REPUBLIKA NG PILIPINAS
SANGGUNIANG PANLUNGSOD
LUNGSOD NG ORMOC

EXCERPT FROM THE MINUTES OF THE REGULAR SESSION OF THE FOURTEENTH SANGGUNIANG PANLUNGSOD NG ORMOC HELD AT THE SANGGUNIANG PANLUNGSOD SESSION HALL, ORMOC CITY HALL BUILDING ON FEBRUARY 14, 2019

PRESENT:

Benjamin S. Pongos, Jr., (Acting City Vice-Mayor & Temporary Presiding Officer) SP Member
Vincent L. Rama, SP Member, Majority Floor Leader
Mario M. Rodriguez, SP Member, Presiding Officer "Pro-Tempore"
Tomas R. Serafica, SP Member, Asst. Majority Floor Leader
Eusebio Gerardo S. Penserga, SP Member
Gregorio G. Yrastorza III, SP Member
Nolito M. Quilang, SP Member
John Eulalio Nepomuceno O. Aparis II, SP Member
Minority Floor Leader
Lea Doris C. Villar, SP Member, Asst. Minority Floor Leader
Esteban V. Laurente, Ex-Officio SP Member, Chapter President, Liga ng mga Barangay ng Ormoc
Jasper C. Yerro, Ex-Officio SP Member, Chapter President, Panlungsod Pederasyon ng mga Sangguniang Kabataan ng Ormoc

ON OFFICIAL BUSINESS:

Leo Carmelo L. Locsin, Jr. (OIC-City Mayor), City Vice Mayor & Presiding Officer

RESOLUTION NO. 2019-034

A RESOLUTION APPROVING AND ADOPTING THE ENHANCED ORMOC CITY LOCAL CLIMATE CHANGE ACTION PLAN (LCCAP).

WHEREAS, Sections 2a, 15, and 3i of the Local Government Code (RA 7160) mandates every Local Government Unit (LGU), as a political unit, to exercise their inherent powers, as well as share with the national government the responsibility in the management and maintenance of ecological balance in their respective territorial jurisdiction;

WHEREAS, Section 11, Par. 2 of the Philippine Disaster Risk Reduction and Management Act of 2010 (RA 10121) states that, Local Government Units (LGUs) shall ensure the integration of disaster risk reduction and climate change adaptation into local development plans, programs and budgets as a strategy in sustainable development and poverty reduction;

WHEREAS, Section 14 of the Climate Change Act of 2009 (RA 9729), as amended by RA 10174, provides that, Local Government Units (LGUs) shall be the frontline agencies in the formulation, planning and implementation of climate change action plans in their respective areas consistent with the provisions of the Local Government Code (LGC), the National Framework Strategy on Climate Change (NFSCC), and the National Climate Change Action Plan (NCCAP);

WHEREAS, Section 1 of the Climate Change Act of 2009 (RA 9729), as amended by RA 10174, recognized the need to ensure that national and sub-national government policies, plans, programs and projects are funded upon sound environmental considerations and the principle of sustainable development, to systematically integrate the concept of climate change in various phases of policy formulation, development plans, poverty reduction strategies and other development tools and techniques by all agencies and instrumentalities of the government;

WHEREAS, in line with the local government's initiative to address risks to hazard (notably natural hazards which is greatly affected by changing climatic condition), the Local Climate Change Action Plan contains measures that a local government unit must undertake and mainstream to be able to adopt to climate change, to mitigate its effects, and to maximize its benefits;

WHEREAS, the City Development Council (CDC) during its full Council Meeting on February 27, 2017, unanimously approved to adopt the Local Climate Change Action Plan (LCCAP) as presented, as it deemed necessary and in accordance to the need of the City;

WHEREAS, the Enhanced LGU Guidebook on the formulation of Local Climate Change Action Plan was released by the Local Government Academy of the Department of Interior and Assessment Report 5 of the Intergovernmental Panel on Climate Change in 2014, Supplemental Guidelines on Mainstreaming Climate Change and Disaster Risks in CLUP of Housing and Land Use Regulatory Board in 2015, and the Community-Level GHG Inventory for Local Government Units in the Philippines of Climate Change Commission in 2017;

WHEREAS, the existing Local Climate Change Action Plan 2016-2025 is enhanced to comply with the guideline requirements in order to access the People Survival Fund and other funding windows for climate action, a copy of the enhanced LCCAP is attached hereto and made an integral part of this resolution;

WHEREAS, this enhancement is supported by the United Nations Human Settlements Programme (UN Habitat) through its two (2) projects – the Building Climate Resiliency through Urban Plans and Designs (BCRUPD) and the Vertical Integration and Learning for Low Emission Development (V-LED) wherein the City of Ormoc declared its commitment as partner City to the BCURPD Project;

WHEREAS, Ormoc City expects climate change characterized by increasing temperature at +2.1C and increasing rainfall at +220mm under the mid-century of RCP 8.5 scenario poses impacts to population, natural and built environments – particularly the production zones in the east and urban areas in the city center;

WHEREAS, the City Development Council (CDC) during its full council meeting on October 24, 2018, unanimously approved to adopt the enhanced Local Climate Change Action Plan (LCCAP) as presented, as it deemed necessary and in accordance to the need of the City;

WHEREAS, the enhanced Local Climate Change Action Plan outlines adaptation and mitigation objectives and initiatives of the city from CY 2019 to 2030;

WHEREAS, the Enhanced Local Climate Change Action Plan (LCCAP) was declared approved and adopted at the Committee Level by the Committee on Environment and Natural Resources and Energy Conservation last January 31, 2019;

WHEREAS, upon close thorough review, this Sanggunian finds that the Enhanced LCCAP is not contrary to law, public policy, public morals and existing contracts, and that the aim of this plan is highly noble in that it will greatly benefit the inhabitants of the City and its environment, so therefore, most deserving of this august Body's full support and affirmative action;

WHEREFORE, upon motion of SP Member Gregorio G. Yrastorza, III, Chairman, Committee on Environment, Natural Resources & Energy Conservation, severally seconded by SP Members Tomas R. Serafica, Nolito M. Quilang, Esteban V. Laurente and Jasper C. Yerro; be it

RESOLVED, AS IT IS HEREBY RESOLVED, to pass a RESOLUTION APPROVING AND ADOPTING THE ENHANCED ORMOC CITY LOCAL CLIMATE CHANGE ACTION PLAN (LCCAP);

ADOPTED, February 14, 2019.

RESOLVED, FURTHER, that copies of this resolution be furnished to the Secretary of the Department of Environment and Natural Resources, Manila, through its Regional Director VIII (Tacloban City); the City Mayor of Ormoc, Richard I. Gomez; the City Administrator, Mr. Vincent L. Emnas; the City Legal Officer, Atty. Josephine M. Romero; the United Nations Human Settlements Programme (UN Habitat), Manila; the Environment and Natural Resources Office (ENRO) Ormoc; the Office of the Barangay Affairs; the Office of Liga ng mga Barangay; the City Planning & Development Office; the City Disaster & Risk Reduction Management Office; the City Development Council-Secretary; the OIC-City Director, DILG; and other offices concerned in Ormoc City.

CARRIED UNANIMOUSLY.

I HEREBY CERTIFY to the correctness of the above resolution.

MARIA ANTONIETA G. CO HAT
(OIC – SP Secretary)
Supervising Administrative Officer

ATTESTED:

BENJAMIN S. PONGOS, JR.
(Acting City Vice Mayor & Temporary Presiding Officer)
SP Member

Local Climate Change Action Plan 2019-2030

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(blank page – UNH message)

(blank page – TWG message)

(blank page – Local Ordinance on LCCAP)

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Key Terminologies

Adaptation. Process of reducing harm and benefiting from the opportunities of current and projected climate in people and environment (both natural and built).

Adaptive capacity. Current capability or potential to implement adaptation initiatives to reduce vulnerabilities and increase resilience.

Anthropogenic. Changes brought about by human activities.

Baseline. Dataset where climate projections are compared. This refers to data observed from 1971-2000.

Biodiversity. Presence of living organisms in both aquatic and terrestrial systems described with its quantity and quality in a given observation period.

Canopy. Refers to roofs of building and houses, top of trees or any other vegetation cover, and other structures elevated from the ground.

Climate. Average and variability of atmospheric conditions (temperature, precipitation, and wind) over a period of time (at least 30 years).

Climate change. Shift on the average and variability of atmospheric conditions (temperature, precipitation, and wind) due to natural changes in the environment and anthropogenic sources altering the atmosphere composition.

Climate model. Mathematical representation of climate systems.

Coral bleaching. Whitening of corals from loss of symbiotic algae, mainly caused by increase in sea surface temperature.

Disaster risk reduction. Practice of managing the causes of hazards to reduce damages.

Drought. Period of low amount of precipitation, or 60% below normal.

Ecosystem. The interaction of living and non-living elements based on function and location.

El Niño Southern Oscillation (ENSO). Changes in ocean temperatures in the tropical Pacific, and sea level pressure. Its cold phase is La Niña.

Emission. Gases emitted to the atmosphere posted by trigger – fire or land use.

Exposure. Units of people, natural environment and built environment within susceptible areas of natural hazards.

Extreme weather event. Time-specific and location-specific weather that is beyond historical and regular conditions.

Global warming. Increase in average surface temperature caused by GHG trapping radiation intended to be release outside the atmosphere.

Greenhouse effect. Process of trapping radiation by the GHGs resulting to warming.

Greenhouse gas (GHG). Gases that emit and absorb radiation causing greenhousegas effect, primarily water vapor (H2O), carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4), and ozone (O3).

Land use. Human activities in particular region of land area, resulting to its possible changes.

Landfall. Event of typhoon center directly above land form from the ocean.

Mangrove. Plant or forest growing in the intertidal zones of marine coastal ecosystems.

Mitigation. Reducing sources of GHG emissions or enhancing carbon sinks for its removal.

Monsoon. Seasonal wind flow with rainfall due to temperature changes in ocean and land – southwest monsoon (habagat), and northeast monsoon (amihan).

Philippine Area of Responsibility (PAR). Geographic region under the responsibility of Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) weather monitoring.

Representative Concentration Pathways (RCPs). Basis of climate scenarios in climate research assuming emissions and concentrations of GHGs, aerosols and chemically active gases, land use/land cover.

Resilience. State of immediate recovery from or absence of negative impacts of climate change and natural disaster.

Risk. Characteristics of area with exposed units susceptible to hazards that is highly influenced by its frequency or likelihood of occurrence.

Sea-level rise. Increase in mean sea level cause by change in its volume.

Susceptibility. Characteristics of hazard based on geological and natural conditions that will affect the exposed units, and considered in prioritizing risk.

Tropical cyclone. Refers to tropical depressions, tropical storms, hurricanes, and typhoons – low pressure systems with inward winds in circularly symmetric spiral, with intense rain and winds.

Urban heat island. Urban areas have relative warmer surface temperature compared to rural areas due to concrete structures and absence of natural vegetation cover.

Urbanization. Use or conversion of natural environment or production areas to or for residential, commercial, and other urban uses.

Vulnerability. Condition of exposed units to climate impacts and natural disasters, high adaptive capacity may lower vulnerability.

Executive Summary

Climate change characterized by increasing temperature at +2.3 C and increasing rainfall at +220 mm under the mid-century of RCP 8.5 scenario poses impacts to population, natural and built environments – particularly the production zones in the east, and urban areas in the city center. Increase in temperature will lead to degradation of mangroves and forest, decline in fish catch, intensification of surface temperature in Ormoc City's urban center, and decrease in production and water supply. Increase in precipitation, coupled with increase in frequency and intensity of typhoon events, will lead to flood events that results to decline in agricultural produce, destruction of both private properties and public facilities, and stoppage of economic activities. The city experienced two major disasters TY Uring (Thelma) in 1991 causing flashflood with 4,000 deaths, and TY Yolanda (Haiyan) in 2013 causing PhP 2. 059 billion damages in agriculture. These impacts will further worsen the social and economic conditions of people – particularly the 8, 000 workers in the informal economy, 1, 686 fisher folks, and the 4, 540 farmers. There are 73 barangays with 109, 673 people in 27,359 households within flood-prone areas. This includes 1,892 informal settlers, 1,988 houses made from light materials, and 14, 892 families under poverty line. From this, 29 barangays in 445.17 hectares valued at PhP 13.36 billion is detected at high risk. In terms of agricultural production, there are 32 barangays with 2, 510.17 hectares of productive lands susceptible to flood, which 16 barangays in 297.60 hectares amounting to PhP 13.16 million at high risk.

The city will take advantage of the excessive rainfall to capture, store, and re-use for domestic and public use, and the increased opportunity to cultivate assorted vegetables in the uplands. Increase in temperature will produce temporal work for the informal sector with stabilize flow of tourist.

These climate impacts are coupled with susceptibility on geologic hazards – earthquake, consequent liquefaction or tsunami in an active volcanic zone. Landslide and storm surge are also susceptible with possible impact of at least PhP 32.97 billion, affecting 109, 880 people.

In 2017, the greenhouse gas emissions is at 151,493.2035 tonnes CO_2e highly attributed to agricultural production (64.21%) and livestock (43.32%). Forest sink accounts to removal of about 35.17%. Electricity consumption on public infrastructure and other uses accounts 18.20%, residential use at 14.93%, and commercial use at 2.67%. This is projected to increase at 198,182.43 tonnes CO_2e if no reduction efforts will be implemented. High potential for reduction is identified through increasing carbon sink, changing facilities with low electricity requirement, and changes on its use. Sources of renewal energy, Tongonan Thermal Geothermal Field and Dolores Solar Farms, are operating in the city.

This plan outlines adaptation and mitigation objectives and initiatives of the city from 2019 to 2030. This plan is implemented with the following tools – Climate and Disaster Risk Assessment of the Housing and Land Use Regulatory Board, Community-level GHG Inventory of the Climate Change Commission, based on Enhanced LGU Guidebook on the Formulation of Local Climate Change Action Plan (LCCAP) Book 3 of the Local Government Academy of Department of Interior and Local Government. This is supported by the United Nations Human Settlements Program through the Building Resiliency through Urban Plans and Designs (BCRUPD) Project and the Vertical Integration and Learning for Low-Emission Development (V-LED) Project.

1. Background

1.1 Geographic information

The City of Ormoc is situated on the northwestern coastal plain of Leyte Island frequently visited and directly hit by tropical cyclones formed from the West Pacific Ocean. It is bordered in the east by Amandiwing mountain range, particularly by Mt. Mindiwin, with hilly and mountainous landscape peaking at 1,304 masl and slopes ranging from 30% to 50% (Class Q) classified as protected forestlands comprising 29.20% of the total land area of 46, 430 hectares. However, these forest lands fall within the critical watersheds of Bao River, Pongso River, Mainit River, and Binhaan River. This connects with Anonang-Lobi Mountain Range of the Eastern Visayas Biodiversity Corridor, a key biodiversity area.

The forest ecosystem include the NIPAS-declared Lake Danao Natural Park with total land area of 140 hectares. There are two smaller lakes both situated within the Tongonan Geothermal Reservation Field: Lake Kasudsuran (12.83 ha) in Barangay Ga-as in the southeast, while Lake Janagdan (2.88 ha) in Barangay Cabintan in the northeast. Northeastern and western portions of the city are characterized by rolling to moderately steep (Class P) lands with slope ranging from 18% to 30% account for 20.35% (9,448.51 hectares) of land area. These areas are with detected risk to landslide.

The remaining 6.68% (3,101.52 hectares) in the central and eastern region of the city are moderately sloping to rolling (Class O) lands with slope ranging from 8% to 18% appropriate for seasonal and permanent crop production. Basaltic hills have well-drained soils with moderate to high fertility. Gently sloping volcanic piedmont and meta-volcanic hills have soils with very low fertility. Other landform categories have fine loamy and well-drained soils. These areas are susceptible to flooding.

Coastal plains have poor to well-drained soils with high organic matter content. The broad alluvial plains have fine to medium fine clayey soils that are poorly drained but fertile, such as the Luisiana Clay, the Guimbalaon Clay, the Palompon Clay and the Madellin Clay.

Several rivers and streams traverse the plains of Ormoc and serve as water sources for the vast agricultural lands. Potable water sources include Bao River in the north, Pagsangaan River in the east, Bagongbong River and Panilahan River in the south, and Anilao River and Malbasag River that border the eastern and western portion of the city proper.

The Anilao River and the Malbasag River are the two major rivers that drain the Ormoc Watershed. In the northern part of the watershed is the 13-kilometer Anilao river system with three main tributaries, namely Panagbongon, Magasue and Matutugnaw. In the southern part is the 10-kilometer Malbasag river system with a small tributary upstream called Ogmok. All in all, the river network spans approximately 64 kilometers.

Irrigation canals are integrated in Ormoc's network of waterways. These canals are constructed and maintained by the National Irrigation Administration (NIA) in order to cater to the rice-producing barangays in the northeast of city.

Western and southwestern portions are nearly level to undulating lands forming the Ormoc Valley. Level to nearly level (Class M) lands and very gently sloping to undulating (Class N) lands constitute around 22.77% (10,572.11 hectares) and 22.08% (10,251.74 hectares) of the total land area, respectively. Suitable for urban and residential development and lowland rice production, lands of these categories represent the central, western, and southwestern portions of the city.

Areas beyond the city center are large highly-restricted agricultural lands that are irrigated and covered by the Comprehensive Agrarian Reform Program (CARP).

As per records of the City Agriculture Office – Fisheries Division, there are 226.58 hectares of marine reserve areas and fish sanctuaries declared from 2003 to 2006 by the local government in 9 barangays protecting seagrasses and reefs. Mangrove forests covers 945 hectares in barangays of Naungan, Lao, and San Juan with 17 species.

Ormoc City is prone to floods (riverine and flashfloods), rain-induced landslides, typhoons and storm surges, ground rupture, and earthquakes that may result to liquefaction and tsunamis. Areas that are most at exposed are the barangays along the coast, including the city center, and the production areas.

Figure 1. Location map

1.2 Demographic trends

The population census in 2015 by the Philippine Statistics Authority accounted at 215, 031 people with 50, 341 households. A parallel census through the Community-based Monitoring System accounted 212, 563 people with almost equal gender break of male (51%) and female (49%). This is also accounted 46, 564 households of which 6.76% are informal settlers and 7.92% living in makeshift housing. There is 52.23% households below the poverty threshold, while 36.33% below the food threshold. There are 48, 807 males and 20, 168 females in labor force, which 6.44% are unemployed. There is 67.55% dependency rate.

There are 110 barangays in Ormoc, classified as 31 urban, 10 urban coastal, 63 rural, and 6 rural coastal barangays. The 35% of the population is currently living in the urban center, where commercial and institutional spaces are also concentrated.

By 2030, at the end of the implementation of this plan, the population will increase to 300, 688 by natural growth. By mid to late 2040s, the population is expected to double.

1.3 Income classification and economic base

Ormoc City is classified as first class and independent city of Leyte Province by virtue of Republic Act. No. 6388 "Charter of Ormoc City" dated June 21, 1947, repealing Republic Act No. 179. The town is founded in February 26, 1834 under the Spanish colonization. The city is identified as one of the centers in the Eastern Visayas Region.

The city's economic base is transitioning from agriculture to commerce with its economic value and employment, in accordance to spatial development strategy. Business Permits, Franchising and Licensing Office records in 2017 state that there are 6,779 businesses registered categorized into 171 banks, 189 manufacturing, 2, 078 retails and 4, 341 services. These include new registrations for 16 banking and financing institutions, 46 manufacturing, 522 retails, and 789 services. The capital asset of the service sector is valued at PhP 40.6 billion, retail sector at PhP 7.7 billion, manufacturing at PhP 5.8 billion, while banks at PhP 754 million. Service sector employs the largest with 8, 140 males and 3, 542 females, while retail employs 2, 943 males and 2, 821 females. Increasing the inflow and outflow of goods, services, and people is facilitated with the presence of commercial and transportation facilities – Ormoc Port (2,670.50 sqm) operated by the Philippine Ports Authority, and currently under renovation Ormoc Airport (52 ha) operated by Civil Aviation Authority of the Philippines.

As per 2015 records, agriculture remains widely participated with total identified protected agricultural land at 7, 494, currently utilized at 5, 791.5 ha with 4, 337.5 ha irrigated. For non-irrigated production land currently summed at 17, 756 ha will decrease to 14, 516,72 ha high characterized by 10, 707.75 ha plantation of highly valued crops (5, 736 ha for sugarcane, 3, 160 ha for coconut, and 850 ha for pineapple), 1, 151 ha of grazing lands, and 961 ha of corn fields. In 2017, livestock production is highly commercial, accounted with the following: swine (32, 843), cattle (1, 591), carabao (1, 582), goat (1, 315), and poultry (4, 965, 354). While, aquaculture is dominantly commercially operated in fishponds with 254 ha, and backyard operates within 3.33 hectares of fishpond and 0.114 ha of fish cages.

There are 4, 540 rice farmers and 4, 474 fisher folks in the city. The city accounts for significant share of food production in Eastern Visayas serving as a natural "bagsakan" (drop-off point) for fishing and farming produce in Leyte.

The city currently identified a total of 833.78 ha of industrial land, to be expanded to 893.62 ha. However, this is highly underutilized.

Tongonan Geothermal Power, the biggest in Asia supplying both to the region and Luzon, is operating in the city shared with the Municipality of Kananga. Its five (5) power plants produce 708 megawatts, which is 37% of the estimated gross potential reserves of the country at 5,000 megawatts. The power plants also accounts 60% of the country's installed capacity in the southern parts of Luzon and the Visayas of via sub-sea cables.

1.4 Plan context and timeframe

The LCCAP is part of the city's initiative to comprehensively address its climate vulnerabilities and climate-related hazard risk. This plan includes new climate information, conduct of greenhouse gas inventory, and application of new climate and disaster risk assessment methodology.

The climate information is based from the recent projection data generated by the Philippine Atmospheric, Geophysical and Astronomical Services Administration. Climate scenario under the Representative Concentration Pathway (RCP) 8.5 or high emission scenario is used in this plan.

The greenhouse gas inventory applied the methodology for community-level assessment developed by the Climate Change Commission. Information from the inventory allows the city to determine local mitigation targets as part of its climate action plan. This is the first greenhouse gas inventory of the city.

The new approach in assessing climate and disaster risk with land use as spatial unit of analysis released by the Housing and Land Use Regulatory Board is applied on this plan. This aligns on the inclusion of hazard as function of risk together with vulnerability and susceptibility.

This plan complies with the prescriptions of LCCAP Guidebook 3 developed by the Local Government Academy of the Department and Interior Local Government.

This plan enhancement initiative is supported by the United Nations Human Settlements Program through its two projects – Building Resiliency through Urban Plans and Designs (BCRUPD) and the Vertical Integration and Learning for Low-Emission Development (V-LED).

The plan will be implemented for the next 11 years, from 2019 to 2030.

1.5 Key responsible persons and offices

The plan enhancement is carried out by the Technical Working Group constituted for the BCRUPD Project by virtue of Executive Order No. 50 dated 16 November 2017.

Everth Acaso, Jr., *City General Services Office*
Dante Albarico, *City Agriculture Office (Crops)*
Nelson Alindogan, *City Tourism Office*
Eriberto Alkuino, *City Agriculture Office (Fisheries)*
Jesus Jeremy Bagares, *Department of Interior and Local Government*
Milany Bernal, *City Engineer's Office*
Enrique Caberos, City Social Welfare Development Office
Fe Comorposa, *Ormoc Waterworks Office*
Fatima Leira Ebcas, *City Disaster Risk Reduction and Management Office*
Maribeth Paulita Ebcas, *City Planning and Development Office*
Elsie Jaca, *City Health Office*
Dexter Jumao-as, *City General Services Office*
Ian Paul Oliver, *Office of the Building Official*
Judith Paredes, *City Agriculture Office (Crops)*
Pedro Pepito, *Liga ng mga Barangay*
Benjamin Pongos, Jr., *Sangguniang Panlungsod*
Rodrigo Rivera, *Public Affairs, Information and Assistance Office*
Wilson Tolentino, *City Mayor's Office*
Alona Viacrusis, *Ormoc Waterworks Office*
Gregorio Yrastorza, *Sangguniang Panlungsod*

Contact Persons

Ciriaco Tolibao II
Head, City Disaster Risk Reduction and Management Office
Raoul Cam
Head, City Planning and Development Office

2. Climate Information and Situational Analysis

Climate in Leyte Province falls under Type IV of the Modified Coronas Climate Classification characterized by even distribution of rainfall throughout the year.

The average annual temperature in Ormoc for the last three years are as follows: 27.36 C (2015), 27.02 C (2016), and 26.51 C (2017). On the same period, hottest day is recorded in May 2016 at 34.90 C, and coolest March 2015 at 19.30 C.

The total annual precipitation for the last three years are as follows: 1257.92 mm (2015), 1427.16 mm (2016), and 1867.14 mm (2017). The wettest month recorded is September 2017 with 324.80 mm. In the same year, there are 184 days with rain, while there are 106 days in 2015, and 173 days in 2016.

The prevailing wind direction is West-North-West, with average speed of 1.90 m/s (2015), 1.52 m/s (2016), 0.58 m/s (2017). However, wind direction in September 2017 moves variably in South-South-East direction, and observed from August to October of the same year.

With regards to El Nino-Southern Oscillation (ENSO), the recent very significant El Nino season of 2015-2016, had reported damages of PhP 22.453 million in six barangays of Curva, Lao, Licuma, Margen, Rufina M. Tan, and Liloan. As per 31 May 2015, Leyte is initially listed to experience drought or three-consecutive months with more than 60% rainfall reduction compared to normal among other 30 provinces. However, 31 July 2015 assessment restricted the list to 5, excluding the province. The is comparable to very significant El Nino season of 1997-1998 resulting to 70% of the country under drought, with PhP 3 billion of corn damages, water shortages, forest fires, and sickness. For the late quarter of 2018, the ENSO is expected to increase onset of El Nino by 65% to 70%.

Figure 2. Observed Temperature and Precipitation in Ormoc City, Year 2015-2017

Historical timeline of typhoons

There are 9 typhoons since 1970 that landfall in Ormoc, including Typhoon Yolanda (Haiyan) in 2013. The other typhoons had maximum wind speed range of 19.03 m/s (TY Judy, 1974) up to 43.75 m/s (TY Garding (Axel), 1994). These incidence are observed to be frequent during the months of November and December, when the prevailing monsoon is the Northeast Monsoon (Amihan). This climate system brings more rainfall in the origin of its wind in eastern Philippines beside the warm West Pacific Ocean towards the temperate regions in Asia. Three typhoons where recorded towards the end of NEM, and start of Southwest Monsoon (Habagat) usually in May – TY Diding (Wanda) in 1971, TY Bebeng (Cecil) in 1979, and TS Auring (Roke) in 2005. This monsoon influence climate from May to August, and may extend until end of the year. The El Niño Southern Oscillation (ENSO) has weak influence on these typhoons. Leyte Province recorded 35 typhoon landfall from 1970 to 2011.

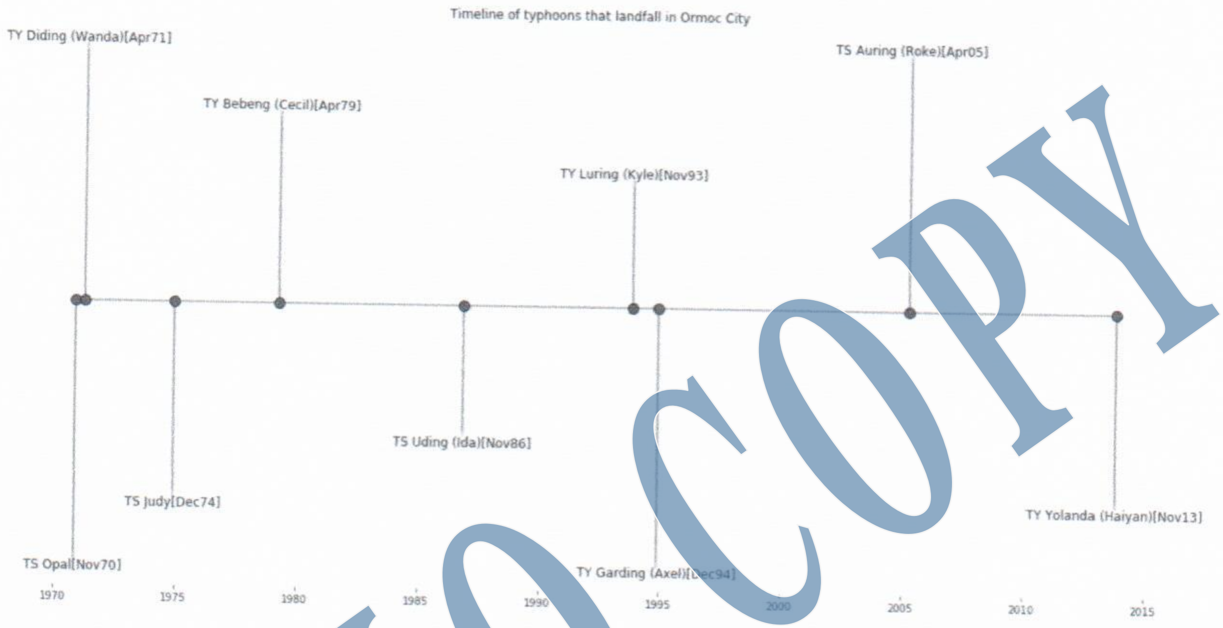


Figure 3. Timeline of typhoons that landfall in Ormoc City, 1970-2013

Table 1. List of typhoons that landfall in Ormoc City. 1970-2013

Year	Typhoon	Date	Maximum Wind Speed (in m/s)	Max Pressure	El Niño Southern Oscillation	Significance	Prevailing Monsoon Season
1970	TS Opal	11-17 November	23.66	1010	La Nina	Moderate	NEM (Amihan)
1971	TY Diding (Wanda)	22 April to 4 May	27.77	1006	La Nina	Weak	SWM (Habagat)

Year	Typhoon	Date	Maximum Wind Speed (in m/s)	Max Pressure	El Niño Southern Oscillation	Significance	Prevailing Monsoon Season
1974	TS Judy	14-18 December	19.03	1006	La Nina	Weak	NEM (Amihan)
1979	TY Bebeng (Cecil)	11-21 April	38.57	1006	El Nino	Weak	SWM (Habagat)
1986	TS Uding (Ida)	10-18 November	25.71	1008	El Nino	Moderate	NEM (Amihan)
1993	TY Luring (Kyle)	17-24 November	36	1006	Neutral		NEM (Amihan)
1994	TY Garding (Axel)	15-27 December	43.75	1010	Neutral	Moderate	NEM (Amihan)
2005	TS Auring (Roke)	12-19 March	28.29	1008	La Nina	Weak	SWM (Habagat)
2013	TY Yolanda (Haiyan)	6-9 November	170	#	Neutral		NEM (Amihan)

Damages of typhoons, particularly of more than 4 hours of flooding, to agricultural sector had been observed. Recent TS Urduja (Kai-tak) in December 2017 had inflicted damages to 730 farmers in 1, 8754 hectares of about PhP 5.8 million. Fish pond production in 129 hectares had total damages of PhP 9.8 million including the lost commercial sales. The same caused damages to livestock and poultry amounting to PhP 3.6 million. Losses from TY Ruby (Hagupit) in December 2014 are accounted to PhP 1.44 million corn production (in 140 hectares) and PhP 44.8 million vegetable production (in 185 hectares). This affected 195 corn farmers and vegetable growers. There are 200 hectares of rice produce damaged affecting 132 farmers, amounting to PhP 11.78 million by TS Gorio (Rumbia) in June 2013. TY Ramon (Banyan) in October 2011 recorded damages of PhP 7.9 million of rice in 1, 326 hectares affecting 1, 820 farmers.

