Climate-Responsive Integrated Master Plan for Mindanao River Basin

Executive Summary

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

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EXECUTIVE SUMMARY

1 RATIONALE

Pursuant to Executive Order (EO) Nos. 510, 816 and 50, a river basin control office was created to develop, among others, a national master plan to address flooding and to provide sustainable supply of water for the entire country. In compliance with EO 510, an integrated river basin management and development master plan was crafted in 2007 identifying eighteen (18) major river basins in the Philippines. The Mindanao River Basin is part of these identified major river basins. On May 2, 2012, the Cabinet Cluster on Climate Change Adaptation and Mitigation passed Resolution No. 2012-001 adopting the eighteen (18) major river basins of the country as priority areas of the government. The importance of these river basins cannot be understated as they are considered as one of the life blood and drivers of the Philippine economy. Hence, they have to be managed sustainably.

An integrated river basin management approach was applied in the preparation of the master plan for each river basin in line with the Philippine Development Plan. The master plan is intended to address several concerns related to watershed conservation, river basin rehabilitation, flood control/mitigation, and water security for domestic, irrigation and industrial use, livelihood and economic opportunities in the area.

The master plan for the Mindanao River Basin was formulated/completed in January 2012 and were approved by the respective Regional Development Councils that have jurisdiction in the area. With the passage of Republic Act (RA) No. 9729 or the Climate Change Act of 2009 and RA 10121 or the Disaster Risk Reduction Law of 2010, the importance of taking into consideration the new climate normal in development planning was recognized. The 2015-16 El Niño event is one of many alarming calls in recent times where many parts of the MRB has been seriously and massively affected through large-scale crop losses, adverse impacts to livestock, widespread power interruption, decreased water supply and eventually resulting to social and political unrests. The need to review and update the existing master plan becomes relevant and imperative. Therefore, climate change perspectives should be incorporated and mainstreamed together with disaster risk reduction issues and measures in the revised MRB Master Plan.
2 OBJECTIVES OF THE STUDY

The objective of this project is to update the Integrated River Basin Master Plan for the Mindanao River Basin, to incorporate the implications of the new climate normals in addressing the concerns of the river basin on:

- Water Resources Management
- Watershed Management
- Flood Control/Mitigation, Disaster Risk Reduction and Hazards Management
- Wetland Management (including rivers, river deltas, marshlands and coastal areas)
- Economic Development, and
- Institutional Linkages and Organizational Structure for River Basin Management.

3 SCOPE

The project updated the Integrated Management and Development Master Plan of the Mindanao River Basin, taking into consideration potential climate change impacts to provide a sound basis for management decisions in the sustainable management of the resources therein. The project consisted of two phases, the scope of which includes:

1. Updating of river basin profile;
2. Revision of vision, missions, 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 approaches, and methods to accomplish the objectives and expected outputs of the project stated in the Terms of Reference. The following tasks, presented in Figure 1, were undertaken.

**Figure 1. Tasks and reports by phases of the Project**
5 ASSESSMENT REPORTS

This report is organized to have the following chapters related to Assessment. This report focuses on background information as to the Project Area, objectives of the Project, the methodology adopted, analysis done and strategies proposed. In conjunction with the objectives and scope of the project, collection of secondary data covering biophysical, socioeconomic, institutional and policy as well as acquisition of GIS data and imageries on watershed boundaries, land use (forest, agricultural lands and built up areas) was done. Moreover, the chapter provides description to the different thematic areas of the project as affected by extreme climate events namely: 1) Water Resources, 2) Watershed, 3) Wetlands, 4) Economic.

5.1 Mindanao River Basin Area Profile

5.1.1 Geographic and Administrative Profile

The Mindanao River Basin (MRB) lies between the coordinates of 7°12’17.06” north latitude and 124°47’35.71” east longitude. It represents five (5) regions, namely Regions X, XI, XII, CARAGA and ARMM, covering the provinces of Bukidnon, Davao del Norte, Lanao del Sur, Maguindanao, Sultan Kudarat, North Cotabato, South Cotabato, some parts of Agusan del Sur and chartered cities - Cotabato City and Davao City. MRB is the second largest river basin in the Philippines, having a total area of 21,503 square kilometers. It has one source of hydroelectric power, the Pulangi 4 Hydro-Power Dam located in Bukidnon and one source of geothermal power and home to the endangered Philippine Eagle, the Mt. Apo. The forest land and alienable and disposable lands are divided into almost equal areas distributed respectively as follows 50.08% and 49.92% (RBCO, 2012).

5.1.2 Natural and Geo-physical characteristics

Climate Trends and Projections

Climate Trends

The basin is under Climatic Types III and IV according to the Modified Corona Climate Classification. Type III is characterized by a relatively dry season from November to April and wet season during the rest of the year, while Type IV is characterized by a more or less evenly distributed rainfall throughout the year. The highest amount of annual precipitation occurs during June to October with a normal average of 2,272.27mm.

Climate Normals

The current normal maximum temperature per month ranges from about 30.8-32.8 degree Celsius; while the minimum temperature from 21.33-22.3 degree Celsius and mean temperature ranges and 26.1-27.37 degree Celsius. In terms of rainfall, the 3-decade average monthly rainfall ranges from 99.8 to 271.23 mm; where the peak month is July (with rainfall amount of 271.23mm), closely followed by June with a rainfall amount of 270.83mm. Rainfall is lowest during the month of February where the average is only 99.88 mm. Average annual rainfall for the 3 decades is about 2,272.27mm, which is 75.73 mm lower than the annual average rainfall of 2,348mm for the whole country (Worldbank, 2016).
Climate Extremes

In terms of temperature, the Davao City Station recorded the highest temperature in May 5, 1905 at 37.3 degrees Celsius. Malaybalay City Station observed the highest temperature last April 24, 1998 at 36.2 degrees Celsius. Based on these information, it appears that currently they could not be considered temperature extremes as no values have breached 38 degrees Celsius.

In terms of rainfall, in Malaybalay station, the highest rainfall for the month of January is 140.6mm, which was observed on January 14, 2014. Among the three stations, the greatest rainfall recorded was 242.6 mm, which occurred on August 2, 1902.

Climate Projections

The projected annual mean temperatures (average of maximum and minimum temperatures) are expected to rise by 1.0°C to 1.2°C in 2020 and by 1.9°C to 2.5°C in 2050. In terms of rainfall change, in the 2020 scenario, all provinces will experience a decrease in rainfall amount in the March-April-May (MAM) and June-July-August (JJA) seasons. Lanao del Sur, Maguindanao, North Cotabato and Sultan Kudarat is predicted to increase in the months of September-October-November (SON) while the other provinces are estimated to decrease. All provinces will experience an increase in the December-January-February (DJF) season. In 2050, projected increases in rainfall amounts in all provinces except Lanao del Sur, Davao del Norte and Agusan del Sur are possible. Rainfall amount will probably continue to decrease in all provinces during the March-April-May and June-July-August seasons. In September-October-November, there will be a decrease in all provinces except for Sultan Kudarat.

Topography and Geo-morphology

Watershed Profile

Mindanao River Basin is the second largest river system in the Philippines next to Cagayan River in Luzon; and is also the second longest river in the country with an approximate length of 373 kilometers or 231.8 miles. Its headwaters can be found in Impasug-ong in Bukidnon, where it is known as the Upper Pulangui River; going downstream, it then joins with Kabacan River, where it is now called Mindanao River. Lower Pulangui, in its lower portion, drains in Ligawasan Marsh. It splits into two sections as it goes to the ocean towards the Moro Gulf—these sections are the Rio Grande de Mindanao and Tamontaka River, which are separated by the City of Cotabato.

Its major tributaries include the Kabacan, Libungan, Malitbog and Maridagao Rivers in the Cotabato Province; Kulaman River in Bukidnon, which constitutes the northern part of the river basin. The southern part includes the rivers Allah, Banga, and Buluan.

High elevation areas, that is, 500-1000 and above 1000 masl are found in the Bukidnon range going to Lanao del Sur and some portions in Agusan del Sur; however, in general, the river basin have areas with elevations ranging from 300-400 masl. It gradually lowers down to 200-300 masl in the mid-section of the Province of Bukidnon; down to 100-200 masl in the larger portions of North Cotabato and Maguindanao, central portions of Sultan Kudarat and northern portions of South Cotabato. When it comes to slope, the river basin is considered to have a moderate to steep slope. However, majority of the sub-watersheds belong to the steep slope category.
There are 16 sub-watersheds comprising MRB. Sub-watersheds sizes ranges from the smallest, which is MRB_13 (146.06 km²) to the largest MRB_07 (3,315.35 km²). The average bifurcation ratio among the 16 sub-watersheds is 2.62. Low bifurcation ratios indicate susceptibility to flooding. Those sub-watersheds with low bifurcation ratios and thus will be have higher tendencies for flooding are: 16th, 15th, 1st and 14th sub-watersheds. The average elongation ratio is 0.63, which is indicative of elongated watersheds and steep slopes. The average circularity ratio is 0.23, which means the sub-watersheds are not too near in having values of 0.4-0.50 which is indicative of strongly elongated watersheds. In terms of basin length, the average is 67 km while the longest basin length is 144 km and the shortest is 17 km. There is 0.29 km/km² average drainage density.

