

# **Climate Change-Responsive Integrated River Basin Management and Development Master Plans for the 8 Clustered River Basins**

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Executive Summary for Cluster 4  
(Iwahig Penal, Inagawan, Aborlan, Batang-batang, and  
Malatgao)

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## 1 RATIONALE

The River Basin Control Office (RBCO) is mandated through Executive Order Nos. 510, 816, and 50 to create and develop master plans for the country's river basins to solve environmental problems such as flooding and to provide sustainable water supply for the entire country.

Watersheds play an important role in the Philippine economy. It dictates the welfare of industries and people living in the area. Hence, sustainable management of these watersheds is essential. Preparation of integrated watershed master plan is a step to sustainable management. An integrated watershed management approach will be used in the formulation of master plans which are in line with the Philippine Development Plan. It is envisioned to address concerns such as watershed conservation, watershed rehabilitation, flood control/mitigation, and water security for domestic, irrigation and industrial use, livelihood and economic opportunities in the area.

Since 2007, there are already existing master plans for 18 major river basins in the Philippines pursuant to Executive Order No. 510. These 18 river basins were identified in accordance to the Climate Change Adaptation and Mitigation (CCAM) Cluster's Program Budget and Approach (PBA) in CY 2013 and CY 2015. The PBA also provided opportunities to expand to cover other river basins outside these 18 major river basins. Thus, a total of 26 river basins were identified as focus of this project. These river basins were selected based on the following criteria: (a) absence of Integrated River Basin Management and Development Master Plans (IRBMDMP) and appropriate institutional mechanisms; (b) environmental problems such as flooding, landslides, deforestation, and water quality degradation are present in the area; (c) high poverty incidence; and (d) contributes to high economic growth of the country.

## 2 PROJECT OBJECTIVES

The objective of this project is to formulate an Integrated River Basin Management and Development Master Plan (IRBMDMP) for the eight (8) Clustered River Basins taking into consideration the biological diversity and their capacity to provide ecosystem goods and services. The plan incorporates the implications of the new climate normal in addressing the concerns of the clustered river basin on the following critical areas of concern:

1. Forest ecosystem and biodiversity management;
2. Water resources management;
3. Wetland management (to include rivers, river deltas, marshlands, and coastal areas);
4. Flood control/mitigation, disaster risk reduction and hazards management;
5. Economic development; and
6. Institutional linkages and organizational structure for river basin management.

### **3 SCOPE AND LIMITATION**

The project focused on the Formulation of the River Basin Management and Development Master Plan for the Cluster 4 River Basin. Potential climate change impacts were considered to provide sound basis for management decisions in the sustainable management of the resource. The project consisted of two phases, the scope of which includes:

1. Formulation of the climate change-responsive integrated river basin management and development master plan for the Cluster 4 River Basin;
2. Formulation of vision, mission, and goals;
3. Identification of strategies, programs, and projects;
4. Evaluation of strategies, programs, and projects; and
5. Investment and implementation planning.

## 4 METHODOLOGY

The project adopted the following methods and approaches to accomplish the objectives (Figure 1). The following tasks were undertaken during the implementation of the project:

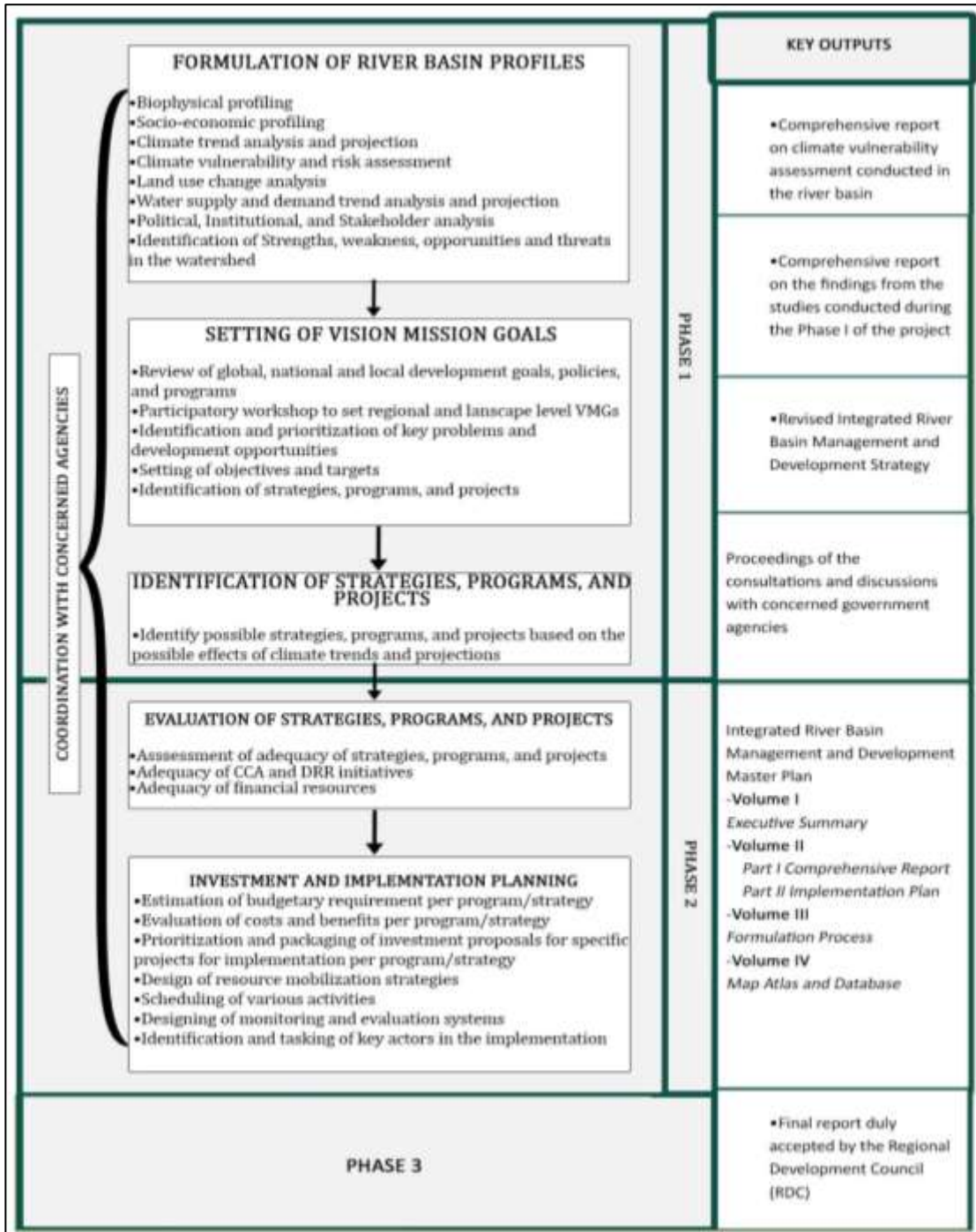


Figure 1. Flow of activities in the formulation of the master plan for Cluster 4 River Basin.

## 5 ASSESSMENT REPORTS

### 5.1 Geophysical Profile

#### *Geophysical Location*

The Cluster 4 River Basin is located within the MIMAROPA Region, specifically within the Southern Palawan. The cluster consists of five principal river basins namely, Iwahig Penal, Inagawan, Aborlan, Malatgao, and Batang-batang. The cluster also covers 19 minor watersheds located in-between the five principal river basins. The entire cluster has an area of 147,797 hectares. It covers the City of Puerto Princesa and the municipalities of Aborlan, Narra, and Quezon. In addition, a total of 50 barangays that were under the jurisdiction of these areas are within the cluster.

#### *Climate Trends*

The Cluster 4 River Basin has Type I and Type III climate type based on the Corona System of climate classification. The areas that have Type I climate is dry from the month of November to April and wet throughout the year, while areas with Type III climate has short dry season and no pronounced rainfall. The annual average maximum temperature within the cluster was 31.5°C while the annual average minimum temperature within the cluster was 23.9°C. The cluster received the largest amount of rainfall in the month of October with a total rainfall of 216.10 mm while obtained the smallest amount of rainfall during the month of February with a total rainfall amount of 23.7 mm.

Climate projections within the cluster used two models from PAGASA the RCP 4.5 and RCP 8.5 models. The maximum mean projected temperature in 2050 using RCP 4.5 is 29.3 °C while using RCP 8.5 is 29.8 °C. The maximum mean temperature in 2085 using RCP 4.5 is 29.8 °C while using RCP 8.5 is 31.2 °C. By 2050, the maximum average amount of rainfall is 737.8 mm using RCP 8.5 while 688.2 mm using RCP 4.5. The projected average amount of rainfall in 2085 during wet season is only 645.2 mm using RCP 4.5 while only 635.5 mm using RCP 8.5.

#### *Topography*

Generally, the elevation of the lands within the Cluster 4 River Basin ranges from 0-100 meters above sea level particularly the western side of the cluster. In addition, about 58% of the entire cluster has steep slopes of more than 18%.

#### *Soils and Geology*

There are ten (10) soil types identified in the Cluster 4 River Basin. Of which, the most abundant is rough mountainous land which covers 57% of the cluster area. On the other hand, five (5) geologic formations, namely the Gneiss, schist, phyllites-slates, Recent deposits, Undifferentiated, Marl, reworked tuff, pyroclastic, and Ophiolites and Ophiolitic rocks, are present in the cluster.

#### *Mineral Resources*

The Province of Palawan has the greatest number of mineral resources development projects within the MIMAROPA region. Two metallic minerals specifically nickel and chromium were present. In addition, non-metallic resources such as sand and gravel, and limestone in the cluster.

### **Water Resources**

The surface water resources within the principal river basins of the Cluster 4 are three rivers, namely, Batang-batang, Malatgao, and Montible. The 80% dependable flow of the whole cluster has an average value of 20.45 m<sup>3</sup>/s or 644.88 MCM/yr. In addition, the cluster's overall present and 2050 ground water potential are 28.98 MCM/yr and 22.71 MCM/yr, respectively.

### **Land classification and Land Cover**

Majority of the lands within the Cluster 4 River Basin are classified as Game Refuge and Bird Sanctuary, comprising 57% (83,309 hectares) of its total land area while the identified alienable and disposable lands is about 21,664 hectares constituting 15%. In terms of land cover, 59% is covered with closed forest in 2003 while open forest became the most common land cover within the cluster covering almost half of the total land area of the cluster in 2010 and 2015. Moreover, built-up areas within the cluster only contributes 2% of the whole cluster as of 2015.

