Climate Change-Responsive Integrated River Basin Management and Development Masterplans for the 8 Clustered River Basins

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Executive Summary of Cluster 1 River Basin
(Amburayan, Baroro, and Bauang)

Submitted by:
College of Forestry and Natural Resources
University of the Philippines Los Baños

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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 Development of the River Basin Management and Development Master Plan for the Cluster 1 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. Development of the climate change-responsive integrated river basin management and development master plan for the Cluster 1 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 following tasks, presented in Figure 1, are undertaken in order to achieve the objectives of the project.

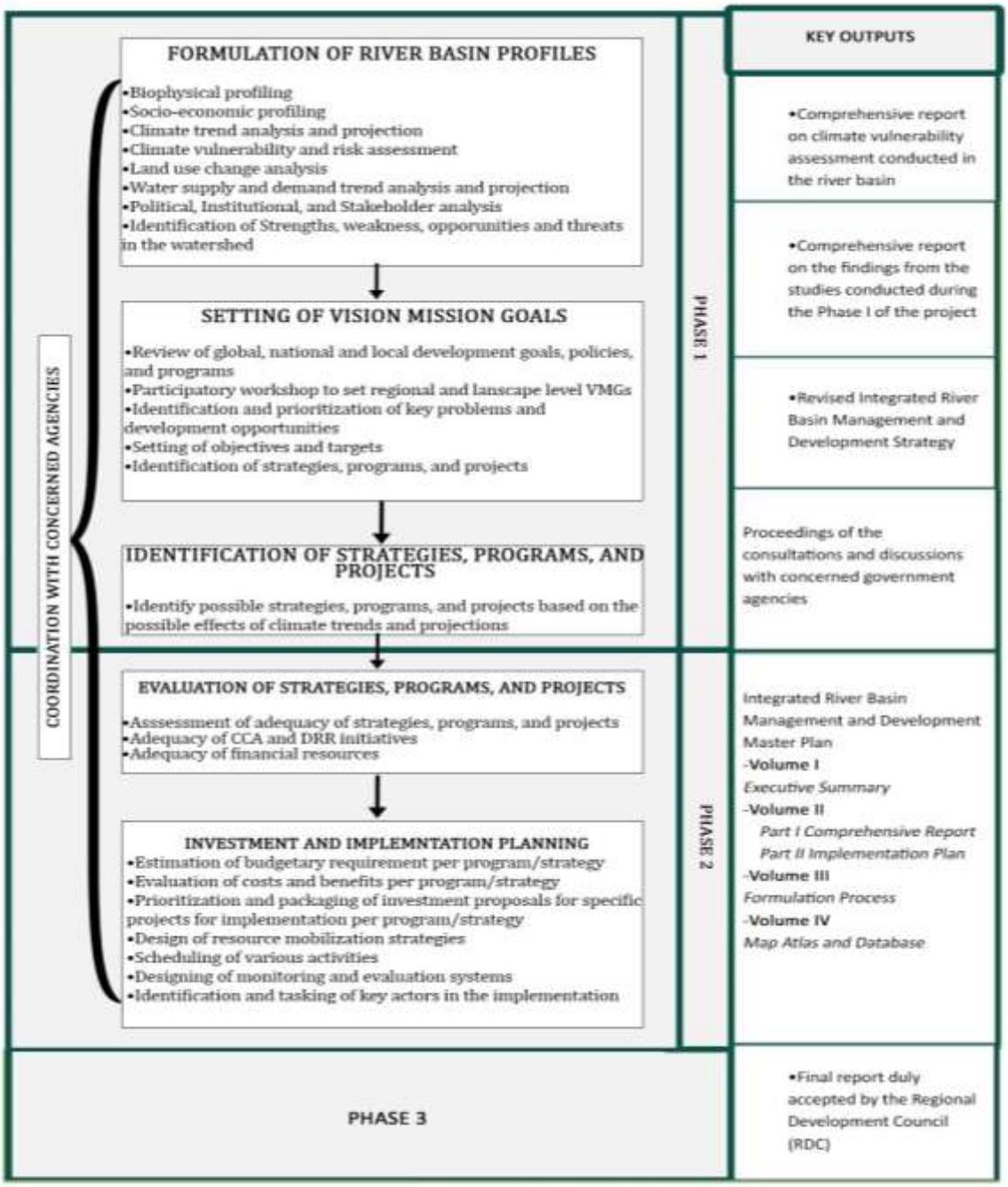

Figure 1. Flow of activities in the formulation of master plan for Cluster 1 River Basin

5 ASSESSMENT REPORTS

5.1 GEOPHYSICAL PROFILE

5.1.1 Geographical Location

The Cluster 1 River Basin is composed of three (3) principal river basins and three (3) minor watersheds which are located at the northwest of Philippines and west of Luzon Island. The cluster is composed of Amburayan, Baroro, and Bauang Principal River Basins and Busilac, Darigayos, and Maragayap Minor Watersheds. All of these drain to the West Philippine Sea. The principal river basins comprise 88.9% (199,969 hectares) of the aggregated area of the cluster while the minor watersheds constitute 11.1% (24,992 hectares).

The cluster encompasses the regions of Cordillera and Ilocos covering three (3) provinces, namely, Benguet, Ilocos Sur, and La Union. In terms of administration coverage, the cluster is composed of 3 provinces, 2 cities, 31 municipalities, and 547 barangays which totals to 244,961 hectares.

5.1.2 Climate Trends

The climate of Cluster 1 River Basin belongs to Type I of the Modified Corona Climate Classification System which is characterized by two (2) distinct seasons – the dry and wet seasons. Herein, the dry season is experienced from November to April whereas the wet season is experienced during the rest of the year. The months of June to September generally receive the most amount of rainfall. The cluster has an average annual precipitation of 2,833.2 millimeters and mean annual temperature of 24.9 ˚C. The normal average minimum temperature ranges from 18.2 to 22.0 ˚C whereas the average maximum temperature ranges from 28.2 to 31.3 ˚C.

