenario. After validating the proposed options, a questionnaire was developed to determine the best management solutions for LPPWP. A total of 15 experts from various sectors were asked to fill in the questionnaire. Results of the survey were analyzed using MCDA by employing the entropy weight method and Technique of Order Preference Similarity to the Ideal Solution (TOPSIS) method. The results were then used in coming up with the top management options that will aid the LPPWP management to address current issues as they update and implement the LPPWP management plan.

The MCDA is a tool that aims to evaluate the relative importance of multiple criteria in a decision scenario. The purpose of the decision-making was to select the most desirable alternatives from a discrete set of feasible alternatives to a finite set of criteria. The set of alternatives for the management of LPPWP was assessed using MCDA. As shown in Figure 4, the steps in MCDA using combined entropy weight method (EWM) and TOPSIS involve

defining the problem, identifying the options and criteria to rank potential solutions, scoring the options against the criteria, developing the decision matrix by averaging all individual decisions matrixes to depict the group opinion, calculating the weight of the criteria using the EWM, conducting the multicriteria evaluation using TOPSIS, and finally ranking the alternatives.

Figure 4: Framework of analysis for this study on LPPWP



Step 1. Define the problem and identify the management options based on CRVA

Assessing the climate risk, hazard, and vulnerabilities of the protected area is an important step to ensure its conservation since it helps in selecting the right management solutions and climate change mitigation and adaptation measures. Using online databases and web-based online climate tools, the climate risk and vulnerability of the LPPWP was assessed in this study by (i) characterizing the basic terrain of LPPWP using shapefiles from PhilGIS and generating maps using the System for Automated Geoscientific Analyses (SAGA) program, and calculating the baseline and projected climate using downloaded data from World Bank Climate Change Knowledge Portal and Meteoblue, and (ii) evaluating the climate risks and hazards based on the

projected changes in temperature and rainfall by generating hazard maps using web-based online tools such as ThinkHazard, Project Noah, and HazardHunter. The result of the CRVA was used to validate the applicability of the management options initially laid out in the draft 2014 Vulnerability Report. The validated management options were identified as the set of alternatives for the MCDA.

Step 2: Score management options against criteria

Description of the set of alternatives or the proposed management options validated in step 1 and the questionnaire developed for this study were shared with the experts in the field of environment, social safeguards, and economics who are the respondents in this study. The experts were asked what attributes (criteria) should be considered in developing a management plan for LPPWP. The experts then evaluated the performance of each option and scored against the criteria. A Likert scale was used from 1 to 5 (1 being the lowest, and 5 being the highest).

Step 3: Construct decision matrix and weigh criteria using EWM

The decision matrix was then constructed by averaging all individual scores given by the experts. Weights of the criteria were calculated by employing the EWM using the information within the decision matrix. EWM was used since according to traditional literature, the results of the EWM are always reliable and effective (Lu, et al., 2010; Zhou, et al., 2012) and it is often

combined for assessing weights in the TOPSIS method (Table 3). In the entropy method, every criterion has the probability of execution or chances (Mohare, 2020). The steps involved in calculating weights of criteria using EWM are shown in Table 2.

Table 2. Steps in the Entropy Method used in calculating weights of criteria

(1) Normalize the decision matrix and calculate the entropy value. The entropy weight function is based on the discrete probability distribution $$ej = \frac{-1}{\ln(m)} \sum_{i=1}^{m} nij \ln (nij)$$ *where m = no. of alternatives, and n = no. of criteria*
(2) The degree of diversity (d) possessed by each criterion is evaluated as $$dj = 1\text{-}e, j = 1,2,3$$
(3) The weight objective for each criterion is given by $$Wj = \frac{di}{\sum_{i=1}^{n} di}$$

Source: DMT Learning website

Step 4. Multicriteria Evaluation

The Technique of Order Preference Similarity to the Ideal Solution (TOPSIS), a classical MCDA method, was used to compare and rank the alternatives using the weights calculated from EWM (Step 3 above). The TOPSIS model was selected because it is an easily understandable method, and it does not limit the number of criteria identified in the decision-making process. The TOPSIS calculates the relative closeness of weighed criteria to

an ideal alternative. It considers the distances of the alternatives to both positive ideal solution (PIS) and negative ideal solution (NIS). A preference order is ranked according to their relative closeness and a combination of these two distance measures. The best alternative has simultaneously the shortest distance from the PIS and the farthest distance from the NIS. The PIS is identified with a hypothetical alternative that has the best values for all considered attributes, whereas the NIS is identified with a hypothetical alternative that has the worst attribute values. The steps involved in TOPSIS are shown in Table 3.

Table 3. Steps in the TOPSIS Method used in analyzing the results of the survey in LPPWP

(1) Normalize the decision matrix $nij = \frac{xij}{\sqrt{\sum_{i=1}^{m} xij^2}}$, i=1,2,...m, j=1,2,...n
(2) Calculate the weighted normalized decision matrix *Nij = wij * nij*
(3) Determine the positive (Aj^+) and negative (Aj^-) ideal solutions $Aj^+ = \{(\max Nij \mid j \in J'), \{(\min Nij \mid j \in J'),\ i=1,2,...m = \{A_1^+, A_2^+, A_3^+, \cdots A_n^+\}$ $Aj^- = \{(\min Nij \mid j \in J'), \{(\max Nij \mid j \in J'),\ i=1,2,...m = \{A_1^-, A_2^-, A_3^-, \cdots A_n^-\}$
(4) Measure the distance from positive and negative ideal solutions $Si^+ = \sqrt{\sum_{j=1}^{n}(Nij - Aj^+)^2}$ *for i € [1,m] and j € [1,n]* $Si^- = \sqrt{\sum_{j=1}^{n}(Nij - Aj^-)^2}$ *for i € [1,m] and j € [1,n]*

(5) Calculate the closeness coefficient (CC) to the ideal solutions $CCi = \frac{si^-}{si^- + si^+}$ *where* $0 \leq CCi \leq 1, i \in [1,m]$
(6) Rank the preference order

SOURCE: DMT Learning website

Step 5: Deliberate options based on results

Based on the result of the decision-making tools used and taking into consideration experts' opinions, a set of solutions to improve the management of LPPWP are recommended.

B. Sampling

Purposive sampling, a type of non-probability sample technique, particularly expert opinion sampling was used. An expert is defined as someone having specialist knowledge acquired through training, education, or experience. Krueger et.al. (2012) mentioned that sample sizes of 6-12 can achieve the objectives of the expert identification process above, and beyond these numbers, gains in robustness may be too small to outweigh higher costs.

In many complex environmental systems, the best available information may be in the form of expert opinion, which can help provide a summary of the limited available knowledge, to inform policy before conclusive scientific evidence becomes available, and to serve as the basis for action when problems are too urgent or stakes are too high to postpone measures until more complete knowledge is available (Kangas & Leskinen, 2005; Knol et al., 2010).

Expert sampling was used in this study because it aims to provide a recommendation on the finalization of the Management Plan for LPPWP. Experts can validate the proposed management options from the draft 2014 Vulnerability Assessment due to their expertise and experience, and propose more management solutions if they deem necessary.

This study collected information from 15 experts who have a high degree of knowledge and experience in the field of environment, economics, and social development. Respondents include (i) environmentalists, climate change specialists, and conservation managers, (ii) social safeguards specialists, (iii) economists, and (iv) representatives from civil society organizations, and wild bird enthusiasts.

C. Data Collection

1. ***Desk Reviews***. Data on climate change were gathered from various reports and analyses by international agencies (World Bank Climate Change Knowledge Portal, Food and Agriculture Organization), government organizations (PAG-ASA, Project Noah), and research institutes.

a. ***Baseline Climate***: Data for LPPWP were initially collected from Meteoblue, a weather provider that models climate based on the Nonhydrostatic Meso-Scale Modelling (NMM) technology, which enables the inclusion of detailed topography (mesoscale = 20-1 km; micro-scale = < 1 km), ground cover (e.g., forest, fields, rock, water) and surface cover (e.g., water),

as well as the initialization (measurement data at the start of calculation) into the modeling process. Temperature data from Meteoblue, simulated from Ninoy Aquino International Airport (NAIA), the nearest weather station from LPPWP, yields a relatively higher temperature data. This is because, even if the distance from NAIA to LPPWP is only 5 kilometers, the landscape is very different — NAIA is an airport within a city while LPPWP is a wetland, with many trees and mangroves. For this reason, a modeled temperature data from World Bank Climate Change Knowledge Portal (CCKP) was downloaded, compared with MeteoBlue data, and was used as the baseline climate.

b. Projected Climate: Data were gathered from World Bank CCKP and PAGASA website. Projections of climate variables i.e., rainfall, maximum temperature, and minimum temperature are based on the statistical downscaling of global climate models (GCMs). GCMs estimate the possible future climate conditions given a particular greenhouse gas (GHG) concentration i.e., representative concentration pathway (RCPs). RCPs, introduced by the Intergovernmental Panel on Climate Change Fifth Assessment Report (IPCC AR5; IPCC, 2013) is based on different GHG emissions scenarios developed to capture the uncertainty of the scale of future economic activity and the global response to reducing emissions. The four scenarios are:

- RCP2.6: Major GHG mitigation scenario (421 ppm CO_2 by 2100)
- RCP4.5: Some GHG mitigation, stabilization scenario (538 ppm CO_2 by 2100)
- RCP6.0: Some GHG mitigation, stabilization scenario

(670 ppm CO_2 by 2100)

- RCP8.5: Very high GHG emissions scenario, little effort to reduce emissions (936 ppm CO2 by 2100).

RCP8.5 is referred to as the "business as usual" scenario. RCP4.5 and RCP6.0 scenarios both assume some reductions in GHG emissions. RCP2.6 aims at a very high GHG mitigation and is not considered realistic for strategic planning purposes.

PAGASA data downscaled the GCMs to regional climate models (RCMs) to provide a more spatially detailed quantity at local scales. Climate projections in the Philippines were based on RCP4.5 (moderate level GHG emissions) and RCP8.5 (high level of GHG emissions). Using the RCP-based collections and the new Climate Information Risk Analysis Matrix (CLIRAM) Tool, DOST-PAGASA projected climate futures for 2036-2065 and 2070-2099 relative to historical climate (1971-2000) for all provinces in the country.

Since PAGASA data are on a province-level only, i.e., single data point for Metro Manila, the World Bank CCKP was used to gather data for LPPWP given the latitude and longitude as input to the database. World Bank CCKP employs the Coupled Model Intercomparison Project, Phase 5 (CMIP5) model with data presented at a 1°x1° global grid spacing and provides options to visualize climate variables and indices for different timeframes, statistics, and RCP scenarios.

c. ***Climate Risks and Hazards*** were mapped using ThinkHazard, a service by the World Bank; from Project Noah, a program managed by the University of the Philippines that combines science and technology for disaster risk reduction and management and uses advanced technologies to enhance geo-hazard vulnerability maps; and from HazardHunter, a tool which generates hazard assessment reports based on updates provided by government agencies. Basic terrain such as slope, flow accumulation, water channels, and closed depressions was analyzed and mapped using the SAGA-GIS program using data from PhilGIS. SAGA GIS is a free open-source software that provides a user interface with many visualization options. PhilGIS is a single-access portal of free Philippine geospatial data for educational and nonprofit use.

d. ***Data on vulnerability due to anthropogenic activities.*** Virtual library and internet research were also conducted to find the most relevant articles and studies connected to the research problem.

e. ***Management options and climate change and mitigation measures.*** The main source of the management solutions to solve the problems in LPPWP is the draft Vulnerability Assessment Report prepared by DENR in 2014.

2. ***Consultations with Experts:*** Environmentalists, climate change specialists, conservation managers, and environmental advocates have first-hand knowledge and experience on the extent of how climate stressors affect the area. Consultations and collaboration with experts are necessary to gain

their perspective on the vulnerabilities of the critical habitat to climate change and anthropogenic activities. Economists and social safeguards specialists were also consulted to obtain their views on the economic and social value of LPPWP. Individual elicitation was carried out remotely using questionnaires, which gives freedom for the interviewees to respond in their own time, and safe from COVID-19 since no travel and face to face interaction is required. Input from experts was used to reveal their perception of the system, to elucidate the preferences in the MCDA, to identify and refine preferred management solutions, and to add more recommendations, if necessary.

3. ***Site visit.*** A site visit was requested from DENR and was granted to this researcher to access the site on 21 November 2020. Site visit was conducted to verify, and supplement information gathered from secondary sources, to speak with any of the available Park staff, and to take photographs of the site. Site visit strictly followed COVID-19 protocols to ensure the safety of both the researcher and the Park staff.

Chapter IV.

RESULTS AND DISCUSSION

A. CLIMATE RISK AND VULNERABILITY ASSESSMENT OF LPPWP

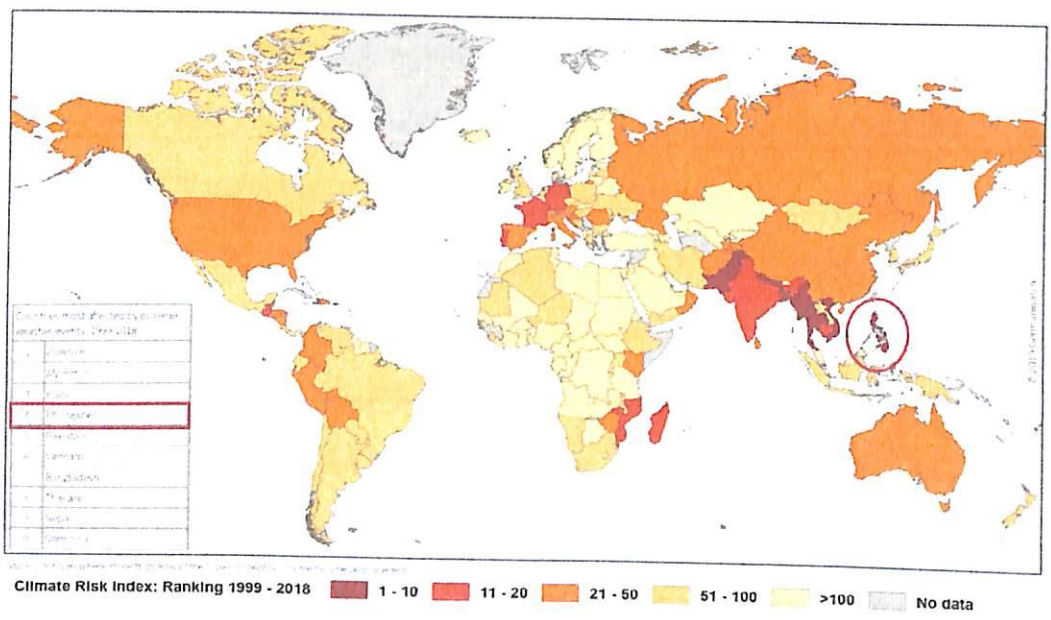
Climate change refers to a statistically significant variation in either the mean state of the climate or in its variability, which persists for an extended period, typically decades or longer. Climate change may be due to natural processes or to persistent anthropogenic changes in the composition of the atmosphere or land-use (IPCC & WMO). It involves increasing temperature that causes global warming, which then results in a rise in sea level, weather changes, extreme droughts and La Niña, and others which impact food security, habitats, and pose risk to humanity.

In the Philippines, climate change will significantly impact the poor and the vulnerable. As of 2018, the Philippines has a population of 106.7 million, with 16.6% living below the poverty line, who are most likely self-employed farmers, fishermen, or other agricultural workers. Seventy-five percent of these people live in severe disaster-risk areas that are highly rural. On average, the Philippines experiences 22 tropical cyclones a year, of which around 6 to 7 cause significant damage (UN Ocha, 2020). Between the period 1997-2016, a total of 289 weather events, of which 10 were deadly, resulted in annual average mortality of 860 people and caused total damage to crops, infrastructures, and properties of over P140 billion. Five out of the 10 deadliest

typhoons occurred only since 2006, which experts believe to be caused by climate change.

The Philippine geography is the major factor that makes it the 2nd most affected country by climate change, as listed by the Global Climate Risk Index (CRI) 2020. Due to its geographical location, it is recurrently affected by catastrophes such as tropical cyclones (Typhoon Bopha in 2012; Typhoon Haiyan in 2013; Typhoon Mangkhut in 2018; and Typhoon Rolly and Ulysses in 2020) that cause strong winds and heavy rains making it continuously rank among the most affected countries in the global CRI. CRI indicates a level of exposure and vulnerability to extreme events. The Philippines is an archipelago located in the Pacific Ocean (Figure 5), which makes it vulnerable to sea-level rise and strong typhoons.

Figure 5. Global climate risk index rating (1999-2018)



SOURCE: Global Climate Risk Index 2020.

In an article by the United Nations (2018), scientists said that the Earth only has 12 years to maintain global warming at 1.5°C. Any further increase in temperature will cause droughts, floods, extreme heat, extreme weather, and poverty. This highlights that climate change is happening. Currently, the earth is 1°C warmer than the pre-industrial level. If it continues to 2°C, there will be water stress, coastal and river flooding, food scarcity, heat-related deaths, more forest fires, extreme weather events, and habitat loss, and coral die-offs.

PAGASA Climate Change webpage shared that climate change is also happening in the Philippines as the change cannot simply be explained by natural variation. It mentions that global warming is caused by an increase in GHG concentrations from human activities, such as the burning of fossil fuels and land-use change. PAGASA presented a study on 3 climate change scenarios (high-range emission scenario), (medium-range emission scenario), and (low-range emission scenario) with two time-slices centered on 2020 (2006-2035) and 2050 (2036-2065). Results showed that the Philippines, like most parts of the globe, has exhibited increasing temperatures and a very slight increase in the number of tropical cyclones with maximum sustained winds of greater than 150 kph and above (typhoon category). The increase in the number of hot days and decrease in the number of cool nights are also statistically significant. The National Capital Region of Manila is one of the areas with the highest vulnerability. With its densely populated areas, disasters pose a serious threat to both people and economic assets (Yusuf & Francisco, 2009).

If climate change is not addressed, the following will continue — increasing ocean temperature, rising of the sea level, extreme heating events, extreme rainfall events, and disturbed water budget. In the country, the sea level is rising at a rate twice the world's average, which contributes to increased storm surges like in the case of Typhoon Haiyan in 2013. The Philippines is one of the countries hit hardest by climate change impacts because it is more vulnerable to the damaging effects of a hazard but have lower coping capacity.

The Las Piñas–Parañaque Wetland Park

The LPPWP is particularly vulnerable to the above impact of climate change since it is located along a coastal area. These projected impacts are major threats to the protected area and will challenge its continued provision of ecosystem services. Being a critical habitat for migratory birds and an important component of the East Asian–Australasian Flyway, climate risk identification is necessary to ensure that adequate risk mitigation or adaptation measures are integrated into the finalization of the Management Plan.