Soils

There are about 40 different soil types found in the Mindanao River Basin (Table 22). Mountain soil has the highest area coverage with 781,445.2 hectares, followed by Adtuyan clay, which covers about 112,584.6 hectares. Faraon clay/ River wash has the least area coverage with only about 625.77 hectares.

Geology

The rock formation with the highest cover in the area is the Pliocene-Quaternary with about 615,304.3 hectares, followed by Recent with 536,438.2 hectares. The geologic rock formation with the least cover in the river basin is the Neogene geologic origin.

Fault

There is only 1 active fault inside the river basin. It is located at the lower left part of Maguindanao going down to South Cotabato, this is more commonly known as the Daguma Extension; while there are a few trace approximates traversing the upper right side of Bukidnon, near its boundary, lower left side of Maguindanao, right side of Sultan Kudarat and the upper and lower center of South Cotabato.

Seismicity

According to the old master plan, some parts of the river basin experiences frequent shaking especially along the major faults discussed earlier; however, it rarely exceeds the magnitude of 4.0 in the Richter Scale, so it is not considered seismically active (Woodfields Inc., 2012).

Volcanoes

There are 38 volcanoes within Mindanao River Basin, mostly, however, are inactive or extinct. Only five are considered active, while two are potentially active. Mt. Makaturing is the most active volcano among the five, with 10 recorded eruptions, with which the last was in 1882; while Mt. Ragang has the latest eruption which was recorded in July 1916. The earliest eruption was the eruption of Mt. Parker, located in Cotabato, recorded in January 4, 1604. The highest mountain in the Philippines, Mt. Apo, located in Davao, is actually, a potentially active volcano.

Mineral Resources

Metallic mineral sites within the river basin area are founded with metals including gold (Au), Chromium (Cr), Copper (Cu), Silver (Ag), Manganese (Mn), and Nickel (Ni). Non-metalic mineral present in the river basin includes aggregate/ sand and gravel, clay,
limestones, silica, diatomite and guano rock. The Tampakan Copper-Gold in South Cotabato deposit is estimated to be one of the world’s biggest deposits of copper and gold.

**Water Resources**

**Surface water**

Major rivers within the basin include the Ala River, traversing the Ala Valley in the South; the Pulangi River with headwater from Bukidnon; the Ambal-Simuay River System originating from Lanao del Sur, and; the Mindanao and Tamontaka Rivers in the Lower Cotabato River Basin. Of these rivers, the Kulama River falls under the Class A Category, the M-lang and Ala Rivers under Class C, and Pulangui and Libungan under Class D (DAO 34 s. 1990).

**Ground water**

For the ground aquifers in MRB, the local and less productive aquifers constitute almost 42% with MRB Sub-Basin No. 2 as the highest at 136,682.7 ha. The fairly extensive and productive aquifers constitute 23% in MRB with MRB Sub-basin No. 07 with the largest area at 171,218.1 ha. The extensive and highly productive aquifers constitute only 3% again with MRB Sub-Basin No. 7 with the biggest area at 35,342.73 ha.

**Current Water balance**

Results of the calibration indicated that the annual mean runoff of the Mindanao river basin is about 1,114.4 mm. The total groundwater recharge in the basin is estimated to about 213.38 mm per year. Of this, it is estimated that 10.16 mm per year is recharge to deep aquifers. This accounts about 0.49 percent of the annual rainfall in the basin. Total water yield is estimated to be about 1,337.65 mm per year or 65% of the annual rainfall. The simulated values showed that large proportion of the rainfall is loss as surface runoff (54.19%) and only a minimal proportion is going to recharge the groundwater aquifer (10.38%). On the other hand, stream flow (water yield) of the Mindanao River is about 65 percent of the annual rainfall and peak flows occur during the month of June to October (Figure 2).
Projected water balance

Results of the simulation showed that water yield may decrease in 2020 as a result of the projected decrease in rainfall amounts from March to October. This decrease of the water yield may become more pronounce in 2050 where significant decrease is expected during the months of May to October. The decrease in water yield may adversely affect the operation and production of hydropower plants and irrigation facilities that mainly depend the water from the river. Likewise, decrease in water yield or streamflow may also affect available water supplies of communities within the river basin. It is imperative, therefore, that water harvesting of excess rainfall during the rainy season be adopted to be used during the dry months.

Land Cover

There had been significant changes of land cover within a span of 7 years. In 2003, forests cover is approximately 276,780.18 ha. However, based on the 2010 land cover, 113,022.98 ha is considered as closed forests while another 143,014.08 ha is classified as open forest and 28.25 ha is mangrove forests. Annual crops in 2003 is 750,779.45 ha, and in 2010 it increased to 872,749.5 ha. Built-up areas also increased in 2010, from 5,536.36 ha in 2003 it increased to 31,189.50 ha 2010. Open/barren lands in 2003 is only 80.13 but has more than tripled to 305.29 ha in 2010. Grasslands decreased in 2010, from 140,847.40 ha down to 74,046.46 ha or a decrease of 66,800.94 ha. Wooded grasslands likewise decreased from 447,344.32 ha to 382,690.35 ha in 2010 or a conversion of around 64,653.97 ha.

Land Use Assessment

Within MRB, it is evident that there is a general trend of decreasing forest cover within forestlands or forest reserves. Closed-and open-canopy forests are gradually being transformed into other uses by removing the natural vegetation to favor agriculture, commercial forestry, road construction and rural development.
**Natural Hazards**

**Drought**

The lowest drought index is found in northern and southern portions of the river basin. The moderate drought index is found at the central portion of MRB, mostly the provinces of Maguindanao and North Cotabato. The highest category of the index is found at the north-western portion of the river basin which covers the province of Lanao del Sur.

**Earthquake**

The central portion of the basin, that is Maguindanao, North Cotabato, central Bukidnon and some portions of South Cotabato, has low earthquake hazard while the high earthquake hazard areas are the greater portions of the northern parts of the basin, which is the larger portion of the Bukidnon area. Moderate earthquake hazards are prominent in the western side of Maguindanao, and southern portions of South Cotabato.

**Typhoon**

Mindanao River Basin has a very low record of typhoon occurrence. Strongest typhoons that devastated the island of Mindanao include Typhoon Pablo which hit Mindanao in 2012 that caused massive flooding and killed 1,901 people; Typhoon Titang, with 1,551 causalities; and Typhoon Sendong which hit the northern part of Mindanao on December 15, 2011 which killed 1,439 people (dela Cruz, 2014).

**Flood**

Most of the areas susceptible to floods are in the flood plains. These are the areas within the provinces of Maguindanao, North Cotabato and South Cotabato. Cities of Valencia and Malaybalay, as well as the municipality of Quezon in Bukidnon are areas also highly prone to flooding (PDPFP Bukidnon, 2014). Some other parts in Bukidnon particularly in the northern portions are also susceptible to flood hazard.

**Landslide**

Large portion of highly susceptible areas to landslide are found at the periphery of Bukidnon province. Report in the PDPFP of Bukidnon (2014) revealed that all provincial roads in Talakag, Cabanglasan, San Fernando, Impasug-ong, Sumilao, Lantapan and the city of Malaybalay are prone to rain-induced slides. High lying areas in South Cotabato are also highly prone to rain-induced slides. Also in Maguindanao, high lying areas in Matanog, Buldon, Upi, South Upi are prone to landslide but there were no historical records of occurrences. In North Cotabato, Kidapawan City is among the areas highly prone to landslide.

**Soil Erosion**

Highly erodible areas are more prominent at the southern end of the river basin and includes larger portions of T’boli, Surallah, Lake Sebu, Ampatuan, Isulan, Esperanza, Bagumbayan, Columbio and Tampakan. Moderate erodibility is more evident in many parts of Bukidnon and some portions in the northern part of North Cotabato. There is a low erodibility in the southern portions of North Cotabato down to the northeastern of Maguindanao to the northern half of South Cotabato and some portions of Bukidnon area.
5.1.3 Bio-ecological Profile

Flora and Fauna

DENR Region 12 recorded about 97 floral species found in the Allah Valley Protected Landscape during their Protected Area Suitability Assessment last 2015. Mt. Apo National Park has rich biological species with a total of 1,143 different higher flora and fauna species and with ferns of about 202 species representing major plant group and about 353 for flowering group. Among the listed significant floral species are two species of gymnosperms, i.e., Agathis philippinensis (almaciga, Araucariaceae) and Dacrycarpus cumingii (iguem, Podocarpaceae), and eight species of angiosperms, i.e., Adinandra (sangnauan, Theaceae); Lithocarpus philippinensis; Lithocarpus apenosis; Lithocarpus mindanaensis; Lithocarpus coopertus (oaks, Fagaceae); Syzygium spp. (collectively known as tambis tambis, Myrataceae); Leptospermum flavescens (malasulasi, Myrtaceae); and Litsea spp. (Lauraceae) (Dr. Precillano Zamora on his article in the Mt. Apo Foundation, as cited by Woodfields Inc., 2012).

