

## **G. SPECIAL STUDY AREAS**

### **G1. CLIMATE CHANGE ADAPTATION AND DISASTER RISK REDUCTION AND MANAGEMENT**

The goal of incorporating climate change adaptation and mitigation and disaster risk reduction into the CLUP is to be able to regulate and control physical development, to reduce casualties and damage from discrete hazard events as well as minimize the negative impacts of slow-onset hazard events. Policies and spatial strategies in the CLUP and Zoning Ordinance should be able to achieve the following:

- Prevent future development in areas highly susceptible to hazards where possible;
- Keep land use intensity, buildings value, and occupancy to a minimum in areas where development cannot be prevented;
- Encourage risk mitigation through proper urban design, site planning, and building design in areas where the above strategies are not viable and development occurs;
- Protect life and existing development from losses;
- Conserve protective environmental systems; and
- Prevent future development from creating conditions that contribute to risk.

#### **Climate and Disaster Risk Assessment**

Risk assessment is a process which involves identifying the nature and behavior of the hazards the city/municipality is exposed to; identifying what elements are at risk to these hazards and why they are at risk; estimation of potential damages and losses as a result of a hazard event; and evaluation of risk levels to determine the possible strategies to manage or reduce the risk. Climate change is considered through its impact (particularly its effect on the frequency and magnitude) on climate hazards such as floods, rain-induced landslide, and droughts.

#### **Climate Change Vulnerability Assessment**

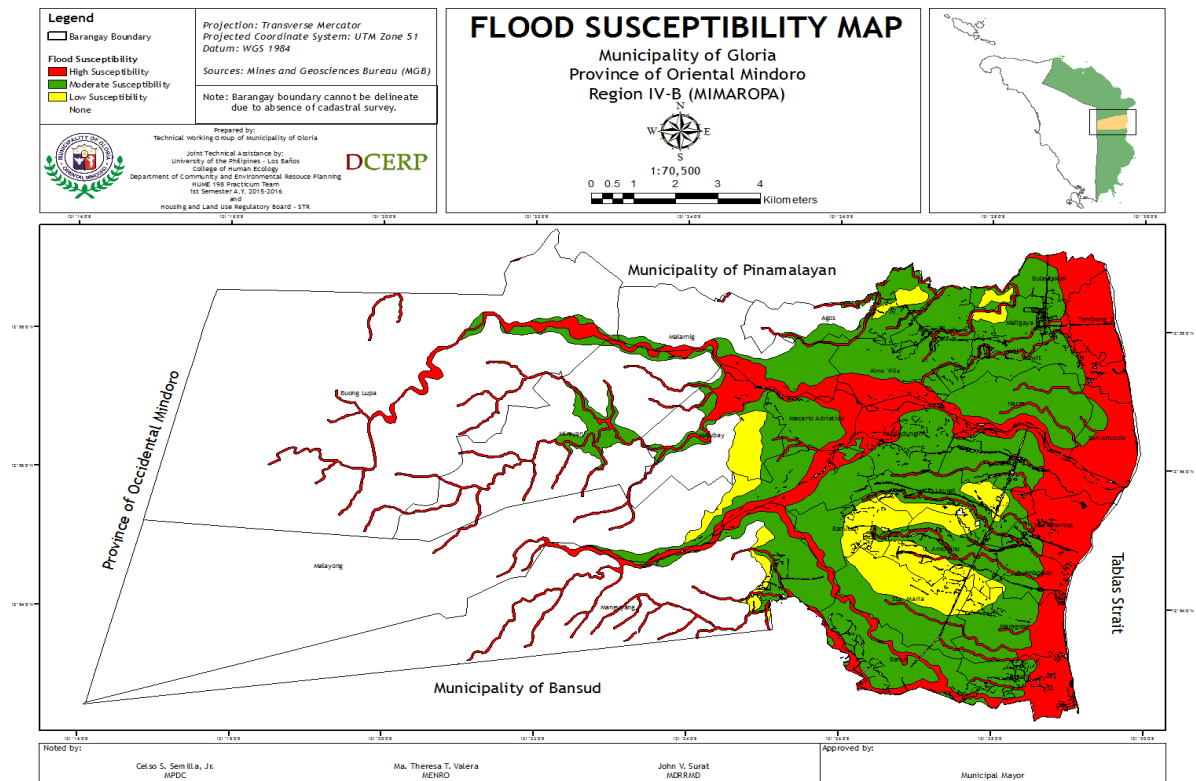
Vulnerability assessment is a process of examining the degree to which a system is susceptible to, and unable to cope with adverse effects of climate change. It involves determining the nature and degree to which a system is exposed to climate variations (exposure), the degree to which it is affected adversely or beneficially (sensitivity), and the ability of the system to adjust to climate change (adaptive capacity).

There are three (3) type of hazards declared in the municipality, flooding, landslide and storm surge. Newly constructed evacuation centers, all elementary schools, selected churches and barangay halls/multi-purpose hall in the municipality are designated as evacuation sites.

Table CL- 4. Potentially Affected Population in Hazard Areas

Barangay	Type of Hazard [Flooding]					
	High Susceptibility		Moderate Susceptibility		Low Susceptibility	
	No. of Persons	No. of HH	No. of Persons	No. of HH	No. of Persons	No. of HH
Agsalin	0	0	0	0	678	178
Agos	0	0	0	0	1,036	239
Alma Villa	0	0	1411	335	0	0
Andres Bonifacio	0	0	0	0	1,320	320
Balete	0	0	2,864	628	0	0
Banus	0	0	2,298	499	0	0
Banutan	0	0	906	223	0	0
Buong Lupa	0	0	969	227	0	0
Bulaklakan	0	0	1,126	231	0	0
Gaudencio Antonino	0	0	0	0	1,651	391
Guimbonan	0	0	1104	278	0	0
Kawit	0	0	2,022	493	0	0
Lucio Laurel	0	0	0	0	2,649	578
Macario Adriatico	0	0	0	0	1,139	248
Malamig	0	0	0	0	2,929	624
Malayong	0	0	1,228	268	0	0
Maligaya (Pob.)	0	0	3,246	731	0	0
Malubay	0	0	1,319	290	0	0
Manguyang	0	0	0	0	1,633	399
Maragooc	0	0	1,258	316	0	0
Mirayan	0	0	0	0	938	227
Narra	0	0	2169	549	0	0
Papandungin	0	1110	0	0	0	0
San Antonio	0	1330	0	0	0	0
Santa Maria	0	0	0	0	2,034	488
Santa Theresa	0	0	1,523	344	0	0
Tambong	0	3183	0	0	0	0

All barangays have observed and experienced flooding, the most high susceptible barangay in flooding is Brgy. Tambong with 3,138 individuals expected to be affected while Barangay Agsalin has the lowest number of individuals-678 affected by floods. Though schools are most commonly used evacuation site, some schools are high risk to flooding; Manuel Sadiwa Memorial Elementray School in Guimbonan, Kawit Elementary School, Gloria Central School, Langgang Elementary School in Sta. Theresa and Tambong Elementary School; this means that all of the said school is incapable of sheltering the residents in the near future. On the other hand, the safest barangay in the municipality in case flooding occurs is Brgy. Malubay since their barangay hall, churches and health center are situated on the higher ground. 5.9864 hectares (3.42%) of the residential areas of the municipality are not susceptible to flood; 19.9844 hectares (11.40%) are susceptible to low flood; 106.6981 hectares (60.87%) are susceptible to moderate flood; 42.6224 hectares (24.32%) are susceptible to high flood. Thirty five percent or 0.1283 hectares of the commercial areas of the municipality are not susceptible to flood while 1.7783 hectares (4.90%) are susceptible to low flood; 17.2004 hectares (47.43%) are susceptible to moderate flood; 17.1561 hectares (47.31%) are susceptible to high flood



More than thirteen kilometers (13.515) of the national road are not susceptible to flood; 0.415 kilometers are susceptible to low flood; 5.45 kilometers are susceptible to moderate flood and 0.524 kilometers are susceptible to high flood. Almost forty four (44.723) kilometers of the provincial and municipal roads are not susceptible to flood; 11.954 kilometers are susceptible to low flood; 60.88 kilometers are susceptible to moderate flood and 39.273 kilometers are susceptible to high flood.

Type of Hazard [ <b>LANDSLIDE</b> ]						
Barangay	High Susceptibility		Moderate Susceptibility		Low Susceptibility	
	No. of Persons	No. of HH	No. of Persons	No. of HH	No. of Persons	No. of HH
Agsalin	0	0	0	0	678	178
Agos	0	0	0	0	1,036	239
Alma Villa	0	0	0	0	1411	335
Andres						
Bonifacio	0	0	0	0	1,320	320
Balete	0	0	0	0	2864	628
Banus	0	0	0	0	2298	499
Banutan	0	0	0	0	906	223
Buong Lupa	0	0	969	227	0	0
Bulaklakan	0	0	0	0	1126	231
Gaudencio						
Antonino	0	0	0	0	1,651	391
Guimbonan	0	0	0	0	1104	278
Kawit	0	0	0	0	2022	493
Lucio Laurel	0	0	0	0	2,649	578
Macario						
Adriatico	0	0	1139	248	0	0
Malamig	0	0	0	0	2,929	624
Malayong	0	0	0	0	1228	268
Maligaya (Pob.)	0	0	0	0	3246	731
Malubay	0	0	0	0	1319	290
Manguyang	0	0	1633	399	0	0
Maragooc	0	0	0	0	1258	316
Mirayan	0	0	938	227	0	0
Narra	0	0	0	0	2169	549
Papandungin	0	0	0	0	1110	269
San Antonio	0	0	0	0	1330	315
Santa Maria	0	0	0	0	2,034	488
Santa Theresa	0	0	0	0	1523	344
Tambong	0	3183	0	0	0	0

In terms of landslide, Brgy. Manguyang has the most number of persons to be affected meanwhile, barangays (Buong Lupa, Malamig, Malayong, Malubay, and Mirayan) that are situated on the mountains have experienced rain induced landslide. More than ninety nine percent or 175.2356 hectares of the residential areas of the municipality are susceptible to low landslide while 0.00557 hectares (0.033%) are susceptible to moderate landslide.

National road that is susceptible to low landslide is about 0.415 kilometers, a total of 155.962 kilometers of the provincial and municipal roads are susceptible to landslide while 1.832 kilometers are susceptible to moderate landslide, an estimated ₱18,320,000 are the exposed value of roads susceptible to landslide

Type of Hazard [ <b>STORM SURGE</b> ]						
Barangay	High Susceptibility		Moderate Susceptibility		Low Susceptibility	
	No. of Persons	No. of HH	No. of Persons	No. of HH	No. of Persons	No. of HH
Agsalin	0	678	0	0	0	0
Agos	0	0	0	0	0	0
Alma Villa	0	0	0	0	0	0
A. Bonifacio	0	0	0	0	0	0
Balete	0	2864	0	0	0	0
Banus	0	0	0	0	0	0
Banutan	0	0	0	0	0	0
Buong Lupa	0	0	0	0	0	0
Bulaklakan	0	0	0	0	0	0
G. Antonino	0	0	0	0	0	0
Guimbonan	0	1104	0	0	0	0
Kawit	0	2022	0	0	0	0
Lucio Laurel	0	0	0	0	0	0
M. Adriatico	0	0	0	0	0	0
Malamig	0	0	0	0	0	0
Malayong	0	0	0	0	0	0
Maligaya (Pob.)	0	0	0	0	0	0
Malubay	0	0	0	0	0	0
Manguyang	0	0	0	0	0	0
Maragooc	0	1258	0	0	0	0
Mirayan	0	0	0	0	0	0
Narra	0	0	0	0	0	0
Papandungin	0	0	0	0	0	0
San Antonio	0	1330	0	0	0	0
Santa Maria	0	0	0	0	0	0
Santa Theresa	0	1523	0	0	0	0
Tambong	0	3183	0	0	0	0

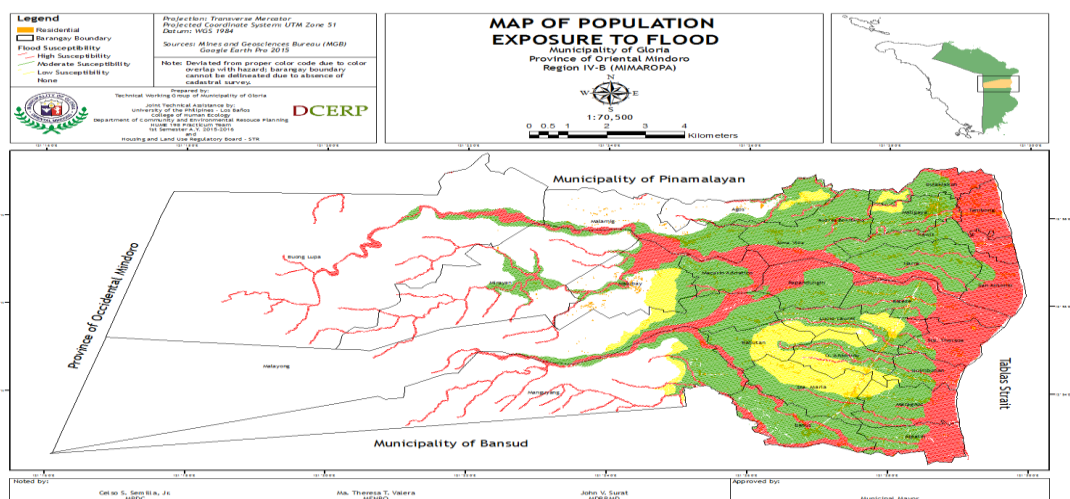
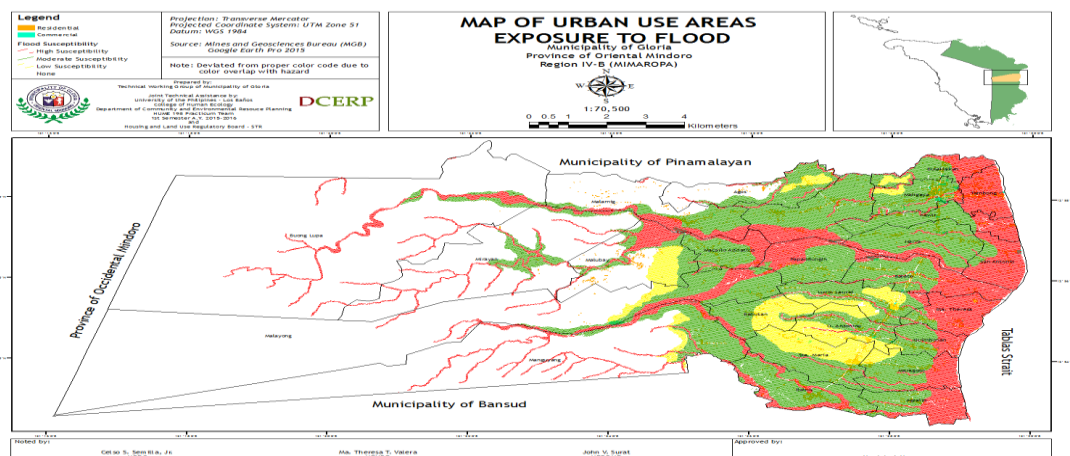
Eight coastal barangays (Tambong, Kawit, San Antonio, Balete, Sta. Theresa, Guimbonan, Maragooc and Agsalin) have seen changes on sea level rise and experienced storm surge. All barangays in the municipality have experienced drought.

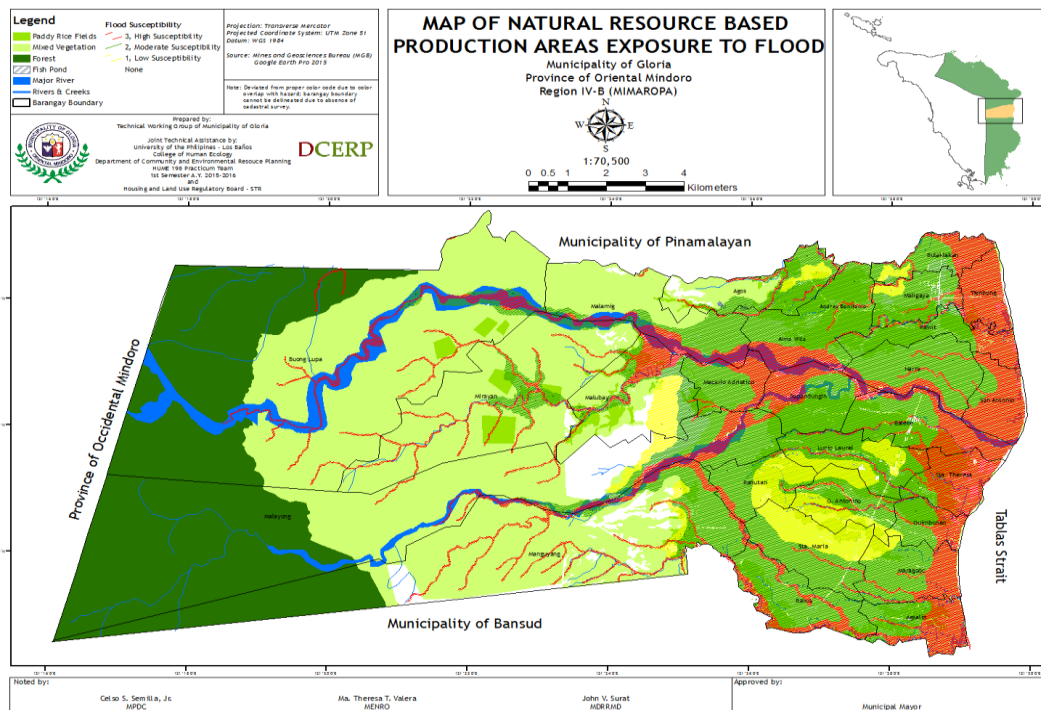
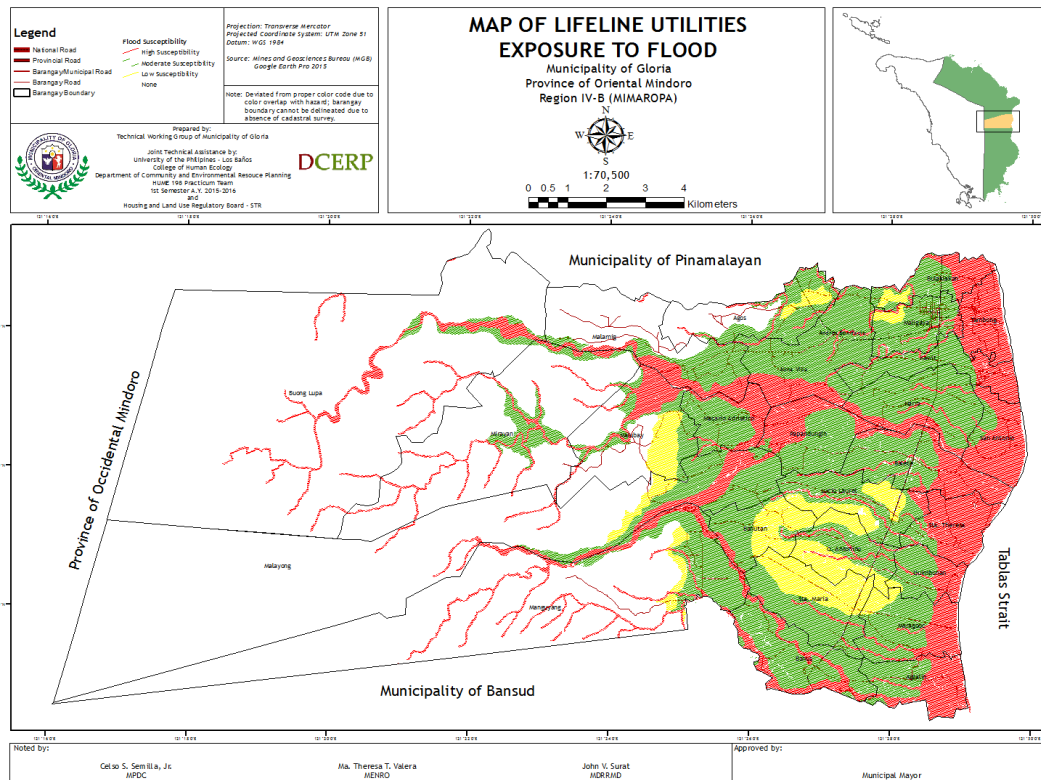
There is a possibility that all barangays will experience liquefaction based on the 2015 study UPLB-CHEDCERP. The top five barangays that are highly susceptible to liquefaction in terms of susceptible structures are Barangay Sta. Maria, Lucio Laurel, Andres Bonifacio, Banus, and Malamig. 3.12% of the commercial areas of the municipality are not susceptible to liquefaction; 19.4928 hectares (53.75%) are susceptible to low liquefaction; 15.6406 hectares (43.13%) are susceptible to high liquefaction.

National road that is not susceptible to liquefaction has an estimated length of 0.415 kilometers; 13.916 kilometers are susceptible to low liquefaction; 3.071 kilometers are susceptible to moderate liquefaction, 14.172 kilometers of the provincial and municipal roads are not susceptible to liquefaction; 72.382 kilometers are susceptible to low liquefaction; 71.235 kilometers are susceptible to high liquefaction. An estimated total of ₱18,320,000 are the exposed value for the provincial and municipal roads.