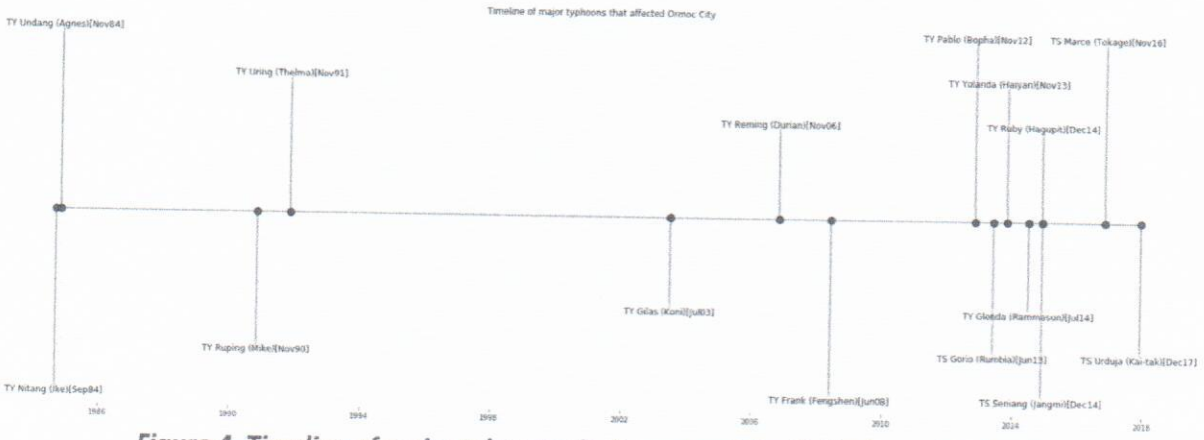


Figure 4. Timeline of major tyhpoons in Ormoc and the Philippines, 1984-2017

Table 2. List of major typhoons in Ormoc City and the Philippines, 1984-2017

Year	Typhoon	Date	Maximum Wind	Max Pressure	El Niño Southern Oscillation	Significance	Prevailing Monsoon Season
1984	TY Nitang (Ike)	3-6 September	46.29	1006	La Nina	Weak	SWM (Habagat)
1984	TY Undang (Agnes)	29 October to 11 November	54.01	1008	La Nina	Weak	NEM (Amihan)
1990	TY Ruping (Mike)	6-18 November	51.43	915	Neutral		NEM (Amihan)
1991	TY Uring (Thelma)	1-8 November	20.57	1006	El Nino	Strong	NEM (Amihan)
2003	TY Gilas (Koni)	15-22 July 2013	30.86	1008	Neutral		SWM (Habagat)
2006	TY Reming (Durian)	25 November to 6 December	54.01	1006	El Nino	Weak	NEM (Amihan)
2008	TY Frank (Fengshen)	18-23 June	46.29	1008	La Nina	Weak	SWM (Habagat)
2011	TY Ramon (Banyan)	9-14 October	18	1008	La Nina	Moderate	NEM (Amihan)
2012	TY Pablo (Bopha)	25 November to 12 December	140	#	Neutral		NEM (Amihan)
2013	TS Gorio (Rumbia)	27 June to 1 July	65	#	Neutral		SWM (Habagat)
2013	TY Yolanda (Haiyan)	6-9 November	170	#	Neutral		NEM (Amihan)

Year	Typhoon	Date	Maximum Wind	Max Pressure	El Niño Southern Oscillation	Significance	Prevailing Monsoon Season
2014	TY Glenda (Rammasun)	13-17 July	135	#	El Nino	Weak	SWM (Habagat)
2014	TY Ruby (Hagupit)	3-10 December	155	#	El Nino	Weak	NEM (Amihan)
2014	TS Seniang (Jangmi)	23-28 December	45	#	El Nino	Weak	NEM (Amihan)
2016	TS Marce (Tokage)	14-28 November	50	#	La Nina	Weak	NEM (Amihan)
2017	TS Urduja (Kai-tak)	13-23 December	50	#	La Nina	Weak	NEM (Amihan)

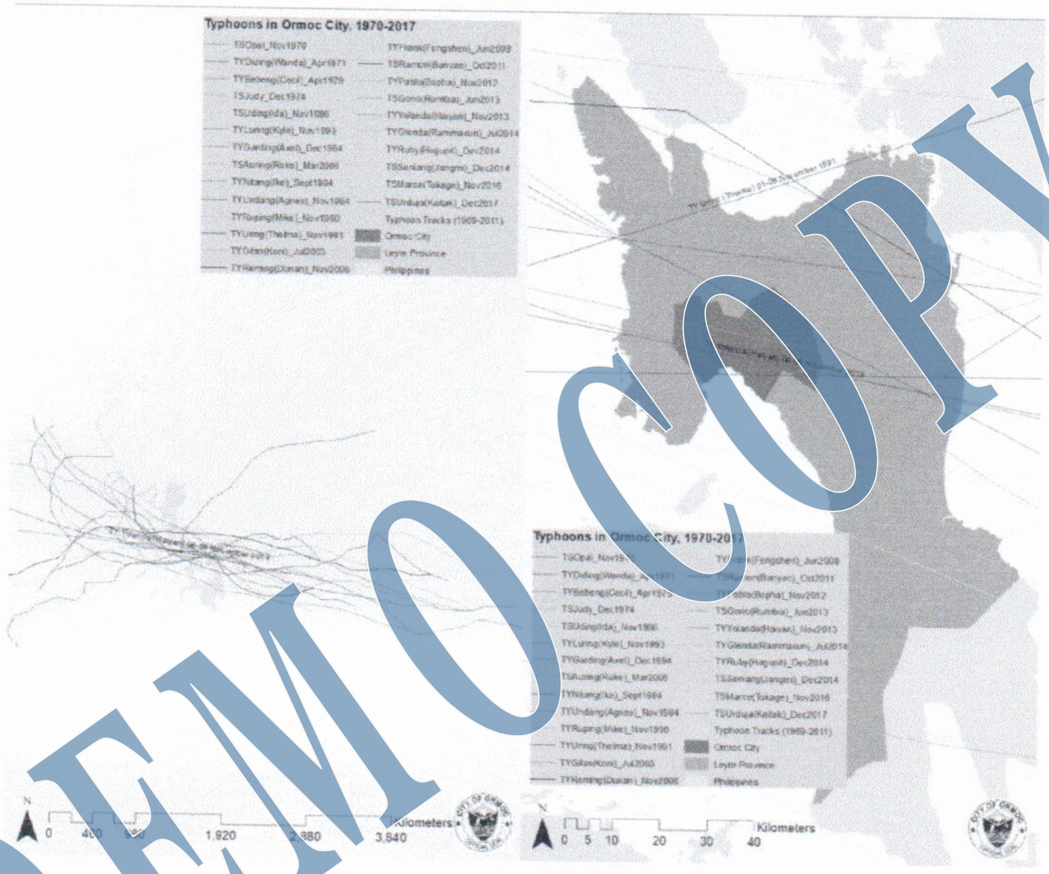


Figure 5. Typhoon tracks that affected Ormoc City

Most notable destructive typhoons

There are two extreme cases of typhoon event that affected Ormoc City - TY Uring (Thelma) in November 1991, and TY Yolanda (Haiyan) in November 2013.

TY Uring (Thelma) affected the whole city with population of 122, 636 in 22, 891 households. Total damages are observed in 2, 915 houses, and partial damages on 11, 514 house. The validated casualties account to 4, 000 deaths, 3, 020 injured, and 2, 514 missing. Damages in agriculture recorded high at PhP 35 million, PhP 230 million in government facilities, and PhP 135 million of private properties. Electricity and water is down.

TY Uring (Thelma) developed in the West Pacific Ocean in November 1 and within Philippine Area of Responsibility by early morning of November 2. It has winds of 55 kph, initially tracking northwest direct, but moved southwest in afternoon of November 3. By November 5 in the morning, it landfall in Tacloban City, with its maximum winds of 75 kph. It crossed the Visayas islands, until it dissipated before crossing northern Palawan in morning of November 6. Intense rainfall is observed between 9:30 AM to 12:30 AM. The Philippine National Oil Company, now Energy Development Corporation, on its 48-hour observation, November 4 (8:00 AM) - 6 (8:00 AM), in two rain gauges recorded 350 mm and 580.5 mm. PNOC (EDC) is located in the city upland, where rainfall is expected to be intense. PAGASA station in Tacloban recorded 140.2 mm, in 24-hour observation, noting intense downpour between 7:30 AM to 10:30 AM. Station inside the Visayas State College of Agriculture, now Visayas State University, in Baybay City recorded 138.8 mm from 8:00 AM to 1:00 PM on November 5. Before the typhoon, two significant typhoons are recorded – TY Undang (Agnes) in November 1984 (153 mm) and TY Ruping (Mike) in November 1990.

Dubbed as the "Ormoc Tragedy", a flashflood occurred at around 11:00 AM of November 5, after an hour of intense downpour that lasted for three hours. The city center was covered by 3 feet to 5 feet of water, with maximum rise of 7 feet within 15 minutes at its peak. It left 2 feet of sediments on the streets. An estimated of 22, 835, 000 cubic meters is the volume of water flood pushing forest debris to the city and water networks, delaying drainage to Ormoc Bay. The city center is bounded by the large tributaries of the Anilao-Malbasag (Ormoc) Watershed where the flood water originated. The most affected region is the Anilao River delta, Isla Verde, inhabited by informal settlers in houses made of light materials. A flood control project was implemented together with Japan International Cooperation Agency in 1998 to 2001. TS Gilas (Koni) in July 2003 fell around the city, with the same rainfall of TY Uring (Thelma), validating the effectiveness of the project, concentrating waters in the river but reached a critical level.

TY Yolanda (Haiyan) left with 30, 546 totally damaged and 25, 043 partially damaged houses. Its damages to agriculture sector totaled to PhP 2.059 billion of which PhP 1.862 billion area damages from standing crops - infrastructure (PhP 15.3 million), fishery (PhP 22.9 million), and stocks (PhP 158.491 million). In 8 November 2013, DOST-NOAH released a storm surge warning that can rise up to 5.2 meters at around 2:00 PM, topping the list of most affected in the Leyte and Southern Leyte localities. The typhoon had destroyed power and water lines. Power supply is out for 5 days, the same case with water which pumps are dependent.

2.1 Vulnerabilities, Risks and Opportunities

2.1.1 Current climate-related hazards and issues

This section outlines the current state of vulnerability and risk of each ecosystem on climate-related hazards and issues. Vulnerability describes the conditions of the people and both natural and man-built environments based on hazard susceptibility (mainly influenced by geologic and physical character), and its dynamics. Risk assessment is conducted using the Housing and Land Use Regulatory Board CDRA Tool, uniting the vulnerability and its severity to likelihood of occurrence (frequency) of a hazard, with land use as spatial unit of analysis. This assessment is observed to be highly linked on the likelihood of occurrence. This action plan is based on the detected level of risk. Opportunities to take advantage from changes in rainfall and temperature will be included in points of actions.

Figure 6. Land Use Map of Ormoc City

Figure 7. Flood Risk Map, Ormoc City

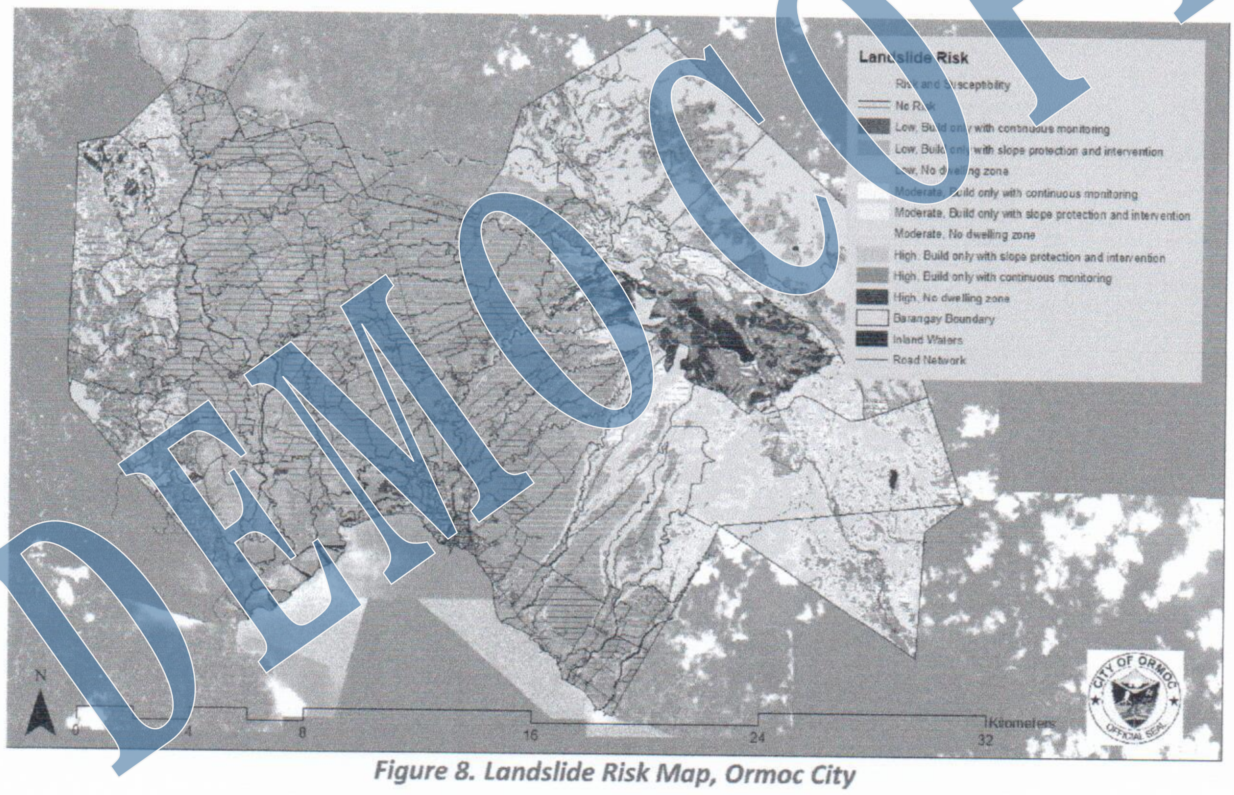


Figure 8. Landslide Risk Map, Ormoc City

Figure 9. Storm Surge Risk Map, Ormoc City

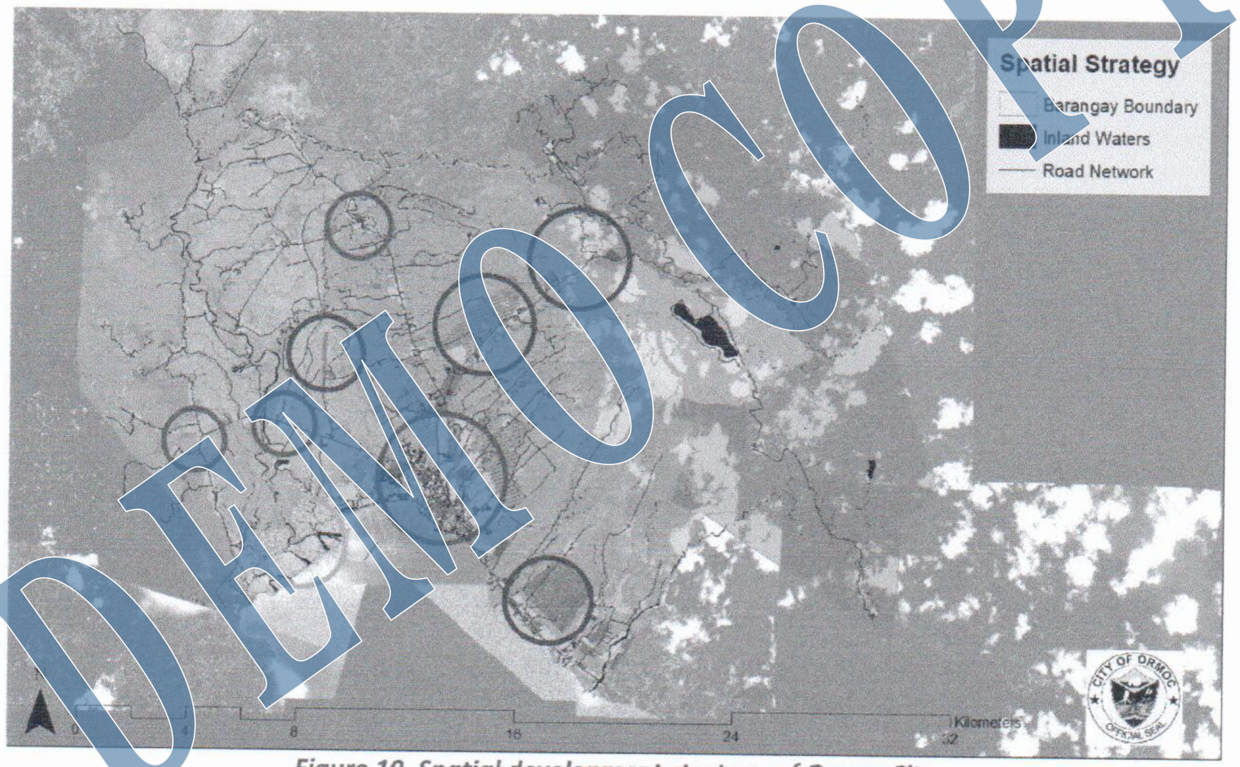


Figure 10. Spatial development strategy of Ormoc City

Spatial development strategy

The city identified four levels of development nodes. The major node (red) is the city center and adjacent barangays expected to cater major residential and commercial developments. Secondary nodes (blue) are industrial zones and major transportation linkages including Ormoc Airport. Industrial zone in Ipil is connected main node with the development of diversion road in the midlands, and identified as possible port expansion. Geothermal plants in Tongonan and solar farms in Dolores are considered secondary nodes. Minor nodes (green) are intended to cater commercial developments to support the growing population within its area. These includes the northern barangays to converge in Valencia, and the road junctions in Curva and Lilo-an to serve the agricultural production zones. Eco-tourism nodes (orange) are identified in the areas of Danao Lake, mangrove areas in Naungan, and the cave sites in Nueva Sociedad. These are considered growth points under the tourism sector. Growth movement is prioritized towards north of the city, regulating development in the city center, while capitalizing on the natural ecosystem for tourism.

Coastal Ecosystem

Ormoc Bay comprises 8, 345.8 hectares classified as municipal waters, with coastal length of 18.635 kilometer across 15 barangays. The mangrove areas in Naungan, Lao, and San Juan are considered ecotourism node and protected area based on its spatial strategy.

There are 226.58 hectares of marine reserve areas and fish sanctuaries declared from 2003 to 2006 by the local government in 9 barangays protecting seagrasses and reefs. Mangrove forests covers 945 hectares in barangays of Naungan, Lao, and San Juan with 17 species. Reforestation efforts in the 1990s through Family Approach Reforestation covered 191 hectares, while the National Greening Program expanded its coverage, however reported to have 95% damage after typhoon.

The Naungan-San Juan Mangrove Planters managed 191 hectares under Community-based Forest Management Program of the DENR. The City Tourism Office is set to develop a tourist hub in the area. Previous studies identified Sonneratia and Avicennia as suitable species for rehabilitation programs.

However, the occupancy of informal settlers in these areas, particularly in Sitio Quinto Limbo with 231 households of which 70% are fisher folks, posts environmental degradation and water coliform contamination due to improper solid waste disposal.

The area is susceptible to storm surge, and the delta of the Pagsangaan River. There are 4, 474 people dependent on coastal resources, with 35% or 1, 686 individuals performing open sea fishing. The current average monthly income is PhP 14, 300 with daily fish catch of 5 kilograms. The barangay of Naungan is detected to be 0 meters above sea level, inhabited by 5, 075 people, with 170 informal settlers, and 243 house in make-shift. The area will be affected by a reclamation project related to a coastal road project by the Department of Public Works and Highways.

Risk of Mangrove Areas
Storm surge risk is low at 602.99 hectares in San Juan, Lao and Naungan.

Urban System

The residential and commercial establishments concentrated in the city center, immediate nearby urban barangays, and along the Ormoc-Kananga-Tacloban national highway, where flooding is highly susceptible, is the identified major node of development on its structure plan, qualified as its urban corridor. Risk on flooding in these areas are highly decreased by the flood control projects along Anilao River and Malbasag River. Areas of settlements, even resettlement sites, are located along the Pagsangaan River that increase its risk on flooding.

There are 81 barangays with flood risk with equivalent population of 204, 240 in 47, 749 households. This includes 2, 687 informal settler families, and 3, 448 makeshift houses. There are 23, 390 families below poverty line.

Areas with risk to landslide is detected in 41 barangays with 96, 496 people in 22, 564 households. There are 1, 506 informal settler families, and 1, 263 makeshift houses. There are 10, 485 families below poverty line.

Storm surge poses risk to 21 barangays with 83, 628 people in 19, 110 households. This includes 1, 329 informal settler families, and 1, 262 makeshift houses. There are 8, 275 families below poverty line.

There is 85% health insurance coverage on the population by the government. Flood areas comprise 75.45% of 1, 224.33 hectares of total urban areas at high, mostly within the Pagsangaan Watershed and Ormoc (Anilao-Malbasag) Watershed. From previous major typhoons, there are 30, 546 totally damaged and 25, 043 partially damaged houses during TY Yolanda (Haiyan) in 2013, and 2, 915 totally damaged and 11, 514 partially damaged during TY Uring (Thelma) in 1991. Assessment after Typhoon Yolanda provides housing gap of 6, 447 households, coupled with expected population growth and informal settlements upgrade, with 16, 667 households, where Comprehensive Shelter Plan 2017-2025 is formulated. Water turbidity is high during flood event posing much work on the filtration process in Ahag Water Gallery. Ormoc's main water source is surface water along the upstream of Malbasag River. The city also adopted Ordinance No. 32 for the Proper Harvesting, Storage and Utilization in Ormoc City being implemented by the Office of the Building Official on new building permit applications.

In 2017 alone, water-borne and vector-borne diseases are recorded such as 476 cases of diarrhea and 5 cases of amoebiasis. There are 34 health centers and 2 hospitals in flood prone areas. There are an estimated 8, 000 workers with intermittent income flow during wet season in the informal economy.

Submergence of road networks and school buildings to flooding posed disruption on operations of 80 schools and government offices. TY Uring (Thelma) damages worth to PhP 286 million on roads, PhP 188 million on drainage systems, and PhP 48 million on bridges. Open parks and spaces, including the tourism sites in the city center, has a total of 73.99 hectares. It is observed that during wet seasons, there is a drop on number of tourists visiting the city. Pocket flooding is observed in portions of low-lying barangays of Alegria, Punta and Linao, exacerbated by clay soil, water (seepage) overflow from the drainage system, and patches of back-filling to level with or higher than street.

Riverine flooding in settlement areas at east of the city is observed, with quarrying activities in Panalian River in Ipil and Bagongbong River in San Antonio. This activity had been stopped along Panilahan River in Macabuga and Danhug.

~~Vulnerabilities~~

Risk Assessment per Land Use in Urban Systems

Residential Land Use. Flood risk is observed in 81 out of 110 barangays, equivalent to 758.72 hectares of residential areas with total cost replacement cost of PhP 22.76 billion. Total of 29 barangays in 445.17 hectares valued at PhP 13.36 billion is detected at high risk. From this, 17 barangays (58.47 ha at PhP 1.75 billion) are with susceptibility of 1.5 meters and above. At the same risk category, flood depth of 0.5 meter to 1.5 meters is expected in 27 barangays (246 hectares at PhP 7.39 billion), and below 0.5 meters in 26 barangays (140.52 hectares at PhP 4.26 billion). The most at risk barangay is Liloan in 46.95 hectares (PhP 1.40 billion). Forty-six barangays in 249.78 hectares (PhP 7.49 billion) is at low risk category, while 37 barangays in 63.77 hectares (PhP 1.91 billion) is at moderate risk category. Ten barangays in 15.36 hectares (PhP 468.90 million) is at low risk.

Landslide risk is observed in 41 barangays in 104 hectares, equivalent to replacement value of PhP 3.12 billion. At high risk are 6 barangays in 14.70 hectares (PhP 441 million). From this, 2.21 hectares (PhP 66.3 million) shared by Alta Vista and Manlilinao are detected within prescribed no dwelling zone. Building with continuous monitoring is recommended in 5.48 hectares (PhP 164.4 million) in 4 barangays (Alta Vista, Mabato, Mahayahay, Manlilinao), and with slope protection in 7.01 hectares (PhP 210.3 million) in 5 barangays (Gaas, Hugpa, Mabato, Mahayag, Manlilinao). Manlilinao (5.94 ha at PhP 178.2 million) and Mabato (4.08 ha at PhP 122.4 million) are the most at risk barangays. Thirty-two barangays in 74.21 hectares (PhP 2.23 billion) is at low risk category, while 12 barangays in 15.09 hectares (PhP 452 million) is at moderate risk category. Fourteen barangays in 12.66 hectares are with the lowest risk.

Storm surge risk is in low category detected in 21 barangays (333 hectares at PhP 11.55 billion). Considering 5 meters surge height, or Storm Surge Alert 4 scenario, 17 barangays in 154 hectares (PhP 8.75 billion), water is expected to be above head. Other areas will expect chest deep in 114 hectares and knee-deep in 65 hectares.

Socialized Housing. Flood risk is detected in 14 barangays in 61.56 hectares with value of PhP 1.85 billion. Five barangays at are high risk category Liloan, Margen, Can-untog, Valencia, and Lao, with accumulated area of 52.45 hectares (PhP 1.57 billion). The large areas at risk are in Liloan (21.42 hectares at PhP 642.6 million), Margen (14.93 hectares at PhP 447.9 million), and Can-untog (12.37 hectares at PhP 371 million). In Liloan, 6.01 hectares (PhP 180.3 million) are susceptible to above 1.5 meters flood. Low risk is detected in 7 barangays at 6.74 hectares (PhP 202.2 million), while moderate risk is detected 8 barangays in 2.37 hectares (PhP 71.1 million).

Landslide risk is detected low in 5 barangay of Dolores, Domonar, Liloan, Margen, and Valencia, with total area of 7.66 hectares (PhP 229.80 million). Within this area, 0.60 hectares (PhP 18 million) is detected in no built zone, while 3.07 hectares (PhP 92.1 million) require slope protection. Domonar has an area of 1.72 hectares (PhP 51.6 million) requiring slope protection.

Storm surge at low risk is detected in 5.09 hectares (PhP 152.7 million) in Lao, which 4.73 hectares (PhP 141.9 million is chest-deep.

Commercial Land Use. Flood is observed in 75 barangays with total area of 98.63 hectares (PhP 2.96 billion). At high risk category are 22 barangays in 23.95 hectares (PhP 718.5 million). Susceptible to flood depth above 1.5 meters are the 7 barangays of Can-adieng, Guiguitingan, Ipil, Leondoni, Licuma, Mas-in, and Maticaa covering 1.70 hectares (PhP 51 million). In the same risk level, 14 barangays in 7.87 hectares (PhP 236.1 million) and 19 barangays in 14.83 hectares (PhP 431.4 million) are susceptible to below 0.5 meters and 0.5 meters to 1.5 meters, respectively. Six barangays (Don Potenciano Larrazabal, Kadaohan, Labrador, Liloan, Mas-in, San Juan) are at highest risk in 3.73 hectares (PhP 111.9 million). Low risk is observed in 50 barangays at 71.60 hectares (PhP 2.15 billion), and moderate risk in 11 barangays at 3.08 hectares (PhP 92.4 million).