In the recent BMS findings of DENR Region 12 last 2015, there were 13 species of birds found; in which 2 are vulnerable (G. platenaeis and D. carola), Trichoglossus johnstoniae, more commonly known as Mindanao lorikeet is classified near-threatened; Nisaetus philippensis or the Philippine hawk eagle is classified endangered; while Pithecophaga jefferyi, widely known as the Philippine eagle, a keystone species, is already critically endangered. The rest of the species listed are least concern, which means they have a low risk of being endangered in the near future.

Conservation Areas and Other Special Interest Areas

Protected Areas

Of the nine protected areas in the river basin, 6 fall under the category of resource reserve, all are Watershed Forest Reserves to be exact. Others fall under protected landscape, natural park and wildlife sanctuary. However, these nine protected areas only cover about 13% of the total area of the whole river basin; wherein Allah Watershed Forest Reserve is the largest covering about 4% of the total area of MRB. Allah WFR covers the municipalities of Lake Sebu, T’boli, Surallah, Sto. Nino, Banga, and Norala in the province of South Cotabato; City of Tacurong and municipalities of Isulan, Esperanza, Lambayong, Bagumbayan in the province of Sultan Kudarat.

Key Biodiversity Areas

There is but a little area coverage of KBA’s within the basin. Majority of the area, that is 87%, still has no identified KBAs. Allah Valley is the largest KBA, which also covers the Lake Sebu Watershed Forest Reserve.

There are 20 Conservation Priority Areas within or near the river basin. Included are 11 mountains/ mountain ranges, 2 marshes, 2 rivers, 3 lakes, 1 forest reserve and 1 coastal area. There are 5 CPAs which are categorized under extremely high urgent areas, thus, priority and immediate protection and conservation measures are urgently needed in these sites. Among them are the Mountains Kitanglad, Matutum, Busa-Kiamba and Apo, which are found to be high in species diversity and endemcity.
Community-Based Forest Management

Most of the tenurial instruments are Integrated Forest Management Agreements and CBFMA’s. Most areas are in the northern region the provinces of Bukidnon and North Cotabato. Some large portions are also located in Sultan Kudarat. There are also some patches of Forest Land Grazing Lease and Management Agreements (FLGLA’s and FLGMA’s) and Socialized Industrialized Forest Management Agreement (SIFMA) in the parts of North Cotabato and Bukidnon.

Certificate of Ancestral Domain Title

The tribe with the largest area of CADC Conversion is Ata Manobo with 117,410.9 hectares; followed by T’boli, B’laan with 88,184.18 hectares. The least area is 5,320.23 hectares applied for by Ubo Manobo.

Manobo tribes are widely scattered in the river basin particularly in Bukidnon, in North Cotabato, and Sultan Kudarat. Higaunons are found in the Bukidnon area, while Tedurays are in Maguindanao. The T’bolis live in South Cotabato, while the B’laans live on the eastern part of South Cotabato. The Obo and Obo Manobo tribes inhabit portions of North Cotabato, with the Obo Manobo tribe occupying the boundary of the river basin.

Fish sanctuaries

There are no known fish sanctuaries or marine protected areas inside the MRB. There are those found only adjacent to the provinces of Maguindanao, Sultan Kudarat and Davao del Sur. This includes Lasang-Banawan in Davao City which is the largest fish sanctuary with an area of 415 hectares; while Salaman Seagrass Sanctuary in Lebak, Sultan Kudarat have the least area of only 1 hectare.

Wetlands

There are two well-known wetlands in Mindanao, these are: the Agusan Marsh and the Liguasan Marsh. Liguasan Marsh, which spans the provinces of Sultan Kudarat, North Cotabato and Maguindanao, is the largest marsh in the Philippines having an area of 220,000 hectares. It is a collection of three marshes: Ligawasan, Libungan and Ebpanan; and home to the locals whose primary source of income are fishing when water levels are high, and agriculture when water levels are low. Also, Liguasan Marsh is rich in biodiversity. In fact, about 30,000 hectares of the marsh is a game refuge and bird sanctuary (PCHMB, 2009). Agusan Marsh, on the other hand, is as important as Liguasan Marsh. It is also rich in biodiversity and a home to the indigenous people in Agusan del Sur. It occupies about 90,000 hectares where 48.83% (43,954 hectares) of the area was declared as a wildlife sanctuary under the National Integrated Protected Areas System (NIPAS). Habitat fragmentation, environmental degradation, different kinds of erosion and sedimentation, unsustainable agricultural practices and land conversion, over-exploitation of resources, introduction of invasive alien species, are just some of the current challenges and threats to the health status of the marsh.

Critical Habitats

In February 23, 2011, the Biodiversity Management Bureau (BMB) issued DENR Administrative Order No. 2011-02 declaring an area of more or less 2 hectares in Sitio Kalanganan, Brgy. San Vicenter, Baungon, Bukidnon as a critical habitat for Rafflesia schadenbergiana.
Only three (3) classes of caves could be found in MRB, Lagbasan Cave in Sultan Kudarat classified as Class I; three sites for Class II, these are: Sumalsag Cave in Bukidnon, Catajay Cave in Sultan Kudarat and Puting Buhangin Cave in Agusan del Sur; Tinalon Cave in Sultan Kudarat is classified Class III.

5.1.4 Demographic Characteristics

Population

For the five year period from 2010 to 2015, there was an increase in the population in all the provinces in MRB with the highest increase of 183,695 in Davao del Sur. The lowest was in Agusan del Sur at 5,217. The province, with the least population, however, is Davao del Norte with only 93,827 in 2010 and 103,816 in 2015. Total population within the river basin in 2010 was 6,424,431, which swelled to 7,163,052 or an increase of 738,621 persons over the five-year period. Considering the MRB land area of 2,085,491 hectares, the population density is 3.43 persons/hectare for the year 2015. On the average, females have higher life expectancy at 70 years compared with males at 65 years.

5.1.5 Socio-economic Profile

Ethnic Groups

Mindanao has been known for its rich and diversified culture, as there are several indigenous communities within the region. They are called the Lumads. There are 18 major Lumad groups, namely: Subanen, B’laan, T’boli, Mandaya, Mansaka, Tiruray, Higaonon, Manobo, Bagobo, Bukidnon, Tagkaolo, Ubo, Banwaon, Kalagan, Dibabawon, Talaandig, Mamanwa and Manguangan (KAMP, 2002 as cited by Carino 2012). Some major Lumad tribes living within the river basin includes: B’laan, Kaulo, Higaonon, Mansaka, and Sangil (IPEACE Mindanao, 2010).

Literacy and Education

When it comes to literacy, an average of 464 out of 1000 individuals are literate in all the provinces inside MRB. Highest literacy rate is in Davao del Norte with 92.39%, followed by South Cotabato with 89.44%, the lowest is in Maguindanao with just 66.27%. The 2010 NSO data revealed that majority of the population in MRB are able to complete only elementary education indicating a very low educational level.

Poverty Incidence

In 2006, the poverty incidence in MRB is highest in Cotabato City where families with income of Php 7,459 are already considered poor. In 2015, however, highest poverty incidence shifted to Davao del Norte where families with income of Php 12,040 are already considered poor.

Average poverty incidence among families in provinces within MRB is 41.1% in 2015 a slight decrease from the 2012 level of 41.7%. Lowest poverty incidence among the provinces is lowest in 2009 where only 34.9% of the families inside MRB are rated as poor.
On a per province, the province of Davao del Sur has the lowest poverty incidence among population at 20.1% in 2015 while the highest level in Lanao del Sur at 74.3%. Highest average income for all income classes is Php 194,000 in Region XI, while the lowest is in ARMM with only Php 130,000.

**Human Development Index**

Highest index was obtained by the province of South Cotabato (0.612) while the lowest was in Maguindanao (0.3). Average HDI for the Mindanao River Basin is 0.47.

**Employment**

About 66 million of the Philippine population are considered as source of labor force and 94% are employed. In the regions that covers the MRB, an aggregate of 13 million of the labor force were from regions 10, 11, 12, CARAGA and ARMM. Labor participation rate in the Philippines is about 63% and the MRB provinces has about the same labor participation at 63%. Highest labor participation is contributed by Region 10 at 68% and lowest was contributed by the ARMM at 53%.

**Natural Resource Dependent Activities**

**Agriculture**

Major staple foods in the area are corn and rice. In 1990, corn is produced way higher than palay with a difference of 1,243,981 metric tons; however, there was a linear increase in palay production from 1990 to 2014; thus the difference was reduced to 61,640 metric tons. This could mean that there was a change of preference of staple food and/or an increase of demand in rice as the staple food in MRB.

Among other crops, banana is the most highly produced in the river basin with 4,884,239 metric tons, followed by sugarcane with 4,401,433 metric tons. The least produced is cacao with 2505.06 metric tons.

**Livestock and poultry production**

In terms of 2016 livestock production, goats exhibited the highest number at 626,930 heads followed by carabaos at 516,840 heads and lowest is cattle population at 388,263 heads. Highest number of goats are found in the province of Davao del Sur while carabaos are highest in the province of Maguindanao.