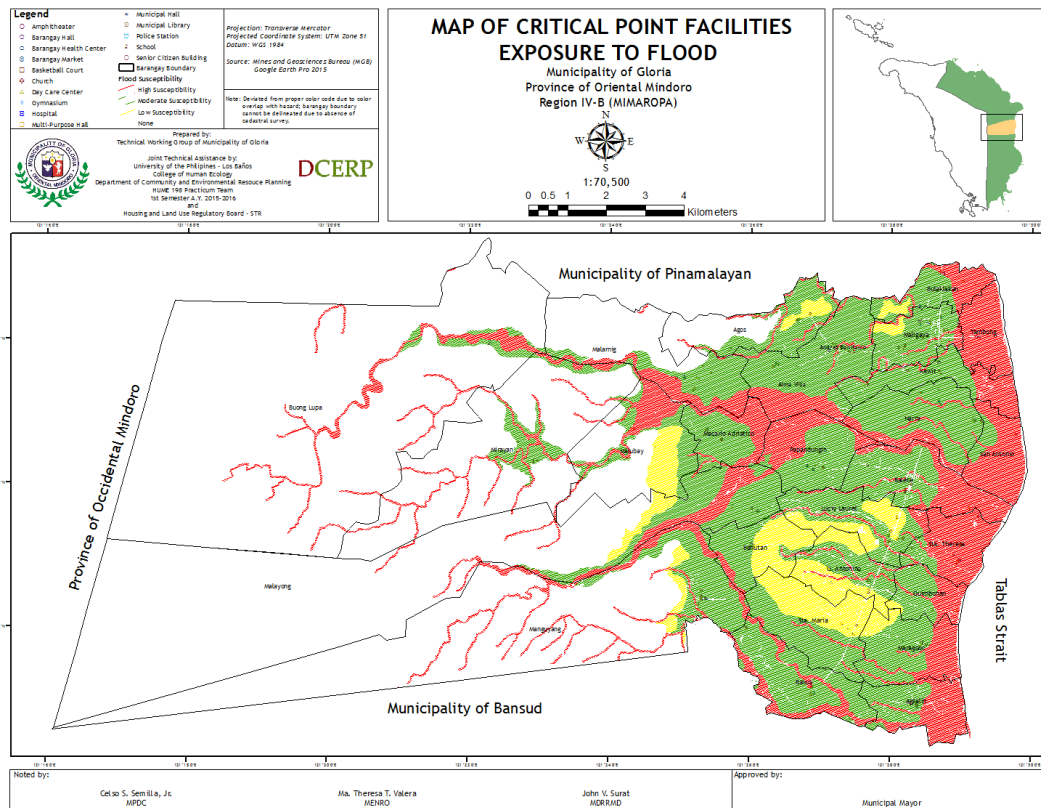
## Exposure Maps

### Flooding

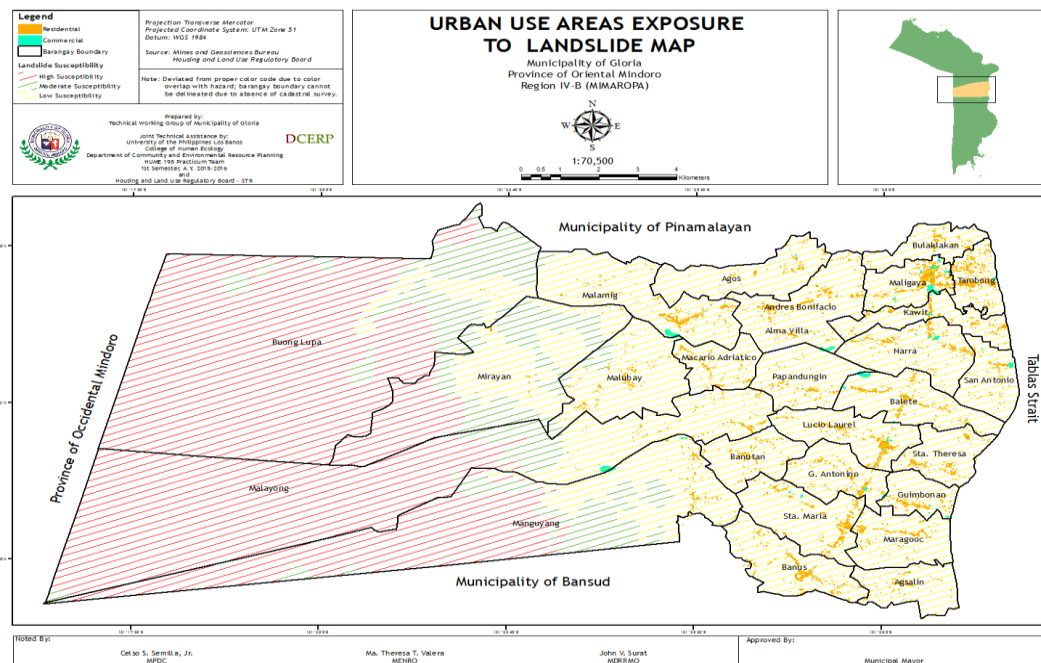


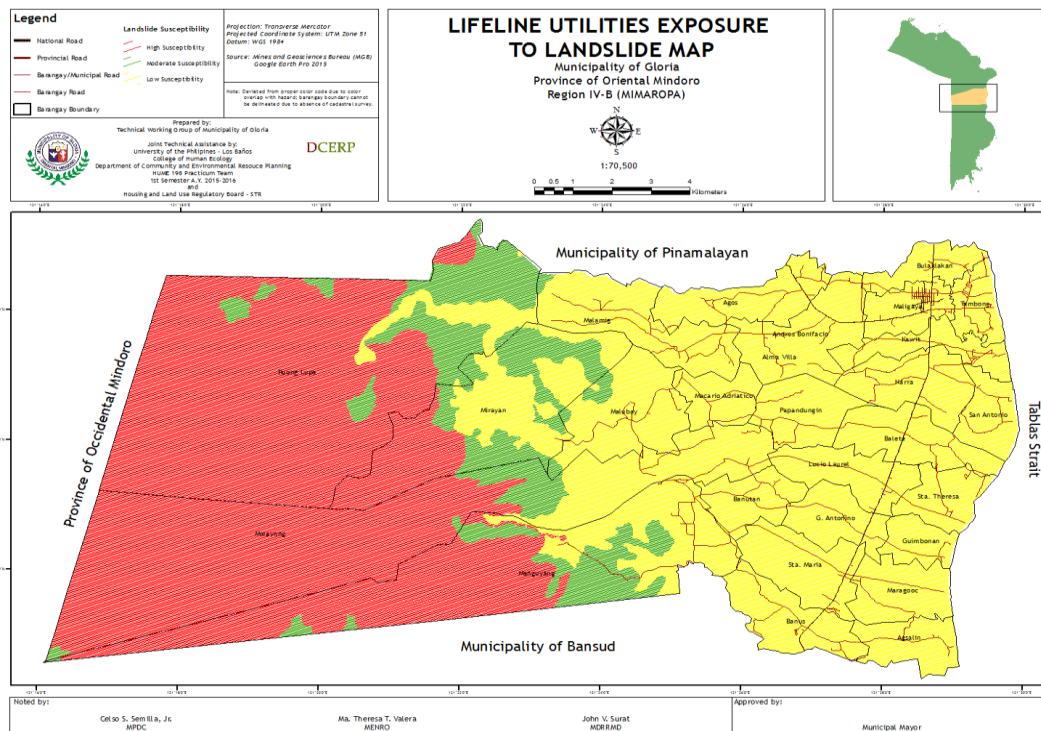
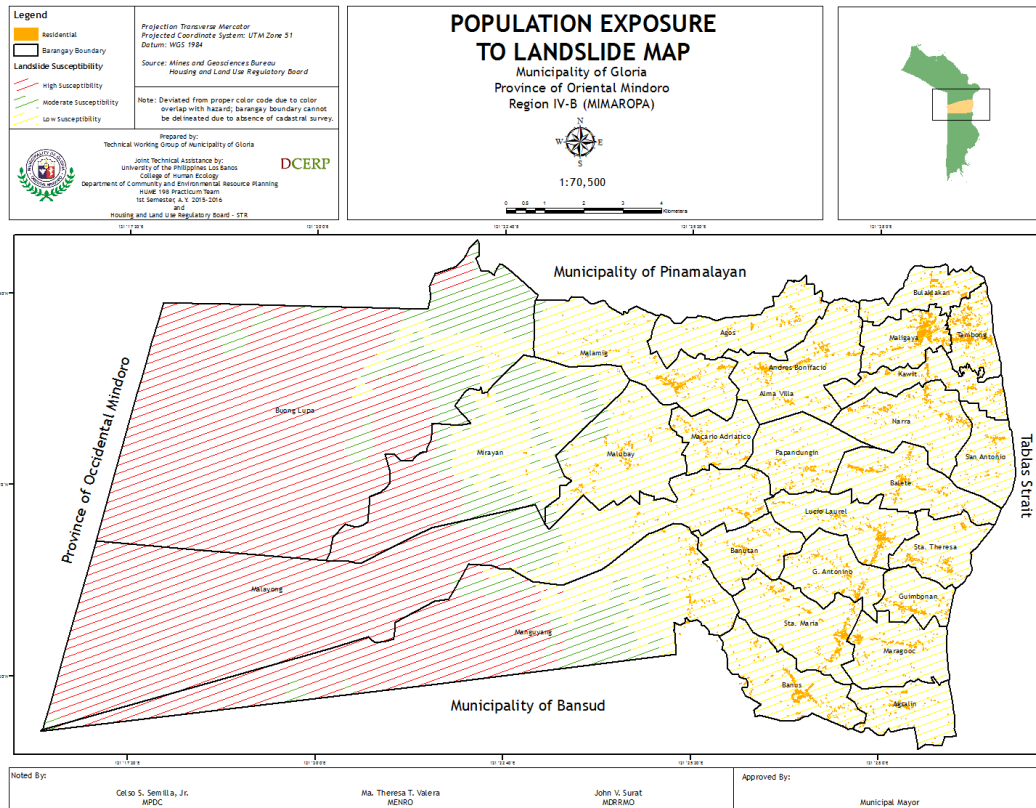




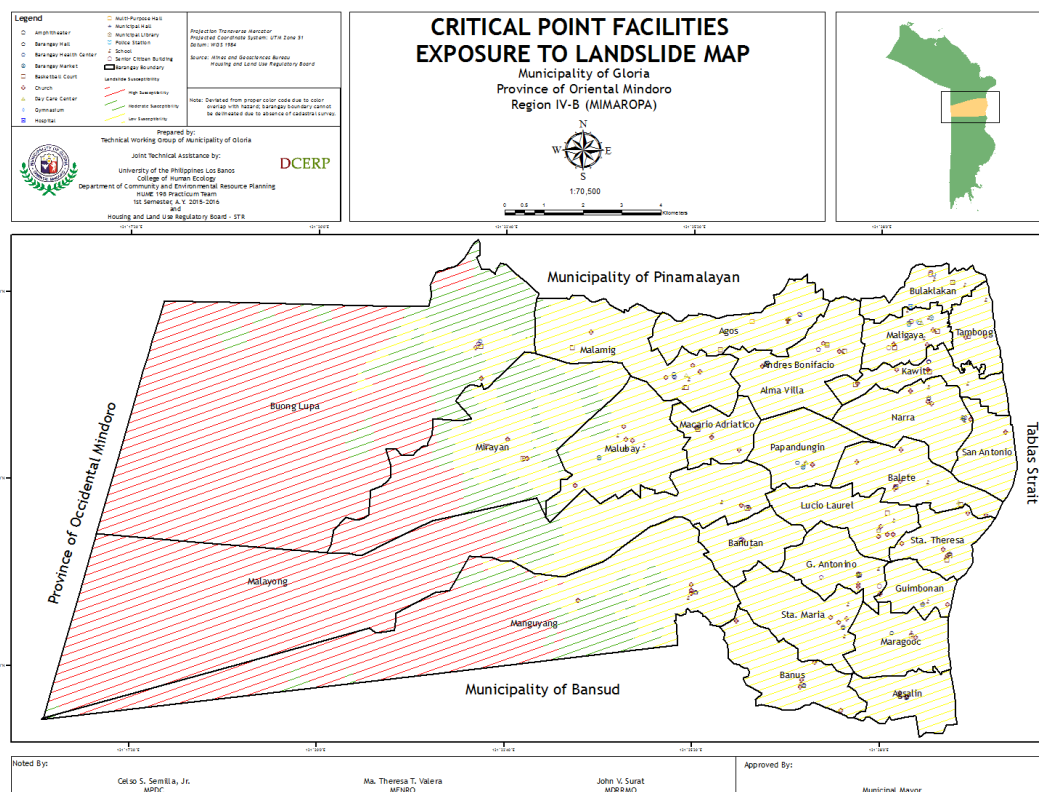
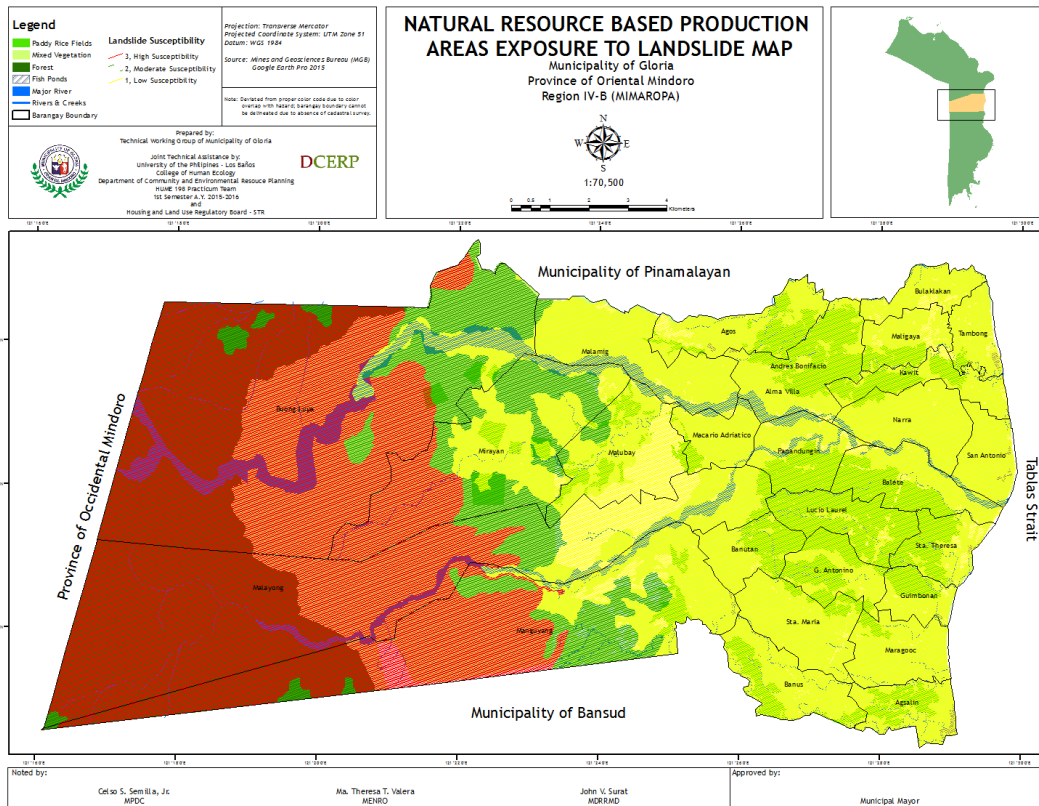


## Landslide

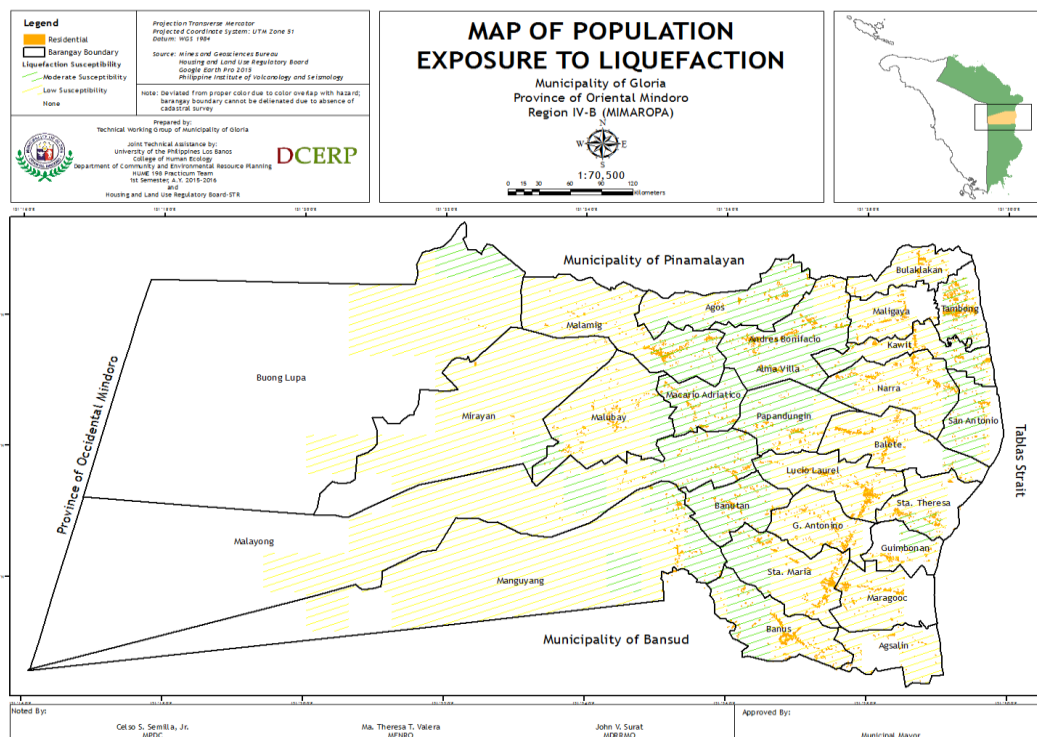
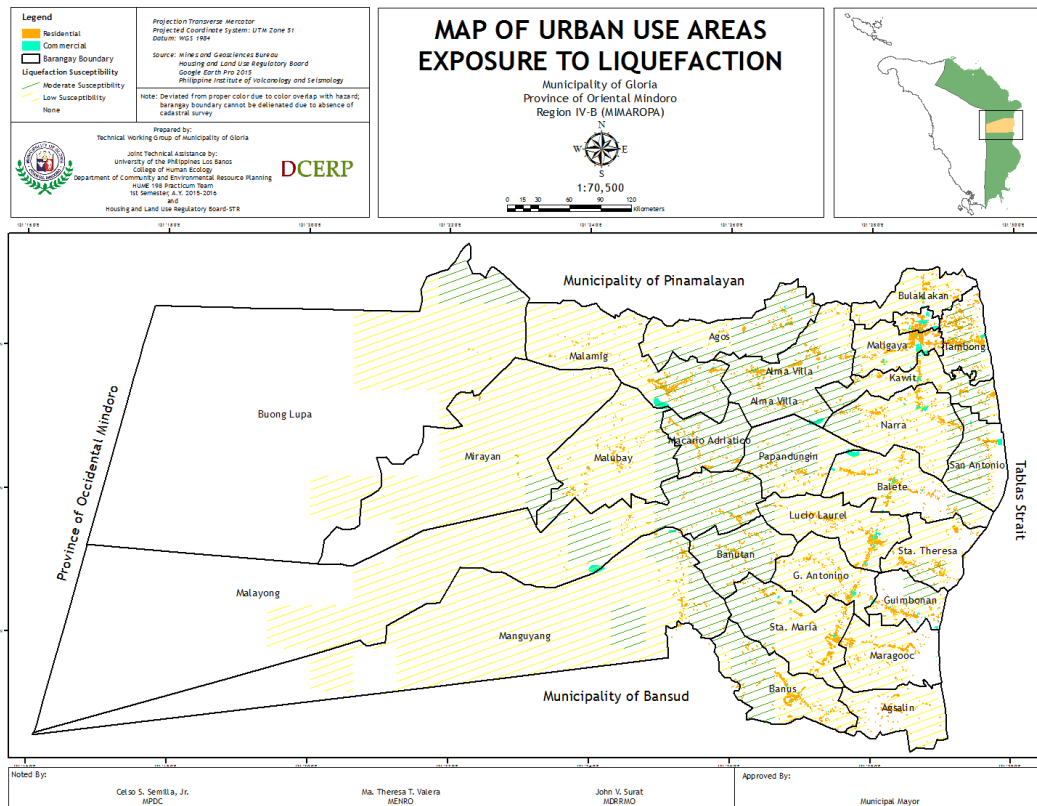