From 1947 to 2017, a total of 94 tropical cyclones have crossed the provinces within the cluster boundary. It is also expected that the amount of precipitation will decline in all covered provinces. Highest observed reduction of rainfall amount is 10.5 mm. Moreover, all mean temperatures will have increases during all seasons. Highest temperature increase is 3.3 ˚C.

5.1.3 Topography

More than half of the Cluster 1 River Basin has elevation of greater than 500 meters above sea level. Of which, 32% of the area belongs to elevation class of more than 1,000 masl. Further, nearly 44% of the entire cluster is situated below 500 masl. Highest elevation is mostly located in the province of Benguet. In addition, the cluster is generally classified as steep to severely steep which is also mostly found in Benguet. Nearly half of the cluster area is classified as severely steep which is indicative of likely susceptibility of the cluster to erosion and landslide events. Conversely, roughly 20% of the cluster has flat and gentle to moderate slope.

5.1.4 Soils and Geology

The Cluster 1 River Basin is made up of wide range variety of soil which is specifically composed of about 27 different series of soil. Roughly 45% of the entire cluster is made up of mountain soil (undifferentiated) with 100,958 hectares. Other common soil series are Bauang clay and rough mountainous land which constitutes 23.1% and 11.5% of the total land area, respectively.

In terms of the geologic origin, the cluster is composed of nine (9) different geologic formations. More than half of the entire cluster originated from sandstones, shales, and reef limestone which comprises 53% covering a total of 119,248 hectares of land. Other dominant geologic formations are undifferentiated metavolcanics and marine clastics and pyroclastics. Moreover, the cluster is abundant in metallic mineral resources such as copper and gold and non-metallic resources such as clay, lime, and limestones.

5.1.5 Water Resources

In terms of water quality, all river systems in the downstream part of the cluster were classified as Class C waters. These are the Lower Amburayan, Naguilian, and Baroro. As for the Upper Amburayan, it was classified as Class B whereas Balili (Upper Naguilian) was classified as Class A. Generally, the total coliform and fecal coliform of all river systems did not pass the DENR Guidelines. Higher concentration of these coliforms indicates that bacteria from the intestinal tracks of human and animals are present in Lower Amburayan and Naguilian River Systems. The presence of fecal coliforms can cause numerous health problems.

5.1.6 Land Classification and Land Cover

The land classification of Cluster 1 River Basin is predominantly classified as forest lands. These are lands of public domain that are subdivided into communal forest, forest reserve, national park, and unclassified public forest. Roughly 56% of the entire cluster is categorized as forest land covering 125,518 hectares. Of which, 90.5% belongs to forest reserve. In addition, there is a very small portion of a National Park which constituting only 2.3% of the total forest land area. On the other hand, alienable/disposable lands constitute 44.2% of the cluster, slightly lower than of forest lands. As for the land cover, nearly half of the cluster is primarily covered with brush/shrublands in 2010 and 2015. The built-up and open/barren areas and mangrove forests increased.

5.1.7 Natural Hazards

Hazards identified in the Cluster 1 River Basin are drought, flooding, rain-induced and earthquake-induced landslides, liquefaction, ground shaking, erosion, storm surge, and tsunami. In terms of drought, the cluster experienced moderate to extreme drought events with peak SPI value of -1.20 and an average SPI value of -0.68 for 8 month-duration starting June 1993 to February 1994.

As for flooding, susceptible areas are usually found near the outlet of the cluster and along flood plains. In totality, an estimate of 11.5% of Cluster 1 is found to be susceptible to flooding. Largely, flood-susceptible areas are Alilem, Sugpon, Tagudin in Ilocos Sur and Naguilian and Sudipen in La Union.

High landslide susceptible areas, on the other hand, are usually located in the midstream and upstream sections of the river basins which contributes about 117,048 hectares of the cluster area. Of which, 20% of the area is considered to have very high susceptibility. Most of these susceptible areas are situated in the municipalities of Bakun, Kapangan, and Kibungan of Benguet province and municipalities of Alilem, Sigay, Sugpon, and Tagudin of Ilocos Sur province.

In terms of soil erosion, roughly 85% of the cluster is susceptible. Areas with severe erosion is approximately 18.4% of the whole area wherein largest coverage belongs to the municipality of Suyo in Ilocos Sur province with 4,070 hectares which is specifically found within the Amburayan Principal River Basin.

In terms of liquefaction, only about 9.4% of the cluster is found to be susceptible whereas the remaining 90.6% are not susceptible. These areas are greatly found in Tagudin, Ilocos Sur and Sudipen, La Union. Prone areas, however, are largely located in the municipalities of Naguilian and San Juan in La Union province.

In terms of areas susceptible to ground shaking, it accounts for 63.6% of the cluster area which totals to 143,054 hectares. These areas are located only in Amburayan and Bauang PRBs. Highest coverage belongs to Bakun, Benguet with around 22,132 hectares of susceptible areas to hazard.

In terms of storm surge, there is less than a hectare of the cluster, only one-tenth of a percent, which is considered susceptible to the hazard of Level 1. On the other hand, there are 3,487 hectares susceptible to Level 4. Susceptible areas to storm surge are Bacnotan and Bauang in La Union. In terms of susceptibility to tsunami, the cluster has a total of 2,281.2 hectares of area susceptible to tsunami. Areas found to be susceptible to this hazard are Tagudin in Ilocos Sur and Bacnotan, Bangar, and San Juan in La Union.

