DAVAO DEL NORTE
LOCAL CLIMATE CHANGE ACTION PLAN (LCCAP) (2017-2022)

SP Resolution No. 231 Series of 2018

Chapter I: INTRODUCTION

1.1 Rationale

Climate patterns play a fundamental role in shaping natural ecosystems, and the human economies and cultures that depend on them. It has been observed, however, that trends in climate variation have significantly changed over time bringing with it disruptive impacts to human health, agriculture, freshwater supplies, coastlines, forests and other natural resources that are vital to any nation's economy. The extreme changes in climate is reflected in the rising sea levels; unprecedented typhoons, excessive rains, drought, fires, etc.

Nations around the globe have realized the need to reduce human-caused greenhouse gas emissions to avoid worsening climate impacts and reduce the risk of creating changes beyond man's ability to respond and adapt in order to create a clean energy economy. While it is recognized that even if countries reduce greenhouse gas emissions are reduced some changes in the climate and their consequent impacts cannot be avoided. It becomes more imperative for nations and societies take strong steps in order to reduce its worsening impacts. There is that growing consensus that no area can attain long term and sustainable economic growth without addressing climate change. In order to reap the gains from economic development, conscientious efforts must be made to cushion the negative impacts of climate change.

1.2 Legal Framework

The United Framework Convention on Climate Change (UNFCC) held yearly conferences to promulgate solutions to the worsening condition. These promulgations were aimed at reducing country emissions to slow down global warming. In 2015, the 196 countries that attended the UN Climate Change Conference in Paris adopted the Paris Agreement which aimed at limiting global warming rise to less than 2ºC two degrees Celsius, and limiting the rise by 1.5ºC. The Paris Agreement was signed in 2016 and will take into effect upon ratification by the 55 countries which were observed to emit 55% of greenhouse gas in the planet.

In the Philippines, the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAG-ASA) projected that in 2050 the temperature of the country will increase from 1.9 to 2.2˚C. The impact of climate change is already felt through the chain of extreme environmental calamities that happened in the country like those brought about by typhoons Sendong, Pablo and Yolanda. These events have taken lives, damaged structures, caused economic losses, and created social instability. The turn of events placed the Philippines as one of the most vulnerable countries in the world. In its drive to build the resiliency of the different sectors to climate change issues, the Philippine government ratified Republic Act 9729 in 2009 to mainstream climate change in the policy formulation in all of the plans of the government agencies. To reinforce the operation of RA 9729, the Climate Change Commission formulated the National Climate Change Action Plan in 2011 that would help increase the country's adaptive capacity, increase the resilience of natural ecosystems to climate change, and optimize mitigation opportunities. In addition, Republic Act 10174 of 2012 established the Peoples Survival Fund to provide the local government units access to long term financial support in their efforts to mitigate measures to increase resiliency towards climate change. The Department of the

Interior and Local Government issued memorandum circular no. 2014 – 135 in 2014 to provide guidelines on the formulation of Local Climate Change Action Plan.

The extreme environmental events that happened in the international, national and local levels prompted the province of Davao del Norte to craft a Local Climate Change Action plan. The various policies made in the international level and national level guided the formulation of this plan. It is anchored on the belief that local communities are at the cutting edge of the climate change challenge because they have responsibility for a wide range of decisions that are vital to our collective future. Many of the adverse and negative impacts of climate change, such as flooding, will result in costs to businesses and householders, and solutions to the problems they pose need to be developed locally. Adaptation to the risks presented by climate change, such as those experienced by local communities (which vary depending on the ecosystem), is key to future proofing local communities and making sure that new developments maintain quality of life and are affordable now and in the future. Then there is the issue of spatial planning that is crucial in shaping new and existing developments in ways that reduce carbon dioxide emissions and positively build community resilience to problems experienced by the local communities. Spatial planning has the potential to deliver the right development in the right place in a fair and transparent way, informed by the imperative of sustainable development.

This document recognizes the fact that planning is vital in helping shape places to secure radical reductions in greenhouse gas emissions, minimising vulnerability and providing resilience to the impacts of climate change, and supporting the delivery of renewable and low carbon energy and associated infrastructure in order to attain the economic, social and environmental dimensions of sustainable development. Planning makes a significant contribution to both mitigating and adapting to climate change, through decision-making on the location, scale, mix and character of development.

1.3 The National Climate Change Action Plan as Anchor of the Local Climate Change Action Plan

The Provincial CCA Plan is designed with the following work priorities, strategies, approach & targeted outcomes anchored to the National CCA Plan:

1. Food Security
   The objective is to enhanced climate change resilience of agriculture and fisheries production and distribution systems as well as the agricultural and fishing communities from climate change;

2. Water sufficiency
   In light of climate change, water governance must be restructured towards Integrated water resources management in watersheds and river basins, sustainability of supplies and access to safe water must be ensured and should enhance the knowledge and capacity for climate change adaptation in the water sector;

3. Ecosystems and Environmental Stability
   Ecosystems must be protected, rehabilitated and restores ecological services. Climate change mitigation and adaptation strategies for key ecosystems must be developed and implemented while improving the management and conservation of protected and key biodiversity areas. Environmental laws must also be strictly implemented and enhance the capacity for integrated ecosystem-based

management approach in protected areas and key biodiversity areas. Lastly, natural resources accounting should be institutionalized.

4. Human Security
   Climate Change Adaptation and Disaster Risk Reduction should be practiced by all sectors at the national and local levels. Health and social sector delivery systems are and must be responsive to climate change while developing, promoting & adopting adaptive human settlements and services. Green cities and municipalities must also be promoted and sustained;

5. Climate-Friendly Industries and Services
   NCCAP prioritizes the creation of green and eco-jobs and sustainable consumption and production. It also focuses on the development of sustainable cities and municipalities;

6. Sustainable Energy
   Promotes city-wide energy efficiency and conservation& enhance sustainable energy development. The city will also adopt environmentally sustainable transport and rehabilitate and improve the energy systems and infrastructures; and,

7. Knowledge and Capacity Development
   The province will enhance the science of climate change as well as the capacity for climate change adaptation and mitigation at the national and local level to be able to establish an accessible climate change knowledge management to all sectors.

Chapter II: PROVINCIAL PROFILE

2.1 History of the Province

The original mother Province of Davao was divided into three (3) provinces, namely: Davao del Norte, Davao del Sur and Davao Oriental by virtue of the bill authored by then Congressman. Hon. Lorenzo S. Sarmiento, Sr., which bill was passed into law and became known as R.A. 4867 dated 8 May 1967. The three provinces simultaneously celebrated their anniversary every 1st of July, which date was then the start of the Fiscal Year and marked the official commencement of operation as created provinces.

When it was created, Davao Province was composed of thirteen (13) municipalities, namely: Asuncion, Babak, Compostela, Kapalong, Mabini, Mawab, Monkayo, Nabunturan, Panabo, Pantukan, Samal, Sto. Tomas and Tagum. Six (6) additional municipalities were created in May 6, 1970. These included Carmen, Kaputian, Maco, Montevista, New Bataan and New Corella. In 1979, San Vicente (now Laak) was created as a new municipality. In 1988, Maragusan was added to the list of municipalities and Talaingod was created in 1990, bringing the total to 22 municipalities as of 1996. Hon. Verulo C. Boiser was appointed by the President as the first Governor of Davao del Norte. He served the Province for ten years, from July 1, 1967 to July 7, 1977. This corresponded to two years as appointed Governor and two terms as duly elected Governor. In June 17, 1972, Davao Province was renamed to Davao del Norte by virtue of Republic Act No. 6430.

The second Provincial Chief Executive was Hon. Gregorio R. Dujali, a presidential appointee, when the Hon. Boiser stepped down from his post in July 7, 1977. Governor Dujali also served as the appointed governor of Davao Province for one year and as an elective governor for two terms until March 31, 1986.

In February 25, 1986, Her Excellency, Mrs. Corazon C. Aquino was installed as President of the Philippines by virtue of the “People Power” otherwise known as the EDSA Revolution. Davao Province was among the local government units that experienced a change of officials. Hon. Prospero S. Amatong was appointed as the OIC-Governor of Davao Province in April 4, 1986. Six other board members were also appointed, but four of them resigned when they ran for congressional positions. Consequently, four new members of the Provincial Board were appointed to fill in the vacancies.

On January 30, 1998, President Fidel V. Ramos signed *Republic Act No.8470* creating the Province of Compostela Valley out of Davao Province, and renamed Davao Province back to Davao del Norte. Other historical events that transpired in Davao del Norte together with the creation of Compostela Valley were: the enactment of *Republic Act No. 8471*, creating the Island Garden City of Samal comprising the former municipalities of Babak, Samal and Kaputian; *Republic Act No. 8472* converting Tagum municipality into Tagum City, the seat of the provincial government of Davao del Norte Province; and *Republic Act 8473* creating the municipality of Braulio E. Dujali from the municipalities of Carmen and Panabo are components of Davao del Norte province. In the turn of events, the province had a political composition of eight municipalities and two cities with 223 barangays.

The term of Governor Prospero S. Amatong ended on March 26, 1998 when he took his Oath of Office as Governor of the newly created province of Compostela Valley on the same day.
The national and local election period from April 1 to June 30, 1999 necessitated the appointment of interim provincial officials headed by Hon. Anecito M. Solis as the Acting Governor.

Hon. Rodolfo P. del Rosario was elected and sworn into office as the first Governor of the new Davao del Norte Province in July 1, 1998. In March 31, 2001, the Municipality of Panabo was converted into a city by virtue of Republic Act 1015. This changed the administrative composition of Davao del Norte to seven municipalities and three cities. Hon. Congressman Antonio R. Floirendo, Jr. sponsored the bill creating the City of Panabo.

In March 15, 2004, a new municipality was born. Republic Act No. 9265 created the Municipality of San Isidro, the eighth municipality of Davao del Norte. This municipality comprises of 6 barangays culled out from the Municipality of Kapalong and 7 barangays culled out from the Municipality of Asuncion. The bill was sponsored by Cong. Arrel R. Olaño of District I. Barangay Sawata became the seat of this new local government unit.

Governor Rodolfo P. del Rosario served for two terms only. His decision not to run for re-election paved the way for Hon. Gelacio P. Gementiza, Mayor of Tagum City to run for governor of Davao del Norte. His landslide victory gave him a new mandate to head as the governor of the Province of Davao del Norte. During the 2007 election, Governor Rodolfo P. del Rosario decided to run again and won the race against Governor Gementiza.

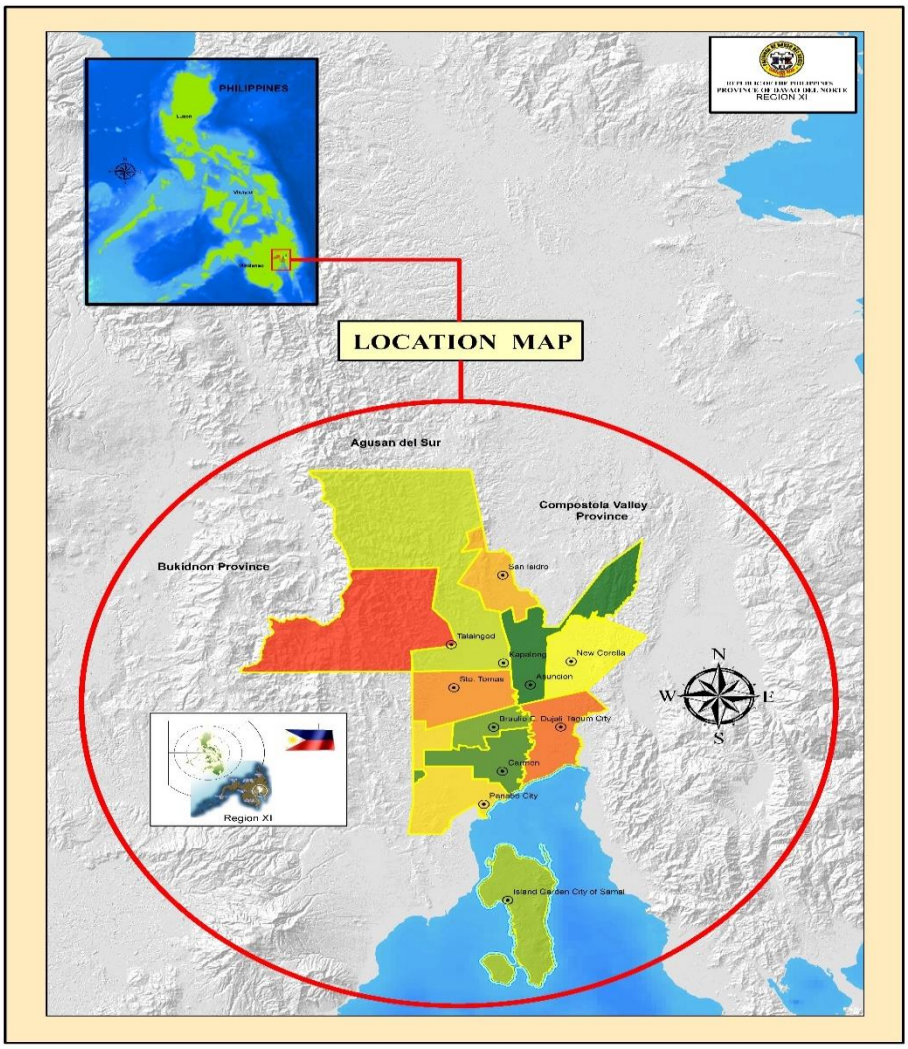
The end of term of Governor Rodolfo P. del Rosario in June 30, 2016 also marked the beginning of the term of office of his son, Governor Antonio Rafael G. del Rosario in July 1, 2016. The past administration had ably prepared the Dabaonons, the province's resources and institutions for the eminent globalization and climate change. The new administration promoted and expanded the human development agenda through adherence to the Äbilidad at Malasakit" brand of governance. "Äbilidad" stands for competitiveness Cluster, which include the Economic and Governance Sectors. On the other hand, "Malasakit" makes up the Welfare Group that covers the Environment and Social Sectors. "Äbilidad at Malasakit" involves raising the competitiveness of the people and institutions to effectively adjust to globalization while creating a close-knit, caring community in providing welfare provision for the poorest of the poor so that they too can lead decent lives. The strategies of "Abilidad at Malasakit" subsumed the B.E.S.T. P.E.O.P.L.E Development Agenda.