Table 4. Characteristics of the LPPWP physical environment based on Ramsar Site No. 2124 information sheet (2013)

Geology and Morphology	Man-made Islands formed from reclamation projects of the government in the early '70s

Soil type & chemistry range	Loam with a dominant component of sand soil type, organic matter laden, pH: neutral to alkaline (5.5- 8.5), phosphate-rich, medium to a high concentration of zinc, copper, and iron
Origin	Artificial, reclamation area
Salinity	Brackish/saline the pH level of water averages 7.2 which falls within the standard for class C freshwater category which is 6.5-8.5. Due to its high nutrient content, the surrounding water is found to be eutrophic
Climate	Dry season from November to April and wet season for the rest of the year. The average temperature for the wet season is 28.1`C while it is 27.1`C for the dry season. The average rainfall for the wet and dry seasons is 244.6 mm and 33mm, respectively.
Tidal Variation	1.25 meters

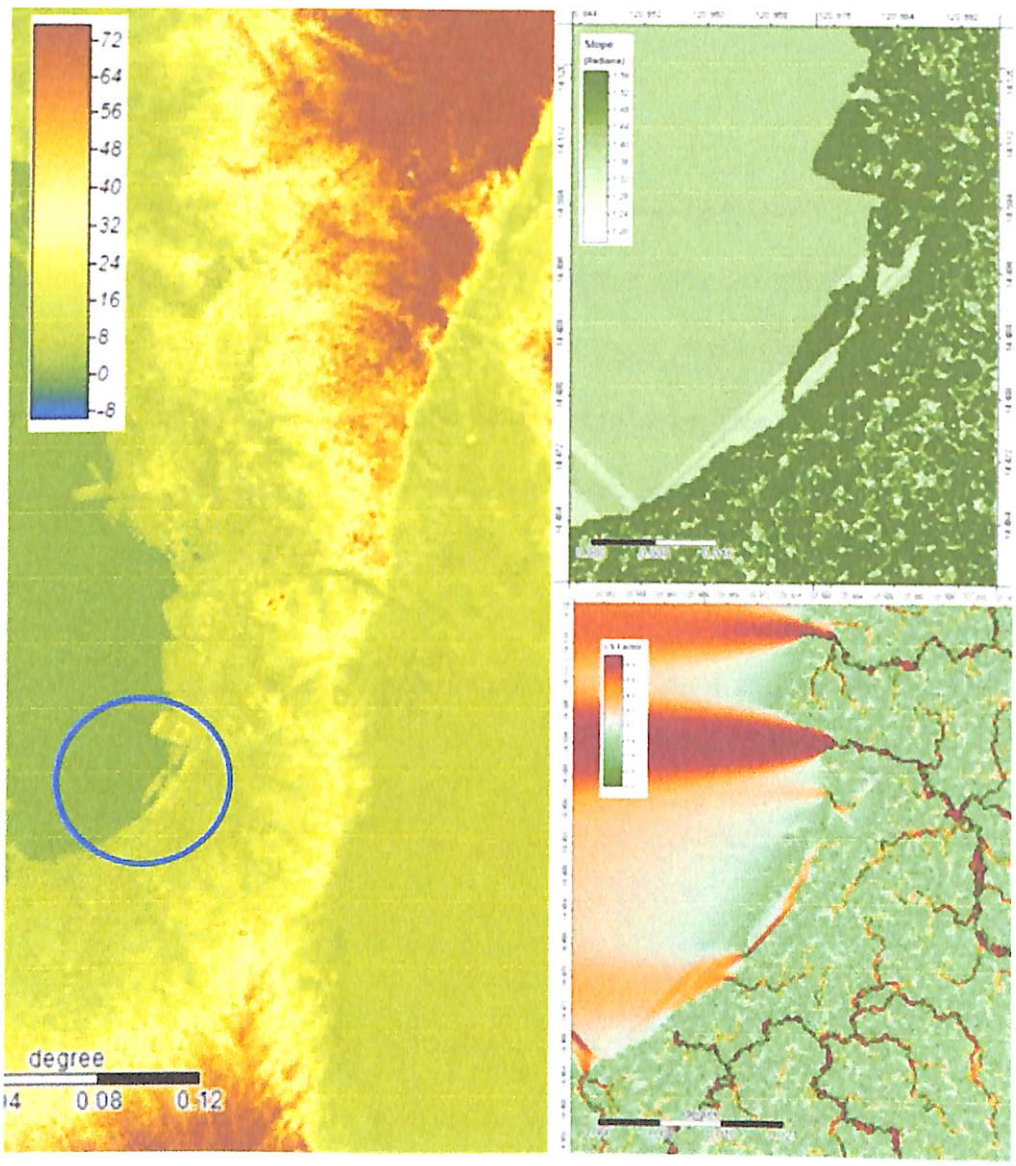
SOURCE: Information Sheet on Ramsar Wetlands, Ramsar Site No. 2124. Ramsar Organization.

Basic Terrain Analysis

Terrain analysis uses elevation data together with other geospatial information to describe a landscape. Using the shapefile downloaded from the PhilGIS website, the terrain map of LPPWP was generated using the SAGA-GIS computer program. Terrain analysis showed that LPPWP is low-lying with

its elevation only 0–7 meters above mean sea level. The slope of LPPWP is around 1.56%, which is the usual slope of basins in Manila Bay. LPPWP is relatively flat, with areas of less than 3% slope (Figure 6).

Figure 6. Elevation, slope, and LS factor of LPPWP



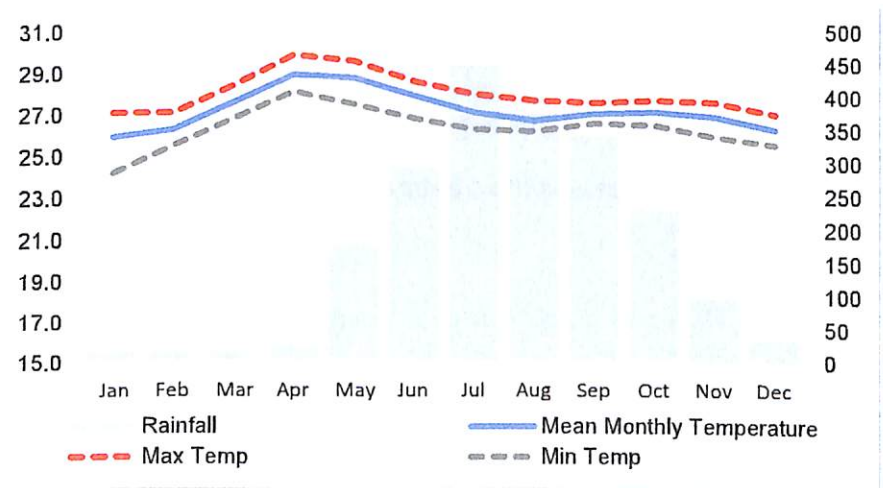
SOURCE: Generated from SAGA-GIS using PhilGIS shapefiles.

Baseline Climate of LPPWP

The baseline climate for LPPWP calculated using downloaded data from World Bank CCKP is presented in Figure 7. The weather archive for LPPWP shows simulation data, not observed data, and is based on 30 years of hourly weather model and simulations. The simulated data give good indications of typical climate patterns and expected conditions.

In Figure 7, the mean maximum (solid red line) shows the maximum monthly temperature for LPPWP. It is highest during the months of March to May ranging from 28°C–30°C. The mean minimum (dotted grey line) shows the average minimum temperature. It is lowest from December to February ranging from 24°C–25°C. The mean annual rainfall in LPPWP varies from 1,800 to 2,600 millimeters annually.

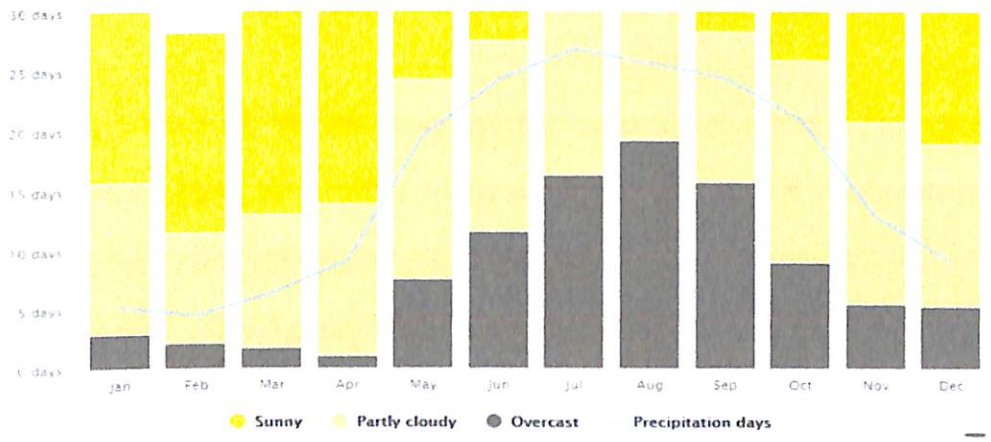
Figure 7. Mean, maximum, and minimum temperature and rainfall in LPPWP



SOURCE: World Bank CCKP, accessed October 2020.

Figure 8 simulated from MeteoBlue, shows the monthly number of sunny, partly cloudy, overcast, and precipitation days. Days with less than 20% cloud cover are considered as sunny, with the longest days from the months of February to April. It is also during April that migratory birds come to LPPWP to rest and refuel, making their way to the warmer regions of the globe. A survey by DENR and Wild Bird Club of the Philippines (2013) found that the number of birds seen in the area can reach as high as 5,000 heads per day during the migration season. Days with 20%–80% cloud cover is partly cloudy and with over 80% is overcast.

Figure 8. Cloudy, sunny, and precipitation days in LPPWP



SOURCE: Generated from Meteoblue, 2020.

Projected Climate of LPPWP

Global climate models have been valuable tools for producing climate projections. The Coupled Model Intercomparison Project 5 (CMIP5) provided several GCMs that incorporate carbon emission scenarios. Using data from

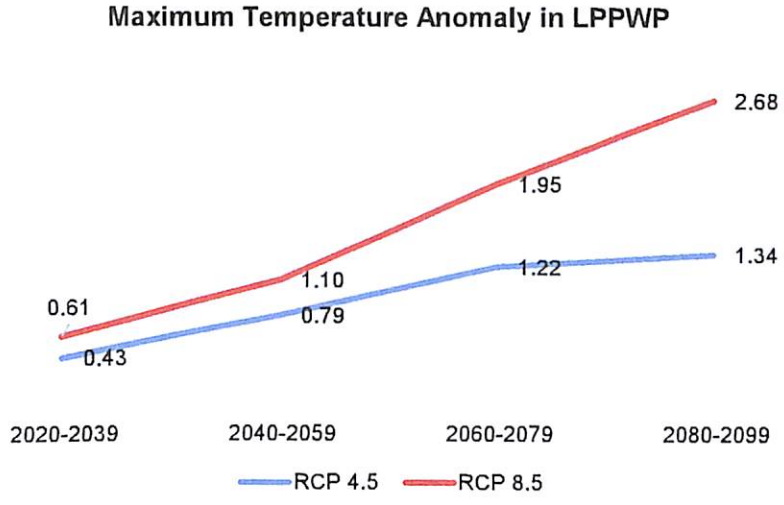
World Bank CCKP, the projected maximum and minimum temperature for LPPWP were calculated for two RCP scenarios: RCP4.5 (medium-low emissions) and RCP8.5 (high emissions). The main climatic factors studied in assessing the impact of climate change are temperature and rainfall (Figure 9).

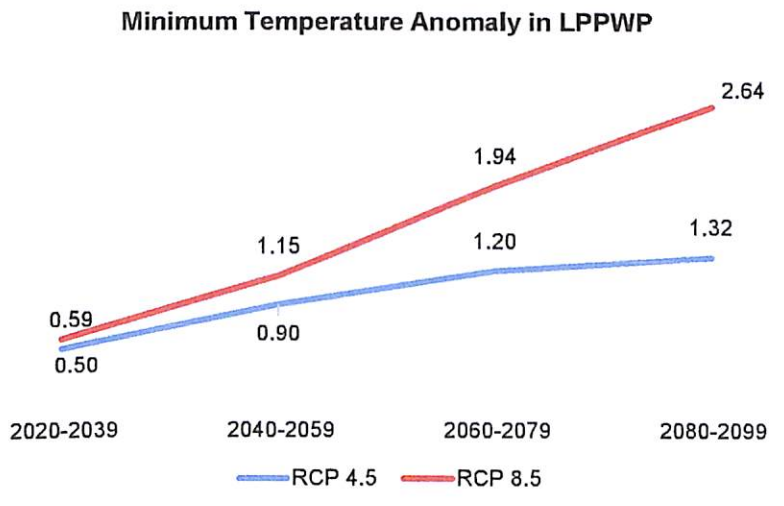
Climate change projections for LPPWP for 2020-2039 horizon are around 0.43^{0}C and 0.61^{0}C above current levels under RCP4.5 (medium-low emissions scenario) and RCP8.5 (high emissions), respectively. Based on Hazard Risks from ThinkHazard, the risk by extreme heat in LPPWP is determined as Medium, interpreted as a 25% chance that at least one period of prolonged exposure to extreme heat, resulting in heat stress, will occur in the next five years.

By 2040-2059, the country's average mean temperature is projected to increase by 0.79^{0}C to 1.10^{0}C under the RCP4.5 and RCP8.5 scenarios. By 2060-2079, the temperature is projected to increase by 1.22^{0}C to 1.95^{0}C under the RCP4.5 and RCP8.5 scenarios.

By end of the century (2090-2099), increase in temperature projections are 1.34^{0}C and 2.68^{0}C above current maximum levels under RCP4.5 and RCP8.5. As per the UN article, if the temperature continues to increase to 2°C in the area, high temperatures and prolonged periods of heatwaves can cause water stress, coastal and river flooding, food scarcity, heat-related deaths, extreme weather events, and loss of habitats and coral die-offs.

Figure 9. Projected changes in maximum and minimum temperature at LPPWP, relative to Reference Period 1971-2000





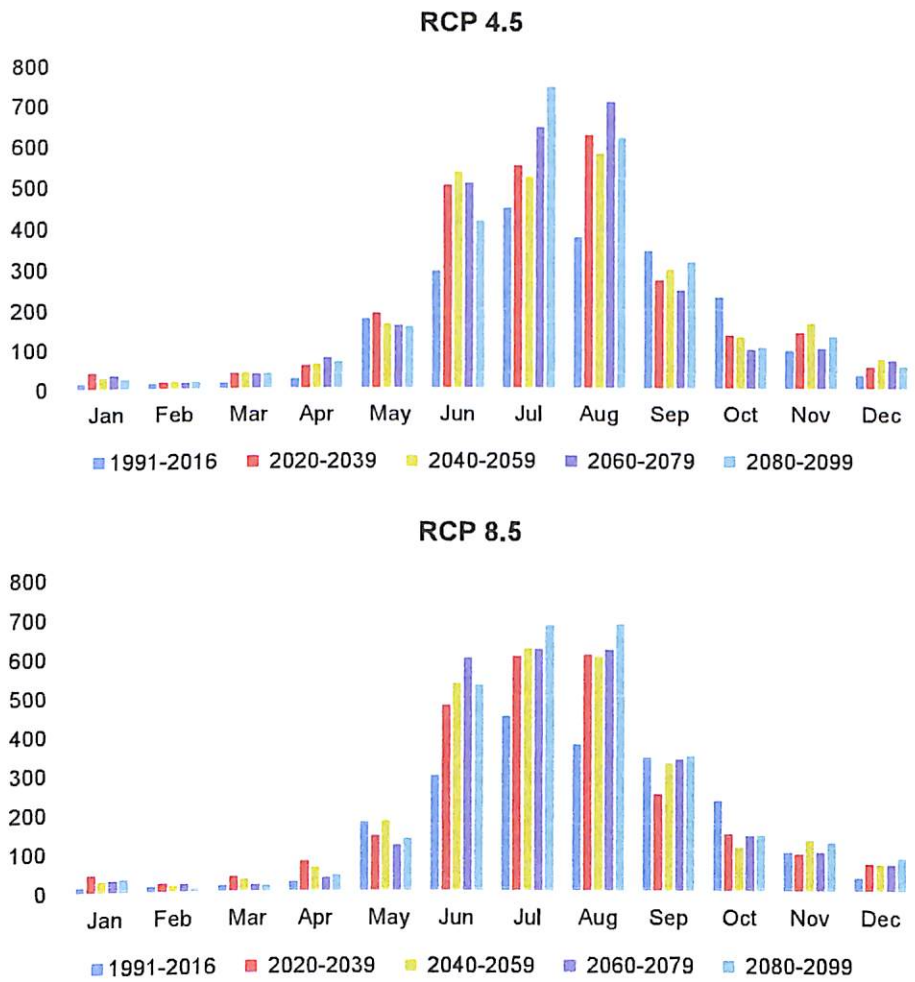
SOURCE: World Bank CCKP, accessed October 2020.

Rainfall Increase

An increase in rainfall intensity is expected for all climate futures for both RCP 4.5 and 8.5 during the rainy season or the southwest monsoon months of

June to August, and a reduction in rainfall is expected during the dry season or the summer months of March to April (Figure 10).

Figure 10. Projected changes in rainfall, relative to the reference period 1991-2016



SOURCE: World Bank CCKP, accessed October 2020.

Average annual rainfall changes are projected at 50%. Rainfall extremes are projected to become more intense, which may cause flooding in the area.

1. Vulnerability of LPPWP to Climate Risks and Hazards

Climate risk is the likelihood that the harmful effects will happen or a measure of the probability of harm to life, property, and the environment that would occur if a hazard took place. It can be a combination of an event, its likelihood, and its consequences. Climate vulnerability is the degree to which a system is susceptible and unable to cope with the adverse impacts of climate change. This depends on the degree to which a system is exposed to significant climatic variations (exposure) and the degree to which a system is susceptible (sensitivity) to climate variability and extremes (IPCC: 2001/2007). The Philippines was hit hardest by climate change impacts because it is more vulnerable to the damaging effects of a hazard but has lower coping capacity.

The tool ThinkHazard (https://thinkhazard.org/en/) provides information on prevalent hazards and risks at the regional level. Risk levels are categorized as very low, low, medium, and high. The hazard levels provided are based on published hazard data provided by a range of private, academic, and public organizations. Table 5 provides the risk profile of Metro Manila, which identifies the various types of natural hazard events that could occur in LPPWP, its varying severity, and the consequences of the events. Research showed that Metro Manila is at a high risk of coastal flood, cyclone, and volcanic eruption. Risks that do not apply to LPPWP are not included, such as landslides and wildfire.

Table 5. Prevalent hazards and risks of Metro Manila

Hazards and Risk Level	Description	Climate change Impact
 Coastal flood – *High*	This means that potentially damaging waves are expected to flood the coast at least once in the next 10 years.	According to the IPCC (2013), there is high confidence that extremes in sea level will increase with mean sea level rise yet there is low confidence in region-specific projections in storm surges. Projects in low-lying coastal areas in island states should be designed to be robust to projected increases in global sea level.
 Cyclone – *High*	There is more than a 20% chance of potentially damaging wind speeds in your project area in the next 10 years. damages can not only occur due to wind but also cyclone induced heavy rainfall and subsequent flooding as well as coastal floods in coastal areas.	Global average tropical cyclone wind speed and rainfall is likely to increase in the future, and the global average frequency of tropical cyclones is likely to decrease or remain unchanged. The frequency of the most intense tropical cyclones may increase substantially in some ocean regions (IPCC, 2013). The present hazard level in areas currently affected by tropical cyclones may increase in the long-term. Projects located in such areas should be robust to future increases in cyclone hazard.