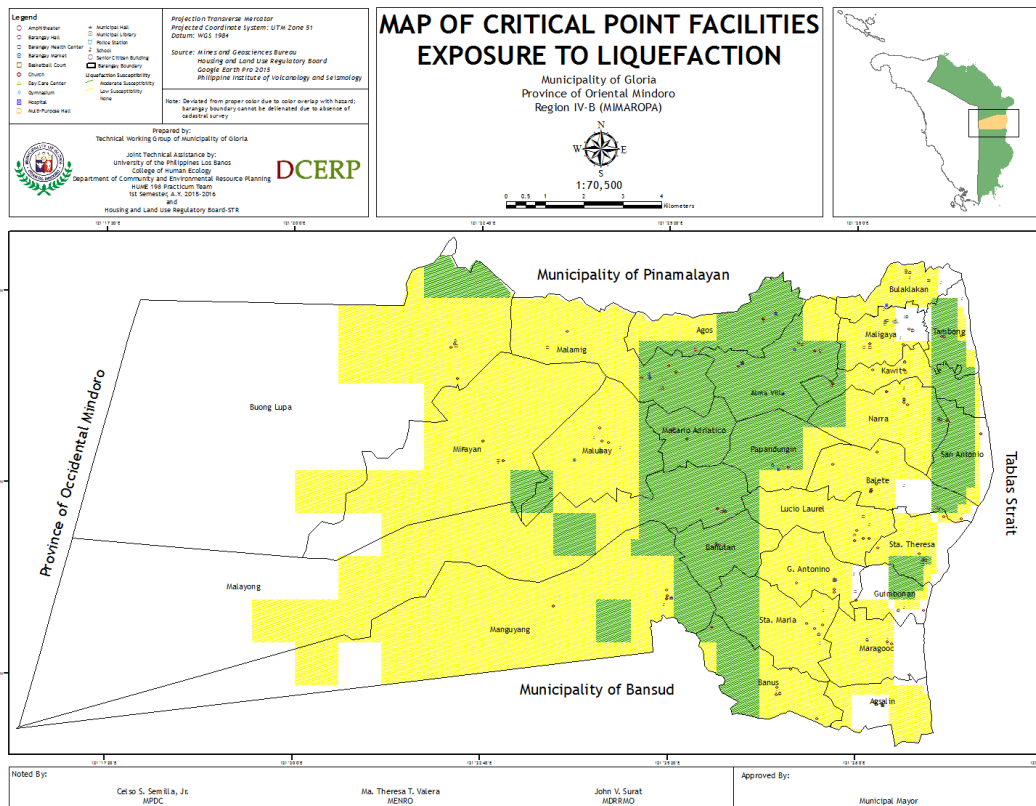


## Liquefaction



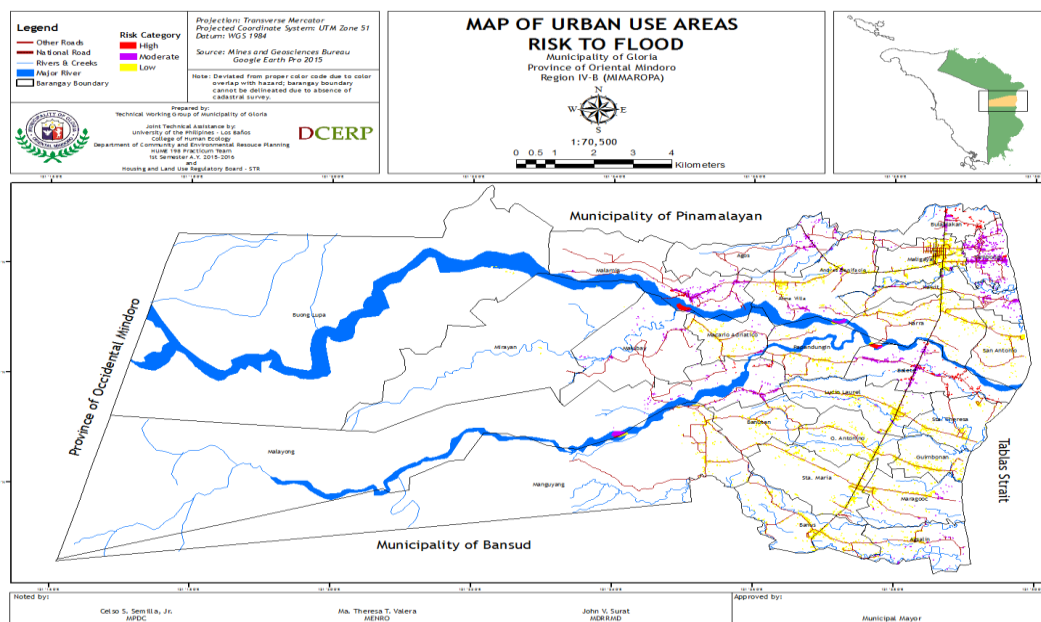


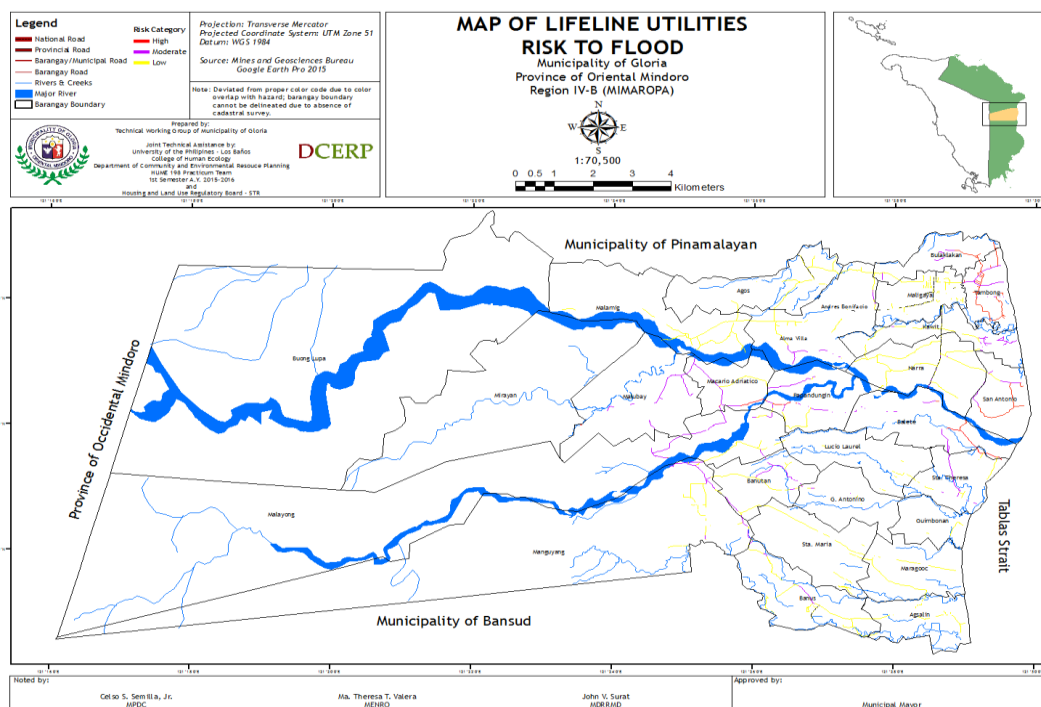
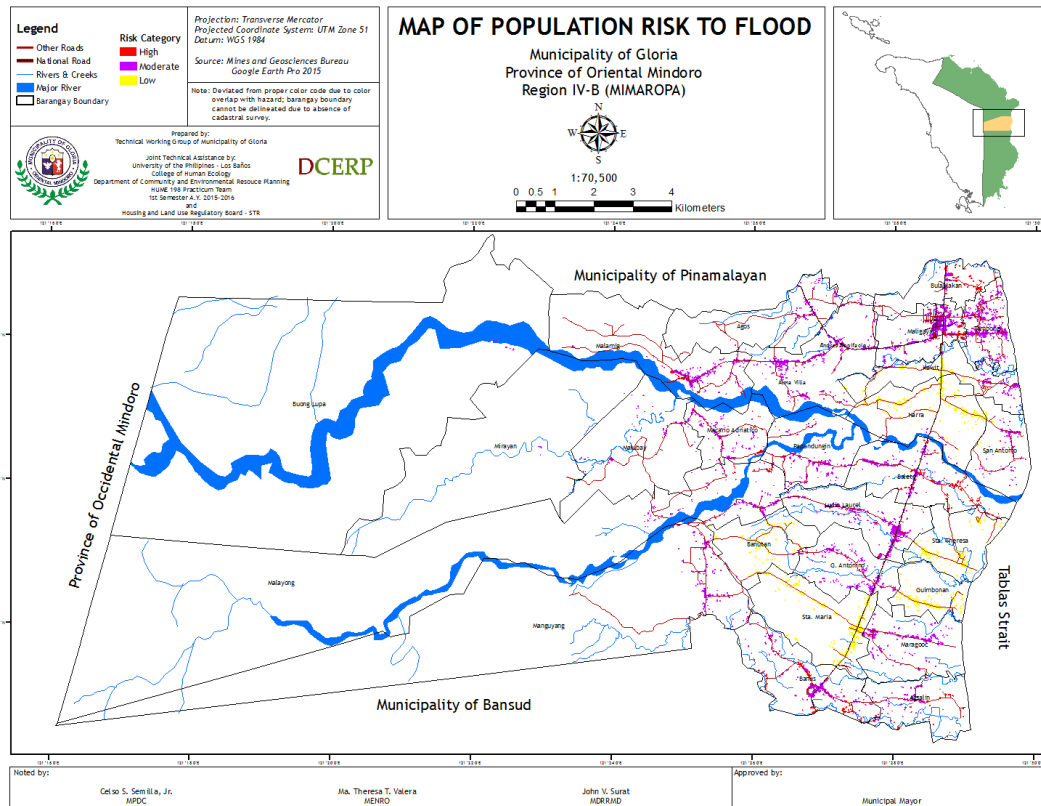




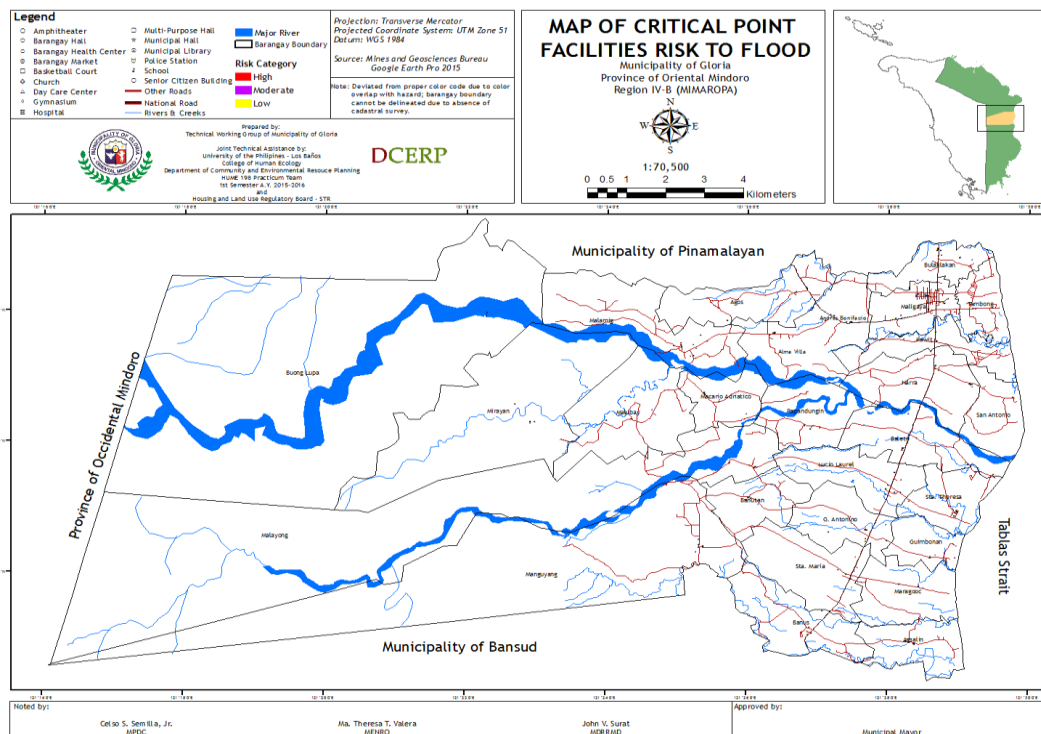
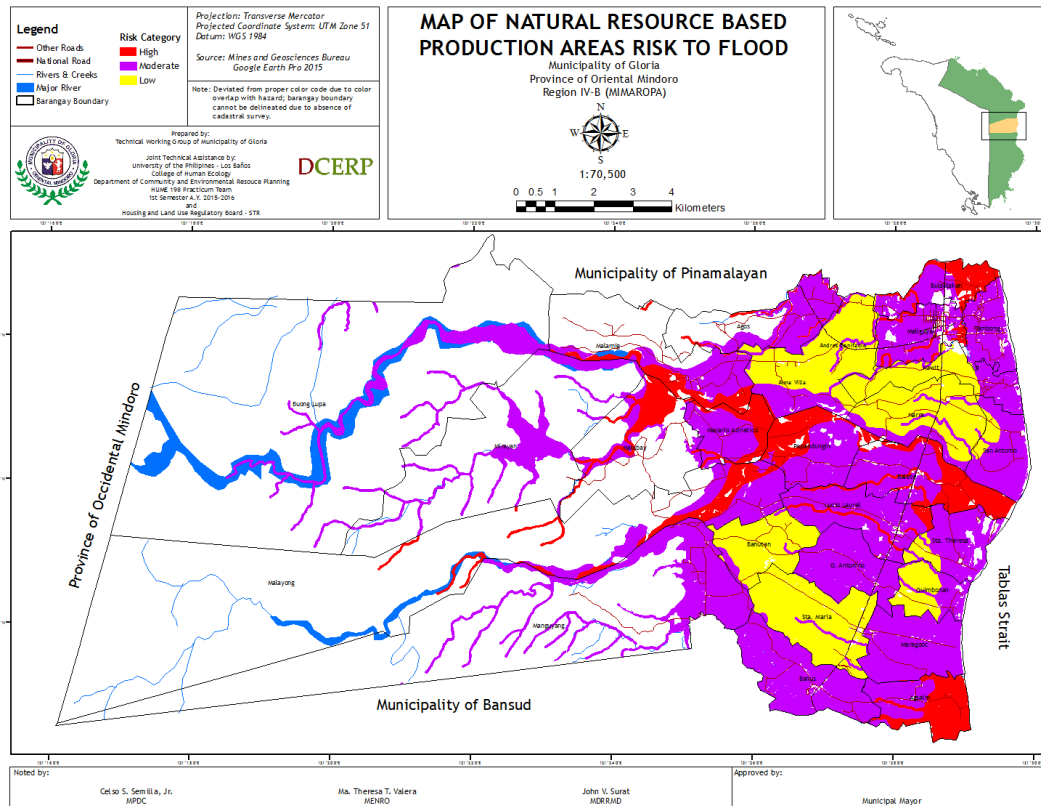
## Risk Maps

### Flooding

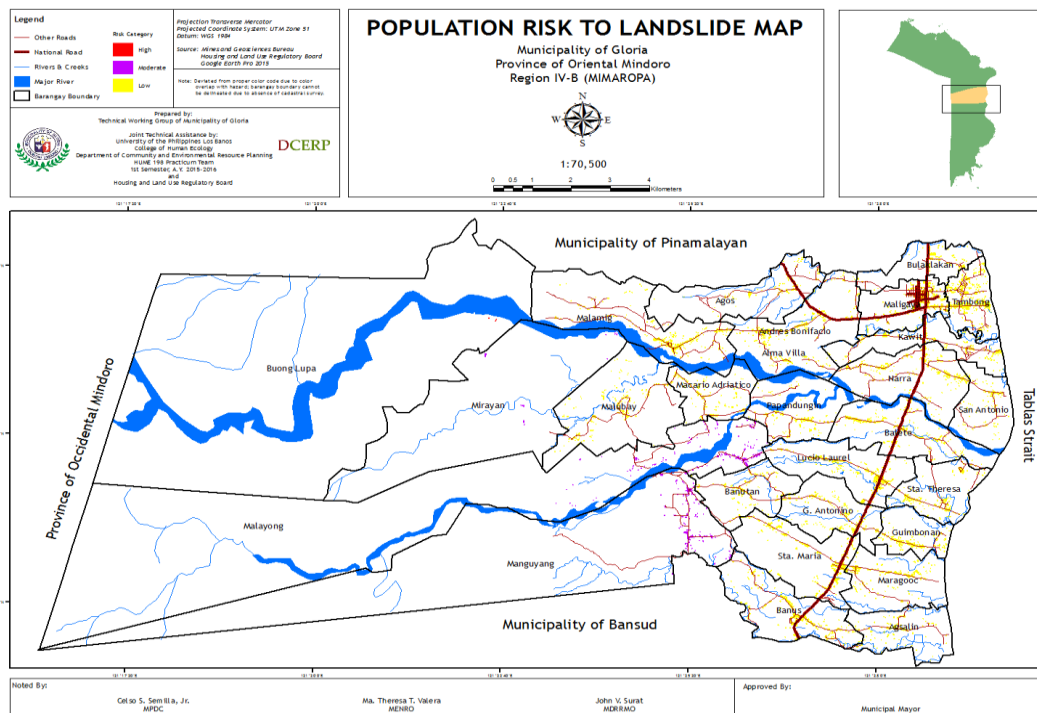
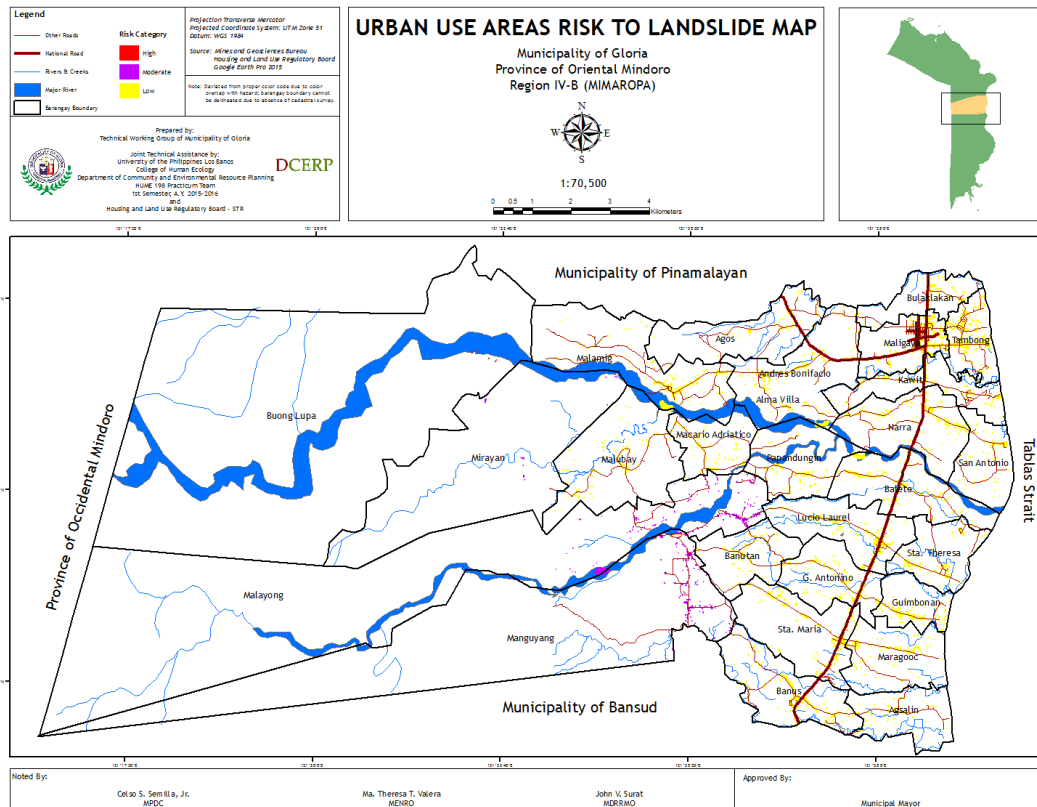


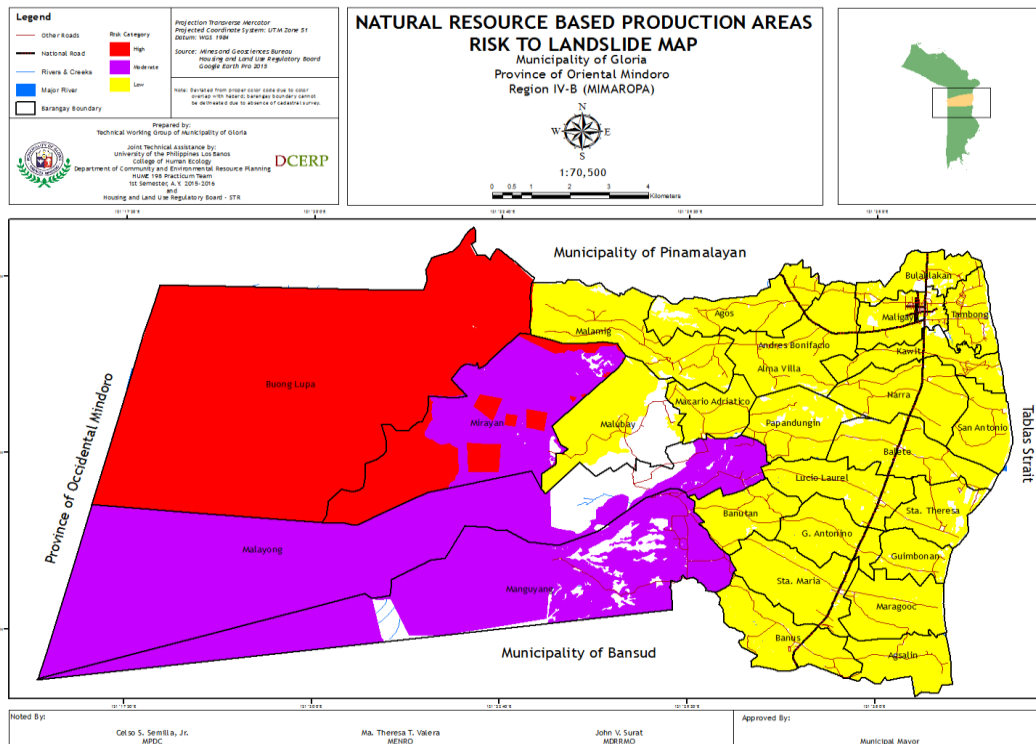
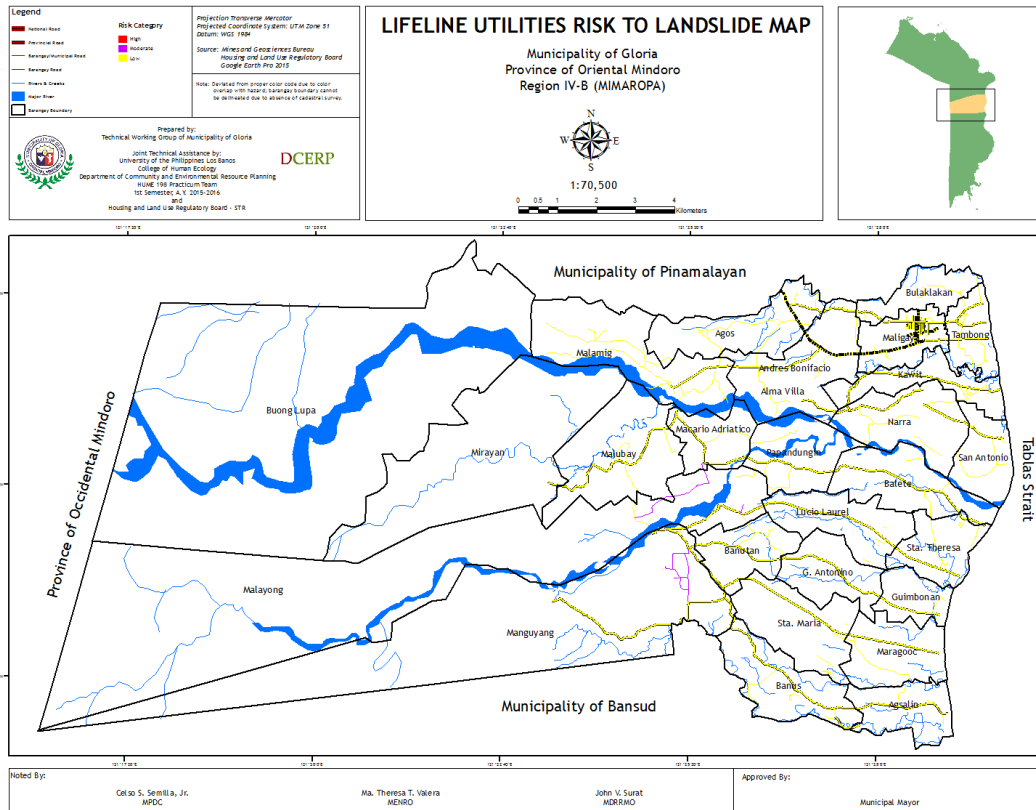