For the 2016 poultry production, the top three provinces that produces the highest chicken population are Bukidnon, South Cotabato and North Cotabato. In terms of duck production, the top three provinces that produces ducks are North Cotabato, Sultan Kudarat and South Cotabato.

**Fisheries**

The values of commercial fisheries increased from 2011 to 2013 but prices have slightly decreased in 2014 to 2015. Marine fisheries also have the same picture that of increasing from 2011 to 2013 and slightly decreased from 2014 to 2015. In 2015, highest value of commercial fishing activity was from the province of South Cotabato valued at PhP 19.6 M South Cotabato. The highest value of marine municipal fisheries was from the province of Lanao del Sur valued at PhP 1.2 M in 2015.
Forestry

In terms of lumber, the provinces of Davao del Norte, Davao del Sur, North Cotabato, Sultan Kudarat and Agusan del Sur have reported producing lumber in 2014. The province of Davao del Sur produces the highest volume of lumber at >120,000 cu. m. The highest lumber production was reported in January of 2014 and the lowest in December 2014. Another peak of production occurs during the month of April which coincides with the highest volume of logs produced within the province.

The only veneer producing regions within MRB are Region 11, Region 12 and Region 13. Region 13 produces the highest veneer at about 29,000 cubic meters in 2014. On the other hand, Region 12 produces the least veneer at around 2,000 cubic meters. Meanwhile, Region 11 has a total veneer production of about 8,000 cubic meters in 2014.

In terms of monthly plywood production in regions within MRB, November 2014 produced the most plywood at about 14,000 cubic meters, followed by about 13,500 cubic meters in July and 13,000 cubic meters in February.

Tourism

A total of 872 accommodation establishments are found in the different provinces within the MRB. These accommodation establishments have 1,841 rooms available for tourists and travelers. Of the total accommodation establishments, 865 are existing while 7 are under construction in 2014.

5.1.6 Infrastructure

Education facilities

A total of 4,895 elementary schools can be found in the different provinces within MRB. The highest number can be found in Lanao del Sur while the least is reported in Davao del Norte. Secondary schools on the other hand were reported to be 948 in number. Highest number was reported in North Cotabato at 188 and lowest in Sultan Kudarat at 59.

Health facilities

The province with the most barangay health stations is North Cotabato with a total number of 378 barangay health stations; the least is the city of Cotabato with 43 barangay health stations. When it comes to the ratio of the population per barangay health stations, Lanao del Sur got the lowest with a ratio of 11,973 people per barangay health station; the highest is North Cotabato with 3,503 people per barangay health station.

Roads and Bridges

A total of 397,906 meters of primary roads were constructed within the MRB. Secondary roads were measured to be around 522,637 meters. Tertiary roads found within the MRB have a total length of 550,511 meters. A total of 1,426 bridges are found in Regions X, XI, XII, and XIII.
**Dams**

A total of 84 dams can be found within the MRB. Most of the dams are located in North Cotabato and Bukidnon, numbering 25 and 21, respectively. Other provinces like Sultan Kudarat has 16 dams, South Cotabato has 13 dams and Maguindanao has 8 dams.

**Domestic Water Supply**

The province of South Cotabato has the most number of households that uses own use faucet community water system followed by the households from Bukidnon and third are those households from North Cotabato. Those using own use faucet community water system represent 26% of the total household population. About 16% and 13% of the households within MRB.

**Sanitation Facilities**

More than 44% of the households within the MRB have exclusive water sealed sewer septic tank. Recent data reveal that 73,914 households have no toilet facility in MRB.

**Waste Disposal**

The most prevalent garbage disposal within MRB is burning as represented by 36% of the household population. About 26% or 455,706 households are dependent on garbage trucks to pick up their garbage and another 18% are dumping their garbage in individual pits but not burned. Only 9% are utilizing their garbage as composting materials and 3% fed their garbage to animals.

**Internet Access**

There are 243,353 households within the MRB that have access to internet. Of these, about 70% are accessing the internet from elsewhere while 30% access the internet from home (approximately 72,000 households).

**Financial Institutions**

A total of 1,106 financial establishments have been established since 1994 until 2008.

5.1.7 **Stakeholder's Analysis**

**Upstream- North**

The site chosen for the northern upstream portion of the MRB was Valencia. A total of 37 participants attended the focus group discussion held on March 5, 2016, of which 32 were from the barangays, 3 from DENR, and 2 from the Central Mindanao University.

Stakeholders considered very important and with high influence are the different government agencies (NPC, NIA, DENR, NCIP, DAR, DPWH, DepEd and RTC), LGUs at the barangay, municipal and provincial levels, and the big business groups (such as the MNCs and water districts). Those deemed very important but with less influence are the transport groups, farmers and the MMT. These power dynamics already signify discrepancy in terms of involvement in decision-making processes. Religious organizations hold an important place in watershed/river basin concerns and with high influence, while the stakeholders recognized as important and with less influence are the resort owners, fishermen, timber poachers, quarry operators and NGOs.
Upstream- South

The sites chosen for the southern upstream part of the MRB were Lake Sebu and Surallah in South Cotabato. Thirty-two participants from the barangays of the two towns attended the participatory risk assessment, which was held on Feb. 18, 2016, in Barangay Lake Lahit, Lake Sebu.

Similar to the case of the northern upstream, the mediating institutions hold the very important with high influence position in the watershed or river basin. Specifically, those named were the DENR, LGUs (at different scales), DPWH, DSWD, DAR, NIA, NCIP, Department of Health (DOH), and PNP AFP. Although very important in the management and certain decision-makings in the watershed, the farmers/upland farmers and fisher folks were noted to have less influence. Stakeholders perceived as important and with high influence are the miners, MNCs and NGOs. It could be observed that both miners and MNCs are very influential in terms of financial or revenue aspect, while the NGOs have always been known to be visible and firm on their stand on social or development issues. Meanwhile, irrigator's association, resort owners, quarry operators, transport companies, local investors, and water districts are the stakeholders regarded as important but with less influence.

Upstream- East

The representative sites for the eastern upstream of MRB were Bagumbayan, Columbio and Tampakan from the province of South Cotabato. Unfortunately, participants from Tampakan were not able to come due to a conflict in schedule. The FGD was held at DENR R-12 Regional Center in Koronadal City, on March 1, 2016. It was attended by 30 participants.

In terms of power dynamics, government agencies (DA, DOH, DENR, NIA), LGUs, hydropower plant (operators), cooperatives and financial institutions were regarded as very important stakeholder with high influence. Based on their identified interests, these groups provide significant services to the people, including development and financial assistance, electrification, and production support. Those considered as very important players but with less influence are the academe, farmers (upland and lowland), irrigators' association and quarry operators. It was observed that most of them are user groups, with the exemption of the academe whose concern is perceived to be in technology transfer. Stakeholders deemed important and with high influence are the NGOs, Sagittarius Mines, Inc., Dole Philippines, business sector, MILF and DPWH. They belong to different categories of stakeholders, i.e., user groups, mediating institutions, and external economic interest group. It can be assumed that their huge influence comes from money, power to dictate development investments, visibility and firm stand on issues, ideologies, and, perhaps to some extent, arms and armaments. Meanwhile, fishermen, AVLDA and SODACO were identified as important groups with less influence.

Midstream

The sites chosen for the midstream part of the watershed were Pigkawayan, Pikit, Pagalungan and Datu Montawal. The participatory risk assessment was held in Kidapawan City, on March 3, 2016. More than 40 representatives from various barangays of the selected municipalities attended the event.

The power dynamics among stakeholders in the midstream of MRB saw the government agencies and big business groups, including fishermen and traders, holding very
important and highly influential position. Farmers were considered very important but will less influence. Transportation owners share the same situation with the farmers. Fish farmers, on the other hand, are deemed important and with high influence. The groups at the lowest level of the power ladder were the charcoal manufacturers, weavers, plantation owners, and resort owners, all of which have livelihood or income as their main interest in the watershed.

5.1.8 Land Capability Assessment

Soil Erosion Potential (SEP)

Almost three-fourth (73.3% or 1,528,521 hectares) of the river basin’s area was estimated to have a SEP within 0-5 tons/ha. On the other hand, 14.8% or 308,155 hectares has an SEP of 5-12 tons/ha, 1.5% or 32,279 hectares with 12-20 tons/ha, 7.9% or 164,595 hectares with 20-30 tons/ha, 51,170 hectares with 30-50 tons/ha and lastly 282 ha with 50-75 tons/ha.

There will be a gradual decrease and increase in the different SEP classes for the 2020 scenario. At the lowest class, the 0-5 SEP increased from 73.3 to 73.4% or an increase by 0.4% which represents a 5-ha increase from the current conditions (1,536,256 hectares). On the other hand, the area falling in the highest SEP class (50-75 tons/ha) has decreased by 0.5%.