5.2 BIO-ECOLOGICAL PROFILE

Based from the combined reports of Conservation and Development Division of DENR Region 1 and Watershed and Water Resources Research, Development and Extension Center - Cordillera, there was a total of 75 identified plant families in the Cluster 1 River Basin. Among these, the dominating family is Fabaceae with 52 individuals. Other common families in the cluster were Poaceae, Moraceae and Asteraceae. Overall, there were twelve (12) threatened species in Cluster 1 River Basin. In terms of vulnerable species, there was a total of six (6) species, namely: Bolong-eta (*Diospyros pilosanthera*), Ipil (*Instia bijuga*), Smooth Narra (*Pterocarpus indicus* forma *indicus*), White Lauan (*Shorea contorta*), Kalantas (*Toona calantas*), and Banuyo (*Wallaceodendron celebicum*). Furthermore, five (5) species were categorized as other threatened species. These species are Bayanti (*Aglaia rimosa*), Malatapai (*Alangium longiflorum*), Kangko (*Aphanamixis polystachya*), Bikal (*Dinochloa acutiflora*), and Amugis (*Koordersiodendron pinnatum*). In addition, the only endangered species found in the cluster is Tindalo (*Afzelia rhomboidea*).

For fauna, the cluster has a total of five (5) terrestrial faunal species that population is under threat in general. Based on the International Union for Conservation of Nature (IUCN), most of the species were categorized as least concern which accounts for about 63% of the total number of individual species in the cluster. It was also observed that there are two (2) critically endangered, two (2) endangered, and one (1) vulnerable species in the entire cluster. The critically endangered species observed were the Isabella Oriole (*Oriolus isabellae*) and Philippine Forest Turtle (*Siebenrockiella leytensis*). The identified endangered species, on the other hand, were Fresh Water eel (*Anguilla*

rostrata) and Luzon Crateromys (*Crateromys schadenbergi*). Furthermore, Carp (*Cyprinus carpio*) was the only vulnerable species in the entire cluster.

The cluster has also six (6) protected areas, namely, Bessang Pass Natural Monument, Mt. Data National Park, Lower Agno Watershed Forest Reserve, Upper Agno River Basin Resource Reserve, Marcos Highway Watershed Forest Reserve, and Naguilian Watershed Reservation. The largest area belongs to Mt. Data National Park covering 32% of the total protected area in the entire cluster. Dangwa Cave and Tinedkaw Cave were also found within cluster boundary. There were also identified wetlands that were primarily mangrove forests located mostly between the minor watersheds. The inland wetlands, showed a generally decreasing trend from 2003 to 2015.

As for the NGP component, only 5.6% of the entire area is covered by the NGP programs. Furthermore, CADT is the most common tenurial instrument in the cluster, which covers more than 225,282 hectares and constitutes about 98.4% of the combined area of all the forest tenurial instruments in the cluster.

5.3 DEMOGRAPHIC PROFILE

Based on the 2015 Census of the Philippine Statistics Authority, the Cluster 1 Principal River Basin have a total population of 715,334, mostly from the province of Benguet which constitutes 61.9% of the cluster population. On the other hand, the minor watersheds have a total population of 200,719 wherein the municipality of Bacnotan holds the highest population. Additionally, the annual population growth rate was approximately 1.0% from 1990 to 2015. In terms of population density, the Cordillera Administrative Region holds the record of the lowest population density of 84 persons per square kilometer compared to the national value of 337. However, the most densely populated area for the 2015 period is Baguio City with 8,930 persons per square kilometer. The trend of projected population density is expected to increase in 2025 and 2045.

The rate of birth in the Cluster 1 River Basin followed a decreasing trend from 2000 to 2015. La Union has the highest birth rate among the three provinces with a rate of 27.3 per thousand populations in 2000. Ilocos Sur, on the other hand, has the lowest birth rate throughout the period. Similar to birth rate, the rate of death in the cluster is decreasing from the same period wherein the highest rate is 6.3. The current fertility rate recorded in 2015 was 2.9 which is lower compared to fertility rate of 3.3 in the 2000. Further, the cluster has relatively high dependent population with a cluster-wide dependency ratio of 55.4%.

5.4 SOCIO-ECONOMIC PROFILE

5.4.1 Settlement Pattern

Generally, the human settlement of Cluster 1 River Basin is classified as rural. About 86% is classified as rural settlement whereas urbanized areas contribute to only 14% of the total settlement pattern of the cluster. This means that there is small percentage of urbanized settlements that needs more advanced opportunities on facilities, amenities, education, and business.

5.4.2 Indigenous Peoples

There are 26 Indigenous People Groups occupying the Cluster 1 River Basin. With a total of 1,452,420 individuals. The indigenous peoples in the cluster is about 10% of the total number of IPs in the entire Philippines. The common indigenous peoples in the cluster are Bago, Ibaloi, Ibanag, Ifugao, Itneg/Tingguian, Kalinga, and Kankanaey.

5.4.3 Land and House Tenure

Nearly 62% (193,228) of the population of the Cluster 1 River Basin has a possession of house and lot. In addition, 18% accounts for the population renting a room or the entire housing unit including the lot. Moreover, there are also residents in the cluster that stay in a rent-free house wherein the owner allows them to stay in the housing unit, making up to 9% (7,542).

5.4.4 Health

A total of 148 infant deaths and 14 maternal deaths were recorded in Cluster 1 River Basin in 2016. In terms of common diseases, both Cordillera and Ilocos Regions recorded that Acute Respiratory Infection, hypertension, and Urinary Tract Infection (UTI) are top three (3) diseases with most number of cases. Other prevailing diseases are ALTRI & Pneumonia, Acute Watery Diarrhea, bronchitis, Influenza, Acute Bloody Diarrhea, Acute Hemorrhagic Fever, and other heart diseases.

5.4.5 Literacy and Education

The literacy rate of Cluster 1 River Basin increased from 98.1 in 2010 to 98.9 in 2015. Moreover, both male and female follow same trend. Population of both gender belonging between 10 and 29 years old, have higher literacy rate among all age groups. Ages from 50 to 64 have lowest literacy rate.

5.4.6 Poverty and Subsistence

The average poverty incidence of the municipalities and cities within the Cluster 1 River Basin is 16%. Among the provinces, Ilocos Sur contributed the highest poverty incidence of 28.6% while La Union contributed the lowest with only 12.6% in 2012. In addition, it is very noticeable that Baguio City and La Trinidad have very low poverty incidence, making these areas with the lowest value among all municipalities and cities within the cluster. In terms of subsistence incidence, highest subsistence incidence belongs to La Union with 5.2% whereas the lowest belongs to Benguet with 0.4% in 2015. Moreover, it was also observed that subsistence incidence of all provinces escalated in year 2009.