Hazards and Risk Level	Description	Climate change Impact
 Volcano – *High*	The selected area is located less than 50 km from a volcano for which a potentially damaging eruption has been recorded in the past 2,000 years and that future damaging eruptions are possible.	Impact far from Hazard Source: Consider the effects of volcanic ashfall and gases on the project. These hazards are the most far-reaching of the volcanic hazards and can affect areas hundreds or even thousands of kilometers downwind of volcanoes
 Urban flood – *Medium*	There is a chance of more than 20% that potentially damaging and life-threatening urban floods occur in the coming 10 years.	Medium confidence in more frequent and intense heavy precipitation days and an increase in the number of extreme rainfall events. The present hazard level may increase in the future due to the effects of climate change.
 Tsunami – *Medium*	There is more than a 10% chance of a potentially damaging tsunami occurring in the next 50 years.	The areas at risk of a tsunami will increase as the global mean sea level rises. According to the IPCC (2013), global mean sea level rise depends on a variety of factors and estimates for 2100 range from ~20 cm to nearly 1 m. Projects in low-lying coastal areas such as island states should be designed to be robust to projected increases in global sea level.

Hazards and Risk Level	Description	Climate change Impact
 Extreme heat – ***Medium***	There is more than a 25% chance that at least one period of prolonged exposure to extreme heat, resulting in heat stress, will occur in the next five years.	IPCC (2013) reported that continued emissions of GHGs will cause further warming, and it is virtually certain that there will be more frequent hot temperature extremes over most land areas during the next fifty years. Warming will not be regionally uniform. In the area selected, the temperature increase in the next 50 years will be much lower than the worldwide average, but still significant. It would be prudent to design projects in this area to be robust to global warming in the long-term.
 Earthquake – ***Medium***	This means that there is a 10% chance of potentially damaging earthquake shaking in the area in the next 50 years.	Interacting Hazards: Determine whether the project site is likely to be affected by the ground failure or other site hazards during an earthquake. Soil investigations should be conducted by a geotechnical engineer to determine the physical properties of the soil including its liquefaction potential, the stability of natural slopes, and other design considerations.

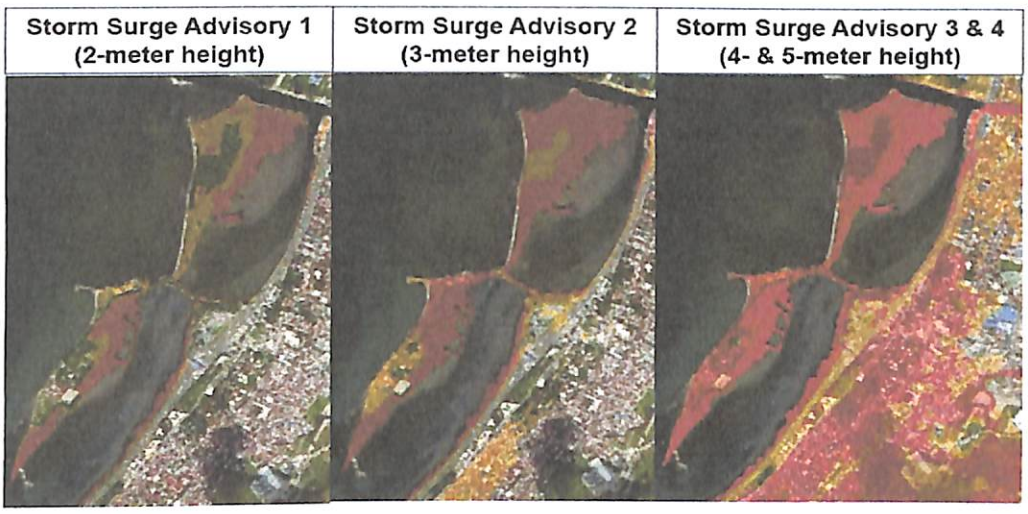
SOURCE: ThinkHazard, 2020.

Unlike ThinkHazard which provides a single data point (regional data) for Metro Manila, Project Noah provides a more localized geo-hazard vulnerability map, translating hazards mapped into municipal-level risk assessments that detail the level of exposure and vulnerability of a community. HazardHunter also generates indicative hazard assessment reports on the user's specified location based on updates provided by government agencies through the GeoRiskPH Integrated System. Data presented in the following sections are simulated for LPPWP from Project Noah portal and HazardHunter PH, while terrain analysis is generated using the SAGA-GIS program.

Vulnerability of LPPWP to Storm Surge and Tsunami

National Oceanic and Atmospheric Administration defines storm surge as the abnormal rise of seawater over the predicted astronomical tides driven against the coast generated by a passing storm. As the climate changes, storm surges are increasing in strength and frequency. Figure 11 simulated from Project Noah shows that LPPWP is at a high risk for a storm surge advisory 3 and 4 or a storm surge height of 4 to 5 meters.

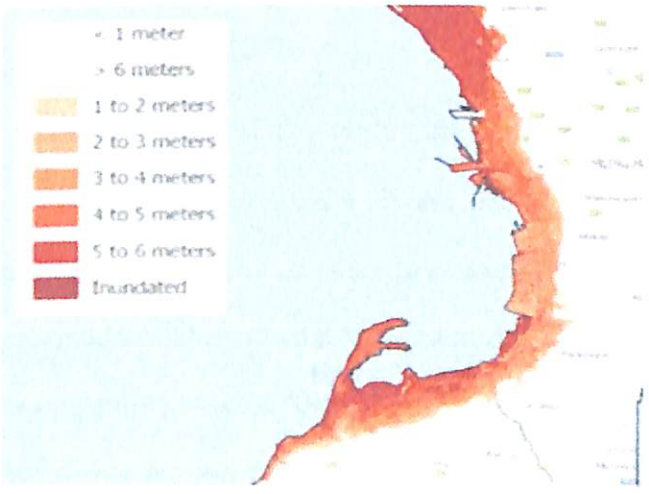
Figure 11. The hazard of storm surge to LPPWP



SOURCE: Generated from Project Noah, 2020.

The area will also be inundated in the event of a Tsunami (Figure 12). Storm surge and tsunami can bring about erosion in LPPWP. Soil erosion is a land degradation process that impacts several functions including biodiversity, and ecosystem services.

Figure 12. Susceptibility to Tsunami of LPPWP



SOURCE: Manila Bay Area Situation Atlas, 2018.

Vulnerability of LPPWP to Tropical Cyclone

Typhoon season in the Philippines occurs between June and December and causes significant damage through heavy rainfall, flooding, and strong winds (Figure 13). Typhoons are also likely to intensify with rising sea surface temperatures, which would mean higher wind speeds (150 kph and above) and more intense rainfall.

Figure 13. Tracks of tropical cyclones in the Philippines in the last 40 years



SOURCE: Generated from Project Noah, 2020

Typhoons and extreme rainfall events may bring floods to LPPWP and may result in increased garbage deposition. It can also uproot young and newly reforested mangroves and if storms continue to intensify, mangrove community structure and dynamics would unavoidably be altered, changing the timing and degree of their ecosystem services. Strong winds due to typhoons also create strong waves and storm surges that may also result in substantial garbage deposition in the LPPWP beaches.

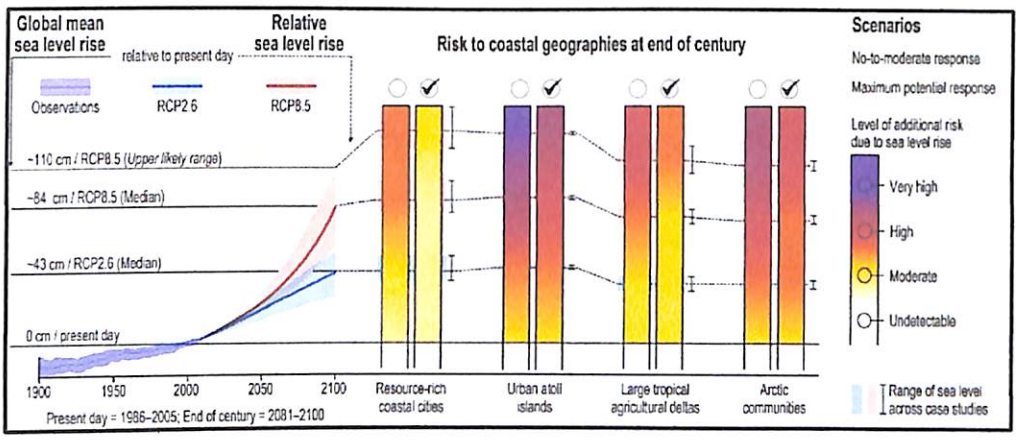
Vulnerability of LPPWP to Sea Level Rise

An increase in sea level rise is one of the major effects of global warming that can influence erosion in coastal areas, result in inundation of low-lying wetland, saltwater intrusion, increased risk of flooding, and storm damage.

Physical changes may bring about alteration of ecosystems such as redistribution of wetlands, reduction in biological diversity and loss of wildlife, and changes in the biophysical properties of the coastal zones. To avoid these, measures must be adapted such as hard engineering (construction of structural buffer walls) and/or soft engineering measures such as mangrove restoration and increasing density of deep-rooted trees.

Sea level rise will have more threatening impacts depending on coastal site-specific characteristics, where the combination with local erosion trends or subsidence phenomena (land lowering driven by natural and/or anthropogenic causes) can determine severe flood risks and crisis (EU, 2012). LPPWP is vulnerable to sea-level rise since it is located along the coast. It is low-lying, only 0-7 meters above mean sea level, and an eventual sea-level rise would lead to loss of coastal area. It is predicted that by end of the century (2090-2099), sea levels will rise by 0.4 meters that are a high risk for urban atoll islands, although the spatial manifestation of this rise will not be uniform due to circulation changes and ocean density (Figure 14).

Figure 14. Projected global sea-level rise



SOURCE: Intergovernmental Panel on Climate Change, 2019.

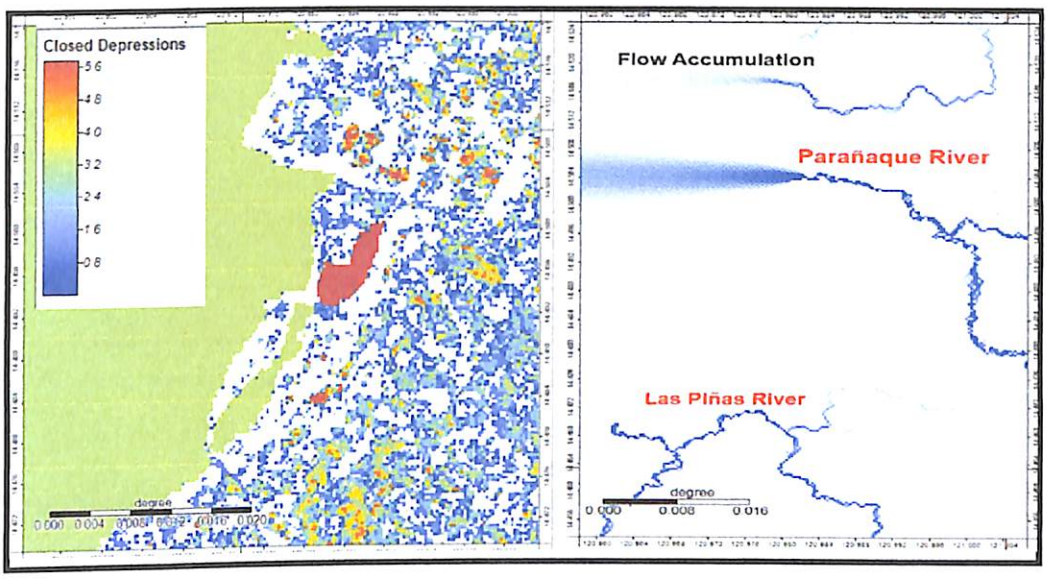
Vulnerability of LPPWP to urban flooding

Flood vulnerability is defined as the degree of susceptibility to damage from hazardous, water-related phenomena (Gallopin, 2006). To identify the flood vulnerability of LPPWP, this study generated the closed depressions and flow accumulation images of LPPWP through SAGA-GIS using a downloaded shapefile from PhilGIS. Closed depressions and flow accumulation are useful for potential flood prediction. Closed depressions are the low part of an area with no outlet that accumulates or receives runoff.

As shown in Figure 15, the area (in red) is a closed depression area which shows that runoff channels may form and deliver runoff water to it. Flow accumulation is an indirect way of measuring drainage areas and increases constantly from the drainage divides to the outlet and river channels (Schäuble et al., 2008). Flow Accumulation image for LPPWP showed that

Parañaque River and Las Piñas River drain directly to LPPWP. This makes LPPWP a flood-prone area.

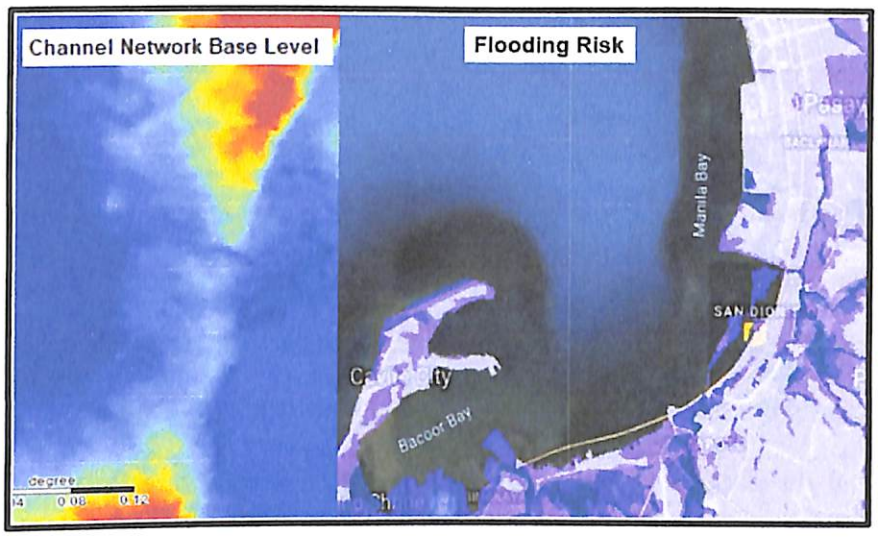
Figure 15. Closed depressions and flow accumulation image of LPPWP



SOURCE: Generated from SAGA-GIS using PhilGIS shapefiles, 2020.

According to the LPPWP Assistant Protected Area Supervisor, the highest recorded flood was 12 meters. The impact of flooding is erosion and accumulation of garbage and other solid waste that came from various water systems including rivers and tributaries that drain in Manila Bay. Flooding could also bring harm especially to the planted mangroves and the mudflats as a habitat of migratory birds (Figure 16). It could destroy the residential areas of the fisherfolk and could threaten their livelihood.

Figure 16. The hazard of flooding in LPPWP



SOURCE: Generated from HunterHazard PH.

Vulnerability of LPPWP to Liquefaction

HazardHunter PH also shows that LPPWP is at very high risk of liquefaction (Figure 17). Liquefaction usually happens in reclaimed land.

Figure 17. The hazard of liquefaction in LPPWP

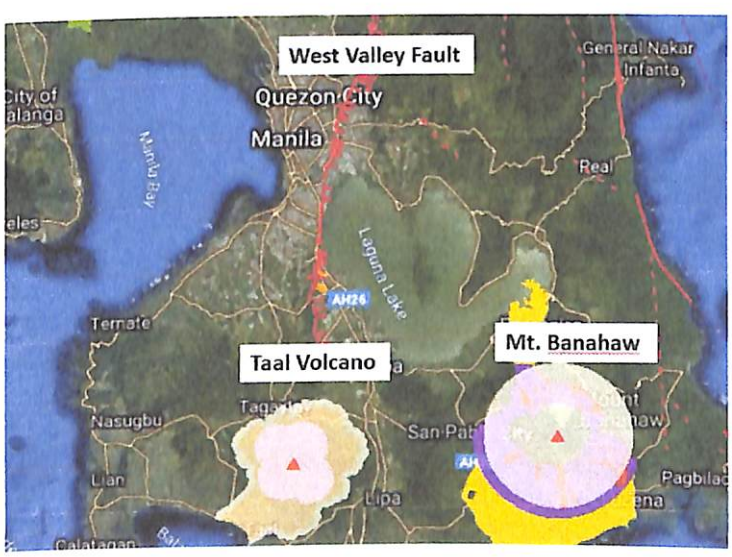


SOURCE: Generated from HunterHazard PH, 2020.

Vulnerability of LPPWP to Volcanic Eruption

The Philippines is located along the border of two tectonic plates on the 'Pacific Ring of Fire', resulting in seismic activities, which means it is also prone to earthquakes and volcanic eruptions. Taal volcano is the nearest volcano in the area located about 50 kilometers south of Manila (Figure 18). Taal is the second most active volcano in the Philippines, posing a high risk to the area with the possibility of future damaging eruptions. A volcanic eruption may cause increased siltation due to volcanic ash and short-term impacts on terrestrial flora as well as mangroves. In the recent Taal volcanic eruption, there are reports from employees that the pyroclastic materials from the volcano reached LPPWP as evidenced by the leaves and infrastructures becoming whitish, but no other negative impacts were recorded or observed.

Figure 18. The hazard of a volcanic eruption in LPPWP



SOURCE: Generated from Project Noah and HazardHunter PH, 2020.

Summary of Major Threats to LPPWP Caused by Climate Change

Storm surge, tsunami, typhoons, sea-level rise, and flooding are the major threats to the area because they can cause erosion. Since LPPWP is a product of an unfinished reclamation, 100% of respondents believe that it is still not stable and may continue to decrease in size depending on the intensity of natural wave actions and storm surges. Metro Manila's coastal areas are sinking as fast as 9 cm (3 ½ inches) every year (Siringan, 2006).

Uncertainty brought by climate change, rainfall, and constant pounding of sea waves, which may grow stronger during typhoons, remain threats to the geological stability and long-term sustainability of the two islands. All respondents believe that there is a possibility that the islands may sink in the future (or with the very little area remaining) and be inundated with seawater due to an increase in sea-level rise brought by climate change, especially if no additional fortifications will be applied.

2. Vulnerability of LPPWP due to Anthropogenic Activities

There are no actual residents in the LPPWP, but it is very near to eight coastal barangays (Table 6) and within its vicinity are two depressed areas (J. de Leon and Ilog Palanyag) making it sensitive to polluted water mainly as a result of industrial and residential wastewater discharges.

Table 6. Socioeconomic profile of barangays near LPPWP, 2015

Barangays	Area (Hectares)	Population as of 1 Aug 2015)
Parañaque City	4,657.0	665,822
San Dionisio	309.69	63,506
La Huerta	53.72	9,569
Las Piñas City	3,298.60	588,894
Zapote	69.68	20,771
Pulang Lupa	338.96	31,401
D Fajardo	30.77	10,425
Ilaya	13.2	6,055
E. Aldana	33.36	10,402
Manuyo Uno	74.85	15,405



SOURCE: Philippine Statistics Authority, 2015.