Soil Erosion Index

For the current conditions, the 0-1 SEI is the largest SEI class that covers MRB (73.7% or 1,537,970.51 ha). Large portions of the provinces North Cotabato, Bukidnon, Maguindanao, Sultan Kudarat, South Cotabato and Shariff Kabunsuan fall in this SEI class. The next higher SEI class, 1-3 covers approximately 15.9% of MRB (331,412.10 ha). Again, significant areas of the provinces in the lower SEI class are also found in this SEI class indicating a low soil erosion rates in the aforementioned provinces. However, those in the highest SEI class (>5) constitute 8.3% or 172,065.69 ha. Big areas of Bukidnon (63,938.91 ha), North Cotabato (47,438.39 ha) and Sultan Kudarat (27,224.74 ha) are estimated to have high erosion rates.

In the 2020 scenario, the 0-1 SEI is still the largest SEI class that covers MRB (76.3% or 1,591,908.61 ha). The next SEI class (1-3) is predicted to decrease slightly at 13.3% (277,474.01 ha). Likewise, the highest SEI class (>5) is estimated to also decrease to 6.7% (139,901.29 ha). Similar provinces are found in the current and 2020 SEI class categories.

The 2050 scenario for SEI show a possible drop for SEI 0-1 at 74.0% (1,542,934.29 ha), an increase in areas falling in the 1-3 SEI class (15.7% or 326,448.33 ha) and a very slight drop in the highest SEI class (>5) which was 6.6% (137,231.90 ha).

Land Capability

The land capability zones output for the current rainfall scenario summarizes the basis for the allocation of lands. The unlimited production comprises half of the entire river basin, which is 54.8% or 1,142,433.45 hectares. Conversely, strict protection in MRB comprises 29.9%, which is about 623,699.7 hectares. Agroforestry production covers 9.6%; limited production is 0.8% while the production and protection buffer zones are 2.3% and 2.6, respectively or a total of 4.9% for the buffer zones.
The land capability classifications for the 2020 scenario relative to the current scenario do not appear to be significantly different. Unlimited Production zone has expanded by 1.1%. There is a 0.5% decrease for the area covered for the Strict Protection zones, resulting to 29.5% (613,628.3 hectares). Production subzones Agroforestry and Limited Production has decreased to 177,795.41 (8.5%) and increased to 25,911.3 hectares (1.2%), respectively. The buffer zones area did not have much significant change for the 2020 rainfall scenario.

Similarly, land capability zones for the 2050 rainfall scenario has minimal changes on the areas covered per zoning classification. Agroforestry Production Zone has the largest possible change at 1.4%. The Limited Production Zone had an increase by 0.3%. Two subzones Strict Protection and Unlimited Production Zones both decreased by 0.2% and 1.0%, respectively. The two buffer zones remained unchanged.

5.1.9 Policy Assessment

There are many Policy frameworks in the Philippines, notable of which are the MDGs (2005-2015), PDP (2011-2016), MSDF (2010-2020), SNAP (2009-2019), NCCA (2011-2028), PSSD (1999) and so on. The recent among these is the United Nation's Sustainable Development Goals, which arose from the Millennium Development Goals developed in 2000 (UNDP, 2016). All these frameworks have a common goal of improving quality of life thru poverty alleviation, sustainable development, capacity building, disaster risk reduction, and climate change adaptation. These frameworks basically evolved from the Water and environment summits and principles such as the Dublin Principle for water scarcity, Earth Summit in 1992, Agenda 21 and the adoption of IWRM by GWP whose main objective is to promote sustainable development of water resources at all levels and sectors.

5.1.10 Institutional setting

Every key government institutions from the national down to local levels play important roles in river basin management and development especially when it comes to combating climate change and its effects on the environment and community. While these agencies have different mandates and functions, they have pertinent roles to play in the implementation of the management and development strategies for the Mindanao River Basin.

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 river basin. In addition, there should be a coordinating body to facilitate delivery of goods and services by the stakeholders as well as provide mechanisms for conflict resolution among stakeholders.

Jurisdictional matters must also be addressed for a more lucid institutional arrangement. Setting straight the ambiguity or confusion with the policies is a necessary step towards policy coherence. To ensure a science-based decision-making and good governance among government institutions that will be responsible for the management and development of Mindanao River Basin, a River Basin Management Council (RMC) is proposed to be enhanced and strengthened as the governing body of the river basin. It shall formulate policies, approve plans, and provide oversight function on the implementation of the climate change mitigation and adaptation master plan. The approved policies, plans and programs of the RMC shall be adopted by all the members of the Council and the LGUs shall pass a resolution to formalize its adoption. The Council
will be responsible to resolve conflicts and generate resources for the implementation of the various river basin plans.

5.1.11 Vulnerability and Risk Assessment

Framework

Risk and vulnerability assessment is the qualitative and/or quantitative scientific estimation of risks and vulnerabilities. Risk is defined as the potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. It is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Vulnerability, on the other hand, is defined as the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt (IPCC 2014).

![Figure 3. Framework for the assessment of climate change impacts, adaptation, risks, and vulnerability (IPCC, 2014)](image)

Flood

In the baseline maps generated in this study, flood depths of 0 m to 3 m cover the majority of the vulnerable areas. However, small portions may have depths up to 6 m, e.g. near the area of Liguasan Marsh where clogging of channels due to water hyacinths had occurred. Areas like Cotabato City, Carmen, Bukidnon and areas near Pikit, Cotabato and Buluan River are vulnerable to flooding.

Comparing the floodplain maps generated for baseline, 2020 and 2050 conditions, it can be observed that there is no apparent difference in the extent of flooding in the Mindanao river basin. In the most upstream part of the basin, the areas which are flooded are located in Subbasin 7. The map shows a slight overflow of the river near Valencia City, Bukidnon where most of the residents are concentrated. The flooded area in Quezon, Bukidnon is upstream of the Pulangui Lake. Massive agricultural lands will be flooded in Quezon, Bukidnon. Also other affected areas will be Matalam, North Cotabato, Pagagawan, Maguindanao and Carmen, Cotabato. Just like in Quezon, Bukidnon, agricultural areas will be flooded in the aforementioned areas. As mentioned before, Carmen Cotabato has high exposure to erosion that caused additional flood in
the surrounding areas which could cause additional to the flood depths of 3m maximum that may occur in the area.

The city of Cotabato in Maguindanao province will be greatly affected if flooding occurs. The area is vulnerable to flood depths to at most 3m. The area of Pikit, Cotabato is near a water body—the Ligwasan Marsh, which experienced growth of water hyacinth that caused clogging in downstream portions of the river (Woodfields Consultants, Inc., 2008). This means that the general public residing in this area will be vulnerable to flooding.

For the 2020 and 2050 scenarios, there will be decreasing flood inundations in terms of its area for the 2 year return period. For the 10 year and 50 year period, however, there would be an increase of 2.76 and 11.92 sq.km in the 2020 scenario, respectively; in the 2050 scenario, there is a difference of 14.96 and 13.52 sq.km., respectively. In terms of depth, there is a decreasing trend both for the 2020 and 2050 scenarios in all of the return periods.

Table 1. Area of flooded regions for 2020 and 2050 climate change scenarios with respect to the current climate

<table>
<thead>
<tr>
<th>Return period</th>
<th>Area (sq.km)</th>
<th>Climate change scenario</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Current</td>
<td>2020</td>
<td>2050</td>
</tr>
<tr>
<td>2-year</td>
<td>990.27</td>
<td>985.75</td>
<td>975.24</td>
</tr>
<tr>
<td>10-year</td>
<td>1076.86</td>
<td>1079.63</td>
<td>1061.90</td>
</tr>
<tr>
<td>50-year</td>
<td>1127.42</td>
<td>1139.35</td>
<td>1113.90</td>
</tr>
</tbody>
</table>

Earthquake

Based from the conducted DSHA in Mindanao River Basin, the basin was affected by Davao River Fault, Mindanao Fault, Lanao Fault System, PFZ: Lianga Fault, Tangbulan Fault, Linugo River Fault, Cabanglasan Fault, Cotabato Trench, PFZ: Mati Fault, PFZ: Surigao Fault, Central Mindanao Fault, and MF: Daguma Extension, which were capable of producing a moment magnitude from a minimum of 6.3 to a maximum if 7.6. Mindanao Fault and MF: Daguma Extension were among the near faults that can produce highest moment magnitude of 7.6 and 7.5 respectively.

Earthquake-induced landslide

It is evident in the map as shown that the displacements are very small for the entire river basin except in some portions shown in red and yellow that have very large Newmark Displacements, which implies that these portions of the river basin will experience large cracking of the ground upon an earthquake occurrence (Jibson, 1993). The results of this study can be further verified by providing geotechnical investigations reports or exploring other methodologies.

Rain-induced Landslide

The steep slopes and the presence of splays of the Mindanao Fault (Daguma extension) and other similar structures skewed the high susceptibility zones only to areas closest to these fault lines. The rest of the basin is moderately (in the uplands) to minimally susceptible to mass wasting. The application of the AHP weights resulted in the
concentration of the highest landslide susceptibility zones closest to the fault zones where the rocks are most likely highly fractured.