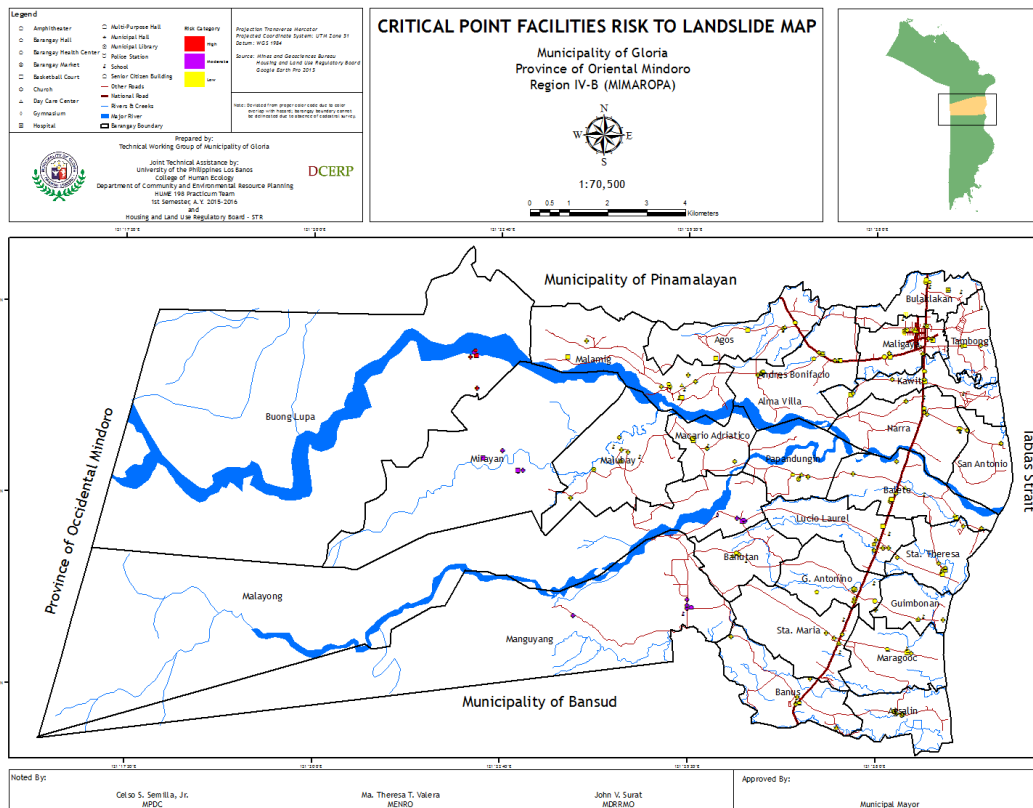




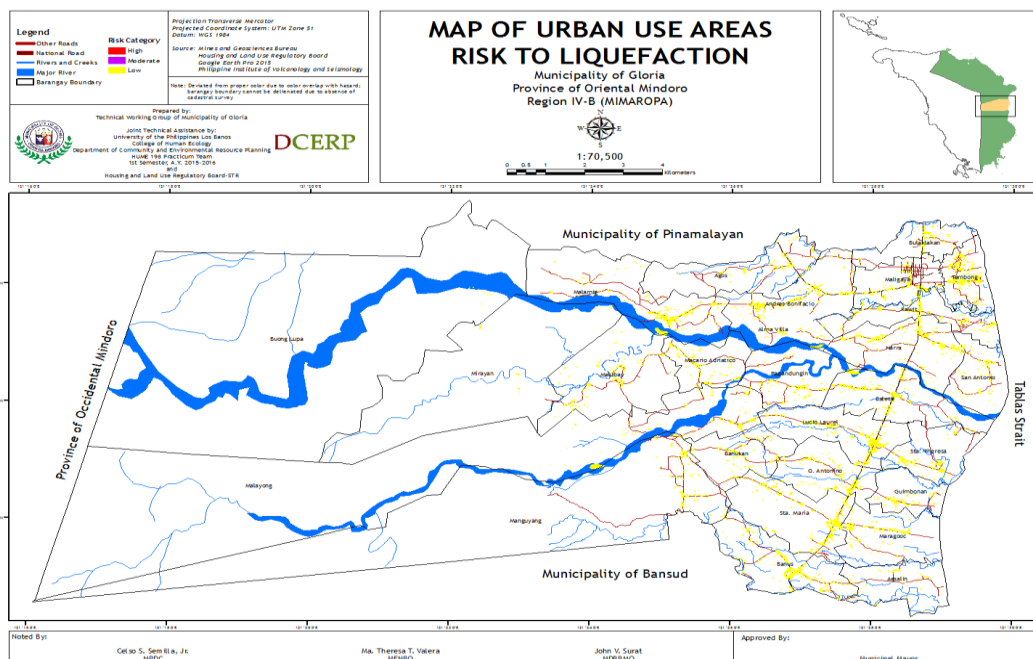
## Landslide

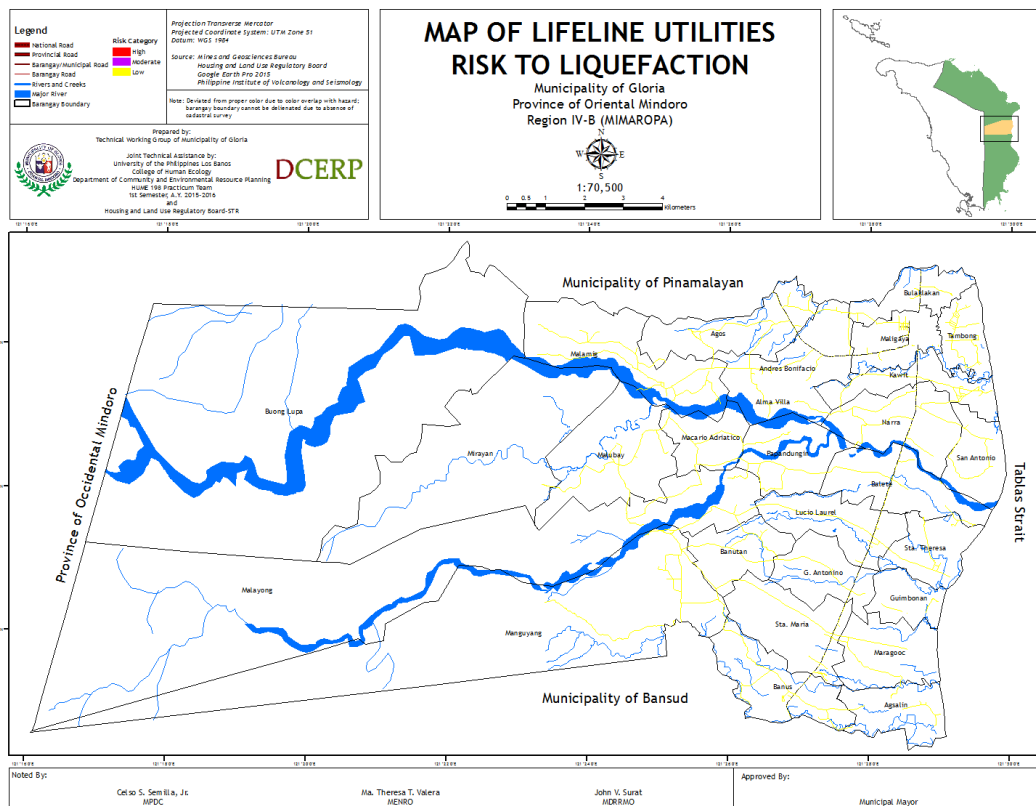
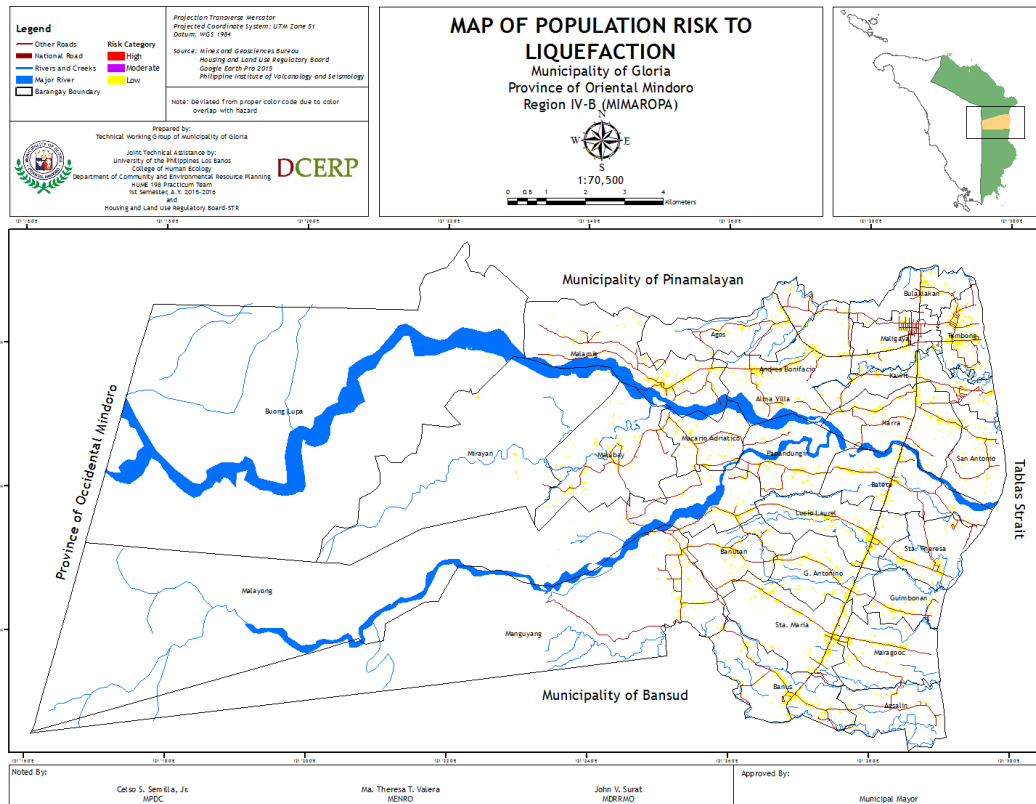




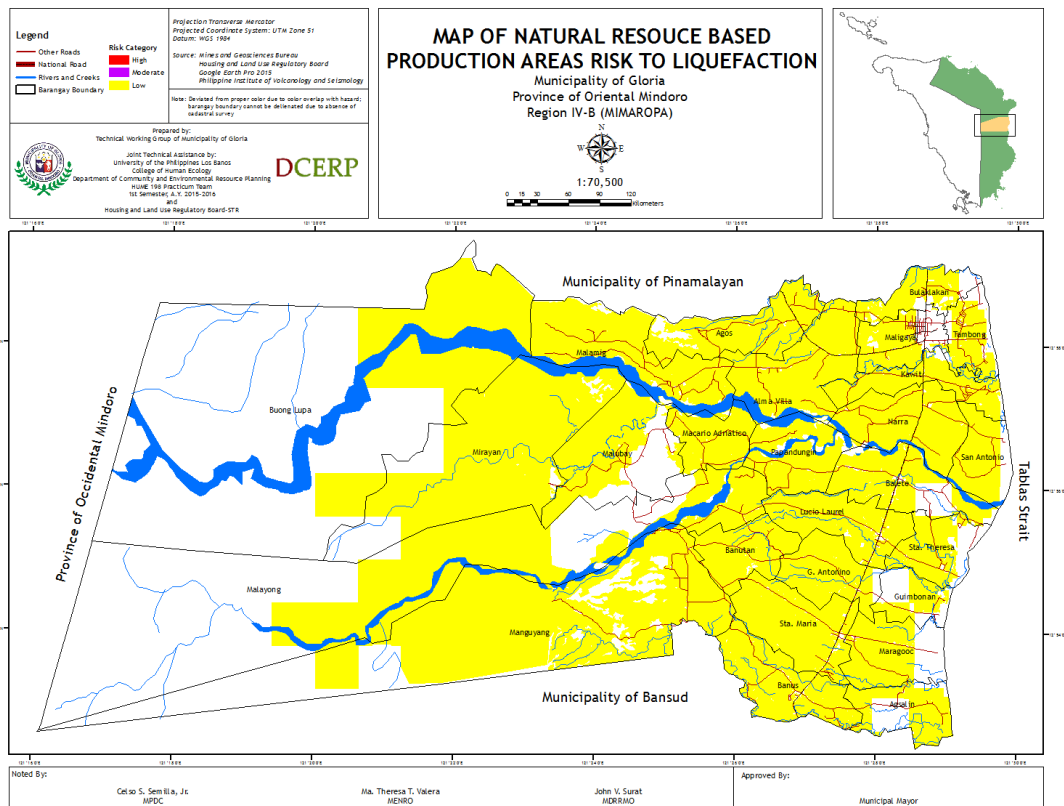


## Liquefaction









## Local Climate Change Scenario

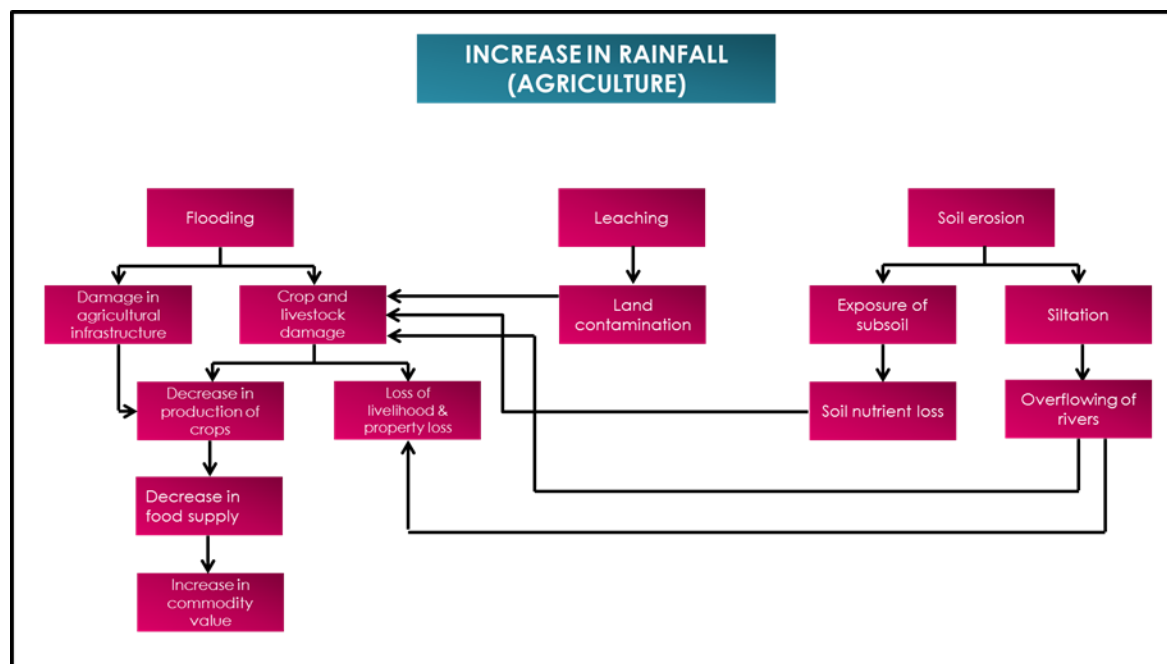
The Philippines is one of the most disaster-prone countries in the world as well one of the countries which will be most affected by climate change. To enable the safe and sustainable growth of its cities/municipalities, climate change adaptation and mitigation and disaster risk reduction and management need to become an integral part of the CLUP process of local governments in the Philippines. In keeping with Climate Change Act of 2009 (RA 9729) and Philippines Disaster Risk Reduction and Management Act of 2010 (RA 10121), this section aims to provide a general overview of the basic principles and concepts, the data collection process and data analysis for integrating these concerns into the CLUP.

The Municipality of Gloria, Oriental Mindoro projections from PAGASA which showed the different projections for the coming years of 2020 and 2050. The climate variables included in the projections are change in season temperature, season rainfall change, and frequency of extreme events, number of dry days and the number of days with rainfall of more than 200 mm. The projection of PAGASA showed that there will be a dramatic increase in the temperature in the municipality in all months. From an average of 26.4 degree Celsius in the months of December, January and February, it is projected to increase to 27.2 degree Celsius in 2020 and 28.2 degree Celsius in 2050. The same goes for the months of March, April and May. From a baseline of 28.3 degree Celsius at present, it is expected to increase to 29.3 degree Celsius in 2020 and 30.3 degree Celsius in 2050. This was computed at a 1-degree Celsius increase in every 30 years for the months of March, April and May. Furthermore, in the months of June, July and August, from an average of 27.6 degrees Celsius, an increase of 1.1 degrees Celsius in 2020 and 2.2 degrees Celsius in 2050 or that is an average of 1.1 degrees Celsius increase in every 30 years. Lastly, in the months of September, October and November, from 27.3 degrees Celsius at present, it is projected to increase to 28.2 degrees Celsius in 2020 and 29.2 degrees Celsius in 2050. In general, there will be an increase in temperature in all months

of the year and dramatically increasing every year.

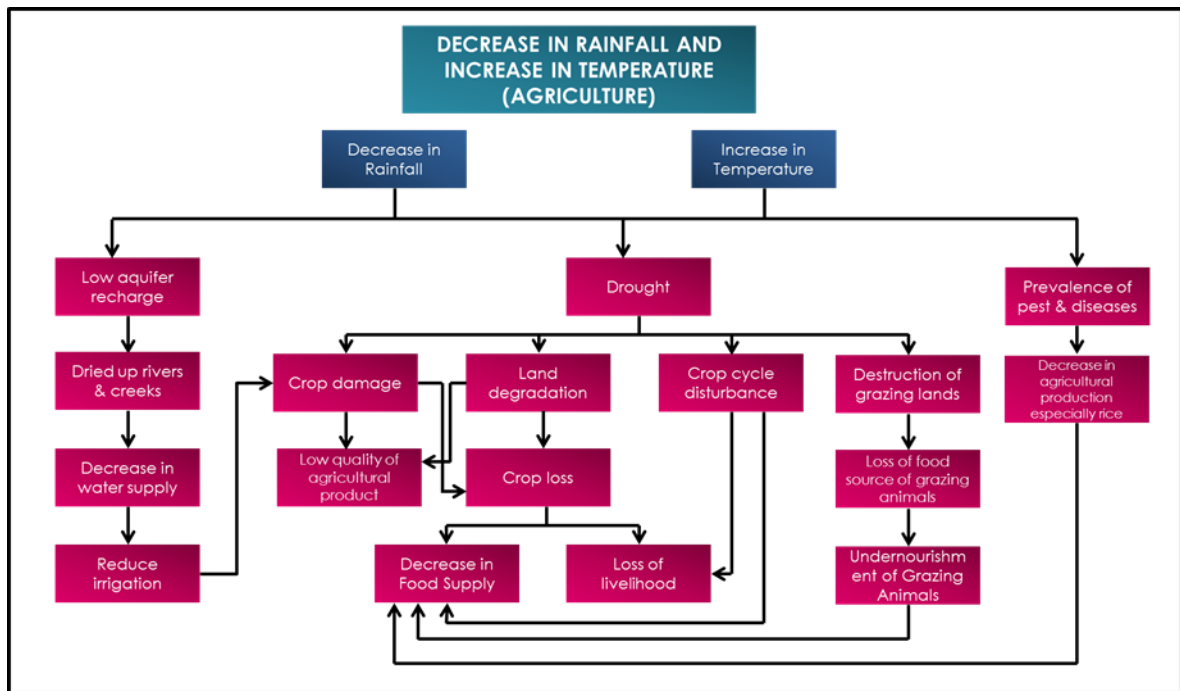
## Climate change impacts per sector or area

### Agricultural Impact



PAGASA projections for the year 2020 where there will be an increase in rainfall which brings about flood problems, it can significantly affect the agricultural lands of the municipality. Increase in rainfall could lead to flooding which can damage the agricultural infrastructures and also damage crops and livestock. Damage in agricultural infrastructures, crops and livestock can lead to the decrease in production, which leads to food insecurity, increase in the demand of food, and increase in the commodity value due to having scarce food production. Crop and livestock damage on the other hand can also lead to the loss of livelihood and property loss.

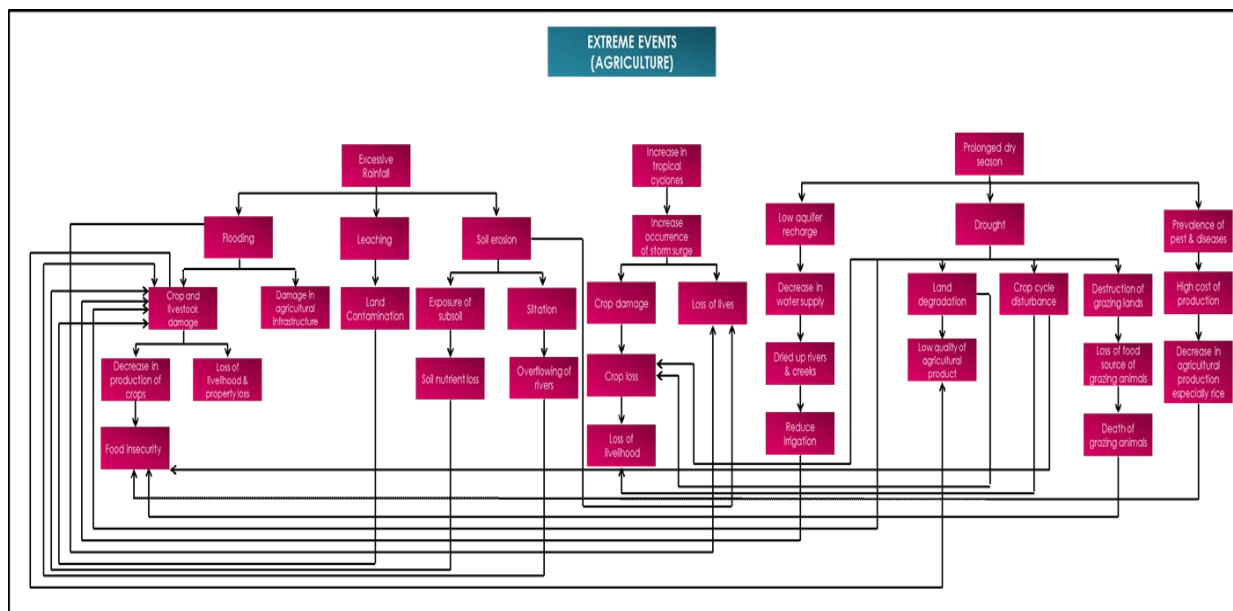
There are three extreme events that may occur in the municipality, these are excessive rainfall, increase in tropical cyclones, and prolonged dry season. Another effect of the increase in rainfall is leaching. It is when the waste in agriculture areas are absorbed by the soil that leads to land contamination and also prevent the nutrients of the soil to be absorbed by the crops therefore, the crops and livestock are damaged. Increase in rainfall also weakens the soil which makes it susceptible to erosion. Soil erosion can lead to two effects, exposure of the subsoil and siltation. The exposure of subsoil causes soil nutrient loss where the nutrient of the soil is degraded that leads to crop and livestock damage. On the other hand, siltation causes river overflow and when it overflows, the crops and livestock will be flooded. In effect, there will be loss of livelihood and property loss.



Decrease in rainfall will happen on year 2050 as projected by PAGASA which may affect the agricultural lands greatly. Also, low aquifer recharge will lead to decrease in water supply, which the residents near the rivers depend on. Decrease in water supply results to dried up rivers and creeks which, in turn, can reduce irrigation water especially for rice and other crops. Crop damage will be prevalent if there will be no sufficient water for crop production.

Drought on the other hand causes crop damage, land degradation, crop cycle disturbance, and destruction of grazing lands. Crop damage can lead to having low quality of agricultural products because of nutrient loss. Land degradation is also a problem which causes crop loss and low quality of agricultural products. Crop loss could lead to food insecurity for the people who depend on agricultural crops for food and livelihood. Crop cycle disturbance due to drought also leads to loss of livelihood and food insecurity. During drought, the grazing lands cannot be utilized. Animals that are dependent on these grazing lands will eventually die if there will be continued scarcity of their food. Meat supply will then be decreased.

Another problem that will arise in the future is increase in temperature. This will lead to the prevalence of pest and diseases for the agricultural crops. There will be a higher cost for production because of the mitigation measures that the farmers will do to save their agricultural lands. The prevalence of pest and diseases and the high cost of production will eventually lead to decrease in agricultural production, especially rice. These problems will then result to food insecurity.

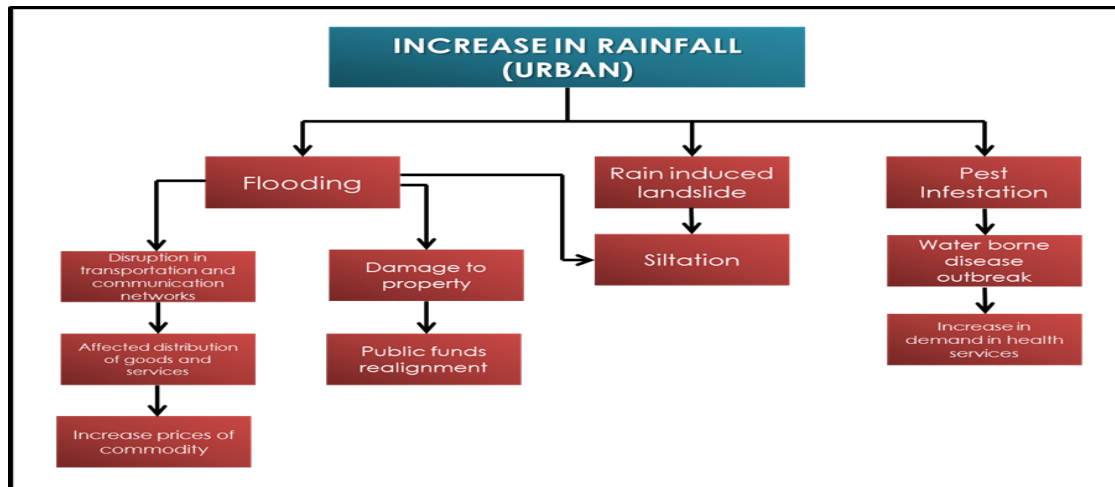


The increase in rainfall by 2020 will bring about the excessive rainfall and increase in tropical cyclones on the first causal level of the impact chain diagram. The prolonged dry season on the other hand will happen on 2050 where there will be a decrease in rainfall as projected by PAGASA.