Landslide risk is observed in 26 barangays in 9.64 hectares (PhP 289.2 million). The barangays of Gaas, Mabato, and Manlilinao in 0.67 hectares (PhP 20.10 million) are at high risk category. Development in Gaas is required with frequent monitoring in 0.36 hectares (PhP 10.8 million) shared with Mabato, and installation of slope protection in 0.31 hectares (PhP 9.3 million) shared with Manlilinao. There are 19 barangays at low risk in 8.45 hectares (PhP 253.5 million), and 7 barangays at moderate risk in 0.52 hectares (PhP 15.6 million). In Alta Vista, at moderate risk, 0.13 hectares (PhP 3.9 million) is detected within prescribed no build zone.

Storm surge at low risk is detected in 32 barangays covering 48.07 hectares (PhP 1.44 billion). At 5 meters surge, 28 barangays at 28.02 hectares (PhP 840.6 million) is expected to have water height above head. The remaining 15.24 hectares (in 27 barangays at PhP 457.2 million) and 4.81 hectares (in 21 barangays at PhP 144.3 million) will experience water at chest-deep and knee-deep, respectively.

Institutional Land Use. Flood risk is observed in 66 barangays at 171.17 hectares (PhP 5.14 billion). Twenty-nine barangays are at high risk in 39.65 hectares (PhP 1.19 billion). With susceptibility of 1.5 meters flood depth in 2.81 hectares (PhP 84.3 million) are the 9 barangays of Can-untog, Dpn Potenciano Larrazabal, Guinguitingan, Leondoni, Licuma, Mas-in, Maticaa, Rufina M. Tan, and San Jose. In same risk category, 26 barangays in 28.03 hectares (PhP 840.90 million) and 20 barangays in 8.81 hectares (PhP 264.30 million) are susceptible to 0.5 meters to 1.5 meters and below 0.5 meters, respectively. There are 34 barangays in 127.85 hectares (PhP 3.84 billion) and 18 barangays in 3.67 hectares (PhP 110.10 million) detected in low risk category and moderate risk category, respectively.

Landslide risk is detected in 23 barangays in 31.37 hectares (PhP 941.10 million). At high risk category are 4 barangays (Gaas, Mabato, Mahayahay, and Milagro) in 2.92 hectares (PhP 87.6 million), and 2 barangays (Manlilinao, Milagro) in 7.51 hectares (PhP 225.30 million) are within building areas however prescribed to have continuous monitoring and provision of slope protection, respectively. A total of 3.19 hectares (PhP 95.7 million) in Manlilinao and Milagro are detected within no built zone. Twenty-one barangays in 17.29 hectares (PhP 518.7 million) are at low risk, with 10 barangays in 4.53 hectares (PhP 135.90 million) within no built zone. Moderate risk is detected in 0.46 hectares (PhP 13.80 million) in four barangays of Alta Vista, Gaas, Manlilinao, and Milagro. From this, 0.23 hectares (PhP 6.9 million) shared by Manlilinao and Milagro is detected within no built zone.

Low risk of storm surge is detected in 16 barangays at 43.29 hectares (PhP 1.30 billion). In Storm Surge Alert 4 scenario, inundation in 9 barangays (10.32 hectares at PhP 309.6 million) is expected to be chest-deep, while in 8 barangays (5.87 hectares at PhP 176.10 million) is at knee-deep. Twelve barangays in 27.10 hectares (PhP 813 million) will have above head surge.

Parks and Open Spaces. Flood risk is present in 65 barangays in 63.25 hectares (PhP 1.90 billion). It is categorized high in 26 barangays with an area of 41.28 hectares (PhP 1.24 billion). In 34 barangays within 18.03 hectares (PhP 540.9 million) are considered at low risk, while 28 barangays in 3.94 hectares (PhP 118.2 million) at moderate risk.

Landslide risk is detected in 28 barangays in 13.02 hectarhectares es (PhP 390.60 million). It is high in 3 barangays of Mabato, Mahayahay, and Manlilinao at 2.29 (PhP 68.7 million). Low risk is detected in 26 barangays (9.89 hectares at PhP 296.7 million), and ay moderate risk in 4 barangays (0.84 hectares at PhP 25.2 million).

Storm surge at low risk is detected in 12 barangays (25.78 hectares at PhP 773.4 million). Most areas are within above head surge height in 11 barangays (18.45 hectares at PhP 553.5 million). Five barangays in 2.76 hectares (PhP 82.8 million) is within knee-deep inundation, while 6 barangays in 4.57 hectares (PhP 137.10 million) in chest-deep inundation.

Roads Networks and Transport Utilities. (PhP 10,000 per meter, 1000 meter in kilometer or PhP 10 M per kilometer) Flood risk is observed in 108 barangays with total length of road network of 133.39 kilometers. Risk category are detected high in 33 barangays with 62.36 kilometers, low in 73 barangays with 57.54 kilometers, and moderate in 35 barangays with 13.94 kilometers.

Landslide risk is observed in 52 barangays with 58.35 kilometers. High risk is detected in 7 barangays (16.93 kilometers), requiring slope protection in 6.3 kilometers covering, including 8.78 kilometers in no built zone. Low risk is detected in 42 barangays (28.19 kilometers), requiring slope protection in 8.73 kilometers in 30 barangays, with 15.19 kilometers in 28 barangays at no dwelling zone. At moderate risk level are 28 barangays with 13.23 kilometers, including 5 barangays with 4.53 kilometers requiring slope protection, and 5.66 kilometers in 14 barangays at no dwelling zone.

Storm surge is at low risk level and may affect 45 barangays in 50.32 kilometers. In 34 barangays with 33.36 kilometers, surge is expected above head. Chest-deep inundation is expected in 36 barangays with 12.44 kilometers, and knee-deep inundation in 31 barangays with 4.52 kilometers.

Production Systems

The development thrust of the city intends to shift its economic base from agricultural production towards service and manufacturing. The spatial strategy identified agro-industrial zones. The land use plan differentiated agricultural zones to protection zones and production zones. The former are areas currently included in the irrigation network of the National Irrigation Authority, other areas are classified as production.

There are 32 barangays in protection zone and 66 barangays in production susceptible to flooding. Records by the City Agriculture in 2015 accounted 4, 540 rice farmers (in 60 barangays) and 794 corn farmers (in 43 barangays), while there are 4 barangays with multiple crops including vegetables, fruits, and food staples – banana, sweet potato and gabi. There are agricultural plantation covering 850 hectares of pineapple, and 5, 736 hectares of sugarcane, mostly in the production zone.

Typhoon events resulted to damages on crops during flowering and booting stages. TY Urduja (Kai-tak) in December 2017 left damages amounting to hP 5.8 million on rice and PhP 1.8 million on corn, on two days continuous rainfall affecting 730 rice farmers and 47 corn farmers. TY Ruby (Hagupit) in December 2014 left PhP 880, 000 damages in rice (302 farmers) and PhP 1.4 million in corn (195 farmers). TY Gorio (Rumbia) in June 2013 destroyed 200 ha of rice equivalent to PhP 11.78 million affecting 132 farmers. TY Yolanda (Haiyan) in November 2013 reported damages to agriculture sector totaled to PhP 2.059 billion of which PhP 1.862 billion area damages from standing crops. El Nino in 2015 reported damages of PhP 22.453 million in six barangays of Curva, Lao, Licuma, Margen, Rufina M. Tan, and Liloan.

Cost of rice production is from PhP 10, 000 up to PhP 15, 000 per hectare resulting to 2 tons for PhP 40 per kilo, with expected gross income of PhP 80, 000 and net of PhP 55, 000, while corn production per hectare is from PhP 10, 000 up to PhP 15, 000 for hybrid yellow and PhP 8, 500 up to 15, 000 for OPV white resulting to 4.2 tons and 3.0 tons respectively for PhP 13 and PhP 11 per kilo, with expected gross income of PhP 54, 000 or PhP 33, 000 and net of PhP 39, 900 or PhP 9, 500. For rice cropping season of November 2015 to April 2016, average production is 3.34 MT/ha, while May to October 2016 averages 4.19 MT/ha. As of 2016 there is 86.93% rice self-sufficiency index.

Of the total 5, 791.5 hectares of rice production lands, only 4,337.5 hectares is being covered by irrigation. An estimated 2, 500 hectares is considered insufficient, while the remaining areas are supplied by spring (1, 220 hectares) or water impoundments (799.5 hectares). The remaining 1, 400 hectares are still not irrigated by any source. Irrigation coverage ensures 15% to 20% increase in total crop yield.

Less than 10% of farmers are not covered by crop insurance amounting to PhP 10,000 per hectare, while average land ownership is 1.5 hectare per farmer.

In 2017, livestock production are as follows: swine (32, 843), cattle (1, 591), carabao (1, 582), goat (1, 315), and poultry (4, 965, 354). Aquaculture is highly dominated with commercial fishpond at 254 hectares, while backyard activity is within 3.33 hectares for fishpond and 0.114 hectares for fish cages. Main produce are tilapia and bangus, with average production of 1.3 tons in 50 meter square pen/cage. This requires an inputs of 7000 fingerlings at PhP 6 each.

Farming in the upland barangays are primarily producing assorted vegetables.

Risk Assessment per Land Use in Production Ecosystem

Agricultural Protection. Flood risk is detected in 32 barangays at 3, 739.95 hectares (PhP 175 million). Twenty-one barangays at 3, 052.37 hectares (PhP 141.1 million) and 11 barangays at 687.58 hectares (PhP 33.94 million) are in moderate risk category and low risk category, respectively.

Landslide risk is observed in 20 barangays at 1, 466.35 hectares (PhP 64.35 million). Classified under moderate risk category are 6 barangays at 513.23 hectares (PhP 21.09 million), while 14 barangays at 953.12 hectares (PhP 43.26 million) at low risk category. Slope protection is required in 12 barangays (332.90 hectares at PhP 15.17 million) at low risk, and 6 barangays (199.46 hectares at PhP 8.19 million) at moderate risk. No dwelling zone is prescribed in 14 barangays (433.32 hectares at PhP 19.52 million) at low risk, and in 6 barangays (182.66 hectares at PhP 7.22 million) at moderate risk.

Storm surge at low risk is observed in 6 barangays of Lao, Libertad, Liloan, San Isidro, and Sto. Nino, covering 386.08 hectares (PhP 18.53 million). Above head surge is expected in 162.75 hectares (PhP 8.23 million), chest-deep inundation in 176.47 hectares (PhP 8.32 million), and knee-deep at 46.86 hectares (PhP 1.96 million).

Agricultural Production. Flood risk is observed in 66 barangays at 4, 416 hectares under this land use classification, however only 32 barangays in 2, 510.17 hectares are productive with value of PhP 125.22 million. At high risk with above 1.5 meters depth are 20 barangays (512.18 hectares) with only 16 barangays (297.60 hectares) productive at PhP 13.16 million. In 19 barangays (348.81 hectares) of below 0.5 meters flood susceptibility, 16 barangays (308.11 hectares) are productive with value of PhP 15.31 million. Eighteen barangays in 645.27 hectares out of 25 barangays (819.92 hectares) with value of PhP 29.53 million is susceptible to 0.5 meters to 1.5 meters flood. At low risk category are 10 barangays (283.40 hectares) out of 32 barangays (1, 432.91 hectares), with accumulated value of PhP 17.98 million. Twenty-two barangays (in 975.79 hectares) out of 34 barangays (1, 303.16 hectares) with value of PhP 49.24 million are categorized with moderate risk.

Landslide risk is observed in 26 barangays (1, 557.87 hectares) from classified 60 barangays (4, 215.87 hectares), with value of PhP 26.55 million. At high risk are the barangays of Mabato and Manlilinao (155.13 hectares) from 6 barangays (375.57 hectares) with value of PhP 157, 749.76. Production in Mabato is required to have monitoring in 7.27 hectares (PhP 30, 000) and slope protection in 10.61 hectares (PhP 45, 000). Production is detected in no built zone with 137.25 hectares (PhP 82, 749.76) in Mabato and Manlilinao. Low risk is detected in 20 barangays (327.77 hectares) out of 44 barangays (1, 335 hectares) with value of PhP 18.85 million. At same risk, in 19 barangays are detected in no built zone (112.74 hectares of 648.69 hectares in 41 barangays) with value of PhP 5.94 million, and in zone requiring slope protection (134.76 hectares of 436.07 of 44 barangays) with value of PhP 5.32 million. At moderate risk category are 6 productive barangays (1, 074.97 hectares) out of 17 barangays (2, 503.08 hectares) with value of PhP 7.54 million. The same barangays are detected in no built zone (520.08 hectares out of 1, 144.87 hectares in 15 barangays) with value of PhP 3 million, and in areas requiring slope protection (393.43 hectares out of 986.52 hectares in 17 barangays) with value of PhP 2.07 million.

Storm surge at low risk is detected in 15 barangays (793.07 hectares), however productive lands are present in 8 barangays (653.30 hectares) with value of PhP 16.58 million. Six barangays in 385.88 hectares (out of 12 barangays in 498.47 hectares at PhP 7.83 million) is susceptible to above head surge, 8 barangays (51.63 hectares out of 14 barangays in 58.51 hectares with value of PhP 2.76 million) to knee-deep inundation, and 7 barangays (215.79 hectares out of 13 barangays in 236.09 hectares at PhP 5.99 million) to chest-deep inundation.

Fishpond. Flood risk is detected in barangays of Lao, Naungan, and San Juan with total area of 254.95 hectares and value of PhP 4.08 million. At high risk is a total area of 159.77 hectares with value of PhP 2.56 million susceptible to flood depth above 1.5 meters, while 83.84 hectares (PhP 1.34 million) at 0.5 meters to 1.5 meters. A total area of 11.34 hectares (PhP 181, 440) is at moderate risk category.

Landslide risk is detected at low level in 0.13 hectares (PhP 2, 080) in Naungan.

Storm surge risk is at low category. Chest deep is expected in 0.80 hectares (PhP 12, 800), while above head surge is expected in 411.52 hectares (PhP 6.58 million) – Lao (303.86 hectares at PhP 4.86 million), Naungan (69.17 hectares at PhP 1.11 million), and San Juan (38.49 hectares at PhP 615, 840).

Forest Ecosystem

The protected forest zone includes the delineated Lake Danao Natural Park under the NIPAS Act with 2, 1103.43 hectares as ecotourism zone. The area falls within the Bao River Watershed considered critical in status by the DENR together with other 8 legally delineated watersheds in the region. The forest production area are located mostly located in the central portion of the city, with vast track of private ownership. This area also includes the solar farms in Dolores, and geothermal power plant in Tongonan. All remaining forest lands are classified as protected forest with total area of 15, 508 ha. This includes the Lake Danao Natural Park under the NIPAS Act with total land area of 2, 110.43 ha, currently being developed for eco-tourism activities. However, the water quality of the lake is being rehabilitated from the coliform breakout in 2010. There is a total of 103.07 ha with high risk to rain-induced landslide.

The remaining forest of the city was classified to be residual forest, highly affected by logging activities in the 1950s to 1960s. This is second growth forest is highly classified as open forest, with low capacity of holding rain water. This is observed within the vicinity of the Danao Lake where landslide is detected at 810 masl. Dense forest areas are observed within the lower elevation between 280 masl to 450 masl in Tongonan and Dolores. Lake water is currently being rehabilitated from the coliform breakout in 2010 coming from domestic waste of people residing near it. The lake is considered a potential for tourism activity currently inviting local tourists, and with city plans on its further development. The same is considered source of water supply in the city.

Risk Assessment per Land Use in Forest Ecosystem

Forest protection. Flood risk is detected at low category in 1, 150.74 hectares – 427.78 hectares above 1.5 meters, 539.50 hectares from 0.5 meters to 1.5 meters, and 183.46 hectares below 0.5 meters. Landslide risk is observed in 11, 197.90 hectares. There are 6, 169.22 hectares at low risk, and 5, 028.68 hectares at moderate risk. No dwelling zone is detected in 4, 452.20 hectares (low risk), and 2, 437.04 hectares (moderate risk). Slope protection is required in 1, 438.08 hectares (low risk), and 2, 140.16 hectares (moderate risk).

Forest production. Flood risk is detected at low category in 12.63 hectares – 0.64 hectares above 1.5 meters, 5.91 hectares from 0.5 meters to 1.5 meters, and 6.08 hectares below 0.5 meters.

Landslide is at low risk in 49.02 hectares – Cabintan (41.33 hectares) and Tongonan (7.69 hectares). There is 38.23 hectares in no dwelling zone and 7.29 hectares requiring slope protection.

Eco-tourism. Flood is detected in low risk at 154.02 hectares. Flood depth is expected to be at 1.5 meters above in 50.56 hectares, 0.5 meters to 1.5 meters in 83.41 hectares, and below 0.5 meters in 20.05 hectares. This is primarily detected in Danao at 119.21 hectares – 32.89 hectares, 68.09 hectares, and 18.24 hectares, accordingly.

Landslide is detected in 1, 876.13 hectares. At high risk category, are detected no dwelling zone (594.86 hectares) and slope protection zone (654.40 hectares), all in Danao (1, 249.26 hectares). Low risk is detected in 114.03 hectares, and moderate risk in 512.84 hectares. No dwelling zones are detected in 76.29 hectares (low risk) and 271.84 hectares (moderate risk). Slope protection is required in 34.52 hectares (low risk) and 127.75 hectares (moderate risk).

2.1.2 Future climate-related hazards and issues

2.1.2.1 Climate Change Projections

For this plan, the climate data projection for mid-20th century, average values of climate data covering years of 2036 up to 2065, will be used under RCP 8.5. This values are recommended for planning activities by Year 2020, while the late century data (2070 to 2099) projections by Year 2050. Both data are presented in this section. Data on extreme events from RCP models (CIMP5) are not available in the Philippines. Thus, the data from the SRES (Special Report on Emission Scenarios of CMIP3) are use as follows: 1398 days are above 35 C, 5199 dry days, and 7 days are above 300mm rainfall of 7300 days in 20 years (2006-2035).

Temperature Changes in RCP 8.5

Increasing temperature across all season	The months of MAM and JJA expected to have the extreme rise in Temperature, maximum at 30.2 (2020) and 32.1 C (2050), increase of 2.3 C (2020) and 4.1 C (2050).

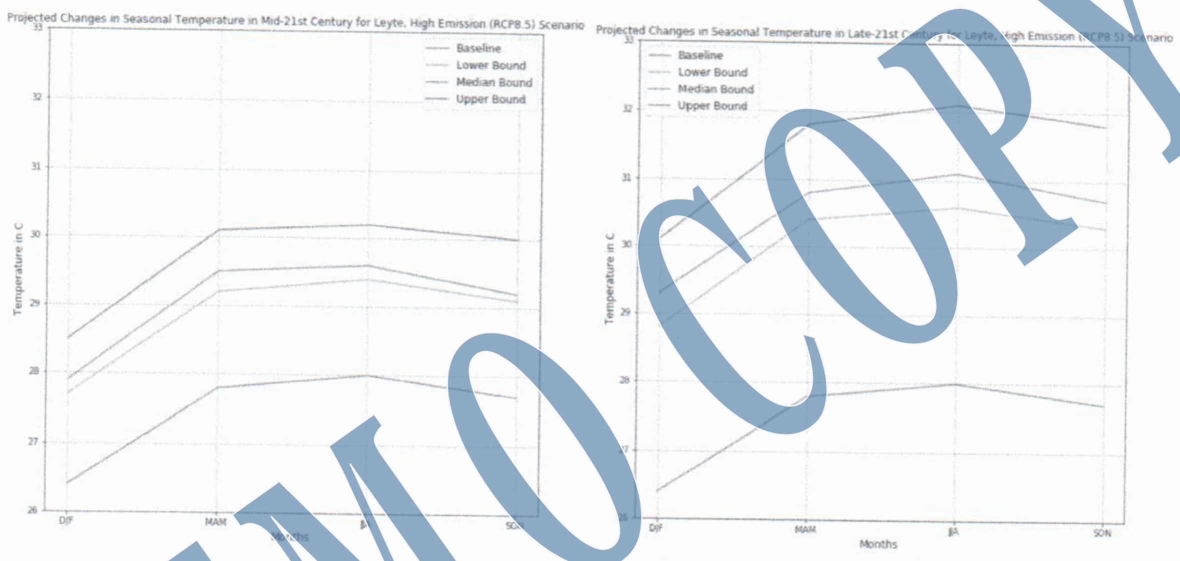


Figure 11. Projected Temperature for Leyte in the 21st Century, RCP 8.5 Scenario

Precipitation Changes in RCP 8.5

Decreasing rain fall during dry seasons (MAM, JAJ), and increasing rainfall during wet seasons (SON DJF)	The lowest decrease is observed on SON of 2020 at 534 mm (-191.5 mm), while the highest increase is observed on DJF of 2020 at 909.8 mm (or +202.3 mm). The lowest decrease is observed on MAM of 2050 at 318 mm (-24 mm), while the highest increase is observed on DJF of 2050 at 1106.4 mm (or +416.9 mm).

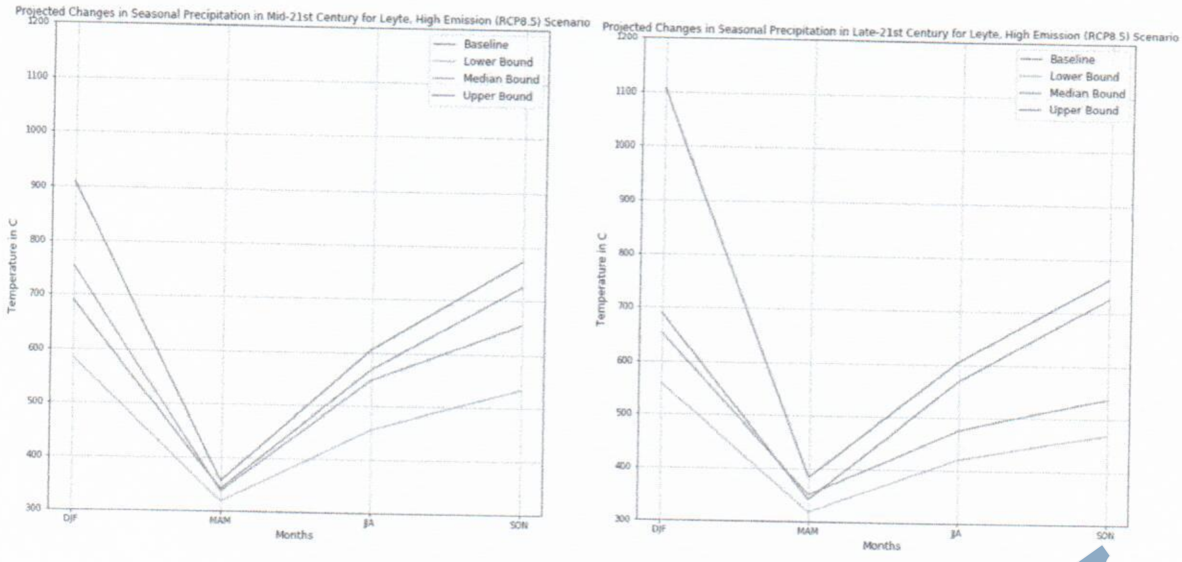


Figure 12. Projected Precipitation for Leyte in the 21st Century, RCP 8.5 Scenario

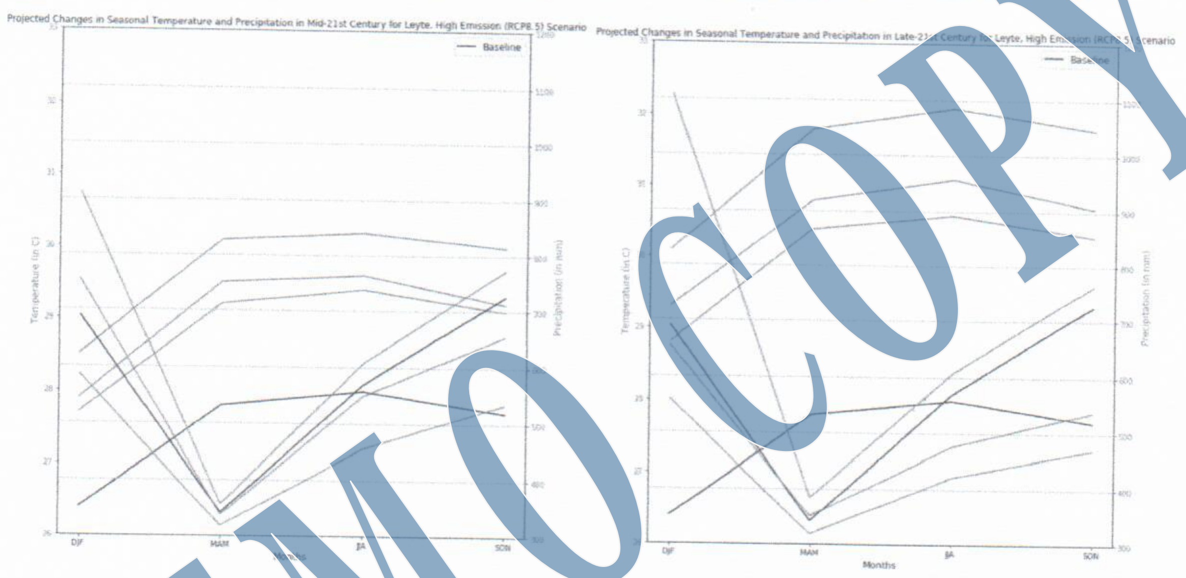


Figure 13. Projected Temperature and Precipitation in Leyte in the 21st Century, RCP 8.5 Scenario

These observations aligned with the general expected conditions in the country as dry seasons will become drier, and wet seasons be wetter.

2.1.2.2 Climate Change Impacts

Below discusses the impact of climate change information on level of risks in terms of people affected and cost, coupled with results from the greenhouse gas emission inventory.

Coastal Ecosystem

Increase (average) in temperature by 2.3 C by 2020. There will be a decrease in income from PhP 14, 300 (5 kgs/day at P130/kg for 22 days) to PhP 8, 580 (3 kgs/day), with 5 hours decrease in working time from 4am-9am to 4am-7am, and 4pm-10pm to 6pm-10pm, particular to 1, 686 or 35% who are directly conducting open sea fishing. Existing ordinance on off-season for 6 days (3 day before and 3 days after full moon) is considered on this impact. Regular fishing activity are periodic on the months of July, August, September, October due to Habagat, leaving fisher folks with active income in 8 months, while absence or periodic in 4 months. It is noteworthy that increase in number of fisher folks may lead to over carrying capacity of Ormoc Bay.

Decreased fish catch available to market for consumption may contribute to food shortage currently accounted at 16, 854 households under food threshold, and 311 households experienced food shortage. Increase in temperature may decrease the current 226.58 hectares of sea grass or reef due to coral bleaching. There are no possible expansion of marine reserve area or marine protected area. Increase on population of crown of thorn fish is expected. This also leads to siltation affecting 719 ha of mangroves, and eventual fish migration.

Increase (maximum) in precipitation by 220mm by 2020. Increase in rainfall, and eventual flooding will lead to increase in siltation affecting coral reefs and mangroves. This is currently observed, and expected to be exacerbated on two coastal barangays of Ipil and San Antonio, where sand and gravel extraction is practiced. Typhoon events will damage fish pens in Ormoc Bay, decreasing fish yield. Intermittent fishing activity during habagat season will be further lessen.

Flooding transports coliform to Ormoc Bay from the residential areas along the coast posting aggravated public health implications.

National projects coming underway, particularly the construction of national highway may lead to destruction of existing mangrove forest.

Points of actions
The mangrove area at the end of Pagsangaan River is in level with the sea water, where volume of water is expected to be constantly present, and increase during typhoons. The state of mangrove forest must be kept, with work on its expansion anticipating storm surge currently at low risk. The income of fisher folks must be maintained and increased through maintaining its catch yield and providing support infrastructure and systems to the sector. There must be strict environmental impact assessment of any development. There must be zero tolerance on erecting human habitat in the area, while the relocation on Sitio Quinto Limbo that is already included in the Comprehensive Shelter Plan is to be strictly followed. A study to include the remaining population of Naungan must be commenced. In immediate time, evaluation on the strength

of housing units to sustain flooding must be conducted, while introducing retrofit works. Low emission technique in any development such as the tourism hub must be employed.

Urban System

Increase (average) in temperature by 2.3 C by 2020. This will have 11, 460 residential and 423 commercial customers in 2017 to increase electric consumption due to installation of cooling units. This will increase GHG emissions of these two sets of customers currently at 22, 615.71 CO2 e and 4, 037.69 CO2 e, respectively. Temporal demand for work on installation and maintenance of these cooling units are expected. However, this will also serve as opportunity to implement and introduce passive cooling mechanisms on structures. The city center is expected to be hotter compared to other areas of the city, particularly to midland and upland, inviting movement on these areas. Increased demand for water use is expected, increasing consumption from current average of 30 cubic meter per household each month. Dry days will also increase tourist visits posing increase in GHG emissions from transportation and electric consumption of hotels, lodges, and inns.

Cases of dengue is expected to increase, as reproduction of the carrier mosquito is shortened from 9 days to 5 days, in 30 C and above condition. There are 63 cases in 2016 and 469 cases in 2017 recorded. It may also increase cases of skin diseases from 692 cases recorded in 2017.