**Water Availability**

While the water availability would not be a problem in the MRB overall, there will still be municipalities where water deficit problems are projected in the future. Specifically, Davao City and some municipalities in the river basin would expect to have water deficits by 2020 and 2050. It should be reiterated that the water demand and availability were estimated as annual totals and while there is an observed overall increase of annual water yield, water supply during the summer months (MAM) would likely decrease as consequence of less rainfall during the summer months. It is imperative, therefore, that water savings of excess rainfall during the rainy season be adopted to be used during the dry months. Moreover, water deficits in some areas can easily be remedied by sourcing water from adjacent areas. For example, irrigation dams are usually located in the uplands and may be used to supply the irrigation demand of several municipalities downstream. These aspects are not often reflected in the water availability computations.

**Participatory Risk and Vulnerability Assessment**

An overall evaluation of risk events was performed in MRB. 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). Using these values, the degree of likelihood and consequences for each risk event was averaged from the three FGD sites. Also, risk event that was relevant in one site only was taken out from the list, e.g., strong winds. Results showed that flood poses the highest risk in MRB, followed by drought, and landslide and soil/riverbank erosion (Table 2). Flood was assessed to be an extreme risk event, where immediate actions are required. On the other hand, drought and landslide fall under high-risk events, which calls for high priority control measures.
To reflect the sensitivity of the system, historical records of the occurrences or risk events (particularly flood) and corresponding damages were obtained from OCD and other secondary sources. The most serious flood events incurring billion(s) of pesos damages in agriculture happened during Typhoon Pablo (Bopha) in December 2012 and the continuous heavy rains that prevailed in Mindanao from 4-31 July (NDCC 2009). Both events have caused combined damages to agriculture and infrastructures reaching more than one billion pesos in the most affected province alone (Table 3). Thus, including the damages from other provinces from the same flood event would further increase the value.

Table 3. Recorded floods incurring the highest damages in MRB (Source: OCD).

<table>
<thead>
<tr>
<th>Date</th>
<th>Province</th>
<th>Rainfall Amount (mm)</th>
<th>Five-day Antecedent (mm)</th>
<th>Affected Population (Persons)</th>
<th>Damage to Agriculture (PhP, '000)</th>
<th>Damage to Infrastructure (PhP, '000)</th>
<th>Total Damages (PhP, '000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/06/12</td>
<td>Davao del Norte</td>
<td>64.8</td>
<td>64.0</td>
<td>2,810,058</td>
<td>768,269</td>
<td>3,578,327</td>
<td></td>
</tr>
<tr>
<td>07/25/09</td>
<td>Cotabato</td>
<td>46.0</td>
<td>75.0</td>
<td>137,029</td>
<td>1,028,900</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01/08/07</td>
<td>Agusan del Sur</td>
<td>33.8</td>
<td>45.4</td>
<td>21,574</td>
<td>27,831</td>
<td>38,592</td>
<td>664,230</td>
</tr>
<tr>
<td>01/19/13</td>
<td>Davao del Norte</td>
<td>47.8</td>
<td>112.4</td>
<td>387,147</td>
<td>98,069</td>
<td>486,002</td>
<td></td>
</tr>
<tr>
<td>12/16/03</td>
<td>Agusan del Sur</td>
<td>64.6</td>
<td>56.8</td>
<td>400,241</td>
<td>400,241</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02/12/06</td>
<td>Agusan del Sur</td>
<td>14.8</td>
<td>30.8</td>
<td>131,212</td>
<td>88,287</td>
<td>219,499</td>
<td></td>
</tr>
<tr>
<td>01/26/09</td>
<td>Cotabato</td>
<td>0.0</td>
<td>10.0</td>
<td>113,976</td>
<td>378,100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01/03/02</td>
<td>Agusan del Sur</td>
<td>55.0</td>
<td>40.1</td>
<td>371,060</td>
<td>117,771</td>
<td>488,831</td>
<td>312,370</td>
</tr>
<tr>
<td>04/26/08</td>
<td>Cotabato</td>
<td>26.0</td>
<td>76.0</td>
<td>25,398</td>
<td>25,398</td>
<td></td>
<td>288,000</td>
</tr>
<tr>
<td>04/09/08</td>
<td>Cotabato</td>
<td>38.0</td>
<td>26.0</td>
<td>78,785</td>
<td>78,785</td>
<td></td>
<td>196,544</td>
</tr>
</tbody>
</table>
Meanwhile, as of February 2016, the recent drought that hit Mindanao from third quarter of 2015 up to the first quarter of 2016 had an estimated damage worth PhP 800 M in Northern Mindanao alone (Bukidnon, Misamis Oriental and Misamis Occidental provinces). Corn was the most affected crop. In Bukidnon, out of the 33,554.37-ha agricultural areas affected, crops in 28,943.77 ha cannot no longer be salvaged (Mascarinas 2016). In North Cotabato, where the so-called “Kidapawan Massacre” happened, crop loss due to dry spell is estimated at almost PhP 1 B, while those destroyed due to rat infestation is valued at PhP 84.5 M (CHRP 2016).

The above figures on the cost of damages by floods and drought confirm the findings of the participatory risk assessment that livelihood, particularly agricultural production, is the most affected by risk events. The impacts on livelihood spill to other sectors of the society, causing migration, peace and order, health, and even more environmental problems (as locals resort more to unsustainable livelihood practices). In general, the sensitivity of MRB to the impacts of risk events can be attributed to high dependence of the population on primary industries, i.e., agriculture, for livelihood, amidst deteriorating watershed functions and services due to environmental degradation and siltation. This is also aggravated by the peace and order condition in the area.

Factors that influence the ability of a system to adapt, such as economic resources, awareness and information, technology, skilled labor, infrastructure, institutions and equity (Smit and Pilifosova 2001; Dumaru 2010), were used as measures for adaptive capacity. Based on the socio-economic profile of MRB, its Human Development Index is 0.47, with Maguindanao registering the lowest score at 0.3. This is way below the average Philippine score of 0.668 in 2014, and comparable to scores of countries in Africa (UNDP 2015).

MRB is a region with among the highest poverty incidence; for instance, Lanao del Sur records a very high poverty incidence at 74.3%. Literacy rate, which is also a measure of adaptive capacity, is low in some province, with Maguindanao scoring 66%. In terms of equity, farmers, who are likely the most affected stakeholders, consider themselves with high importance yet with low influence in terms of participating in watershed or river basin management.

The adaptive capacity of institutions, in general, can be rated moderate to high as their functions just usually shift to more “urgent” tasks during times of calamities, and budget is generally allocated, with easy access to DRRM funds. What is critical, however, is to operationalize the “river-basin” or integrated approach, and avoid the fragmented and “not in my backyard” attitude, especially among LGUs, to deliver more holistic adaptation measures that would bring equitable and greater benefits to all.

Adaptation measures recommended by the FGD participants to tackle impacts of flood involve both short-term and long-term strategies. The former highlights “response” actions when flood occurs, such as having evacuation centers and provision of rescue boat and other equipment. The latter consists of structural, green or vegetative, and soft approaches that could in the long run prevent or mitigate the occurrence of floods. These strategies are dredging, tree planting and review of policies (particularly on Protected Areas or PAs). All the proposed adaptation actions can be implemented within a 10-year period and are acceptable by the public. They just vary in terms of cost and effectiveness. Dredging would incur the highest expenditure, while the review of policies, the lowest. The review of policies and the preparation of evacuation centers are perceived to have moderate effectiveness, while the others are thought as highly effective.
Reducing the risks from landslide features taking advantage of services from ecosystems such as tree planting and promoting natural technologies such as the use of coco-matting. Both adaptations are regarded as highly effective and acceptable. It is, however, acknowledged that tree planting would take long time before its benefits are realized. At times, tree planting also relies on major additional funding from external sources.

Drought directly affects the livelihood of the people, particularly those engaged in agriculture. It is not surprising that adaptations proposed relate to NIA improving their irrigation service, either through deep well or water impounding system. Provision of alternative livelihood is also emphasized. Both strategies can be performed within a period of 10 years, although might require a lot of funds. They nonetheless are deemed highly effective and acceptable.
6 DEVELOPMENT AND MANAGEMENT PLAN

6.1 Major Issues and Concerns

The development of plans and programs for the Mindanao River Basin is highly relevant to the ecological and economic development of the country and the Mindanao Region in particular. By integrating the present status and conditions of the river basin, and incorporating the projected climate changes, various issues and challenges were determined. In general, major issues and concerns are listed as the following:

a. Water shortage,
b. Water quality degradation,
c. Watershed degradation,
d. Reduced wetland productivity,
e. Drought,
f. Flood,
g. Landslide,
h. Poverty, and
i. Inadequate institutional mechanisms to promote integrated and coordinated basin-wide inclusive environmental and socioeconomic development

6.2 Vision and Goal

6.2.1 Vision

The development vision, and goals for the Mindanao River Basin, was crafted from the vision and goals of the previous Mindanao River Basin Master Plan back in 2012. With new challenges particularly with changing climate and river basin management, different stakeholders from the government and private organizations were convened to revisit the original vision, mission and goals and to develop a more responsive and relevant vision.