Extreme events in agriculture that can be experienced are excessive rainfall, increase in tropical cyclones, and prolonged dry season. Excessive rainfall, can be an effect of prolonged dry season where in drought, low aquifer recharge and prevalence of pest and diseases will be a direct effect. Another effect of extreme event is having an increase in tropical cyclones. There will be an increased occurrence of storm surges which leads to crop damage and loss of lives. Crop damage will then result to crop loss and eventually loss of livelihood for farmers.

Excessive rainfall, as discussed earlier, has different effects. Flooding can also lead to loss of lives as well as soil erosion. Flooding causes crop and livestock damage where in agricultural areas would be having a problem in low quality of agricultural products. Lastly, prolonged dry season, or having drought, reduces irrigation waters and effect to having crop and livestock damage. Crop cycle disturbance is also an effect of prolonged dry season. The municipality greatly depends on the agricultural products especially rice. If poor crop production persists, food insecurity will happen.

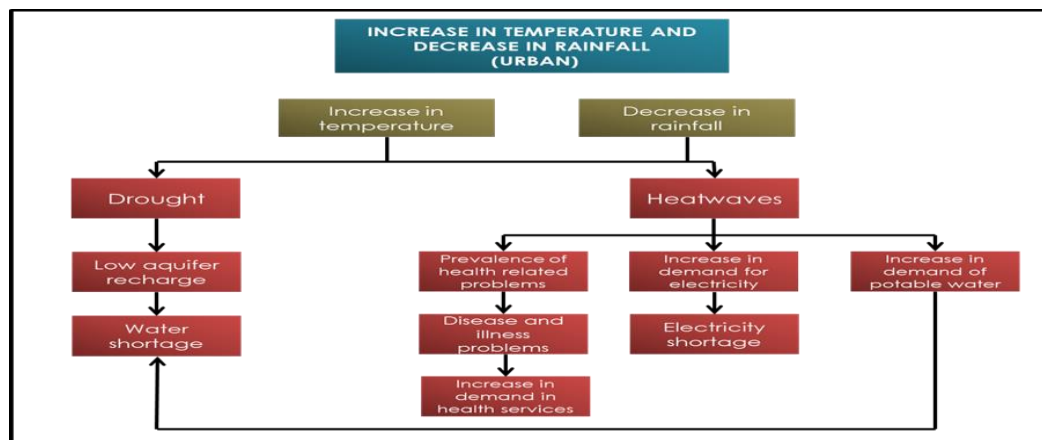
## Urban Use Areas Impact



PAGASA projections indicate that there will be an increase in rainfall in the Municipality of Gloria during the year of 2020 to 2050. Increase of rainfall during these years will bring three major effects to the urban areas of the municipality which are flooding, rain induced landslide and pest infestation.

Flooding, one of the major effects of increase in rainfall would lead to disruption in transportation and communication networks since most of the roads in the municipality will be significantly affected. Since major roads are flooded or damaged by increased rainfall, most forms of land transportation are hindered causing difficulty in the distribution of goods and services. This complication may lead to increased prices of commodity. Flooding may also result in damage to properties, both private and public. Public properties, such as roads, bridges and schools will be damaged due to rise in water level of the rivers and ocean. Allocation of public funds will be done for the replacement costs of the damages incurred.

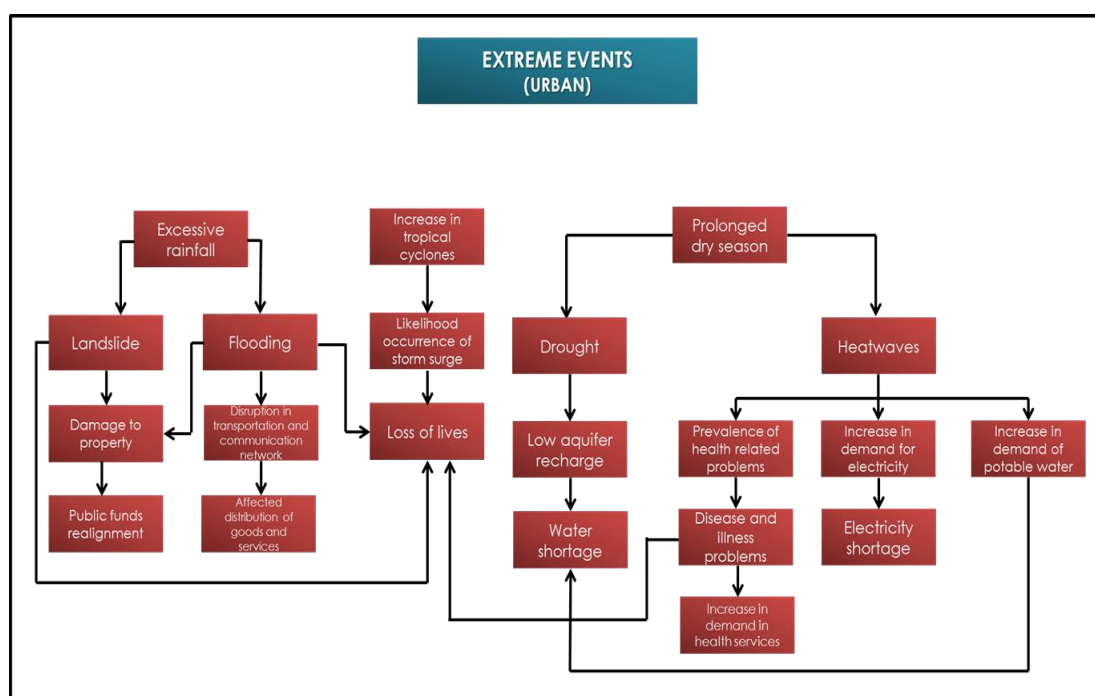
Another major effect of increase in rainfall is landslide. Urban areas of the municipality situated along the upland areas are the most vulnerable to this hazard. Siltation of rivers is also a problem faced by the communities of all the barangays in Gloria. The eroded soil from the upland areas are being washed and carried to the river systems. The silted soil easily causes the rivers to overflow during moderate and heavy rainfall. Increase in rainfall may also cause pest infestation. Stagnant rainwater has a big role in pest infestation since mosquitos reproduce in these areas. The number of mosquitos and rats will increase since the climate is favorable for their reproduction and growth which may result to waterborne disease outbreak such as malaria or dengue and leptospirosis throughout the municipality.





For the impact chain in urban areas, two constant effects are considered, increase in temperature and decrease in rainfall. These effects will be experienced in the municipality in a span of 30 years, 2020-2050, as projected by PAGASA. Increase in temperature and decrease in rainfall will bring about drought and problems on heat waves. Due to the decrease in rainfall, drought in urban areas would lead to low aquifer recharge since the aquifer recharge depends on rainwater. Urban areas use aquifer recharge as potable water and for domestic uses. The demand for water increases during dry seasons but the supply is no longer sufficient to accommodate the needs of the people thus, water shortage is prevalent.

Another problem in the community is the increase in temperature. Heat waves occur when there is not enough rainfall to cool off the environment. Various health-related problems such as heat stroke and other skin diseases arise. The demand for health services increases during these times. Another effect of heat waves is increase in demand for electricity. Air cooling devices are more frequently used since the weather is hotter. The supply of electricity will not be sufficient to accommodate the demand which will cause shortage in electricity. And lastly, the demand for potable water would also increase for it is the basic necessity of man. Because there is higher evaporation rate of water due to high temperature, water supply for the community will be insufficient.



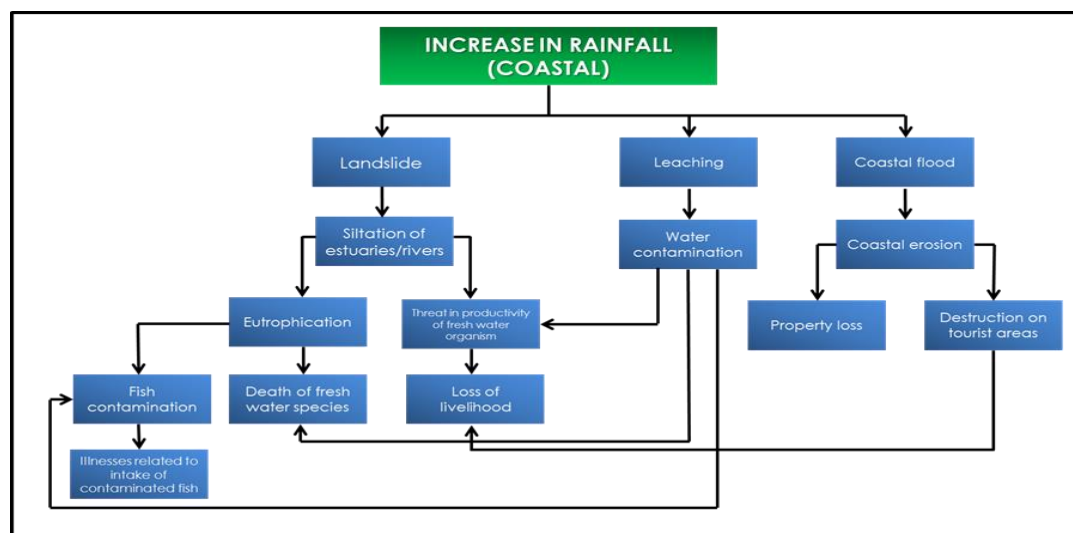
Relying on the projections of PAGASA for 2020, extreme events will happen in the municipality, specifically excessive rainfall and increase in tropical cyclones. Another extreme event is prolonged dry season as an effect of decrease in rainfall (Fig. 13).

The excessive rainfall can cause landslide and flooding. Communities situated along upland areas or mountains are highly to incur damages to property from landslides. Another effect of excessive rainfall is flooding. Flooding would lead to disruption in transportation and communication networks since most of the roads in the municipality will be significantly affected. Increase in occurrence of tropical cyclones is also one of the extreme events. It is one of the reasons which causes flood that takes away the lives of the people.

In the case of prolonged dry season, the surroundings will become hotter than its usual temperature which causes drought and heat waves. Drought may lead to low aquifer recharge which leads to water

shortage. On the other hand, heat waves can cause health related problems and prevalence of diseases. These problems lead to the increase in demand of health services and loss of lives. Another effect of heat waves is the increase in demand of electricity which later on will lead to electricity shortage. And lastly, the demand for potable and domestic water will also increase because of the very dry season.

## Impact for Coastal Areas

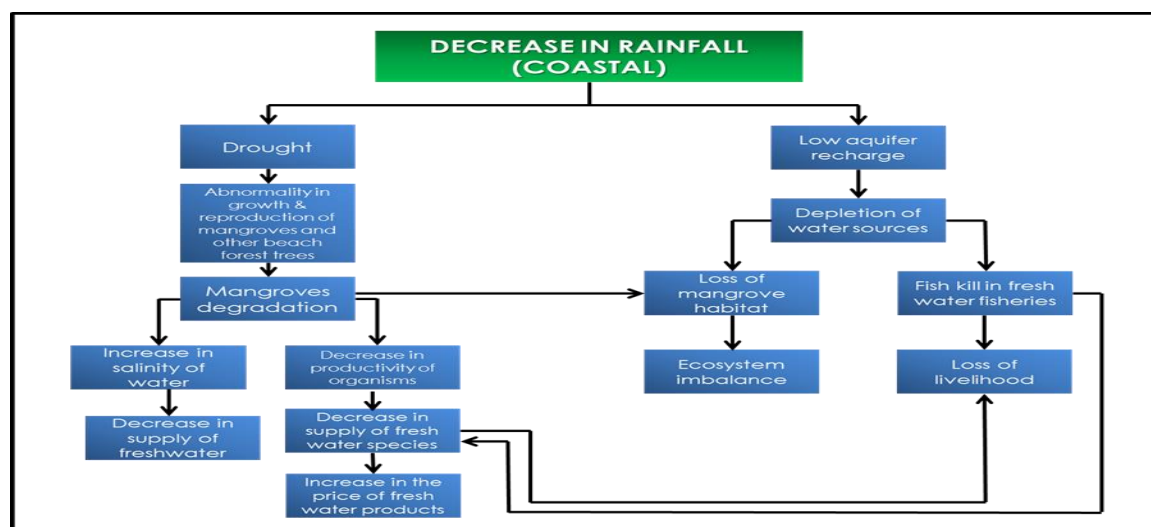


As expected from the projection of PAGASA, there will be an increase in rainfall for the year 2020. As consequence of this phenomenon, the coastal area may experience landslide, leaching, and coastal flooding.

Even if the coastal area is far from mountains where landslides usually occur, the two ecosystems are connected by the river system. An increase in rainfall can cause landslides on the mountainsides. The consequence is the erosion of earthly matter, fine sand or mud, carried off by running water and disposed as sediments. When sediment or silt is suspended in the water, the habitat of fresh water organisms will be affected, which in turn can cause the loss of livelihood of communities that depend on aquaculture. Furthermore, some of the land that is washed up in rivers may contain chemical nutrients such as nitrate and phosphate materials. These two chemicals promote excessive growth of algae, and when these algae die and decompose, high levels of organic matter and decomposing organisms deplete the water of available oxygen (Art, 1993). Eutrophication causes the death of organisms living on the fresh water and this phenomenon can also lead to fish contamination when fish take in the nitrate and phosphate. As per bio magnification, when humans consume the contaminated fishes, the phosphate and nitrate concentrations become higher that of normal values and can lead to illnesses and diseases (Oxford University, 2008).

Leaching is another direct effect of increase in rainfall in coastal areas. Surface and Aqueous Geochemistry Group of Stanford USA (2007) states that "leaching is the process by which inorganic, organic contaminants or radionuclides are released from the solid phase into the water phase under the influence of mineral dissolution, desorption, complexation process as affected by pH, redox, dissolved organic matter and (micro) biological activity". When the water phase of these organic contaminants

mixes with the river system, the river waters will be contaminated. Contaminated water plays a big role in the disruption of growth and reproduction of fresh water organisms, as well as in the death of fresh water species. The rise in sea level will result to coastal flooding, causing the breakdown of land and removal of beach sediments. If this happens, communities living near the shore line will be washed up, resulting to potential loss in both properties and lives. Furthermore, coastal erosions can cause destruction to tourist spots like beaches and resorts that can potentially affect tourism in the said community.

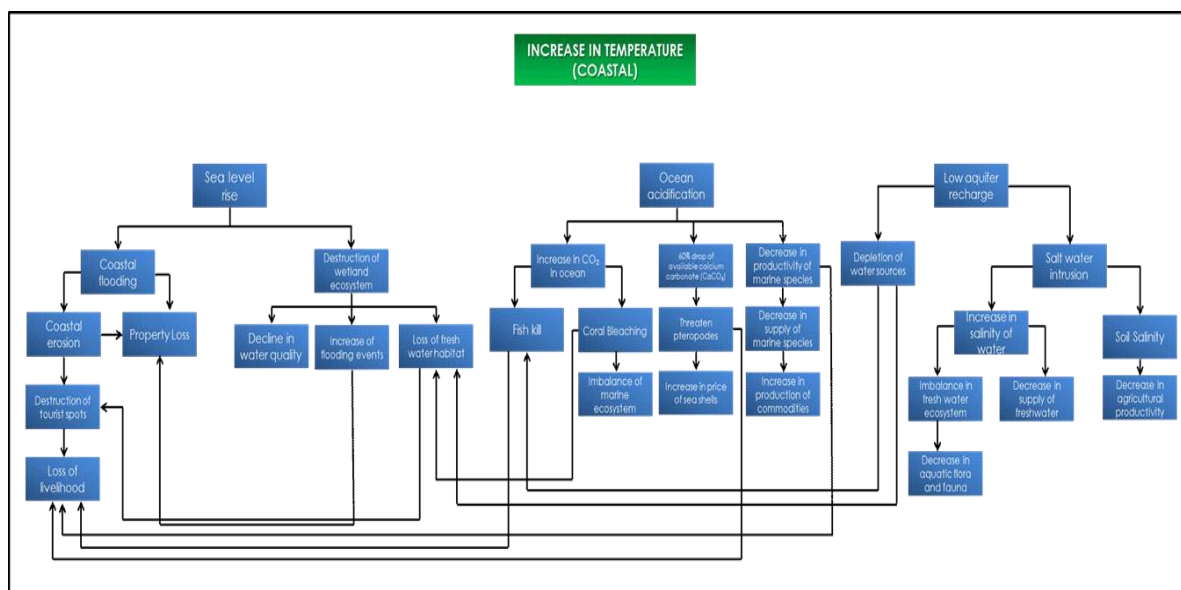


Philippine Atmospheric Geological and Astronomical Service Association (PAGASA) predicted that in the year 2050, there would be a decrease in rainfall that would occur in the Municipality of Gloria, Province of Oriental Mindoro. The direct effect of this decrease in rainfall in the coastal areas would be the occurrence of drought and low aquifer recharge.

Drought in coastal areas would lead to an abnormality in the growth and reproduction of mangroves and beach forest trees, where the growth could be reduced to as much as 50%, as well as degradation of mangroves and other beach forest trees. Mangrove trees serve as habitat and nesting grounds for fresh water species like prawns, crabs, and other fishes found on the estuaries. The destruction and degradation of the mangroves will lead to a decrease in productivity of these organisms. The result of this loss of productivity in fresh water species will result to a steady decrease in their supply as a source of food and export product. As the law of supply and demand states: as the supply decreases and demand stays the same or increase, the price of goods will increase (Pierce,n.d.); thus the price of fresh water goods will spike up.

Furthermore, the aerial roots and top roots of mangrove trees serve as filters of salt in the brackish water where they grow, making water safe for drinking. A loss of the mangroves in the estuaries will result to an increase in the salinity of water, creating shortage in the supply of fresh water for communities living near coastal areas.

Ground water is recharged naturally by rain; but with the prevalence of decreasing rainfall and constant usage of ground water, water sources will be depleted, resulting to dry rivers, creeks, and wetlands which will result to fish kill. Given that there are people who depend on aquaculture for a living, the loss of natural bodies of water will directly affect their livelihood. The depletion of water sources will also result to the loss of the mangrove habitat and greatly affecting the natural balance of the ecosystem since mangroves play a vital part in the maintenance of the wetland ecosystem.



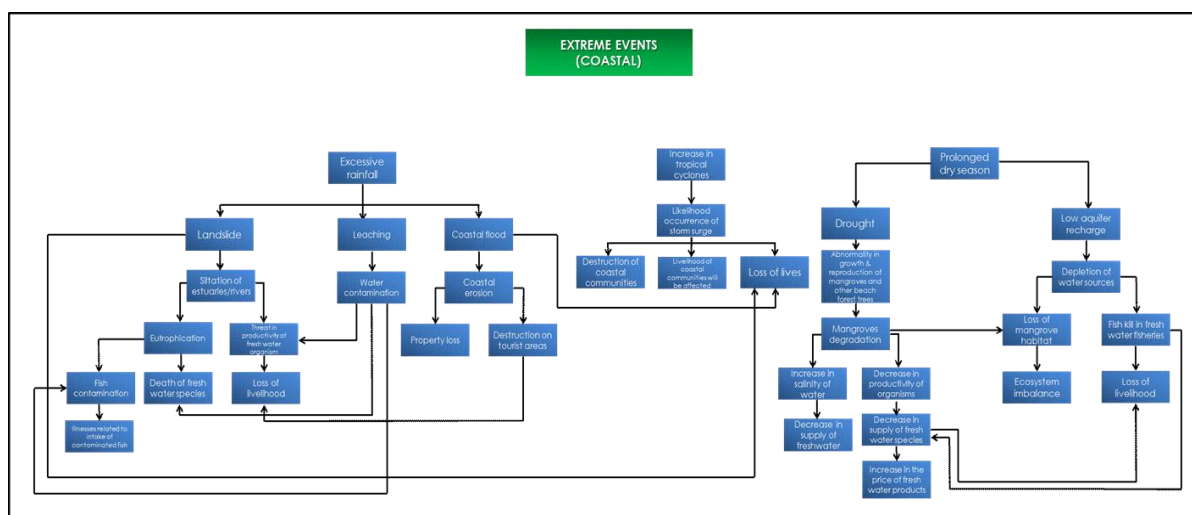
The

effects of increased temperature as projected by PAGASA for the year 2020-2050: sea level rise, ocean acidification, and low aquifer recharge. When there is an increase in temperature, it is expected to have a rise in sea level. The rise in the sea level is an effect of the melting of ice all around the world which inadvertently causes further increase in the sea level. With the presence of coastal flooding, this leads to property loss and coastal erosion of communities. As the land erodes, resorts along the shoreline will be damaged and may result to loss of livelihood in certain communities. Another effect of rise in sea level is the destruction of wetlands ecosystem. Salt water will invade the freshwater systems that will lead to loss of water quality and fresh water habitat. Since wetlands are a natural habitat for mangroves, the destruction of the ecosystem of the wetlands will lead to the possible decline of mangrove trees, which will result to an increase in flooding events as the mangroves help stabilize the water level.

The ocean absorbs about one third of all carbon dioxide emissions which helps slow down global climate change. But because of the ocean's absorption of excess carbon dioxide due industrialization, the ocean is now more acidic than before; resulting to a phenomenon termed as ocean acidification (Huelsenbeck, 2013). An increase in carbon dioxide levels in oceans harm marine animals. Warmer water temperatures and increased carbon dioxide levels in oceans can result to coral bleaching, a phenomenon when corals remove the algae living in their tissues (Marshall & Schuttenberg, 2006). Coral bleaching stresses the corals and if these will not recover, it will result to death. Absence of corals in the marine ecosystem will lead to many of the marine species losing their natural habitat further upsetting the already imbalanced marine ecosystem. Ocean acidification also results to up to a 60% drop of available calcium carbonate which significantly reduces the ability of pteropodes (oysters, corals, clams, mussels, and snails) to produce its shell (Boleman, et.al., 2013). The direct result of this is a loss in the livelihood of communities relying on the ocean for daily sustenance and income. Not to mention there is an impending increase in

price for seafood and other resources derived from the seas and oceans.

The third effect of increased temperatures in the coastal areas is a low aquifer recharge that lead to depletion of water sources that could lead to salt water intrusion. Salt water intrusion is an effect when ground water levels in the aquifers are depleted faster than they can recharge (Ranjan, 2007). Effects of salt water intrusion include an increase in salinity of water which may adversely affect the supply of fresh water. Another effect is an imbalance in the fresh water ecosystem which can lead to the decrease of fresh water flora and fauna.



PAGASA projected for 2020, excessive rainfall and increase in tropical cyclones. Prolonged dry season will happen because of the decrease in rainfall during the year 2050. Extreme events in coastal area have three direct effects, namely: excessive rainfall, increase in tropical cyclones and prolonged dry season. Each direct effect has further secondary effects.