5.4.7 Human Development Index

In general, all provinces in Cluster 1 River Basin follows an improving trend. Among all provinces, Benguet had the highest HDI recorded from 2006 to 2012. However, a very slight decrease was observed in the HDI of Benguet province with value of 0.849 in 2006 and 0.842 in 2012. On the other hand, Ilocos Sur was found to be the province with lowest HDI of 0.556 in 2006 and 0.640 in 2012.

5.4.8 Employment and Labor

The average employment rate of Cluster 1 River Basin is high at 92.4%. However, it is lower than of the Philippines with rate of 94.4%. In addition, Ilocos Sur is the province inside the cluster with the highest employment rate of 94.80%. Unfortunately, the average rate of the entire cluster decreased due to low employment rate of La Union with only 88.5%.

5.4.9 Natural Resource Dependent Livelihood

The rice production in Cluster 1 River Basin increased from 1997 to 2017. After two decades, the volume production of 228,047 metric tons increased to 437,519 metric tons in 2017. Most of the rice production areas are found in Ilocos Sur and La Union. The trend of corn production of the cluster is also increasing from 1997 to 2017. The significant increase in production is 75% of the total corn production after two (2) decades. The highest production of corn was in Ilocos Sur whereas the lowest was observed in Benguet. Moreover, the production of white corn has no significant increase in terms of its volume with an average of only 19,200 hectares from 2013 to 2017. On the other hand, white corn production is continuously increasing. Banana, mango, and tomato have the highest production volume among all other agricultural crops.

The cluster has a total of 1,445 cubic meters of log in 2016. Among the provinces covered, La Union is the highest producer of log with about 54% (778 cubic meters) of the total volume of log produced in the river basin. On the other hand, Benguet only produced 288 cubic meters which is equivalent to 20%. In terms of tourism, there was a total of 1,012,416 domestic and foreign travelers in the cluster in 2017. Approximately 96% (971,718) of travelers in the area come from others areas of Philippines.

5.5 INFRASTRUCTURE

5.5.1 Educational Facilities

The Cluster 1 River Basin has a total of 355 schools established. Of which, 301 schools offer elementary education and 54 schools offer secondary education. The aggregated number of schools based on municipality data revealed that the province of Benguet has the most number of schools with a total of 174 schools. On the other hand, only 56 schools were found in La Union.

5.5.2 Health Facilities

There are 18 hospitals in the entire Cluster 1 River Basin, 50% of which are owned by the government while the remaining 50% are privately-owned. Approximately 56% of the total number of hospitals in the cluster are found in the province of Benguet. In the city of Baguio, there are a total of five (5) hospitals found. Benguet was followed by La Union and then Ilocos Sur which constitute 33% and 11%, respectively. In terms of service capability, there are eight (8) hospitals categorized as Level 1. Furthermore, only four (4) hospitals were categorized with Level 3 Service Capability.

5.5.3 Road and Bridges

There are about 96 road networks and 65 bridges constructed in the Cluster 1 River Basin. Most of these are located in Baguio City due to high frequency of infrastructures in the area.

5.5.4 Dams and Irrigation

The Cluster 1 River Basin has a total of 13 dams solely found in the region of Ilocos. Dams in the cluster area include Batbato, Bato, Cabalayangan, Cabarsican, Cabugbugan, Dawara, Pallogan, and Suyo Proper Diversion Dams, Busol WRP, and Agtipal WIP. Moreover, the cluster has an estimated total of 60,973 hectares of irrigable areas. In addition, there are also existing irrigation systems in the area such as national irrigation systems (NIS), communal irrigation system (CIS), private irrigation system (PIS), and other government agency assisted irrigation systems with 51,500 hectares. Ilocos Sur has the largest service area for irrigation systems with 21,937 hectares (43%). Given this, Ilocos Sur has also the biggest irrigable areas, however only 74.4% of this has irrigation systems. On the other hand, nearly all irrigable areas in Benguet have already irrigation systems (99.5%). There are also no existing national irrigation systems in Benguet.

5.5.5 Waste and Sanitation

Generally, households in Cluster 1 River Basin used water-sealed septic tank that is utilized exclusively by their households. This type of sanitation facility constitutes 66% wherein 262,543 households are using it. In terms of usual manner of disposing garbage, burning is the most common way in the cluster. This indicates that 44% of the households is using this poor practice of waste management, which is quite common in the provinces of Ilocos Sur and La Union.

5.5.6 Financial Institutions

There are 590 financial institutions present in the Cluster 1 River Basin. Of these, 279 are banks and 311 are pawnshops. Among the provinces within the cluster, Benguet has the greatest number of banks and least number of pawnshops. Lowest number of banks is found in Ilocos Sur whereas pawnshops are most popular in La Union.

5.5.7 Energy

There are four (4) general fuel types present in the Cluster 1 River Basin, namely, coal, oil-based, natural gas, and renewable energy. Among all fuel types, coal accumulated the highest installed and dependable capacity. It was followed by renewable energy wherein geothermal, hydro, wind, biomass, and solar energy exists in the Luzon. Most of the renewable energy comes from hydro energy. Moreover, natural gas occupies about one-fifth of the energy resource in the entire island. Lastly, oil-based fuel is the least common which constitutes 16% of the total installed power plants.

5.5.8 Transportation

There are almost 179,000 motor vehicles registered in the Cluster 1 River Basin. Most of the registered vehicles are privately owned comprising 80%. Subsequently, 18.5% of the vehicles are for hire and 1.2% are owned by the government. As observed, highest number of registered motor vehicles was noted in the province of La Union, followed by Benguet and Ilocos Sur.