Excessive anthropogenic pressure also results from its proximity to commercial centers of the adjacent cities, ongoing and future reclamation projects, poaching, significant disturbance from the nearby Coastal Road/ CAVITEX, and airport operation which is hazardous to birds. Anthropogenic activities that pose major threats to the existence of the LPPWP include:

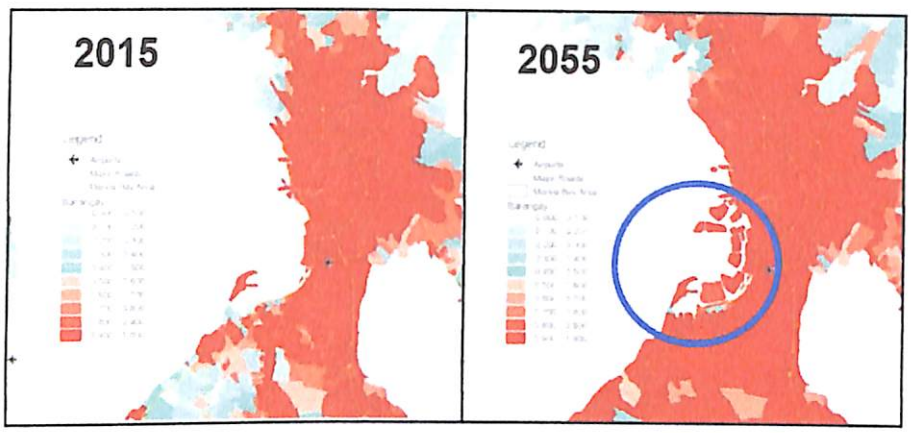
(1) ***Improper waste disposal.*** Around 20% of the population living near the area has no toilet facility and their human waste goes directly to the bay. More than 10% also throw garbage in the bay which accumulates along the coast. Residential and industrial effluents such as heavy metals and other organic contents also affect the area. It is estimated that around 572.76 kg of waste is thrown directly into LPPWP daily (Balangue, 2014).

(2) ***Squatting or illegal settling.*** Parañaque is home to 25,073 informal settler families, who are living in improvised housing (Parañaque City Government, accessed September 2020).

(3) ***Cutting of mangroves.*** Mangroves are the predominant species in the area, consisting of 30 hectares, making it the densest mangrove area within Manila bay. However, an interview with a mangrove warrior revealed that there are incidents of mangrove cutting where it is used as charcoal for cooking food by informal settlers.

(4) ***Future reclamation projects.*** According to the draft Vulnerability Report, there is a high possibility that LPPWP will be developed for commercial establishments similar to commercial centers along Roxas boulevard, Las Pinas City, and Paranaque City. Likewise, sand and gravel quarrying is seen as a threat to the critical habitat in the future as its effect could alter the natural ecological integrity of the critical habitat in the long run. These threats will affect the present ecosystem services provided by LPPWP such as serving as critical habitat of wildlife, ecotourism area, carbon sequestration, and serving as a buffer area protecting the coastal communities from storm surges and floods, etc. Figure 19 shows that reclamation projects will attract more people and it was estimated that by the year 2055, 0.6 million more people will reside in the Manila Bay catchment.

Figure 19. Manila Bay reclamation plans



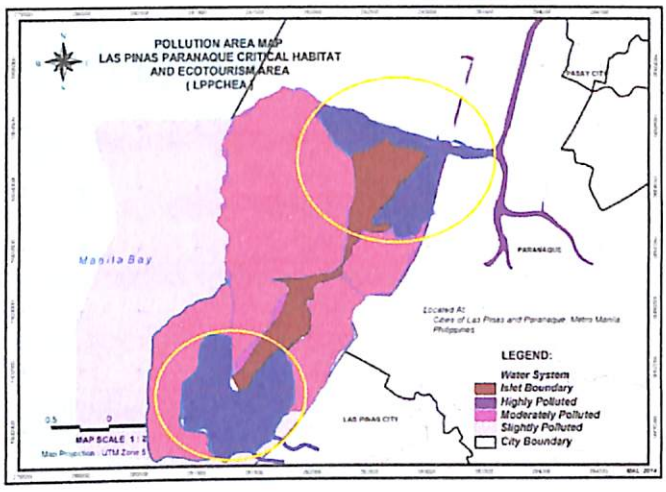
SOURCE: Manila Bay Area Situation Atlas, 2018

These anthropogenic activities make LPPWP vulnerable to pollution, garbage deposition, and flooding.

Vulnerability of LPPWP to Pollution

The map (Figure 20) shows the vulnerability of LPPWP to pollutants. The area in dark purple is highly vulnerable to pollutants since the household and industrial pollution go directly to the LPPWP from the mouth of the Paranaque River in the north and Las Pinas River and Zapote River in the south. Based on the measurements conducted in 2014, the three rivers are the major depository of human and animal wastes as evidenced by high coliform counts. Domestic wastes from the informal settlers go directly to the water due to the lack of a sewage system. Oil and grease measurements in Paranaque and Las Piñas are also above the standard, and mercury concentration, though below the standard, can have a significant impact on marine species. These pollutants affect the water quality and cause the death of marine species.

Figure 20. Pollution area map of LPPWP



SOURCE: 2014 Vulnerability Assessment Report, 2014

Other major rivers draining into Manila Bay include: (i) Pasig River (NCR), (ii) Pampanga River (Nueva Ecija, Pampanga and Bulacan), (iii) Talisay River (Bataan), (iv) Meycauayan river (Bulacan), (v) Navotas-Malabon-Tullahan-Tenejeros river (NCR), (vi) Imus River (Cavite) and (vii) Maragondon River (Cavite), which are also sources of transported wastes.

The odor pollution will also have a negative effect on ecotourism. The unpleasant odor will reduce the park's attractiveness to the ecotourists. Meanwhile, the close proximity of the critical habitat to the national airports causes noise pollution and death of some birds due to bird aircraft strike. Air, water, noise, and solid wastes need to be minimized if not eliminated to protect the wildlife within the area.

Vulnerability of LPPWP to Garbage

In the Vulnerability Assessment report, factors that were assessed relative to garbage disposal to the beaches of LPPWP and along the shore of Manila Bay are: (i) seawater current in Manila Bay, and (ii) absence of environmentally compatible garbage disposal system in coastal communities. The assessment found that LPPWP's proximity to Canacao Bay and Bacoor Bay makes it vulnerable to garbage carried by seawater current coming from southwest to northeast of Manila Bay resulting in garbage deposition. Wastes also came from Parañaque and Las Piñas rivers.

The average daily waste being thrown directly into LPPWP from the coastal barangays alone is estimated to be around 570 kg (Balangue, 2014). During summer, a daily average of 500 sacks of garbage, mostly non-recyclable and non-reusable, particularly single-use sachets, are collected (Sarmiento, 2018). During southwest monsoon season (Habagat), a larger amount of wastes is expected as seen in Figure 21. Garbage deposition will displace the bird population in the habitat and food browsing area. Sinking garbage can also destroy marine habitat and affect the marine species, which in turn will affect the livelihood of the fishermen and their food sources of the birds. Like odor pollution, the presence of garbage will reduce the park's attractiveness to the eyes of ecotourists.

Figure 21. Garbage deposition in LPPWP



SOURCE: DENR website, 2020.

Vulnerability of LPPWP due to Reclamation Projects

Since LPPWP is a protected area inside an urban area, the land-use change in adjacent areas is very dynamic. The protected area has limited influence on the adjacent area because there are other factors being considered outside the PA such as social, economic, and institutional factors. There are conflicting views on the land use of the PA and the areas outside it and there is also a lack of coordination between agencies in charge of urban planning and land use, and PA managers (De Leon et al. 2017).

Because of these, LPPWP became immediately surrounded by densely built-up areas. Also, LPPWP has no buffer zone and there is an abrupt transition from a natural protected area to an urban area right outside the boundary. This makes LPPWP vulnerable due to a high chance of it being developed for commercial establishments similar to its adjacent areas. This

would sacrifice the present uses of LPPCHEA as critical habitat of wildlife, ecotourism area, and a provider of other environmental services.

In 2017, the Environmental Clearance Certificate issued in 2011 to Alltech Contractors, Inc. for their reclamation project was canceled. Although most respondents expressed concern that LPPWP may still be developed and may be subject to land conversion depending on the LGU management's decision, respondents from the Biodiversity Management Bureau (BMB) of DENR assured that the expanded NIPAS Act legislated it as a protected area specifically as a national park, which will protect it from any unwanted development. They added that the BMB-DENR and other stakeholders will not approve of any reclamation plan.

However, reclamation projects in nearby areas will still affect the site even if reclamation inside LPPWP will not proceed. Reclamations will disturb the hydrodynamic/hydro-oceanography (e.g., tide and current flow), which may lead to water concentrations in some areas that can cause massive flooding in LPPWP because it is low-lying. The local community shared that they experienced flooding when the Mall of Asia was developed, expressing fear that future developments will cause a significant negative impact on the Islands. The hydrology in the area will change substantially which will affect ecological balance. Increased siltation of Manila Bay may also impede the natural flow of water from tributary rivers to the sea, resulting in stagnation.

Reclamation will also decrease the area for sustainable fishing and mangrove ecosystem that can result to decrease in bird migration. One respondent shared that the mangrove area has been wiped out near Imus River due to casino development. This, along with other unsustainable practices in reclamation, will lead to food insecurity, vulnerability of coastal communities in times of disaster, loss of jobs, and alarming future for the coastal residents within Manila Bay. Other possible impacts of reclamations include an increase in PM10 and PM2.5 levels, the possible sinking of the area, and a decrease or die-off of the vegetation. The scale and location of the reclamation projects will determine the extent of the impact on LPPWP.

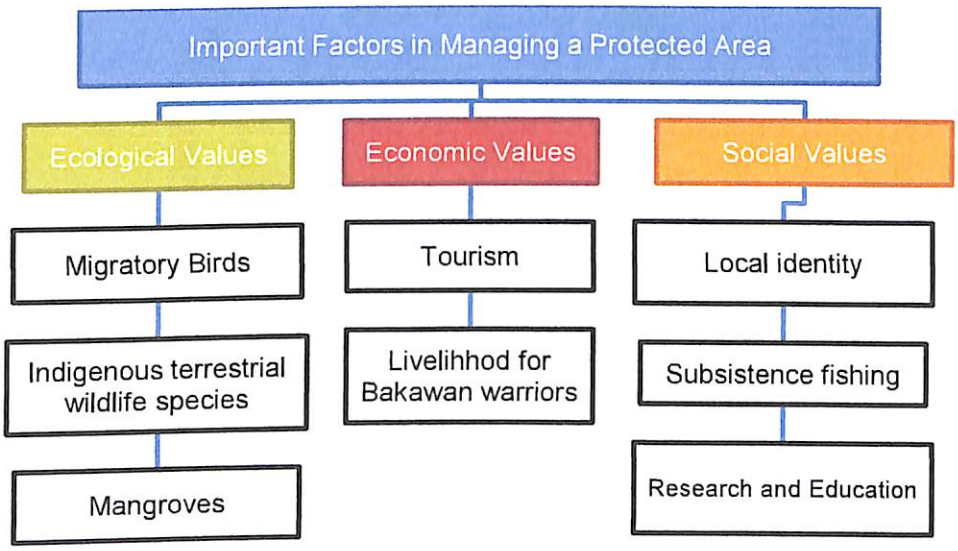
On the pressing issue of white sand (dolomite) in Manila Bay, respondents shared their views that technically, dolomite will have no or very little impact on LPPWP since it is too far from the area. The impact of dolomite will depend on many factors such as relative distance and wave-current direction, thus, further study is suggested. However, if the dolomite is proven harmful to fisheries, it will affect the quality of waters in all areas of the Bay. Respondents also shared views that the cost of dolomite beach nourishment in a small part of Manila Bay could be equivalent to or be more expensive than the whole range of measures being considered to protect and enhance LPPWP.

B. MULTICRITERIA DECISION ANALYSIS OF MANAGEMENT AND ADAPTATION SOLUTIONS

1. Define Problem and Structure Value Tree

Management options are classified along the three dimensions of sustainable development (ecological, economic, and social) as the upper level of criteria and all other criteria were classified as sub-criteria (Figure 22).

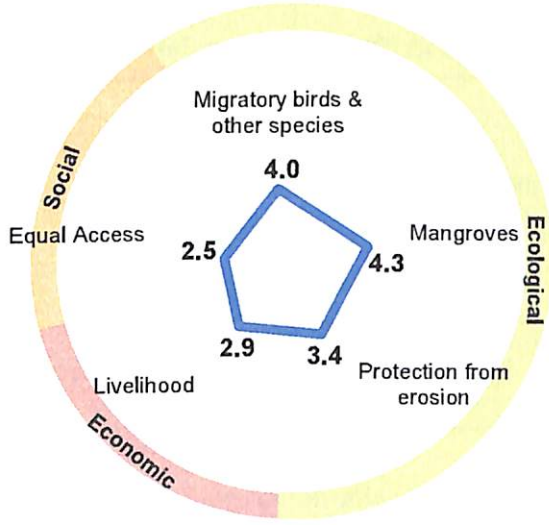
Figure 22. Value tree in LPPWP project – value-focused approach.



- Ecological sustainability of the critical habitat will allow the conservation of migratory birds, indigenous terrestrial wildlife species, and mangroves.
- The economic development of LPPWP can improve the local community by providing livelihood through tourism and hiring of *Mangrove* warriors and garbage collectors.
- Social equity aims that all segments of society can benefit from it.

Figure 23 shows that ecological development was given the highest score by the respondents on development objectives for LPPWP. Mangrove conservation was ranked highest since it encompasses the other two ecological objectives as it provides ecosystem services to protect the island from erosion and provide food and shelter for the migratory birds.

Figure 23. Respondents' views on Development Objectives for LPPWP



2. Identify criteria to compare alternatives and weigh criteria

Based on DENR Technical Bulletin No. 2016-08 (Clarifying the Protected Area Management Planning Process and Providing the Annotated Outline for Protected Area Management Plans), the key values of the protected area shall serve as the primary basis for management interventions. LPPWP is a national park and critical habitat for wild birds and the last remaining mangrove frontier in Metro Manila with the main objective of ecosystem

conservation and protection. As such, the criteria under ecological value had the highest weight using the entropy weight method (Table 7).

Table 7. Weights of Criteria according to the respondents

Value Category	Criteria	Entropy weight
Ecological		**36%**
	• Conservation of migratory birds and other indigenous wildlife species	10%
	• Conservation of mangroves	7%
	• Protection of Islands from erosion	19%
Economic		**18%**
	• Increase in tourism income	10%
	• Additional livelihood for mangrove warriors	8%
Social		**24%**
	• Promotion of Local Identity	7%
	• Subsistence fishing	11%
	• Increase access to Research & Education opportunities	6%
Feasibility		**23%**
	• Ease of implementation	6%
	• Cost of implementation	17%

Criteria resulting from the entropy weight method was used in the final analysis since it eliminates the interference of human factors on the weight of indicators because they are conducted according to the inherent information of indexes. This makes the results consistent with facts thus enhancing the objectivity of comprehensive evaluation results (Jozi et al., 2012; Mohare, 2020). The entropy weight method is widely used in decision making in recent years and also in combination with the TOPSIS method.

3. Development of Alternatives and score management options against criteria

Defining the management domain for the site is an important component of identifying management solutions: (1) those that are within the scope of management (controlled) and (2) those that are external (effects are felt but cannot be influenced directly). It should be noted that the management options gathered from the Vulnerability Assessment report prepared for the LPPWP in 2014 and revalidated by the CRVA (Part I) are those that can be controlled inside the protected area. Table 8 describes the management options.

Table 8. Description of management options for LPPWP in the 2014 Vulnerability Assessment Report

Management Options	
Conservation of the Critical Habitat (Wild birds and Mangroves)	
Installation of Materials Recovery Facility[1]	RA 9003 mandates that every village must set up an MRF where biodegradable waste is converted into fertilizer, recyclable material is recycled or sold to junk shops, and residual waste is collected for transport to sanitary landfills. Operational MRFs in the Philippines generally process 1–5 tons of mixed waste per day by manual separation cost between P0.5–P1.5 million. (ADB, 2010). Given the waste volume in LPPWP and other waste from the nearest barangay estimated to be around 1–2

[1] Currently, there is one vermicomposting facility in LPPWP, but it only processes biodegradable wastes to produce nutrient-rich organic fertilizer. The facility is a temporary structure occupying 240 sqm in the area.

Management Options	
	tons, an amount of **P0.5 million** will be sufficient for the MRF.
Establishment of a Pollutant filtration system to control discharges of effluents	Effluents from residential and industries are drained into the area by 3 major rivers. A study on the cytotoxicity assessment of LPPWP (Beltran-Cruz et al., 2017) concluded that the Las Piñas River and South Lagoon are the most polluted. Thus, Long Island can be prioritized if there is a budget constraint.
Manual cleaning of floating garbage	Removing garbage that comes from nearby cities and provinces and is brought into the area through natural wave action, can prevent the destruction of marine and avian habitats. One recommendation is the manual cleaning of garbage by hiring fishermen or residents. Aside from the benefit of reducing garbage, hiring residents can provide additional income and will decrease pressure on mangroves, which is used as charcoal to cook food. Currently, Paranaque City, which has jurisdiction over Freedom Island, conducts river cleanup using trash boats and declogging of drainage and canals using jet sewer trucks with a capacity of 2.27 tons.
Building a Security Outpost to Prevent Mangrove Cutting	There are residents employed as "Mangrove Warriors" to watch for illegal settlers who cut mangroves to use as charcoal for cooking in the Freedom Island. Building an additional security outpost in Long Island and hiring additional people will help prevent illegal settlers from mangrove cutting, poaching, and quarrying.
Intensive IEC	Many people are not aware of the existence and importance of LPPWP not only in terms of its ecological services but also on the possible contribution to job creation and education and research. Intensive Information and Education Campaign is recommended.