### **Natural Hazards**

The Cluster 4 River Basin is susceptible to drought, flooding, earthquake-induced landslide (EIL), rain-induced landslide, soil erosion, storm surge alert level I (SSA I) and IV (SSA IV), tropical cyclones, and tsunami. The cluster experienced moderate to extreme drought events with peak SPI value of -1.31 and an average SPI value of -1.03 for 6 months duration starting June 1993 to December 1993. In addition, there are 55% of the cluster is susceptible to medium EIL whereas 39% is highly susceptible to rain-induced landslide. In addition, 58% is susceptible to high flooding. The areas within the cluster that are susceptible to moderate soil erosion is 60% of the total cluster area. Half of the cluster area is prone to high level of SSA I and SSA IV. On the average, 89 tropical cyclones have passed the cluster province from 1948 to 2017 and based on the intensity majority of the tropical cyclones that have entered the cluster province are classified as tropical storms. The cluster has a total of 8,933 hectares of lands susceptible to tsunami.

## **5.2 Bioecological Profile**

The islands in Palawan are home to numerous flora and fauna species. There are three (3) Key Biodiversity Areas situated within the Cluster 4 River Basin, namely, the Puerto Princesa Bay, Victoria Anepahan Ranges, and the Rasa Island Wildlife Sanctuary. There are 39 identified floral species within the cluster. The most dominant species in the cluster belongs to Rhizophoraceae family. The dominant species in the family Rhizophoraceae includes: *Bruguiera sexangula*, *Ceriops decandra*, *Ceriops tagal*, *Rhizophora apiculata*, *Rhizophora mucronata*, *Rhizophora stylosa*, and *Scyphiphora hydrophyllacea*. The two critically endangered floral species are *Cycas curranii* and *Orania paraganensis* while the only identified endangered floral species is *Koompassia excelsa*.

The Cluster 4 River Basin is also home to various fauna species. It is home to 82 avian species, four reptile species, and one terrestrial species. Some of the identified critically endangered faunal species include the following: *Cacatua haematuropygia* (Philippine Cockatoo/Katala) and *Polyplectron napoleonis* (Palawan Peacock-Pheasant). On the other hand, the endangered species in the cluster are 21.84%. The species under this category include, *Accipiter trivirgatus* (Crested Goshawk/Sakbit), *Anthracoceros marchei* (Palawan Hornbill/Talusi), *Gorsachius goisagi* (Japanese Night Heron), *Megapodius cumingii* (Tabon Scrubfowl/Tabon), *Otus fuliginosus* (Palawan Scops Owl), *Prioniturus platenae* (Blue-headed Racquet Tail/Pikoy/Loro), *Spizaetus cirrhatus* (Changeable Hawk Eagle/Manao), *Spizaetus philippensis* (Philippine Hawk Eagle/Manao), *Strix seloputo* (Spotted Wood Owl/Kuwago), and *Tupaia palawanensis* (Palawan Tree Shrew/Bising).



### **5.3 Demographic Profile**

As of 2015, there are approximately 7,009 people living within the Cluster 4 River Basin. The population size has an increasing trend which will increase to 1,253,200 in 2020, 1,490,300 in 2030, and 1,769,100 in 2045. According to the Philippine Statistics Authority (2016), the annual number of live births in all the municipalities and city within the cluster is 7,389. On the other hand, the cluster province has 2.14 death rate per 1000 population as of 2016. The fertility rate is 4.41 from 2010 to 2015. Majority of the population are married (287,593). The largest age group is pre-teen with ages 10-14. The dependency ratio is 73.6% as of 2010. The total number of households within the city and municipalities was 84,800 in 2015. Majority of the household population about 97.7% are non-movers.

### **5.4 Socio-economic Profile**

#### ***Settlement Pattern***

In 2007, the population in rural areas within the cluster province is 549,163 and it increased to 578,993 in 2010. On the other hand, the population in urban areas is 132,989 in 2007 and it increased to 192,674 in 2010. A greater number of people within the cluster province are residing in rural areas compared to urban areas.

#### ***Language and Ethnicity***

The cluster province is inhabited by various indigenous groups such as Cuyonon, Hiligaynon, Pala'wan, Tagalog, Bisaya, Cebuano, Ilocano, Cagayanen, Tagbanua, Jama Mapun, and Ilocano.

#### ***Access to Land and Land Rights***

Puerto Princesa City has the highest percentage of households that do not own at least one land about 69% of the total households. On the other hand, the municipality that has the highest percentage of household with at least one own land is the Municipality of Aborlan with 48.98% of the total households.

#### ***House Tenure***

In Cluster 4 River Basin, 75% of the household own their house and lot. The percentage of the household population that owns the house, but the lot is freely rented to them, and has a consent of the owner is 12%. Moreover, 9% of the household rents the lot and 1% of the household population rents the lot free but without consent of the owner.

#### ***Energy and Fuel Consumption***

The households within the cluster are using fuel for cooking and lighting. A total of 88% of the households within the cluster are using fuel through electricity, followed by 7% of the households that uses Kerosene (gaas).

#### ***Health***

Various illnesses within the MIMAROPA region are the leading causes of morbidity. The Acute Respiratory Infection has the highest number of reported cases within the MIMAROPA region (36,243), followed by hypertension (15,172), then ALTRI and Pneumonia (5,651). Another health concern within the cluster is the increasing population in the coming years. The province has a contraceptive prevalence rate of 56.23 while Puerto Princesa City has 59.32.

### ***Literacy and Education***

The household population attending school in the cluster is relatively high for both male and female populations. As of 2015, the recorded literacy rate is 95.7%.

### ***Poverty and Subsistence***

The annual per capita poverty threshold of the Cluster 4 River Basin has an increasing trend while the poverty incidence has a decreasing trend from 2009 to 2015. As of 2015, the poverty incidence rate of the cluster is 17% and the annual per capita food threshold is PhP 6,795.

### ***Human Development Index***

Based on PSA Palawan QuickStat 2018, the Human Development Index of the Cluster 4 River Basin is 0.572 as of 2012.