2.2 Natural Features

Geography

Davao del Norte is strategically located at the southeastern part of Region XI, approximately within 125° 38' east longitude and 7°7' to 8°0' north latitude. It is bounded by the Province of Agusan del Sur on the North, Bukidnon on the Northwest, Davao City on the West, Davao Gulf on the South and the Province of Compostela Valley on the East.

Figure No.1. Location Map, Davao del Norte



Source: PPDO-Davao del Norte

Davao del Norte has a land area of 3,462.80 km^2 (Table 1). It has eight (8) municipalities and three (3) component cities with 223 barangays, sub-divided into two congressional districts. District I comprises the municipalities of Asuncion, Kapalong, New Corella,San Isidro, Talaingod and the City of Tagum, while District II covers the municipalities of B.E. Dujali, Carmen, Sto.Tomas, the City of Panabo and the Island Garden City of Samal.

Table 1. Land Area and Number of Barangays, by City/Municipality
Province of Davao del Norte, 2013

City/Municipality	Land Area (Sq. Km.)	No. of Barangays
District I		
Asuncion	293.47	20
Kapalong	945.86	14
New Corella	321.48	21
San Isidro	152.49	13
Tagum City	182.54	23
Talaingod	454.96	3
District II		
Braulio E. Dujali	91.00	5
Carmen	166.25	20
Island Garden City of Samal	280.71	46
Panabo City	253.63	39
Sto. Tomas	320.41	19
DAVAO DEL NORTE	3,462.80	223

Source: DENR XI
Note: Land area is not authoritative, for planning purposes only.

Topography and Slope

Rugged, mountainous and moderately to steeply sloping areas on the western part and a wide alluvial plain on the central lowland area generally characterize the topography of the province. Comprising the major portion of the alluvial plain is a flat tract of land. However, some places are gently undulating and exhibit a rolling topography.

Davao del Norte has generally a low land terrain comprising 37 percent of the total land area with less than 100 meters elevation. The highest elevation ranging from 1000-2000 meters comprising 3 percent of the total land area is found in the municipalities of Kapalong and Talaingod.

Table No.2 Elevation Characteristics
Province of Davao del Norte, 2013

City/Municipality	Area of Elevation in Hectares						
	<100 m	100-300 m	301-500 m	501-1000 m	1001-2000 m	>2001 m	Total
Davao del Norte	**128,343**	**84,651**	**29,501**	**94,174**	**9,613**	**-**	**346,280**
% Distribution	37 %	24 %	9 %	27 %	3 %	0.00%	100%

Source: BSWM XI

Slope is a key variable affecting the selection and positioning of crops, and likewise influences the type of management infrastructure that must be adopted to sustain land productivity.

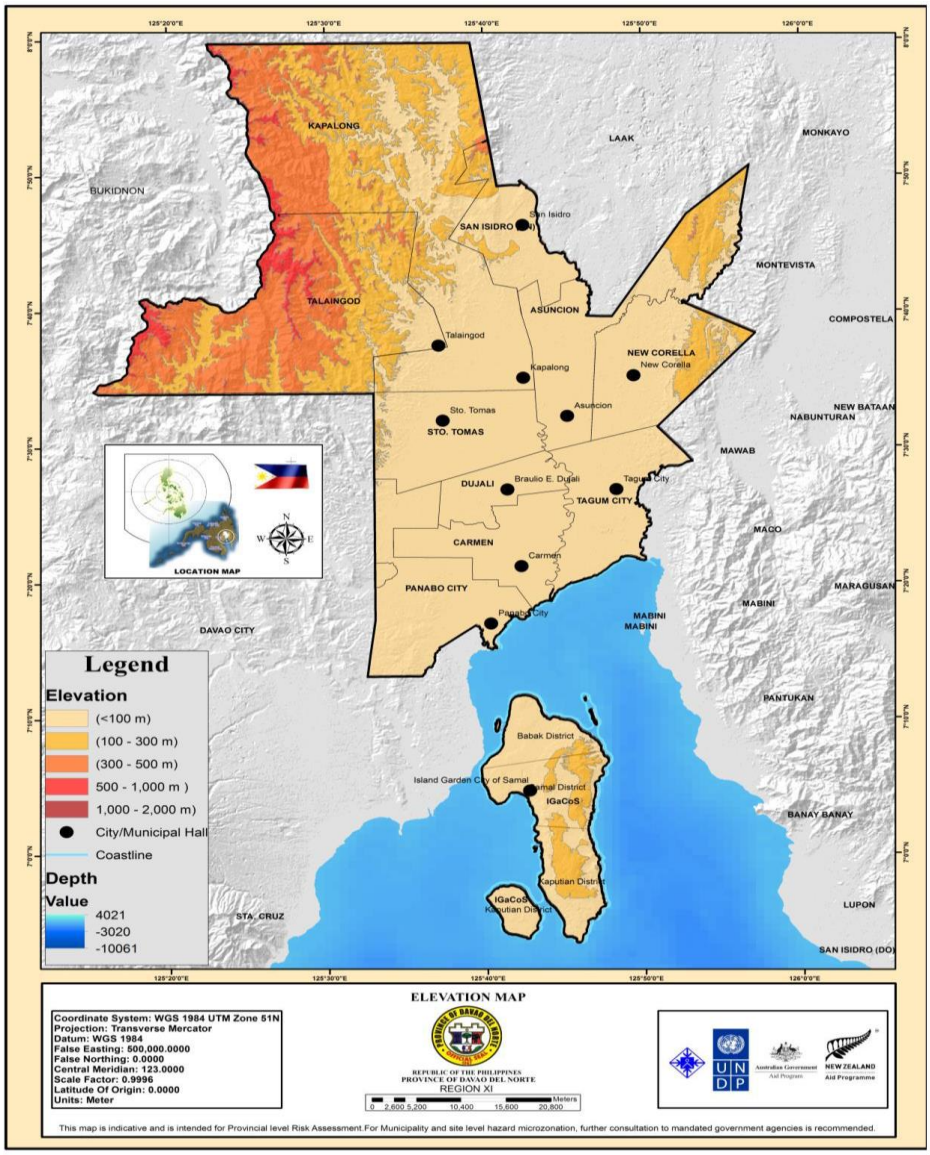
About 53.6 percent of the total land area of the province or 185,687.11 hectares has slope range of 0-18 percent (Table No.3-8). These areas may be used for agriculture, industries and settlements. The remaining 46.4 percent or 160,592.89 hectares of the province are areas with slope ranging from 18 percent to more than 50 percent.

Table No.3 Slope Classification by City/Municipality
Province of Davao del Norte (in Hectares)

City/Municipality	Slope Class						Total
	0-3 %	3-8 %	8-18 %	18-30 %	30-50 %	50 % up	
Asuncion	13,530.90	1,799.30	2,601.80	2,652.70	8,758.80	3.50	29,347.00
B.E Dujali	9,100.00	0	0	0	0	0	9,100.00
Carmen	16,603.30	16.50	5.20	0	0	0	16,625.00
Kapalong	10,850.30	5,551.50	5,543.31	25,806.69	19,025.37	27,808.83	94,586.00
New Corella	12,446.30	3,232.80	4,934.90	3,863.80	7,643.80	26.40	32,148.00
San Isidro	4,627.00	1,871.00	939.00	7,716.00	96.00	0	15249.00
Sto. Tomas	13,093.00	3,670.00	2,793.00	9,350.90	2,999.30	134.80	32,041.00
Talaingod	0	1,656.70	2,235.30	14,453.50	7,716.00	19,434.50	45,496.00
IGC of Samal	11,323.10	8,839.10	5,346.80	853.80	1,357.40	350.80	28,071.00
Panabo City	13,023.50	4,210.50	7,589.00	124.50	415.50	0	25,363.00
Tagum City	16,892.30	1,051.00	310.70	0	0	0	18,254.00
Davao del Norte	121,489.70	31,898.40	32,299.01	64,821.89	48,012.17	47,758.83	346,280.00
% Distribution	**35.10**	**9.20**	**9.30**	**18.70**	**13.90**	**13.80**	**100**

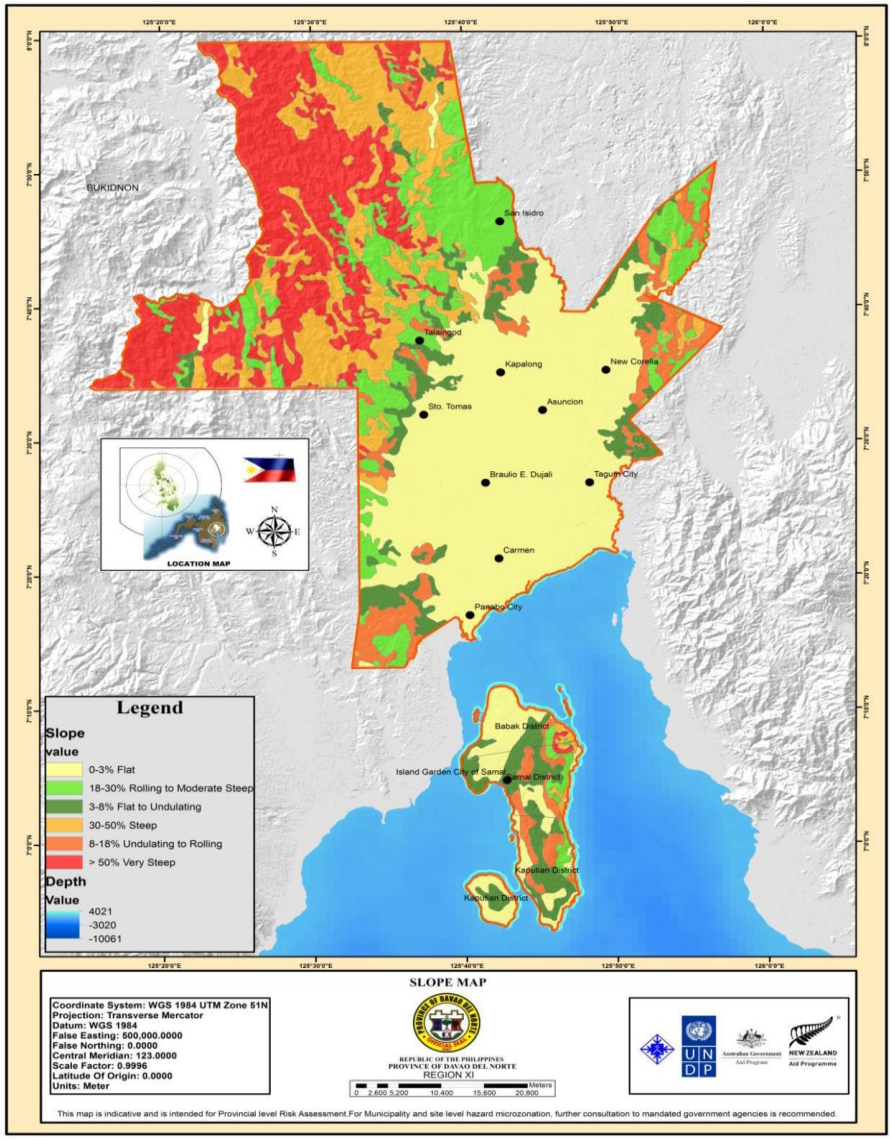
Source: BSWM XI, GIS computations based on the maps by the DENR, BSWM
Note: Land area is not authoritative for any other purposes.