Increase (maximum) in precipitation by 220 mm by 2020. Frequent flooding will affect 153, 351 people equivalent to a tripled replacement cost of PhP 64.96 billion. Submergence of houses to flood causing structural stresses to walls, ceilings, and floors and damages to other domestic properties are expected. However, the availability of more rain can be captured and utilized for domestic and commercial purposes as prescribed by the local ordinance on rainwater capture. Storm surge, currently at low risk, however in 8 November 2013 during TY Yolanda (Haiyan), DOST NOAH alerted Ormoc to experience 5.2 meters storm tide by 2:00 in the afternoon. This scenario may affect 109,880 equivalent to a PhP 32.97 billion. While damages of rain-induced landslide at high risk areas will affect 93, 775 people equivalent to PhP 8.91 billion.

Decrease in income due to disruption of economic activities to an estimate 8, 000 participants of the informal economy. This links with the disruption on flow people (tourists), goods, and services in the formal economy aggravated by suspended transportation both in sea and air.

Submergence of schools and roads due to flooding affecting school operations, requiring adjustments and retrofitting on building, drainage system, roads, and bridges. Increased cases of vector borne diseases and water-borne diseases remained expected, with 5% increase in hospitalization cost compounded yearly.

Open spaces development in the city proper may take opportunity to collect and utilize rainwater for its operations and other public uses.

Points of actions

Place of people habitat and activity must be immediately given action.

As for flooding, residential areas in 29 barangays in 445.17 hectares are at high risk, of which 17 barangays (58.47 ha at PhP 1.75 billion) are with susceptibility of 1.5 meters and above. Social housing areas are at high risk category in Liloan, Margen, Can-untog, Valencia, and Lao, with accumulated area of 52.45 hectares (PhP 1.57 billion). Commercial zones in 22 barangays at 23.95 hectares (PhP 718.5 million) are at high risk with same susceptibility in 7 barangays of Can-adieng, Guiguitingan, Ipil, Leondoni, Licuma, Mas-in, and Maticaa (covering 1.70 hectares at PhP 51 million).

Flooding on these areas are highly characterized by riverine flooding such cases of Licuma, Liloan, and Margen along the Pagsangaan River, Ipil along Bubunawon River, and Can-adieng along Malbasag River. Flood control projects must be in place, and immediate retrofitting of houses.

At high risk to landslide are 6 barangays in 14.70 hectares (PhP 441 million) of residential zone. Manlilinao (5.94 ha at PhP 178.2 million) and Mabato (4.08 ha at PhP 122.4 million) are the most at risk barangays.

Landslide risk areas particular those detected at high category in no dwelling zone must be considered in the resettlement plan, and that require slope protection must implement the latest technology.

This follows retrofitting, installation of rainwater harvester, flood control, and slope protection in government buildings. Twenty-nine barangays are at high risk in 39.65 hectares (PhP 1.19 billion). With susceptibility of 1.5 meters flood depth in 2.81 hectares (PhP 84.3 million) are the 9 barangays of Can-untog, Don Potenciano Larrazabal, Guinguitingan, Leondoni, Licuma, Mas-in, Maticaa, Rufina M. Tan, and San Jose. Landslide risk is detected in 23 barangays in 31.37 hectares (PhP 941.10 million). At high risk category are 4 barangays (Gaas, Mabato, Mahayahay, and Milagro) in 2.92 hectares (PhP 87.6 million), and 2 barangays (Manlilinao, Milagro) in 7.51 hectares (PhP 225.30 million) are within building areas however prescribed to have continuous monitoring and provision of slope protection, respectively.

Repairs and improvement on roads and its drainage system must be in place in a total length of 133.39 kilometers of which 62.36 kilometers. Slope protection is required in 6.3 kilometers of 7 barangays, and strict development in 8.78 kilometers of no dwelling zone.

Flood risk in open spaces is high in 26 barangays with an area of 41.28 hectares (PhP 1.24 billion). The urban spaces must be designed with capacity to capture storm water. Particular with the urban spaces along the coast, it must anticipate the possibility of a storm surge.

Storm surge at low risk maybe significantly damaging with at least PhP 15.4 billion.

Production System
Increase (average) in temperature by 2.3 C by 2020. Each temperature increase by 1 C leads to 10% decrease in production, leading to decrease on net income of rice production from PhP 165, 000 (PhP 13, 750/month) by PhP 31, 350 down to PhP 133, 650 (PhP 11, 137.5 /month) on two cropping season per year by 4, 540 rice farmers and 794 corn farmers. Above this, hotter days will decrease working time. Decreased on water supply for irrigation covering 4, 337.5 ha of total 5, 791.5 ha of rice production lands due to low ground water recharge rate and decrease in surface water volume are expected, posting 10% to 15% yield decrease.

There is expected 80% decrease in inland aquaculture due to increase in water temperature from its current production of 1.3 tons in 50 meter square pen/cage.

Increase (maximum) in precipitation by 220mm by 2020. The 32 barangays at high risk in flooding at 3739.95 ha will have a value of PhP 202.58 million by 2030. Five barangays at low risk to storm surge at 386.05 ha will have a value of PhP 21.45 million by 2030. There is an average of 50% decreased on production during typhoon events. There is expected increase in use of electricity for postharvest activities.

Upland agriculture will have an increased opportunity to cultivate assorted vegetables in 283.4 hectares, with the availability of water on water impoundments.
Depending on amount of rainfall, flooding may result to 20% to 100% damages on inland aquaculture.

Points of action
Flooding in the agricultural farms must be controlled, particularly along the Pagsangaan River. The farmers must be introduced to variety of rice and crops that can withhold long submergence to flooding. Support infrastructure such as buffer stock, irrigation, and post-harvesting facilities must be in place, as well as programs such as trainings and information drives. The participation in crop insurance must be maximized, and must include all farmers. Upland agriculture must be insulated in damages through applying farming methods that prevent landslides.

Forest Ecosystem
Increase (average) in temperature by 2.3 C by 2020. The remaining 15, 508 ha forest lands may have occurrence of wild forest fires, and wildlife migration. This will also lead to decrease in production of wildlings. Availability of water from spring sources may decrease. The critical state of Bao River Watershed will be exacerbated.

Increase in precipitation (maximum) by 220mm by 2020. Availability of precipitation may increase recharge of the aquifer and survival rate of planted seedlings. However, run-off and rain-induced landslide may increase siltation along tributaries, particular in Lake Danao vicinity at high risk, attributed to its low tree coverage.

Points of action
The forest area must be rehabilitated in order to optimally function as natural barrier from typhoons. Thus tree planting and natural slope protection methods must be applied. Formulation of forest land use plan is necessary, as well as enhancement of protected area management plan of Danao Lake. This requires biodiversity study and hydrology study.

Indicative tests on urban heat effect
This section discusses initial spatial tests describing the dynamics of an urban heat effect. This synthesizes three level of tests – simple canopy detection, road density test, and settlement density test. This intends to show the spatial element of the urban heat effect – where will it be hotter, where it will it be cooler. It is further related to the character of the adjacent structures, natural environment, and behavior of the ecosystem. This does not inform prevailing urban heat effect, but may be considered to establish points of observation for its further study, and validation.

Road network test detected the city center towards the barangay of Cogon, Don Felipe Larrazabal, Dona Feliza Mejia, and San Isidro to expect higher temperature compared to other urban barangays. The city center has dense and compact built-up primarily for commercial and residential use. Don Felipe Larrazabal and Cogon are areas for residential, commercial, and institutional uses – including the Eastern Visayas State University (Ormoc City Campus), the New Ormoc City National High School, and the New Ormoc City Hall Complex. Dona Feliza Mejia and San Isidro are with commercial and adjacent middle scale residential subdivisions. This test detected roads as reference of increased temperature, highly detected on portions of Ormoc-Kananga-Tacloban Road, Veloso Street, and road network in the city center – including access roads along the Anilao River and Malbasag River.

In terms of settlement density, higher temperature is expected in barangays of Tambulilid and Linao. Tambulilid is the most populated barangay with 22, 359 residents in 1, 659 households, with 124 houses made from make-shift materials and 11 informal settler families. Linao is the second most populated with 8, 576 people in 2, 137 households, with 91 make-shift houses, and 224 informal settler families. Detected also are portions of residential areas of Cogon, Punta, and Don Felipe Larrazabal.

Enclosed in these two poles are the urban coastal areas of Batuan, Alegria, Punta, and Linao, where temperature may also increase during dry season when there is high evaporation rate in Ormoc Bay. This is the same on the Ormoc Market and Fish Complex, Ormoc City Plaza Complex and coastal settlements in Can-adieng.

These areas are identified to be the major node of development on its spatial development strategy.

Figure 14. Density Test on Roads and Settlements to Indicate Urban Heat Island Effect

The canopy on these areas are detected to be within 1 meter to 5 meters, indicating presence of commercial and settlement infrastructure with probable sporadically located and short vegetation. Its identified expansion of urban corridor to the north is detected to have the same canopy level currently characterized by sporadic commercial buildings, series of settlements, and sugarcane plantations.

Canopy test confirms the presence of agricultural production zones and human settlements in between 0 meter to 1 meter. This aligns with observed impact of intense heat in agcricuture such the case of 2015-2016 El Nino amounting to PhP 22.453 million in six barangays of Curva, Lao, Licuma, Margen, Rufina M. Tan, and Liloan. Canopy along river is detected within 1 meter to 5 meter, and can be attributed to short grasses and shrubs. This detects that the intact forests are located in the midland of Dolores, Hibuna-on, Cagbuhangin, Cabulihan, Concepcion, Juaton, Magaswe, Bagong, and Milagro. The planned industrial expansion in Luna and Dolores may decrease the land area of these intact forest.

The canopy in the midlands northeast of urban center are highly characterized by pineapple and sugarcane plantations. The upland forests in Danao, Cabintan, Tongonan, Ga-as, and Liberty are detected to have patches of thick canopy. These areas are within the critical adjacent watersheds of Bao River, Pongso River, Mainit River, and Binhaan River.

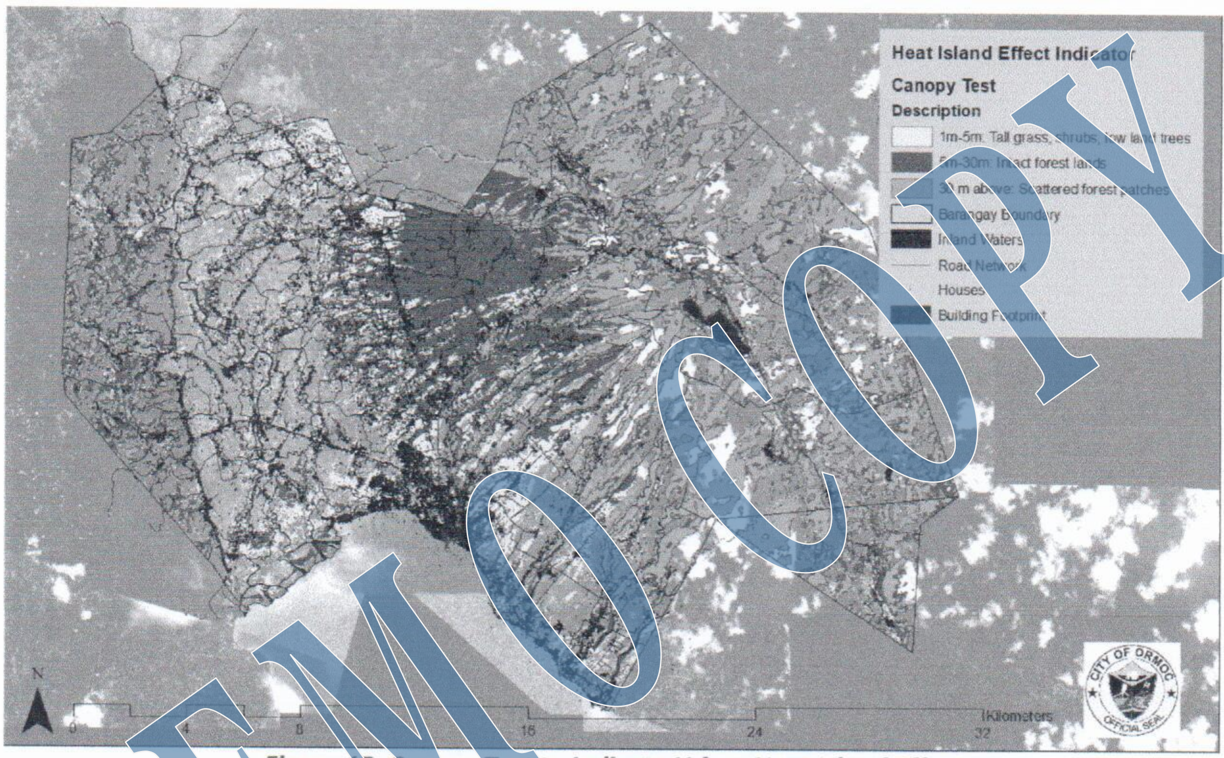


Figure 15. Canopy Test to Indicate Urban Heat Island Effect

Box 1. Set of Indicative Tests for Urban Heat Island Effect

Set of test methods

Simple canopy detection. Canopy may refer to roofs of building and houses, top of trees or any other vegetation cover, and other structures elevated from the ground. This assumes the following:

Color	Height of Canopy	Assumption
Gray	below 1 meter	Agricultural lands, shrubs, grasses, and short vegetation

		and structures, other natural features below 0 meter
Red	1 meter – 5 meters	Human settlements, commercial buildings, tall grass or shrub vegetation, and other infrastructure
Green	5 meters – 30 meters	Intact forest vegetation, based on average maximum height of tropical trees
No color	30 meters above	Not intact forest, taller trees in maximum in scattered location, and other structures

Test are conducted in ArcGIS 10. Requires the following data sets – digital surface model and digital terrain model. Road network, settlement points, and building footprints are overlaid.

Road network (line) density test. This assumes that presence of road and its proximity indicate presence of urban structures where people dwell and conduct business. This assumes that all road networks as well surrounding structures are made of concrete materials that may intensify outside temperature and where no regulation initiatives are being implemented (i.e., trees along roads, green roofing). Road density may provide compactness or absence of spaces among building structures, obstructing wind circulation. Performed in Line Density module of ArcGIS 10. Requires road network line shapefile. Building footprints and settlement points are overlaid.

Settlements (point) density test. This assumes that density (based on number and proximity) of housing structures will cause intensification of heat, absence of tree cover and compactness. This also assumes that there are no initiatives on its regulation, and materials used are concrete. Performed in Point Density module of ArcGIS 10. Requires settlement shapefile. Building footprints and road networks are overlaid.

Interpretation and sense-making

A visual validation on presence of houses, buildings, roads, and other structures is necessary noting its spaces and volume. Understanding location of ecosystem, land use, and planned development strategy will inform on the increasing or decreasing impact. Assumption on maximum height of canopy will depend on the vegetation and building present to the site. If points of commercial buildings are available, density test can also be performed. Areas of the building (residential and commercial) footprint/points and road network will initially signify absence of canopy. Advanced tree canopy analysis can be performed for better precision and accuracy. The sites considered hotter and cooler maybe considered in the installation of climate data observation for further study, analysis, and conclusion of an urban heat island effect.

Compounded risk with geologic hazards

There are 3 tectonic earthquakes recorded in 2017, which epicenter falls within the city. The strongest was on 6 July 2017 at magnitude 6.5 and intensity level 7, with depth of focus at 2 kilometers. This resulted to landslide within the forest areas damaging road networks to Danao Lake. The whole city is susceptible to earthquake categorized at intensity 8 in agricultural production zones, urban center, and highlands around Danao Lake down to the midland, while the remaining areas at intensity 7.

Table 3. Timeline of earthquakes with epicenter within Ormoc City

Date	Magnitude	Intensity	Depth of focus	Location	Origin
23 July 1877	5.5	#	#	#	#
15 December 1999	4.8	VI	#	#	#
27 July 2016	5.2	VI	5 Kilometer	11.00°N, 124.62°E - 002 km N 79° E of Ormoc City (Leyte)	Tectonic
6 July 2017	6.5	VII	2 Kilometer	11.11°N, 124.69°E - 015 km N 39° E of Ormoc City (Leyte)	Tectonic
10 July 2017	5.8	VI	3 Kilometer	11.00°N, 124.73°E - 013 km S 87° E of Ormoc City (Leyte)	Tectonic
23 August 2017	5.1	VI	6 Kilometer	10.96°N, 124.65°E - 007 km N 47° W of Albuera (Leyte)	Tectonic

Earthquakes trigger liquefaction by reducing strength and stiffness of soil. This is likely to happen to areas with saturated soils with increased water pressure moving soil particles. High susceptibility to liquefaction is detected in the lower region of the agricultural production system, expanding to the human settlements along the coast. The production zone upper region is with susceptibility values of moderate to low. These areas are mapped to experience impact of an Intensity 8 earthquake. The city has no recorded liquefaction event.

Soil taxonomy provides that these areas are entisols (entropepts with dystropepts), characterized by thin organic matter and absence of pedogenic (soil development) horizons due to its recent (soil geology) formation due to deposits of alluvium (clay, silt, sand, gravel) at frequent intervals, usually in flood plains. The soils are typified into San Manuel Series (silt, silt loam) in the production zone, Umingan Clay Loam in the city center and south urban zones, and Guimbalaon Clay in between settlements along the coast and midlands. Hydrosols (soil frequently covered with water) are found in the large portion of San Juan, and strips of land mass along coast in Lao and Naungan.

San Manuel soil has relief of level to slightly undulating, moderate water retention, good drainage, and moderate to rapid permeability. It has a mean annual soil temperature higher than 22C isohyperthermic. Its rooting depth is more than 1 meter deep. This is a non-calcareous soil. This is classified to be suited for agricultural production due to its high soil fertility characteristics – pH 6.5 (neutral), very high base saturation, moderate to high nutrient retention, and moderate organic matter.

Table 4. Description of San Manuel Series

Depth cm	Description
0-6	Brown to dark brown 10YR 43 moist silt loam fine to medium granular structure loose many fine to medium roots many fine inped pores abrupt smooth boundary
6-36	Dark yellowish brown 10YR 44 moist sandy clay loam moderate medium subangular blocky structure firm many fine roots few medium and many fine open tubular pores clear smooth boundary
36-69	Very dark grayish brown 10YR 32 moist clay loam moderate fine to medium subangular blocky structure friable few fine roots few fine tubular and many fine inped pores gradual smooth boundary
69-90	Brown to dark brown 10YR 43 moist silt loam moderate fine to medium subangular blocky structure friable very few fine roots few fine tubular and many fine inped pores gradual smooth boundary
90 below	Dark yellowish brown 10YR 44 moist clay loam fine to medium subangular blocky structure friable very few fine roots few fine tubular and many fine inped pores

Umingan series has relief of level to nearly level, moderate water retention, good drainage, and rapid permeability. Rooting depth is deeper than 1 meter, and temperature higher than 22C. This is highly attributed with gravel and pebbles along river networks. This is slightly acidic to neutral (pH 5.5 to pH 7.5), with moderate base saturation, high nutrient retention, and low organic matter.

Table 5. Description of Umingan Series

Depth cm	Description
0-16	Dark grayish brown 10 YR 42 moist clay loam moderate very fine subangular blocky structure firm when moist very sticky and very plastic when wet many very fine and few medium inped pores many very fine roots presence of common fine gravels many very fine Fe nodules and Fe streaks yellowish red 5 YR 46 mottles faint black mottles gray mottles and streaks clay coatings many very tjin worms gradual and smooth boundary
16-27	Brown to dark brown 10 YR 43 moist clay loam moderate fine subangular blocky structure firm when moist very sticky and very plastic when wet many very fine to fine pores common very fine to fine roots presence of few small gravels many fine red 25 YR 46 orange faint black and gray mottles few slickensides clear and smooth boundary
27-70	Dark brown 75 YR 44 moist clay moderate fine subangular blocky structure firm when moist very sticky and very plastic when wet common fine inped and vesicular pores common fine roots common red and orange mottles many black and gray mottles interfingering clay slickensides clay skins diffuse and smooth boundary

Depth cm	Description
70-99	Strong brown 75 YR 46 dark gray 5 Y 41 and very dark gray 5 Y 31 moist silty clay moderate medium subangular blocky structure friable to firm when moist slightly sticky and plastic when wet many fine tubular and vesicular pores many black 75 YR N3 and N2 mottles saprolite slickensides clay skins diffuse and smooth boundary
99-124	Red 25 YR 46 dark gray 5 Y 41 and very dark gray 5 Y 31 moist silty clay moderate medium angular to subangular blocky extremely firm when moist slightly sticky and slightly plastic when wet common very fine vesicular pores very many black 75 YR N3 and N2 mottles slickensides saprolites gravels

The midlands to highlands are with taxonomy of entisols, inceptisols (ranges from very poorly drained to excessively drained occurring on mountain slopes with active weathering [depositing sediments] to river valleys), ultisols (observed mostly in humid climates with precipitation deficit which base saturation is concentrated in shallow depth), and alfisol (holding water at less than 1500 kPa tension for least 3 months).

Guimbalon series has relief of rolling to hilly, with good drainage, and rooting depth to its maximum profile. It is deep, but well drained. Its rolling landscape may cause erosion, thus tree planting, water control, and landslide prevention technology are recommended. Soil temperature is usually in the isohyperthermic level at 22C. This is strongly acidic, with moderate base saturation and organic matter, and low nutrient retention.

Table 6. Description of Guimbalon Series

Depth cm	Description
0-15	Dark yellowish brown 10YR 44 moist clay moderate medium subangular blocky to fine granular structure friable many very fine to fine and few coarse roots many fine inped and common fine tubular pores few Mn concretions rocks probably basalt and andesite present clear wavy boundary pH 54
15-39	Yellowish brown 10YR 54 moist silty clay medium coarse subangular blocky breaking to moderate medium to coarse granular structure friable to firm many fine and few coarse roots many fine inped pores concentration of pebbles 05 3 cm Fe coatings clear smooth boundary
39-69	Light yellowish brown 10YR 64 moist clay weak fine to coarse subangular blocky structure firm common fine roots few fine inped pores few pebbles Mn concretions clear smooth boundary
69-74	Light yellowish brown 10YR 64 and red 10R 48 moist silty clay weak fine to coarse subangular blocky structure firm few fine roots few fine inped pores clear smooth boundary
74 below	Very dark grayish brown 25Y 32 moist massive clay very few fine roots Mn concretions weathered rock present

In the production and urban zones, the geological process of its formation from river deposits in recent epochs immediately post susceptibility to liquefaction. Further, its composition from fine granular to sub-angular block allows high mobility among the soil particles on water. The same characteristics are observed in the upland soils. Earthquakes with magnitudes comparable to July 2017 event or higher may occur periodically due to active volcanic activity in Leyte Island. This may continuously post stress to the soil strength that may cause an actual liquefaction event.

Increase in temperature will result to increase in soil temperature decreasing its clay component and increasing its silt component. Soil tend to have its maximum aggregate stability on temperature beyond 30C. However, this will decrease moisture content and water viscosity, while increase the activation of carbon degradation by microorganism adding to CO2 production. This may naturally prevent liquefaction, but will negatively impact the agricultural productivity.

Increase in precipitation at the production and urban zones will result to flooding that further transport the alluvial materials, increasing its height deposits. This will increase the volume of soil susceptible to liquefaction. Banks degradation, widening its opposite distance, along the Pagsangaan River is observed, exhibiting weak soil composition. A big flooding event followed by a high intensity earthquake will be significantly disastrous. Rainfall in the city is evenly distributed throughout the year.

Tsunami event will cover the whole area of barangays Naungan, Linao, Punta, and Alegria. It will affect half of the area including the mangrove areas in San Juan, and Lao, and urban areas of Tambulilid, Don Felipe Larrazabal, and the city proper. This will also affect the low-lying coastal regions of Can-adieng, Camp Downes, Bantigue, Ipil, San Antonio, Danhug, and Macabug. This event may increase the saturation of this highly susceptible region to liquefaction. If this event will happen in the same time with flooding, water depth on these areas will be worsen. There are no recorded tsunami event in the city.

Even there are no recent records of ground shaking triggering these hazards, considered at low risk, its one-time event can post maximum disaster with prevalence of flood worsening the geo-physical conditions for liquefaction, with the same areas where tsunami is susceptible. Planning with consideration is still needed.