### ***Employment and Labor***

The MIMAROPA Region had an employment rate of 95.2%, but the participating labor were estimated to be 64.0%. Moreover, the unemployment rate within the region was estimated to be 4.8% and the underemployment rate was 23.7%. A higher percentage of men are employed in armed forces, plant and machine operating and assembly, craft and related trades, skilled agricultural, forestry and fishery, and elementary occupations. On the other hand, higher percentage of women are involved in occupations such as service and sales, clerical support, technicians and associate professionals, professional and managerial jobs.

### ***Natural Resource Dependent Livelihood***

The production of rice and corn in the Cluster 4 River Basin increases annually except in year 2008, 2010, and 2014. Aside from rice and corn, the following are the top main crops that are harvested in the cluster province: cassava, cashew, banana, mango, and coconut. Among the livestock, hog is the number one raised and had the highest production within the cluster. The inhabitants are also reliant on fish resources. As of 2017, the top fish resource produced is *galunggong* with 155,154 metric tons. The forestry sector also contributes to the natural resources-based livelihood of the population in the cluster. The total recorded lumber production was 120 cubic meters (m<sup>3</sup>) while the total log production was 18,454 m<sup>3</sup> in 2016. The greatest amount of harvested *Almaciga* resin with a total of 686,040 kilograms while the year with the highest harvested unsplit rattan was 2015 with a total of 1,090,219 lineal meters.

### ***Tourism***

Overall, there were 1,051,446 visitors in the Cluster 4 River Basin in 2017. Majority of the travellers were domestic travellers contributing 687,416 number of travellers, followed by the foreign travellers (343,067), and the overseas travellers (20,963). Puerto Princesa City had the highest number of visitors (1,021,640) within the cluster.

## **5.5 Infrastructure**

### ***Educational Facilities***

Educational facilities that would support proper education within the Cluster 4 River Basin is a very significant factor towards the increase of population literacy rate in the cluster. The cluster has a total of 51 primary, 93 elementary, 29 secondary, and 7 tertiary schools.

### ***Health Facilities***

Overall, there are 70 health facilities within the Cluster 4 River Basin. The Municipality of Narra has the greatest number of health facilities (28) comprising of two government-owned hospital, three privately-operated, and 23 barangay health stations.

### ***Road and Bridges***

The evacuation centers within the Cluster 4 River Basin available to accommodate people who are directly affected by the calamity. There is a total of 65 evacuation centers within the cluster wherein the municipality of Quezon accumulated the highest number of evacuation center (37) while Puerto Princesa City has the least number of evacuation center with only one.

### ***Dam and Irrigation***

Dams are not only a large renewable energy generator but it is also useful in other important purposes such as irrigation, source of water supply for domestic and industrial uses, inland navigation, and flood control. There are two dams within the Cluster 4 River Basin. The first dam is located within Iwahig Penal Principal River Basin and the other dam is situated within the Aborlan Principal River Basin. Moreover, irrigation is necessary to ensure sufficient supply of water in rice fields. The total irrigation service area in the cluster province is 29,654 hectares.

### ***Waste and Sanitation***

In the Cluster 4 River Basin, about 70% of the households have sanitary toilets while there are about 48% that have access to complete basic sanitation facilities. Based on DOH 2016, 54% of the households is practicing satisfactory waste disposal. Most of the garbage are picked up by garbage truck (43%) while, only 4% practices burying as waste disposal.

### ***Communications***

Communication is a vital infrastructure support in modernizing community. Three telephone companies are present within Puerto Princesa City, namely, the Pilipino Telephone Corporation (PILTEL), Globe Telecom, and Telecommunications Distribution Specialist, Inc. (TDSII), which are all privately-owned.

### ***Financial Institutions***

The Cluster 4 River Basin has a total of 66 banks as of 2015. It has an increasing trend of the deposited bank liabilities from 2013 to 2015. There are also 121 total pawnshops present within the cluster province since 2012. The number of pawnshops within the also increases annually.

### ***Energy***

The power provider within the municipalities of Aborlan, Narra, and Quezon is the National Power Corporation (NAPOCOR) and the Palawan Electric Cooperative (PALECO) which are the lone distributors of power in the whole province of Palawan.

### ***Transportation***

The transportation system within the cluster are land, water and air-based. Puerto Princesa City is connected internationally through the Puerto Princesa City International Airport. The mini cabs and tricycles are the primary land transport services within the city. The Municipalities of Narra, Aborlan, and Quezon are accessible by land through the regular daily trips of buses and shuttle vans.

### **5.6 Land Capability**

Land capability refers to the inherent capacity of land to support, on a sustained basis, a particular use or a set of uses (Cruz & Ffolliott 1991). The strict protection areas in the cluster comprise about 76% of the total land area. Agroforestry production accounts 5% while unlimited production areas account for 10% and protection buffer for 9%.

### **5.7 Areas of Concern**

Areas of concerns refer to areas within the five principal river basins of Cluster 4 with certain features that increase its exposure to various natural and human induced hazards, and increase in risk of harm and damages to people, livelihoods, properties, water, biodiversity, soil and other natural resources. Various areas of concerns were identified based on cross tabulation of land use and land cover maps with various thematic maps including that of slope, elevation, KBAs, soil erosion potentials, legal land classification, and tenurial instrument,

### **5.8 Stakeholder Analysis**

The involvement of each stakeholder is significant in the planning process. Knowledge on the economic, political, social, and environmental aspects in each of the Principal River Basins are possessed by the stakeholders. The stakeholders within the Cluster 4 River Basin were further classified into three—User Groups, Mediating Institutions, and External Economic Interest Groups. The identified general categories of issues or motives create and cement stakeholder alliances in the cluster are the following: livelihood opportunities, forest protection and rehabilitation, coastal rehabilitation, provision of farm technologies, conservation of wildlife habitat, implementation of laws, source of funding or financial assistance, and water source used for domestic and agriculture. There were 13 stakeholders that were rated as highly important and highly influential.