5.6 STAKEHOLDER ANALYSIS

There are at least 50 stakeholders belonging to user groups in the cluster. Of which, 26% belongs to user groups, 44% belongs to mediating groups and the remaining 30% belongs to external interest groups.

Most of the alliances in the cluster were formed due to financial assistance, livelihood concerns, governance, and development programs. However, conflicts arise due to illegal activities (e.g. illegal logging, illegal buying, destructive fishing), boundary dispute, and policy conflicts.

In terms of importance and influence, fifteen stakeholders were identified to be very important and very influential. These stakeholders were mainly composed of government agencies. Hence, including these stakeholders in the implementation process will increase the success and degree of impacts of the proposed programs and projects. On the contrary, there were (3) stakeholders categorized as important but with less influence. This implies that there are marginalized stakeholders that need to be empowered and needs to be involved in the management process.

5.7 LAND CAPABILITY ASSESSMENT

The Universal Soil Loss Equation (USLE) is the commonly used formula in determining soil erosion processes. The factors considered in this formula are rainfall erosivity, soil erodibility, slope length, slope gradient, cover and the existing erosion control practice (SEP = RKLS). In general, the Cluster 1 River Basin has very high soil erosion potential of more than 37 tons per hectare accounting for about 53% of the entire area. This indicates that areas with high SEP will be more constrained in being used for intensive land uses than areas with lower SEP. The computed SEP is then standardized by calculating the soil erosion index (SEI). The soil erosion index in the cluster is predominantly very high which constitutes around 52% and totals to about 116,700 hectares. These areas need intensive precaution.

Land capability refers to the capacity of a land area to provide multiple usage under bearable conditions. The different biophysical factors include land cover, soil, topography, rainfall, and hazards. Roughly 60% of the entire cluster is categorized as strict protection which sums to an estimate of 136,000 hectares. Provided this, it is apparent that there are more protection zones than of production. This land capability zone refers to all remaining natural forests, all areas with high erosion potential and slope >50%, all areas known to support important wildlife and with high value for biodiversity conservation, and all other areas with SEI of more than 5. The indicative land use of the zone is limited collection of ornamental plants, herbs, vines, fruits and other non-timber products may be allowed. The general land capability in the Cluster 1 River Basin is the strict protection zone. Roughly 60% of the entire cluster is categorized as strict protection which sums to an estimate of 136,000 hectares.

5.8 POLICY AND INSTITUTIONAL ASSESSMENT

The management of the principal river basins encompasses numerous international and national policies, conventions, and protocols such as Sustainable Development Goals (2015-2030), Ramsar Convention, Montreal Protocol, Kyoto Protocol, Philippine Development Plan (2011-2016), Strategic National Action Plan (2009-2019), and National Climate Change Action Plan (2011-2028).

National and local governments and private businesses all define their interaction with the environment through their policies and institutions. The responsiveness of LGUs to climate change is shaped by policies in several sectors such as forestry, agriculture, housing, industry, and infrastructure. To be effective, DRR and CCA must be incorporated into policy at a range of levels and across many sectors to influence institutional framework and structure geared towards reducing both the risk from the impacts of climate related hazards and vulnerability to them.

Institutions and governance are crucial for watershed development in terms of decision-making, policy implementation, empowerment, and influence. In addition, policy and technological response can be affected due to gap between socio-ecological aspect and institutional arrangements (IPCC, 2014). Hence, it is recommended to establish a management council for the entire Cluster 1 River Basin. In the local context, several LGUs in the Cluster 1 River Basin updated and incorporated the CCA-DRR in their respective plans. These LGUs include Bacnotan and Burgos, and San Fernando City in La Union; Santa Cruz and Sugpon in Ilocos Sur; and Baguio City, Bokod, Buguias, Kabayan, La Trinidad, and Tublay in Benguet.

5.9 VULNERABILITY ASSESSMENT

5.9.1 Flood Vulnerability Assessment

The peak flow could be observed to be concentrated during 13:00HR with rainfall depth ranging from 71 to 280 millimeters. In addition, the hyetograph implies that the longer the return period, the higher the rainfall depth.

In terms of return period, a 2-yr return period corresponds to the average rainfall events and it shows that there are 23,581 ha with a very high vulnerability mostly located near riverbanks and areas close to the river mouth or delta, Thus, these low-lying areas will experience up to 2 m flooding. On the other hand, a 25-yr return period means that at any given year, there is a 4% chance (P = 1/25) that the rainfall event that would cause the flood event will be equaled or exceeded. It can simply be interpreted that there is a 4% chance that the flood event of that magnitude will occur at any given year. Very highly vulnerable areas increased to 34,729 hectares and more areas will also experience high flooding.

A 50-yr return period means that there is a 2% chance (P = 1/50) that the rainfall event of such magnitude will be equaled or exceeded at any given year. Areas previously under moderate or high flooding will have very high flood depths increasing its area to 36,381 hectares. Finally, a 100-yr return period will have a 1% chance (P = 1/100) to be equaled or exceeded at any given year. Its occurrence is much less frequent but the magnitude is much greater which would create a much larger area of 37,970 hectares under very high vulnerability, including most of the coastal areas.

5.9.2 Hazard Vulnerability Assessment

Roughly 2.4% (5,319 hectares) of the Cluster 1 River Basin is found to have high vulnerability to flooding. Overall, there are 18 municipalities categorized to be highly vulnerable. Largest coverage of vulnerable areas is mostly situated in the province of La

Union due to its low elevation wherein approximately 68% of the covered municipalities and cities in La Union has an elevation not greater than 300 meters above sea level.

In terms of landslide, half of the entire cluster is classified as areas with moderate vulnerability to landslide. This constitutes 114,091 hectares which are found in all municipalities and cities covered within the cluster except for Cervantes. In terms of high vulnerability, areas with this vulnerability classification comprise 31% (69,969 hectares) which are mainly situated in Bakun, Kibungan, and Atok of Benguet, and Suyo and Sugpon of Ilocos Sur.