The vision for MRB in the original Master Plan states: “A Mindanao River Basin that is a sustainable area of peace and development where all stakeholders, striving as active collaborators and competent stewards of the Almighty Creator, adhere to the judicious use of its natural resources to enjoy non-discriminatory socio-economic growth, human development and ecological balance that is inclusive for all and without aggression to anyone or anything.”

In the recently held Inter-agency Focus Group in Malaybalay, Bukidnon, the stakeholders agreed to revise the vision as follows:

“A Mindanao River Basin that is climate change-resilient towards peace and sustainable development for all.”

The statement highlighted the need of having a climate-resilient river basin with the different stakeholders working together for the improvement not only of the environment but also of the people themselves particularly emphasizing peace which has been very elusive in many parts of the MRB and has adversely affected the sustainable development and even environmental stability of the region. The vision, then, not only focuses on climate resiliency but also on peace, ecological stability and sustainable development.
6.2.2 Goal

The previous MRB Master Plan also already formulated its goal stated as follows:

"Ensure a focused, comprehensive and integrated development and management of the Mindanao River Basin that would prevent, mitigate and protect its inhabitants and stakeholders from any calamities and disaster risks, and facilitate the attainment of sustainable development."

However, during the focus group, the representatives of the different institutions agreed to simplify it into:

"Ensure a comprehensive and integrated development and management of the Mindanao River Basin that will protect its stakeholders and communities."

6.2.3 Thematic Goals

To ensure the effectivity of the goal, it needs to be holistic in its approach; thus, the stakeholders adopted the thematic goals from the previous MRB Master Plan:

- a. Sustainable management of watersheds focused on its protection and restoration and rehabilitation
- b. Strengthen management and development of water resources
- c. Sustainable development of the wetlands through policy and management interventions
- d. Reduction of the rate of erosion and siltation along the major river systems
- e. Strengthened floods and other disaster risk management through increased cooperation and partnership with local government units and other stakeholders towards building safe and resilient communities
- f. Enhancing social protection measures and developing human capacities
- g. Ensuring economic growth and prosperity through the sustainable use, development and stewardship of all Basin resources—land, air, water, forest and all its life forms.
- h. Institutionalization of MRB-focused basin-level river basin organization.

In essence, MRB has the following goals for the different themes:

Table 4. Thematic Goals of MRB

<table>
<thead>
<tr>
<th>Theme</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water Resources</strong></td>
<td>Strengthen management and development of water resources.</td>
</tr>
<tr>
<td><strong>Watershed Management</strong></td>
<td>Sustainable management of watershed, protection and restoration, and rehabilitation.</td>
</tr>
<tr>
<td><strong>Wetland Management</strong></td>
<td>Sustainable development of the wetlands through policy and management interventions.</td>
</tr>
<tr>
<td><strong>Flood and Disaster Risk Management</strong></td>
<td>Strengthened flood and disaster risk management through increased cooperation and partnership with local government units and other stakeholders towards building safe and resilient communities.</td>
</tr>
<tr>
<td><strong>Socioeconomics</strong></td>
<td>Ensuring economic growth and prosperity</td>
</tr>
</tbody>
</table>
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 sustainable river basin ecosystem management. Figure 4 shows the four principal frameworks and development strategies: Integrated Water Resources Management, Integrated Watershed Management, Wetland Management, and Flood Mitigation.

1. Integrated Water Resources Management – manages fresh water as an economic and public good while recognizing its vulnerability and limited supply.
2. Integrated Watershed Management – organizes land, people, and other resources in the watershed to provide goods and services without harming the soil and water.
3. Wetland Management – manages areas that are submerged or soaked by enough surface or groundwater to support ecosystems such as mangroves, coral reefs, swamps, rice paddies, estuaries, lakes and reservoirs
4. Flood Mitigation – protects and enhances coping capacities of communities and the environment against water-induced hazards
6.4 Thematic Challenges

Integrating the present status and conditions of the river basin, and incorporating the projected climate changes, various issues and challenges were determined. In general, major issues and concerns are listed as the following:

a. Water shortage,
b. Water quality degradation,
c. Watershed degradation,
d. Reduced wetland productivity,
e. Drought,
f. Flood,
g. Landslide,
h. Poverty, and
i. Inadequate institutional mechanisms to promote integrated and coordinated basin-wide inclusive environmental and socioeconomic development

6.5 Implementation Plan

The implementation plan recommends relevant programs and projects for the Mindanao River Basin. These were crafted based on the conditions, issues and problems that are currently affecting the river basin. In addition, the suggested programs and projects aim to make the river basin climate-resilient. Six thematic areas are taken into consideration, the water resources management, the watershed management, wetland management, economic management, disaster risk reduction management and institutional management. Table 5 summarizes the implementation plan.

Table 5. MRB Implementation plan

<table>
<thead>
<tr>
<th>Thematic Area</th>
<th>Objective</th>
<th>Strategy</th>
<th>Program</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Resources</td>
<td>To promote sufficiency of water supply for irrigation, domestic and other uses</td>
<td>Enhancement of water supply system to capture excess water and improve the efficiency and equitability of water supply distribution system</td>
<td>Rehabilitation of Existing and Development of New Water Sources and Supply Infrastructure Program</td>
<td>Strategic Irrigation Development for the Mindanao River Basin (MRB)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Development of Water Impounding Infrastructures in Identified Potential Dam Sites</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Development of Rainwater Harvesting Systems Project</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Protection of major aquifers and critical Ground Water recharge areas</td>
<td></td>
<td>Groundwater Management and Protection for Mindanao River Basin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sustainable spring discharge</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Sustainable water well supply/production and riparian flow.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>To enhance the quality of water</td>
<td>Promotion of soil conservation practices</td>
<td>Restoration and Conservation of Soil Program</td>
<td>Forest Landscape Restoration Project</td>
</tr>
<tr>
<td>Thematic Area</td>
<td>Objective</td>
<td>Strategy</td>
<td>Program</td>
<td>Project</td>
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</tr>
<tr>
<td>resources</td>
<td>Restoration of watershed degraded areas</td>
<td>Monitoring and Evaluation of Land use to Reduce Non-Conforming Uses</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improvement of land use practices</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Improve management of solid waste, waste water and agricultural wastes</td>
<td>Improvement and Monitoring of Water Quality Program</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Monitoring and Evaluation of Land use to Reduce Non-Conforming Uses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Watershed Management</td>
<td>Improve the sustainability of forest, land, soil, biodiversity and other resources including ecosystem services</td>
<td>Improvement of land use practices</td>
<td>Harmonization of Plans</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enhancement of forest cover</td>
<td>Environmental Restoration Program</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Improvement of forest protection and conservation</td>
<td>Enhanced Soil Erosion Implementation Project</td>
<td></td>
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</tr>
<tr>
<td>Wetland Management</td>
<td>Improve wetland productivity</td>
<td>Reduce siltation from erosive land uses (i.e., mining, unsustainable agricultural practices, poor road construction &amp; maintenance)</td>
<td>Restoration and Conservation of Watershed Wetland Resource</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reduce pollution coming from commercial agricultural areas</td>
<td>Agricultural Waste Management and Monitoring Project</td>
<td></td>
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<tr>
<td></td>
<td>Improvement and monitoring of water quality</td>
<td>Comprehensive Research and Development Program on Wetlands</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>To improve knowledge and understanding on wetland ecosystems</td>
<td>Conduct of scientific studies as inputs to wetland management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thematic Area</td>
<td>Objective</td>
<td>Strategy</td>
<td>Program</td>
<td>Project</td>
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<tr>
<td></td>
<td></td>
<td>Enhancement of skills and competence of labor force</td>
<td>Sustainable Livelihood Program</td>
<td>TESDA initiated education, training and Livelihood Development Project</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Provision and Enhancement of Livelihood activities</td>
<td>Expansion of Pantawid Pamilyang Pilipino Program (4Ps)</td>
<td>Payment for Ecosystems Services (PES)</td>
</tr>
<tr>
<td></td>
<td>Eliminate peace and order issues in the region</td>
<td></td>
<td></td>
<td>Renewable Energy Project</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Establishment of War Neutral Zones Project</td>
</tr>
<tr>
<td>Disaster Risk Reduction and Management</td>
<td>To reduce risks and vulnerabilities associated with floods</td>
<td>Promote soil conservation practices</td>
<td>Restoration and Conservation of Watershed Wetland Resource</td>
<td>Forest Landscape Restoration and Rehabilitation Project</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Restoration of watershed degraded areas</td>
<td></td>
<td>Slope stabilization/Soil and water conservation</td>
</tr>
<tr>
<td></td>
<td>To reduce risks and vulnerabilities associated with landslides</td>
<td>Enhancement of resiliency and adaptive capacity of landslide prone areas</td>
<td>Disaster Risk Reduction and Management Program</td>
<td>Design and construction of climate change-ready flood control structures</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Early Warning and Flood Forecasting System</td>
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<td></td>
<td></td>
<td>Acquire necessary equipment and facilities on rescue/response to support LGUs in managing disaster emergency</td>
</tr>
<tr>
<td></td>
<td>To reduce risks and vulnerabilities associated with droughts</td>
<td>Enhancement of resiliency and adaptive capacity of drought prone areas</td>
<td></td>
<td>Basin-wide Risk Assessment and Monitoring Project</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Early Warning and Landslide Forecasting System</td>
</tr>
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<td></td>
<td>Enhancing Climate Resiliency of Farmers</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Drought Mitigation Measures</td>
</tr>
</tbody>
</table>
### Thematic Area