### **5.8 Policy and Institutional Assessment**

Various policies from international, national and local encompass the management of the Cluster 4 River Basin, including the Sustainable Development Goal (2015-2030), Philippine Development Plan (2011-2016), Sustainable National Action Plan (2009-2019), National Climate Change Action Plan (2011-2028), Philippine Strategy for Sustainable Development (1999), SEP Law, etc. These policies have a single goal—to improve the quality of life through poverty alleviation, sustainable development, capacity building, disaster risk reduction, and climate change adaptation.

Also, various key government agencies from national and subnational levels play important roles in river basin management and development. The institutional arrangements of these agencies possess differing relationship in terms of mandates and functions. Nevertheless, they have important roles to perform under the components of river basin management and development framework, namely; water resource management, forest ecosystem and biodiversity, wetland management, disaster risk and reduction management, economic development, and institutional development.

To implement these management strategies and as a solution to further eliminate the issue of fragmentation, lack of coordination, inefficiency, overlaps, there must be a coordinating mechanism that would harmonize the initiatives in the cluster. The three main points in river basin governance: a) organizational structure of River Basin Organizations, b) decentralization, relation of government units and ownership, and c) financing of River Basin Organizations must be regarded as requirements in their institutionalization.

## **5.9 Vulnerability Assessment**

### ***Water Resources Assessment***

The domestic water demand within the cluster is expected to increase in 2030 and 2050. The total projected domestic water demand within the cluster in 2030 is 8.039 MCM/year while the projected domestic demand in 2050 is 9.792 MCM/year. The projected agricultural demand in 2030 and 2050 also has an increasing trend. The total agricultural water demand in 2030 is 1,262.517 MCM/yr and 1,393.076 MCM/yr in 2050. The projected total available water by 2030 is 671.945 MCM/yr. The total projected available water within the cluster continue to decrease by 535.370 MCM/yr in 2050.

### ***Participatory Risk and Vulnerability Assessment***

An overall evaluation of risk events was performed in Cluster 4 River Basin. The general risk estimates for the whole river basin was arrived at by assigning a numerical value for the degree of likelihood and consequences (i.e., very low = 1; low = 2; moderate = 3; high = 4; and very high = 5). Based on the assessment the drought/ dry spell, typhoon, flooding, intense heat, and forest fire are the extreme risk events within the cluster and these require immediate controls, while storm surge, landslide, La Niña, deforestation, and urbanization fall to high risk events and these require high priority control measures.

### ***Hazard Vulnerability Assessment***

Based on the results of the vulnerability assessment, approximately, 2% (2,638 hectares) of the cluster has high vulnerability to flooding. The Barangays in Puerto Princesa City that have high vulnerability to landslide is Inagawan, iwahig, and Kamuning; Poblacion, Tagpait, and Tigman in Aborlan; Antipuluan, Narra (Pob.), Panacan, and Panacan 2 in Narra.

Vulnerability assessment showed that around 51,387 ha (35% of the total area) of the Cluster 4 River Basin is under the high landslide vulnerability areas while around 48,572 ha (33%) is under the high vulnerability. In terms of storm surge, this hazard is not prominent in the cluster. Although, all areas in the cluster were found to be vulnerable, only 1.2% has high vulnerability covering an area of 1,833 hectares. These highly vulnerable areas are located at Barangays Tigman and Poblacion in Aborlan; Barangays Antipuluan and Panacan 2 in Narra; and Barangay Kamuning in Puerto Princesa City.

## 6 MANAGEMENT AND DEVELOPMENT PLAN

### 6.1 Vision

The Vision statement of the Cluster 4 River Basin that was agreed upon by the various stakeholders during the Inter-agency Focus Group Discussion:

*“Dynamic community-driven, sustainably-managed and climate change-responsive watersheds within Cluster 4 River Basin providing ecosystem good and services for the present and future generations of Palaweños through stakeholder collaboration towards poverty-free river basins.”*

### 6.2 Mission

*“To protect, conserve, and efficiently utilize the natural resources of the watersheds within the Cluster 4 River Basin to ensure continuous provision of goods and services to the present and future generations of Palaweños.”*

### 6.3 Integrated River Basin Management and Development

Formulated by RBCO in 2007, the Integrated River Basin Management and Development (IRBMD) Framework is the basic system used for all strategies in the Philippines on sustained river basin ecosystem management. It is further composed of four principal frameworks and development strategies, namely Integrated Water Resources Management, Integrated Watershed Management, Wetland Management, and Flood Mitigation (Figure 2).



Figure 2. The Integrated River Basin Management and Development Framework.

## **6.4 Development Issues and Challenges**

### ***Water Resources***

The decrease in water quantity and quality is the primary problem identified by the water resources theme. The decrease in water quantity and quality is caused by increasing population, increasing agricultural, domestic, and industrial water demand, decreasing available water, and soil erosion.

### ***Forest Ecosystem and Biodiversity***

The primary concern of the forest ecosystem and biodiversity thematic area within the Cluster 4 River Basin is watershed degradation which is primary caused by deforestation. Various factors lead to deforestation within the cluster such as charcoal making, timber poaching, Kaingin, mining, and illegal land conversion.