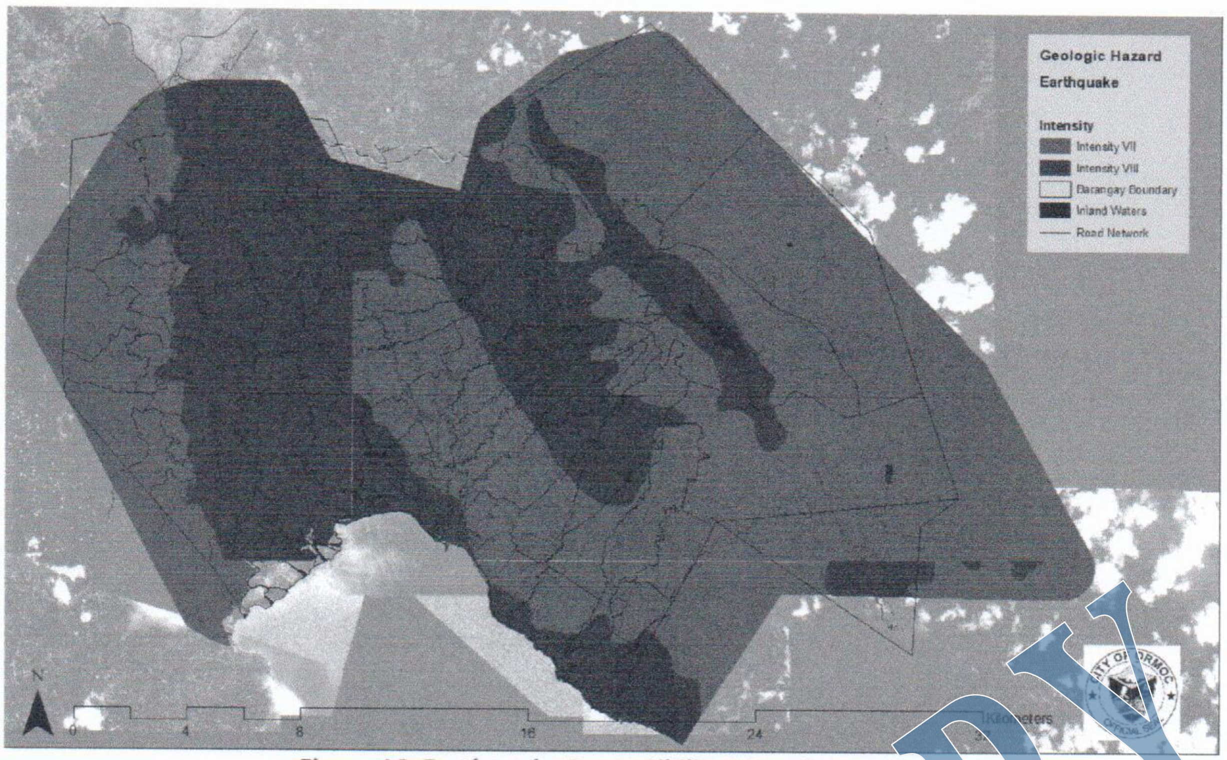


Figure 16. Earthquake Susceptibility Map, Ormoc City

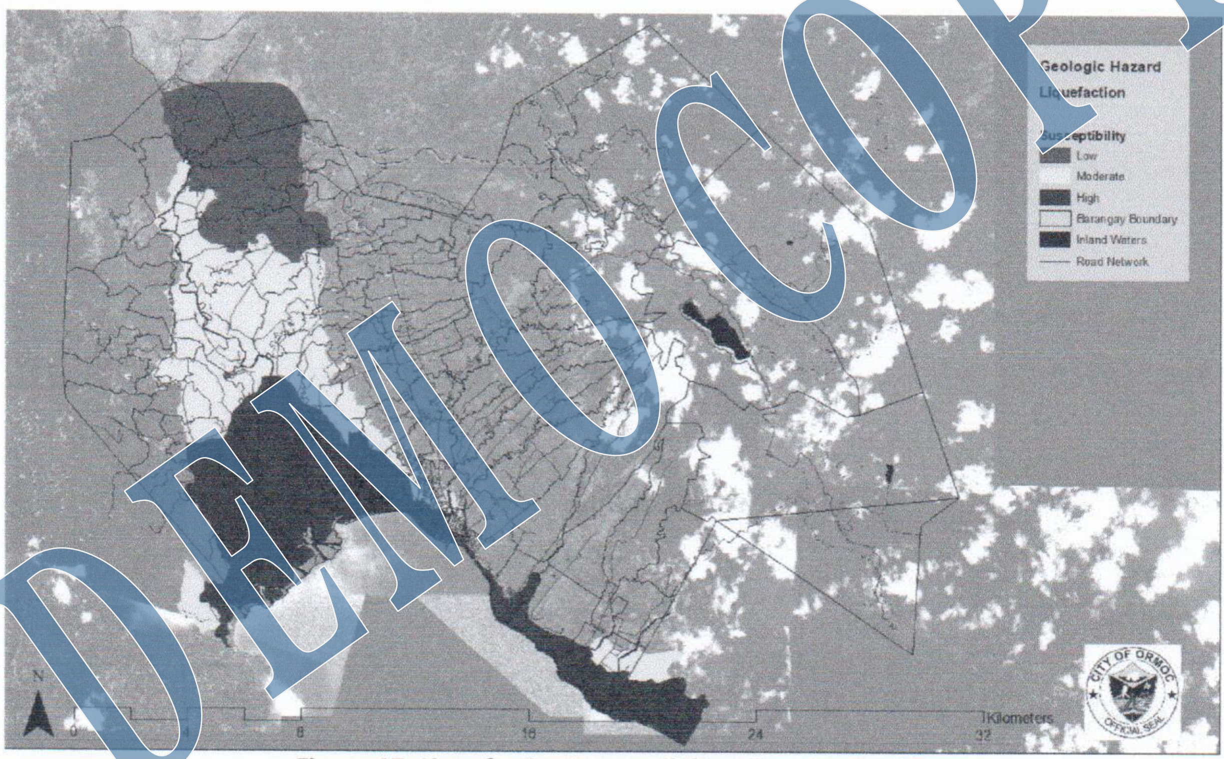


Figure 17. Liquefaction Susceptibility Map, Ormoc City

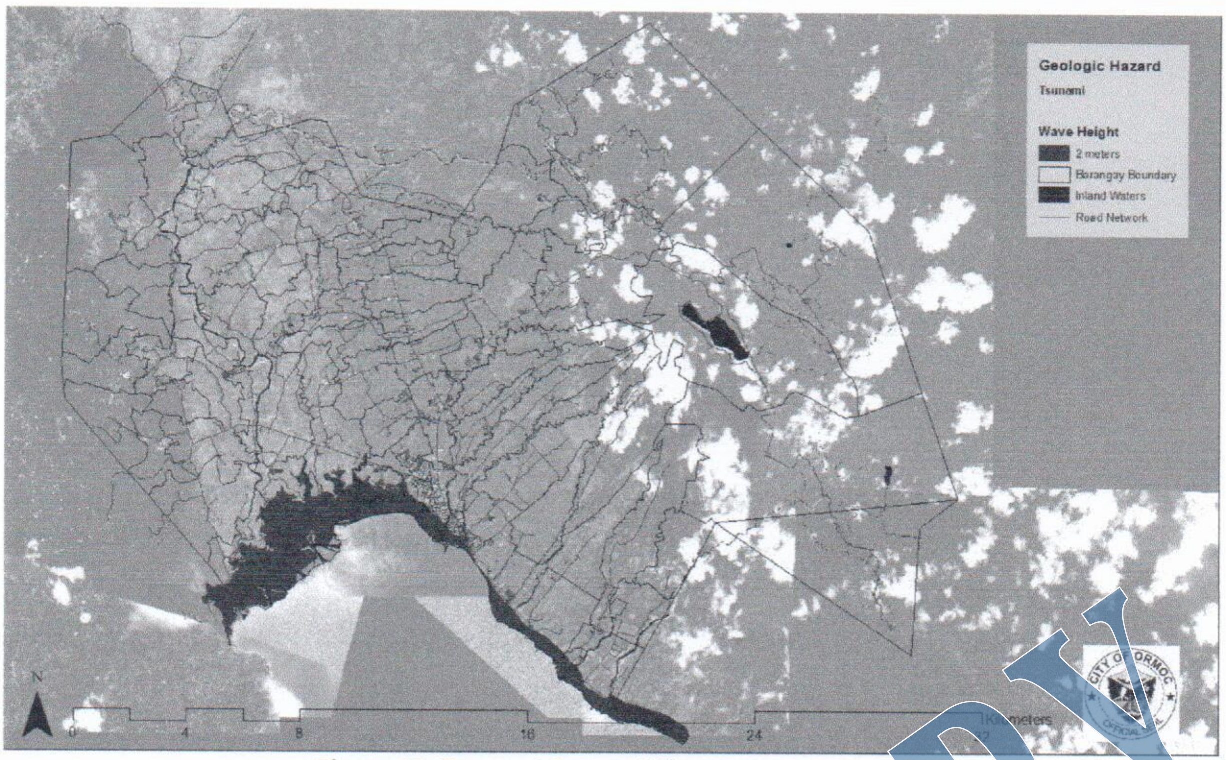


Figure 18. Tsunami Susceptibility Map, Ormoc City

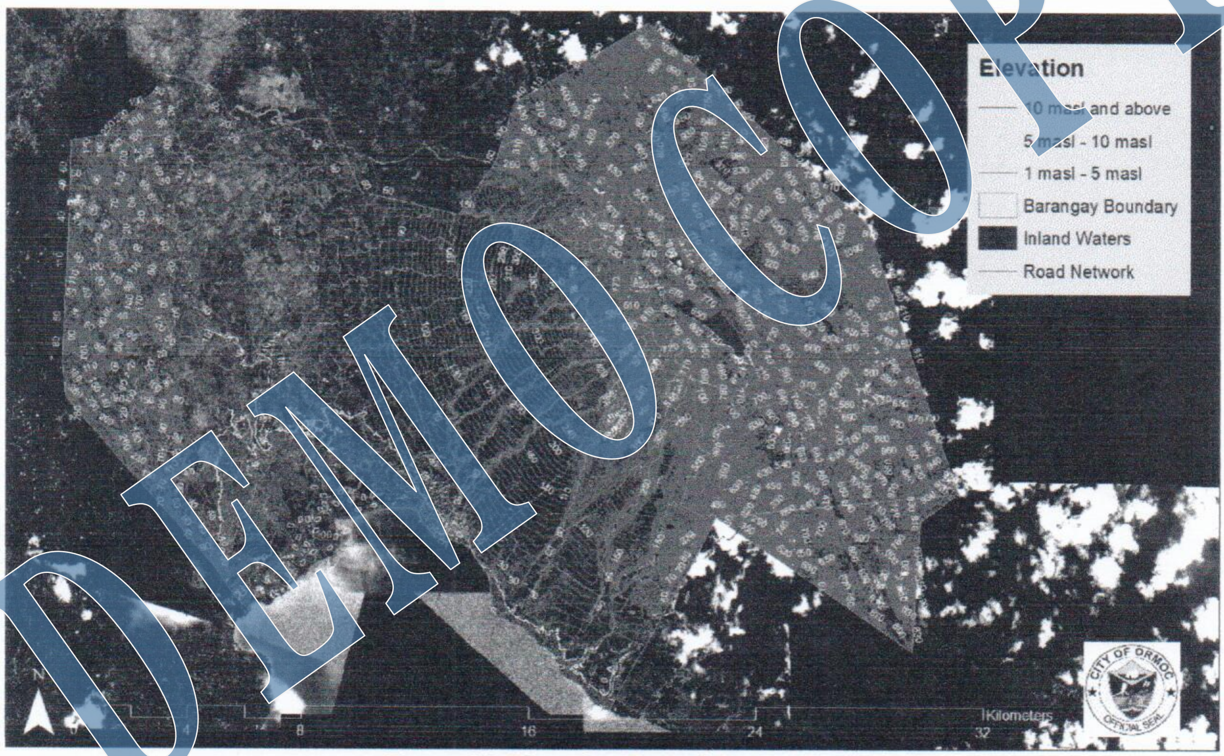


Figure 19. Elevation Test of Ormoc City

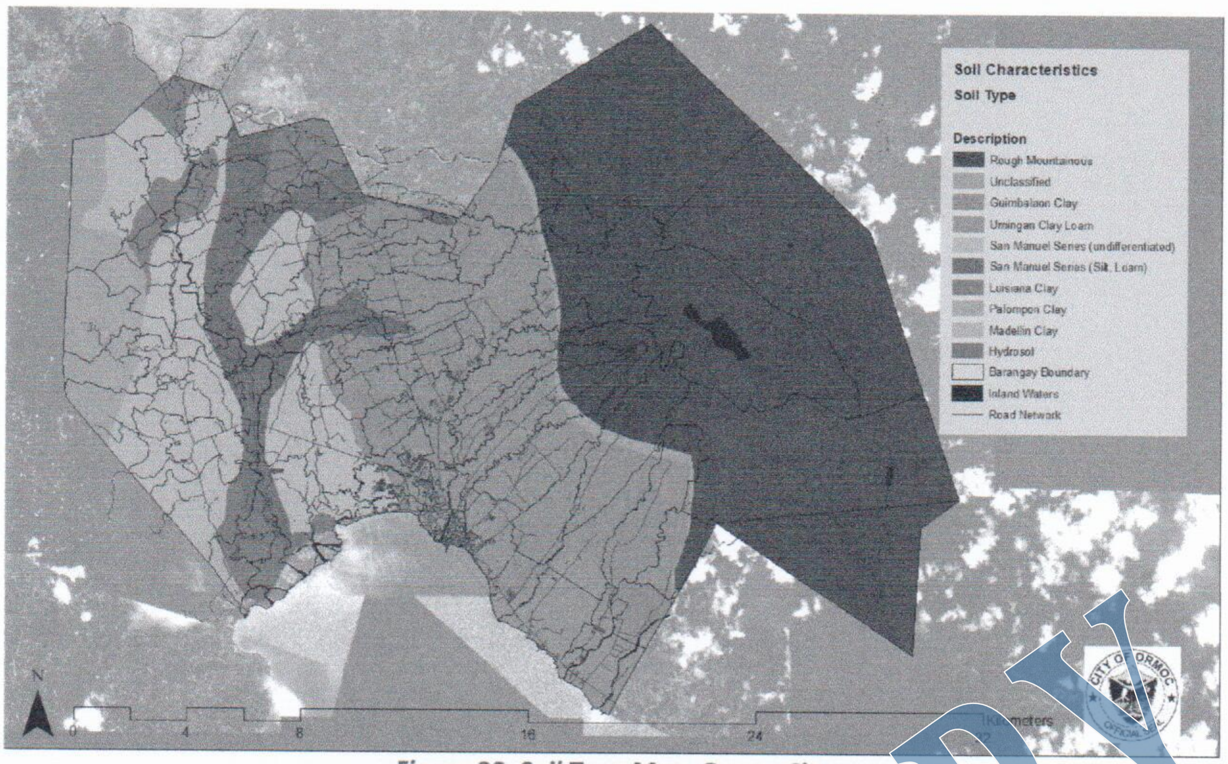


Figure 20. Soil Type Map, Ormoc City

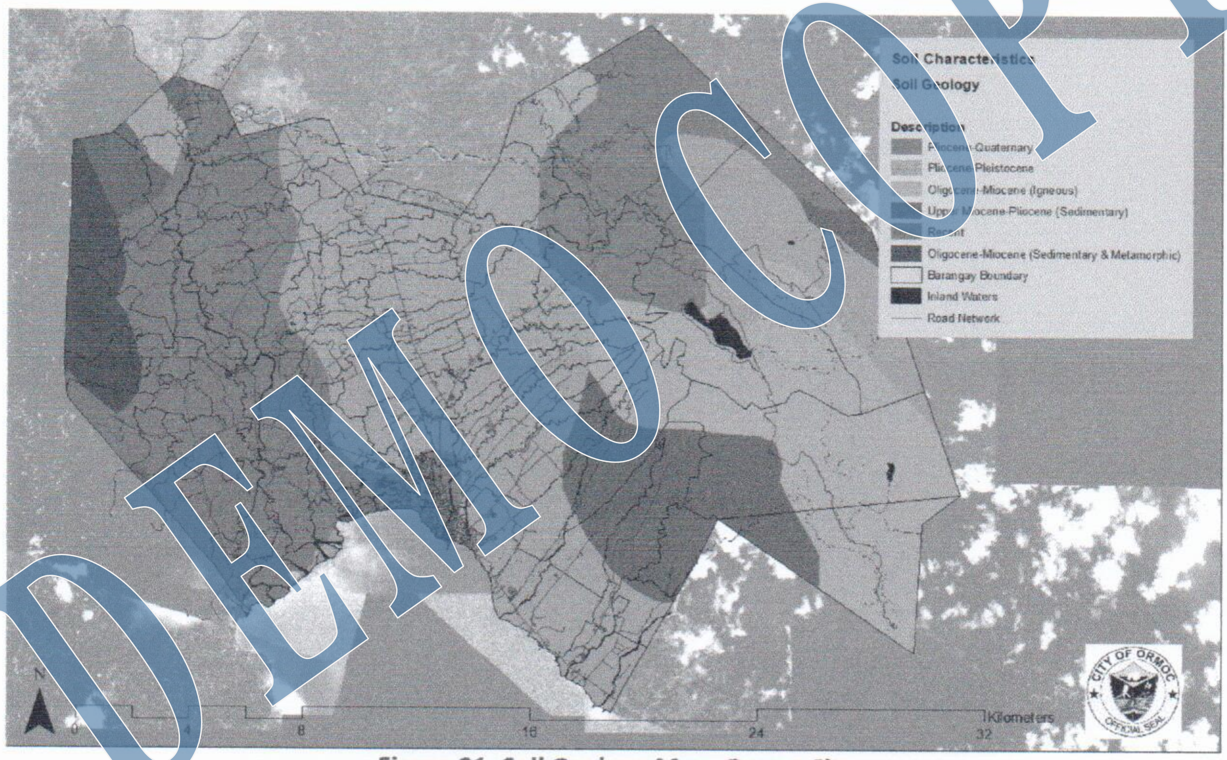


Figure 21. Soil Geology Map, Ormoc City

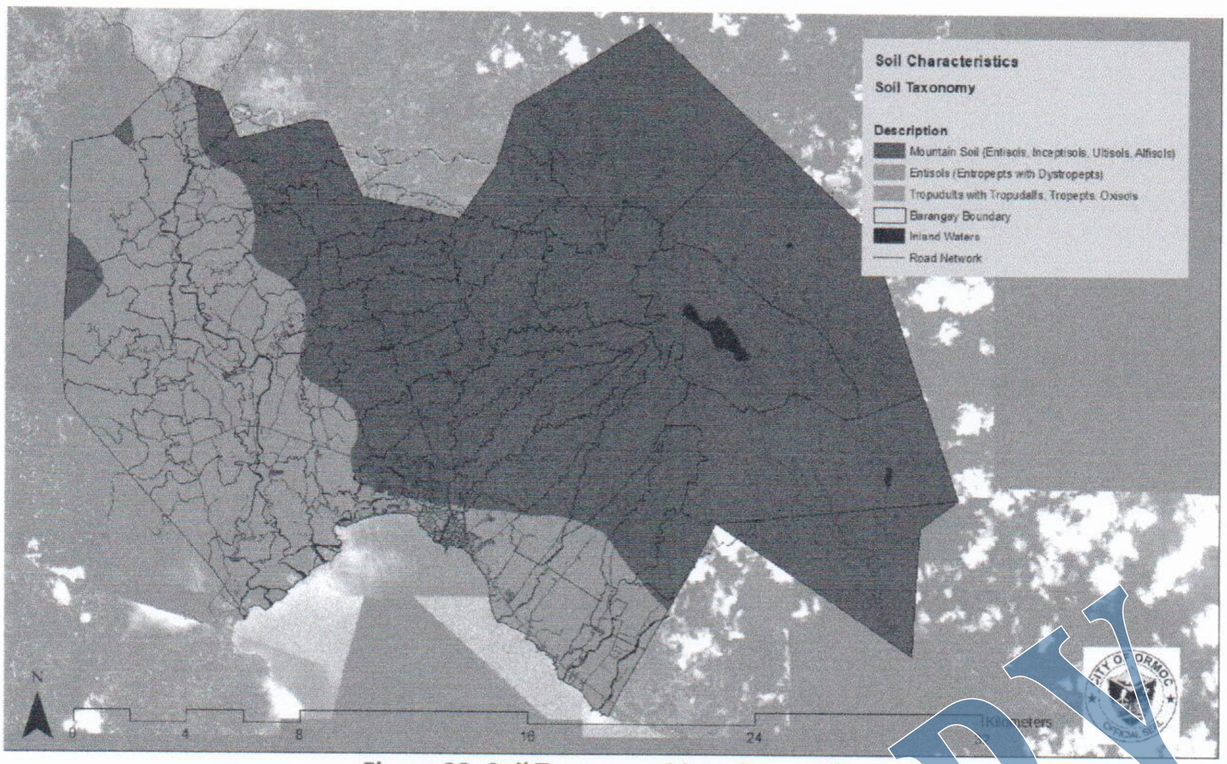


Figure 22. Soil Taxonomy Map, Ormoc City

2.2 Greenhouse gas emissions and reduction efforts

2.2.1 Summary of GHG accounting results

The greenhouse gas (GHG) inventory of Ormoc City is conducted to produce a baseline of its emission level in community-level (city level). The observation year is 2017. Its inventory is processed through the GHG Inventory Quantification Support Spreadsheet developed with Community-level GHG Inventory for Local Government Units in the Philippines User's Manual by the Climate Change Commission.

Data Gathering and Information Development

Data and information development for the inventory is implemented through a multi-stakeholder approach. The following data types are gathered from the following offices.

Data	Offices
Fuel consumption (based on annual sales)	Business Permits, Licensing and Franchising Office
Fuel type	Land Transportation Office – Ormoc City
Population, fuel use, household	City Planning and Development Office
Electricity consumption (residential, commercial, other uses)	Leyte Electric Cooperative V
Agriculture and Livestock data	City Agriculture Office
Solid Waste data	Environment and Natural Resource Division
Waste Water Data	Environment and Natural Resource Division, City Health Office
Forest Data	City Planning and Development Office

Inventory Results and Interpretation

This inventory is reflective of the 2017 data, and will be utilized for climate action planning of the city. Ormoc City recorded a total GHG emission of 151,493.2035 tonnes CO2e (carbon dioxide equivalent). This emission is break into two: Scope 1 emissions are GHG emissions within the city territorial limits, while Scope 2 emissions are emissions within the city territorial limits but sourced outside. Scope 1 emissions accounted 64.21% of which 43.32% accounted for livestock, and 30.69% accounted for crops. This emission accounts for almost 5 million heads of poultry produced, and 4, 338 hectares of farmlands for rice production.

Scope 1 includes accounting for solid waste treatment (12.46%) and waste water discharge (11.74%). Using ICLEI Method, the solid waste generated in a daily average of 90 tons, equivalent to 32, 923 tons annually, produced GHG emission of 19, 017.213 tonnes of CO2e. This accounts the semi-aerobic type of the city-managed landfill located in Barangay Green Valley. This accounts to 76 out of 110 barangays serviced by the city. All upland barangays are not serviced. For waste water, the 87% of population with septic tanks accounted 18, 151.07 tonnes of CO2e.

Scope 2 emissions are based on electric consumption distributed by the LEYECO V. it is observed that the other sources such as government and public infrastructure utilized the highest share at 18.20% (or 27, 565.78298 tonnes of CO2e), closely followed by residential use at 14.93% (or 22,615.7146 tonnes of CO2e), and commercial use at 2.67% (or 4,037.690308 tonnes of CO2e). In 2017, LEYECO V recorded the following break of electric consumption – 36, 995, 769 kWh (residential); 6, 484, 972 kWh (commercial), and 45, 125, 295 kWh (other uses).

It is noteworthy that the 15375.89 hectares of forestland translated to removal from sink of 53, 277.459 tonnes of CO2e, decreasing the emissions by 35.17%.

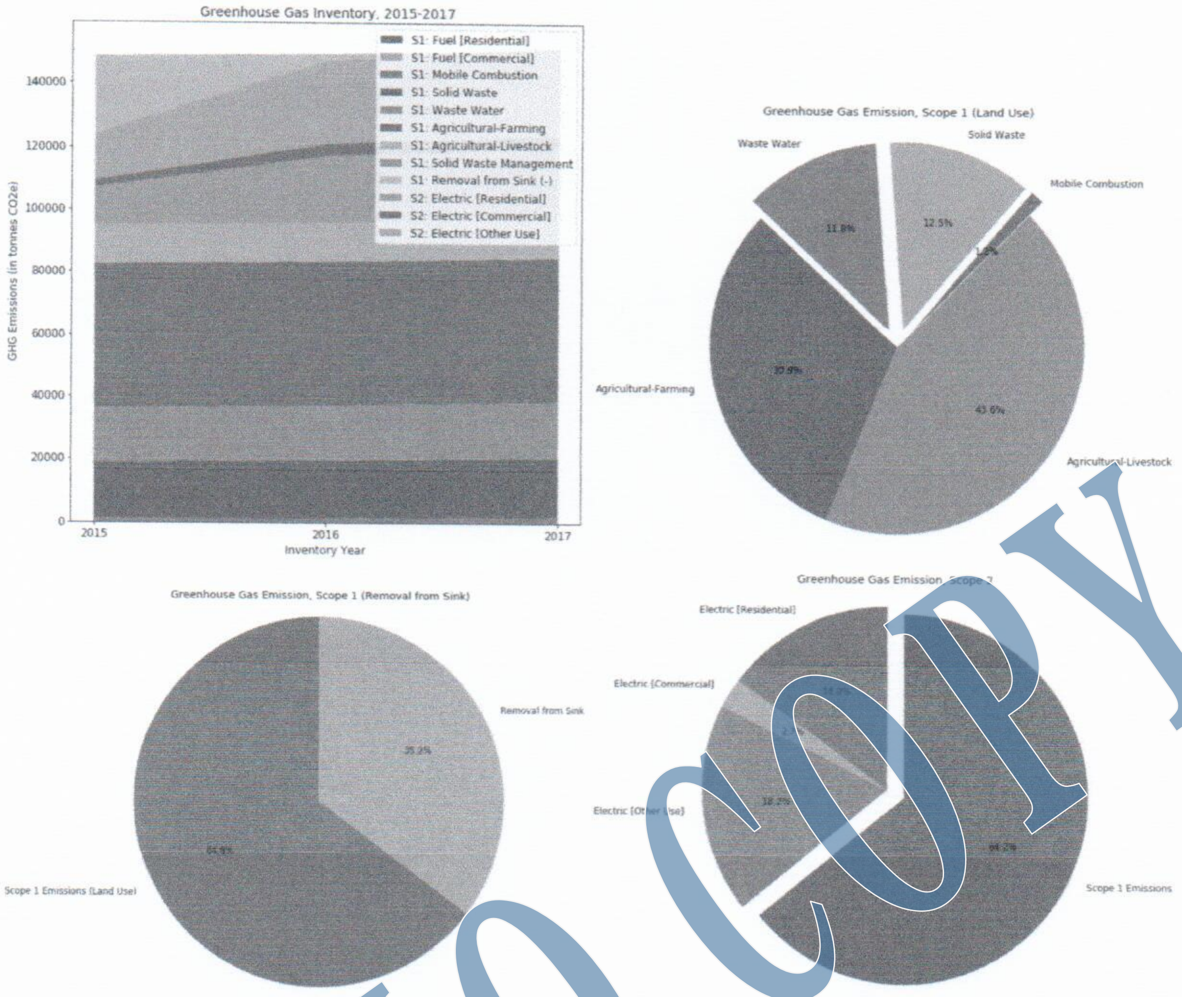


Figure 23. Greenhouse Gas Emissions Inventory for Year 2017, Ormoc City

Simple BAU Scenario emissions projection using significant multiplier

The current city emission at 151, 493.21 tonnes of CO2e is to increase by 198,182.43 tonnes of CO2e (+30.81%) in 2030 under business as usual scenario. The projection utilized multipliers based on rate of production increase for agriculture (in pesos), rate of forest degradation (in hectares), and rate of population increase for analysis on waste, transportation and energy. Absence of relevant industry to be included in the baseline inventory limits its projection, however may post increase when this sector develops in the succeeding years.

Target reduction level is 10% compared to baseline calculated at 136, 343.89 tonnes CO2e, with decrease of about 15,149.32 tonnes of CO2e. An ideal scenario at 131,016.14 tonnes of CO2e requires decrease in production area, waste generation, and fuel use, while maintaining the current forest lands (no changes on sink). This is a further decrease of 4% from target.

However, a mid-range scenario, a plausible scenario is calculated at 167,498.18 tonnes of CO2e with consideration of agricultural lands expected to expand and increase its production, while decrease on human activities that generate waste and fuel use be significantly decreased, with sink also decreasing. This scenario will result to further increase of 36, 482.04 tonnes of CO2e or 11% increase compared to baseline or 23% more (31, 154.29 tonnes of CO2e) versus ideal. This emission is still below 15% from the BAU scenario in 2030.

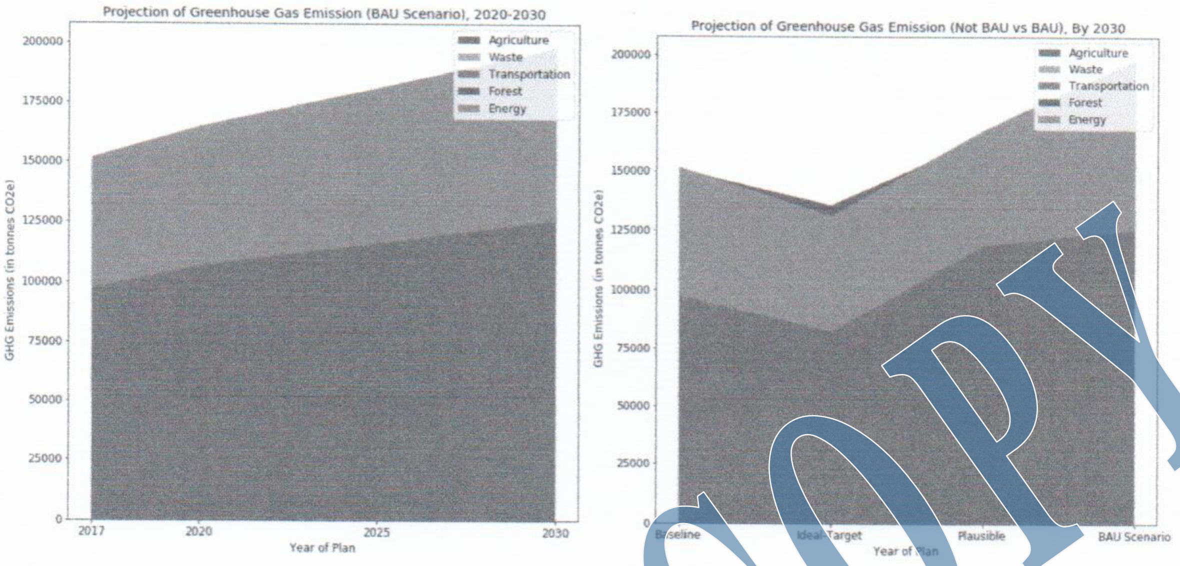


Figure 24. Projected Greenhouse Gas Emission Scenarios, Ormoc City

2.2.2 Summary of GHG reduction efforts

The city is conducting tree planting activities that may increase carbon sink. Solid waste management is also promoted, while their landfill is characterized as aerobic and managed.

The city envisions to be the renewable energy capital of the country, capitalizing with the operations of Energy Development Corporation on the Tongonan Geothermal Plants, and solar farms in Dolores.
The Leyte Geothermal Production Field (LGPF) is considered the second largest wet steam-producing field in the world. The Leyte geothermal plants supply power not only in the Eastern Visayas, but also to Central and Western Visayas and part of Luzon via submarine cables. The production field has a total capacity of 2,000 Megawatts (MW) of which 20 Mega Volt Ampere (MVA) are intended for substations in Ormoc City. The solar power farm can generate power with a total capacity of 30 Megawatts (MW).

2.3 Decision Areas and Summary of Technical Findings

The following are areas of the city for GHG emission sectors where climate change impact are observed and climate adaptation and mitigation interventions are to be pursued.

1. The valley character of Ormoc provides physical susceptibility to flood events due to huge amount of precipitation in two major watersheds – the urban development center within Ormoc (Anilao-Malabasag) Watershed, and the production zones with human settlements in Pagsangaan Watershed, particularly along the river traversing from the north boundary shared with Kananga down to Ormoc Bay. Coastal areas as well as the lower portion of the production zones are also susceptible to storm surges. A huge flood control project was implemented in 1998 to 2001 along Anilao River and Malbasag River that significantly abated flood events in the city center. Recent typhoon records show occurrence of more than 4-hour flooding, once every two years in the production zones. The two extreme typhoons recorded are TY Uring (Thelma) in 1991 causing flash floods in Ormoc Watershed, and TY Yolanda (Haiyan) in 2013 with strong winds, both destroying agricultural produce and building structures. The same flood prone areas are susceptible to geologic hazard such liquefaction (soil are formed from alluvial deposits) and tsunami, which to be triggered by earthquakes. Flooding events enhance the susceptibility of these areas due to water saturation. Recent records show three events in 2017 with magnitude above 5.0 and intensity of 6. There is active volcanology in Leyte Province.
2. El Nino event in 2015-2016 had recorded damages to agricultural sector of PhP 22.453 million in six barangays of Curva, Lao, Licuma, Margen, Rufina M. Tan, and Liloan.
3. The midlands and highlands are susceptible to landslide event due to intense rainfall and earthquake. Earthquake in July 2017 had recorded damages to road networks and landslide within the vicinity of Danao Lake Natural Park. These areas are included in the critical watershed of the region. The remaining intact forest are observed in the midlands of Dolores, Cagbuhangin, and Milagro.
4. Climate data suggest under high emission scenario (RCP 8.5) that the Leyte Province is to expect temperature maximum increase of 2.3 C by 2020, and 4.1 C by 2050 in dry months of MAM and JJA. In terms of precipitation, the months of DJF will expect maximum precipitation of 909.8 mmby 2020, and 1106.4 mm in 2050. This accounts additional rainfall of 220.3 mm and 416.9 mm, respectively. Lowest rainfall is observed in the months of MAM at 318 mm, corresponding to decrease of 23 mm. These observations aligned with the general expected conditions in the country as dry seasons will become drier, and wet seasons be wetter.
5. The following are the direct impacts of these changes to each ecosystem.

   a. The expected increase in temperature by 2.3 C will result to the following.

Coastal Ecosystem.

TC1. Decrease in income of 1, 686 fisher folks from PhP 14,300 to PhP 8,580 due to decreased work time and catch yield.

TC2. Occurrence of coral bleaching in 226.58 hectares of marine protected areas in 9 barangays, increase in highly competitive crown of thorn fish species, and bank siltation covering 719 hectares of mangroves in Naungan, San Juan, and Lao, leading to fish migration.

Urban Ecosystem.

TU1. Increase in electric consumption of 11, 460 residential and 423 commercial establishments for cooling units, primarily to 42 urban barangays where heat will be more intense due to compactness of concrete buildings that do not employ passive cooling architecture. This will lead to migration towards the upland areas.