Figure No. 2. Elevation Map, Davao del Norte



Source: PDPFP, Davao del Norte

Figure No. 3. Slope Map, Davao del Norte



Source: PDPFP, Davao del Norte

Climate and Rainfall

The province has Type IV climate under the coronas classification and is characterized by unpronounced dry and wet seasons. Rainfall is more or less evenly distributed throughout the year with no pronounced rainy season and dry season. Davao del Norte is no longer typhoon-free as it is used to be. The province has experienced the onslaught of typhoon Pablo in December 2012 which brought damages on infrastructure and agriculture.

a. Historical Records on Precipitation

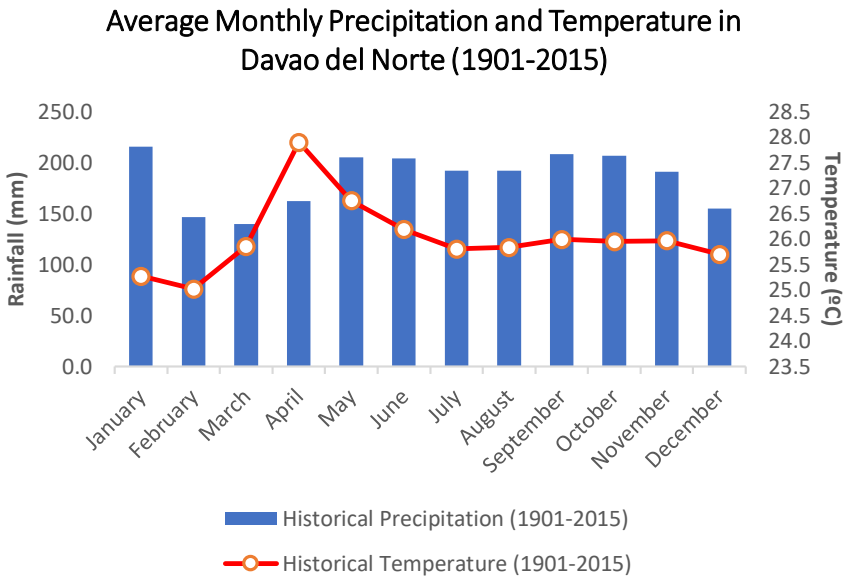
Historical data on mean seasonal precipitation as shown in Figure No. 4 indicates that from 1901-2015, Davao del Norte has experienced most rainfall during months of September, October and November (SON) with a 201 mm rainfall (average rainfall of SON), followed by months of June, July and August (JJA) with a 195 mm average rainfall (average rainfall of JJA).

The graph also displayed scenario that reduction in rainfall is at most in the months of February, March and April. Wet season starts at May to the rest of the months, including January.

b. Historical Records on Temperature

Historical data on mean temperature as shown in Figure No. 4 indicates that from 1901-2015, the province temperature is at its peak in the months of March, April and May (MAM) at 26.83ºC (average temp of MAM). While the months of JJA and SON with most rainfall are the months with cooler temperature at 25.96ºC (JJA and SON average temperature). December, January and February (DJF) are the coolest of temperature.

Figure No. 4 Historical Records



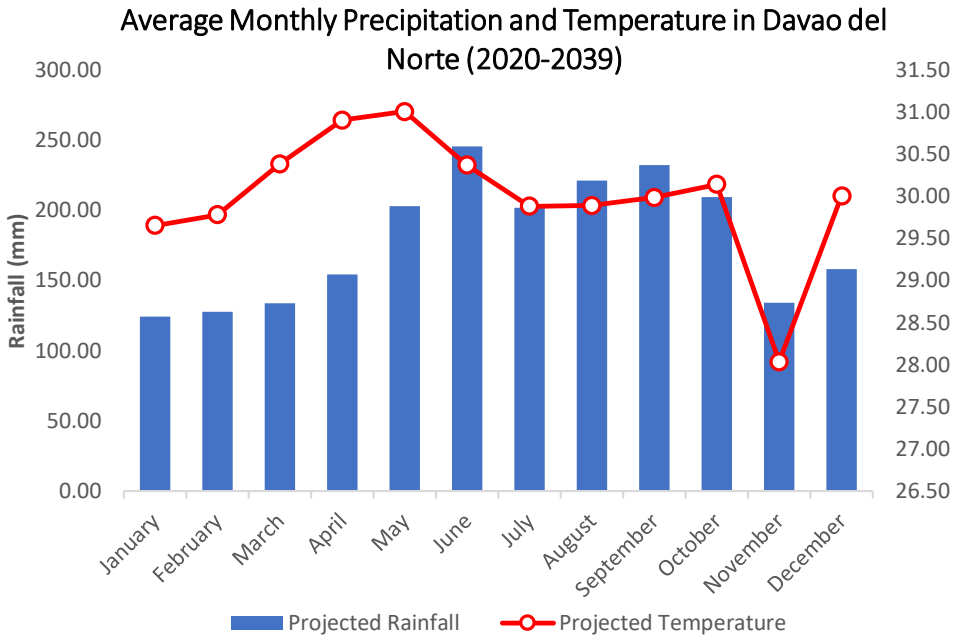
Source: PENRO-Generated from Climate Change Knowledge Portal, World Bank

c. Projections on Precipitation

Projected data on mean precipitation as shown in Figure No. 5 indicates that Davao del Norte will experience most rainfall earlier, in the months of JJA with a 222.56 mm rainfall (average rainfall of JJA), with an increase of 21.56 mm compared to historical record.

The graph also displayed scenario that reduction in rainfall will start as early as November up to April. This means that there will be six (6) dry months in a year, much longer than what the province has experienced based from the historical record.

Figure No. 5 Projections



2.3 Demography

Population and Density

a. Size and distribution

Tagum City, the seat of the provincial government of Davao del Norte has the largest population among the cities and municipalities in the province. It has a total population of 242,801 or 25.7% share of the total provincial population during the 2010 census, while only occupying a land area of 182.54 sq km. or 5.3% of the provincial land area.

It is followed by Panabo City having a population of 174,364 or 18.4% share, third is the municipality of Sto. Tomas with 109,269 or 11.5% share, fourth is Island Garden City of Samal with 95,874 or 10% share, and the fifth are the municipalities of Carmen with 69,199 or 7.3%, Kapalong with 68,261 or 7.3% share of the total provincial population. (Table No.2)

The rest of the municipalities of Davao del Norte, namely Asuncion ranks sixth with 55,844 or 6.0%. Seventh place is New Corella with 50,699 or 5.4%, eighth place is Braulio Dujali with 28,339 or 3%, ninth

placers are San Isidro with 25,548 or 2.7% and Talaingod with 25,566 sharing 2.7% of the total provincial population.

Accordingly, based on 2010 population of 945,764 and with an annual population growth rate (APGR) of 2.43, it is estimated that the population of Davao del Norte will reach 1,222,539 by 2020, and expected that the population size of the province will double in 29 years.

Table No. 4 Population, Annual Population Growth Rate & Density
By City/Municipality of Davao del Norte, 2000, 2007 & 2010

City/Municipality	Population			Population (% Share)			APGR	Density		Area	
	2000	2007	2010	2000	2007	2010	2007-2010	2007	2010	Square Km	%
Asuncion	46,910	50,731	55,844	6.3	6.0	6.0	3.56	173	190	293.47	8
Braulio E. Dujali	18,050	24,886	28,339	2.4	2.9	3.0	4.84	273	311	91.00	2
Carmen	55,144	61,656	69,199	7.4	7.3	7.3	4.29	371	251	275.16	8
Kapalong	57,966	61,763	68,261	7.8	7.3	7.3	3.71	65	72	945.86	27
New Corella	44,590	46,311	50,699	6.0	5.5	5.4	3.35	144	158	321.48	9
Panabo City	133,950	154,329	174,364	18.0	18.2	18.4	4.54	608	687	253.63	7
IGACOS	82,609	90,291	95,874	11.1	10.6	10.0	2.21	322	342	280.71	8
San Isidro	24,100	24,696	25,548	3.2	2.9	2.7	1.24	162	168	152.49	4
Sto. Tomas	84,367	97,210	109,269	11.3	11.5	11.5	4.35	303	341	320.41	9
Tagum City	179,531	215,967	242,801	24.1	25.5	25.7	4.35	1183	1,330	182.54	5
Talaingod	16,594	19,600	25,566	1.3	2.3	2.7	10.15	43	56	454.96	13
DAVAO DEL NORTE	743,811	847,440	945,764	100.0	100	100.0	4.07	245	245	3,462.80	100.0

Source: Philippine Statistics Authority
Computations by Provincial Planning and Development Office

In comparison to the previous censuses, three cities and 1 municipality increased their population shares since 2000 and constituted 65% of the provincial population. These are Tagum City, Panabo City, and Sto. Tomas, Island Garden City of Samal. The rest of the municipalities shared 35% of the total provincial population. These are Kapalong, Carmen, Asuncion, New Corella, Braulio Dujali, San Isidro and Talaingod.

With this increasing population trend among the cities and municipalities, it can be observed that population is clustered towards the largest settlements in the province.

Table No. 5: Population Shares, by City/Municipality
Davao del Norte, 2000, 2007, 2010

City / Municipality	Population (% share)			Cumulative Population			% change
	2000	2007	2010	2000	2007	2010	2000-2010
Asuncion	6.3	6.0	6.0	6.3	6.0	6.0	0.3
Braulio E. Dujali	2.4	2.9	3.0	8.7	8.9	9.0	-0.6
Carmen	7.4	7.3	7.3	16.1	16.2	16.3	0.1
Kapalong	7.8	7.3	7.3	23.9	23.5	23.6	0.5
New Corella	6.0	5.5	5.4	29.9	29	29.0	0.6
Panabo City	18.0	18.2	18.4	47.9	47.2	47.4	-0.4
IGACOS	11.1	10.6	10.0	59.0	57.8	57.4	1.1
San Isidro	3.2	2.9	2.7	62.2	60.7	60.1	0.5
Sto. Tomas	11.3	11.5	11.5	73.5	72.2	71.6	-0.2
Tagum City	24.1	25.5	25.7	97.6	97.7	97.3	-1.6
Talaingod	2.2	2.3	2.7	100.0	100.0	100.0	-0.5

Source: Based on Census on Population, 1990, 2000, 2010
Computations by Provincial Planning and development Office

b. Density and urbanization

The City of Tagum recorded the highest population density with 1,130 persons/square kilometer in 2010 census. On the other hand, the municipality of Talaingod has the lowest at 56 persons/square kilometer. All in all, the provincial data showed 273 persons/square kilometers.

Other cities/municipalities with population densities higher than the provincial average are Panabo City (687), Sto. Tomas (341), Island Garden City of Samal (342), and Braulio E. Dujali (311) persons/square kilometer (Table No. 3).

c. Growth rate

Between 2007-2010 censuses, the municipality of Talaingod exhibited the highest annual population growth rate (APGR) of 10.15% among the cities and other municipalities within the province. This may be the effect of road opening to other provinces for future linkages and exchange of goods and services and the formation of marketing outlets of products. (See Table No. 2)

On the other hand, the municipality of Braulio E. Dujali also experienced a high APGR of 4.84% in 2007-2010 censuses; maybe because of the existence of TADECO banana plantation, located in Barangay Tanglaw, as a result, there was an increase in the number of employees coming into the area between these years.

d. Densities and growth rates

1. High density and fast-growing settlements: Tagum City, and Panabo City

   Tagum City, the center of trade and commerce in the province does not only cater the neighboring cities and municipalities within the province; however, its strategic location extended its linkages as far as the provinces of Davao Oriental, Compostela Valley, Agusan del Sur, and Bukidnon. Panabo City, on the other hand, with its proximity to Tagum City and Davao City integrates the development of these big cities and compliments to the industrial activities of Davao City because of its seaport facility.

2. Low density and fast-growing settlements: Braulio E. Dujali, Sto. Tomas and the Island Garden City of Samal.

   The municipality of Braulio E. Dujali is adjacent to Sto. Tomas, and as mentioned earlier, is the fastest growing municipality based on the 2007-2010 censuses. Maybe, one factor that contributed to the increase in its population is the existence of TADECO banana plantation located in Barangay Tanglaw. In like manner, the vast banana plantation in the municipality of Sto. Tomas definitely boosts the municipality's economic condition which is an avenue for population settlement in the area. Growth in the Island Garden City of Samal is attributed to the boom in its tourism industry as it offers pristine white beaches, good diving facilities and panoramic residential sites away from the hustle and bustle of city life.

3. Low density and slow-growing settlements: Carmen, Asuncion, New Corella, San Isidro, Kapalong, and Talaingod.

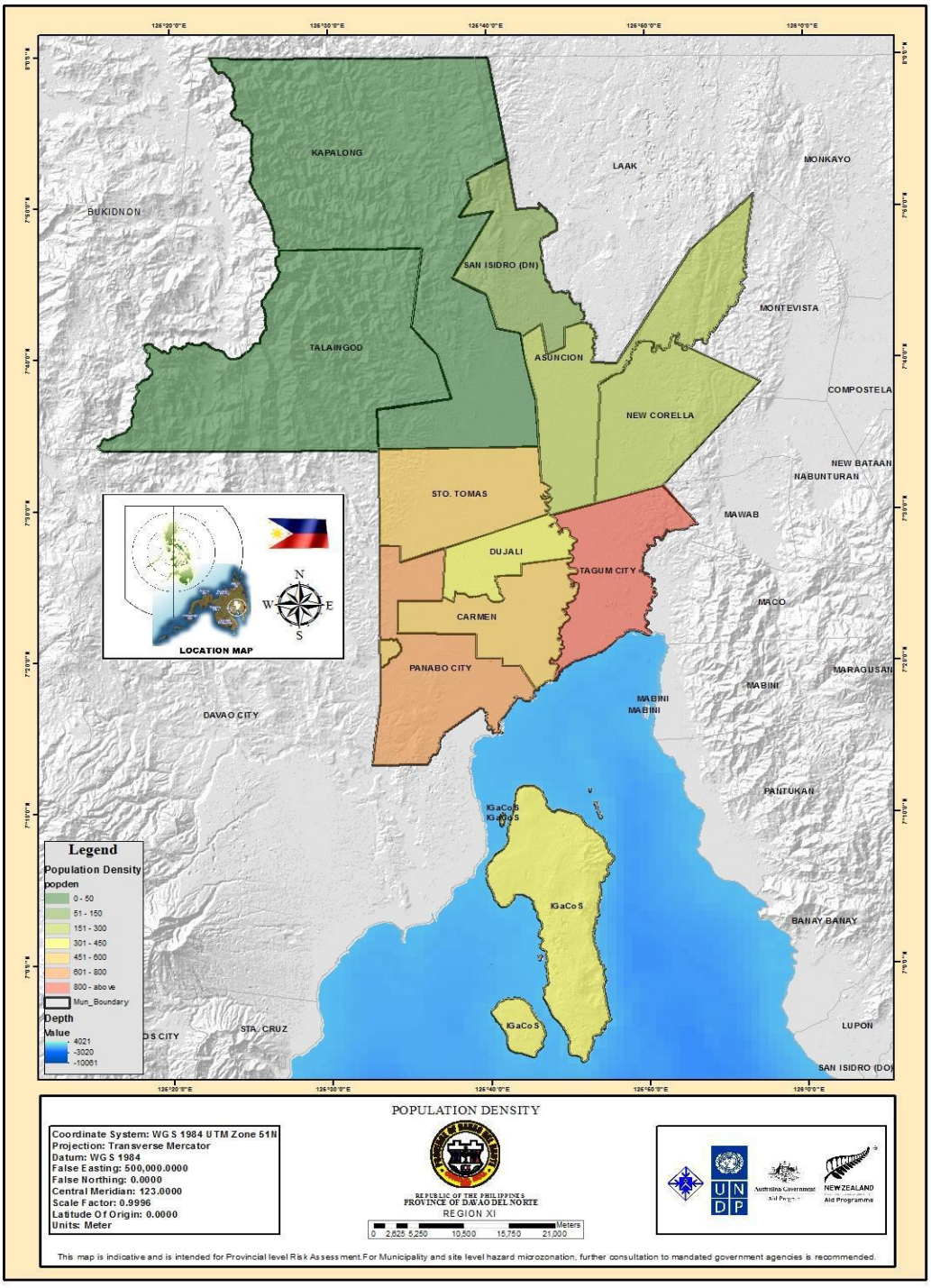
   The municipalities of Asuncion and New Corella as neighboring local government units (LGUs) provided agricultural products and services to its big brother, Tagum City. The newly created municipality of San Isidro also provided agricultural products and services being one of the members and nearest municipality in Tagum cluster.