As for the storm surge vulnerability, all areas in the Cluster 1 River Basin are identified to be vulnerable to the hazard. However, only 1,610 hectares were found to be highly vulnerable. These areas comprise less than a percent of the whole area. Additionally, areas with moderate and low vulnerability cover 1,517 hectares and 45,905 hectares, respectively. In terms of very low vulnerability, these areas under this vulnerability level constitute 78% with 175,929 hectares.

5.9.3 Water Supply

The projected 2030 total domestic, municipal, and industrial water demand to 16.6 MCM/yr, 6.7 MCM/yr and 50.5 MCM/yr for Amburayan Principal River Basin, Baroro and Bauang Principal River Basins, respectively. For 2050, the total domestic, municipal, and industrial water demand grew further to 15.9 MCM/yr, 6.6 MCM/yr and 57.2 MCM/yr for Amburayan, Baroro, and Bauang Principal River Basins, respectively. Moreover, the available groundwater supply in the cluster far exceeds the domestic, municipal and industrial water demands in the region. Except for Baroro PRB, the cluster has sufficient amount of water, both surface and groundwater, to sustain the exaggerated water demand projections for 2030 and 2050.

5.9.4 Participatory Risk and Vulnerability Assessment

The risk level of typhoons, landslides, and flooding are considered as high risks indicating that high priority controls are required due to its high probability of occurrence and high consequences. On the other hand, Therefore, adaptation measures should be applied to address wide-range impacts of the risk events. However, common problems in financial and time still exist, thus evaluation and prioritization of adaptation actions shall be conducted.

6 MANAGEMENT AND DEVELOPMENT PLAN

6.1 VISION

The crafted integrated vision was based from the several focus group discussions participated by different agencies such as government agencies, people's organizations, local government units, and academe.

"*A sustainable, waste-free, and climate-resilient Cluster 1 River Basin maintaining a well-balanced ecosystem to provide well-utilized water resources, sufficient livelihood, and empowered community through holistic approach management.*"

6.2 MISSION

In line with the crafted vision statement, the mission statement for the principal river basins were created.

"Conserving and protecting the Cluster 1 River Basin through sustainable watershed management, capacity building and policy development."

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 for all strategies in the Philippines for sustained river basin ecosystem management. It has four principal frameworks and development strategies: Integrated Water Resources Management, Integrated Watershed Management, Wetland Management, and Flood Mitigation (Figure 2).

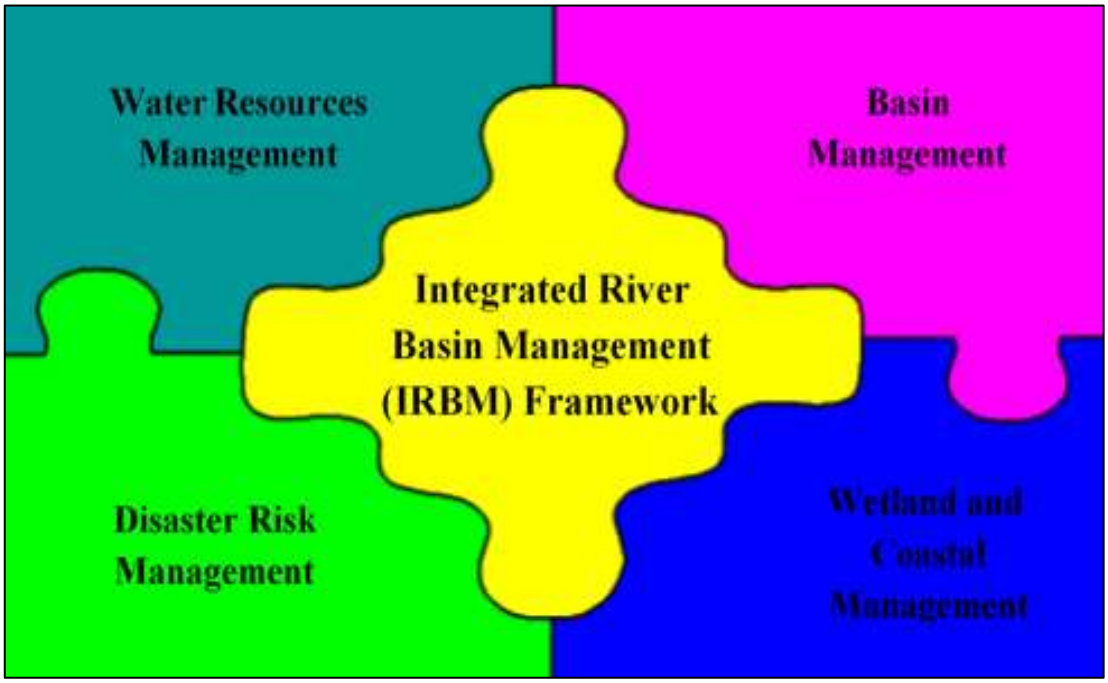

Figure 2. Integrated River Basin Management and Development (IRBMD) Framework

6.4 DEVELOPMENT ISSUES AND CHALLENGES

6.4.1 Forest Ecosystem and Biodiversity Management

The core problem of the Cluster 1 River Basin on forest ecosystem and biodiversity is its degradation. The degradation rooted from numerous reasons such as deforestation caused by forest fire, illegal logging, and timber poaching. Forest rangers and other official guardians of the forests are lacking; hence, these activities are not strictly observed. In addition, land conversion is another reason which exacerbated by the presence of illegal settlers in the forest land and improper land use zoning. Construction of roads and farm-to-market roads provides access to people living in the uplands. Moreover, rapid population growth resulted to degradation of each principal river basin due to increasing demand of resources. Pollution greatly contributes to the degradation which is mainly caused by improper waste management. Furthermore, execution of illegal activities is a reason resulted from poor enforcement and implementation of environment and natural resource – related laws and low awareness of community to these laws. Ecosystem degradation affects the provision of basic services, livelihood, and biodiversity level.