TU2. Increase in demand for water, increasing consumption from current average of 30 cubic meter per household each month.

TU3. Increase in cases of dengue, as reproduction of the carrier mosquito is shortened from 9 days to 5 days, in 30 C and above condition. It may also increase cases of skin diseases from 692 cases recorded in 2017.

Production Ecosystem.

TP1. Decrease in net income of rice production from PhP 165, 000 (PhP 13, 750/month) by PhP 31, 350 down to PhP 133, 650 (PhP 11, 137.5 /month) on two cropping season per year on 4, 540 rice farmers and 794 corn farmers (increase by 1 C leads to 10% decrease in production).

TP2. Decrease in water supply for irrigation covering 4, 337.5 ha of total 5, 791.5 ha of rice production lands due to low ground water recharge rate and decrease in surface water volume are expected, posting 10% to 15% yield decrease.

TP3. Decrease by 80% in inland aquaculture due to increase in water temperature from its current production of 1.3 tons in 50 meter square pen/cage.

Forest Ecosystem.

TF1. Occurrence of wild forest fires, wildlife migration, and decrease of wildling production in 15, 508 remaining forest lands.

TF2. Decrease in volume of water in spring sources and continual degradation of the Bao River Watershed.

b. This expected changes in rainfall will result to the following.

Coastal Ecosystem.

RC1. Increase in siltation affecting coral reefs and mangroves, particularly exacerbated in Ipil and San Antonio with gravel extraction activities.

RC2. Decrease in fish yield due to destruction of fish pens and inability to conduct open sea fishing.

RC3. Flooding event that transports coliform to Ormoc Bay from the residential areas along the coast.

Urban Ecosystem.

RU1. Flood event that affect 153, 351 people equivalent to a tripled replacement cost of PhP 64.96 billion by 2030.

RU2. Submergence of houses to flood causing structural stresses to walls, ceilings, and floors and damages to other domestic properties in 29 high risk barangays.

RU3. Decrease in income due to disruption of economic activities to an estimate 8, 000 participants of the informal economy, related to disrupted tourist flow due to suspended sea and air transportation.

RU4. Flood event that will submerge schools and roads due affecting its operations, requiring adjustments and retrofitting on building, drainage system, roads, and bridges.
RU5. Increase cases of vector borne diseases and water-borne diseases, with 5% increase in hospitalization cost compounded yearly.

Production Ecosystem.
RP1. Flood event that will damage production in 32 high risk barangays at 3739.95 ha valued at PhP 202.58 million in 2030.
RP2. Decrease of 50% in production every typhoon events.
RP3. Increase use of electricity for postharvest facilities
RP4. Flood event that decrease by 20% up to 100% on inland aquaculture production.
RP5. Increase water saturation that will enhance conditions for liquefaction.

Forest Ecosystem.
RF1. Landslide event on highly saturated and scattered forest cover areas, particularly in Lake Danao.
RF2. Increase in siltation along tributaries transported by surface water run-off.
RF3. Increase in under-ground water recharge.

6. The following are the identified opportunities with these changes in climate.
   a. *Increase in temperature*
   This change may lead to temporal demand for mechanic work on installation of cooling units. This may possibly lead to open business opportunities in the informal economy. Dry climate may stabilize the flow of tourist. **(TO1)**

   b. *Changes in rainfall*
   This will lead to increase of available water for capture, storage, and use. There is an existing Ordinance No. 32 for the Proper Harvesting, Storage and Utilization in Ormoc City being implemented by the Office of the Building Official on new building applications. The current redevelopment efforts on city parks and urban spaces are plausible entry point on including this on the structural design. This will also be embedded on the current efforts to develop the drainage and sewerage master plan. **(RO1)** This will also lead to increased opportunity to cultivate assorted vegetables in 283.4 hectares in the uplands, with the availability of water on impoundments. **(RO2)**

7. The following are impacts and opportunities of the changing climate to greenhouse gas emission.
   a. The total GHG emission is 151,493.2035 tonnes CO2e (carbon dioxide equivalent) - 64.21% (livestock), 30.69% (crops), electricity in public uses (18.20%), electricity in residences (14.93%), solid waste treatment (12.46%), waste water discharge (11.74%), and electricity for commercial use at (2.67%). **(GHG1)**
   b. Forest sinks translated to removal of 53, 277.459 tonnes of CO2e, decreasing the emissions by 35.17%. **(GHG2)**
   c. Increase in temperature and rainfall will increase the demand of electricity in all types – residential, commercial, and public uses. This will be high in the urban zones particularly in

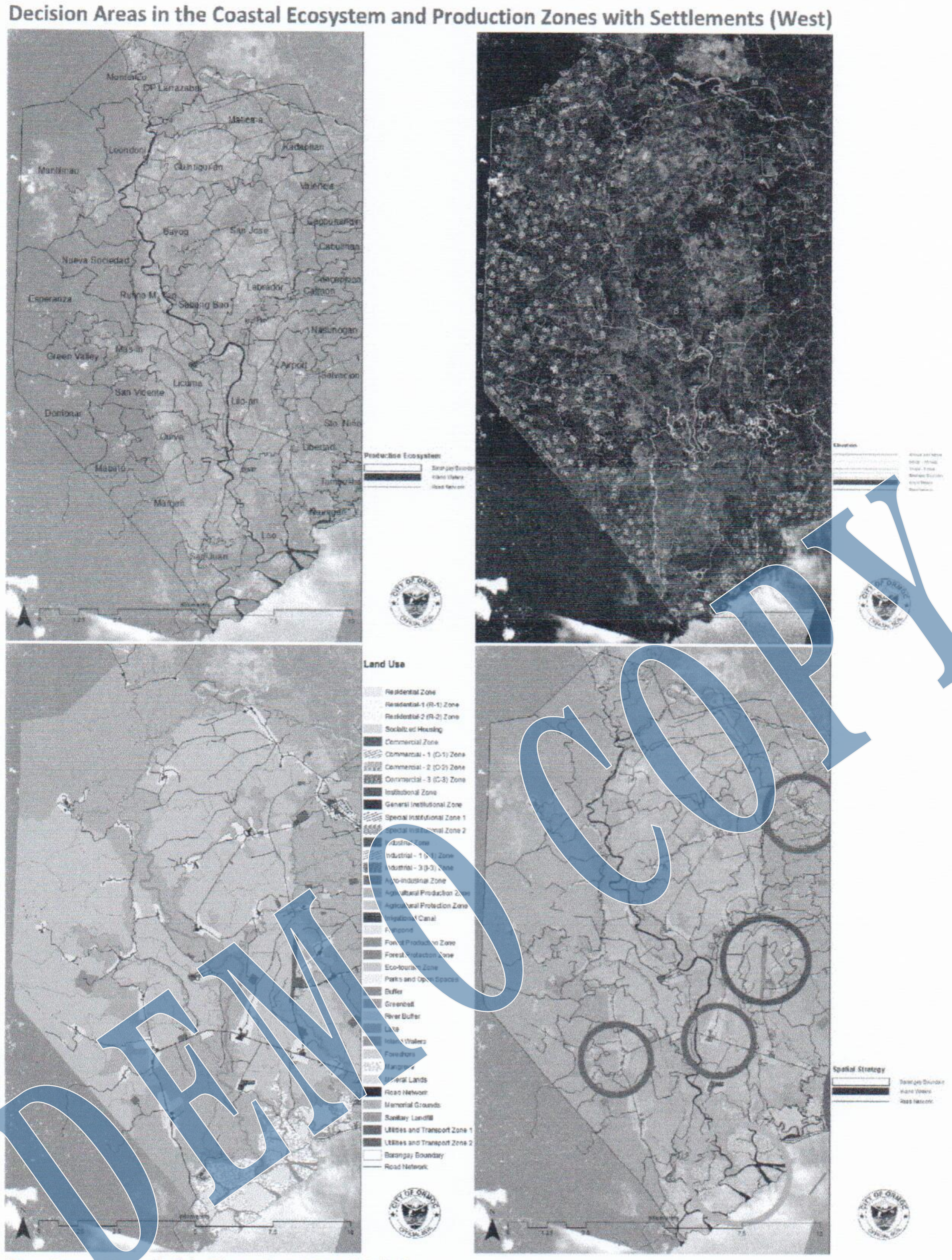
residential use. Emission from the transportation sector will also increase due to movement of people towards the upland due to heat in urban center, and area expansion of the urban corridor. **(GHG3)**

d. Agriculture sector will remain the biggest contributor, with expected increase of 5% in productivity every five years. However, expected land conversion on these lands toward urban use, particularly along the roads of the urban corridor expansion will increase GHG emission. Intense heat fastens microbial-level degeneration that will be available CO2. **(GHG 4)**

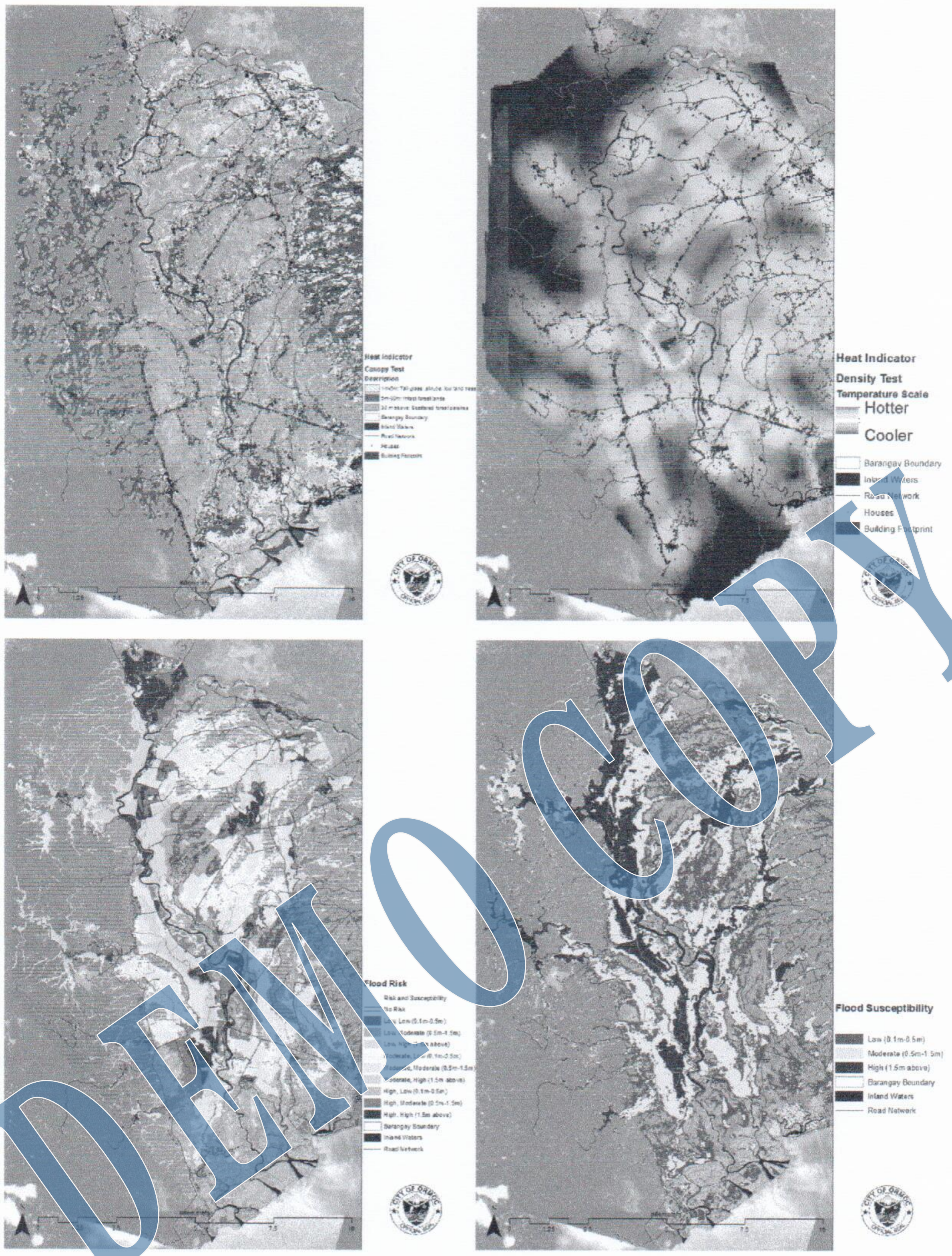
e. Opportunities for reduction includes utilization of low carbon emission technologies and appliances in urban areas, implementation of renewable-energy fueled transportation system, expansion of tree cover (carbon sinks) in parks and open spaces, and rehabilitation of mangrove and forest ecosystem. **(GHG5)**

8. Typhoon events with storm surge is currently at low risk, however a one-time event may affect 109,880 people equivalent to a PhP 32.97 billion. These areas coincides where high risk of flood and high susceptibility of liquefaction are detected. Storm surge alert 4 was issued during TY Yolanda (Haiyan) in November 2013 with 5.3 meter surge tide.

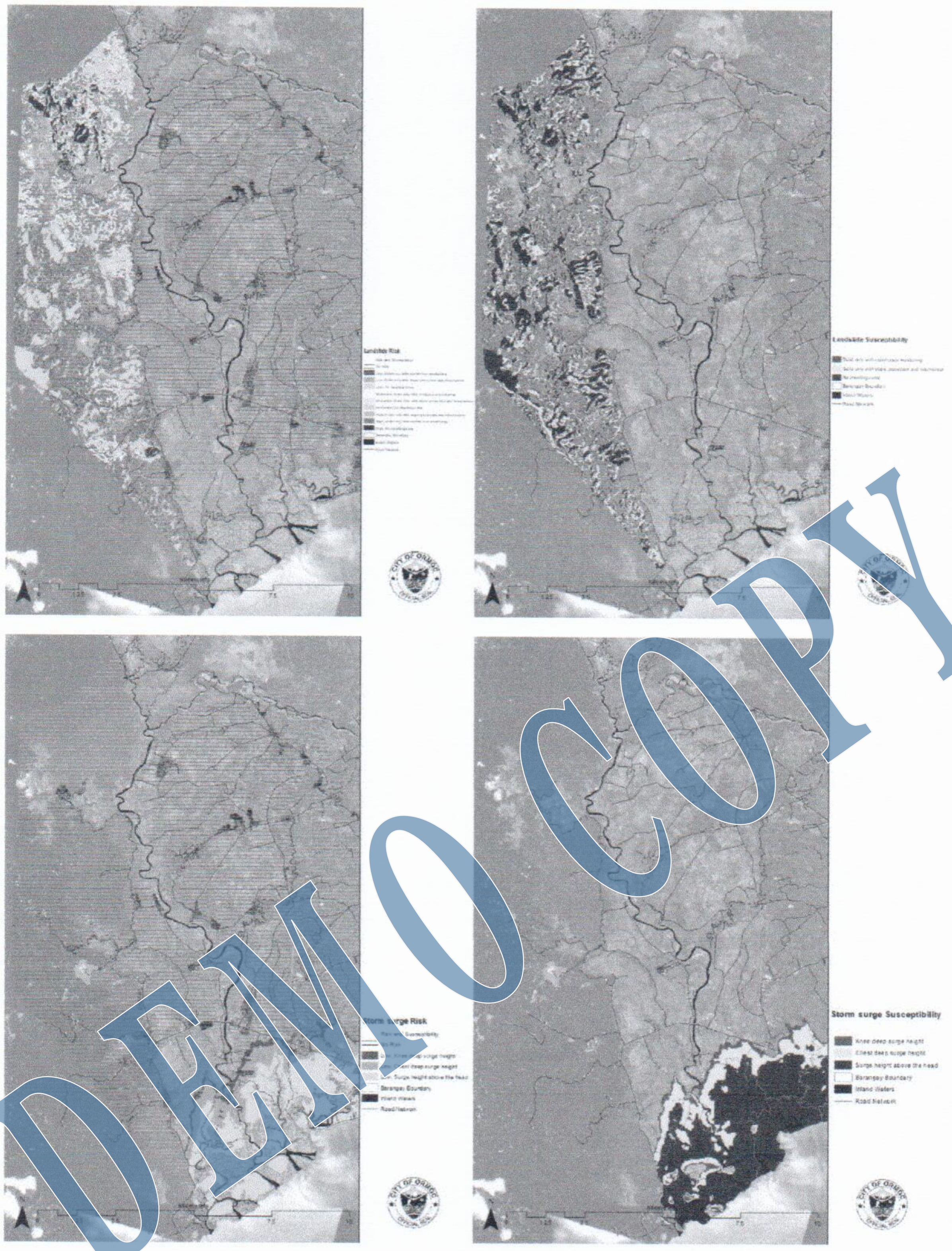
Decision Areas in the Coastal Ecosystem and Production Zones with Settlements (West)



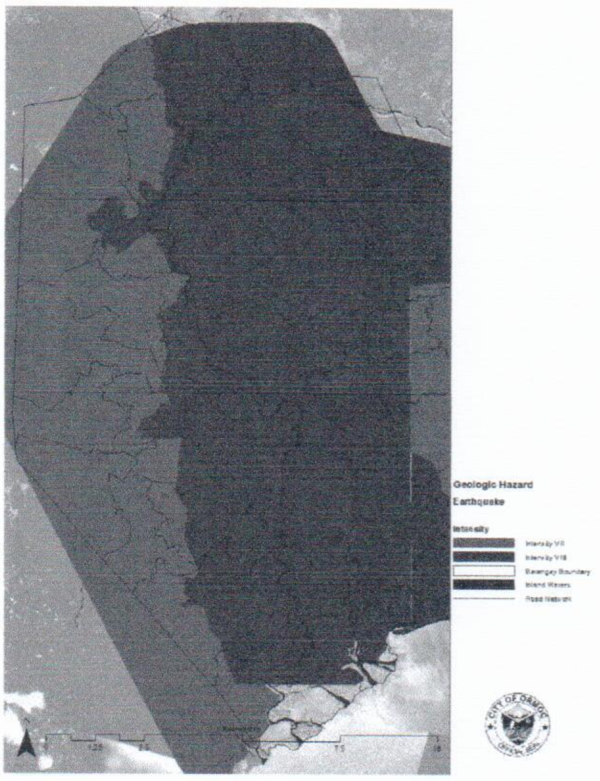
Top: **Base Map (left), Elevation Map (right)**
Bottom: **Land Use Map (left), Spatial Strategy Map (right)**

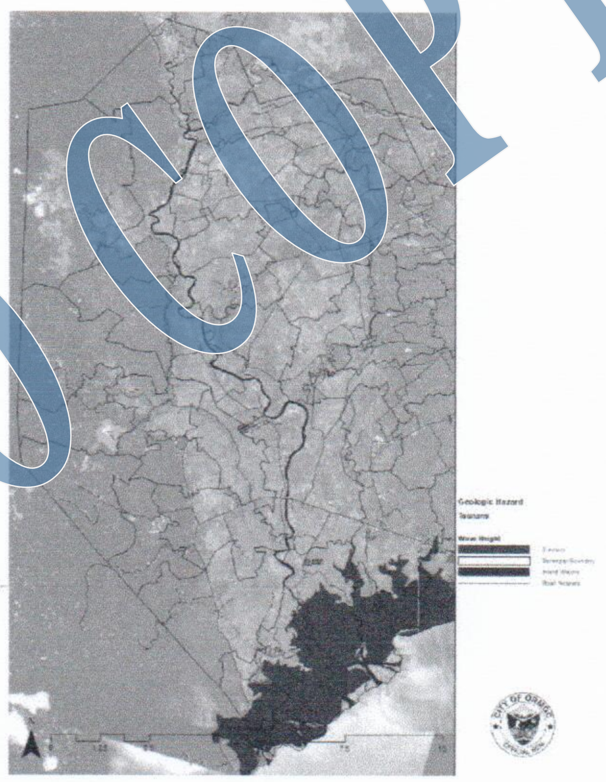


Top: **Density Test (left), Canopy Test (right)**
Bottom: **Flood Risk Map (left), Flood Susceptibility Map (right)**



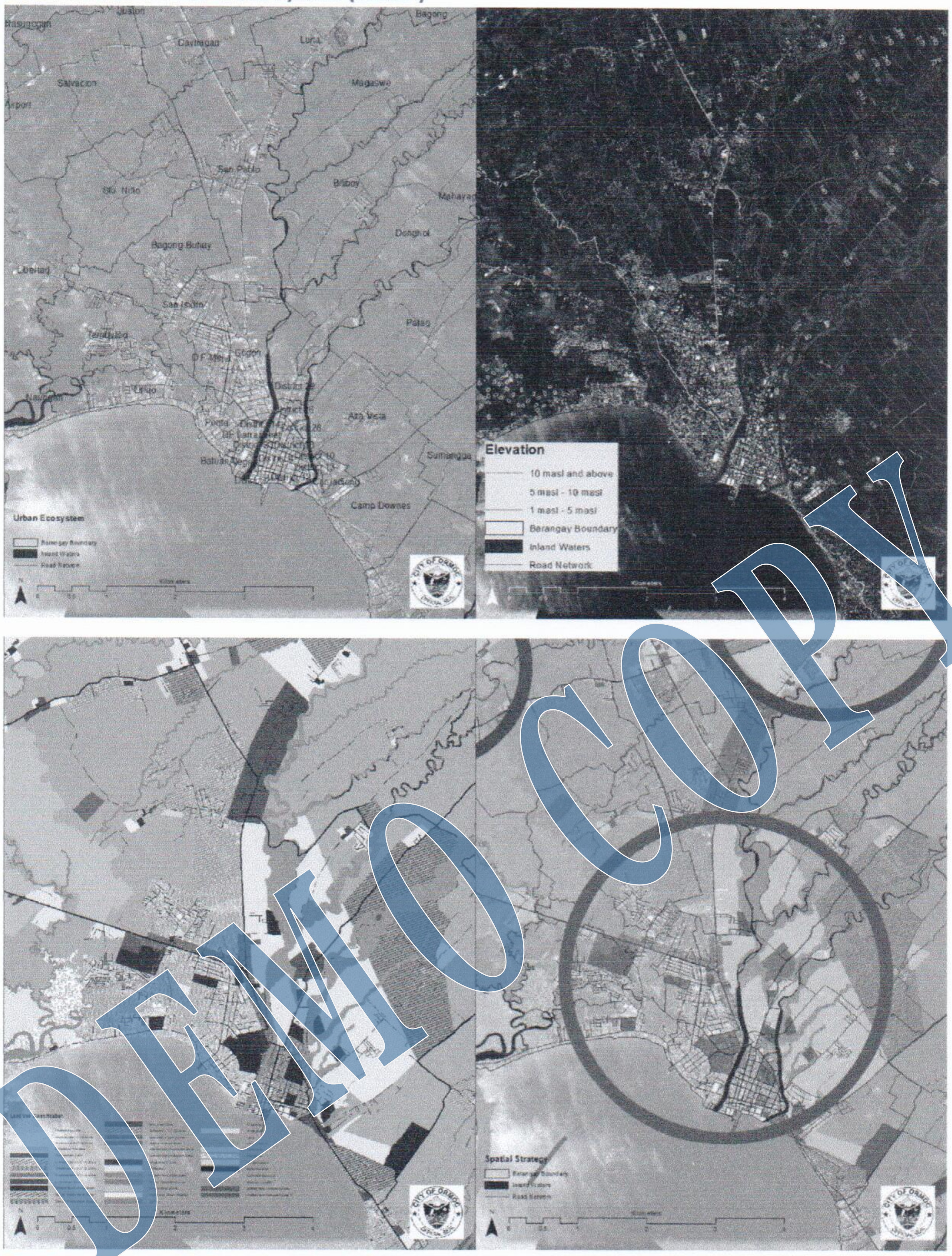
Top: **Landslide Risk Map (left), Landslide Susceptibility Map (right)**
Bottom: **Storm Surge Risk Map (left), Storm Surge Susceptibility Map (right)**



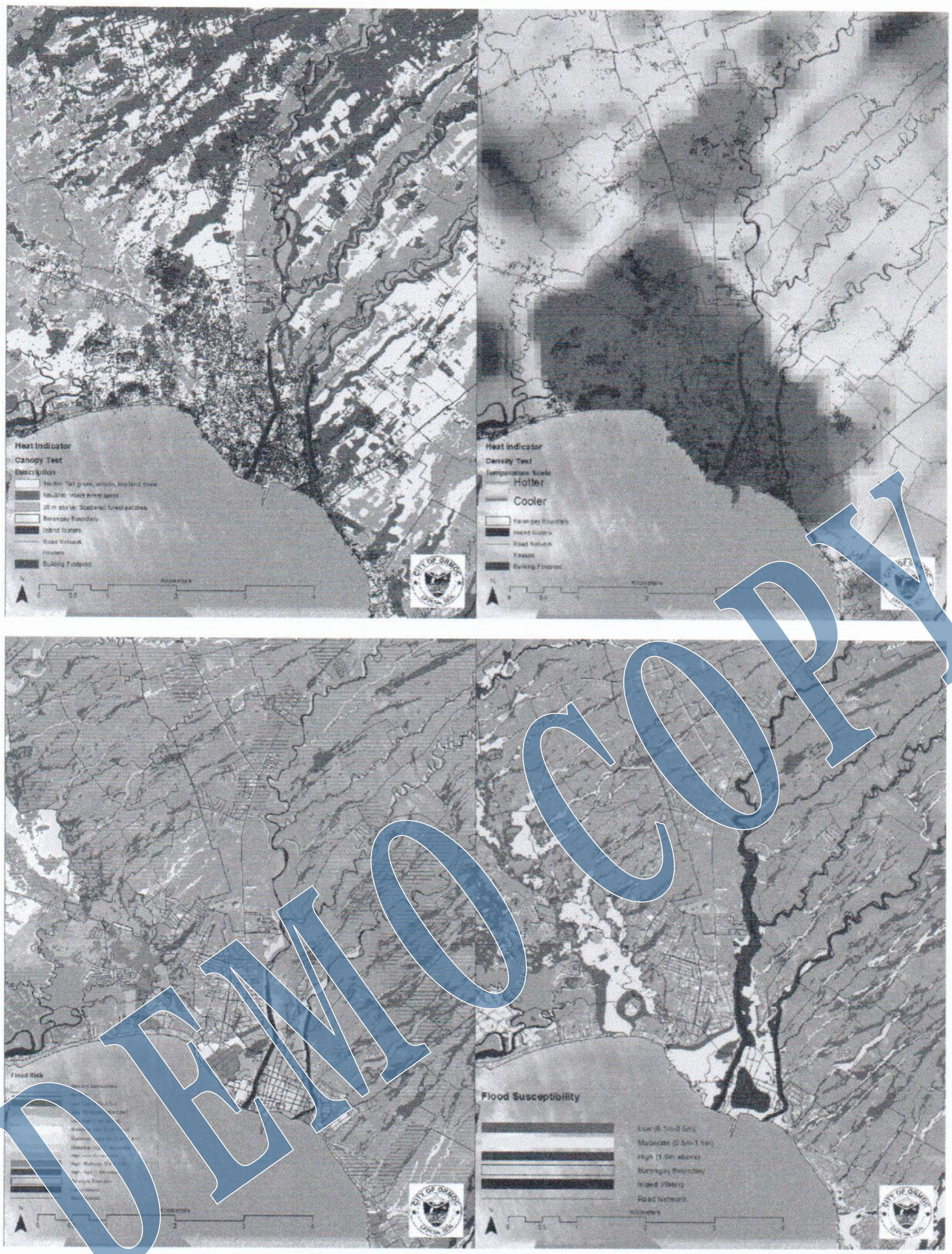


Top: **Earthquake Susceptibility Map (left)**
Bottom: **Liquefaction Susceptibility Map (left), Tsunami Susceptibility Map (right)**

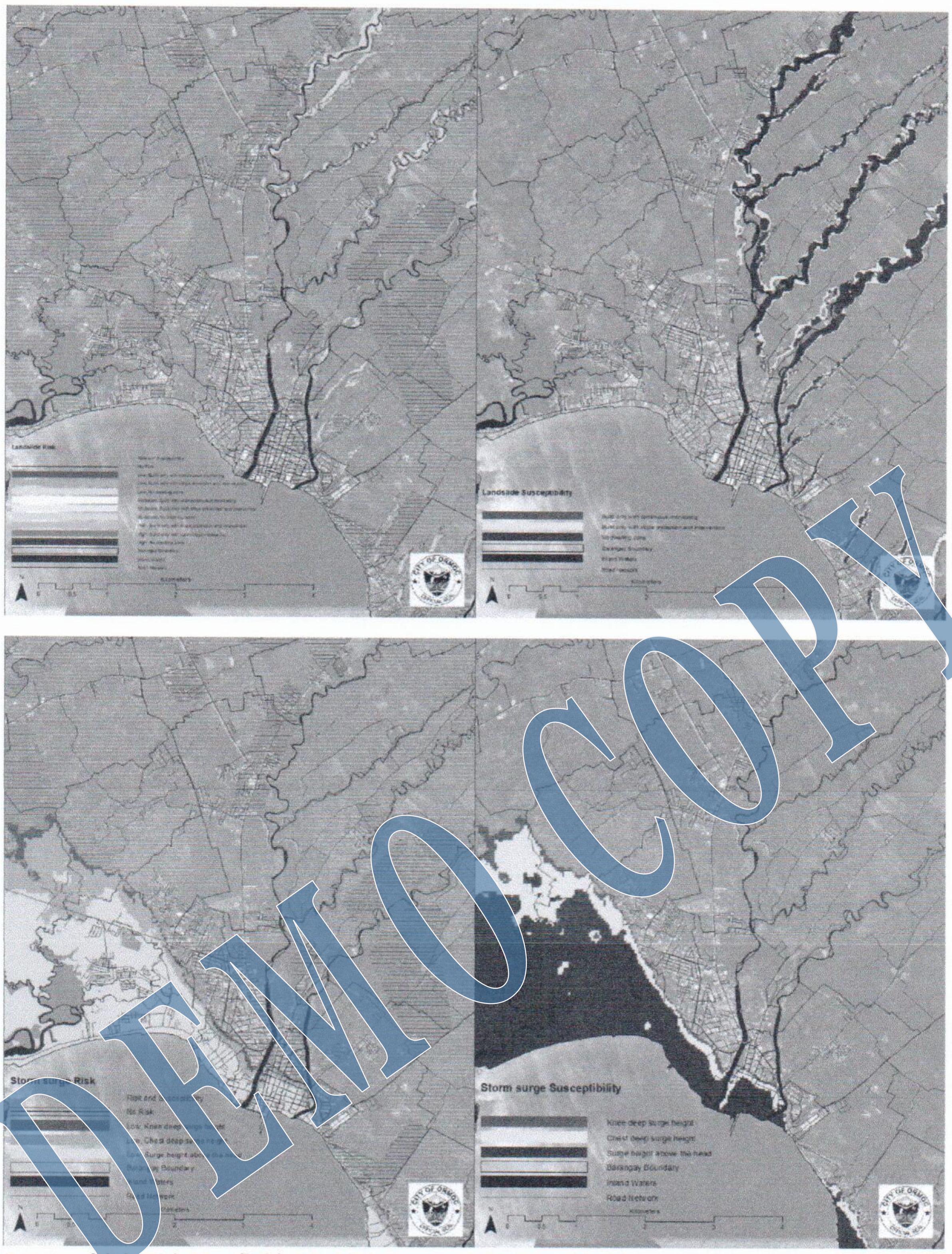
Decision Areas in the Urban System (Center)