Excessive rainfall may cause landslide on the forest areas that can cause siltation of rivers and estuaries that later on may lead to eutrophication, death of fishes and loss of livelihood for the people relying on rivers, fish cages as source of livelihood. Another extreme event that may be experienced is the increase in tropical cyclones that can bring likelihood occurrence of storm surges. Strong typhoons may lead to destruction of houses and other properties of communities residing near the sea. Livelihood of fisher folks will also be affected since they cannot catch fish if there are storm surges.

Prolonged dry season is another extreme event that may be experienced in the coastal area. This may cause drought and low aquifer recharge. Further effects of prolonged dry season are decrease in supply of fresh water, salt intrusion that can cause fish kills in fresh water, and loss of mangrove habitat that can cause ecosystem imbalance.



## Summary of Climate Change Impact

Table Summary of climate change effects and impacts.

Climate Variable	General Changes Expected in Climate Variables	Information About Patterns of Change	Population	Natural Resource-based Production Areas	Critical Point Facilities	Urban Use Areas	Infrastructures and Utilities
Temperature	<ul style="list-style-type: none"> <li>Increase in temperature for all seasons expected in 2020 &amp; 2050</li> </ul>	<ul style="list-style-type: none"> <li>Temperature increase in all months</li> </ul>	<ul style="list-style-type: none"> <li>Decrease on food supply because of dying crops due to drought that leads to loss of livelihood for the farmers and food insecurity for the community</li> </ul>	<ul style="list-style-type: none"> <li>Drought will cause migration of wild animals, low aquifer recharge and crop damage in agro-forest areas, insect outbreak, forest fire and stunting of rainforest growth will also be a problem that may cause loss of wildlife habitat.</li> <li>Increase in temperature will cause trees to wilt and the forest cover to diminish thus, the forest will be vulnerable to landslide.</li> <li>Less fish catch due to warm surface waters and ocean acidification which reduces the income of fishermen</li> <li>Coral bleaching</li> <li>Salt water intrusion to water systems near the ocean will happen</li> <li>Increase in the salinity of ocean water and destruction of wetland ecosystems</li> </ul>	<ul style="list-style-type: none"> <li>Increase in demand for hospitals and rural health units because of health problems and disease outbreaks</li> <li>Water and power related facilities will not function well</li> </ul>	<ul style="list-style-type: none"> <li>Causes drought which leads to water shortage</li> <li>Occurrence of heat waves which may lead to prevalence of health related problems and increase in demand of potable water and electricity</li> </ul>	<ul style="list-style-type: none"> <li>Water distribution networks (irrigation) that rely on water will not function properly</li> <li>Roads will be prone to damages like cracks and holes</li> </ul>
Rainfall	<ul style="list-style-type: none"> <li>Decrease in rainfall by 2020 and increasing by 2050 during DJF</li> <li>Decrease in</li> </ul>	<ul style="list-style-type: none"> <li>Reduction in rainfall during summer of 2020 &amp; 2050</li> <li>Increase in rainfall during Habagat of</li> </ul>	<ul style="list-style-type: none"> <li>Decrease in rainfall causes migration of wild animals from forest to low lands which may impact their quality of life and wellbeing.</li> </ul>	<ul style="list-style-type: none"> <li>Decrease in rainfall causes drought which decreases the crop yield/harvest of farmers thus, reducing the farmer's income</li> <li>Decrease in rainfall causes drought that may lead to</li> </ul>	<ul style="list-style-type: none"> <li>Decrease in rainfall may increase the demand for hospitals and rural health units to cure illnesses of the people.</li> <li>Increase in rainfall can bring floods to the</li> </ul>	<ul style="list-style-type: none"> <li>Prevalence of heat waves</li> <li>Increase in energy demand</li> <li>Increase in demand for potable water</li> <li>More incidence of</li> </ul>	<ul style="list-style-type: none"> <li>Roads will be more prone to damages like cracks and holes due to loose soil</li> <li>Increase in rainfall can cause</li> </ul>

	<ul style="list-style-type: none"> <li>rainfall by 2020 and 2050 by MAM</li> <li>Increase in rainfall by 2020 and 2050 by JJA</li> <li>Increase in rainfall by 2020 and 2050 by SON</li> </ul>	<ul style="list-style-type: none"> <li>2020 &amp; 2050</li> <li>Increase in rainfall during Amihan (SON) in 2020 &amp; 2050</li> <li>Wetter Amihan months in DJF in 2020 and 2050</li> </ul>	<ul style="list-style-type: none"> <li>Decrease in rainfall will result to low aquifer recharge</li> <li>There will be land degradation due to loose soil</li> <li>Loss of mangrove habitat</li> <li>Increase of rainfall causes overflowing of river systems that may cause loss of property and loss of livelihood for the people.</li> <li>Rain induced landslide will cause the animals from the forest to migrate on low lands that may bring about threat to the security of the people.</li> </ul>	<ul style="list-style-type: none"> <li>competition for water irrigation</li> <li>Heavy rainfall causes flooding due to overflowing rivers which destroys agricultural lands</li> <li>Frequent and heavy rainfall causes landslides that diminishes forest cover thus, ecosystem imbalance may occur</li> </ul>	<ul style="list-style-type: none"> <li>community which affects the function of socio-economic support services like schools, hospitals, local government buildings, air/sea ports, communication towers, power related facilities &amp; water related facilities</li> </ul>	<ul style="list-style-type: none"> <li>disease and insect problems</li> <li>Increase in rainfall can cause prevalence of vectorborne diseases and pest outbreaks</li> </ul>	<ul style="list-style-type: none"> <li>damages to road transportation networks</li> <li>Water distribution and power distribution networks will be disrupted when flood occurs</li> <li>Disruption to transportation and communication network</li> <li>Affected distribution of goods and services</li> </ul>
Number of Hot Days	<ul style="list-style-type: none"> <li>Increase number of hot days (exceeding 35°C)</li> </ul>	<ul style="list-style-type: none"> <li>Significant increase in the number of hot days expected in 2020 and 2050</li> </ul>	<ul style="list-style-type: none"> <li>Occurrence of health-related illness, particularly among the elderly, the poor, and vulnerable population</li> </ul>	<ul style="list-style-type: none"> <li>Agricultural lands dry up which increases the demand for irrigation due to longer and warmer season</li> <li>Unable to plant crops especially when it often rains</li> </ul>	<ul style="list-style-type: none"> <li>Demand for potable water and electricity will increase so that the socio-economic support services facilities will function well</li> </ul>	<ul style="list-style-type: none"> <li>Demand for electricity increased due to increased usage of electric fans and air conditioners</li> <li>Demand for potable water will increase</li> </ul>	<ul style="list-style-type: none"> <li>Demand for water and power distribution networks will increase</li> </ul>
Number of Dry Days	<ul style="list-style-type: none"> <li>7037 days with &lt;2.5 mm of rain in 2020</li> <li>6902 days with &lt;2.5mm of rain in 2050</li> </ul>	<ul style="list-style-type: none"> <li>Decrease number of dry days (&lt;2.5mm of rain)</li> </ul>	<ul style="list-style-type: none"> <li>Crops will not grow properly thus affecting the livelihood of the farmers</li> <li>Production of crops and fishes that needs to be dried will decrease hence, decreasing the sales of farmers and fishermen</li> <li>People will be more vulnerable to accidents on roads</li> </ul>	<ul style="list-style-type: none"> <li>Poor quality of agricultural products</li> <li>Cases of flooding and landslide will be higher because of frequent rainfall</li> </ul>	<ul style="list-style-type: none"> <li>May weaken the structure of the buildings due to frequent rainfall</li> </ul>	<ul style="list-style-type: none"> <li>Solar-powered driers will not function well</li> <li>The price of water and electricity will be cheaper because of frequent rains</li> </ul>	<ul style="list-style-type: none"> <li>Damages the roads (occurrence of cracks and holes) due to frequent rain</li> </ul>

## Rice

Sunlight, temperature and rainfall are the main drivers of crop production; hence, agriculture is directly affected by climate change. But it should also be noted that agriculture also affects climate change as it is responsible for about one-third of greenhouse gas emissions, a major cause of global warming. When

it comes to rice production, ninety percent (90.06%) of rice fields are exposed to flood, of the said exposure, 16.91% or equivalent to 432.0111 hectares has low exposure, while 1,501.2182 hectares or 58.77% is under moderate exposure and 367.54282 hectares (14.39%) has a high exposure to flooding with an estimated Php. 314,745,626 exposed value loss of rice fields due to floods.

Only 9.3611 hectares or 0.37% of total rice fields area in the municipality are exposed to landslide with high level susceptibility, while 3.80% or 97.1111 hectares are mediumly exposed to landslide and 2,448.1198 hectares or 95.83% are in the low level of exposure, resulting to large volume of rice production in the municipality. There is an estimated 349,468,185 pesos exposed value loss of rice fields to landslide.

Liquefaction takes place when loosely packed, water-logged sediments at or near the ground surface lose their strength in response to strong ground shaking. Almost Ninety five percent (95.22%) of rice fields are exposed to liquefaction with the following levels of exposure to liquefaction; 1,578.6991 hectares or 61.80% has a low exposure and 33.42% or 853.7091 hectares has a moderate level of exposure. There is an estimated 332,753,441 pesos exposed value loss of rice fields to liquefaction.

## Mixed Vegetation

			due to frequent rains that causes the roads to be slippery	
Extreme Daily Rainfall Events	<ul style="list-style-type: none"> <li>Heavy daily rainfall &gt;200mm increasing in 2020 and 2050</li> </ul>	<ul style="list-style-type: none"> <li>More extreme daily rainfall expected (&gt;200mm) in 2020 and 2050</li> </ul>	<ul style="list-style-type: none"> <li>Recurrent rainfall causes flooding and rain-induced landslide that affects the security and well-being of the people</li> <li>Destroyed crops due to flooded agricultural lands leads to loss of livelihood for the people</li> <li>Coastal flooding will occur and may cause loss of lives</li> </ul>	<ul style="list-style-type: none"> <li>Heavy rainfall causes flooding due to overflowing rivers which destroys agricultural lands</li> <li>Recurrent and heavy rainfall causes landslides that diminishes forest cover thus, ecosystem imbalance may occur</li> <li>Station of rivers and estuaries which results to death of marine species and decrease in marine species</li> </ul>
			<ul style="list-style-type: none"> <li>Disrupts the function of socio-economic support services facilities</li> </ul>	<ul style="list-style-type: none"> <li>Causes flooding and landslide which leads to property loss that affects the local economy</li> <li>Destruction of tourist spots</li> <li>Water contamination which may affect the source of potable water</li> </ul>
				<ul style="list-style-type: none"> <li>Causes flooding that gives rise to problems in the distribution of goods and services (transportation) and property loss that affects the economy of the municipality</li> <li>Impacts on business infrastructures located in floodplains or coastal areas</li> <li>Damaged sea walls due to big ocean waves</li> </ul>
Sea Level		<ul style="list-style-type: none"> <li>Increase in sea level</li> </ul>	<ul style="list-style-type: none"> <li>Submerged low-lying lands which damages the houses along the coast</li> <li>Salt water intrusion to water system near the ocean</li> </ul>	<ul style="list-style-type: none"> <li>Destruction of coastal wetlands and other coastal ecosystems such as mangroves</li> <li>Intrusion of salt water into rice fields and fresh water ecosystems</li> </ul>
			<ul style="list-style-type: none"> <li>Submergence of socio-economic support services facilities near the coastal area</li> </ul>	<ul style="list-style-type: none"> <li>Reduced potable water and food supply</li> <li>Destruction of the wetland ecosystems such as mangroves and coastal ecosystems like the coral decreases the tourism spots in the area</li> </ul>
				<ul style="list-style-type: none"> <li>Increased erosion or damage to coastal infrastructures like roads</li> </ul>

The effect of climate change on mixed-vegetation is expected due to changes in the temperature, rainfall, and climate pattern as a result of which nutrient cycles, microbial activities, as well as physiological activities of plants will vary. Changes in precipitation may change moisture regimes. Soil erosion, salinity, acidity, and other physical and chemical factors may be affected as well. All these factors are closely related to vegetation growth, majority of mixed vegetation in locality is composed of banana, 5,792.148 hectares or 44.59 % of mixed vegetation is exposed to flood with the following levels of exposure to flood. 407.0806 hectares or 3.13% has low level of exposure to flooding, 24.28 percent or 3,153 hectares are in medium level of exposure and only 2,231 hectares or 17.18% has high level exposure to flooding. Estimated 347,528,880 pesos exposed value of mixed vegetation loss due to flooding.

Mixed vegetation has the following levels of susceptibility to landslide; 7,004.2474 hectares or 53.92% has low susceptibility, medium susceptibility has an estimated area of 1,875.3769 or 53.92% and 31.64% or 4,109.2447 hectares of the total mixed vegetation area has high level of susceptibility to landslide. Estimated 779,332,140 pesos exposed value loss of mixed vegetation to landslide. In liquefaction, there are 10,,253.6004 hectares or 78.94% of mixed vegetation is exposed to liquefaction with the following levels of susceptibility, low level susceptibility has an area of 7,570.0917 or 58.28%, while 2,683.5087 hectares or 20.66% has moderate susceptibility, estimated amount of PhP. 615,216,024 are exposed value loss of mixed vegetation to liquefaction.

### **Fisheries (Fish Ponds)**

In relation to fish ponds the top five barangays that are highly exposed to flood which incurred the highest value in terms of replacement cost are Agsalin (P2,761,863.75), Tambong (P1,426,140.00), San Antonio (P871,357.50), Sta. Theresa (547,965.00), and Manguyang (P468,180.00)

Fishponds of the municipality are also susceptible to different hazards. Dominant fishes in the municipality's aqua culture is Tilapia, In the analysis of Gloria 94.76% of the total fishponds of the municipality are exposed to flood with the following levels of susceptibility. Low: 0.1243 ha (0.55%)Moderate: 2.6316 ha (11.73%)High: 18.5113 ha (82.48%) Estimated PhP. 7,177,680 is exposed to a value loss of fisheries to flood. 100% of fish ponds are exposed to low level susceptibility of landslide. Estimated 3,070,216 pesos is exposed to a value loss of fisheries to landslide. 18.115 hectares or 93.18% of fish ponds are exposed to liquefaction with the flowing levels of susceptibility. Low: 12.7821 ha (56.95%)Moderate: 5.3294 hectares (36.23%)Estimated 2,477,653 pesos is exposed to a value loss of fisheries to liquefaction.

### **Forest**

Forest areas are an important factor for the municipality for it caters many of the wonders of nature.The municipality has about 4,799.0028 hectares of forest, this means that the municipality relevantly contributes to the total amount of forest in the country. Given this situation, the forest areas must be taken care of.In case of disasters like flooding and landslide, forest are still prone in this kinds of events.Illegal logging is the major problem constituted to forest areas. Illegal logging can affect forest areas and those that surround it. For the municipality, there is still a problem of having deforested areas. With the present situation of the municipality , there is still no forest ranger at the municipality due to lack of funds.

Approximately 139.659 hectares (2.91%) of forest is exposed to high susceptibility of flood. There are only three barangays which has forest covers that are highly exposed to landslide namely Malayong,Buong Lupa and Manguyang100% of forest is prone to landslide with the following levels of susceptibility. Moderate: 137.8733 ha (2.87%)High: 4661.129 ha (97.13%) 236.4945 (4.93%) of forest has low susceptibility to liquefaction 96.58% or 41,139 individuals are exposed to flood with the following levels of susceptibility.Low: 4,856 individuals (11.40%)Moderate: 25,926 individuals (60.87%)High: 10,357 individuals (24.32%) 100% or 42,594 individuals are exposed to landslide with the following levels of susceptibility Low: 42,580 individuals (99.97%)Moderate: 14 individuals (0.033%) 84.29% or 35,903 individuals are exposed to liquefaction with the following levels of susceptibility.Low: 22,616 individuals (53.10%).

## Adaptive Capacities of Urban Use Areas

Exposure database and adaptive capacity of urban use areas.

EXPOSURE				SENSITIVITY					ADAPTIVE CAPACITY				
Barangay	Area per Land Use description in Hectares	Existing Land Use (specific use)	Replacement Cost per Sq. Meter (PhP)	Percentage living in dwelling units with walls made from light to salvageable materials	Proportion of Buildings in dilapidated/ condemned condition	Structure not employing hazard resistant building design	Structures with no access/ area coverage to infrastructure related mitigation measures	Households living in makeshift house	Construction materials of walls (Residential)	Construction materials of roof	Available alternative sites	Insurance Coverage	Local Government capacity to impose/implement zoning regulations
Agos	0.1311	Commercial	₱15,000.00	44.96%		VERY HIGH	VERY HIGH	0.36%	52.53% of the total number of households (residential) have walls that are made of stone materials (concrete, brick, stone, wood and galvanized iron). On the other hand, 33.02% are made up of light materials (bamboo, sawali, cogon, nipa hut). Houses with strong walls can tolerate higher impact of disasters.	61.09% of households in the municipality have strong materials (concrete, bricks, stones, galvanized iron). For light materials (bamboo, sawali, cogon, nipa hut) are composed of 28.13% of the total households. Stronger materials can withstand higher impacts of disasters.	Alternative sites like barren lands are still available within the municipality which can accommodate existing land uses.	Majority of residential structures do not have property insurances.	Non residential and residential structures are conforming with the zoning ordinance imposed by the municipality. There are regular zoning inspections and buildings with no permit are given enough actions.
			₱15,000.00										
	3.441	Residential	₱15,000.00										
			₱15,000.00										
Agsalin	0.0125	Commercial	₱15,000.00	32.18%		VERY HIGH	VERY HIGH	8.05%					
			₱15,000.00										
	4.1646	Residential	₱15,000.00										
			₱15,000.00										
Alma Villa and Andres Bonifacio	2.8929	Commercial	₱15,000.00	31.11%		VERY HIGH	VERY HIGH	0.50%					
			₱15,000.00										
	10.6098	Residential	₱15,000.00										
			₱15,000.00										
	3.8103	Commercial	₱15,000.00	32.27%		VERY HIGH	VERY HIGH	3.85%					
			₱15,000.00										

Balete	9.8523	Residential	₱15,000.00										
			₱15,000.00										
Banus	0.1916	Commercial	₱15,000.00	21.35%		VERY HIGH	VERY HIGH	4.47%					
			₱15,000.00										
	13.5085	Residential	₱15,000.00										
			₱15,000.00										
Banutan	0.0123	Commercial	₱15,000.00	32.78%		VERY HIGH	VERY HIGH	2.22%					
			₱15,000.00										
	4.1082	Residential	₱15,000.00										
			₱15,000.00										
Bulaklakan	0.4596	Commercial	₱15,000.00	22.43%		VERY HIGH	VERY HIGH	1.35%					
			₱15,000.00										
	3.9857	Residential	₱15,000.00										
			₱15,000.00										
Buong Lupa	NONE	Commercial	₱15,000.00	85.04%		VERY HIGH	VERY HIGH	0.00%					
			₱15,000.00										
	0.1284	Residential	₱15,000.00										
			₱15,000.00										
G Antonino	1.2781	Commercial	₱15,000.00	33.43%		VERY HIGH	VERY HIGH	0.00%					
			₱15,000.00										
	5.3383	Residential	₱15,000.00										
			₱15,000.00										
Guimbonan	0.9336	Commercial	₱15,000.00	38.75%		VERY HIGH	VERY HIGH	0.37%					
			₱15,000.00										





			₱15,000.00										
Malubay	0.0321	Commercial	₱15,000.00	62.98%		VERY HIGH	VERY HIGH	0.00%					
			₱15,000.00										
	3.6965	Residential	₱15,000.00										
			₱15,000.00										
Manguyang	1.8665	Commercial	₱15,000.00	54.52%		VERY HIGH	VERY HIGH	2.62%					
			₱15,000.00										
	4.8873	Residential	₱15,000.00										
			₱15,000.00										
Maragooc	0.005	Commercial	₱15,000.00	44.97%		VERY HIGH	VERY HIGH	0.34%					
			₱15,000.00										
	7.8697	Residential	₱15,000.00										
			₱15,000.00										
Mirayan	0.0146	Commercial	₱15,000.00	90.08%		VERY HIGH	VERY HIGH	0.00%					
			₱15,000.00										
	0.673	Residential	₱15,000.00										
			₱15,000.00										
Narra	1.6042	Commercial	₱15,000.00	30.08%		VERY HIGH	VERY HIGH	0.19%					
			₱15,000.00										
	6.6766	Residential	₱15,000.00										
			₱15,000.00										
Papandungin	1.1731	Commercial	₱15,000.00	42.16%		VERY HIGH	VERY HIGH	8.58%					
			₱15,000.00										
	3.9421	Residential	₱15,000.00										
			₱15,000.00										
San Antonio	1.5965	Commercial	₱15,000.00	35.91%		VERY HIGH	VERY HIGH	0.70%					
			₱15,000.00										

	2.5403	Residential	₱15,000.00											
			₱15,000.00											
Sta Maria	0.6949	Commercial	₱15,000.00	24.83%		VERY HIGH	VERY HIGH	0.22%						
			₱15,000.00											
	14.5074	Residential	₱15,000.00											
			₱15,000.00											
Sta Theresa	0.0538	Commercial	₱15,000.00	26.55%		VERY HIGH	VERY HIGH	0.00%						
			₱15,000.00											
	5.4288	Residential	₱15,000.00											
			₱15,000.00											
Tambong	0.6647	Commercial	₱15,000.00	17.94%		VERY HIGH	VERY HIGH	0.16%						
			₱15,000.00											
	13.1134	Residential	₱15,000.00											
			₱15,000.00											

## Urban Use Area Adaptive Capacity

In the case of the urban areas, commercial and residential areas have been vulnerable to hazards through the years because of the constant changes in the environment. Adaptive measures like developing the foundation and walls of buildings have been employed to increase its resiliency to disasters. These adaptive measures are difficult to be realized especially if the community have no funds for development projects and plans.

In the case of the houses in the municipality, most of the houses are only made from light to salvageable materials. Barangay Mirayan had the most people living in dwelling units made from light materials with 90.08% followed by Buong Lupa with 85.04% and by Malubay with 62.98%. There are also households living in makeshift houses. The most households living in makeshift houses are found in Barangay Maligaya with 16.60% followed by Lucio Laurel with 14.09% and Papandungin with 8.58%. Majority of residential structures does not have property insurances as well.

Another problem is that all the structures in every barangay are not employed with hazard resistant building design as well as structures without access or area coverage to infrastructure related mitigation measures. These structures are highly vulnerable to disasters. In the case for the materials used for walls, 52.53% of the total number of households (residential) have walls that are made of strong materials (concrete, brick, stone, wood and galvanized iron). On the other hand, 33.02% are made up of light materials (bamboo, sawali, cogon, nipa). Houses with strong walls can tolerate higher impact of disasters. The materials used for roofing is also an important factor for adaptive capacity building. A total of 61.09% of households in the municipality have strong materials for roof (concrete, bricks, stones, galvanized iron). For light materials (bamboo, sawali, cogon, nipa hut) are composed of 28.13% of the total households. Stronger materials can withstand strong gusts of winds and heavy rainfall.