6.4.2 Water Resources

The main problem of the Cluster 1 River Basin in water resources is the declining water quality. The declining of water quality is primarily caused by environmental pollution and lack of investment on water facilities such as rainwater harvesting. One of the significant causes of pollution in the cluster is the improper waste disposal because households are not practicing segregation. This kind of behavior roots from the poor implementation of policies and unapproved ten-year solid waste management plan. Additionally, the degradation of water quality is also related to problems on sanitation facilities and urbanized areas. Moreover, there is lack of Information, Education, and Communication (IEC) programs to promote awareness on the importance of proper waste and water management. Land conversion, illegal cutting of trees, kaingin, and unregulated use of fertilizers and other chemicals caused sedimentation to rivers, springs, and other water bodies. The effects of the declining water quality vary from the dwindling water supply, chemically polluted water, fish kill, and outbreak of diseases.

6.4.3 Wetland Management

The main concern in the wetlands of Cluster 1 River Basin is its degradation. The problem is chiefly contributed by siltation, environmental pollution, unsustainable livelihood practices, and lack of awareness in managing wetlands. Primarily, the siltation is caused by different disastrous state of events such as deforestation, forest fragmentation, *kaingin*, timber poaching, and land conversion. Moreover, fisherfolks use unsustainable livelihood practices that destroy wetland habitat and resources. Additionally, the condition of resources is intensified due to increasing demand on aquaculture. Lastly, stakeholders of wetlands lack awareness on how to manage it.

6.4.4 Disaster Risk Reduction and Management

The main problem on disaster risk reduction and management of the Cluster 1 River Basin is the aggravated impacts of climate-related disasters. This is proven by the location of the cluster wherein the Northern Region is characterized by very high density of tropical cyclones. This indicates that the area of the cluster has high occurrence of tropical cyclones. In addition, the Cluster 1 River Basin is susceptible to different hazards such as

landslides and soil erosion due to its slope wherein about half of the entire cluster is severely steep. Apparently, disasters are considered as a main problem due to changing climate which exacerbate the impacts to people, environment, and economic. In addition, community cooperation for programs to minimize the impacts of climate-related disasters is lacking. This lack of community cooperation is a sister problem of insufficient DRR programs, equipment, and facilities. IEC programs, warning signs and devices are also lacking in the cluster due to lack of funding. Risks of disasters are intensified due to weak monitoring of compliance to zoning ordinance. The consequences of disasters are interrupted basic activities, outbreak of diseases, damages on crops, goods, infrastructures and properties, and presence of casualties.

6.4.5 Economic Development

The principal economic issue of Cluster 1 River Basin is poverty. This resulted from anthropogenic and institutional factors such as rapid population growth, natural and man-made hazards, limited resource utilization, insufficient funding, and unsustainable livelihood activities. Poverty affects numerous sectors such as basic services, institutional, and agriculture. Due to poverty, limitation to basic services such as health and education will be intensified. Apparently, hazards leading to poverty brought damages to agricultural products, access roads, and infrastructures. Moreover, since poverty prevails, many people will not be able to adapt to changing climate because they have limited resources. These impacts will ultimately lead to extreme poverty.

6.5 IMPLEMENTATION PLAN

6.5.1 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 13 indicators, only a total of eight (8) shortlisted key indicators were eventually chosen. These indicators were Water Stress Index, Fecal Coliform, Forest Cover, Shannon Biodiversity Index, Soil Erosion Rate, Wetland Area (based on Land Cover), Number of Vulnerable Barangays to Hazards, and Poverty Incidence. Baseline 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 1.

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.

6.5.2 Programs and Projects

Six (6) thematic areas were considered in the recommendations of relevant programs and projects in the implementation plan. The thematic areas that are taken into consideration were forest ecosystem and biodiversity, water resources, wetland management, disaster risk reduction, economic development, and institutional development (Table 1). Crosscutting projects were also considered.

Table 1. Different projects identified for each thematic area

Theme	Objective	Measure	Program/Project
Forest Ecosystem & Biodiversity	Stable and Productive Ecosystem	Forest Ecosystem Restoration	***Adaptive Forest Ecosystem Restoration (A-FORESTORE) Program***
			Native Forest Restoration Project
			Traditional Plantation Project
			Conservation Farming Villages
Water	Improvement of water Quality and Water Availability	Supply-side Management	***Supply-side Management Program***
			Rehabilitation/Restoration of Existing National and Communal Irrigation System (NIS & CIS)
			Construction of Additional NIS and CIS Project
			Construction of Rainwater Collectors
			Construction of Bulk Water Supply
			Installation of New Deep Wells and Distribution Systems
		Demand-side management	***Demand-side management***
			Improvement of Irrigation Water Management Project
			Rehabilitation of existing systems and water supply facilities
		Waste management	***Effective Waste Management Program***
			Effective Solid Waste Management Project
			Waste-to-Energy
			Water Quality Monitoring System Project
			Installation of Centralized/Decentralized Treatment Plants Project
Wetland	Improvement of sustainability and resilience of wetlands	Restoration and protection of wetland ecosystems	***Wetland Ecosystem Management Improvement Program***
			Wetland Protection and Restoration
			Coastal Resource Protection
Disaster Risk Reduction	Disaster Risk Reduction - Climate Change Adaptation	Improvement of adaptive capacity and reduction of risks	***Adaptive Capacity Program***
			Literacy Development
			Livelihood Development
			Improvement of Communication Facilities
			Improvement of infrastructure system
			Improvement of Early Warning System
			Enhancement/Construction of Evacuation Centers
			Climate-Adaptive Hazard Mitigation Infrastructure Program
			Flood Control Project