Management Options	
Protection from Erosion	
Increase area of Mangrove Plantation	Mangrove planting is a regular activity of the Local Government Unit, Department of Tourism, and Philippine Reclamation Authority. Dedicating an expanded area for mangroves will significantly increase its ecosystem services and will increase ecotourism and livelihood for Mangrove warriors and other LPPWP staff. It will also increase the potential of LPPWP to act as a carbon sink helping the sequestration of carbon dioxide from Paranaque and Las Piñas areas.
Increase density of deep-rooted trees	Deep-rooted big trees can prevent landslide and erosion brought by extreme rainfall and strong typhoons caused by climate change.
Construction of structural buffer walls	In the 1980s, LPPWP is only one landmass dumped into the Manila Bay area as part of a reclamation project. Due to the absence of the typical wall built as part of the engineering foundation in reclamation projects, 3 islands emerged due to liquefaction. Then, the smaller landmass no longer exists, and only 2 landmasses remained. Stronger typhoons and extreme weather brought by climate change will continue to threaten the stability and long-term sustainability of the two islands. The structural buffer wall will prevent the soil from being eroded back to the sea and protect the reclamation area from strong waves and storm surges. Based on past projects, the construction of a buffer wall is costly and labor-intensive since Long Island and Freedom Island stretch for 4 km.
Income from Tourism	
Eco-tourism with Entrance Fee	In the Draft Framework Plan, it was mentioned that it is the mission of the Management Council to ensure that the coastal lagoons and mudflats of Las Piñas and

Management Options	
	Parañaque are transformed into a premier learning and **tourist destination** providing excellent service and exemplifying responsible management of critical habitats On a rough estimate, more than 3000 visitors are coming to visit the area annually (RIS, 2013). If there will be an entrance fee, the collected amount can be used for the maintenance and labor cost for the LPPWP.
Equal Access to Resource	
Allowing fishing in the sustainable zone	The surrounding waters of LPPWP are utilized by fishermen for fishing and shell gathering for daily consumption. Allowing fishing in a sustainable zone can promote livelihood and social equity since it provides equal access to the natural resource.
Eco-tourism with Free Entrance	LPPWP has immense potential as a nature reserve for scientific research and recreational and educational purposes. Opening the area to the public with no entrance fee can increase awareness of the importance of the wetland and provide access to the public for research and education

4. Multicriteria evaluation using TOPSIS

Based on the results of the MCDA using TOPSIS (Table 9), specific adaptation measures and management solutions recommended to improve the management of LPPWP as a national park are as follows, in order of priority:

Figure 24. Respondents' ranking of proposed adaptation measures and management solutions using MCDA

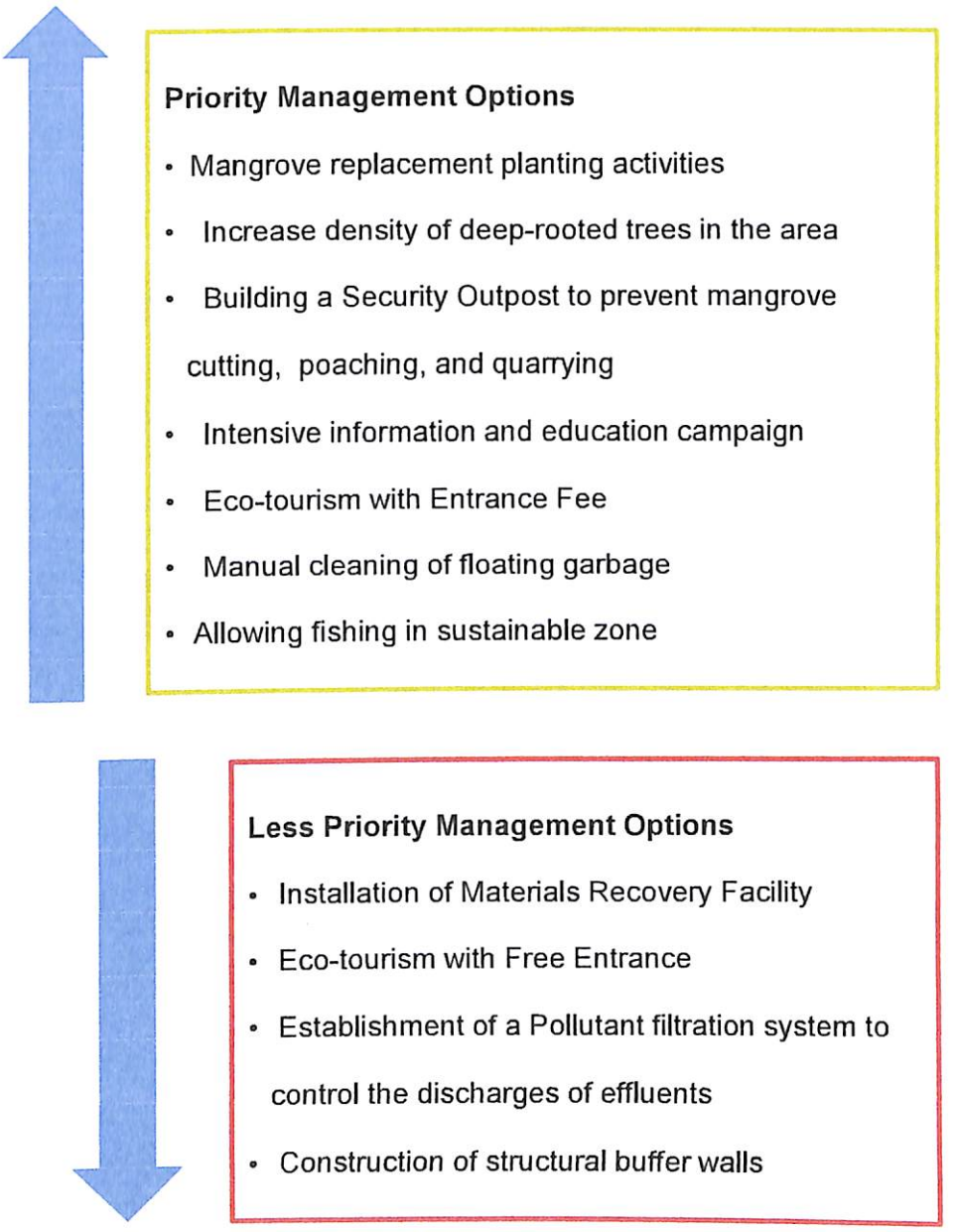


Table 9. Decision matrix with the results of the MCDA using TOPSIS

Management Options	Management Objective										RANK
	Ecological			Economic		Social			Feasibility		
	Conservation of migratory birds and indigenous wildlife species (C1)	Conservation of Mangroves (C2)	Protection of Islands from Erosion (C3)	Increase in Tourism Income (C4)	Additional Livelihood for Mangrove warriors (C5)	Promotion of Local Identity (C6)	Subsistence fishing (C7)	Increase access to Research & Education opportunities (C8)	Technical Implement ation (C9)	Financial /Cost of Implement ation (C10)	
Conservation of the Critical Habitat											
Installation of Materials Recovery Facility	3.9	3.7	2.7	3.3	3.0	2.6	3.2	2.8	3.5	3.0	8
Establishment of a Pollutant filtration system	4.3	3.9	2.9	3.4	2.6	2.6	4.1	3.0	2.5	3.9	10
Building a Security Outpost to Prevent Mangrove Cutting, poaching and quarrying	4.1	4.3	3.7	3.6	3.5	3.0	3.3	3.1	3.7	2.6	3
Manual cleaning of floating garbage	3.8	3.6	2.5	3.5	3.7	3.3	3.5	2.9	3.7	2.7	6
Intensive information and education campaign	4.5	4.7	3.7	3.8	3.1	3.7	3.1	3.8	3.8	2.9	4
Protection from Erosion											
Increase area of Mangrove Plantation	3.8	4.2	4.3	3.3	3.4	3.1	3.3	3.4	3.3	2.8	1
Increase density of deep-rooted trees in the area	3.7	3.9	4.5	3.4	3.2	3.1	2.9	3.5	3.3	2.7	2
Construction of structural buffer walls	2.6	2.9	4.0	2.2	2.2	2.1	2.1	2.2	2.7	4.3	11
Income from Tourism											
Eco-tourism with Entrance Fee	3.4	3.4	2.6	4.5	3.8	3.6	2.6	3.2	3.9	2.5	5
Equal Access to Resource											
Allowing fishing in sustainable zone	3.1	3.2	2.2	2.6	3.2	2.9	4.1	2.8	3.6	2.3	7
Eco-tourism with Free Entrance	2.6	2.7	2.1	2.9	2.6	3.1	2.3	3.0	4.0	1.9	9

Criteria 1-8:	Not important at all	Of little Importance	Of average Importance	Very Important	Absolutely Essential
Criteria 9:	Very difficult	Difficult	Average	Easy	Very easy to implement
Criteria 10:	Very high	High	Average	Low	Very Low

Priority Management Options for LPPWP

1. Mangrove restoration

Respondents requested to change the initial option of "*increasing area of mangrove plantation*" to "*mangrove restoration activities.*" A respondent from BMB explained that expanding the mangrove area would compromise other wetland habitats in the area, which is why the DENR is only interested in replacement planting activities. Maintaining mangrove density through restoration activities provides the following substantial add-on benefits to biodiversity, fisheries, tourism, and coastal protection:

- Mangroves contribute significantly to the resilience of the Islands to the impact of climate change. It is a soft engineering technique relying on vegetation to prevent erosive forces from reaching the backshore.
- Mangrove is a "blue carbon" ecosystem. It helps in sequestering carbon since it is found to be extremely effective at storing atmospheric carbon (up to 100 times faster and more permanently than terrestrial forests), thereby reducing GHG emissions and mitigating climate change (Salmo, et al, 2017).
- Mangroves help in the conservation of wild birds as it serves as breeding and nesting grounds for them.
- Mangroves provide food source for fish and birds by producing leaf litter and detrital matter — one hectare of mangrove produces up to 3.6 tons of litterfall per year. These form the base of the aquatic food chain as these

are sources of food of microorganisms and detritivores, which later become food for higher species in the food chain (e.g., fish and birds) (RIS, 2013). The loss of mangroves corresponds to the reduction in fish catch per year (Gamido et.al., 2017). The economic equivalent of one hectare of mangrove per year is estimated at PhP 22,800 (White & Trinidad, 1998).

Figure 25. Mangrove area in the Freedom Island



Photo was taken during Site Visit on 21 November 2020

2. *Increase density of deep-rooted trees in the area*

A respondent from BMB DENR mentioned that LPPWP is a wetland, and even if there is erosion, planting vegetation can support natural accretion of land and if proper species are planted, further erosion can be prevented. Deep-rooted trees absorb and store rainwater, which reduces runoff and sediment deposit after storms. These trees also increase filtration, hold soil particles together, and slow wind and water flow, preventing erosion. Deep-rooted trees that should be added in LPPWP include talisay, mahogany, molave, narra, and

Palawan cherry. Meanwhile, invasive tree species introduced into the area such as ipil-ipil should be replaced as these trees rapidly extend to other wetland habitats. They also compete with other vascular plant species for sunlight and organic nutrients in the soil and hinders the growth of seedlings and saplings planted in LPPWP.

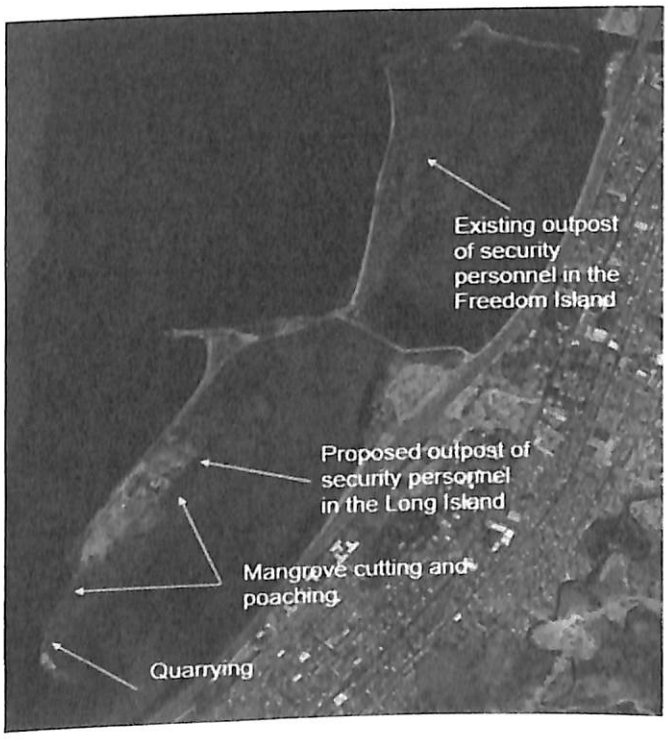
3. *Building a security outpost to prevent mangrove cutting, poaching, and quarrying*

MCDA results show that building a security outpost in Long Islands, which currently has none, is one of the preferred options. Freedom Island has currently 22 employees securing the area from mangrove cutting, poaching, and quarrying. According to an LPPWP Former-OIC PA supervisor, there were incidents of sand quarrying reported to the contractual guards of the Philippine Reclamation Authority. In 2016, DENR hired mangrove warriors in the Freedom Island who underwent several training programs about protected area management, including identification of tree and bird species, and on the impact of climate change. They are tasked to write accomplishment reports on their daily activities including how many meters are cleaned up and how many volunteers they assisted, among other things. They watch over the mangroves due to the rampant cutting of mangroves for fuelwood/charcoal use by informal settlers. Another task is for them to remove the floating bamboo houses of the informal settlers along the seaside. The job offered by the DENR to some of the residents as mangrove warriors increased their quality of life because of the stable income they receive. Aside from the salary paid to them by DENR, they

are also allowed to continue small-scale fishing outside their work hours. They also serve as stay-in guards during weekends.

Since Long Island is also exposed to mangrove cutting, poaching, and quarrying, building a security outpost there will help prevent these illegal activities (Figure 26). The wages will be at the standard security guard's rate. There should be security 24/7. This option proposed in the 2014 Vulnerability Assessment Report will increase the participation of the local community since they will be hired to take care of the protected area and will feel increased ownership of this common resource.

Figure 26. Location of existing and proposed security outposts in LPPWP



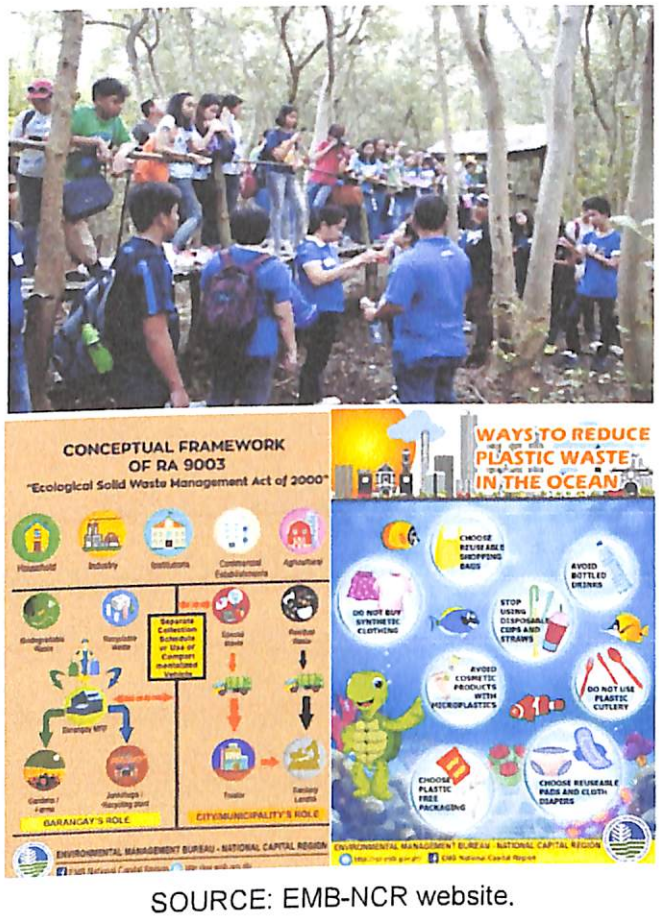
SOURCE: 2014 Vulnerability Assessment Report and Google Earth, 2020.

4. *Intensive information and education campaign*

IECs are already being conducted by DENR for LPPWP (Figure 27) but sustained and more frequent IEC is recommended. The topics proposed by the respondents are the following:

- seminars/training programs on conservation among LGUs that will be affected by reclamation,
- preparing a brochure or information sheet about wetlands providing ecosystem services and its potential economic uses such as ecotourism,
- seminar on ecological mangrove restoration principles highlighting the importance of mangroves and the threats it faces,
- training the LGUs on how to educate their constituents on proper waste management and garbage disposal,
- building awareness among communities on sustainable waste management policies such as Pollution Control Law, Philippine Environmental Policy and Code, Clean Air Act, and Ecological Solid Waste Management Act,
- informing coastal communities about the importance of migratory birds and their habitats. Training the locals to become bird guides (tourist guides) by teaching them to identify birds, know where these birds can be found inside the LPPWP, etc. It will give them an additional source of income while teaching them to protect the birds and mangrove ecosystems,
- increasing public awareness on the impact of climate change, and
- call for action for all stakeholders to conserve the LPPWP.

Figure 27. Current information and education campaigns by DENR



SOURCE: EMB-NCR website.

5. *Eco-tourism with entrance fee*

This is the top preferred management option by the respondents since it can help achieve the ecological, economic, and social value of the national park. One of the missions of LPPWP is to transform it into a premier learning and tourist destination. Market-based financing mechanisms, such as tourism user fees, parking fees, and recreation fees can provide the financing to manage the PA more efficiently, equitably and environmentally sustainable. Respondents say that the entrance fee collected, which may also serve as a user/environmental fee, can be used for the operation and maintenance of the

area such as payment for labor of the mangrove warriors and security officers, maintaining the cleanliness of the site, marketing, and promotion, etc. In addition, opening it as an ecotourism site can also achieve the economic value of LPPWP since it will contribute to the local economy through related local businesses and local community involvement. The social value of opening it to the public can promote the identity/existence of the national park while providing access to research and education opportunities.

In setting user fees, the provisions and principles in DAO 2016-24 should be complied with. Setting the amount of protected area entrance fees should be guided by the cost-recovery principle which means that revenues collected should cover a reasonable proportion of all costs incurred in protecting, maintaining, and enhancing the natural attractions of the PA. The Asst. PA Supervisor recommends an amount of PhP30 as entrance fee (in line with DAO 2016-24 shown in Table 10). With expected visitors of around 25 persons per day, this would amount to about PhP20,000 per month.

Table 10. User fees as provided in DAO 2016-24

Types of PA Visitors	PA Entrance Fee
For Filipino Citizens	
• Adults	PhP30.00 per person
• Students	PhP15.00 per person

Types of PA Visitors	PA Entrance Fee
• persons with disabilities, senior citizens and children below 7 years old	No Entrance fee required
For foreigners	PhP100.00 per person

SOURCE: DAO 2016-24.

The Assistant PA Supervisor believes that hiring two technical staff is enough, following the government standard salary grade. The number of visitors per day is expected to increase in the future since the Department of Tourism is planning to create a catalog of all migratory and local birds in the LPPWP to promote the area and to add it as a destination in the NCR itinerary for city tours.

Public transport modes available to go to LPPWP include jeepneys and buses. Guided tours are done via bus. There are designated parking slots inside the Wetland Center Complex. Restaurants will also be built inside the Complex. DAO 2016-24 provides standard facility use fees for PAs (Table 11).

Table 11. Minimum rates for daily use of facilities and recreational activities as provided in DAO 2016-24

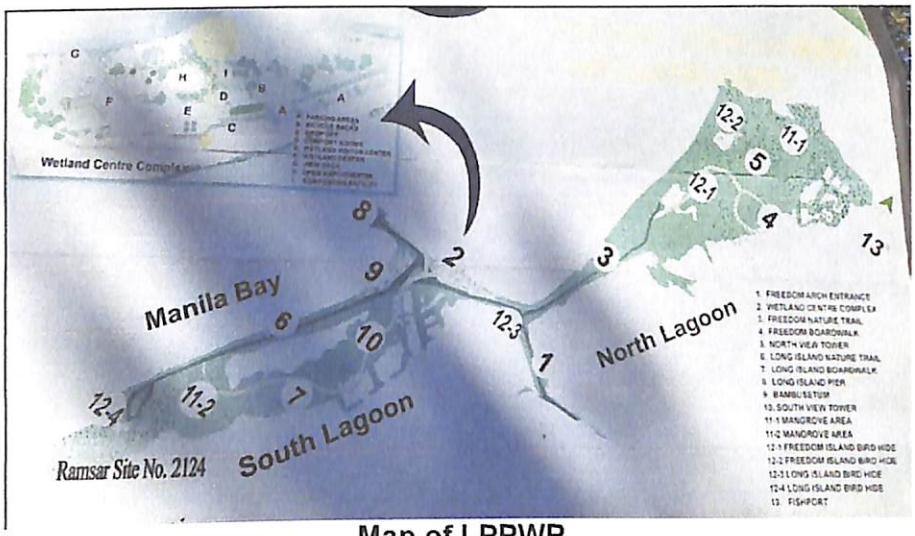
PA Facility	Facility Use Fee
Parking area	
• Tricycle/motorcycle	PhP20.00 (1st 2 hours), PhP5.00 (succeeding hours)

PA Facility	Facility Use Fee
• Cars/SUV	PhP45.00 (1st 2 hours), PhP10.00 (succeeding hours)
• Passenger jeep/coaster	PhP60.00 (1st 2 hours), PhP20.00 (succeeding hours)
• Mini-bus and tour bus	PhP150.00 (1st 2 hours), PhP30.00 (succeeding hours)
Biking within designated areas	PhP60.00 for Filipinos PhP100.00 for Foreigners

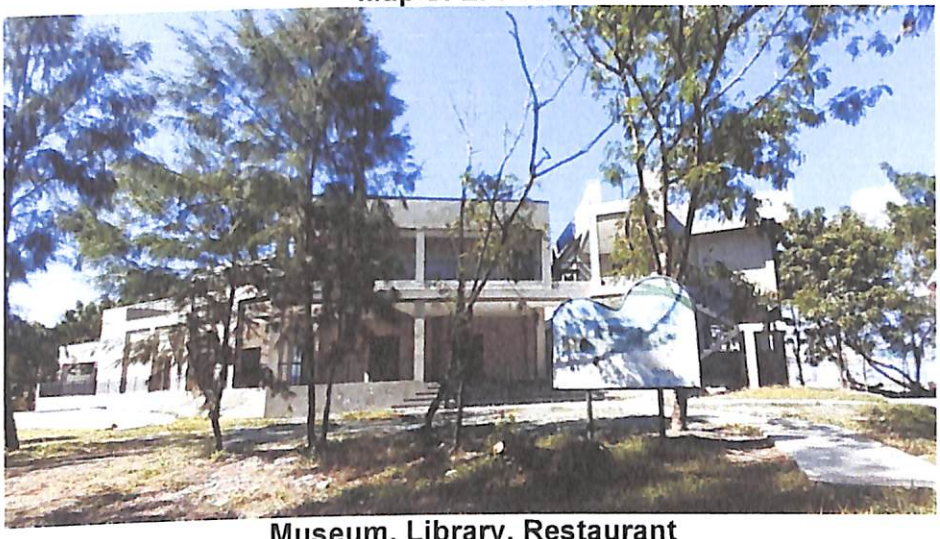
Fees that are directly related to specific tourist recreational activities can be either charged separately or in addition to the entrance fee. It may be more cost-effective and acceptable to tourists to pay a single fee rather than pay separate amounts for various activities. PA Managers should first evaluate the willingness to pay for fees among tourists and tour operators and consult the public to determine is the appropriate pricing mechanism.