   The municipality of Carmen located in the midway of two progressive cities of Tagum and Panabo provided services and likewise, covered by the influence area of Panabo City benefited from the economic activities of these cities.

   The municipalities of Kapalong and Talaingod considering its distance from the urban centers of Tagum city and Panabo City also provided agricultural products and support services to these big cities.

   These six municipalities of Davao del Norte contributed to the development of the province and further gave support to population growth.

Figure 6. 2010 Population Density Map, Davao del Norte



Source: GIS Division, PPDO

Table No. 6: Projected Population, by City/Municipality
Province of Davao del Norte, 2011-2022

LGU	2000	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Asuncion	46,910	55,844	57,828	58,845	59,880	60,933	62,005	63,095	64,205	65,334	66,483	67,652	68,842	70,052
BE Dujali	18,050	28,339	29,346	30,700	32,117	33,599	35,149	36,771	38,467	40,242	42,099	44,042	44,816	45,605
Carmen	55,144	69,199	71,658	73,304	74,987	76,709	78,470	80,272	82,116	84,001	85,930	87,903	89,449	91,022
Kapalong	57,966	68,261	70,687	71,852	73,036	74,240	75,464	76,707	77,972	79,257	80,563	81,891	83,331	84,797
New Corella	44,590	50,699	52,501	53,179	53,866	54,562	55,267	55,982	56,705	57,438	58,180	58,932	59,968	61,023
San Isidro	24,100	25,548	26,456	26,611	26,766	26,923	27,081	27,239	27,398	27,559	27,720	27,882	28,373	28,872
Sto. Tomas	84,367	109,269	113,152	116,117	119,159	122,281	125,485	128,773	132,147	135,609	139,162	142,808	145,320	147,875
Talaingod	16,594	25,566	26,474	27,644	28,865	30,140	31,471	32,861	34,313	35,828	37,411	39,063	39,750	40,449
IGCSamal	82,609	95,874	99,281	100,770	102,282	103,817	105,374	106,955	108,560	110,189	111,842	113,520	115,516	117,548
Panabo	133,950	174,364	180,560	185,384	190,338	195,423	200,644	206,005	211,510	217,161	222,963	228,920	232,946	237,043
Tagum City	179,531	242,801	251,429	259,135	267,078	275,263	283,700	292,396	301,357	310,594	320,114	329,925	335,727	341,631
Davao del Norte	743,811	945,764	979,372	1,003,541	1,028,374	1,053,890	1,080,111	1,107,056	1,134,749	1,163,212	1,192,467	1,222,539	1,244,039	1,265,916

Source: Provincial Planning and Development Office,2000 & 2010 are actual census data from NSO, 2011 to 2022 are projections

2.4 Socio-Economic

Land Use Opportunity/Potentials

Land use opportunity refers to lands that are composite with lands actively utilized for various activities and have properties favorable for economic development and investments. The socio-economic and physical limitations inherent in these lands can be manipulated and corrected through proper and sustainable management with favourable policies and incentives.

Land use opportunity is classified into six (6) sub-categories, namely: agricultural areas, expansion areas, areas needing rehabilitation, areas for preservation, wetland areas and miscellaneous areas. Map 30 shows the land use opportunity of the province.

The land use opportunity in Table 3-171 indicates that 126,390.78 hectares or 36.5 percent of the total provincial land area are best suited for agricultural activities.

Expansion areas or lands with potential for the expansion of both agriculture and urban areas cover about 95,859.98 hectares or 27.7 percent of the total land area of the province. These consist of grasslands or shrub lands with potential for built-up areas or agro-forestry development.

A total of 66,149.78 hectares or 19.1 percent of the total area of the province is considered rehabilitation areas. These include denuded areas within forestlands and critical watersheds; and those areas in the uplands that are used for crop cultivation that employs unsustainable farming practices.

Preservation areas are those which are to be permanently retained with forest cover. These are NIPAS areas and watersheds which should be protected from any intrusion or other economic activities. The province's preservation area covers about 54,477 hectares or 15.7 percent of its total area.

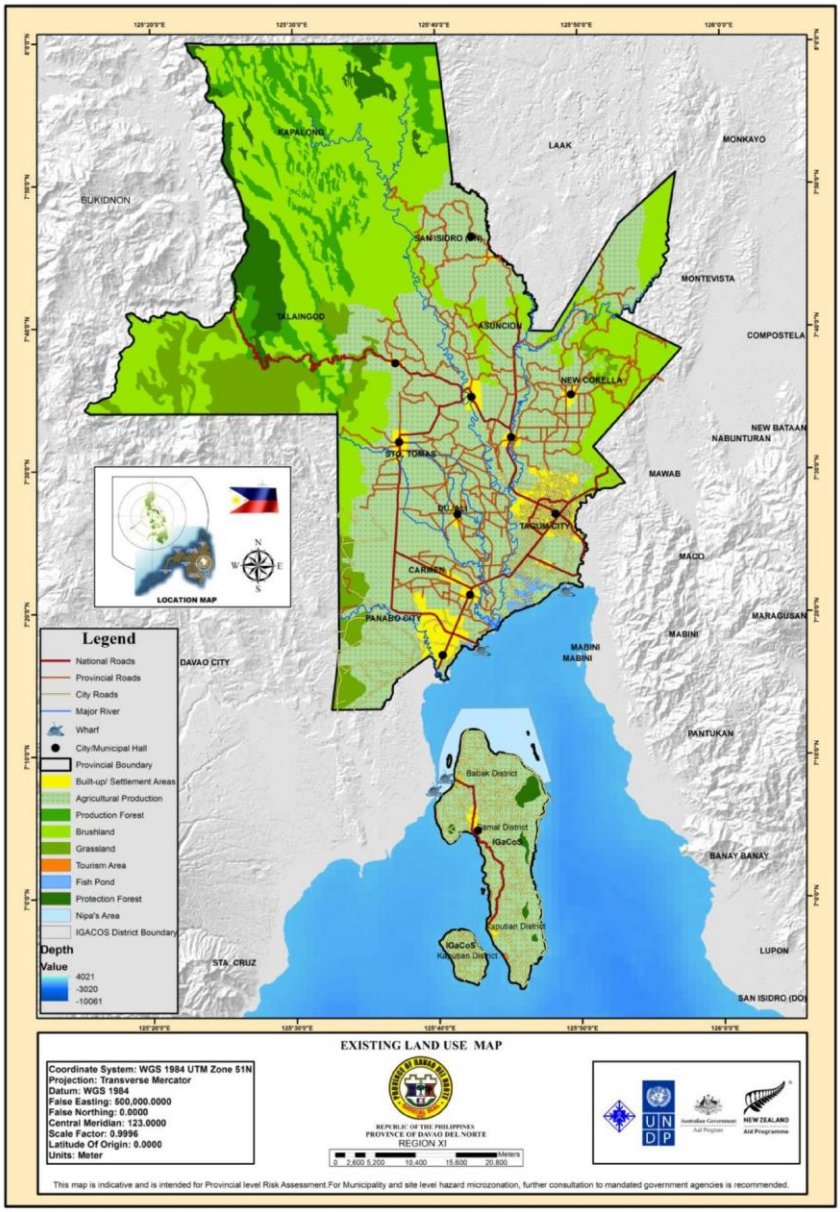
The remaining 3,237.18 hectares or 1.0 percent of the province's total land area are best suited for aquaculture and for miscellaneous activities.

Table No. 7 Distribution of Land Area by Land Use Opportunity Classification, Davao del Norte, 2007

Land Use Opportunity Classification	Area (in hectares)	% Distribution
Agricultural	126,390.78	36.5
Expansion	95,859.98	27.7
Rehabilitation	66,149.78	19.1
Preservation	54,642.28	15.7
Wetlands	1,332.50	0.4
Miscellaneous	1,904.68	0.6
Davao del Norte	346,280.00	100

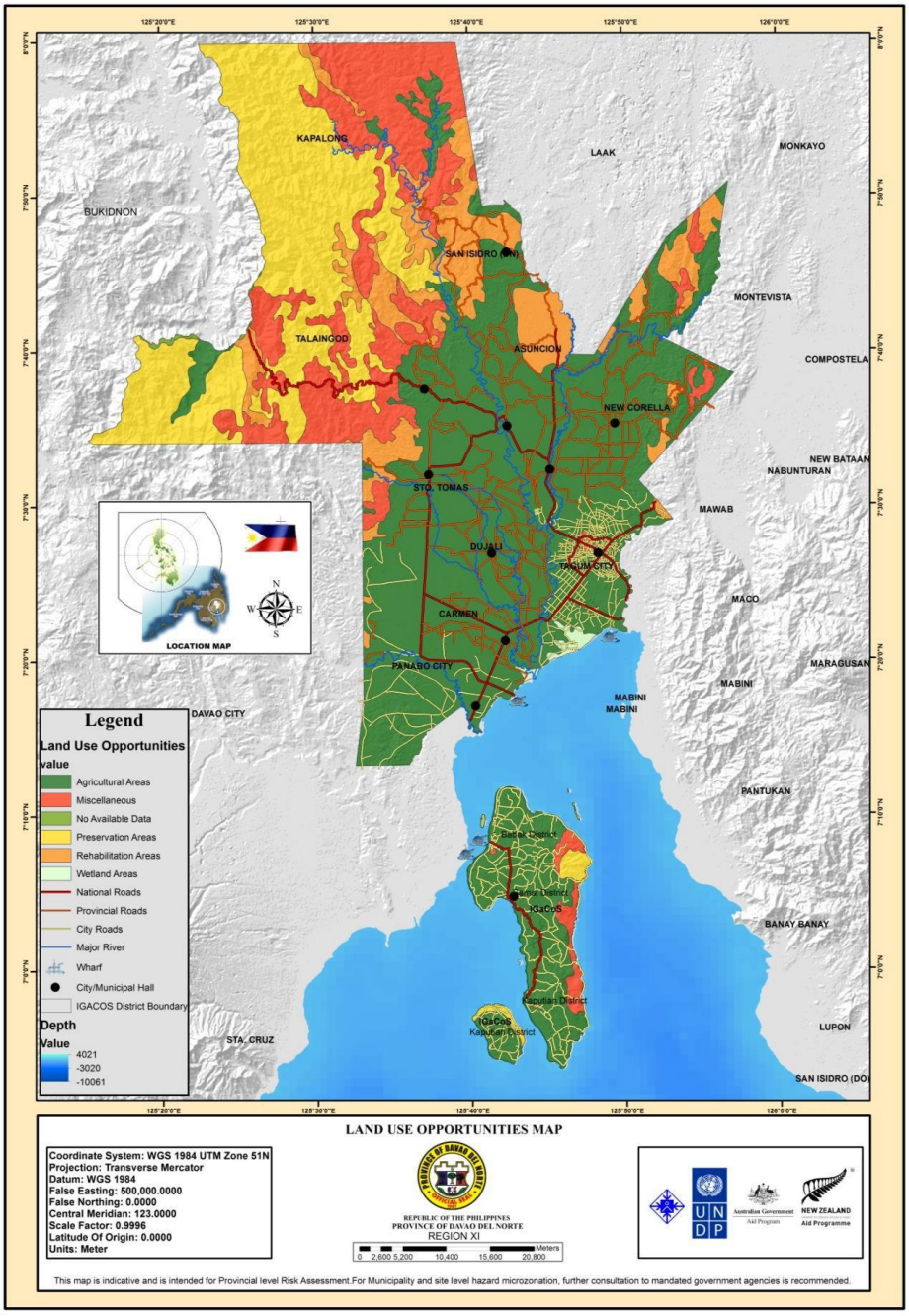
Source: BSWM-XI/RPFP

Figure No. 7 Existing Land Use Map
Province of Davao del Norte



Source: PDPFP, Davao del Norte

Figure No. 8 Land Use Opportunities Map
Province of Davao del Norte



Source: PDPFP, Davao del Norte

Land Classification

Davao del Norte has a total land area of 346,280[1] hectares, of which 192,459.52 hectares or 55.6 percent are classified as Alienable and Disposable (A&D) and 153,820.48 hectares or 44.4 percent as forestland. Land classification is based on the criteria set by law. All lands with an 18-degree slope and higher are considered forestland regardless of whether these lands have forest cover or not. Areas characterized with a slope of less than 18 degrees are classified as alienable and disposable.