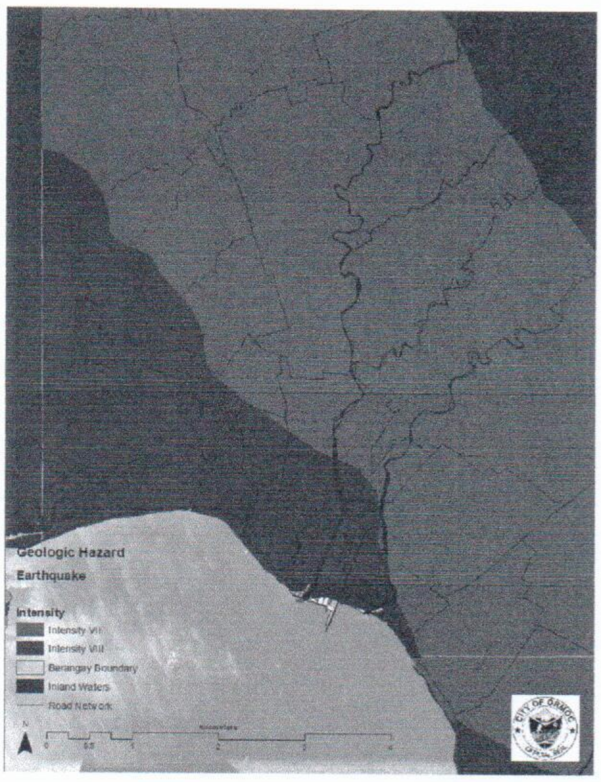
***Top:* Base Map (left), Elevation Map (right)**
***Bottom:* Land Use Map (left), Spatial Strategy Map (right)**

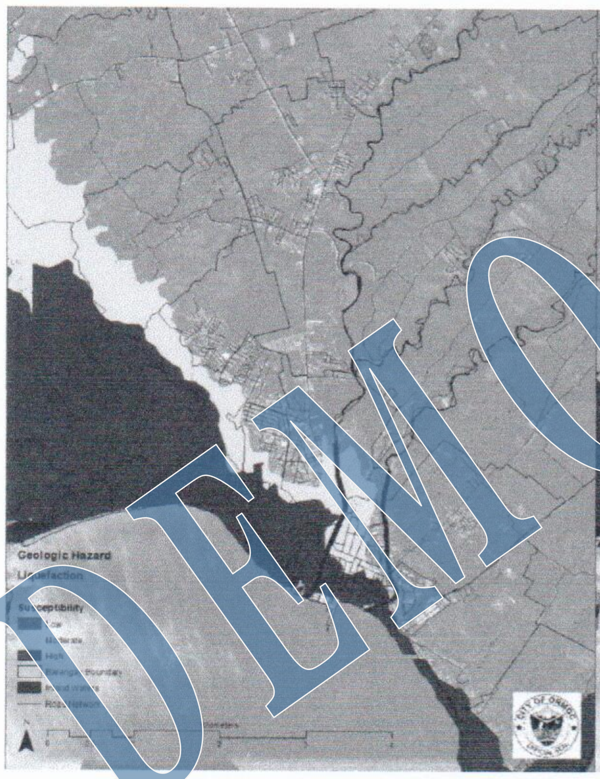


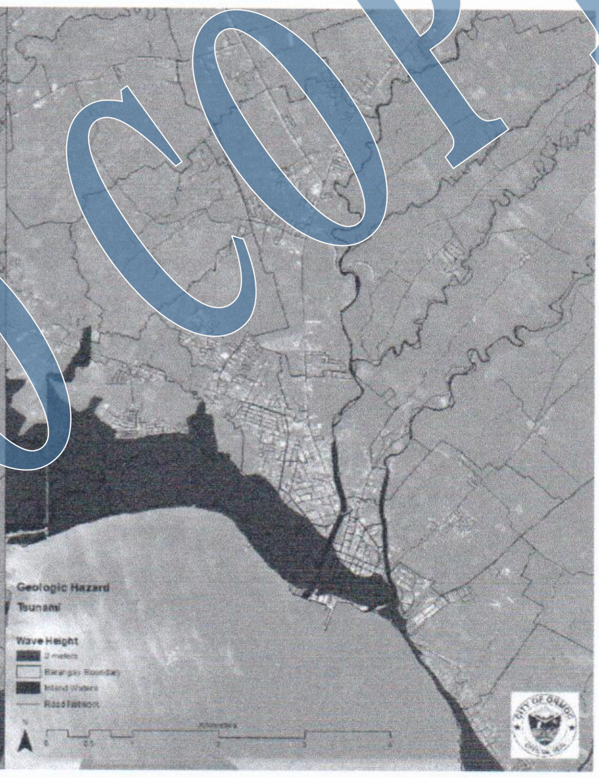
Top: **Density Test (left), Canopy Test (right)**
Bottom: **Flood Risk Map (left), Flood Susceptibility Map (right)**



Top: **Landslide Risk Map (left), Landslide Susceptibility Map (right)**
Bottom: **Storm Surge Risk Map (left), Storm Surge Susceptibility Map (right)**

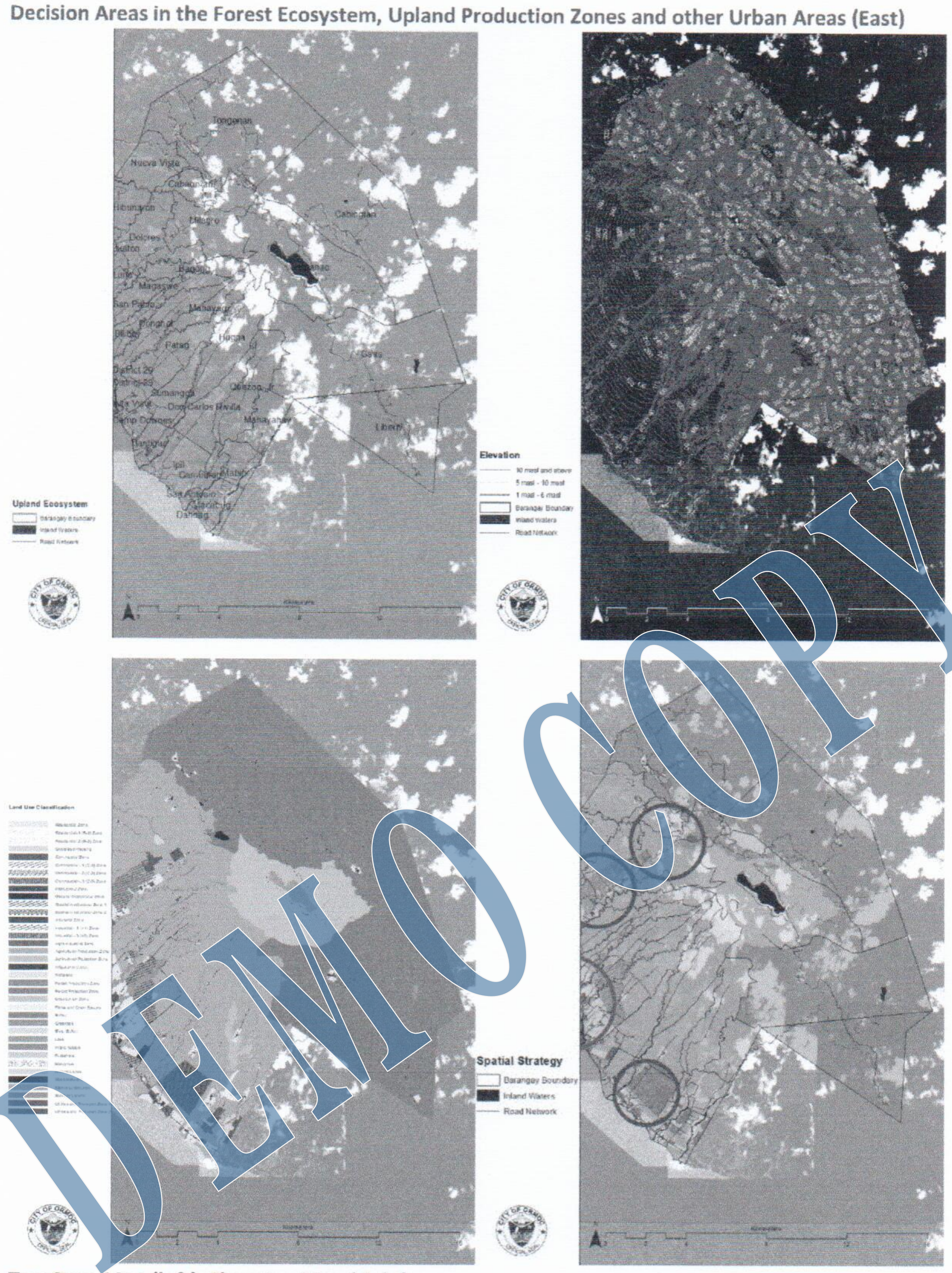




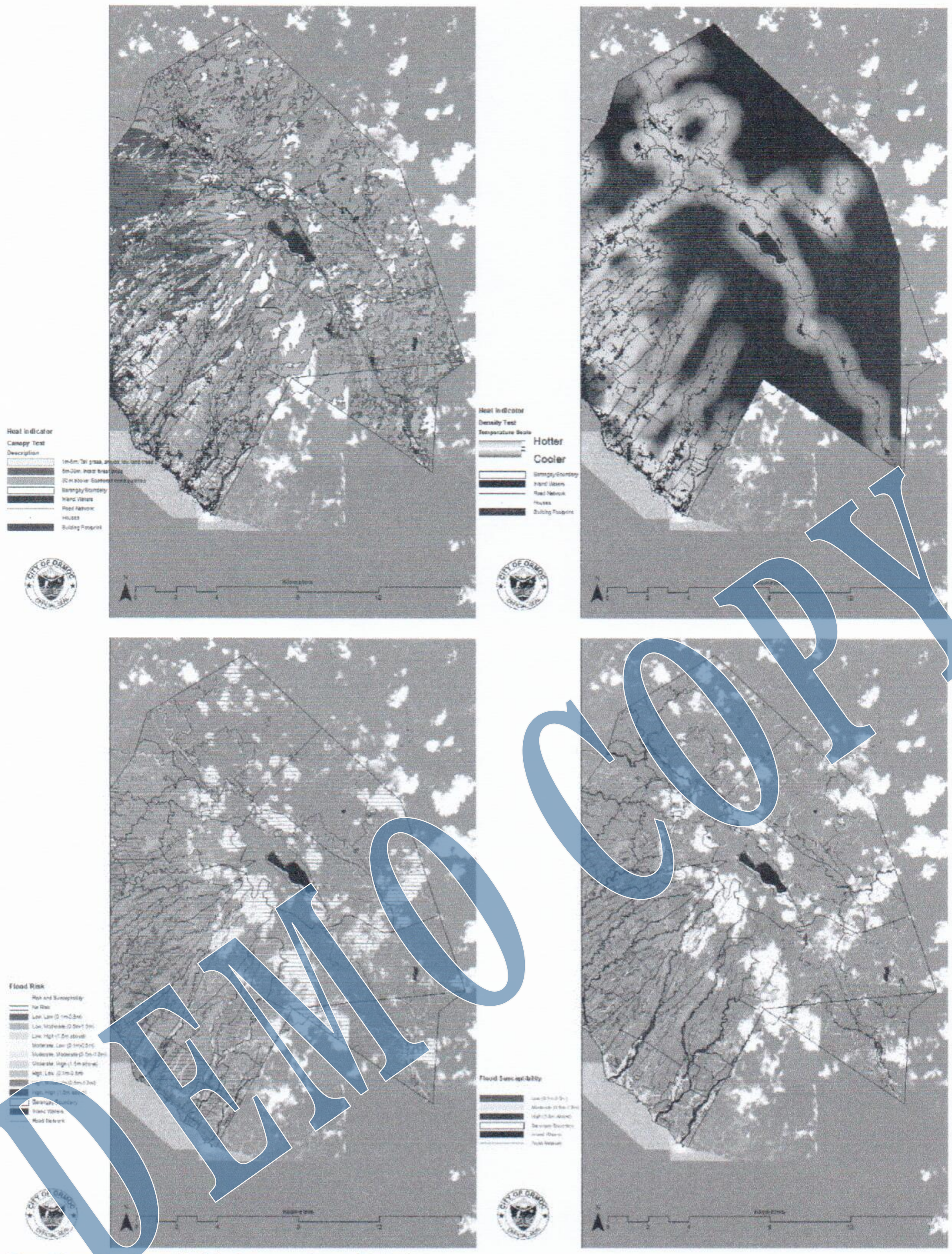


Top: **Earthquake Susceptibility Map (left)**
Bottom: **Liquefaction Susceptibility Map (left), Tsunami Susceptibility Map (right)**

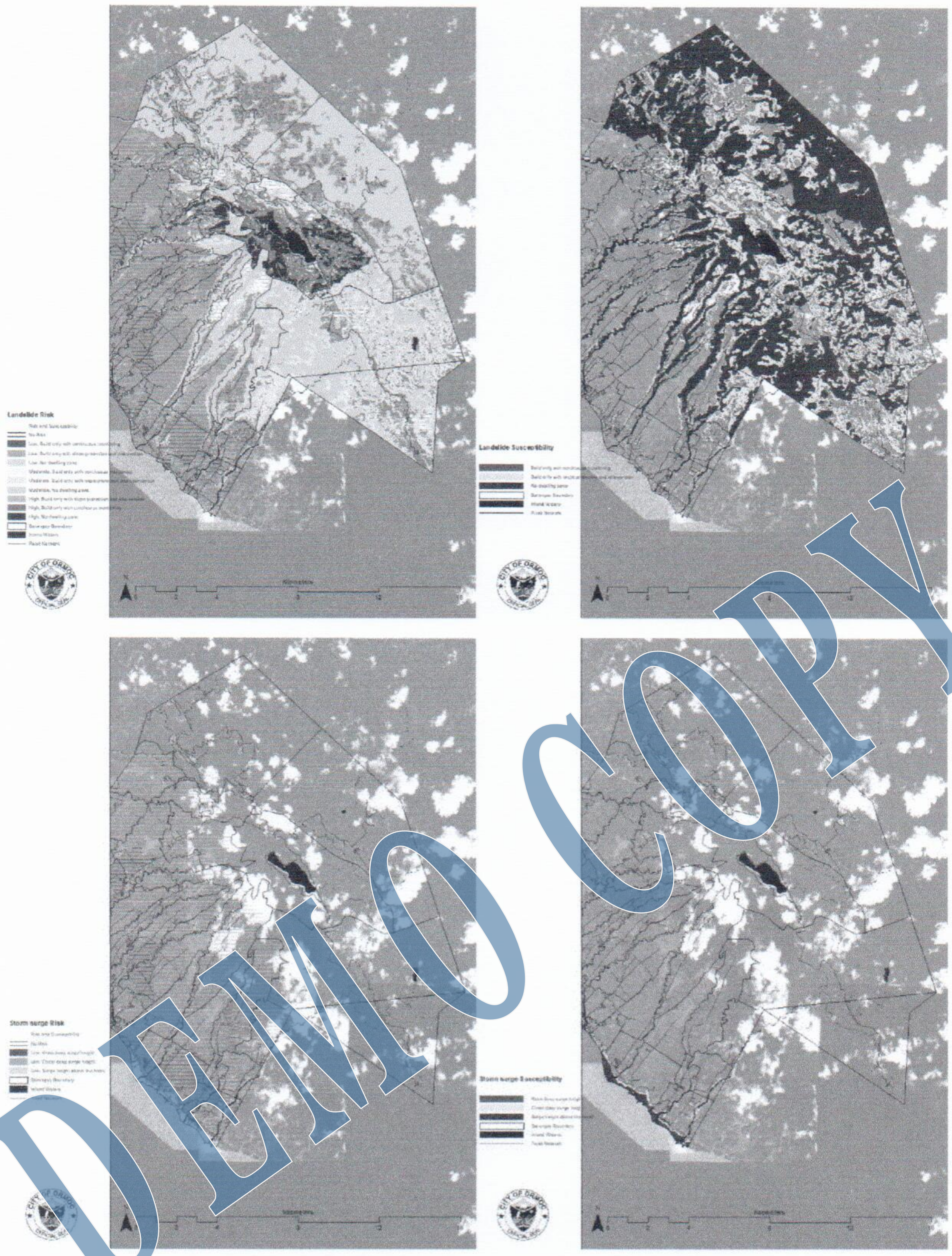
Decision Areas in the Forest Ecosystem, Upland Production Zones and other Urban Areas (East)



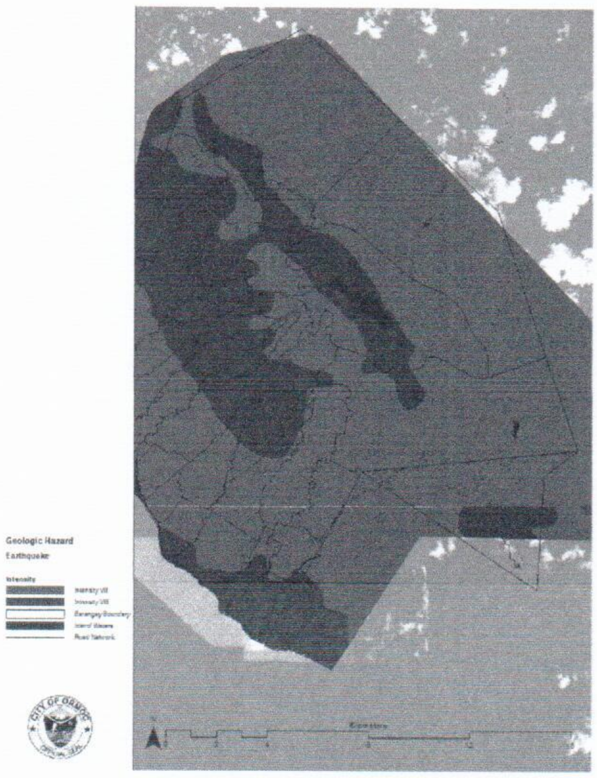
Top: **Base Map (left), Elevation Map (right)**
Bottom: **Land Use Map (left), Spatial Strategy Map (right)**

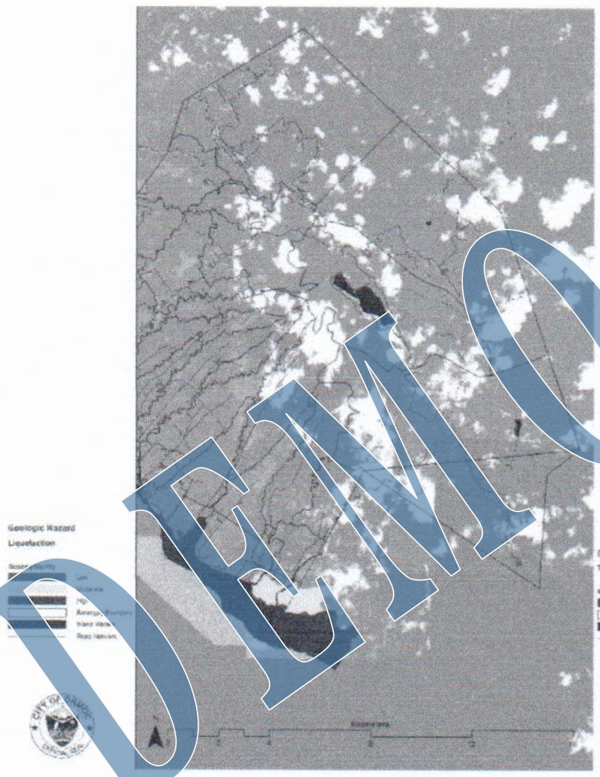


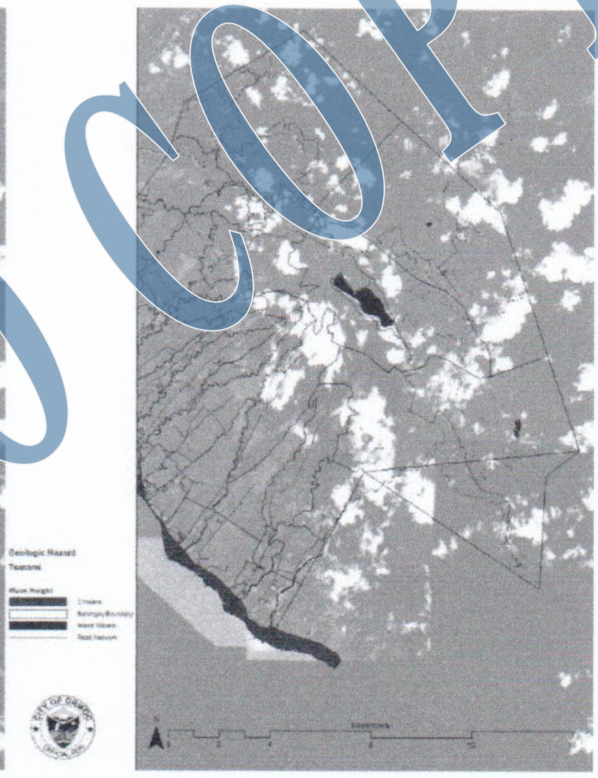
Top: **Density Test (left), Canopy Test (right)**
Bottom: **Flood Risk Map (left), Flood Susceptibility Map (right)**



Top: **Landslide Risk Map (left), Landslide Susceptibility Map (right)**
Bottom: **Storm Surge Risk Map (left), Storm Surge Susceptibility Map (right)**







Top: **Earthquake Susceptibility Map (left)**
Bottom: **Liquefaction Susceptibility Map (left), Tsunami Susceptibility Map (right)**

3. Objectives and strategies of the plan

Review of city's vision and goals

The development of the Comprehensive Development Plan 2017-2027 and Comprehensive Development Plan 2017-2027 are guided by the city vision and over-all development goals below. These are reinforced by 85 specific goals and objectives in four areas – physical, social, economic and institutional. Each sector has goals and objectives. Physical sector covers infrastructure, utilities and transportation; urban design; heritage sites; and environment. Social sector covers services and housing. Economic sector covers commerce, industries, and trade, and tourism.

Vision	Ormoc City as the agro-commercial and industrial gateway in Eastern Visayas and the Renewable Energy Capital of the Philippines; with a growth-inclusive economy, in a disaster-resilient environment, administered by an accountable local government.
Over-all Development Goals	Lead in specific areas based on the city's unique features and assets Draw on key functional roles to promote local growth Better equip individuals and communities to undertake productive pursuits Protect and preserve resources while pursuing economic targets

These development goals and objectives are supported by a spatial development strategy articulated in CLUP, referred to as Structure Plan, identifying 9 growth nodes and sub-nodes. The city proper is identified as major node coinciding with heritage nodes and transportation zones. Four secondary nodes includes the identified industrial zone, airport area, the solar farm areas, and the geothermal plant areas. Minor nodes are those zoned as agro-industrial areas. Eco-tourism nodes include cave sites in Nueva Sociedad, and protected areas of mangrove forest in Naungan, and the Lake Danao Natural Park. These are been translated to land use with 19 strategies. This leads to a long list of prioritized programs, projects, activities.

On the other hand, the Comprehensive Development Plan and Long-term Development Investment Plan identified 63 prioritized projects. From this, 35 projects are considered to be addressing results of the climate and disaster risk assessments and greenhouse gas inventory. Note however that these PPAs are generally articulated and to be pursued until 2027. The implementation of Local Climate Change Action Plan is ranked 22nd tagged under environment management sector.

Objectives for local climate change action

For this plan, the Technical Working Group revised and crafted new adaptation and mitigation objectives. The initial list of goals are assessed to be articulated either as strategy or program/project/activity.

However, few goals are properly articulated but seemed to fall short on being specific, measurable and relevant.

These adaptation goals are articulated in terms of increasing the adaptive capacity of people and the ecosystem in order to reduce its vulnerabilities.

The following are the adaptation objectives developed for each ecosystem.

Table 7. Adaptation Objectives, Coastal Ecosystem

Technical Analysis	*Adaptation Objectives*	*Indicators*
TC1, RC2	Increased income by 50% of 1, 686 fisher folks (35%) by 2020 **(CA1)**	1, 686 fisher folks with income of PhP 21, 450 (based from current income, close to current household poverty threshold of [PhP 21, 003 (rural) and] PhP 21, 595 (urban), 5kg per day maintained or increased in 8 months
TC2	Enhanced quality of existing mangrove forest **(CA2)**	Area of forest (in hectares) with improved vegetation
RC3	Improved water quality by 2025 **(CA3)**	International Water Quality standards (in ppm)

Table 8. Adaptation Objectives, Urban Ecosystem

Technical Analysis	*Adaptation Objectives*	*Indicators*
TU1, RU2	Improved design of housing units and commercial establishments **(UA1)**	No. of houses, buildings
TU3	Decreased cases of dengue by 2030 **(UA2)**	No. of cases
RU5	Increased on public investment on health by 5% every year **(UA3)**	Cost of investment (in PhP)
RU1	Decreased risks of population in flooding by 10% every 3 years in 10 years **(UA4)**	No. of people and households
RU3, TO1	Increased household income by 5% in 2020, 10% in 2025, and 25% in 2030 **(UA5)**	Average household income (in PhP)
TU1, RU4	Improved conditions of institutional buildings **(UA6)**	No. of buildings
RU4	Improved design of roads, sidewalks, and drainage systems **(UA7)**	Length of roads, sidewalks, and drainage systems (in km)

Technical Analysis	*Adaptation Objectives*	*Indicators*
RU5	Decreased cases of water-borne and vector-borne diseases by 2030 **(UA8)**	No. of cases
RO1	Improved design development and re-development of parks and open spaces, ecotourism spots and cultural heritage sites **(UA9)**	Volume of water collected, stored, and used

Table 9. Adaptation Objectives, Production Ecosystem

Technical Analysis	*Adaptation Objectives*	*Indicators*
TP2	Increased irrigation efficiency on 1,150 ha by 2025 and 2,300 ha by 2030 **(PA1)**	Irrigation coverage (in hectares)
TP2	Increased coverage of irrigation by 200 ha in 2020, 700 ha in 2025, and 1,400 ha in 2030 **(PA2)**	Irrigation coverage (in hectares)
TP1, RP1, RP2, RP5	Increased rice yield by 47% equivalent to 1.6T/ha, from 3.4T/ha to 5T/ha and attain 100% rice self-sufficiency by 2030 **(PA3)**	Production of 7.5 tons or income of Php121,323.50 per farmer from current 5.1 tons or income of Php82,500 (ave. 1.5 ha/farmer)
TP3, RP4	Improved fishery production by 2030 **(PA4)**	Production yield (in tons)
RP3	Improved post-harvest facilities **(PA5)**	No. of post-harvest facilities and its capacity
RO2	Increased production of vegetable crops **(PA6)**	Production yield (in tons)

Table 10. Adaptation Objectives, Forest Ecosystem

Technical Analysis	*Adaptation Objectives*	*Indicators*
TF1, TF2, RF1, RF2, RF3	Enhanced quality of existing forest cover **(FA1)**	Area of forest (in hectares) with improved vegetation

Below is the city's mitigation objective. This is primarily anchored on implementing low-emission technology in household to community level, increasing carbon sink in urban zones, and maintaining and expanding forest cover.

Table 11. Mitigation Objective

Technical Analysis	*Mitigation Objectives*	*Indicators*
GHG 1, 2, 3, 4, 5	Decreased GHG emissions by 10% compared to 2017 baseline by 2030 **(MO1)**	GHG emissions in tonnes of CO2e Presence of canopy cover in urban areas Reduction on non-renewable fuel use (in tons) Increase on renewable sources of energy (in tons) Upland areas with intact and closed forest

Plan strategy is maximizing the co-benefits of climate actions

This plan intends to maximize the benefits of achieving adaptation objectives and mitigation objectives. In particular, rehabilitating and increasing stability of flood prone mangroves areas (coastal) and landslide prone forest areas will keep the major carbon sink intact. This is complemented by inclusion of tree covering on redesigning parks and open spaces for water capture, storage, and use. Further, inclusion of trees and other vegetation must be adopted on improvement works on road, drainage, and buildings susceptible to high volume of water. Trees and these vegetation may consider fruit-bearing trees and serve as food source. A policy on implementation of green building architecture that mandates to lower electricity consumption and introduce passive cooling will be coupled with the existing ordinance on installation of rainwater catchment. Strategies on low-emission approach must be observed in all structural development, including all that directly and indirectly increase adaptive capacity to climate change impacts.