The Wetland Center Complex, currently under construction inside LPPWP, will serve as a scientific, recreational, and education center where residents of Metro Manila and other regions can learn about the local, national, and global importance of wetlands. The Wetland Center will be the place where interaction between people and nature happens and CEPA (communication, education, participation, and awareness) activities occur in support of wetland conservation. Existing ecotourism facilities within LPPWP are shown in Figure 28.

Figure 28. Existing ecotourism facilities in LPPWP



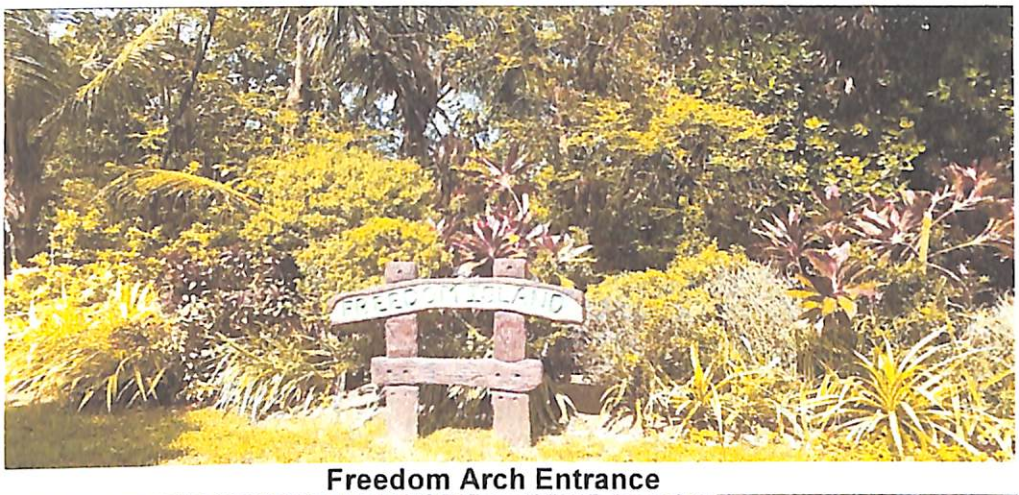
Map of LPPWP



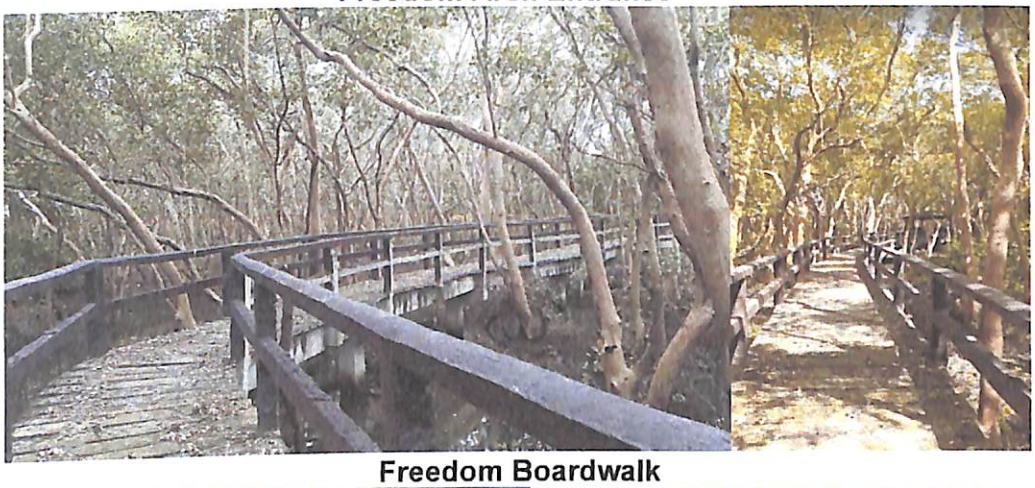
Museum, Library, Restaurant



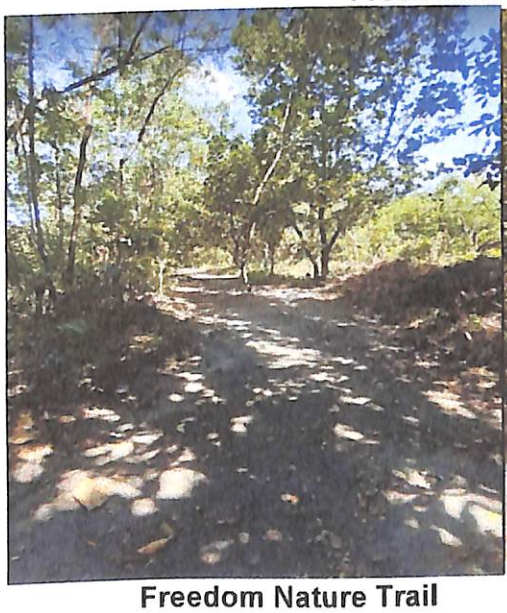
Open Amphitheater



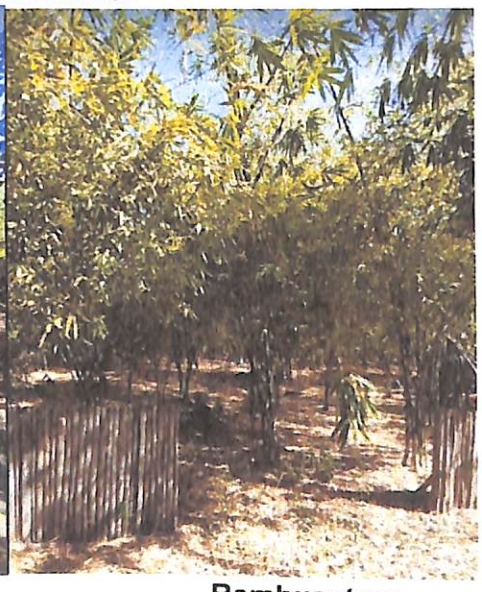
Freedom Arch Entrance



Freedom Boardwalk



Freedom Nature Trail



Bambusetum

Photo was taken during Site Visit on 21 November 2020

The IUCN's (2018) "*Tourism and visitor management in protected areas*" provides the best practice guidelines in managing visitors in protected areas, which the LPPWP Manager can use as a reference. It mentions that visitor experiences can be transformative and increase one's sense of support for protected area values. However, inappropriate, and poorly managed tourism can cause negative impacts on the biodiversity, landscapes, and resource base of protected areas. Among the best practices mentioned include:

- Supporting community-based delivery of tourism services
- Designing with nature and adopt nature-based solutions
- Zoning
- Hardening (i.e., building hard-surfaced boardwalks on portions of trails that cross fragile wetlands)
- Rationing to minimize the impact of visitors (Table 12)

Table 12. Rationing techniques to minimize the impact of visitors

Tourism rationing system	**Characteristics**
Reservation systems	Requires potential visitors to reserve a space or permit in advance of their visit
Lotteries	Allocates opportunities or permits on a random basis
First-come, first-served or queuing	Requires potential visitors to wait for available spaces or permits
Pricing	Requires visitors to pay a fee for a permit, which may 'filter out' those who are unable or unwilling to pay

Tourism rationing system	Characteristics
Merit	Requires potential visitors to 'earn' the right to a permit under demonstrated knowledge or skill (e.g., low-impact recreation behavior)

SOURCE: IUCN, Stankey & Baden, 1977; Cable & Watson, 1998; Whittaker & Shelby, 2008; Manning, 2011

- Harnessing the skill and enthusiasm of volunteers through citizen science
- Using environmental education and interpretation programs to emotionally engage visitors and connect them with the values the area is protecting
- Visitor monitoring
- Capacity building of staff and local communities
- Local business involvement and local community employment through concessionaires
- Generating tourism revenue from individual and business donations (an amount for every tree planted, company donations, etc.)

6. *Manual cleaning of floating garbage*

This may help but respondents believe that a more proactive means to prevent wastes from entering the area must be developed. Reduction of waste leakage from adjacent communities through wastewater treatment in residential and commercial/industrial zones is recommended more to ensure that

waterways are restored and water flows freely. However, wastewater management outside the area is not within the control of LPPWP managers but should be a shared responsibility among local and provincial government agencies as well as conservation organizations, private corporations, and other interest groups. If adopted, fishermen and other local community members may be hired, with minimum wage working 3-5 days a week.

7. *Allowing fishing in the sustainable zone*

This is the last in the list of recommended options because respondents believe that it may result in overfishing given the great demand for fish and fish products in the surrounding locality. This may result to decline in bird population during the migratory season since less fish means less food for migratory species. Respondents believe that subsistence fishing could be allowed but with restrictions and sufficient information and awareness raising campaign among fisherfolk. Since the viability of subsistence fishing in the area depends on its productivity, a thorough assessment should be done on the fish and other marine fauna populations as well as their habitat. A managed approach will have better outcomes towards this end as compared to a "no program" approach. Other measures to prevent overfishing include establishing a maximum sustained yield framework, enforcing the minimum size of fish that can be caught, and not allowing fishing when fish are laying eggs.

BMB-DENR confirmed that subsistence fishing is viable in the sustainable zone because fishes are abundant in the area. They clarified that only artisanal fishing is allowed hence there will be little risk of overfishing to

the extent detrimental to migratory birds. However, as much as possible, fishing is highly discouraged because the waters of Manila bay pose health hazards for consumers of fish caught here.

Less Preferred Management Options

8. Eco-tourism with free entrance

The former OIC-PASu of LPPWP does not agree with this proposal while the current Assistant PA Manager claimed that protected areas must generate income to sustain its management.

Management options that require investment or those with a high cost of implementation are at the bottom of the ranking. These include the establishment of a pollutant filtration system, construction of structural buffer walls, and installation of a materials recovery facility. Respondents believe that these options are questionable to some degree since having these physical facilities will not ensure success in minimizing the discharges of effluents to control the waste accumulation and habitat degradation.

9. Materials Recovery Facility

Figure 29 shows the collected waste after coastal clean-up during this researcher's site visit. The current practice is to segregate the collected

garbage with the biodegradable wastes processed in the vermicomposting facility while the non-biodegradable wastes are collected by LGU.

Figure 29. Photos showing non-biodegradable waste to be collected by LGU (top) and biodegradable waste to be processed in the vermicomposting facility (bottom)



SOURCE: Photo was taken during this researcher's site visit last 21 November 2020

If an MRF will be built, the recovered non-biodegradable waste materials can be recycled or can be sold to junk shops, providing additional livelihood. The MRF can also lessen the cost of logistics for waste collection and transportation to sanitary landfills since the volume of waste will be reduced and the number of routes for collection can be decreased thereby saving fuel and labor costs. An MRF requires manual labor and existing staff or local community members can be trained to operate it. A financial analysis conducted for this study (Figure 30) for installing an MRF to treat wastes from LPPWP and nearby barangays shows its feasibility. The installation cost of an MRF will be recovered in 3 years if the design has a maximum capacity of 2 tons and minimum waste collected is 0.6 tons per day. Sensitivity analysis, which tests the robustness of the result, shows that if the waste is <0.6 tons, the recovery will be achieved in 7 years but if the waste collection is maximum at 2 tons, the cost will be recovered in 3 years.

Figure 30. Financial analysis of MRF installation

Waste collected	0.6 tons	Recovery	50%				
Waste Components	Tons	Recycled	Price P/ton	Revenue P			
Plastics	0.17	0.09	10,000	861.98			
Rubber	0.01	0.00	5,000	17.70			
Styrofoam	0.01	0.00					
Glass	0.01	0.01	1,500	8.98			Net
Plastic bottle	0.05	0.03	15,000	393.51	P million	P million	Revenue
Other organics	0.34			**1,282.17**	0.47	0.10	**0.37**
Total	**0.6**			Total/day	Sales/Year	O&M	

	Investmen	Equity	Debt	Interest	Income	Divident	Repayment	
	1.13	30%	70%	8%	0.37	15%		
Year 0	1.130	0.34	0.791	0.06328	0.305	0.051	$0.254	
Year 1	0.876	0.34	0.537	0.042971	0.325	0.051	$0.274	
Year 2	0.602	0.34	0.263	0.021037	0.347	0.051	$0.296	
Year 3	0.306	0.34	-0.033	-0.002651	**0.371**	0.051	$0.320	**Cost**
Year 4	-0.014	0.34	-0.353	-0.028234	0.396	0.051	$0.345	**recovery in**
Year 5	-0.359	0.34	-0.698	-0.055864	0.424	0.051	$0.373	**3 years**

However, the Assistant PA Supervisor suggests that the MRF should be built outside the protected area since LGUs are mandated to build MRFs in each barangay. This will require the LPPWP management to approach nearby LGUs to implement the MRF installation within their barangays. The LPPWP can collaborate with nearby barangays for the maintenance of their MRFs.

10. Establishment of a pollutant filtration system

For an area as large as the LPPWP and considering the numerous sources of pollutants, the scale of the system would have to be extremely huge to be effective. It would also be costly.

11. Construction of sea walls

Construction of sea walls as a climate change adaptation measure is not considered necessary by respondents because of its high cost, labor-intensive requiring specialized skills, and uncertainty of the future impact of climate change to LPPWP. Constructing a sea wall to minimize the effect of storm surge can be used as an adaptation measure but only for the short to medium term. For the long term, a comprehensive plan should be formulated to include climate change adaptation and mitigation measures to prevent or reduce sea level rise. Building with natural solutions such as permeable structures is suggested to counter erosion.

Government initiatives for LLPWP

Conservation measures undertaken by DENR since the designation of LPPWP as a Critical Habitat and Ecotourism Area in 2007 include:

- ✓ Creation of the Management Council
- ✓ Restricting access to the protected area
- ✓ Organization of bird-watching tourism
- ✓ Regular monitoring of the presence of bird species through the "Asian Waterbird Census"
- ✓ Mangrove rehabilitation, enrichment planting, and regular monitoring of survival rate (currently 70%)
- ✓ Quarterly water quality monitoring
- ✓ Coastal cleanup activities
- ✓ Construction of the vermicomposting facility
- ✓ Construction of the Wetland Wave with available seats made up of recycled plastic
- ✓ Involvement of local communities by employing mangrove warriors to watch out for mangroves and to prevent illegal settlers from constructing floating houses in the bay.
- ✓ Raising public awareness about the importance of the site especially during coastal clean-up
- ✓ Cooperation between NGOs and governmental institutions
- ✓ Legislation of LPPWP as a National Park in 2018
- ✓ Development of draft Framework Plan in 2012, but not complete

Current LPPWP Draft Framework Plan

The current Framework Plan for LPPWP mentions that the PA management will build on inter-related strategies of (1) environment protection; (2) research and education; (3) livelihood generation; and (4) institutionalization. However, there is no clear plan of action on how to implement these strategies and how it will be linked to the plans of the adjacent municipality and the province where it exists. LPPWP cannot be managed as a separate island or secluded area from the rest of the NCR as it is also impacted by the dynamics of adjacent areas. The rapid increase in population and urbanization resulted in an increased amount of waste generated per day. The weak compliance to policies and lack of cooperation of the local community, lack of infrastructure for recycling and efficient transportation of waste, and weak governance are the major issues that hinder the effective implementation of waste management, which in turn negatively impact the LPPWP. Although LPPWP can just rely on the Manila Bay Master Plan for the overall implementation of waste management, LPPWP management should also do its best to address the above issues and coordinate with the LGUs.

The current draft LPPWP Framework Plan shows that most wetland management problems originate outside of the wetland. Waste management, in particular, requires the support from nearby LGUs for the Islands to continue to exist as a wetland and protected area. However, the draft Framework Plan does not contain a section that outlines its strategy to manage waste coming from within and outside the PA. The waste management plan should include

clear systems of waste reduction, reuse, recycling, processing and treatment as well as regular and voluntary clean up drives. The LPPWP can encourage LGUs to install MRFs in their barangays and the PA management can collaborate in maintaining such MRFs as repository for waste collected from the area.

The draft Framework Plan does not have a section on sustainable financing. Adequate budget is needed to manage the three zones within LPPWP that require enough staff complement to be managed and protected properly. Currently, the budget of LPPWP comes from the DENR NCR Office which covers the salaries of existing staff and operations. The draft Framework Plan should include the type and number of staff members needed as well as the required budget to adequately manage the LPPWP. Other financing schemes such as collection of user fees and securing grants from private and international donors or sponsors may be identified to augment government funds allocated for the PA.

Moreover, the draft LPPWP Framework Plan needs to be updated to address concerns and strategies for climate change adaptation and mitigation, disaster risk reduction and management, and gender and development. The gender and development action plan should be incorporated in the sustainable zone since this is the area reserved for use and access of local communities for livelihood. The action plan can target a percentage of women's participation in training and employment.

Finally, a review of the draft LPPWP Framework Plan reveals the lack of a Logical Framework to guide its implementation and monitoring. It is recommended that a Logical Framework should be included in finalizing the LPPWP Management Plan as a guide to achieving the desired results. The LogFrame should contain the PA's goal, target outputs and indicators, schedule of activities, and monitoring and means of verification. Adding risks and assumptions in the LogFrame is critical particularly if the achievement of the outputs is affected by economic, political, social, behavioral, financial, environment, and institutional factors. As defined by the ADB's guidelines for Preparing Design and Monitoring Framework (ADB, 2020):

> "Assumptions are the positive conditions, events, or actions that are expected to occur, although not with 100% certainty, and are, required for the achievement of the project's planned results...Risks are factors that can hinder progress from one results level to the next. They are potential conditions, events, or actions that would adversely affect, or make it difficult to achieve, the outputs and outcome, or to sustain the outcome."