Theme	Objective	Measure	Program/Project
			Slope Stabilization Project
Economic Management	Inclusive Economic Growth	Enhancement of value chain systems	***Value Chain Enhancement Program***
			Access Market Improvement
			Establishment and enhancement of post-harvest facilities
			Marketing Systems Improvement
			Climate-resilient agriculture project
			Sustainable fisheries project
			Community-based ecotourism project
			Industry and enterprise development
			Cooperative development
Institutional Development	Crosscutting		Capacity Building
			Cultural Impact Assessment
			Governance Improvement
			Strict implementation of Zoning Ordinances
			Mainstreaming of DRR and CCA in Local Development Plans
			Gender Equity and Social Inclusion Development
			Caravan/Roadshow
			Sustainable Financing Mechanism
			Institutionalizing Collaborative and Integrated ENR Management
			Feasibility Assessment of Cluster 1 River Basin Master Plan
			Creation of River Basin Management Council
			Induced River Basin Coordinating Management Council Formation
			Establishment of River Basin Management Office
			Development of Result-Based Management System and Management Information System
			Watershed Monitoring Program
			Comprehensive Natural Resource Assessment and Monitoring
			Watershed Instrumentation

6.6 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 the Cluster 1 River Basin, which is composed of Amburayan, Baroro, and Bauang Principal River Basins as well as Busilac, Darigayos, and Maragayap Minor Watersheds. In order to pursue the objectives, set forth in the Master Plan, five (5) component thematic areas were developed: Forest Ecosystem and Biodiversity Management, Water Resources Management, Wetland Management, Disaster Risk Reduction and Management, and Economic Development. In addition to these five programs are two (2) other programs and ten (10) other projects that are considered crosscutting in nature as they address concerns of more than one program.

The total investment requirement of the Plan over a fifteen-year period is PhP 32.658 Billion, as shown in Table 2. The Forest Ecosystem and Biodiversity Management Thematic Area has the highest funding requirement among the five thematic areas at PhP 12.616 Billion (38.6% of total), followed by the Water Resources Management Thematic Area (PhP 9.794 Billion or 30% of total), Disaster Risk Reduction and Management Thematic Area (PhP 9.633 billion or 29.5% of total), Crosscutting Projects (PhP 250 Million or 0.8%), Economic Development Thematic Area (PhP 199.6 Million or 0.6% of total), and Wetland Management Thematic Area (PhP 165.4 Million or 0.5%).

Table 2. Total Cost of Programs and Projects Proposed for the Cluster 1 River Basin

PAP	Indicative Cost (PhP)
FOREST ECOSYSTEM AND BIODIVERSITY MANAGEMENT	**12,616,332,000**
Adaptive Forest Ecosystem Restoration (A-FORESTORE) Program	**12,616,332,000**
Native Forest Restoration Project	6,949,983,600
Traditional Plantation Project	5,235,278,400
Conservation Farming Villages	431,070,000
WATER RESOURCES MANAGEMENT	**9,793,506,074**
Supply-side Management Program	**5,526,646,074**
Rehabilitation/Restoration of Existing National and Communal Irrigation System	2,114,581,790
Construction of Additional NIS and CIS Project	2,742,324,284
Construction of Rainwater Collectors	58,500,000
Construction of Bulk Water Supply	551,000,000
Installation of New Deep Wells and Distribution Systems	60,240,000
Effective Waste Management Program	**4,195,560,000**
Effective Solid Waste Management Project	68,000,000
Waste-to-Energy	700,000,000
Water Quality Monitoring System Project	51,360,000
Installation of Centralized/Decentralized Treatment Plants Project	3,376,200,000
Demand-side management	**71,300,000**
Improvement of Irrigation Water Management Project	32,500,000
Rehabilitation of existing systems and water supply facilities	38,800,000
WETLAND MANAGEMENT	**165,447,626**
Wetland Ecosystem Management Improvement Program	**165,447,626**
Wetland Protection and Restoration	75,601,946
Coastal Resource Protection	89,845,680
DISASTER RISK REDUCTION AND MANAGEMENT	**9,632,533,653**
Adaptive Capacity Program	**5,648,670,000**
Literacy Development	11,150,000
Livelihood Development	6,300,000

PAP	Indicative Cost (PhP)
Improvement of Communication Facilities	15,300,000
Improvement of infrastructure system	5,200,000,000
Improvement of Early Warning System	12,720,000
Enhancement/Construction of Evacuation Centers	403,200,000
Climate-Adaptive Hazard Mitigation Infrastructure Program	***3,983,863,653***
Flood Control Project	1,131,790,000
Slope Stabilization Project	2,852,073,653
ECONOMIC DEVELOPMENT	**199,600,000**
Enhancement of Value Chain Program	**199,600,000**
Access Market Improvement	65,600,000
Establishment and enhancement of post-harvest facilities	8,000,000
Marketing Systems Improvement	1,200,000
Climate-resilient agriculture project	3,200,000
Sustainable fisheries project	3,200,000
Community-based ecotourism project	32,000,000
Industry and enterprise development	80,000,000
Cooperative development	6,400,000
CROSSCUTTING PROGRAM AND PROJECT	**250,262,880**
Creation of River Basin Management Council	**17,700,000**
Induced River Basin Coordinating Management Council Formation	700,000
Establishment of River Basin Management Office	7,000,000
Development of Result-Based Management System and Management Information System	10,000,000
Watershed Monitoring Program	**59,182,880**
Comprehensive Natural Resource Assessment and Monitoring	30,000,000
Watershed Instrumentation	29,182,880
Other Projects	**173,380,000**
Capacity Building	19,400,000
Cultural Impact Assessment	40,000,000
Improvement of Governance	6,700,000
Strict implementation of Zoning Ordinances	4,500,000
Mainstreaming of DRR and CCA in Local Development Plans	12,000,000
Gender Equity and Social Inclusion Development	7,480,000
Caravan/Roadshow	12,000,000
Sustainable Financing Mechanism	20,000,000
Institutionalizing Collaborative and Integrated ENR Management	1,300,000
Feasibility Assessment of Cluster 1 River Basin Master Plan	50,000,000
Grand Total	**32,657,682,233**

6.7 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 four (4) programs to be prioritized were Climate-Adaptive Hazard Mitigation Infrastructure, A-FORESTORE, Adaptive Capacity Development, and Effective Waste Management. Moreover, the crosscutting programs and projects were not included in the prioritization because these are considered as non-negotiable.