Alternative sites in the municipality like barren lands are still available within the municipality which can accommodate existing land uses. These areas can be used as relocation sites and as reserved lands for future Disaster Risk Reduction and Mitigation projects. The municipality also sees to it that the non-residential and residential structures are conforming to the zoning ordinance. There are regular zoning inspections and buildings with no permit are given just punishment in accordance to the law.

## Adaptive Capacity of Population

### Exposure database and adaptive capacity of the population

Barangay	EXPOSURE			SENSITIVITY						ADAPTIVE CAPACITY								
	Barangay Population	Estimated Residential Area (Hectares)	Residential Area to Population Density (Population/Area)	Percentage of Informal Settlers	Percentage living in dwelling units with walls made from light to salvageable materials	Percentage of young and old dependents	Percentage of persons with disabilities	Percentage below the Poverty Threshold	Percentage Malnourished Individuals (Severe)	Employed members of the labor force	Nature of employment	Households with access to electricity	Access to information	Literate persons 10 years old and above	Households who have disaster preparedness kit	Government capacity to generate jobs	Philhealth coverage	Government financial Assistance
Agos	1218	3.441	353.96687	1.80%	44.96%	39.90%	1.41%	66.55%	2.97%	91.96% of the labor force of the municipality is employed. A labor force member includes all members 15 years old and above who are currently working or actively seeking for work.	60.27% of the employed members of the labor force are permanently employed while 37.21% are short-term, seasonal or casual. On the other hand, only 6.42% are working on different jobs on day to day or week to week basis.	77.29% of the total households in the municipality have an access to electricity. Televisions, radios, computers are important media for information during the occurrence of disasters.	62.4% of the total population has a television, 14.4% has a radio, 39.29% has cell phones, 3.58% has an internet connection and 0.59% has a telephone.	97.27% of the total population (10 years old and above) are literate. Meaning they can read and write simple messages in any language or dialect. This implies that high number of the population can easily understand information vital for disaster preparedness. Furthermore, they have more basic knowledge on survival.	14.92% of the households has a disaster preparedness kit. Disaster preparedness kit includes materials that are needed when a certain disaster strikes the municipality.	The municipality has enough job offers to provide for the labor force population. The government of Gloria provides livelihood trainings such as cell phone repair training for the PWDs, tailoring training each barangay, making of eco bags, snack food and products packaging and sustainable livelihood program for the members of 4Ps.	To date, there are 10,979 individuals or approximately 25.78% of the population have Philhealth coverage.	3,399 families are members of the government's 4Ps or Pantawid Pamilyang Pilipino Program.
Agsalin	694	4.1646	166.64265	1.15%	32.18%	39.05%	1.58%	60.34%	2.02%									
Alma Villa and Andres Bonifacio	2546	10.6098	239.96682	7.16%	31.11%	40.30%	3.07%	61.23%	1.12%									
Balete	2621	9.8523	266.02925	4.85%	32.27%	39.83%	1.42%	59.53%	0.00%									
Banus	2104	13.5085	155.75378	2.44%	21.35%	43.58%	0%	54.27%	0.38%									
Banutan	742	4.1082	180.61438	0.00%	32.78%	42.72%	0.13%	72.78%	0.00%									
Bulaklakan	1025	3.9857	257.16938	5.83%	22.43%	39.22%	0.00%	59.64%	2.72%									



Buong Lupa	1045	0.1284	8138.6293	34.19%	85.04%	45.55%	0.67%	72.22%	0.00%									
G Antonino	1551	5.3383	290.54193	1.97%	33.43%	35.14%	1.14%	48.60%	0.90%									
Guimbonan	1076	4.6732	230.24908	0.00%	38.75%	39.87%	0.38%	66.42%	0.00%									
Kawit	1844	6.2879	293.26166	0.00%	27.93%	38.18%	0.38%	61.49%	0.87%									
Lucio Laurel	2442	12.8757	189.65959	12.54%	29.55%	39.19%	1.58%	54.30%	0.32%									
Macario Adriatico	1095	3.8314	285.79631	0.82%	29.92%	36.53%	0.74%	52.87%	0.72%									
Malamig	2673	7.0791	377.59037	0.81%	36.81%	43.02%	0.00%	65.31%	0.00%									
Maligaya	3106	18.3369	169.38523	2.49%	23.27%	39.12%	1.47%	34.63%	0.25%									
Malayong	1208	3.7352	323.40972	6.44%	54.93%	45.20%	0.42%	75.00%	0.00%									
Malubay	1226	3.6965	331.66509	3.44%	62.98%	37.77%	0.50%	63.36%	0.00%									
Manguyan	1551	4.8873	317.35314	11.66%	54.52%	41.20%	0%	64.43%	0.85%									
Maragooc	1221	7.8697	155.15204	2.35%	44.97%	41.52%	4.28%	56.04%	0.54%									
Mirayan	996	0.673	1479.9406	0.79%	90.08%	42.17%	0.10%	72.62%	0.00%									

Narra	2247	6.6766	336.54854	1.37%	30.08%	39.02%	1.39%	67.97%	0.00%									
Papandun gin	1033	3.9421	262.04307	1.12%	42.16%	37.95%	1.18%	67.91%	0.77%									
San Antonio	1182	2.5403	465.29937	0.00%	35.91%	38.75%	0.94%	70.07%	2.81%									
Sta Maria	1880	14.5074	129.58904	0.45%	24.83%	38.62%	0.50%	43.40%	0.00%									
Sta Theresa	1454	5.4288	267.83083	10.73%	26.55%	40.51%	0.42%	59.04%	1.77%									
Tambong	2814	13.1134	214.58966	11.43%	17.94%	36.46%	1.15%	41.90%	0.00%									

## Population Sensitivity and Adaptive Capacity

The sensitivity table of population is composed of six elements namely the percentage of informal settlers, percentage living in dwelling units with walls made from light to salvageable materials, percentage of young and old dependents, percentage of persons with disabilities, percentage below the poverty threshold and percentage of malnourished individuals (severe cases). These elements are measures of vulnerability since these factors tackle the weaknesses that alter the capacity of the population to rise again when disaster strikes. The percentage of informal settlers imply that certain part of the population are living on land that they do not own therefore, there is a bigger chance that they will build their houses from materials that are temporary using light to salvageable materials. When calamity occurs, these houses are more prone to damage. The top three barangays with the highest percentage of informal settlers are Buong Lupa (34.19%), Lucio Laurel (12.54%) and Manguyang (11.66%). While barangays with the highest percentage living in dwelling units with walls made from light to salvageable materials are Mirayan (90.08%), Buong Lupa (85.04%) and Malubay 92.98%).

Percentage of young and old dependents, percentage of persons with disabilities, percentage below the poverty threshold and percentage of malnourished individuals (severe cases) are elements that show the most vulnerable sector of the community. Young and old dependents are composed of 0-14 years old and 60 years old and above. This part of the sector is usually those who do not earn and is depend financially to others. People that belong to the poverty threshold are those who earn either just enough or less than what they need every day. Finance is needed when calamity strikes for the repair of damages, to buy supplies and to continue livelihood. Without enough finances, the population living in the poverty threshold and with the most number of dependent population can be severely affected. Given the data, Malayong (75%), Mirayan (72.62%) and Buong Lupa (72.22%) are the top three barangays with the highest percentage of poverty threshold. Furthermore, Buong Lupa (45.55%), Malayong (45.20%) and Banus (43.58%) have the highest number of young and old dependent population.

Percentage of persons with disabilities is also taken into consideration. Parts of the population who are disabled need more attention and are harder to evacuate when calamity strike. Barangay Maragooc (4.28%), Barangay Alma Villa and Andres Bonifacio (3.07%), Lucio Laurel and Agsalin (1.58%) have the highest percentage of people with disabilities. The last element for vulnerability is the percentage of malnourished individuals (severe cases). Poverty is directly proportional to the number of malnourished individuals; the higher the percentage of malnourished individuals, the higher the incidence of poverty. If these people do not have enough money to buy basic needs like food, it will be harder for them to recover from a disaster.

Given this vulnerability or sensitivity, there are adaptive measures that can help decrease the risk from a hazard. Employment rate of the municipality is high reaching 91.96% of the total labor force. This implies that a high number of the population is financially independent from the government; there is a high number of the population that has source of income. Furthermore, 60.27% of the employed labor force are permanently employed. Based on the data, the municipality of Gloria has the capability to provide jobs for its people. There are livelihood trainings for PWDs, women, and members of 4Ps that can help add to their income. Employment and source of income is a good indicator of one's adaptive capacity. It shows that a certain population has the capability to get through a calamity. Moreover, this is also an implication that when disaster occurs, less people will be dependent to the government for

financial support and aid.

A total of 77.29% of the population has an access to electricity. To add up, 62.4% of the total population has television, 14.4% has a radio, 39.29% has cellphones, 3.58% has an internet connection and 0.59% has a telephone. These medium of communication are helpful source of information when disaster arrives. These are helpful in giving updates of the current situation of the community. Literacy also plays a big role in adaptive capacity. As per record, 97.27% of the total population (10 years old and above) are literate. Reading and writing skills are essential for survival and can be used to disseminate necessary information.

The government also provides financial assistance to its people. A total of 3,399 families are members of the government's 4Ps or Pantawid Pamilyang Pilipino Program. Livelihood and extra financial aid are given to these families that can be used to purchase food, medical kits and other necessities to survive. Also, to date, there are 10,979 individuals or approximately 25.78% of the population have PhilHealth insurance coverage. Diseases are rampant in times of calamities but with Philhealth, it can help decrease medical expenses. Lastly, 14.92% of the households have a disaster preparedness kit. Disaster preparedness kit contains things that are vital for survival. These include canned goods, matchstick, candles and other necessities. These things can help ease hunger or survive the impacts of calamity.

### Adaptive Capacity of Natural Resource Based Production Areas Rice, Agricultural Mixed Vegetation and Fisheries

Exposure database and adaptive capacity of the natural resource based production areas (rice, agriculture mixed vegetation and fisheries).

	EXPOSURE			SENSITIVITY						ADAPTIVE CAPACITY			
Barangay	Area by Dominant Crop (Hectares)	Dominant Crop/Fish	Average output per hectare	Number of Farming Families who attended climate field school	Proportion of farming families using sustainable production on techniques	Number of farmers with access to hazard information	Number of production areas with flood infrastructure coverage	% Areas with Irrigation Coverage	% Areas with water Impoundment	Number of Farming Families with access to Early Warning System.	Access to insurance	Alternative Livelihood	Agriculture programs
Agos	128.9029	RICE	₱136,800.00	<5%	None	100%	None	100%	None	100% of farming families have access to early warning systems (EWS) related to agricultural production. The barangay leaders give early notice to the community whenever there is a disaster coming.	Only 10% of the total agricultural lands (rice and mixed vegetation) are covered by insurance. The municipality encourages farmers to avail insurance so that in case of disaster and agriculture products are damaged, farmers can get 20,000 pesos for 1 hectare of rice, 150 pesos per fruit tree, 9,000 pesos for 1 hectare of high valued crops, 15,000 for livestock's, 12,500pesos for pigs and 2,000 pesos for goats.	There are programs offered by the Municipality Agricultural Office as alternative livelihood. Programs like chicken and goat dispersal, payoutang of seeds and fertilizers, fish processing, carpentry and masonry trainings.	The Municipality Agriculture office imposes a program called "Plant now, pay later" encourages farmers with no capital to plant rice or other agricultural products. Infrastructure programs like Farm to Market road are also implemented across the municipality for better transport of agricultural products.
	333.7342	COCONUT	₱105,000.00										
	2.2555	TILAPIA	₱337,500.00										
Agsalin	85.5284	RICE	₱136,800.00	None	None	100%	None	100%	None				
	219.0437	COCONUT	₱105,000.00										
	8.1833	TILAPIA	₱337,500.00										
Alma Villa and Andres Bonifacio	287.7753	RICE	₱136,800.00	None	None	100%	None	100%	None				
	258.1722	COCONUT	₱105,000.00										
	0.9883	TILAPIA	₱337,500.00										
Balete	208.1929	RICE	₱136,800.00	None	None	100%	None	100%	None				
	196.5497	COCONUT	₱105,000.00										
Banus	104.8277	RICE	₱136,800.00	None	None	100%	None	100%	None				
	357.161	COCONUT	₱105,000.00										



	0.0249	TILAPIA	₱337,500.00										
Banutan	129.9452	RICE	₱136,800.00	None	None	100%	None	0%	None				
	187.0658	COCONUT	₱105,000.00										
	0.0564	TILAPIA	₱337,500.00										
Bulaklakan	0.0015	RICE	₱136,800.00	None	None	100%	None	0%	None				
	205.152	BANANA/ VEGETABLES	₱180,000.00										
Buong Lupa	49.9964	RICE	₱136,800.00	None	None	100%	None	100%	None				
	2628.7286	BANANA	₱60,000.00										
	2090.3688	TIMBER	₱250,000.00										
G Antonino	184.8038	RICE	₱136,800.00	None	None	100%	None	99.51%	50%				
	145.6782	COCONUT	₱105,000.00										
Guimbonan	67.1235	RICE	₱136,800.00	None	None	100%	None	100%	None				
	125.7205	COCONUT	₱105,000.00										
	0.4497	TILAPIA	₱337,500.00										
Kawit	133.6553	RICE	₱136,800.00	None	None	100%	None	96.25%	None				
	167.6445	VEGETABLES	₱300,000.00										
Lucio Laurel	355.6432	RICE	₱136,800.00	None	None	100%	None	100%	None				
	44.0216	VEGETABLES	₱300,000.00										
	0.1716	TILAPIA	₱337,500.00										
Macario Adriatico	32.1314	RICE	₱136,800.00	None	None	100%	None	24.10%	None				
	229.5698	COCONUT	₱105,000.00										
Malamig	0.6289	RICE	₱136,800.00	None	None	100%	None	100%	None				

	652.9181	COCONUT	₱105,000.00										
Maligaya	62.4962	RICE	₱136,800.00	None	None	100%	None	100%	None				
	156.3134	COCONUT	₱105,000.00										
Malayong	33.6173	RICE	₱136,800.00	None	None	100%	None	90%	None				
	1422.3609	VEGETABLES	₱300,000.00										
	0.0493	TILAPIA	₱337,500.00										
	2129.9117	TIMBER	₱250,000.00										
Malubay	100.2879	RICE	₱136,800.00	None	None	100%	None	57.06%	60%				
	361.5375	BANANA	₱60,000.00										
Manguyang	65.7362	RICE	₱136,800.00	None	None	100%	None	86.90%	None				
	1781.691	BANANA	₱60,000.00										
	1.8331	TILAPIA	₱337,500.00										
	578.7218	TIMBER	₱250,000.00										
Maragooc	21.5571	RICE	₱136,800.00	None	None	100%	None	72.22%	None				
	378.7573	COCONUT	₱105,000.00										
Mirayan	131.3304	RICE	₱136,800.00	None	None	100%	None	60.98%	None				
	1544.6478	BANANA	₱60,000.00										
Narra	16.4799	RICE	₱136,800.00	None	<5%	100%	None	93.90%	None				
	442.4617	VEGETABLES	₱300,000.00										
Papandungin	159.1092	RICE	₱136,800.00	None	None	100%	None	100%	None				
	146.1694	VEGETABLES	₱300,000.00										
San Antonio	263.5971	VEGETABLES/ CORN	₱230,000.00	None	None	100%	None	0%	None				

	2.5818	TILAPIA	₱337,500.00										
Sta Maria	40.0183	RICE	₱136,800.00	None	None	100%	None	88.66%	None				
	459.9835	COCONUT	₱105,000.00										
Sta Theresa	146.2312	RICE	₱136,800.00	None	None	100%	None	100%	None				
	111.3413	COCONUT	₱105,000.00										
	1.6236	TILAPIA	₱337,500.00										
Tambong	8.5719	RICE	₱136,800.00	None	None	100%	None	0%	None				
	168.8525	VEGETABLES	₱300,000.00										
	4.2256	TILAPIA	₱337,500.00										

## **Natural Resources Adaptive Capacity**

### **Rice, Agricultural Mixed Vegetation and Fisheries**

Whether a barangay is highly, moderately or unlikely to be affected by a disaster, adaptive measures have been set up to reduce the severity of the consequences a disaster may bring. In the case of the municipality of Gloria, the natural resources that have been identified to be most valuable to be assessed in terms of its capability to adapt to sudden changes in the environment are the rice fields, mixed vegetation, fish ponds and forests.

Various methods, plans and programs are now being used by all the barangays in the municipality to increase their capacity to adapt to the impacts of disasters. It aims to make the farmers and fishermen be less vulnerable to any hazard present in the community. Farming families, for example, are given options to attend seminars in the Climate Field School regarding climate change and inform them on what they can do to save and protect their agricultural lands. Only less than five percent (5%) of the farming families in barangay Agos have been able to attend it as well as the sustainable production techniques taught to the farmers of barangay Narra, but the municipality is doing its best to reach out to the other farmers to help them. In a matter of fact, in terms of hazard information, all the farmers of each barangays are knowledgeable of it. Also, all the farming families have access to Early Warning Systems (EWS) related to agriculture production. Whenever there is a disaster coming, barangay leaders give early notice to the community.

The municipality also encourages the farmers to avail insurances so when agricultural products are damaged during calamities, they will be able to receive ₱20,000.00 for a hectare of rice, ₱150.00 per fruit tree, ₱9,000.00 per hectare of high valued crops, ₱15,000.00 for livestock, ₱12,500.00 for pigs and ₱2,000.00 for goats. Insurances for the fishermen are also available where the boats are replaced or repaired if damages have been incurred during a disaster.

Programs are also offered by the Municipal Agricultural Office (MAO). These are alternative livelihood programs which includes chicken and goat dispersal, loan for seeds and fertilizers, fish processing, carpentry and masonry trainings. There is also a program called "Plant Now, Pay Later", it encourages farmers with no capital to plant rice or other agricultural products. Infrastructure programs like Farm to Market road are also implemented across the municipality for better transport of agricultural products. The local government of Gloria in partnership with the Department of Environment and Natural Resources are doing programs for the protection of forest areas. DENR is responsible of the higher part of the forest while the LGU of Gloria is in charge of the lower part. The DENR is doing re-greening programs while the municipality is doing tree planting programs. Unfortunately, the maintenance of the trees being planted is poor since the seedlings are not well taken care of. There is also a program and policy that prohibits illegal logging in the municipality but still, illegal logging is rampant. There are on-going cases against illegal loggers but most of them are not given just punishment. At present, there is no forest ranger stationed in the forest since there is no budget for their honorarium.

There are still projects that needs to be done like flood infrastructure coverage for production areas, water impoundment system and irrigation coverage all over the municipality.

## Forest

### Exposure database and adaptive capacity of the natural resource based production areas

	EXPOSURE				SENSITIVITY					ADAPTIVE CAPACITY			
Barangay	Area by Dominant Trees (Hectares)	Exposed Area <sub>1</sub> (Hectares)	Exposure Percentage <sub>2</sub>	Average Potential Income per Hectare per year (Php)	Number of Farming Families who attended climate field school	Proportion of farming families using sustainable production on techniques	Number of farmers with access to hazard information	Number of production areas with flood infrastructure coverage	Number of Farming Families with access to Early Warning System	Government programs	Monitoring of logging		
Buong Lupa	2090.3688	1950.710	93.32%	₱250,000.00	None	None	100%	None	100%	The local government of Gloria in partnership with the Department of Environment and Natural Resources are doing programs for the protection of forest areas. DENR is responsible of the higher part of the forest while LGU of Gloria is in charge of the lower part. The DENR is doing greening program in the higher parts of the forest municipality is doing tree planting programs in the lower part. Unfortunately, the maintenance of the trees being planted are poor since there is a high mortality of trees because the communities and barangays in charge of the maintenance neglect to take care of the seedlings.	There is a program and policy that prohibits illegal logging in the municipality. Unfortunately, illegal logging is still rampant. There are on going cases against illegal loggers but most of them are not given enough punishment. Still, illegal logging is still going. At present, there is no bantay gubat in the forest since there is no budget for the honorarium of bantay-gubat.		
		0	0.00%	₱250,000.00									
		0	0.00%	₱250,000.00									
		139.659	6.68%	₱250,000.00									
Malayong	2129.9117	2129.912	100.00%	₱250,000.00	None	None	100%	None	100%				
		0	0.00%	₱250,000.00									
		0	0.00%	₱250,000.00									
		0	0.00%	0									
Manguyang	578.7218	578.7218	100.00%	₱250,000.00	None	None	100%	None	100%				
		0	0.00%	₱250,000.00									
		0	0.00%	₱250,000.00									
		0	0.00%	₱250,000.00									



## Forest Adaptive Capacity

Forest areas are an important factor for the municipality for it caters many of the wonders of nature. In the country, there are degrading numbers of forest areas due to illegal logging. The municipality has about 4,799.0028 hectares of forest areas, this means that the municipality relevantly contributes to the total amount of forest areas in the country. Given this situation, the forest areas must be taken care of. In cases of disasters like flooding and landslide, forest areas are still prone to these kinds of events. With the level of sensitivity factor that were given in table 126, there were only less than 5% of families who attended climate field school which only took place in Barangay Agos. It means that there are only few families who had the chance to know and be informed about climate field school and what help it can offer to people in cases of disaster.

In land use planning, mitigation of climate change can be done by the identification of forest areas, and also the adaptation to climate change. When it comes to sustainable production techniques, there are only less than 5% of families who uses this. It means that the knowledge of using this kind of techniques are not yet properly disseminated to the farming families. Even with these, there is still a 100% access of farming families to hazard information and access to early warning system.

Adaptation capacities can help the municipality plan on how to handle the impacts of disaster. Government programs are done for the protection of forest areas; this is in partnership with the Department of Environment and Natural Resources. The higher areas of the forest in the municipality are being maintained by the DENR with the re-greening program. On the other hand, the LGU maintains the lower parts of the forest through the tree planting activities but unfortunately, there is a problem with the maintenance of the seedlings. The barangays who are in charge of taking care of the seedlings are not able to properly take care of it. Illegal logging is the major problem constituted to forest areas. Illegal logging can affect forest areas and those that surround it. For the municipality, there is still a problem of having deforested areas. With the present situation of the municipality, there is still no forest ranger at the municipality due to lack of funds.

### Adaptive Capacities of Critical Point Facilities

Exposure database and adaptive capacity of critical point facilities.