Analyzing risks and assumptions will help identify and monitor unintended outcomes and negatives effects and can help protected area managers in preparing action plans to avoid them or address them if they arise.

Chapter V.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

LPPWP provides important ecosystem services. It provides shelter and food for migratory and local bird species which use the site as breeding grounds and as a stopover during their migration. It is also an ecotourism area that provides a place for environmental education and scientific research, and nature conservation activities. It offers nature-friendly activities such as birdwatching, ecotours, and nature walk. The wetland, due to the presence of mangroves, can filter pollutants, protect the coastal communities in Paranaque and Las Piñas from storm surges and floods, and acts as a carbon sink and for offsetting carbon emission. The aquatic territory in the immediate proximity is also used for subsistence fishing.

LPPWP needs active, effective, and responsive management. The government has done many conservation measures inside the LPPWP since its designation as a Critical Habitat and Ecotourism Area in 2007. However, the overall condition of the wetland is still unsatisfactory mainly due to garbage deposition carried by seawater current coming from southwest to northeast of Manila Bay. Added to it are the liquid wastes coming from municipal and industrial effluents. Respondents believe that cleanup activities are good for the media's attention but not enough to solve the garbage problem in the long term. It is just an immediate and temporary solution to the accumulation of trash. One respondent commented that coastal cleanup is evidence of poor governance.

Another major threat to the protected area is its geological instability. All expert respondents believe that the Islands are vulnerable to erosion and may continue to decrease in size or even sink due to changing climate that brings heavy rainfall and constant pounding of sea waves, which may grow stronger during typhoons. Erosion can also be caused by anthropogenic activities such as reclamation projects in nearby areas and urban flooding.

Based on the Climate Risk and Vulnerability Assessment in this study, LPPWP is vulnerable to storm surge, tropical cyclone, sea-level rise, and flooding, thus appropriate risk mitigation or adaptation measures must be implemented. The protected area is also vulnerable to anthropogenic activities that will continue due to the increasing population. Results of the MCDA present the top priority management options and adaptation measures that can be controlled and implemented inside LPPWP to mitigate the impact of climate change and anthropogenic activities (Table 13). It highlights the importance of mangroves in the conservation of the Islands and on the conservation of migratory birds and other indigenous terrestrial wildlife species. Mangroves can protect the Islands from erosion and possible sinking because it acts as a buffer area from storm surges and floods. It also serves as a shelter for various insects and other wildlife, which in turn serve as food for birds and other predators.

Table 13. Proposed measures to mitigate the impacts of climate change and anthropogenic activities on LPPWP based on the results of the study

Hazard	Impact on LPPWP	Proposed Management Options/Adaptation Measures
Climate Change		
Storm Surge	Erosion	Building a security outpost to prevent mangrove cutting Mangrove restoration activities Increase density of deep-rooted trees in the area Intensive information and education campaign Manual cleaning of floating garbage in addition to existing initiatives and *Installation of trash traps in rivers that drain in Manila Bay
Tropical Cyclone	Erosion, flooding, increased pollution, and garbage deposition	
Sea Level Rise	The sinking of the Islands	
Heavy Rainfall and Floods	Erosion, increased pollution, and garbage deposition	
Anthropogenic Activities		
Squatting or illegal settling	Pollution	Intensive information and education campaign Ecotourism with entrance fee to generate income that will be used to manage the area Manual cleaning of floating garbage in addition to existing
Improper waste disposal	Garbage deposition	

		initiatives and *Installation by DENR of trash traps in rivers that drain in Manila Bay
Cutting of mangroves	Erosion, the sinking of the Islands, decrease in breeding and nesting ground for birds	Mangrove restoration activities Building a security outpost to prevent mangrove cutting Intensive information and education campaign Allowing fishing in the sustainable zone. This will give fishermen their source of food.
Reclamation	Flooding	Intensive information and education campaign

*DENR started installing trash traps in July 2020.

Of the proposed management options, IEC and manual cleaning can help in addressing the garbage problem coming from surrounding cities and provinces. Other options proposed to manage waste particularly the Materials Recovery Facility is not encouraged inside the PA and the costly Pollutant Filtration System is believed to not be feasible by the respondents. Respondents believe that the root cause of the garbage problem, which is unmitigated waste disposal, should be understood from source to endpoints. The solution should take into account other strategies including the strict enforcement of laws on solid waste management and improvement of waste reduction and waste management systems such as the installation of sewage treatments in households that must be enforced by the LGUs. Recently, DENR

initiated the installation of floating and permanent trash traps. Trash traps are engineered contraptions designed to capture floating solid waste in waterways before it flows farther downstream and is believed to be more effective than manual cleaning (DENR, 2020). During this researcher's site visit on 21 November 2020, floating trash traps were recently installed in the site to prevent the garbage from entering the mangrove areas and the waters of Manila Bay. These trash traps should also be installed in all other rivers that drain into LPPWP including the Paranaque River, Las Pinas River, and Zapote River, and in the seven major rivers from 26 catchments that drain in Manila Bay.

LPPWP can help in the perennial waste problems through IEC campaigns, which is one of the top recommended management solutions, by promoting awareness on waste management policies including the Ecological Solid Waste Management Act of 2000 or RA 9003. Salient features of RA 9003 include mandating the LGUs to be the primarily responsible units, construction of sanitary landfill, mandatory 25% waste diversion through composting, re-use and recycling, and creation of materials recovery facilities in every barangay. IEC campaigns can promote waste management programs and increase compliance with the laws. Manual cleaning can also help but it is a solution only done at the endpoint.

In the IUCN's (2003) "*Guidelines for Management Planning of Protected Areas*", protected areas are mostly developed separately and managed as 'islands' but there is a new paradigm that the PA should be planned as part of national, regional, and international systems and developed as 'networks'

(strictly protected areas, buffered and linked by green corridors). This is very much applicable to LLPWP. The LPPWP's main objective of ecosystem conservation and protection will require a continuing partnership with the national and local governments. LPPWP is included in the Manila Bay Sustainable Development Master Plan, but the Master Plan extends across three regions and the National Capital Region, which also implies increasing conflicting interests. Since Manila Bay and the adjacent coastal zones and catchment basin are very big, it also means a lesser focus on LPPWP. Thus, a comprehensive and integrated Management Plan for LPPWP is critical.

The Final LPPWP Management Plan is currently being prepared. The study recommends including in the Final Plan the missing sections in the Draft Plan and the proposed actions related to it, i.e., linkage to the plans of adjacent LGUs; action plan on waste management (collection and processing or transportation to sanitary landfills); sustainable financing and staff management; climate change adaptation and mitigation, disaster risk reduction and management, and gender and development; and including a Logical Framework. Respondents propose additional management options to further improve the management of LPPWP as listed in Figure 31.

Figure 31. Additional proposed measures for LPPWP by expert respondents in the study

Policy

- Ban on single use plastics to help reduce solid wastes
- Secure partnership with private sector and other interested stakeholders to come up with Sustainability Plans to fund its operation and for cleanup of rivers contributing to its pollution
- Allocation of funds from BMB-DENR

Institutional

- Strengthen collaboration with LGUs in which LPPWP is located, particularly on action plans on waste management
- Institutionalization of a periodic dialogue with LGU executives and City ENRO (e.g. Annual LPPWP Stakeholders Convention)
- Collaboration with Manila Bay Sustainable Development Plan Council to ensure protection of LPPWP from reclamation plans.
- Mobilization of local environment advocacy groups as partners. These groups can help in the public education, particularly in awareness raising and in development and distribution of IEC materials. If these groups are present, assistance to strengthen them should be made available.
- Assigning of permanent Environment and Natural Resources Officer, complemented by staff.

Social/Gender Development

- Develop alternative livelihood for communities
- Inclusion of women for alternative biodiversity friendly enterprises

This study also proposes to include in the Final Management Plan the results of the MDCA on the management solutions that can be controlled inside LPPWP (Figure 9), aside from the existing conservation measures currently being implemented and the additional management measures proposed by respondents (Figure 23).

Further work is needed from the PA managers to conduct a public consultation to present the proposed solutions to stakeholders to develop a functional management plan and increase their participation in its implementation. In addition, the approach in the preparation of the Final Management Plan should be holistic integrating policy, institutional, and enforcement aspects. It is also recommended that the Final Management Plan should have a clear set of action items based on a logical framework.

Management solutions that are controlled or within the scope of the PA managers alone will not solve the management problems of the LPPWP. Strict implementation of policies and laws, institutional development, and encouragement of collective action from the local communities through IEC are necessary to achieve a balance between the ecological, economic, and social value of the wetland.

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APPENDICES

APPENDIX 1. DATA USED FOR TEMPERATURE AND RAINFALL PROJECTIONS DOWNLOADED FROM WORLD BANK CLIMATE CHANGE KNOWLEDGE PORTAL

Appendix Table 1. Maximum Temperature Anomaly under RCP 4.5

Maximum Temperature	RCP 4.5			
	2020-2039	2040-2059	2060-2079	2080-2099
Jan Anomaly	0.38155	0.64137	1.01690	1.11370
Feb Anomaly	0.72819	0.94141	1.18522	1.32499
Mar Anomaly	0.58484	0.99037	1.37539	1.39668
Apr Anomaly	0.58284	0.99521	1.53746	1.63437
May Anomaly	0.43352	0.96929	1.54990	1.81592
Jun Anomaly	0.32053	0.63519	1.31231	1.52192
Jul Anomaly	0.47643	0.71683	1.11654	0.94557
Aug Anomaly	0.25931	0.78135	0.93995	1.20161
Sep Anomaly	0.52391	0.75478	1.43328	1.20495
Oct Anomaly	0.44491	0.85959	1.41592	1.38851
Nov Anomaly	0.25769	0.57022	0.91747	1.19382
Dec Anomaly	0.12708	0.65981	0.88355	1.31803
AVERAGE	0.42673	0.79295	1.22366	1.33834

Appendix Table 2. Maximum Temperature Anomaly under RCP 8.5

Maximum Temperature	RCP 8.5			
	2020-2039	2040-2059	2060-2079	2080-2099
Jan Anomaly	0.30454	0.93577	1.47626	2.23509
Feb Anomaly	0.52876	0.78707	1.52705	2.15641
Mar Anomaly	0.73083	1.16275	1.85603	2.41063
Apr Anomaly	0.69529	1.37201	2.36178	3.05244
May Anomaly	1.01567	1.29643	2.85367	3.73490
Jun Anomaly	0.72954	1.10491	2.06688	3.03447
Jul Anomaly	0.54887	1.02155	2.02201	2.63726
Aug Anomaly	0.50927	1.19517	2.01646	2.69591
Sep Anomaly	0.72225	1.17844	1.81535	2.67802
Oct Anomaly	0.63209	1.27314	2.07778	2.69124
Nov Anomaly	0.51424	0.91577	1.82121	2.45386
Dec Anomaly	0.36081	1.00705	1.55613	2.41465
AVERAGE	0.60768	1.10417	1.95422	2.68291

Appendix Table 3. Maximum Temperature Anomaly under RCP 4.5 & RCP 8.5

	2020-2039	2040-2059	2060-2079	2080-2099
RCP 4.5	0.43	0.79	1.22	1.34
RCP 8.5	0.61	1.10	1.95	2.68

Appendix Table 4. Minimum Temperature Anomaly under RCP 4.5

Minimum Temperature Anomaly	RCP 4.5 2020-2039	2040-2059	2060-2079	2080-2099
Jan	0.43150	0.67635	1.01521	1.09980
Feb	0.55629	0.91052	1.02079	1.16067
Mar	0.76843	1.24726	1.51461	1.44086
Apr	0.50431	1.10178	1.30688	1.46716
May	0.59844	1.05190	1.37290	1.64907
Jun	0.53840	0.83922	1.32889	1.41841
Jul	0.53081	0.83086	1.16827	1.28152
Aug	0.48050	0.82457	1.15205	1.23051
Sep	0.54041	0.75940	1.10919	1.18858
Oct	0.45998	0.94541	1.21030	1.26601
Nov	0.37177	0.82481	1.14452	1.41743
Dec	0.22919	0.73055	1.00038	1.23043
Average	0.50084	0.89522	1.19533	1.32087

Appendix Table 5. Minimum Temperature Anomaly under RCP 8.5

Minimum Temperature Anomaly	RCP 8.5 2020-2039	2040-2059	2060-2079	2080-2099
Jan	0.26922	0.94755	1.49359	2.24844
Feb	0.41788	0.70940	1.43804	2.05225
Mar	0.73530	1.31201	1.85137	2.57168
Apr	0.68694	1.31181	2.12564	2.78280
May	0.78131	1.37674	2.35284	3.07463
Jun	0.71141	1.28939	2.11805	2.88433
Jul	0.69435	1.19540	2.06142	2.77036
Aug	0.62606	1.28091	2.02397	2.74803
Sep	0.67878	1.21439	1.96251	2.74202
Oct	0.51723	1.12553	2.13784	2.73611
Nov	0.51684	1.05656	2.05346	2.63636
Dec	0.43260	0.94618	1.65100	2.48563
Average	0.58899	1.14716	1.93914	2.64439

Appendix Table 6. Minimum Temperature Anomaly under RCP 4.5 & RCP 8.5

	2020-2039	2040-2059	2060-2079	2080-2099
RCP 4.5	0.50	0.90	1.20	1.32
RCP 8.5	0.59	1.15	1.94	2.64

Data used for Rainfall Projections downloaded from World Bank CCKP

Appendix Table 7. Average Rainfall under RCP 4.5 and RCP 8.5

Average Rainfall (mm)	2020-2039		2040-2059		2060-2079		2080-2099	
	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Jan	43.371	44.360	30.940	28.828	35.524	29.892	25.103	33.352
Feb	17.144	21.890	20.947	16.547	16.716	21.249	19.463	9.854
Mar	39.545	39.039	42.498	32.584	37.686	16.943	39.145	16.652
Apr	58.419	78.079	62.849	62.252	78.720	35.608	67.971	42.093
May	190.009	140.775	164.823	179.555	160.735	117.721	157.547	135.128
Jun	505.316	478.004	537.603	534.612	510.339	599.144	417.552	530.871
Jul	553.416	603.233	525.744	623.323	648.884	621.764	750.920	683.458
Aug	630.178	606.868	583.345	602.387	713.836	620.210	624.396	685.842
Sep	272.663	249.232	298.912	328.575	248.511	338.343	318.690	347.359
Oct	136.796	146.349	133.463	112.586	100.676	141.242	105.988	142.704
Nov	143.327	94.582	167.099	129.618	102.658	99.537	133.911	124.869
Dec	56.764	70.906	77.766	69.598	72.836	68.526	57.120	84.130

Appendix Table 8. Percent Change in Rainfall under RCP 4.5

	RCP 4.5 Average Rainfall (mm)				RCP 4.5 Percent Change relative to Reference Period 1991-2016			
	2020-2039	2040-2059	2060-2079	2080-2099	2020-2039	2040-2059	2060-2079	2080-2099
Jan	43.371	30.940	35.524	25.103	189%	106%	137%	67%
Feb	17.144	20.947	16.716	19.463	14%	40%	11%	30%
Mar	39.545	42.498	37.686	39.145	147%	166%	136%	145%
Apr	58.419	62.849	78.720	67.971	129%	146%	209%	166%
May	190.009	164.823	160.735	157.547	7%	-7%	-9%	-11%
Jun	505.316	537.603	510.339	417.552	71%	82%	73%	41%
Jul	553.416	525.744	648.884	750.920	23%	17%	44%	67%
Aug	630.178	583.345	713.836	624.396	67%	55%	89%	65%
Sep	272.663	298.912	248.511	318.690	-21%	-13%	-28%	-7%
Oct	136.796	133.463	100.676	105.988	-41%	-42%	-57%	-54%
Nov	143.327	167.099	102.658	133.911	46%	70%	4%	36%
Dec	56.764	77.766	72.836	57.120	60%	119%	106%	61%
Average	220.6	220.5	227.3	226.5	58%	62%	60%	51%

Appendix Table 9. Percent Change in Rainfall under RCP 8.5

	RCP 8.5 Average Rainfall (mm)				RCP 8.5 Percent Change relative to Reference Period 1991-2016			
	2020-2039	2040-2059	2060-2079	2080-2099	2020-2039	2040-2059	2060-2079	2080-2099
Jan	44.360	28.828	29.892	33.352	196%	92%	99%	122%
Feb	21.890	16.547	21.249	9.854	46%	10%	42%	-34%
Mar	39.039	32.584	16.943	16.652	144%	104%	6%	4%
Apr	78.079	62.252	35.608	42.093	206%	144%	40%	65%
May	140.775	179.555	117.721	135.128	-20%	1%	-34%	-24%
Jun	478.004	534.612	599.144	530.871	62%	81%	103%	80%
Jul	603.233	623.323	621.764	683.458	34%	39%	38%	52%
Aug	606.868	602.387	620.210	685.842	61%	60%	64%	82%
Sep	249.232	328.575	338.343	347.359	-27%	-4%	-1%	1%
Oct	146.349	112.586	141.242	142.704	-37%	-51%	-39%	-38%
Nov	94.582	129.618	99.537	124.869	-4%	32%	1%	27%
Dec	70.906	69.598	68.526	84.130	100%	96%	93%	137%
Average	214.4	226.7	225.8	236.4	63%	50%	34%	40%

APPENDIX 2. RESPONDENTS' PROFILE

Appendix Table 10. Expert Respondents' Profile

1	National Lead for the No Plastics in Nature Initiative, Worldwide Fund for Nature (WWF)
2	Climate Change Consultant
3	Environment Specialist Consultant
4	Former member of PAMB/CSO representative
5	Environmental Safeguards Officer
6	Wild Bird Club Secretary/CSO rep
7	Wetlands International Philippines member
8	Wild Bird Photographers of the Philippines member
9	Economics Officer
10	Tourism graduate with units in master's in economics
11	DENR Asst. Protected Area Supervisor
12	DENR Former-OIC Protected Area Supervisor
13	Wild Bird Club member/CSO representative
14	Wild Bird Club President/CSO representative
15	Senior Social Development Specialist

APPENDIX 3. MULTICRITERIA DECISION ANALYSIS USING COMBINED ENTROPY WEIGHT METHOD AND TOPSIS

Appendix Table 11. Average rating of experts' scores on alternatives against management criteria

Management Options	Management Objective									
	Ecological			Economic		Social			Feasibility	
	Conservation of migratory birds and indigenous wildlife species (C1)	Conservation of Mangroves (C2)	Protection of Islands from Erosion (C3)	Increase in Tourism Income (C4)	Additional Livelihood for Mangrove warriors (C5)	Promotion of Local Identity (C6)	Subsistence fishing (C7)	Increase access to Research & Education opportunities (C8)	Technical Implementation (C9)	Financial /Cost of Implementation (C10)
Conservation of the Critical Habitat										
Installation of Materials Recovery Facility	3.9	3.7	2.7	3.3	3.0	2.6	3.2	2.8	3.5	3.0
Establishment of a Pollutant filtration system	4.3	3.9	2.9	3.4	2.6	2.6	4.1	3.0	2.5	3.9
Building a Security Outpost to Prevent Mangrove Cutting, poaching and quarrying	4.1	4.3	3.7	3.6	3.5	3.0	3.3	3.1	3.7	2.6
Manual cleaning of floating garbage	3.8	3.6	2.5	3.5	3.7	3.3	3.5	2.9	3.7	2.7
Intensive information and education campaign	4.5	4.7	3.7	3.8	3.1	3.7	3.1	3.8	3.8	2.9
Protection from Erosion										
Increase area of Mangrove Plantation	3.8	4.2	4.3	3.3	3.4	3.1	3.3	3.4	3.3	2.8