Table No. 8 Area and Location of A&D Lands and Forestlands
Province of Davao del Norte

City/Municipality	Total Area (has.)	Alienable and Disposable (A&D)		Forestlands	
		Area (has.)	% Distribution	Area (has.)	% Distribution
Asuncion	27,347.00	18,924.12	69.2	8,422.88	30.8
B. E Dujali	9,100.00	9,100.00	100	0	0
Carmen	16,625.00	16,525.25	99.4	99.75	0.6
Kapalong	94,586.00	19,673.89	20.8	74,912.11	79.2
New Corella	30,822.00	24,657.60	80.0	6,164.40	20.0
San Isidro	15,249.00	4,788.19	31.4	10,460.81	68.6
Sto. Tomas	32,041.00	26,658.11	83.2	5,382.89	16.8
Talaingod	45,496.00	2,274.80	5.0	43,221.20	95.0
IGC of Samal	28,071.00	25,572.68	91.1	2,498.32	8.9
Panabo City	25,363.00	24,881.10	98.1	481.90	1.9
Tagum City	19,580.00	19,403.78	99.1	176.22	0.9
Total	346,280.00	192,459.52	***55.6***	153,820.48	***44.4***

Note:GIS computation based on the Land Classification Map from DENR-XI, land area not authoritative, for planning purposes only, includes area for mangrove forest.
Source: DENR XI

2.5 Planning Context

The existing Vision of the province was assessed using the Vision-Reality Gap Analysis. It is a tool that measure the performance of every sector or departments in terms of its contribution to the attainment of the key element of the Vision, vis-a- vis the current situation. The analysis revealed that although, the provincial government is on track in achieving its desired state, much is still to be done in terms of its full attainment. As a result, an enhanced Vision that is more responsive and significant to the current reality was formulated.

The provincial government takes full cognizance of two major factors that it must be wary of: one is the climate change adaptation and disaster risk reduction and management; the other is the ASEAN Free Trade Act or (AFTA) which will take effect in 2015. Both require the province to be resilient. Thus, global competitiveness and climate change adaptation and risk resiliency are among the key elements of the enhanced Vision of Davao del Norte.

VISION

A premier province in producing export quality agricultural products that are globally competitive with climate change adaptive and risk-resilient communities, social equity, improved quality of life under a transparent and responsive governance.

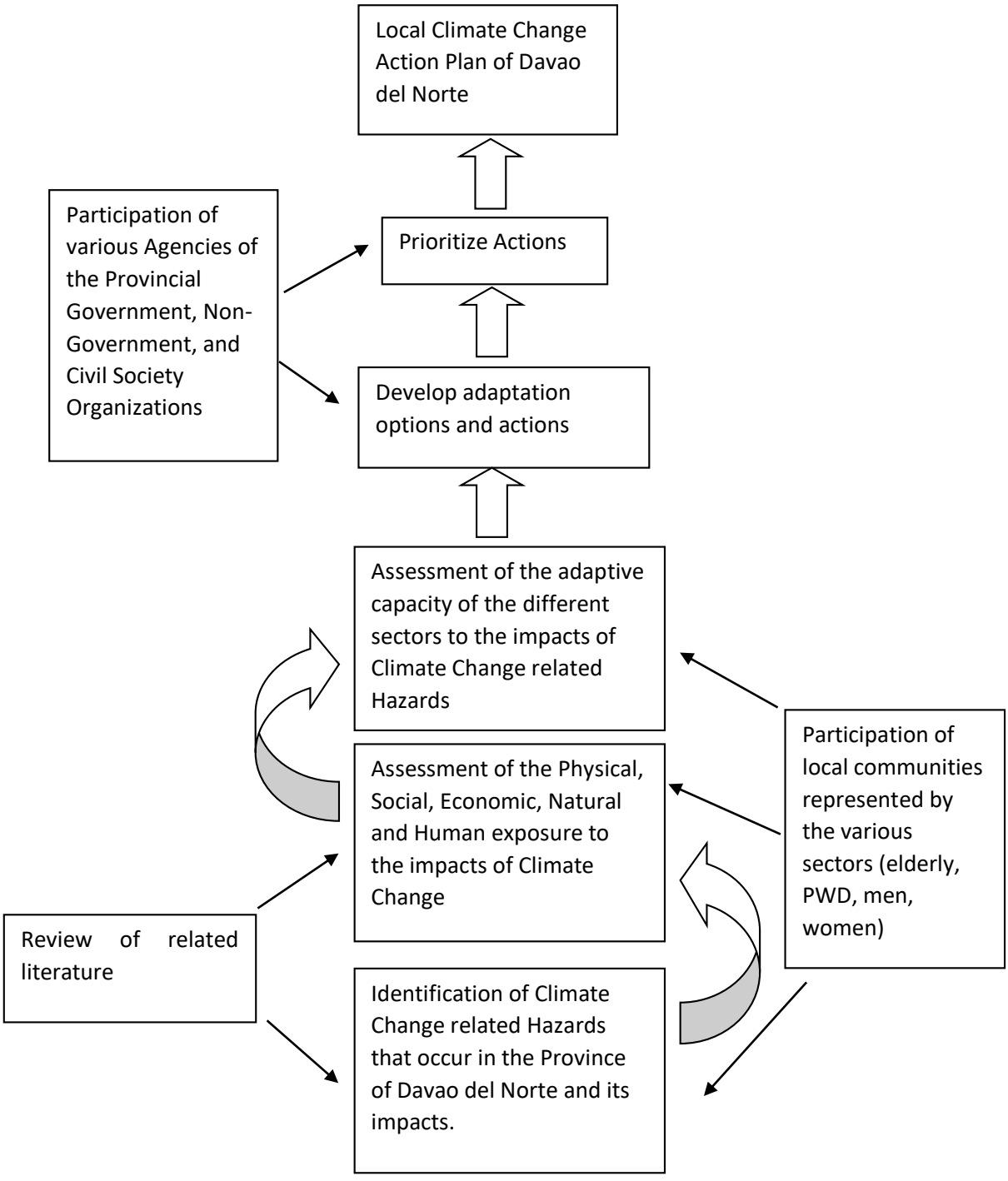
MISSION

We the officials and employees of the provincial government of davao del norte, commit ourselves to uplift the quality of life for all dabaonons through: transparent, effective and gender responsive governance; adopting a science-based policy in agriculture, climate change adaptation and disaster risk reduction and management; providing adequate facilities and services; and providing avenues for people's participation.

Thus, ensuring sustainable development.

Planning Approach

This plan looked at the exposure, sensitivity and adaptive capacity of Davao del Norte communities. It utilized as references data from secondary sources like the CCA-DRR Plan, KALASAG 2016, Tagum Libuganon River Basin Master Plan, minutes of PDRR Council meetings and PAGASA advisories. It also used the data and relevant information from the OPLAN Advocacy on Natural Disaster Awareness Management (A.N.D.A.M.) workshops, which ensured holistic participation of different stakeholders from the barangay, municipal, and provincial levels. The information extracted from the ground formed the basis of the proposed solutions in the plan. The Planning Framework of the Provincial Government of Davao del Norte in the formulation of Local Climate Change Action Plan pursues the following:



Chapter III: SITUATIONAL ANALYSIS & VULNERABILITY ASSESSMENT

3.1 Climate-related Hazards (Inventory)

Provincial Physiographic Characteristics

Davao del Norte's physiographic characteristics made it naturally susceptible to hazards, and these characteristics are identified as follows;

a. Flood Prone Areas (Flooding-induced by increase precipitation)

Ten (10) of the eleven cities/municipalities of Davao del Norte are prone to flooding of various susceptibilities. Only the Island Garden City of Samal is not prone to flooding as assessed with different susceptibility indexes. In the mainland, the most frequently affected by this phenomenon are those areas along the major river systems of the Tagum-Libuganon river, Lasang river, Tuganay and Saug rivers. The classified susceptibility indexes are as follows:

a. Areas with very high susceptibility to flooding of 9,605.48 hectares
b. Areas with high susceptibility to flooding of 30,227.65 hectare
c. Areas with moderate susceptibility to flooding of 19,324.95 hectares, and
d. Areas with low susceptibility to flooding of 21,531.45 hectares

Flooding problems need both the short term and long term control measures. Construction of protection dikes, cut-off channels, cross drainage along highways and de-siltation of rivers are among the immediate solutions. Since denudation of the vegetative cover has been identified as the major contributory factor to flooding, reforestation and watershed rehabilitation programs should be undertaken as a long term activities.

b. Soil slope and erosion (Rain-Induced Landslides)

Soil erosion and landslides are caused by different factors which include vegetative cover, topography, drainage, amount and frequency of rainfall and inappropriate human practices. Erosion and rain-induced landslides are often aggravated by slope situations. The steeper the slope- coupled with inappropriate human activities, the higher the degree of erosion and landslide occurrences. Areas susceptible to severe erosion need to be protected from further deterioration. These areas are observable mostly in the mountainous part of Kapalong, Talaingod and Sto. Tomas and in the Island Garden City of Samal. Areas susceptible to severe erosion is approximately 147,477.50 hectares while varying susceptibilities of rain induced landslides affect 262,402 hectares of the province.

c. Geologic Fault Lines (Earthquake-induced landslides, Earthquake-soil liquefaction and Groundshaking)

Two major active fault lines traverse Davao del Norte. The first extends from the municipalities of Mati, Davao Oriental to New Corella, Davao del Norte. The second major fault line is located between the City of Tagum, Davao del Norte and Laak, Compostela Valley.

Fault line is one natural hazard where lateral or vertical displacement (movement) is likely to occur. Episodic movements along this “active” fault lines cause earthquakes with accompanying destruction of property and may be loss of life.

The geohazard mapping conducted by the Mines and Geosciences Bureau-XI revealed that several barangays in Davao del Norte are susceptible to mass movements. The areas that are prone to hazard includes 7 barangays in Asuncion, 12 barangays in New Corella, 7 barangays in Sto. Tomas, 3 barangays in Talaingod, 4 barangays in San Isidro and 5 barangays in the Island Garden City of Samal.

Earthquakes and/or ground shaking is produced during seismic earth movements as results of the presence of fault lines. Earth quakes may induce ground shaking and landslides. All of the eleven municipalities and cities are, to some extent, prone to ground shaking (183,466 hectares). Around 100,605 hectares are also prone to earthquake-induced landslides.

Since earthquakes are natural phenomena, the people of Davao del Norte, especially those living in high risk areas need to be always prepared in case of its occurrence. There is a need to strengthen disaster and risk management programs and activities by strengthening IEC initiatives and formulation of disaster risk management plan.

Local building officials must ensure that all existing building and those to be constructed should strictly conform to building standards particularly in high risk areas.

d. Storm Surge

Storm surge is a rise in sea level that occurs during tropical cyclones, intense storms also known as typhoons or hurricanes. The storm produces strong winds that push the water into shore, which can lead to flooding. This makes the storm surge very dangerous for coastal areas.

In general storm surge occurs where winds are blowing onshore. The highest surge tends to occur “near the radius of maximum winds,” or where the strongest winds of the typhoon occur.

There are no reported storm surge occurrences in Davao del Norte. However, to determine the effect of the storm surge and the extent of flooding if so ever it occurs in the province, a simulation using the worst case scenario (5 meter surge) is done through GIS.

e. Other Characteristics/Elements

El Niño due to increase in temperature
It was in 1998 that Davao del Norte suffered major damages due to El Nino. In 2015 to 2016 the province was included as one of the provinces hit by dry spell in fact in the middle of 2016, a State of Calamity was declared to support agricultural

Sea Level Rise
There are no available data for the extent of sea level rise in the coastal areas, but local folks signified that sea water was quiet far from their residences before but now adays it is just a few meters away.

Typhoons Occurred in the Province
Prior to Typhoon Pablo in 2012, Davao del Norte was usually declared as typhoon free. However, being one of the areas hit by Typhoon Pablo and followed by other weather disturbances, a typhoon free province is no longer valid.

Vector and Water borne Diseases
As reflected in the available information (Table No. 9), epidemic such as dengue and diarrhea had been reported in some areas of the province.

Climate-related Hazard Profile

During the workshop conducted by the TWG with the frontline PDRRMC agencies, CSOs, the Local Disaster Risk Reduction and Management Councils and Officers of the component cities and municipalities, flooding has been identified as the most frequent and high risk hazard experienced by Davao del Norte. It is followed by landslides.