EXPOSURE				SENSITIVITY				ADAPTIVE CAPACITY	
Facility Type	Storey	Area Occupied	Number of Classrooms/ Rooms/ Bed Capacity	Wall Materials	Existing Condition	Employing Hazard Resistant Design	Wall Materials	Local Government Resources for risk mitigation	Presence of other agencies
Barangay Hall		0						The local government has a calamity fund of 5% of the total overall budget. This budget is being used to repair government establishments when damaged by disaster. Majority of the schools are either privately owned or managed by the regional DEPED.	There is a KALAHI CIDDs in the municipality that provides assistance for disaster. This agency helps in repairing government buildings, schools if need assistance. KALAHI CIDDs also builds evacuation centers that can be used in times of disasters. Before building evacuation centers, the agency make a study and inspection to the site to make sure that the site is not prone to any disasters.
Health Center	1	0	0						
Day Care Center		0							
Agos Elementary School	1	6,999 sq. meters	8						
Barangay Hall									
Senior Citizen									
Agsalin Elementary School	1	1 hectare	4						
Lighthouse	1	0.007	0						
Alma Villa Barangay Hall									
Andres Bonifacio Barangay Hall									
Alma Villa Elementary School		7,300 square meters	7						
Batingan Elementary School	1	1 hectare	6						
Chuch	1	0.0009	0						
Barangay Hall									
Day Care Center									
Balete Elementary School	1	5,000 square meters	15						
Banus Elementary School	1	1.3 hectares	13						

Banutan Elementary School	1	1 hectare	10				
Barangay Hall							
Day Care Center	1		0				
Bulaklakan Primary School		9,600 square meters	3				
Pres. Diosdado Macapagal National High School		1.35 hectares	24				
Barangay Hall	1		0				
Erhard Science and Technological School		9,600 square meters					
Barangay Hall							
Buong Lupa Elementary School,	1	1 hectare	6				
Barangay Hall							
Senior Citizen	1		0				
Tinalunan Elementary School	1	7,091 square meters	9				
Barangay Hall	0	0.0071	0				
Manuel Sadiwa Memorial Elementary School		1 hectare					
Lighthouse	0	0.0823	7				
Church	0	0	0				
Barangay Hall							
Day Care Center	1		0				
Kawit Elementary School	0	1,080 square meters	7				
Don Juakin Roque Memorial Elementary School	1	1 hectare	17				
Barangay Hall							
Oriental Mindoro Institute		1,400 square meters	5				
Lighthouse	1						
Barangay Hall							

Melecio D. Cantos Elementary School	1	1 hectare	7				
Day Care Center	1		0				
Barangay Hall	1		0				
Malamig Elementary School		1 hectare	17				
Malamig National Highschool	0	2 hectares	10				
Barangay Hall, Health Center	1		0				
Municipality Hall							
Center for Excellence Development Academy		600 square meters	3				
Nursery, PDMNH, Banks, FAITH, Senior Citizen, Pro. Vet Office							
Jesus M. Punzalan Covered Court, Tourism, DSWD, DRRM, Rural Health unit, Senior Citizen, Church, Barangay Hall	1		0				
Gloria Central School		1.5 hectares	29				
Sacred Heart Academy Elementary School		1 hectare	7				
Sacred Heart Academy	1	1 hectare	16				
Barangay Hall							
Health Center	1						
Malayong Elementary School	0	1 hectare	7				
Malubay Elementary School	0	1 hectare	8				
Manuel Adriano Memorial National High School	1	3 hectares	8				
Barangay Hall, Church	1		0				
Pakpak Lawin Elementary School		5,000 square meters	2				
Barangay Health Center, Day Care Center, Multipurpose Hall	1						
Manguyang Elementary School	1	1 hectare	9				
Barangay Health Center							

Maragooc Elementary School		3,000 square meters	7				
Day Care Center, Barangay Hall, Multipurpose Hall	1						
Barangay Hall							
Mirayan Elementary School		5,361.5 square meters	7				
Military Camp	1						
Barangay Hall							
Malusak Elementary School	1	1 hectare	12				
Barangay Hall							
Papandungin Elementary School	1	1 hectare	10				
Day Care Center							
Barangay Hall							
Dalagan Elementary School	1	5,000 square meters	7				
Barangay Hall, KALAH Training center	1		0				
Bulbugan National High School	1	1 hectare	20				
Barangay Hall							
Langgang Elementary School	1	1.2 hectares	7				
Barangay Hall							
Day Care Center							
Tambong Elementary School	1	5,200 square meters	10				

## **Critical Point Facilities Adaptive Capacity**

At present these facilities are still safe as evacuation sites but in the coming years the impacts of disaster will worsen and the critical point facilities will also be affected. But at present the purpose these facilities are still used. The main facilities that the municipality classifies as evacuation sites in terms of disasters are schools, local government buildings and churches.

All the barangays in the municipality of Gloria have schools, churches and local government buildings like Barangay hall and health center for evacuation sites, but the most common evacuation center are the schools. The schools that are high risk to flooding are Manuel Sadiwa Memorial Elementary School in Guimbonan, Kawit Elementary School, Maligaya Central School, Langgang Elementary School in Sta. Theresa and Tambong Elementary School; this means that all of the said school is incapable of sheltering the residents in the near future whenever a disaster, like flooding, happens. On the other hand, the safest barangay in the municipality in case flooding occurs is in Malubay since their barangay hall, churches and health center is not affected by this. Moreover, the schools, churches and local government buildings in the municipality of Gloria are with low susceptibility, this means that the likelihood of occurrence of having landslide is low. In the case of having liquefaction in the municipality, the probability is low since liquefaction only occurs every 100 years.

On the other hand, the local government has risk mitigation in case these disasters happen. The local government has a calamity fund of 5% of the total overall budget. This budget is used to repair government establishments in case of damage brought by natural calamities. There is also a KALAHI CIDDs in the municipality that provides assistance in the repair of buildings and schools affected by natural calamities, as well as building evacuation centers that can be used in times of calamity. Prior to the construction of proposed evacuation centers, the agency studies and inspects the site to secure that the location of interest is not, in anyway, at risk itself to the effects of any natural calamity.

## **Summary of Land Use Constraints**

Based on the findings, all barangays experience flooding but those who are situated near the river banks and coastal areas have the highest susceptibility to flood. Barangay Buong Lupa, Malayong, Manguyang, Malamig, and Mirayan experience landslide however barangay Buong Lupa, Malayong, Manguyang have the highest susceptibility to landslide since they are located at high terrain areas. Liquefaction only occurs every 100-200 years, consequently most of the barangays are lowly susceptible to liquefaction while the rest are moderately susceptible.

Almost all the barangays do not have protection dikes and proper drainage systems, consequently, when heavy rainfall occurs especially in the mountain areas the rain water cannot flow properly through the rivers and creeks. The major river in the municipality, Baleta River, is shallow and wide which causes it to easily overflow. In addition, lands along the riversides are deep so when the river overflows the water will flow towards the community. The logs due to illegal logging and wastes also contribute to the overflowing of rivers. Considering these factors the low-lying barangays are greatly affected by flooding since the water cannot flow properly towards the ocean. As a result, the water flows towards the barangays near the rivers and creeks. On the other hand, when heavy rainfall and storm surge are present severe flooding will occur in the coastal barangays.

In contrast, when flooding occurs great number of the population will be affected. There is a possibility of an aftermath of water contamination that can bring illnesses like water borne diseases. Moreover, there is a significant number of severely malnourish which lowers the municipality's adaptive capacity, thus making them more prone to hazards. People who are below the poverty threshold are most vulnerable to calamities. Daily activities of people residing in the affected sitios are severely affected.



Natural Resource Based Production Areas like agricultural lands could be easily flooded and damage due to lack of drainage and sewage systems. Lack of forest cover may also contribute to low land flooding. It is expected to have a high damage to crops since farmers in some barangays do not practice sustainable farming. I return there will be a great economic loss in the municipality. Thus, majority of the farmers have no capacity to start again when calamity strikes.

Urban Use Areas including commercial and residential infrastructures are likewise significantly affected by flooding. Majority of the infrastructures in the municipality are made from light to salvageable materials which are more prone to damage. If these infrastructures are damaged or destroyed there is a need for financial assistance from the government. There is a lack of flood resistant design regulations that increases the risk and exposure of residential and commercial areas. Disruption of activities in most commercial areas will happen.

Some of the critical point facilities present in the municipality that is exposed to hazards is not safe as evacuation centers. For each barangays, most of the facilities are not enough to accommodate evacuees during calamities. There are lots of basketball courts in the municipality that can be used as an evacuation centers however most of them are not covered. Some of the facilities in the municipality are highly or moderately susceptible and are at high risk to hazards. Lack of lots and budgets prevents the barangays to construct and improve their evacuation sites.

The Lifeline Utilities covers the road network system. In terms of disaster, roads play a very serious role for it will be a way to rescue the people and it links other important nodes within the municipality. When flooding occurs some of the roads in the municipality are disrupted causing difficulty in evacuation and response. Also it causes delay in exporting goods and services. Furthermore, most of the roads are not cemented which are easily damage by flooding thus it is prone to road accidents especially when slippery. Some roads in the municipality have low elevations which are easily flooded.

High terrain areas are high susceptible to landslide. Due to heavy rainfalls rain-induced landslide may occur. In the municipality there are only three barangays that are located in high terrain areas and are highly susceptible to landslide which are; barangay Buong Lupa, Malayong and Manguyang while barangay Malamig and Mirayan are the nearby barangays that also experiences landslide despite being moderately susceptible. Due to illegal logging and Kaingin the forest cover decreased over the past years. In times of disaster, it is hard for the people to ask assistance since they do not have good source of communication. In agricultural areas, damages to crops are expected. When it comes to road networks, concrete roads are destroyed due to landslide.

There are no recorded data about liquefaction in the municipality. However, the total land area (100%) of barangays Alma Villa and Macario Adriatico are moderately susceptible to liquefaction.

There are several interventions in each barangays to mitigate the effects of hazards. Only a few barangays have early warning systems but majority plan to have so such as sirens, rain gauge, bridge with water levels, and catch basins. Most of the barangays also have equipment for disaster preparedness such as multi-cabs, megaphones, sound systems, and disaster preparedness kits. Moreover, in the municipal level there are available rescue vehicle and boats ready for calamities. Seminars on disaster preparedness and climate change are provided by the municipality. There are also plans to construct proper drainage systems and protection dikes to minimize the overflow of river systems. There are also irrigation systems that can help control the flow of water in the rice fields. Seminars regarding organic and sustainable farming are also provided by the agriculture sector. There is available crop insurance per hectare but it is limited for one use. In urban areas, most of the residents expand their houses to two-story. Some houses are already sturdy and can withstand calamities. Some barangay have plans to construct evacuation sites that can accommodate large number of evacuees. There are already existing road concreting projects in some barangays.

Overall, the municipality has a disaster risk reduction management council that plans and provides equipment in relation to disasters and an operation center which can be used during disasters. Some disaster equipment available are; aluminum stretcher, chain saws, fire equipment, first aid kits, harness, life vests, lifebuoy, siren, two-way radios, generator sets, rescue vehicles, rescue boats, flood lights, motorcycle etc. In the barangay level, there are allocated funds for disasters provided which can be used to pursue future plans and projects. Even though the municipality already have mitigation measures and practices it is not enough to withstand the impacts of disasters.

## **Recommendations for Climate Chain Adaptations**

### **Agriculture**

Rice, corn, banana, coconut and vegetables are the dominant crops planted in the agricultural lands of the municipality of Gloria. The forest and ocean surrounds the municipality making it vulnerable to various hazards. The impacts of hazards could be minimized to lessen threatening the community. An example of this is a coping mechanism to maximize the production of crops even during the long dry and wet seasons. By 2020 it was foreseen that there will be less rainfall and increase in temperature. Agricultural crops like Cashew, Mango, Santol, Star Apple, Siniguelas, Okra, Eggplant, Cowpea, Lima Beans, Pepper, Tomato, Cucumber and Watermelon are advisable to be planted. Rice varieties tolerant to drought, submergence to water, cold, heat, salt and poor soils have been developed by the scientists of International Rice and Research Institute (IRRI) in Los Baños, Laguna to help farmers continue their production despite the changing environment. The rice varieties that they have been developed are the “sahod-ulan” varieties for dry seasons and “Salinas” for salt tolerant rice variety. By 2050, it has also been predicted that there will be an increase in rainfall in Gloria. The “Swarna-sub1” rice variety has been developed to endure the flood. The flooded agricultural lands near the ocean and rivers are the main causes why production of crops is affected. These modified varieties of rice will be very helpful in the coming years where the effects of climate change will be more severe and apparent. Sloping agricultural technologies has also been proven effective to decrease the effects of soil erosion and landslide on high terrain grounds. Organic farming is also a good way to combat the negative effects of pesticides on the water ways of the municipality. The campaign of using organic pesticides should be strengthened so that the old ways of the farmers of using pesticides will be replaced by a safer and more environment friendly method of farming. The farmers should also stop the burning of rice straws because carbon gases are being released through this process which pollutes the air.

The water ways are also important not only for the crops but also for the community that is why the management of the Pola watershed should be prioritized. According to PAGASA projections it is most probable that there will be longer dry seasons, therefore the community should learn how to conserve water. Water conservation could be achieved through adaptation by utilizing rainwater through the use of small water impounding system or rain harvesting system in every barangay. Through this, excessive rainfall could be utilized and not just wasted.

Flooded agricultural fields are one of the problems during storm surge, longer wet seasons and increase in precipitation. Submergence of agricultural lands result to decrease in production. To mitigate adverse effects of flood, proper maintenance, expansion and improvement of the municipal drainage system should be done. The existing drainage system should also be maintained and expanded. Crop rotation could also be a good strategy when the weather is often changing and so is alternative livelihood for the farmers. Every year, farmers continue to be more resourceful and develop more efficient ways in farming.

## **Coastal**

The municipality of Gloria is surrounded on the east by the ocean, making the barangays along the shore vulnerable to changing tidal pattern. Sea walls and break water structures have been adapted to mitigate the effects of sea level rise but these should be maintained and expanded. If salt water intrusion will happen on the coastal communities, relocation and evacuation sites should be prepared and ready to be used anytime. Information campaign about water conservation will also be helpful in times when salt water intrusion happens and contaminate their potable water. The community can also help themselves to reduce the impacts of sea level rise by planting more mangroves, beach forest trees and dwarf coconuts along the sea shore. In terms of protecting the coastal resources, marine protected areas should be expanded and the marine zone regulations be strictly implemented. The corals are very important not only for the fishes but also for the municipality for they value these corals as part of their tourism campaigns. Fish catch will also not be a problem anymore if fish open and close seasons especially for spawning grounds will be adapted by the fishermen as well as expanding the no fishing zones. Designated areas should only be the fishing grounds during the open season. The fishermen should be informed about alternative livelihood so that they will still earn money even though it is fish holiday or when the sea current is very strong.

## **Forest**

The forest cover will eventually diminish if it will not be protected and cared for. The Forest Land Use Plan should be strengthened to ensure the forest's continued productivity. Forest clean-up as well as river clean-up are great help in maintaining the life of the species depending on it. The number of Forest Rangers or "Bantay Gubat" should be increased so that cases of illegal cutting of trees will be monitored as well as hunting of animals in no hunting zone areas. The watershed is also vital for the maintenance of lush forest cover, and vice versa. The POLA watershed plans should be strictly implemented.

Landslide is also one of the main problems of the municipality in terms of diminishing forest cover. More trees should be planted and afforestation should be adapted to increase the number of forests in the future. Substitute crop plantation that can endure higher temperature will also be ideal to be done where PAGASA have predicted an increase of a degree of temperature in the next thirty years. If disaster happens, safe evacuation sites should be designated and ready to use anytime. For those families who depend on merchandising forest products as source of their income, they should learn about alternative livelihoods so that when worst case scenarios happen, they will be prepared financially.

## **Urban**

The urban areas are as much important as the rest of the ecosystems present in the municipality. It is where the people live and spend their daily lives. Ensuring that the place where one lives is safe is a must. A lot of conservation strategies could be done by the community to help themselves in times of disasters. Campaigns about the importance of waste management, energy and water conservation should be more publicized. At an early age, children should be informed about the importance of water and energy conservation. This can be done through integrating conservation strategies in their curriculum. One way to save water is by collecting rainwater for domestic uses. Campaigns on waste management as well as clean-up drive of waste water are also vital so that sewage systems will not be clogged and rainwater can be drained out of the roads and houses in times of heavy rainfall.

The urban areas are also vulnerable to flood because of its low terrain but the effects of flood could be mitigated through the construction of drainage systems. Safe housing and relocation sites should be identified for disaster preparedness. Early warning systems should also be formulated so that the community will be informed on what they should do when disaster happens. Regular conduct of disaster drills should also be done and exercised. Capability buildings are also done now by municipalities to

assess if the community is ready to face future adversities.

Green urbanism should also be practiced wherein more open spaces, parks and green spaces should be opened. Part of this is the promotion of green buildings. A green building refers to both a structure and the using of processes that are environmentally responsible and resource efficient throughout a building's life cycle from siting to design, construction, operation, maintenance, renovation and demolition. River easement should be implemented where 3 meters from the riverside should be considered as an open space. No buildings or structures should be built within this range.

The local government is also liable on the procurement of disaster preparedness and mitigation equipment. The regular update of the Comprehensive Land Use Plan (CLUP) is a must for the municipality to accomplish. This will ensure the safety of the people in the municipality in the long run.

### **Recommendations for Disaster Risk Reduction**

After assessment of the disaster risk of Gloria Oriental Mindoro through thorough data gathering, data analysis and research, analysis of previous disasters, series of focused group discussions, key informant interviews, and analysis of disasters and PAG-ASA projections, researchers of this study have found ways to disclose the current situation of the municipality in terms of disaster preparedness.

Each barangay has their own plans but it should be unified to mitigate the impacts of hazards. In lieu of this, the problem should be viewed through the concept of “ridge to reef” approach. In the situation of the municipality of Gloria, Oriental Mindoro a general plan for disaster is suggested since it is found out that disaster occurring in one barangay affects most parts of the municipality. Heavy rain in the forest areas might cause flooding to barangays that are situated in low lands and even on the coastal barangays. The problem can be seen as “domino effect” and it is not enough that each barangay have its own adaptive capacity and policy interventions. The problem should be seen in a bigger picture, not only in a specific barangay. Therefore, a plan that would encompass the needs of all barangays should be prepared. The municipality should examine the information that is available from all appropriate sources, data like areas that are exposed, susceptibility, risk, vulnerability and adaptive capacities of the barangays. From this, there will now be a comprehensive disaster plan for the town.

With the assessment, disaster management should be a priority not just of the municipality but of the barangays. It is recommended that each barangay should form and empower Barangay Disaster Risk Reduction Management Council (BDRRM) that will focus on disaster management from preparation of hazard records, information dissemination and programs for responses during calamities.

Based from the interviews done during the Focus Group Discussions at the barangays, majority of the flooding in the municipality are caused by Balete River. When there are heavy rains, the river overflows and many communities are flooded. Each barangay has policy interventions and suggestions on how to solve the growing problem about the overflowing river. Building of dikes, bamboo plantation and dredging are some of the policy interventions noted. It was endorsed that there should be a general plan for the river because programs for it will not be effective if not all barangays, where the river traverses, will participate. This plan should be inclusive of all the stakeholders.

Also based from FGDs, the community has identified that one of the causes of flood are the wastes or garbage that goes to the river and drainage systems. Therefore, it is recommended that the RA 9003 or the Solid Waste Management Act of the Philippines should be strictly implemented. There should be MRF or the Material Recovery Facilities in each barangays that would serve as the drop off area of the wastes. Designated personnel at the MRF will facilitate the segregation of wastes. Waste segregation should be practiced by every household and even in the government offices. Regular collection of garbage should also be monitored.

Construction of drainage systems should also be prioritized. There are existing drainage systems in the municipality but most of it is either not finished or has no outlet. What the existing drainage systems do is that they just redirect the water to another area. The problem is not really solved but rather creating another bigger problem. These existing drainages should be expanded and connected to each other and having an ideal outlet that will exit to the Tablas Strait.

There should also be a forest management plan that would give specific strategies on the administration of the forest. The forest area of Gloria plays a big role on the disasters being experienced in the municipality. First, Balete river starts from the mountains and forests hence actions taken on the upland would help mitigate flooding and reduce effects of landslide. Protection of the forest cover would help a lot in decreasing possible effects of flooding and landslide. Trees play a big role in holding the soil cover and controlling water volume. There should also be a harmony between the people residing on the forests, for this matter the tribe of Mangyans and the people on the low lands. Two parties can work hand on hand for the protection of the forest covers.

Preparation and formulation of LCCAP or Local Climate Change Act Plan should also be prioritized. Since it is a big help in mainstreaming climate change adaptation, disaster risk and vulnerability reduction in municipal policies, plans, and programs (Local Framework Comprehensive Land Use Plan) of the municipality is also needed to be updated regularly and timely to guide the future actions of a community. It presents a vision for the future; with long-range goals and objectives for all activities that affect the local government. DRRM plans should also be implemented. Since all barangays are prone to different hazards, procurement of more disaster preparedness equipment and implementation of mitigation measures is highly recommended.

Lastly, with all the Disaster Risk Assessment Process that have been done, based on spatial analysis, every barangay faces different problems brought by disasters. The barangays (Buong Lupa, Mirayan, Malayong, Manguyang) are more prone to landslide. The coastal barangays (Bulaklakan, Tambong, Kawit, San Antonio, Balete, Sta Theresa, Guimbonan, Maragooc, Agsalin) and barangays near the Balete River are more exposed to flooding. Meanwhile, Barangay Agos, Malamig, Andres Bonifacio, Alma Villa, Papandungin, Malubay, Lucio Lurel, Banutan, Sta Maria, Banus, and Narra has a hundred percentage of exposure. But since liquefaction is a rare event and only occurs every 100 to 200 years and all low lying barangays have low susceptibility to landslide therefore, susceptibility to flood will be the main basis for choosing the most ideal place for constructing evacuation centers. It is recommended that the best areas to construct evacuation centers are parts of Barangays Agos, Malamig, Malayong, Malubay, and Manguyang.

A total of 1,047.3539 hectares in the municipality is affected by low flooding. Shoreline roadways and beaches will often be completely flooded out. Coastlines may experience large and destructive waves that strike weak structures to bits and severely damage well-built homes and businesses. A total of 3,391.4352 hectares is susceptible to high flooding.

The total land area of the municipality that may experience low level of landslide is 1,1508.6162 hectare. Also, a total land area of 2,250.9847 hectares and 9,329.6135 hectares are susceptible to moderate and high level of landslide respectively. Barangays Buong Lupa, Malayong, Manguyang and western parts of Mirayan are identified to be highly susceptible to landslide.

Based on the DCERP-UPLB study in 2015, all of the coastal barangays have seen changes in the sea level rise and experienced storm surge. Storm surge is an abnormal rise of water generated by storm, over and above the predicted astronomical tide.

There are several interventions in each barangays to mitigate the effects of hazards. Only few barangays have early warning systems but majority plan to have such as sirens, rain gauge, bridge with

water levels and catch basins but most of the barangays also have equipment for disaster preparedness. At the municipal level there are available rescue vehicle and boats and other equipments ready for calamities. Seminars on disaster preparedness and climate change are provided by the municipality. There are also plans to construct proper drainage system and protection dikes to minimize the overflow of river systems. There are also irrigation system that can help control the flow of water in rice fields. Seminars regarding organic, climate resilient planting materials and sustainable farming are also provided by the local government.

In urban areas, most of the residents expand their houses for two-storey. Some houses are already sturdy and can withstand calamities. There are some barangays that already constructed evacuation centers with the help of KaLaHi-NCDDP Program of Department of Social Welfare and Development, it can accommodate large number of evacuees. There are already existing road concreting projects in some barangays.

Based on 2017-2031 Local Climate Change Adaptation Plan of the municipality fifteen years programs, projects and activities are categorized into food security, water sufficiency, ecological and environmental stability, human security, climate-smart industries and services, sustainable energy, knowledge and capacity development, cultural heritage and indigenous people resiliency and administrative. This will support to increase the resilience of vulnerable sectors and natural eco-system to climate change and optimize mitigation opportunities towards gender-responsive and rights-based sustainable development with the integration of concerned agencies.