Increase density of deep-rooted trees in the area	3.7	3.9	4.5	3.4	3.2	3.1	2.9	3.5	3.3	2.7
Construction of structural buffer walls	2.6	2.9	4.0	2.2	2.2	2.1	2.1	2.2	2.7	4.3
Income from Tourism										
Eco-tourism with Entrance Fee	3.4	3.4	2.6	4.5	3.8	3.6	2.6	3.2	3.9	2.5
Equal Access to Resource										
Allowing fishing in sustainable zone	3.1	3.2	2.2	2.6	3.2	2.9	4.1	2.8	3.6	2.3
Eco-tourism with Free Entrance	2.6	2.7	2.1	2.9	2.6	3.1	2.3	3.0	4.0	1.9

Appendix Table 12. Criteria Weights Calculation using the Entropy Method

Normalization value (n_{ij})

(C1)	(C2)	(C3)	(C4)	(C5)	(C6)	(C7)	(C8)	(C9)	(C10)
0.10	0.09	0.08	0.09	0.09	0.08	0.09	0.08	0.09	0.09
0.11	0.10	0.08	0.09	0.08	0.08	0.12	0.09	0.07	0.12
0.10	0.11	0.10	0.10	0.10	0.09	0.10	0.09	0.10	0.08
0.10	0.09	0.07	0.10	0.11	0.10	0.10	0.09	0.10	0.08
0.11	0.12	0.11	0.10	0.09	0.11	0.09	0.11	0.10	0.09
0.10	0.10	0.12	0.09	0.10	0.09	0.09	0.10	0.09	0.09
0.09	0.10	0.13	0.09	0.09	0.09	0.08	0.10	0.09	0.09
0.07	0.07	0.11	0.06	0.06	0.06	0.06	0.07	0.07	0.14
0.08	0.08	0.08	0.12	0.11	0.11	0.08	0.10	0.10	0.08
0.08	0.08	0.06	0.07	0.09	0.09	0.12	0.08	0.09	0.07
0.06	0.07	0.06	0.08	0.08	0.09	0.07	0.09	0.11	0.06

Ln (n_{ij})

(C1)	(C2)	(C3)	(C4)	(C5)	(C6)	(C7)	(C8)	(C9)	(C10)
-2.33	-2.39	-2.56	-2.39	-2.43	-2.55	-2.38	-2.49	-2.39	-2.36
-2.22	-2.34	-2.51	-2.37	-2.58	-2.55	-2.14	-2.42	-2.73	-2.09
-2.26	-2.24	-2.26	-2.32	-2.29	-2.41	-2.34	-2.40	-2.32	-2.50
-2.35	-2.43	-2.66	-2.33	-2.23	-2.32	-2.28	-2.44	-2.32	-2.48
-2.17	-2.15	-2.24	-2.26	-2.41	-2.19	-2.40	-2.18	-2.30	-2.38
-2.35	-2.27	-2.11	-2.41	-2.32	-2.36	-2.35	-2.29	-2.45	-2.43
-2.37	-2.34	-2.06	-2.37	-2.37	-2.36	-2.47	-2.26	-2.45	-2.45
-2.73	-2.63	-2.18	-2.81	-2.74	-2.75	-2.79	-2.73	-2.65	-1.99
-2.47	-2.50	-2.59	-2.09	-2.20	-2.21	-2.57	-2.35	-2.27	-2.54
-2.56	-2.54	-2.77	-2.65	-2.36	-2.43	-2.14	-2.49	-2.36	-2.63
-2.74	-2.71	-2.80	-2.55	-2.59	-2.38	-2.72	-2.42	-2.25	-2.80
							1/ln(m)		**-0.41703**

(n_{ij}) x *Ln* (n_{ij})

(C1)	(C2)	(C3)	(C4)	(C5)	(C6)	(C7)	(C8)	(C9)	(C10)	
-0.23	-0.22	-0.20	-0.22	-0.21	-0.20	-0.22	-0.21	-0.22	-0.22	
-0.24	-0.23	-0.20	-0.22	-0.20	-0.20	-0.25	-0.22	-0.18	-0.26	
-0.24	-0.24	-0.24	-0.23	-0.23	-0.22	-0.23	-0.22	-0.23	-0.21	
-0.22	-0.21	-0.19	-0.23	-0.24	-0.23	-0.23	-0.21	-0.23	-0.21	
-0.25	-0.25	-0.24	-0.24	-0.22	-0.25	-0.22	-0.25	-0.23	-0.22	
-0.22	-0.23	-0.26	-0.22	-0.23	-0.22	-0.22	-0.23	-0.21	-0.21	
-0.22	-0.23	-0.26	-0.22	-0.22	-0.22	-0.21	-0.24	-0.21	-0.21	
-0.18	-0.19	-0.25	-0.17	-0.18	-0.18	-0.17	-0.18	-0.19	-0.27	
-0.21	-0.21	-0.19	-0.26	-0.24	-0.24	-0.20	-0.22	-0.23	-0.20	
-0.20	-0.20	-0.17	-0.19	-0.22	-0.21	-0.25	-0.21	-0.22	-0.19	
-0.18	-0.18	-0.17	-0.20	-0.19	-0.22	-0.18	-0.22	-0.24	-0.17	
-2.38	**-2.39**	**-2.37**	**-2.38**	**-2.39**	**-2.39**	**-2.38**	**-2.39**	**-2.39**	**-2.37**	**SUM**
0.994	**0.995**	**0.987**	**0.993**	**0.995**	**0.995**	**0.992**	**0.996**	**0.996**	**0.990**	**eij**
0.006	0.005	0.013	0.007	0.005	0.005	0.008	0.004	0.004	0.010	**dij**
0.10	**0.08**	**0.20**	**0.10**	**0.07**	**0.07**	**0.12**	**0.06**	**0.06**	**0.16**	**Wij**

Multicriteria Decision Analysis using TOPSIS Method

Appendix Table 13. MCDA Using TOPSIS: Squared value of scores

Alt	(C1)	(C2)	(C3)	(C4)	(C5)	(C6)	(C7)	(C8)	(C9)	(C10)
1	15.0	13.9	7.5	11.1	9.0	6.8	10.2	7.8	12.0	9.0
2	18.8	15.5	8.2	11.6	6.8	6.8	16.5	9.0	6.1	15.5
3	17.1	18.8	13.4	13.0	12.0	9.0	11.1	9.4	13.9	6.8
4	14.4	13.0	6.1	12.5	13.4	10.7	12.5	8.6	13.9	7.1
5	20.6	22.4	13.9	14.4	9.4	13.9	9.8	14.4	14.4	8.6
6	14.3	17.8	18.4	10.8	11.3	9.9	10.8	11.8	10.8	7.8
7	13.9	15.5	20.0	11.6	10.2	9.8	8.6	12.5	10.7	7.5
8	6.8	8.6	16.0	4.8	4.8	4.6	4.6	4.8	7.1	18.8
9	11.3	11.3	7.0	20.3	14.3	13.3	7.0	10.3	15.4	6.3
10	9.4	10.3	4.9	6.6	10.4	8.6	16.6	7.8	12.8	5.2
11	6.6	7.4	4.6	8.2	6.6	9.4	5.2	9.0	16.0	3.7

Appendix Table 14. Normalization value

	(C1)	(C2)	(C3)	(C4)	(C5)	(C6)	(C7)	(C8)	(C9)	(C10)
1	0.32	0.30	0.25	0.30	0.29	0.26	0.30	0.27	0.30	0.31
2	0.36	0.32	0.26	0.30	0.25	0.26	0.38	0.29	0.21	0.40
3	0.34	0.35	0.33	0.32	0.33	0.30	0.31	0.30	0.32	0.27
4	0.31	0.29	0.23	0.32	0.35	0.32	0.33	0.29	0.32	0.27
5	0.37	0.38	0.34	0.34	0.29	0.37	0.29	0.37	0.33	0.30
6	0.31	0.34	0.39	0.29	0.32	0.31	0.31	0.33	0.28	0.28
7	0.31	0.32	0.41	0.30	0.31	0.31	0.28	0.34	0.28	0.28
8	0.21	0.24	0.37	0.20	0.21	0.21	0.20	0.21	0.23	0.44
9	0.28	0.27	0.24	0.40	0.36	0.36	0.25	0.31	0.34	0.25
10	0.25	0.26	0.20	0.23	0.31	0.29	0.38	0.27	0.31	0.23
11	0.21	0.22	0.20	0.26	0.25	0.30	0.22	0.29	0.35	0.20

Appendix Table 15. Calculated weights using the entropy method

(C1)	(C2)	(C3)	(C4)	(C5)	(C6)	(C7)	(C8)	(C9)	(C10)
0.10	**0.08**	**0.20**	**0.10**	**0.07**	**0.07**	**0.12**	**0.06**	**0.06**	**0.16**

Appendix Table 16. Normalized Weighted Matrix

	(C1)	(C2)	(C3)	(C4)	(C5)	(C6)	(C7)	(C8)	(C9)	(C10)
1	0.03	0.02	0.05	0.03	0.02	0.02	0.03	0.02	0.02	0.05
2	0.03	0.02	0.05	0.03	0.02	0.02	0.04	0.02	0.01	0.06
3	0.03	0.03	0.07	0.03	0.02	0.02	0.04	0.02	0.02	0.04
4	0.03	0.02	0.04	0.03	0.03	0.02	0.04	0.02	0.02	0.04
5	0.04	0.03	0.07	0.03	0.02	0.02	0.03	0.02	0.02	0.05
6	0.03	0.03	0.08	0.03	0.02	0.02	0.04	0.02	0.02	0.04
7	0.03	0.02	0.08	0.03	0.02	0.02	0.03	0.02	0.02	0.04
8	0.02	0.02	0.07	0.02	0.02	0.01	0.02	0.01	0.01	0.07
9	0.03	0.02	0.05	0.04	0.03	0.02	0.03	0.02	0.02	0.04
10	0.02	0.02	0.04	0.02	0.02	0.02	0.04	0.02	0.02	0.04
11	0.02	0.02	0.04	0.03	0.02	0.02	0.02	0.02	0.02	0.03

Appendix Table 17. Positive Distance from Ideal Solution

(C1)	(C2)	(C3)	(C4)	(C5)	(C6)	(C7)	(C8)	(C9)	(C10)
0.04	0.03	0.08	0.04	0.03	0.02	0.04	0.02	0.02	0.03

Appendix Table 18. Negative Distance from Ideal Solution

(C1)	(C2)	(C3)	(C4)	(C5)	(C6)	(C7)	(C8)	(C9)	(C10)
0.02	0.02	0.04	0.02	0.02	0.01	0.02	0.01	0.01	0.07

Appendix Table 19. Ranking of Alternatives

Si Pos	Si Neg	Cci	Rank	Alternatives
0.04	0.03	0.44	8	Installation of Materials Recovery Facility
0.05	0.03	0.41	10	Establishment of a Pollutant filtration system to control the discharges of effluents
0.02	0.05	0.68	3	Building Security Outpost
0.04	0.04	0.48	6	Manual cleaning of floating garbage
0.02	0.05	0.66	4	Intensive information and education
0.02	0.05	0.71	1	Increase area of Mangrove Plantation
0.02	0.05	0.70	2	Increase density of deep-rooted trees
0.06	0.03	0.38	11	Construction of structural buffer walls
0.04	0.04	0.51	5	Eco-tourism with Entrance Fee
0.05	0.04	0.46	7	Allowing fishing in the sustainable zone
0.05	0.04	0.43	9	Eco-tourism with Free Entrance

APPENDIX 4. QUESTIONNAIRE:

1. Please rate the outcomes that should be considered in decision making for the management of LPPWP in terms of their importance and value to you. Add others that you believe should be included.

Value Category	Criteria	Importance and Value to You				
		Unimportant	Low	Medium	High	Very High
Ecological	Migratory Birds					
	Indigenous terrestrial wildlife species					
	Mangroves					
Economic	Tourism Income					
	Livelihood for the local community (e.g., Bakawan warriors)					
Social	Local Identity					
	Subsistence fishing					
	Research and education					
Feasibility	Ease of Implementation					
	Cost of Implementation					

2. **Development objectives of LPPWP**

Please rank your specific objectives for the economic and environmental future of the LPPWP. Add other specific objectives/goals that you believe should be included.
(1 being the highest priority)

Development Objective for LPPWP	Rank
Conservation of migratory birds and other indigenous terrestrial wildlife species	
Conservation of Mangroves	
Protection of Islands from erosion	
Livelihood for the local community through tourism	
Social equity by Delivering recreational benefits to resident and local communities, facilitate research and educational opportunities	

3. Alternative Management Options

I believe the management option would achieve this objective to this degree. (1 being the lowest, 5 being the highest)

e.g., I believe the installation of a Materials Recovery Facility would achieve conservation of migratory birds to this degree.

I believe that this management option	*would achieve*	**this objective**	**To this degree**				
			1	**2**	**3**	**4**	**5**
Installation of Materials Recovery Facility		Conservation of migratory birds and other indigenous terrestrial wildlife species, and mangroves Conservation of mangroves					
Establishment of a Pollutant filtration system to control the discharges of effluents							
Intensive Information and Education Campaign							
Manual cleaning of floating garbage (fishermen may be hired)							
Building a Security Outpost to Prevent Mangrove Cutting							
Increasing Mangrove Density		Protection of Islands from erosion					
Increasing density of deep-rooted trees in the area							
Construction of structural buffer walls							
Eco-tourism with Entrance Fee		Livelihood					
Allowing fishing in the sustainable zone		Social equity					
Eco-tourism with Free Entrance							
(Please add other management options that you believe should be included							

4. **Decision Matrix**

The section aims to identify the management actions that would be viable and effective for achieving the management objectives—reducing environmental threats to LPPWP or ensuring the economic values or social equity of the LPPWP.

Please evaluate the management options against the management objective and add other options you identify as important.

Criteria 1-8: What degree of importance does the **Management Option** (Column A) will affect the **Management Objectives** (Row 3)?
e.g., What degree of importance does the Installation of Materials Recovery Facility affects the conservation of migratory birds?
(1) Not important at all, (2) Of little Importance, (3) Of average Importance, (4) Very Important, (5) Absolutely Essential
Criteria 9: Ease of Implementation = **(1) very difficult, (2) difficult, (3) average, (4) easy, (5) very easy to implement**
Criteria 10: Cost = **(1) very low, (2) low, (3) average, (4) high, (5) very high**

	Management Objective									
	Ecological			Economic		Social			Feasibility	
Management Options	Conservation of migratory birds and other indigenous wildlife species (C1)	Conservation of Mangroves (C2)	Protection of Islands from Erosion (C3)	Increase in Tourism Income (C4)	Additional Livelihood for Bakawan warriors (C5)	Promotion of Local Identity (C6)	Subsistence fishing (C7)	Increase access to Research & Education opportunities (C8)	Technical Implementation (C9)	Financial /Cost (C10)
Conservation of the Critical Habitat										
(1) Installation of Materials Recovery Facility										
(2) Establishment of a Pollutant filtration system to control the discharges of effluents										
(3) Building a Security Outpost to Prevent Mangrove Cutting, poaching and sand and gravel quarrying										

Management Options	Management Objective									
	Ecological			Economic		Social			Feasibility	
	Conservation of migratory birds and other indigenous wildlife species (C1)	Conservation of Mangroves (C2)	Protection of Islands from Erosion (C3)	Increase in Tourism Income (C4)	Additional Livelihood for Bakawan warriors (C5)	Promotion of Local Identity (C6)	Subsistence fishing (C7)	Increase access to Research & Education opportunities (C8)	Technical Implementation (C9)	Financial /Cost (C10)
(4) Manual cleaning of floating garbage (fishermen may be hired)										
(5) Intensive information and education campaign										
Protection from Erosion										
(1) Increase area of Mangrove Plantation										
(2) Increase density of deep-rooted trees in the area										
(3) Construction of structural buffer walls										
Income from Tourism										
(1) Eco-tourism with Entrance Fee										
Equal Access to Resource										
(1) Allowing fishing in the sustainable zone										
(2) Eco-tourism with Free Entrance										

Remarks: _____

1. LPPWP is just a reclaimed area only. Do you think it is still not stable and may still decrease in size due to natural wave actions and storm surges?

2. Do you think it will sink in the future due to the increase in sea-level rise brought by climate change?

3. According to the Vulnerability Assessment conducted in 2014, there is a high chance that LPPWP will be developed for commercial establishments similar to commercial centers along Roxas boulevard, Las Pinas City, and Paranaque City. Do you think this still holds true today?

4. What are the possible impacts of reclamation projects in other parts of Manila Bay to LPPWP?

5. Do you think the white sand in Manila Bay will have an impact on LPPWP?

6. Have you experienced flooding in LPPWP? What is the impact of river flooding on LPPWP?

7. What is the effect of the Taal eruption on LPPWP last January 2020?

8. Is subsistence fishing viable in the sustainable zone? What is the fish productivity in the area? Do you think there will be a risk of overfishing if allowed, which will, in turn, affect the migratory and wild birds since fish is their source of food?

9. In your opinion, are the current coastal clean-up activities enough to sustain the area?

10. Currently, Paranaque City, which has jurisdiction over Freedom Island, conducts river cleanup using trash boats and declogging of drainage and canals. Are these efforts by the LGU effective in preventing or minimizing the entry of garbage and effluents into the LPPWP?

11. Aside from mangrove cutting, is there an incidence of poaching and sand and gravel quarrying inside LPPWP?

12. Where is the source of drinking water for wild birds in the LPPWP?

Request for Data on:

This is for DENR, but if you have any knowledge from experience, please also answer esp. No. 4.

1. Estimates of Garbage Deposited Annually in Long Island and Freedom Island Beaches
2. Results of water quality monitoring for LPPWP
3. Collection Efficiency for Solid Wastes of Las Pinas and Paranaque
4. For the cost of management options:

	Estimated cost
Installation of Materials Recovery Facility	0.5 million to 1-5 million for 1 ton to 5 tons of mixed waste
Establishment of a Pollutant filtration system to control the discharges of effluents	Cost of Pollutant filtration system: _____ No of filtration system to be installed: _____
Manual cleaning of floating garbage (fishermen may be hired)	Per day rate of cleaner: _____ No. of days per week: _____
Building a Security Outpost to Prevent Mangrove Cutting	Per day rate of Security personnel: _____ No. of days per week: _____
Mangrove Plantation	Cost of planting mangrove: _____ Area for extension: _____sq. m
Increase density of deep-rooted trees in the area	Cost per tree: _____ No. of trees to be planted: _____ No. of person to be hired: _____ No. of days for tree planting activity: _____
Construction of structural buffer walls	Length of structural buffer wall: _____ meters Construction cost per meter _____
Subsistence fishing	No cost
Eco-tourism with Entrance Fee	Entrance fee: P20, P50? No. of visitors expected: _____ Additional no. personnel to be hired (reception, etc.) _____ Per day salary: _____
Eco-tourism with Free Entrance	Additional no. of personnel to be hired (reception, etc.) _____ Per day salary: _____