<table>
<thead>
<tr>
<th>Objective</th>
<th>Strategy</th>
<th>Program</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>with droughts</td>
<td>Development of framework and mechanisms</td>
<td>Capacity Development Program</td>
<td>Strengthening of River Basin Organizations and Institutional Linkages</td>
</tr>
<tr>
<td>To promote the integration of plans and programs of various agencies and Local Government Units</td>
<td>Gender Development Program</td>
<td>Organizational development and Capacity Building of existing women, elderly and youth groups</td>
<td></td>
</tr>
<tr>
<td>Communication Plan</td>
<td></td>
<td>Information Education and Communication campaign on gender roles in RB management for climate resiliency</td>
<td></td>
</tr>
</tbody>
</table>

### 6.6 Investment Plan

The total investment requirement of the Plan over a 15-year period is 91.532 billion. The new Master Plan has six major program components, namely Water Resources, Watershed Management, Wetland Management, Economic Development, Disaster Risk Reduction Management, and Institutional Management Programs and Projects. The programs and projects were designed based on the assessment findings and in consultation with the various stakeholders of Mindanao River Basin.

Among the six programs, the Economic Development has the highest investment requirement at among the six programs at PhP 38.097 billion (42% of total). This is followed by Watershed Management programs and projects at PhP 27.659 billion (30%), Disaster Risk Reduction and Management at PhP 20.154 billion (22%), Water Resources Management at PhP 5.455 billion (6%), Wetland Management at PhP 120.118 million (0.1%), and Institutional Management at PhP 46 million (0.05%).
Table 6. Total Cost of the Updated Programs/Projects for the Climate-responsive Integrated River Basin Management and Development Plan for the Mindanao River Basin

<table>
<thead>
<tr>
<th>PROGRAMS/PROJECTS</th>
<th>Total Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WATER RESOURCES</strong></td>
<td></td>
</tr>
<tr>
<td>Rehabilitation of Existing and Development of New Water Sources and Supply Infrastructure Program</td>
<td></td>
</tr>
<tr>
<td>Development of Water Impounding Infrastructures in Identified Potential Dam Sites</td>
<td>1,460,000,000.00</td>
</tr>
<tr>
<td>Strategic Irrigation Development for the Mindanao River Basin (MRB)</td>
<td>2,455,000,000.43</td>
</tr>
<tr>
<td><strong>Improvement and Monitoring of Water Quality Program</strong></td>
<td></td>
</tr>
<tr>
<td>Establishment of water quality monitoring system</td>
<td>400,000,000.00</td>
</tr>
<tr>
<td>Development of Water Supply Systems and Sanitation Facilities</td>
<td>1,460,000,000.00</td>
</tr>
<tr>
<td><strong>Restoration and Conservation of Soil Program</strong></td>
<td></td>
</tr>
<tr>
<td>Forest Landscape Restoration Project</td>
<td>-</td>
</tr>
<tr>
<td>Monitoring and Evaluation of Land use to Reduce Non-Conforming Uses</td>
<td>900,000.00</td>
</tr>
<tr>
<td>Development of Rainwater Harvesting Systems Project</td>
<td>15,000,000.00</td>
</tr>
<tr>
<td>Groundwater Management and Protection for Mindanao River Basin</td>
<td>25,000,000.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>5,815,900,000.43</td>
</tr>
<tr>
<td><strong>WATERSHED RESOURCES</strong></td>
<td></td>
</tr>
<tr>
<td>Environmental Restoration Program</td>
<td></td>
</tr>
<tr>
<td>Forest Landscape Restoration</td>
<td>23,659,016,850.00</td>
</tr>
<tr>
<td>Enhanced Soil Erosion Implementation Project</td>
<td>1,200,000,000.00</td>
</tr>
<tr>
<td>Forest Biodiversity Monitoring and Assessment Project</td>
<td>20,000,000.00</td>
</tr>
<tr>
<td>Renewable Energy Project</td>
<td>2,720,020,000.00</td>
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<tr>
<td><strong>Harmonization of Plans</strong></td>
<td></td>
</tr>
<tr>
<td>Cultural Impact Assessment (CIA) for Mindanao River Basin</td>
<td>30,000,000.00</td>
</tr>
<tr>
<td>Enhancing Indigenous People’s Well-being through Culturally-Sensitive Development Projects in Ancestral Domains</td>
<td>-</td>
</tr>
<tr>
<td>Strengthening LGUs and Government Agency Relations for Forest Protection laws and plans</td>
<td>30,000,000.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>27,659,036,850.00</td>
</tr>
<tr>
<td><strong>WETLAND RESOURCES</strong></td>
<td></td>
</tr>
<tr>
<td>Comprehensive Research and Development Program on Wetlands</td>
<td></td>
</tr>
<tr>
<td>Wetland Biodiversity Research, Assessment, Mapping, and Monitoring</td>
<td>20,000,000.00</td>
</tr>
<tr>
<td><strong>Restoration and Conservation of Watershed Wetland Resource</strong></td>
<td></td>
</tr>
<tr>
<td>Forest Landscape Restoration and Rehabilitation Project</td>
<td>-</td>
</tr>
<tr>
<td>Restoration and Rehabilitation of Wetlands</td>
<td>118,750.00</td>
</tr>
<tr>
<td>Agricultural Waste Management and Monitoring Project</td>
<td>80,000,000.00</td>
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</tbody>
</table>
### CLIMATE RESPONSIVE INTEGRATED MASTER PLAN FOR MINDANAO RIVER BASIN

#### Programs/Projects

<table>
<thead>
<tr>
<th>Programs/Projects</th>
<th>Total Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td><strong>100,118,750.00</strong></td>
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<tr>
<td><strong>Economic Management</strong></td>
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<tr>
<td>Sustainable Livelihood Program</td>
<td></td>
</tr>
<tr>
<td>Payment for Ecosystems Services (PES)</td>
<td>30,500,000.00</td>
</tr>
<tr>
<td>Expansion of Pantawid Pamilyang Pilipino Program (4Ps)</td>
<td>38,000,000,000.00</td>
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<tr>
<td>TESDA initiated education, training and Livelihood Development Project</td>
<td>30,000,000.00</td>
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<td><strong>Total</strong></td>
<td><strong>38,097,025,000.00</strong></td>
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<tr>
<td><strong>Disaster Risk Reduction and Management</strong></td>
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</tr>
<tr>
<td>Disaster Risk Reduction and Management Program</td>
<td></td>
</tr>
<tr>
<td>Early Warning and Flood Forecasting System</td>
<td>870,000,000.00</td>
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<tr>
<td>Early Warning and Landslide Forecasting System</td>
<td>30,000,000.00</td>
</tr>
<tr>
<td>Acquire necessary equipment and facilities on rescue/response to support LGUs in managing disaster emergency</td>
<td>544,000,000.00</td>
</tr>
<tr>
<td>Drought Mitigation Measures</td>
<td>8,500,000,000.00</td>
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<tr>
<td>Design and construction of climate change-ready flood control structures</td>
<td>3,800,000,000.00</td>
</tr>
<tr>
<td>Basin-wide Risk Assessment and Monitoring Project</td>
<td>650,000,000.00</td>
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<td>Enhancing Climate Resiliency of Farmers</td>
<td>900,000,000.00</td>
</tr>
<tr>
<td>Restoration and Conservation of Watershed Wetland Resource</td>
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</tr>
<tr>
<td>Forest Landscape Restoration and Rehabilitation Project</td>
<td>-</td>
</tr>
<tr>
<td>Slope stabilization/Soil and water conservation</td>
<td>4,860,000,000.00</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>20,154,000,000.00</strong></td>
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<tr>
<td><strong>Institutional Management</strong></td>
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</tr>
<tr>
<td>Capacity Development Program</td>
<td></td>
</tr>
<tr>
<td>Strengthening of River Basin Organizations and Institutional Linkages</td>
<td>10,000,000.00</td>
</tr>
<tr>
<td>Gender Development Program</td>
<td></td>
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<td>Organizational development and Capacity Building of existing women, elderly and youth groups</td>
<td>6,000,000.00</td>
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<tr>
<td>Information Education and Communication campaign on gender roles in RB management for climate resiliency</td>
<td>3,000,000.00</td>
</tr>
<tr>
<td>Mindanao River Basin Master Plan Caravan/Roadshow Project</td>
<td>27,000,000.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>46,000,000.00</strong></td>
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<tr>
<td><strong>Grand Total</strong></td>
<td><strong>91,872,080,600.43</strong></td>
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</table>
7 References


Woodfields Consultants Inc (June 2012) *Mindanao River Basin Integrated Management and Development Master Plan*. Department Of Environment And Natural Resources (DENR), River Basin Control Office (RBCO), Mindanao Development Authority (MinDA) And Office Of Civil Defense (OCD).