Table No 9. Hazard Profile and Assessment, Province of Davao del Norte

Type of Hazard	Frequency of Occurrence			Extent of Damage		
Natural Hazards:	H	M	L	H	M	L
Flooding - River flooding - Flash floods - Urban flooding - Sheet flooding	H			H		
Typhoon (Agaton, Crising, Zoraida, Pablo)		M		H		
Landslide (rain induced/earthquake induced)	H				M	
Localized Freak Tornado		M			M	
Tail-end of Cold Front		M			M	
Inter Tropical Convergence Zone (ITCZ)		M			M	
Low Pressure Area		M			M	
Earthquake			L			L
Human –Induced Hazards						
Armed Conflict (social unrest)			L	H		
Fire			L			L
Epidemic-dengue/diarrhea			L			L
Crop infestations	H			H		

The level of risks on the likelihood to occur of the identified hazards were categorized as HIGH which means there is high probability of occurrence; MEDIUM means occasional and seldom to happen and LOW with low probability of occurrence or improbable-less likely to occur.

The extent of damage or the level of risks on the impacts of hazards was also categorized as HIGH which means high impact with major damages and also high severity which is catastrophic and critical. MEDIUM means with medium impact and moderate damage. LOW means with low impact and minor damage.

3.2 Elements and Sectors Exposed to Climate-related Hazards (Impacts)

a. Flooding

Induced by increase in precipitation

Davao del Norte's physiographic characteristics made it naturally susceptible to floods and flash floods. The province has generally a low land terrain comprising 35.1 percent of the total land area with slope of 0-3%. Fifteen (15) rivers and several creeks traverse the province. The bigger rivers such as the Lasang, Tagum/Libuganon, Saug and Tuganay drain the broad plain west and north into Davao Gulf. Tagum/Libuganon River with a total length of 95 kilometers is the longest among the major rivers in the province and has a total watershed area of 247,500 hectares. It is one of the 18 major river basins in the country. It originates from the eastern hillside of the Mindanao Central Cordillera and flows to the central alluvial plain, and then extends to Davao Gulf.

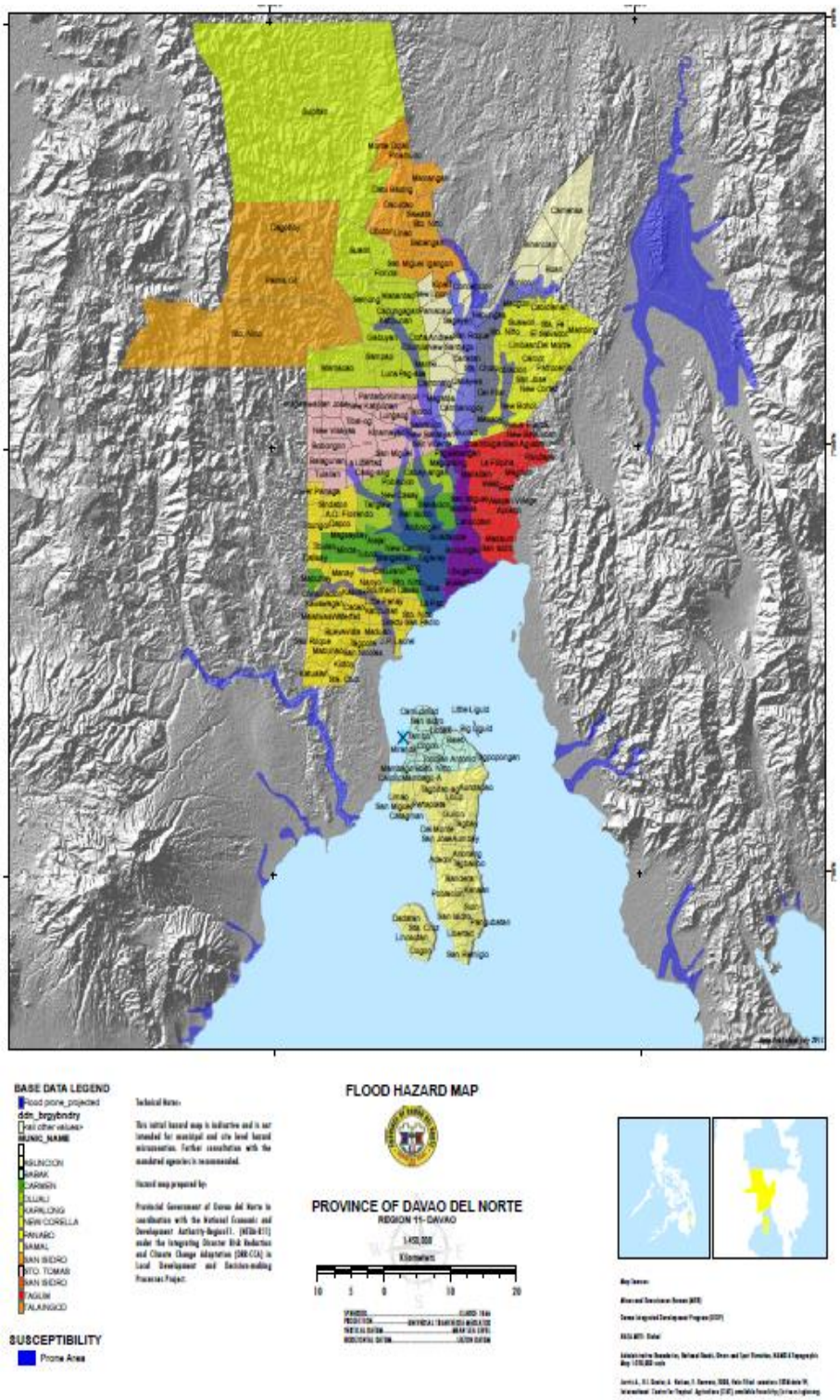
Alluvial plains of Davao del Norte are mostly affected by flooding due to its low physiography and the inability of the nearby rivers to cope with high flood discharge due to heavy siltation of the rivers and other waterways, thereby limiting the physical and economic productivity of the land. About 360 square kilometers or 11.20 percent of the total provincial lands are prone to flooding. The municipalities of Carmen, Asuncion, B.E. Dujali, Kapalong and New Corella, and the City of Tagum are among the LGUs with a large area prone to flooding (Table 6). Floods (river flooding, dike overflows, sheet flooding and urban flooding) and flashflood incidence in the past has become a challenge to the resiliency of the Dabaonons.

Table No 10. City/Municipality Prone to Flooding, Davao del Norte

City/Municipality	No. of Barangays	Area (SQ. KM.)
Asuncion	16	72.705
B.E. Dujali	4	31.771
Carmen	17	76.885
Kapalong	6	18.81
New Corella	12	50.165
San Isidro	3	4.701
Sto. Tomas	11	25.92
Panabo City	18	19.198
Tagum City	10	64.439
Davao del Norte	97	354.594

Note: Data from GIS generated map of MGB, PPDO, Davao del Norte

Figure No. 9 Flood Hazard Map, Davao del Norte



Note: Area generated thru GIS from the MGB Map, PPDO, Davao del Norte

Flood Occurrence

The recurrence of floods almost every year in the province reveals its vulnerability to the hazard based on the flooding events recorded from year 2006 to 2014. The municipalities of Carmen, B.E. Dujali, Asuncion, New Corella, Kapalong and the City of Tagum are mostly affected by flood occurrences. The lowland areas of these municipalities form the greater plain area and the central part of the province. Flood events usually occur in the 1st and the last quarter of the year. Population displacement usually happened during flooding. Agricultural lands, crops, livestock and infrastructure were also destroyed or damaged every time flooding occurs.

In December 4, 2012, typhoon Pablo hit Davao del Norte and caused massive destruction in the province and its neighboring provinces of Compostela Valley and Davao Oriental. A 25 mm per hour rainfall was recorded in the Automatic Weather Systems installed at the PDRRMC Operations Center in the Provincial Capitol at the height of the typhoon. The recorded rainfall intensity was more than enough to submerge most areas of Davao del Norte, particularly the flood prone areas and those areas lying along the major river courses of Libuganon, Saug, Tuganay and Hijo rivers.

There was widespread destruction in the province due to strong winds brought by the typhoon and the flooding in low lying areas due to high intensity rainfall. Roads were damaged due to scouring caused by floods and run-offs. Some bridges were also damaged due to scouring of embankments and abutments caused by debris carried by strong water currents in swelling river courses. Major river courses swelled during the typhoon. Libuganon, Saug, Tuganay, and Hijo rivers exceeded their carrying capacities due to intense rainfall spawned by the storm. In effect, many areas were inundated affecting farmlands and built-up areas. Many houses, schools and other infrastructures were damaged due to strong winds. Number of families were evacuated because their houses were damaged and severely flooded.

Typhoon Pablo brought massive damages and destruction in the agriculture industry in Davao del Norte, particularly the Cavendish banana industry. The industry propelled the economy of the province, contributing more than 60% of provincial income and provides livelihood to a lot of families. Damages to the industry valued at Php 2.62 Billion contributed to the reduction of the income of the province. Around 13,600 Cavendish banana workers were greatly affected by losing at least Php 300.00 per day for four to nine months. In an unabated condition, affected populace clamored for government assistance and subsidies, and a number of them were added to the recipients to the 4Ps program of the government.

The damages to roads and bridges greatly affected the delivery of goods and services to areas served by the networks. It stagnated development and

caused inconveniences and artificial shortages of basic goods in the area affected.

Overlaying the administrative map and the flood prone map, there are a total of 181,971 persons in the province that are highly exposed to flood which is 20 percent of the total population. In terms of the most exposed populations, Tagum City with 80,666 population rank first among the local government units. But in terms of the percentage of population that is exposed to hazard, the municipality of Carmen has the highest percentage with 46 percent. B.E Dujali ranks second with 35 percent.

Table No. 11 Population Exposed to Flood, by City/Municipality
Davao del Norte

City/ Municipality	Total Population	Population Exposure within the Flood Prone Areas	Population Exposure Percentage within Flood Prone Areas
Asuncion	55,844	14,500	25%
B.E. Dujali	28,339	10,223	35%
Carmen	69,199	31,881	46%
Kapalong	68,261	3,482	2%
New Corella	50,699	11,083	21%
San Isidro	25,548	714	2%
Sto. Tomas	109,269	13,134	12%
Talaingod	25,566	0	0
Island Garden City of Samal	95,874	0	0
Panabo City	174,364	16,288	9%
Tagum City	242,801	80,666	33%
Davao del Norte	**945,764**	**181,971**	**20%**

Source: PPDO, Davao del Norte

In terms of agriculture area, 20 percent or 30,687 hectares of the 150,836 hectares agricultural lands are exposed to flooding.

Table No. 12 Agricultural Areas Exposed to Flood by City/Municipality
Davao del Norte

City/Municipality	Total Agricultural Area (Has.)	Exposed Agricultural Area	Exposure percentage
Asuncion	18,060	5,539.07	31%
BE Dujali	8,584	3,177.15	37%
Carmen	14,780	6,908.99	46%
IGaCoS	25,600	-	-
Kapalong	14,930	1,488.65	10%
New Corella	9,597	4,013.24	42%
Panabo City	16,140	1,840.59	11%
San Isidro	12,470	469.54	4%
Sto. Tomas	16,000	2,592.03	16%
Tagum City	10,360	4,658.54	45%
Talaingod	4,315	-	-
TOTAL	150,836	30,687.79	20%

Source: PPDO, Davao del Norte

Out of the 14,298 hectares built-up areas, 2,851 hectares or 19 per cent are exposed to flooding. The Municipality of New Corella has the highest percentage followed by the Municipality of Carmen.

Table No. 13 Built-up Areas Exposed to Flood by City/Municipality Davao del Norte

City/Municipality	Total Built-up Area (Has.)	Exposed Built-up area within flood prone (Has.)	% Exposed within flood prone
Asuncion	390.30	193.60	50.00
BE Dujali	278.72	0	0.00
Carmen	905.81	541.26	60.00
IGaCoS	952.36	0	0.00
Kapalong	785.46	392.36	50.00
New Corella	342.56	309.51	90.00
Panabo City	3,709.20	740.77	20.00
San Isidro	135.03	0	0.00
Sto. Tomas	705.61	0	0.00
Tagum City	5,945.14	673.49	11.00
Talaingod	148.28	0	0.00
TOTAL	14,298.47	2,851.00	19.00

Source: PPDO, Davao del Norte

Based on the destruction of properties and its effects on the victims and their families, flooding proved to be the number one on the list of disasters in the Province. A rundown of flood and flashflood occurrences that have affected the province in the past is presented in Table No.14.

Table No. 14. Flooding Incidents by Year 2006-2014
Davao del Norte

Year	Month	No. of Affected Municipalities/ Cities	No. of Affected Barangays	No. of Families Affected	Agri. Area affected (has.)	Damage crops (est. Cost) (in million pesos)	Damage Livestock (est. Cost) (in million pesos)	Damage Fishery (est. Cost) (in million pesos)	Damage Infra (est. Cost) (in million pesos)
2006		3	19	8,159		6.655			17.430
2007		7	63	24,562		82.210	0.185	63.505	52.316
2008		4	32	6,777		19.891	0.150	0.650	24.008
2009		7	74	19,343		66.241	0.188	6.819	60.050
2010		3	5	82		0.035			
2011									
	Dec 26-29	7	63	14,689		115.594			8.956
2012									
	Dec 4	11	106	42,413	23,160.03	2,808.610	0.547	0.900	768.269
	Nov 23-27	5	32	5,111		57.525			0.681
	Nov 21-23	6	23	5,349		88.235			0.980
2013									
	Nov 11-15	8	41	7,575		22.145			4.022
	June 6-18	1	2	167		2.861			5.100
	Feb 20	2	16	11,707		108.060			14.875
	Jan 18-23	7	80	57,538		400.417			85.760
2014									
	Jan 9-25	7	63	9,334		144.697			39.503
	Feb 19-21	5	48	13,045		128.065			14.470
	Apr 17	1	10						
	July 1	1	3	231	93				

Source: Provincial Disaster Risk Reduction and Management Division, Davao del Norte

b. Landslides

Landslides (or mass movements) are downward and outward movement of materials, including rock and soil due to various causes such as excessive rain, earthquake, volcanic eruption, rapid undercutting by rivers, waves or man's activities. Areas prone to landslides typically include old landslide deposits along, near or beneath steep slopes and down slope of streams and creeks; thick soil or fractured rocks; those along or on top of cut slopes; and developed steep slopes with no appropriate drainage. Human activities sometimes contribute to the susceptibility of the area to landslides. Building structures around or on top of slopes, pipe leakages, septic system and irrigation discharges, and vibrations from machinery and from blasting can increase pressure and weaken the soil.