### ***Wetland Management***

The wetland degradation is the primary problem that the wetland management theme has identified and it is primarily caused by seasonal changes in temperature and amount of rainfall, soil erosion, and decrease in mangrove area. The decrease of mangrove areas within the cluster river basin are caused by illegal land conversion and illegal logging of mangrove species.

### ***Disaster Risk Reduction and Management***

The concerns of the Disaster Risk Reduction and Management thematic area focuses on the following risk events that were experienced by the residents of the Cluster 4 River Basin: flooding, landslide, and dry spell/ drought which are caused by increasing temperature, *habagat*, typhoons with intense rains, and reducing amount of rainfall.

### ***Economic Development***

The key issue under economic development thematic area is poverty. The increasing population trend is one of the causes of poverty within the cluster river basin as well as high underemployment rate, and low educational attainment.

## 6.5 Implementation Plan

### *Initial Identification of Preferred Measures*

PAPs refer to specific programs, activities and projects that are designed to contribute to the attainment of set targets once implemented fully. The selected preferred measures and PAPs without saying are climate proofed having been selected based on the future targets calibrated against the projected influences of ongoing PAPs and climate change on the future values of each indicator. It is implied that the preferred measures and PAPs have built in ability to adapt to climate change and reduce disaster risks associated with extreme rains, temperatures, and winds. The process consisted of six (6) steps that are briefly described below:

#### 1. Selection of Key Indicators

In order to facilitate the identification and selection of preferred measures and PAPs, key indicators were chosen from many possible indicators. A total of thirteen indicators were initially identified. From a long list of 11 indicators, only a total of seven (7) shortlisted key indicators were eventually chosen. These indicators were Forest Cover, Soil Erosion Rate, Water Stress Index, Biological Oxygen Demand, Wetland Area (based on Land Cover), Number of Vulnerable Barangays to Hazards, and Poverty Incidence. Baselines and targets were then determined.

#### 2. Identification of the Current PAPs

If implemented fully and properly as planned originally by concerned agencies, the current PAPs are expected to contribute positively in the attainment of the desired targets on improving forest cover, conserving biodiversity, improving water quality and availability, reducing poverty, DRR/CCA and other key targets of the government related to the Cluster 4.

#### 3. Estimation of the Reference Case Values of the Key Indicators

The reference case values are the baseline values of the key indicators taking into consideration climate change and the influence of PAPs currently being implemented. Using the panel of experts, the reference values of the key indicators were estimated the results.

#### 4. Estimation of the Gaps

Gaps here refer to the difference between the desired targets and the reference case values of the key indicators. Positive difference means that the current PAPs will contribute in the attainment of the desired targets for the key indicators. On the other hand, negative difference represents the additional increase in the original desired targets for a key indicator. This implies that the amount of investments required to attain the adjusted target for a key indicator will be greater to implement enhanced current PAPs or new additional PAPs.



## 5. Identification of Preferred Measures

After the adjusted targets for each key indicator were determined, potential measures with corresponding PAPs were identified by the panel of experts and research staff. Each of the measures were then rated by the panel on how many percentage points each of these measures will likely contribute in attaining the desired targets for each key indicator.

## 6.6 Implementation Plan

The implementation plan recommends relevant programs and projects for the Cluster 4 River Basin. These are crafted based on the issues and problems that are currently faced by the river basin and congruent to the vision, mission, and goals. Six thematic areas are taken into consideration, the water resources management, the forest ecosystems and biodiversity, wetland management, economic development, disaster risk reduction management and institutional development. There are also projects that cut across the different thematic areas.

Table 1. Different projects identified for each thematic area

| Goal   | Objective   | Measure  | Program/Project  |
|--|---|--|--|
| <b>Water Resources Management</b>                                |   |  |  |
| Sustainable supply of clean water within the cluster river basin | Improved quality and sustained supply of water within the cluster river basin | <ul style="list-style-type: none"> <li>• Water quality monitoring and management</li> <li>• Supply-side management</li> <li>• Effective ecological solid waste management</li> <li>• Enhancement of value chain systems</li> </ul> | <b>Water Resource Management Program</b> <ul style="list-style-type: none"> <li>• Rehabilitation/ Restoration of Existing National and Communal Irrigation Systems (NIS &amp; CIS)</li> <li>• Construction of Additional Communal Irrigation Systems (CIS)</li> <li>• Improvement of irrigation water management</li> <li>• Installation of new deep wells and distribution systems</li> <li>• Rehabilitation of existing systems and water supply facilities</li> <li>• Water Quality Monitoring System Project (Monitoring Wells and River Water Quality Network, including databasing and analysis)</li> <li>• Installation of centralized/decentralized treatment plants</li> <li>• Effective Ecological Solid Waste Management (Program)</li> </ul> |