Approaches and strategies on plan implementation

The city has four points of general strategy in implementing the plan – multi-stakeholder engagement, policy-backed projects and initiatives, active sourcing and local allocation of budget, and consistent monitoring, reporting and validation.

Multi-stakeholder engagement. The city banks on the participation of the people, particularly on the social acceptance of the project. Thus, social preparation activities are highly required in all projects, especially those that will require movement and actual participation. Further, the city gives high regards to participation of the private sector. Active engagements with the civil society, academe, non-government organizations, and other groups will be practiced.

Policy-based initiatives. The city must ensure that all projects are based on local policies, consistent to the development goals and objectives. The initiatives must be backed with sound business case, primarily aligning with two major plans – the Comprehensive Land Use Plan-Zoning Ordinance and the Comprehensive Development Plan.

Budget allocation and fund outsourcing. Funding of projects must be given importance in order for it to be implemented. The city must ensure allocation from its local funds, particularly allocated in the Local Development Investment Plan, and the Annual Investment Plan. Barangay-level funding is also encouraged. The city will be actively seeking funding assistance from the private sector and other funding agencies.

Monitoring, reporting and evaluation. The city must conduct regular monitoring of its projects, for regular assessment of its progress. These reports must be available to the public. This includes annual conduct of greenhouse gas inventory.

List of policy requirements

In order for this plan to be effective, the following policies are needed to be adapted.

Local Ordinance on Open Sea Fishing Regulation in Ormoc Bay. This policy will dwell on the regulation on number of fisher folks to be permitted for open sea fishing. Increase on number on currently registered fisher folks may lead to carrying capacity issues. Strict regulation of registration and monitoring of fishing activities will be conducted led by the City Agriculture Office – Fisheries Division. (CA1, CA3)

Local Ordinance on Green Building Architecture. This policy will require the exhibition of low-emission development principles on new building applications. This will include passive cooling, water-saving technologies, greeneries, and other possible efforts on the development. This will also encourage the existing buildings to retrofit or renovate. (UA1)

Local Ordinance on Deployment of E-jeepney Program. This will layout the comprehensive goal and direction of Mass Transportation Modernization Program for economic enterprise (Phase 2). (MO1)

Local Ordinance on the protection of Irrigated Agricultural Lands. This policy intends to protect the existing irrigated agricultural lands. This will align with Zoning Ordinance and policy on land conversion. This will highlight the role of agricultural lands in achieving food security. (PA1, PA2)

Local Ordinance on city declared protected network. This will identify and expand existing protected areas both in marine and terrestrial ecosystem. (CA2, FA1, MO1)

Local Ordinance on Greenhouse Gas Inventory. This articulates the regular detection, processing, analysis, and reporting of greenhouse gas emissions. Mainstreaming data requirement on new building applications will be implemented to capture emission level on private entities. The city government will also monitor its emissions. (MO1)

Local Ordinance on Climate Change Action Council. This intends to create a long-term set-up of monitoring climate data, identifying current and future impacts, implementing and monitoring action plan, and developing a comprehensive local ordinance on climate action. (Cross-cutting)

List of existing relevant policies

The following policies must be highly enforced and further enhanced in case needed.

Ordinance No. 032 An Ordinance for the Proper Harvesting, Storage and Utilization of Rainwater in Ormoc City. This mandates the installation of water harvesting facilities on new building applications, monitored by the Office of Building Official. (UA1)

Local Ordinance on Solid Waste Management. This is the adaptation of the national law on ecological solid waste management, Republic Act No. 9003. This mandates the local government to implement for safe and sanitary management. (MO1)

Key disaster risk reduction and management project

The main source of flooding in the production zones with human settlements is the Pagsangaan River. This affects the eastern portion of the city particularly along its bank, traversing from municipality boundary of Kananga down to Ormoc Bay. Flood expands up to the depressions in the barangays of Libetad, Tambulilid, and Sto. Nino towards the major urban network along its minor tributaries.

This river is responsible to the soil formation in this area that is highly fertile for planting. This also serves as the natural drainage of flood. Increase on received amount of rainfall in Pagsangaan Watershed, even without typhoon event, will ensure rise in the water. Typhoons enhance this flooding as the case of TY Urduja (Kai-tak) in December 2017 classified as tropical depression, maximum winds of 55 kph and gustiness 90kph, when it landfall in Samar Island. Its rainfall recorded in 15 December 2017 are as follows: 347.4 mm in Catarman, 331.2 mm in Catbalogan, 155 mm in Borongan, and 109.6 mm in Guiuan. This enclosed the barangays of Liloan and San Juan with water, submerging farm lands, houses and roads. This also resulted to outflow on fish pens, resulting to dispersal of produce.

It is reported that concrete flood control along the banks in the upstream in Bayog and Rufina M. Tan is slowly degrading due to soil degradation. The same is observed in the same structures downstream in Liloan. Distance between opposite banks without flood control or vegetation is observed to widen.

Controlling the water outflow will dramatically decrease the risk of these areas to riverine flooding. However, an extensive study on the vegetation and soil characteristics of the river is highly needed to properly identify the approach on its bank stabilization, and water control. This must also consider the flow of surface runoff (coming from the rain, not a flood event), which drains on this river.

4. Programs, Projects, and Activities

This section outlines the sets of initiatives the city wants to pursue to increase adaptive capacity and decrease vulnerability, particularly on areas with high risk on climate-related hazards.

Activities. These are one-time or continuous initiatives that primarily target capacity building among target beneficiaries.

1. *Training of staff for coastal resource management*. This is a capacity building activity that will introduce management approaches of the coastal ecosystem, in particular to its conservation, protection, and expansion. The participants are the staff of the City Agriculture Office – Fisheries Division, and barangay officials of the following coastal barangays – San Juan, Lao, Naungan, Linao, Punta, Batuan, Alegria, Tambulilid, Can-adieng, Camp Downes, Bantigue, Ipil, San Antonio, Danhug, Macabug, and poblacion barangays 1, 2, and 12 in. This is to be implemented in 2019, requiring PhP 500,000.00 and technical expertise. This will be led by the Fisheries Division with the Department of Agriculture of Bureau of Fisheries and Aquatic Resources, and other non-government organizations. (CA1, CA2, CA3)
2. *Information and education campaigns on solid waste management.* This initiative will be continued and expanded focusing on climate change impacts in regards to solid waste management – increasing GHG emissions, waste enhancing flood events, sustainable consumption and production. This targets the general population through its barangay councils. This will be funded annually under its lead agency, Environment and Natural Resource Division. This will implemented with the Barangay Affairs Office, the barangay councils, development partners, and private institutions. (UA4, MO1)
3. *Comprehensive enlistment of farmers to crop insurance.* This initiative comprehensively includes all 4, 540 farmers registered to the lead agency City Agriculture Office. This intends to ensure benefits of receiving PhP 10, 000 per hectare for each farmers when its produce are affected by major calamity. There is remaining 10% of farmers not registered. This will be implemented with the Department of Agriculture. (PA3, PA6)
4. *Conduct of farmer field school.* This capacity building activity intends to widen understanding and introduce sustainable approaches to agricultural production. This targets the 4, 540 farmers registered to the lead agency City Agriculture Office. This will be implemented with the Department of Agriculture and the Agricultural Training Institute. (PA3, PA6)
5. *Community-based surveillance and monitoring of diseases.* This is a continuous approach to immediately identify, document, assess, and report prevalence of diseases related to climate changes – dengue, water-borne and skin diseases. The City Health Office will be the lead agency with its network of barangay health workers, and the City Social Welfare and Development Office. (UA2, UA3, UA8)
6. *Lot acquisition for housing.* This intends to solve the lack of public lots for relocation, identified as the major impediment to Comprehensive Shelter Plan 2017-2025 implementation. The plan targets the relocation of at risk population to flooding, particularly the informal settlers in Naungan, Ipil, Linao, Can-adieng, and Camp Downes. This also includes ISFs in Bagong Buhay, Curva, Danhug, Barangay (Pob.) 28, and Libertad. This is led by the Urban Poor Affairs Office of the City Social Welfare and Development. (UA4)

Projects on knowledge base development. These are sets of projects intended to identify scientific recommendations based on research and assessments.

1. *Biodiversity assessment*. This intends to update the current state of flora and fauna in coastal and terrestrial (particularly forest) ecosystems – its quantity and quality. This intends to identify hot spots of the adverse impact of climate change, as well as solicits for it management and development approaches. This study will specifically provide inputs in the formulation of Forest Land Use Plan and the Danao Lake National Park Management Plan. This will be implemented in 2019. This will be administered by the City Planning and Development Office with close coordination with the City Agriculture Office and Environment and Natural Resource Division. (CA2, FA1, MO1)
2. *Comprehensive hydrology study*. This intends to develop extent of flooding scenarios based on rainfall amount, volume of collectible water for urban use, and identification of new water source. This also recommends on design of water impoundments in agricultural zones with emphasis on trade of use of space. This will provide inputs in the development of Sewerage and Drainage Master Plan. This will be implemented in 2019.This will be administered by the City Planning and Development Office, co-led by the City Engineer's Office, with the City Agriculture Office, Ormoc Waterworks Office , and the Environment and Natural Resource Division. (PA1, PA2, PA3, UA7)
3. *Installation of climate monitoring system and facilities*. This intends to establish a network of monitoring stations on climate data – rainfall amount and temperature. This will guide decision making on disaster response and adjustments on climate change projects. This includes the repair of climate monitoring station operated by the CAO. This will be implemented in 2020. This will be led by the City Planning and Development Office, with the City Disaster and Risk Reduction Management Office and City Agriculture Office. (Cross-cutting)

Projects on formulation of support plans. These are sets of projects intended to formulate other plans in particular in forest management and water management.

1. *Formulation of Forest Land Use Plan*. This plan intends to specifically delineate the protection, production, and multi-use zone of the forest zone, mandated by the Department and Environment and Natural Resources. This will be developed as input to two larger plans – the Comprehensive Land Use Plan and Danao Lake Natural Park Management Plan. This will be implemented in 2019. This will be administered by the City Planning and Development Office with close coordination with the Environment and Natural Resource Division, and the City Tourism Office. (CA2, FA1, MO1)
2. *Formulation on Drainage and Sewerage Master Plan*. This plan intends to lay-out the structural requirement, develop the details of major component projects (including a water treatment plant), identification of potential water source and its economic feasibility. This is an on-going initiative expected to end by 2019. This will provide input in the *Formulation of a Master Plan for the Sustainable Urban Infrastructure Development in Metro Ormoc*. Both initiatives are under the National Economic and Development Authority-Eastern Visayas Region Office, with close engagement with the City Planning and Development Office and the City Engineer's Office. (UA7)

Adaptation projects on natural ecosystem. This set of projects intends to stabilize the state of the natural ecosystem, particularly in the coastal and forest ecosystems.

1. *Construction of fish attracting devices*. This intends to install fish attracting devices (payaw) in Ormoc Bay in order to ensure catch production, which is expected to decrease with climate change and degrading water quality. This will benefit 1, 686 fisher folks. This is led by the City

Agriculture Office – Fisheries Division. This will be implemented in two years from 2019 to 2020. (CA1)

2. *Construction of artificial reefs.* This intends to create zones in Ormoc Bay favorable for fish reproduction, and limit its migration. This will ensure continuous presence of fish in the bay. This will benefit 1, 686 fisher folks. This is led by the City Agriculture Office – Fisheries Division. This will be implemented in two years from 2019 to 2020. (CA1)
3. *Design and development of fish port complex.* This intends to provide support facilities that will ensure storage, transport and market link of fish catch. This is an on-going development, expected to end by 2020. This is led by the City Engineer's Office with the City Agriculture Office-Fisheries Division. (CA1)
4. *Forest beach project.* This intends to enhance and expand the coverage of mangroves along the coast of Ormoc Bay. Priority areas are in San Antonio, Macabug, and Naungan with aggregate area of 50 hectares. This will be implemented for two years, 2019 to 2020, for planting, nurturing, maintenance, and protection. (CA2, MO1)
5. *Toilet design study and implementation.* This intends to develop feasible structural requirement for household septic tank along the coastal barangays. The septage from these areas are considered the cause of high coliform presence in Ormoc Bay. Priority areas include the highly populated barangays of Linao, Punta, Naungan, Camp Downes, Bantigue, Ipil, San Antonio, Danhug, and Macabug. This will be implemented in 2019. This will be led by the City Health Office, with the Ormoc Waterworks Office , City Engineer's Office, and Environment and Natural Resource Division. (CA3, MO1)
6. *Installation of slope protection technology.* This intends to stabilize the soil along the road network in Milagro and Danao, which allow access to further upland barangays of Gaas, Cabingtan, Tongonan, Cabao-an, and Nueva Vista. This will be implemented in 2019-2020. This will be led by the City Disaster Risk Reduction and Management Office, City Engineer's Office, and the barangay councils. (FA1)
7. *Tourist hubs development.* This project intends to optimize service delivery on two major natural tourist spots in the city –the mangrove area and the Danao Lake Natural Park. Site development in the area must deploy low emission strategies that will ensure minimal disturbance to ecological conditions of the place, in particular the design of its boardwalks and information post. This is an on-going initiative, and expected to end by 2020. (UA9)

Adaptation projects on built ecosystem. This set of projects intends to improve the conditions of the urban system in the city center and identified urban corridors, particularly institutional buildings and in parks and open spaces.

1. *Installation of rainwater harvester.* This project intends to showcase rainwater harvester project in the city, and to be installed in the government-owned buildings, primarily in the City Hall Complex, and urban spaces. This is to take advantage of increase in rainfall. This is to be implemented in 2019 to 2021, with City Disaster Risk Reduction and Management as lead implementing agency. This is also to be implemented in the site development of the public market complex and a proposed commercial-parking building (old Gaisano building). This is in support of Ordinance No. 032 requiring the same to new building applications on private buildings. (UA6, UA9)

2. *Installation of vertical gardens (urban wall gardens).* This project intends to showcase the use of vertical gardens in absorbing heat in government buildings – city hall, health center, barangay hall, and school. This will be implemented in the urban center, primarily in the Ormoc City Hall and the Ormoc City Central School. This is also to be implemented in the site development of the public market complex and a proposed commercial-parking building (old Gaisano building). This is to be implemented in 2019 to 2021, with City Disaster Risk Reduction and Management as lead implementing agency. (UA6, UA9)
3. *Improvement of roads, sidewalks, and drainage system.* This intends to develop a street network that is characterized by tree cover to absorb heat, with sidewalks made of permeable material that allow rainfall to drain, and drainage that optimally catch water. This will be directed to a water treatment plant for reuse. This is identified to be implemented in city-managed roads – Hermosilla Drive, Lilia Cogon Street, Real Street, Rizal Street Extension, and Veloso Street. This will be considered in the formulation of the Drainage and Sewerage Master Plan. The plan formulation is an on-going initiative, expected to end by 2019. The improvement is from 2019 to 2030. This will be led by the City Planning and Development Office and the City Engineer's Office. (UA7)
4. *Installation of water treatment facility.* This initiative intends to install a technology or infrastructure that will allow the re-use of rain water and waste water. This aligns with the intent to capture water taking advantage of frequent rain, and to reduce waste water reaching the Ormoc Bay in order to improve its water quality. This will be located in the coast of the city, initially in the front of the Ormoc City Plaza, pubic market complex, and the fish port complex. This will connect all water collected and discharged coming from residential, commercial, institutional and open spaces. This is a consideration to the formulation of Drainage and Sewerage Master Plan. This will be implemented by 2019 to 2020. This is led by the City Planning and Development Office and the City Engineer's Office, with Ormoc Waterworks Office and Environment and Natural Resource Division. (CA3, UA7)
5. *Comprehensive parks development.* This intends to develop a network of open spaces characterized by its capacity to capture rain water, integrated to the drainage system towards the water treatment facilities. Further, this will be developed with tree covering to help in heat absorption. The sites will be developed to serve as a public space for recreation and commercial activities. The development will include sites for the consolidation of elements in the informal economy. The initial sites are the City Plaza Complex, and the linear parks along the flood control projects in Anilao River and Malbasag River. These two sites are currently idle with no economic or social function, being encroached by informal settlers posing degradation on water quality and to the infrastructure. (UA9, CA3)

Adaptation projects in production areas. This highly interrelated projects intends to lower vulnerabilities of the production zones with human settlements in Liloan, Licuma, and Curva, as well as inland aquaculture sites in San Juan, Lao, and Naungan.

This set of projects intends to benefit the 4, 540 farmers. This will be led by City Agriculture Office, with its main partners Department of Agriculture, Agricultural Training Institute and Bureau of Fishery and Aquatic Resources. This will be implemented from 2019 to 2021.

a. *Introduction of climate-ready variety of crops*. This intends to introduce rice variety that will be highly resilient on flood or drought. Further, aside from rice, crops that will grow optimum on weather changes will be introduced (multi-cropping), diversifying their produce and ensuring income all year round. (PA3)

b. *Transition support in change cropping pattern.* This intends to introduce a new cropping pattern in consideration of climate changes and multi-cropping. This will ensure synchronization on produce that will allow better market linkages. (PA3)
c. *Construction of irrigation canals.* This will expand the coverage of the irrigation ensuring better production. Absence of irrigation kept production 10% to 15% below optimum production. This will be implemented with the National Irrigation Authority. (PA1, PA2)
d. *Construction of water impoundment facilities.* Based on recommendations of the hydrology study, sites for the construction of water impoundment facilities will determine with alignment on the construction of irrigation canals. This project is also expected on production areas in the midland and upland, with vegetables as main produce. (PA3)
e. *Establishment of production areas implementing sloping agriculture land technology.* The production areas in the midlands and uplands will be introduced with SALT approach in order to lessen changes on natural topography. The suitable crop species must be properly identified, particularly those that strongly hold the soil and minimally alters it organic composition. (PA3)
f. *Fingerlings dispersal.* Based on the recommendation from the biodiversity assessment, fingerling dispersal, bangus and tilapia, will be implemented for inland water agriculture. (PA4)
g. *Delivery and training of alternative livelihood.* This intends to diversify the source of income of the farmers in order to ensure livelihood even on worst cases of climate impacts. This will be implemented with the Department of Trade and Industry and the City Social Welfare and Development. (PA3)
h. *Design and development of post-harvest and buffer stock facilities.* This intends to secure sufficient agricultural resources available on worst impacts of climate change. This will also facilitate post-harvest activities such as drying, milling, storage, packaging, and transport. This will link the production areas to zones. This will be implemented with the City Engineer's Office. (PA5)
i. *Design and construction of fresh water fish hatchery.* This intends to develop a research and training center (with demonstration fishpond) to benefit fish pen and cages operators on methods and approaches on fresh water aquaculture. This will be developed with the Visayas State University. (PA4)

Mitigation projects. These are projects identified that is highly linked in lowering GHG emissions of the city.

1. *Installation of solar panels.* This intends to introduce the use of solar radiation as source of energy in the operations of the government offices. This will be led by the City Disaster Risk Reduction and Management Office and respective offices. This is scheduled in 2019. (MO1)
2. *Procurement and deployment of e-jeepneys.* This intends to introduce and deploy public utility vehicles, jeepneys, using renewable source of energy. This intends to procure 20 units of energy efficient and hybrid vehicles related to the mass transportation modernization program for economic enterprise (Phase 2). This will be led by the City Disaster Risk Reduction and Management Office and respective offices. This is scheduled in 2019. (MO1)

3. *Waste to energy technology deployment.* This intends to engage a private entity to deploy waste to energy (W2E) technology aligning with the solid waste management program. This intends to include adjacent municipalities of Kananga and Albuera in this initiative. (MO1)

5. Monitoring, Validation, and Reporting

This requires an executive order forming and mandating a technical group (i.e., climate change action committee/council) to monitor, report and validate the progress and completion of these initiatives. This must be composed by the climate change action champions of each concerned departments.

The technical group must meet quarterly to report updates on the project development. The report must include the quantity and quality of progress, in particular the key indicators in achieving the objectives. Monitoring must be conducted monthly or frequently as necessary by project development officers. Validation must be conducted right after submission of monitoring report by project evaluation officers. These two reports must be synthesized to the quarterly report, and must always be readily available.

The reports must be circulated monthly for immediate feedback.

A synthesis of the quarterly reports must be made available on the submission of annual accomplishment report to the Local Chief Executive, and other requesting parties. All reports must be communicated to the public regularly.

Table 12. List of programs, projects, and activities

Program, Projects, Initiatives	Objectives	Technical Findings	Timeframe	Lead Agency	Cost	Ranking	1	2	3	4	5	6	7	8	Score
Activities															
Training of staff for coastal resource management	CA1, CA2, CA3	TC1, RC2, TC2, RC3	2019	CAO (Fisheries)	PhP 500,000.00	5	3	3	3	2	3	3	3	2	22
Information and education campaigns on solid waste management	UA4, MO1	RU1, GHG1-5	Continuous	PAO, ENRD	PhP 100,000.00	1	3	3	3	3	3	3	3	3	24
Comprehensive enlistment of farmers to crop insurance	PA3, PA6	TP1, RP1, RP2, RP5, RO6	2019	CAO (Crops)	PhP 1,000,000.00	2	3	3	3	2	3	3	3	3	23
Conduct of farmer field school	PA3, PA6	TP1, RP1, RP2, RP5, RO6	Continuous	CAO (Crops)	PhP 500,000.00	5	2	3	3	3	3	3	3	2	22
Community-based surveillance and monitoring of diseases	UA2, UA3, UA8	TU3, RU5	Continuous	CHO	PhP 500,000.00	2	3	3	3	2	3	3	3	3	23
Lot acquisition for housing	UA4	RU1	2017-2025	CPDO	PhP 35,000,000.00	2	3	3	3	2	3	3	3	3	23
Projects on knowledge base development															

Program, Projects, Initiatives	Objectives	Technical Findings	Timeframe	Lead Agency	Cost	Ranking	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	Score
Biodiversity assessment	CA2, FA1, MO1	TC2, TF1-2, RF1-3, GHG1-5	2019	CPDO, ENRD	PhP 500,000.00	14	2	3	3	2	3	2	3	3	21
Comprehensive hydrology study	PA1, PA2, PA3, UA7	TP1, TP2, RP1, RP2, RP5	2019	CPDO, ORWASA	PhP 1,400,000.00	18	3	1	3	2	3	2	3	3	20
Installation of climate monitoring system and facilities	Cross-cutting	Cross-cutting	2019-2020	CDRRMO, CPDO	PhP 5,000,000.00	14	2	3	3	2	3	2	3	3	21
Projects on support plans															
Formulation of Forest Land Use Plan	CA2, FA1, MO1	TC2, TF1-2, RF1-3, GHG1-5	2019	CPDO, ENRD	PhP 500,000.00	18	3	1	3	2	3	2	3	3	20
Formulation on Drainage and Sewerage Master Plan	UA7	RU4	2019	CEO, CPDO	PhP 500,000.00	18	3	1	3	2	3	2	3	3	20
Adaptation projects in natural ecosystem															
Construction of fish attracting devices	CA1	TC1, RC2	2019-2020	CAO (Fisheries)	PhP 500,000.00	5	3	3	3	2	3	2	3	3	22
Construction of artificial reefs	CA1	TC1, RC2	2019-2020	CAO (Fisheries)	PhP 500,000.00	5	3	3	3	2	3	2	3	3	22

Program, Projects, Initiatives	Objectives	Technical Findings	Timeframe	Lead Agency	Cost	Ranking	1	2	3	4	5	6	7	8	Score
Design and development of fish port complex	CA1	TC1, RC2	On-going	CEO, CAO (Fisheries)	PhP 500,000.00	5	3	3	3	2	3	2	3	3	22
Forest beach project	CA2, MO1	TC2, GHG1-5	2019-2020	ENRD	PhP 500,000.00	35	2	1	2	2	2	2	3	2	16
Toilet design study and implementation	CA3, MO1	RC3, GHG1-5	2019	CHO	PhP 500,000.00	28	3	1	3	1	3	2	3	3	19
Installation of slope protection technology	FA1	TF1-2, RF1-3	2019-2020	CEO	PhP 500,000.00	18	3	1	3	2	3	2	3	3	20
Tourist hubs development	UA9	RO1	2019-2020	CTO, CPDO	PhP 500,000.00	31	2	2	3	2	2	2	3	2	18
Adaptation projects in built ecosystem															
Installation of rainwater harvester	UA6, UA9	TU1, RU4, RO1	2019-2021	CEO, CPDO	PhP 40,000,000.00	18	2	3	3	2	2	3	3	2	20
Installation of vertical gardens (urban wall gardens)	UA6, UA9	TU1, RU4, RO1	2019-2021	CEO, CPDO	PhP 20,000,000.00	18	3	3	3	2	2	2	3	2	20

Program, Projects, Initiatives	Objectives	Technical Findings	Timeframe	Lead Agency	Cost	Ranking	1	2	3	4	5	6	7	8	Score
Improvement of roads, sidewalks, and drainage system	UA7	RU4	2019-2023	CEO, CPDO	PhP 10,000,000.00	14	3	2	3	2	3	2	3	3	21
Installation of water treatment facility	CA3, UA7	RC3, RU4	2019-2020	CEO, CPDO	PhP 10,000,000.00	14	3	2	3	2	3	2	3	3	21
Comprehensive parks development	UA9, CA3	RO1, RC3	2019-2023	CTO, CEO, CPDO	PhP 10,000,000.00	28	3	2	3	2	2	2	3	2	19
Adaptation program in agriculture															
Introduction of climate-ready variety of crops	PA3	TP1, RP1, RP2, RP5	2019-2021	CAO (Crops)	PhP 1,000,000.00	5	3	2	3	2	3	3	3	3	22
Transition support in change cropping pattern	PA3	TP1, RP1, RP2, RP5	2019-2021	CAO (Crops)	PhP 1,000,000.00	5	2	3	3	2	3	3	3	3	22
Construction of irrigation canals	PA1, PA2	TP2	2019-2021	CAO (Crops)	PhP 1,000,000.00	18	3	2	3	2	3	2	3	2	20

Program, Projects, Initiatives	Objectives	Technical Findings	Timeframe	Lead Agency	Cost	Ranking	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	Score
Construction of water impoundment facilities	PA3	TP1, RP1, RP2, RP5	2019-2021	CAO (Crops)	PhP 1, 000, 000. 00	5	3	3	3	2	3	2	3	3	22
Establishment of production areas implementing sloping agriculture land technology	PA3	TP1, RP1, RP2, RP5	2019-2021	CAO (Crops)	PhP 1, 000, 000. 00	18	3	2	3	2	3	1	3	3	20
Fingerlings dispersal	PA4	TP3, RP4	2019-2021	CAO (Fisherie s)	PhP 1, 000, 000. 00	18	3	3	3	2	3	2	2	2	20
Delivery and training of alternative livelihood	PA3	TP1, RP1, RP2, RP5	2019-2021	CAO (Crops)	PhP 1, 000, 000. 00	5	2	3	3	2	3	3	3	3	22
Design and development of post-harvest and buffer stock facilities	PA5	RP3	2019-2021	CAO (Crops)	PhP 1, 000, 000. 00	18	3	1	3	2	3	2	3	3	20
Design and construction of fresh water fish hatchery	PA4	TP3, RP4	2019-2021	CAO (Fisherie s)	PhP 1, 000, 000. 00	28	3	1	3	2	3	2	3	2	19
Mitigation projects															

Program, Projects, Initiatives	Objectives	Technical Findings	Timeframe	Lead Agency	Cost	Ranking	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	Score
Installation of solar panels	MO1	GHG1-5	2019-2020	CDRRMO, CEO, CPDO	PhP 50,000,000.00	31	3	2	2	2	2	2	3	2	18
Procurement and deployment of e-jeepneys	MO1	GHG1-5	2019-2020	CPDO	PhP 50,000,000.00	33	2	2	2	2	2	2	3	2	17
Waste to energy technology deployment	MO1	GHG1-5	2019-2021	ENRD, CPDO	PhP 50,000,000.00	33	3	2	2	1	2	2	3	2	17

Evaluation Criteria for Prioritizations

1: Stakeholder Acceptability
2: Technical Feasibility
3: Urgency of Implementation
4: Ease of Implementation
5: Relative Effectiveness
6: Relative Cost
7: Mainstreaming Potential
8: Multi-sectoral Relevance

References

Plans and ordinances

Comprehensive Land Use Plan 2017-2027
Comprehensive Development Plan/Long-term Development Investment Plan 2017-2013
Annual Investment Plan 2019
Comprehensive Shelter Plan 2017-2025
Local Climate Change Action Plan 2016-2025
Ordinance No. 032 An Ordinance for the Proper Harvesting, Storage and Utilization of Rainwater in Ormoc City
Eastern Visayas Regional Development Plan 2017-2022

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Appendix 1: Data on Demographics

Appendix 2: Data on Flood

Appendix 3: Data on Landslide

Appendix 4: Data on Storm Sur

Appendix 5: Risk Assessment Results

Note to content/layout editor – See long table of risk assessments on drive.
https://drive.google.com/drive/u/0/folders/1JbPsI9ToohcOLIV4kNGwe5cIZHe-3D7f