DENR-MGB has set four possible levels of susceptibility to landslides (Table 11). Each level was defined based on characteristics of slope, cracks, and recent landslide activities. Even without the benefit of a map, one can still identify active landslide areas by looking for cracks or scars, surface

depressions, disturbance of the drainage patterns; hummocky topography; and ear-lobe like bulges near base of slopes.

Table No. 15 Landslide Susceptibility Levels

Susceptibility Levels	Description
High Susceptibility	Presence or active/recent landslides Large tension cracks that would affect the community Areas with drainages that are prone to landslide damming Steep slopes (21%-55%gradient)
Moderate Susceptibility	Areas with inactive and old landslides Small tension cracks are located away from community Moderately steep slopes (15%-30%) Small, shallow landslides (<1.0 vertical displacement)
Low Susceptibility	Gently sloping to sloping Absence of tension cracks Flat terrain (5%-15%)
Possible Landslide Debris Accumulation Zone	Areas to be likely affected by transported landslide materials

Source: PPDO, Davao del Norte

Rugged, mountainous and moderately to steeply sloping areas on the western part and a wide alluvial plain on the central lowland generally characterize the topography of the province. Majority of the area of the province (27.70%) are with a slope ranging from 30-50%. This topographic characteristics of the province, made it highly vulnerable to hazard such as landslides. This is aggravated by the deteriorating condition of the upland areas due to forest degradation brought about by illegal logging activities in the past and unsustainable farming practices.

The GIS generated Rain-Induced Landslide Map from the MGB shows the areas susceptible to the hazard. Based from GIS generated map, 33 barangays in 6 municipalities and 1 city have areas with high susceptibility to rain-induced landslides. These barangays are located in areas with high elevation and steep slopes.

These 33 barangays represents 14.7 percent of the total barangay of the province. Among the municipalities, Kapalong have the widest area which are high susceptible to landslide at 564.349 sq. km., followed by Talaingod with 349.149 sq. km. Majority of the area of these two municipalities are classified as forestland, with 91.4 percent for Talaingod and 81.4 for Kapalong. Please refer to Table No. 16.

Data from the PDRRMC indicate that the province has experienced landslide though in a relatively small magnitude from 2008 to 2014. Fortunately, no damages on person and properties were reported but agricultural crops were affected including accessibility of the areas.

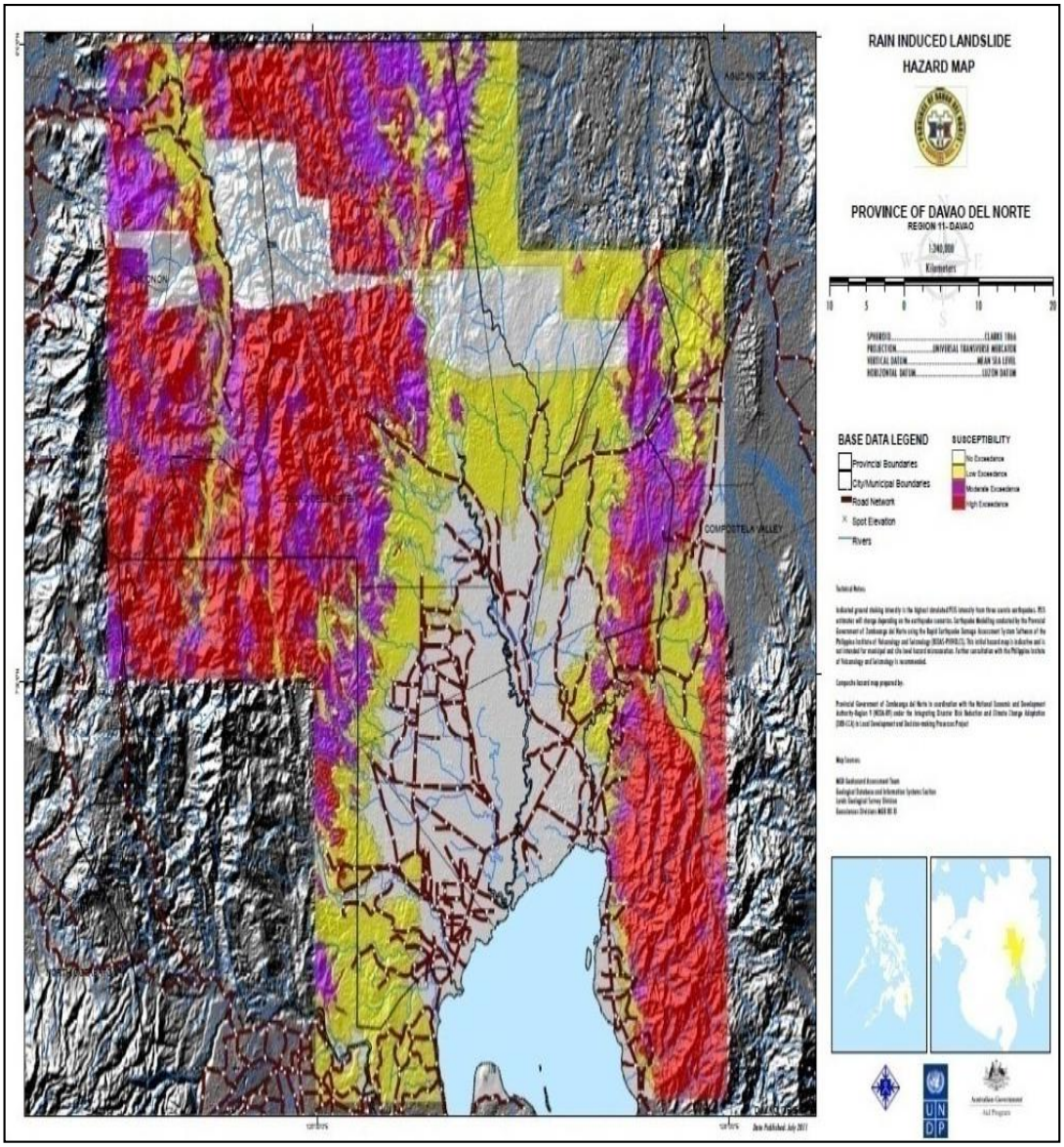
Table No. 16 Rain Induced Landslide by City/Municipality Susceptibility Level, Davao del Norte

City/Municipality	Susceptibility in Sq. km.		
	High	Moderate	Low
Tagum City	0.56	8.439	33.091
Asuncion	12.968	39.467	124.33
New Corella	29.08	42.984	92.568
Kapalong	564.349	249.056	236.711
San Isidro	10.176	9.123	60.383
Talaingod	349.149	67.366	27.806
Sto. Tomas	1.126	21.867	70.859
Panabo City		1.027	116.05
Carmen			5.589
Davao del Norte	**967.378**	**439.329**	**1,529.185**

Source: PPDO, Davao del Norte,

Note: GIS generated data based on the MGB map

Figure No. 10 Rain-Induced Landslide Hazard Map



Source: PPDO, Davao del Norte

Table No. 17 Agricultural Areas Exposed to Rain Induced Landslide by City/Municipality, Davao del Norte

LGU	Total Municipal Agricultural Area	Exposed Agricultural Area within HSA	Exposed Agricultural Area within MSA	Exposed Agricultural Area within LSA	Exposure percentage w/in HAS	Exposure percentage w/in MSA	Exposure percentage w/in LSA
Asuncion	18,058.09	865.26	2,051.45	5,120.01	.04%	.11%	28.3%
BE Dujali	8,584.169	-	-				
Carmen	14,775.6	-	-	23.82			1.6%
IGaCoS	25,598.35	-	-	-			
Kapalong	14,937.3	207.46	445.01	7,927.58	01%	02%	53.07%
New Corella	9,616.434	-	30.20	4,359.91		3.14%	45.33
Panabo City	16,138.56	-	-	7,425.76			46.01%
San Isidro	12,474.51	224.43	-	4,806.98	01%		38.53%
Sto. Tomas	16,002.6	5.99	0.26	3,892.64	3.74%	1.5%	24.32%
Tagum City	10,358.97		312.16	865.19		3%	8.35%
Talaingod	4,315.339	122.69	1,213.43	1,818.01	02%	28%	42.12
TOTAL	**150,836**	**1,425.83**	**4,052.52**	**36,239.92**	**9.45%**	**2.68%**	**24.02%**

Source: PPDO, Davao del Norte
Note: GIS generated data based on the existing land use map

Out of the 150,836 hectares agricultural areas, 1,425 hectares or 9.45% are classified as highly susceptible areas to rain-induced landslides mostly in the municipalities of Asuncion, Kapalong, San Isidro, Sto. Tomas and Talaingod.

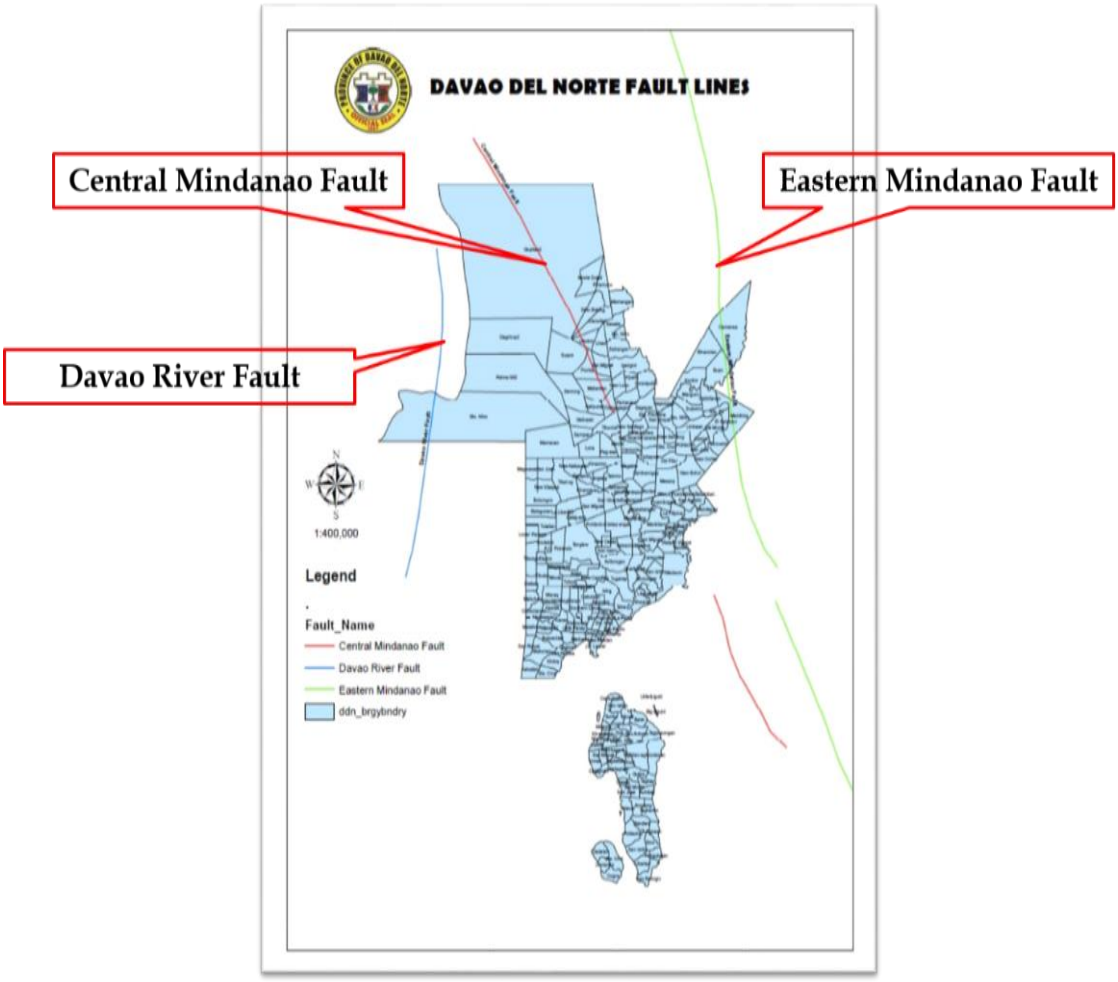
c. Earthquakes

Earthquake and Earthquake-Induced Hazards

The Philippines being in the Pacific ring of fire is vulnerable to earthquake and earthquake-induced hazards. Ground shaking, earthquake-induced landslide and liquefaction are among the earthquake-induced hazard that has high probability of occurrence in Davao del Norte. Aside from these natural hazards, there are also man-made hazards such as water pollution, rock bursts, waste disposal, carbon emission, and global warming that complements the natural hazards and pose a threat to the province. An Earthquake is caused by the constant motion of the earth's surface. This motion creates buildup and releases energy stored in rocks at and near the earth surface. Earthquakes are the sudden, rapid shaking of the earth as this energy is released.