| Goal   | Objective  | Measure   | Program/Project  |
|--|--|---|--|
| <b>Forest Ecosystem and Biodiversity</b>                       |  |   |  |
| Stable and productive forest within the cluster river basin    | <ul style="list-style-type: none"> <li>• Increased level of biodiversity</li> <li>• Increased forest cover</li> <li>• Reduced soil erosion</li> </ul>                                  | Forest ecosystem restoration  | <b>Forest Restoration Program</b> <ul style="list-style-type: none"> <li>• Conservation Forest Villages Program</li> <li>• Conservation Farming Villages</li> <li>• Native Forest Restoration</li> <li>• Traditional Plantation</li> </ul>   |
| <b>Wetland</b>   |  |   |  |
| Resilient wetlands within the cluster river basin              | <ul style="list-style-type: none"> <li>• Protected and increased wetland area within the cluster river basin</li> </ul>  | <ul style="list-style-type: none"> <li>• Wetland protection and restoration</li> </ul>                              | <b>Wetland Ecosystem Improvement Program</b> <ul style="list-style-type: none"> <li>• Biodiversity and ecological assessment of wetlands</li> <li>• Harmonized wetland conservation strategy</li> <li>• Wetland Protection</li> <li>• Coastal Resource Protection</li> </ul>   |
| <b>Disaster Risk and Reduction</b>                             |  |   |  |
| Climate change-adaptive communities within cluster river basin | <ul style="list-style-type: none"> <li>• Reduced number of vulnerable people to hazard</li> <li>• Increased adaptive capacity of communities within the cluster river basin</li> </ul> | <ul style="list-style-type: none"> <li>• Reduce exposure to hazards</li> <li>• Improve adaptive capacity</li> </ul> | <b>Adaptive Capacity Development Program</b> <ul style="list-style-type: none"> <li>• Development of Alternative Livelihood</li> <li>• Enhancement and Construction of Evacuation Centers</li> <li>• Improve infrastructure system (Construction, retrofitting and rehabilitation of key facilities and transportation systems)</li> <li>• Establishment /Improvement of Early Warning System</li> </ul> <b>Climate-Adaptive Hazard Mitigation Infrastructure Program</b> <ul style="list-style-type: none"> <li>• Flood Control</li> <li>• Slope Stabilization</li> <li>• Relocation Project</li> </ul> |
| <b>Economic</b>  |  |   |  |
| Sustainable livelihood of people in the cluster river basin    | <ul style="list-style-type: none"> <li>• Increased sustainable livelihood opportunities within the cluster river basin</li> </ul>  | Enhancement of value chain systems  | <b>Enhancement of Value Chain Systems Program</b> <ul style="list-style-type: none"> <li>• Climate-resilient agriculture projects</li> <li>• Sustainable fisheries projects</li> </ul>   |

| Goal  | Objective | Measure | Program/Project  |
|---|-----------|---------|--|
|   |           |         | <ul style="list-style-type: none"> <li>• Community-based ecotourism projects</li> <li>• Cottage-based enterprise development</li> <li>• Establishment/ Improvement of Agricultural Trade Center</li> <li>• Establishment and enhancement of post-harvest facilities</li> <li>• Renewable Energy Project</li> </ul>   |
| <b>Cross-cutting</b>  |           |         |  |
| United and coordinated agencies that strictly implement laws within the cluster river basin |           |         | <p><b>Creation of River Basin Coordinating Council</b></p> <ul style="list-style-type: none"> <li>• Induced River Basin Coordinating Council Formation</li> <li>• Establishment of the River Basin Office</li> <li>• Result based management system development and MIS development</li> <li>• Various Capacity Development Interventions</li> <li>• Sustainable Financing Mechanism</li> </ul> <p><b>Feasibility Assessment of the Cluster 4 River Basin Master Plan</b></p> <p><b>Participatory Development Program</b></p> <ul style="list-style-type: none"> <li>• Gender Equity and Social Inclusion Project</li> <li>• Cultural Impact Assessment</li> <li>• Cluster 4 River Basin Master Plan Caravan Roadshow/ Roadshow Project</li> </ul> |

## 6.7 Investment Plan

The investment plan indicates the budgetary requirements of the various programs and projects that were developed under the climate change-responsive Integrated River Basin Management and Development Master Plan for Cluster 4 River Basin. To pursue the objectives set forth in the Management and Development Master Plan, five (5) thematic areas were identified: Forest Ecosystem and Biodiversity Management, Water Resources Management, Wetland Management, Disaster Risk Reduction and Management, and Economic Development. In addition, programs and projects that are crosscutting in nature were also identified as they address concerns of more than one thematic area.

The total investment requirement of the Plan over a 15-year period is PhP 42,022,464,411 Billion, as shown in Table 2. Disaster Risk Reduction and Management has the highest funding requirement among the five thematic areas at PhP 24.533 Billion (61% of total), followed by Forest Biodiversity and Ecosystem (PhP 5.801 Billion, 15%), Water Resources Management (PhP 4.612 Billion, 12%), Wetland Management (PhP 4.378 Billion, 11%), Economic Development (PhP 578 Million, 1%), and Crosscutting Programs (PhP 121 Million, 0.30%).

Table 2. Total cost of projects proposed for the Cluster 4 River Basin

| PAP   | Indicative Cost (PhP) |
|---|-----------------------|
| <b>FOREST ECOSYSTEM AND BIODIVERSITY MANAGEMENT</b>                             | <b>5,800,901,000</b>  |
| <b>Forest Restoration Program</b>   | <b>5,800,901,000</b>  |
| Native Forest Restoration   | 4,307,256,000         |
| Conservation Forest Villages  | 1,029,200,000         |
| Conservation Farming Villages   | 464,445,000           |
| <b>Subtotal</b>   | <b>5,800,901,000</b>  |
| <b>WATER RESOURCES MANAGEMENT</b>   | <b>4,611,500,000</b>  |
| <b>Water Resource Management Program</b>  | <b>3,833,500,000</b>  |
| Rehabilitation/Restoration of Existing National and Communal Irrigation Systems | 530,000,000           |
| Construction of Additional Communal Irrigation Systems (CIS)                    | 1,100,000,000         |
| Construction of Rainwater Collectors  | 90,000,000            |
| Rehabilitation of Existing Systems and Water Supply Facilities                  | 3,500,000             |
| Installation of New Deep Wells and Distribution Systems                         | 10,000,000            |
| Bulk Water Supply Project   | 2,100,000,000         |
| <b>Water Quality Monitoring Program</b>   | <b>70,000,000</b>     |
| Water Quality Monitoring System Project   | 20,000,000            |
| Installation of Centralized/ Decentralized Treatment Plans                      | 50,000,000            |
| <b>Effective Ecological Waste Management</b>                                    | <b>708,000,000</b>    |
| Waste-to-Energy Project   | 700,000,000           |
| Enhancement of Solid Waste Management Project                                   | 8,000,000             |
| <b>WETLAND MANAGEMENT</b>   | <b>4,377,984,570</b>  |
| <b>Wetland Protection and Restoration Program</b>                               | <b>4,299,836,250</b>  |
| Biodiversity and ecological assessment of wetland areas                         | 850,757,813           |
| Harmonized wetland conservation strategy  | 850,757,813           |
| Wetland Protection  | 1,701,515,625         |
| Wetland Restoration   | 896,805,000           |
| <b>Coastal Resource Protection Program</b>                                      | <b>78,148,320</b>     |
| <b>DISASTER RISK REDUCTION MANAGEMENT</b>                                       | <b>24,533,128,841</b> |
| <b>Adaptive Capacity Development Program</b>                                    | <b>681,300,000</b>    |
| Development of Alternative Livelihood   | 6,300,000             |
| Enhancement and Construction of Evacuation Centers                              | 100,000,000           |
| Infrastructure System Improvement   | 500,000,000           |

| PAP   | Indicative Cost<br>(PhP) |
|---|--------------------------|
| Establishment /Improvement of Early Warning System                            | 75,000,000               |
| <b><i>Climate-Adaptive Hazard Mitigation Infrastructure System</i></b>        | <b>23,851,828,841</b>    |
| Flood Control Project   | 13,869,650,636           |
| Slope Stabilization Project   | 9,905,128,205            |
| Relocation Project  | 77,050,000               |
| <b>ECONOMIC DEVELOPMENT</b>   | <b>578,000,000</b>       |
| <b><i>Enhancement of Value Chain Systems Programs</i></b>                     | <b>578,000,000</b>       |
| Climate-Resilient Agriculture Project   | 150,000,000              |
| Sustainable Fisheries Project   | 80,000,000               |
| Community-based Ecotourism Project  | 120,000,000              |
| Cottage-based enterprise development  | 120,000,000              |
| Establishment/ Improvement of Agricultural Trade Center                       | 100,000,000              |
| Establishment and enhancement of post-harvest facilities                      | 8,000,000                |
| <b>CROSS-CUTTING</b>  | <b>120,950,000</b>       |
| <b><i>Creation of River Basin Coordinating Council</i></b>                    | <b>42,700,000</b>        |
| Induced River Basin coordinating council Formation                            | 700,000                  |
| Establishment of River Basin Office   | 7,000,000                |
| Result-based management system development and MIS development                | 10,000,000               |
| Various Capacity Development Interventions                                    | 5,000,000                |
| Sustainable Financing Mechanism   | 20,000,000               |
| <b>Watershed Monitoring Program</b>   | <b>52,382,880</b>        |
| Comprehensive Natural Resources Assessment and Monitoring                     | 23,200,000               |
| Watershed Instrumentation Project   | 29,182,880               |
| <b><i>Feasibility Assessment of the Cluster 4 River Basin Master Plan</i></b> | <b>50,000,000</b>        |
| <b><i>Participatory Development Program</i></b>                               | <b>28,250,000</b>        |
| Gender Equity and Social Inclusion Project                                    | 1,250,000                |
| Cultural Impact Assessment Project  | 15,000,000               |
| Cluster 4 River Basin Master Plan Caravan Roadshow/ Roadshow Project          | 12,000,000               |
| <b>Grand Total</b>  | <b>40,022,464,411</b>    |

## 6.8 Prioritization

The process of Multiple Criteria Decision Analysis (MCDA) was applied in the prioritization of PAP in the cluster. MCDA objectively and subjectively assess various PAP alternatives to produce the best possible prioritization output. The method included scoring of each PAP criterion, normalization of values, assignment of weights to each indicator, and computation of weighted scores.

### 1. Scoring of PAP Criteria

Six (6) criteria were chosen for all the programs and stand-alone projects of the cluster. Each PAP is scored based on each of the identified criteria, such as contribution to indicators, social acceptability, cost, policy constraint, technical capability/readiness, and CCA-DRR.

### 2. Normalization of Values

The maximum score of all PAPs in each criterion was determined. PAP score for each criterion was then divided by the maximum score of the criterion, then multiplied by -1 value if the criterion negatively impacts the PAP, or by +1 if it positively impacts the PAP. Among the criterion, only cost has a negative impact for each PAP which means that the higher the cost of a PAP the less preferred it becomes.

### 3. Assignment of Weights for Each Criterion

Each criterion was assigned weights. The criterion given the highest priority is assigned the highest weight. Among the five, the top 3 criteria were CCA-DRR, contribution to indicators, and social acceptability.

### 4. Computation of Total Score per PAP per Criterion

The normalized score of a PAP was multiplied by the weight of a criterion to obtain the total score of each PAP on each specific criterion. Scores of each criterion per PAP were then calculated. The total scores of each PAP were ranked using the 'rank' function of excel.

Among all proposed programs, it was identified that the top priority programs were Coastal Resource Protection, Adaptive Forest Ecosystem Restoration, Adaptive Capacity Development, and Water Quality Monitoring. Moreover, the crosscutting programs and projects were not included in the prioritization because these are considered as non-negotiable.