Faults are fractures in the earth's surface where rock movement has taken place and earthquakes produced. Episodic movements along this "active" fault lines cause earthquakes with accompanying destruction of property and may be loss of life. Active faults that traverse the province of Davao del Norte are Eastern Mindanao Fault, the Central Mindanao Fault and Davao River Fault. Eastern Mindanao Fault or the Mati Fault which emanates from the province of Davao Oriental passes through Compostela Valley and the province of Davao del Norte. It crosses through the municipalities of New Corella and Asuncion. The Central Mindanao Fault Line on the other hand, negotiates from the Davao Gulf and passes through the City of Tagum all the way to the north-western portion of the province (Figure No.11).

Figure No. 11. Davao del Norte Fault Lines



Source: PPDO, Davao del Norte

Very destructive earthquakes occur from fault movements occurring at less than 30 kms. Tsunamis are oftentimes generated if strong shallow earthquake occur under the sea and displace parts of the seabed. Earthquake strength is measured in terms of either the magnitude or intensity. Magnitude measures

the total energy released at the earthquake's point of origin (below the earth's surface) based on the information derived from a seismograph.

Table No. 18. Earthquake Magnitude and Description

Magnitude	Description
1	Not felt. Detected only by seismographs under favorable condition
2	Hardly perceptible. Detected by seismographs
3	"Very feeble". Felt only near the epicenter
4	"Feeble". Generally felt. But doesn't usually cause any damage
5	"Moderate" earthquakes. May cause local damages
6	"Strong" earthquakes. Usually cause local damages
7	"Major" earthquakes. Causes considerable, widespread damages. Maybe accompanied by surface fault rupture and tsunami
8	"Great" earthquakes. Potentially devastating
9	Rare earthquakes. Only five recorded since 1900

Source: PPDO, Davao del Norte

Earthquake Occurrences

History of earthquake occurrences dates back as early as the 18th century. Data generated from PHILVOCS indicates that in the 20th century, Davao del Norte had experience earthquakes of different magnitude ranging from 4.6 to 6.5.

The strongest earthquake that the province had experience was in 1878 with magnitude of 6.5. The latest record was in February 2014 with a 2.5 magnitude. However, no data on the possible damage to lives and properties were obtained. The potential sources of these earthquakes are the three major fault lines that traverse the province namely: Davao River Fault, Eastern Mindanao Fault and the Central Mindanao Fault. Historical data on earthquake occurrence is presented in Table 19.

Figure No. 12. Historical Data on Earthquake Occurrence

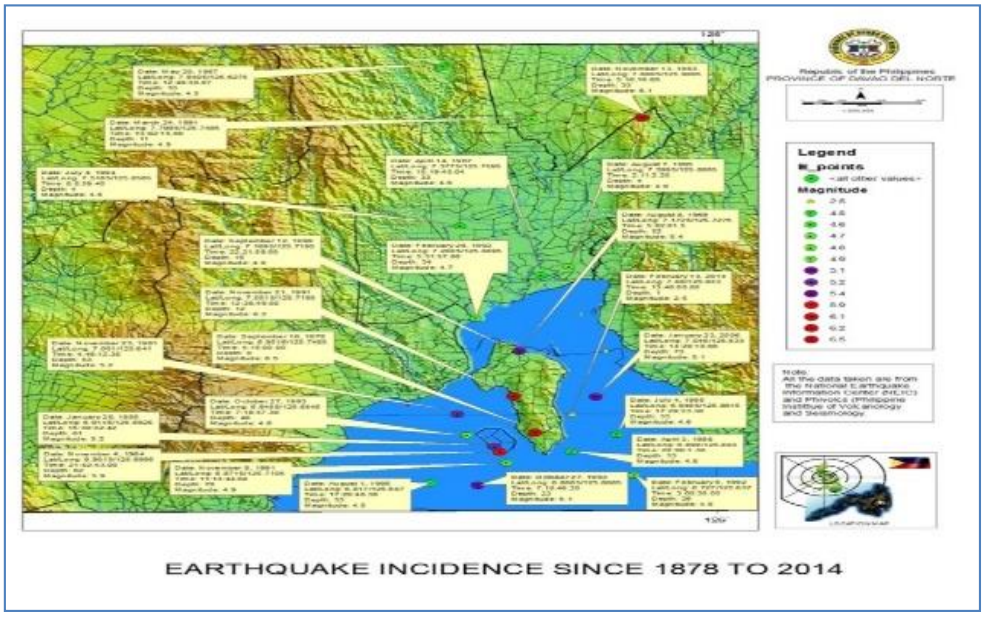


Table No. 19 Historical Data on Earthquake Occurrence

Year	Month	Time	Depth	Magnitude
1878	Sept 16	15:00.0	0	6.5
1963	Nov 13	16:16.6	33	6.1
1964	Nov 4	02:43.0	62	5.9
1969	Aug 8	02:01.5	52	5.4
1981	Nov 23	46:13.3	53	5.2
1985	Jan 28	30:32.4	61	5.2
1987	April 14	19:45.0	33	4.6
1987	May 20	48:36.1	33	4.5
1990	Sept 12	21:59.0	15	4.9
1991	March 24	02:15.0	11	4.9
1991	Nov 8	13:44.6	70	4.9
1991	Nov 21	38:49.0	12	6.2
1992	Feb 6	00:30.1	26	4.9
1992	Feb 26	31:57.8	34	4.7
1993	Oct 27	18:46.2	23	5.1
1993	Oct 27	18:47.3	46	4.8
1994	July 4	08:59.4	4	4.6
1995	July 4	29:33.3	33	4.6
1995	Aug 1	26:46.3	33	4.5
1995	Aug 7	11:02.2	4	4.9
1998	Apr 3	06:01.3	33	4.6
2006	Jan 23	20:10.7	73	5.1
2014	Feb 14	13:40:00	1	2.5

d. Ground Shaking

The main hazard event created by seismic earth movements is ground shaking. This term is used to describe the vibration of the ground during an earthquake. During an earthquake, seismic waves travel rapidly away from the source and through the earth's crust. Upon reaching the ground, they produce shaking that may last from seconds to minutes. The severity of the impact of ground shaking depends on a number of factors, including magnitude of the earthquake, distance from the rupture and the local geological conditions, which may either amplify or reduce the earthquake waves. One general observation is that damage is more severe for buildings founded on unconsolidated material than in rock.

Typically, the nearer one is from the epicenter, the greater is the magnitude of the intensity. As one moves farther from the origin, the intensity decreases.

The PHILVOCS Earthquake Intensity Scale (PEIS) provides descriptions of the consequences of earthquake. It also helps to explain the intensity assigned to a particular location based on the observations made on the consequences from the earthquake event. PEIS I indicates that the

earthquake is scarcely perceptible, PEIS II is slightly felt, PEIS III is weak, PEIS IV is moderately strong, PEIS V is strong, PEIS VI is very strong, PEIS VII is destructive, PEIS VIII is very destructive, PEIS IX is devastating and PEIS X is very devastating.

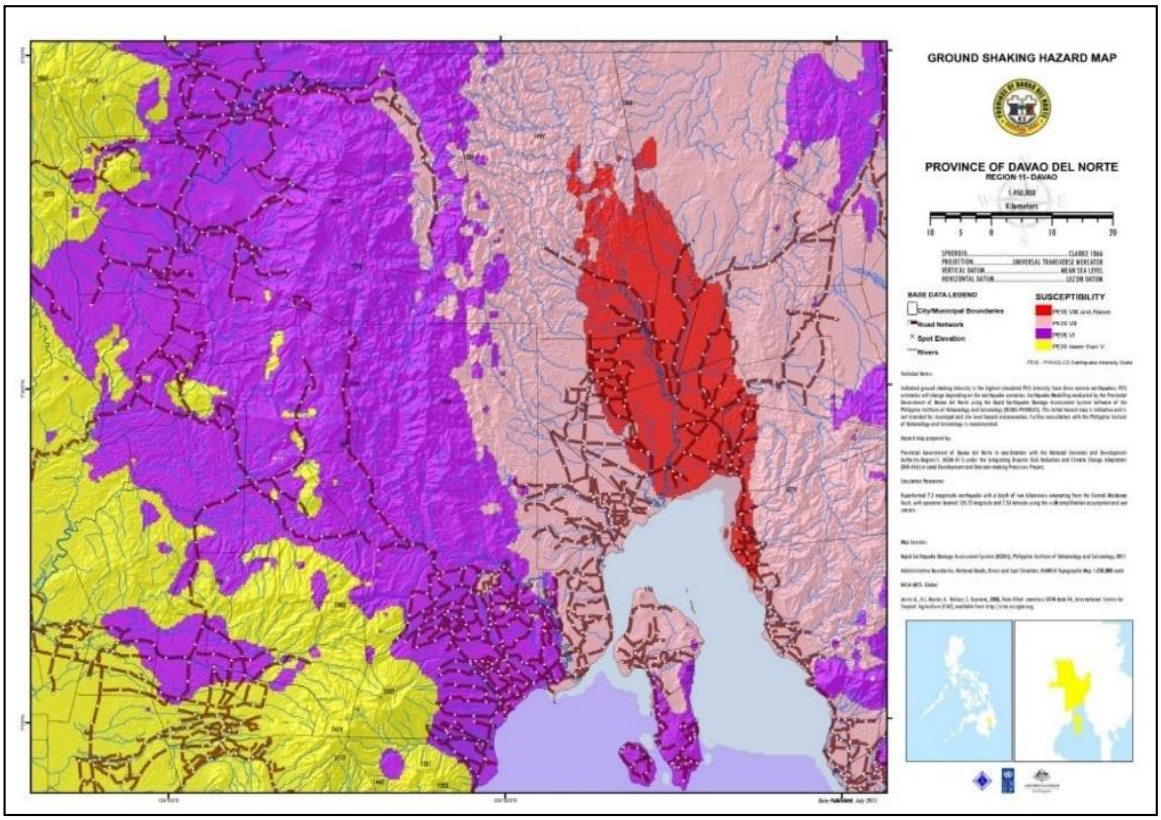
Using the simulation parameters located at the Central Mindanao Fault with a magnitude of 7.2 with a depth of 2 km., with epicenter located at 125.75 longitude and 7.53^0 latitude using the site amplification assumption and wet season, ground shaking data/map is generated. The process generated information on areas that are prone to ground shaking as presented in Table No. 20.

Table No. 20. Areas Prone to Ground Shaking by City/Municipality
Province of Davao del Norte

City/Municipality	Area in sq. kilometers
Asuncion	158.544
B.E. Dujali	52.114
Carmen	64.097
Kapalong	293.651
New Corella	90.752
San Isidro	109.478
Sto. Tomas	103.308
Talaingod	260.103
IGaCoS	124.965
Panabo City	0
Tagum City	183.466

Source: PPDO, Davao del Norte

Figure No. 13. Ground Shaking Hazard Map



Source: PPDO, Davao del Norte

Total agricultural area exposed to ground shaking is 144,082 hectares which accounts 95 per cent of the total agricultural area.

Table No. 21. Agricultural Areas Exposed to Ground Shaking by City/Municipality, Davao del Norte

City/Municipality	Total Agricultural Area (Has.)	Exposed Agricultural Area (has.)	Exposure percentage
Asuncion	18,058.09	11,423.76	63%
BE Dujali	8,584.169	5,062.01	59%
Carmen	14,775.6	6,408.65	43%
IgaCoS	25,598.35	11,653.81	45%
Kapalong	14,937.3	13,741.42	91%
New Corella	9,616.434	7,785.96	80%
Panabo City	16,138.56	0	
San Isidro	12,474.51	9,766.02	78%
Sto. Tomas	16,002.6	10,071.39	62%
Tagum City	10,358.97	10,186.76	98%
Talaingod	4,315.339	376.41	08%
TOTAL	**150,836**	**144,082.58**	**95.52%**

Source: PPDO, Davao del Norte

In terms of the exposure of the built-up areas to ground shaking, Tagum City has the highest land area followed by Asuncion and New Corella.

Table No. 22. Built-Up Areas Exposed to Ground Shaking
by City/Municipality, Davao del Norte

City/Municipality	Built-Up area exposed to ground shaking
Asuncion	390.295803
B.E Dujali	149.412009
Carmen	1.025025
Island Garden City of Samal	257.015983
Kapalong	787.8634
New Corella	342.559947
Panabo City	0
San Isidro	135.027466
Sto. Tomas	259.433256
Tagum City	5945.159469
Talaingod	99.884298

Source: PPDO, Davao del Norte

e. Earthquake-Induced Landslides

Incident of earthquake-induced landslide in Davao del Norte happened at Mambing, New Corella which destroyed thirty-three (33) houses.

Most moderate and large earthquakes trigger landslides, and these landslides commonly account for a significant portion of total earthquake damage and injuries. Among the many causes of landslides, those triggered by earthquake and heavy rainfall are the most common throughout the country. Thus, formulating scenarios where earthquake-induced landslides are likely to occur can help local authorities plan emergency response and mitigate landslide risk.

Using GIS and the available data from PHILVOCS, the simulation conducted indicate that the municipality of Kapalong has the widest area of 320.1038 square kilometers with high exceedance to earthquake-induced landslide. Other localities that are prone to earthquake-induced landslide are Talaingod, San Isidro and New Corella.

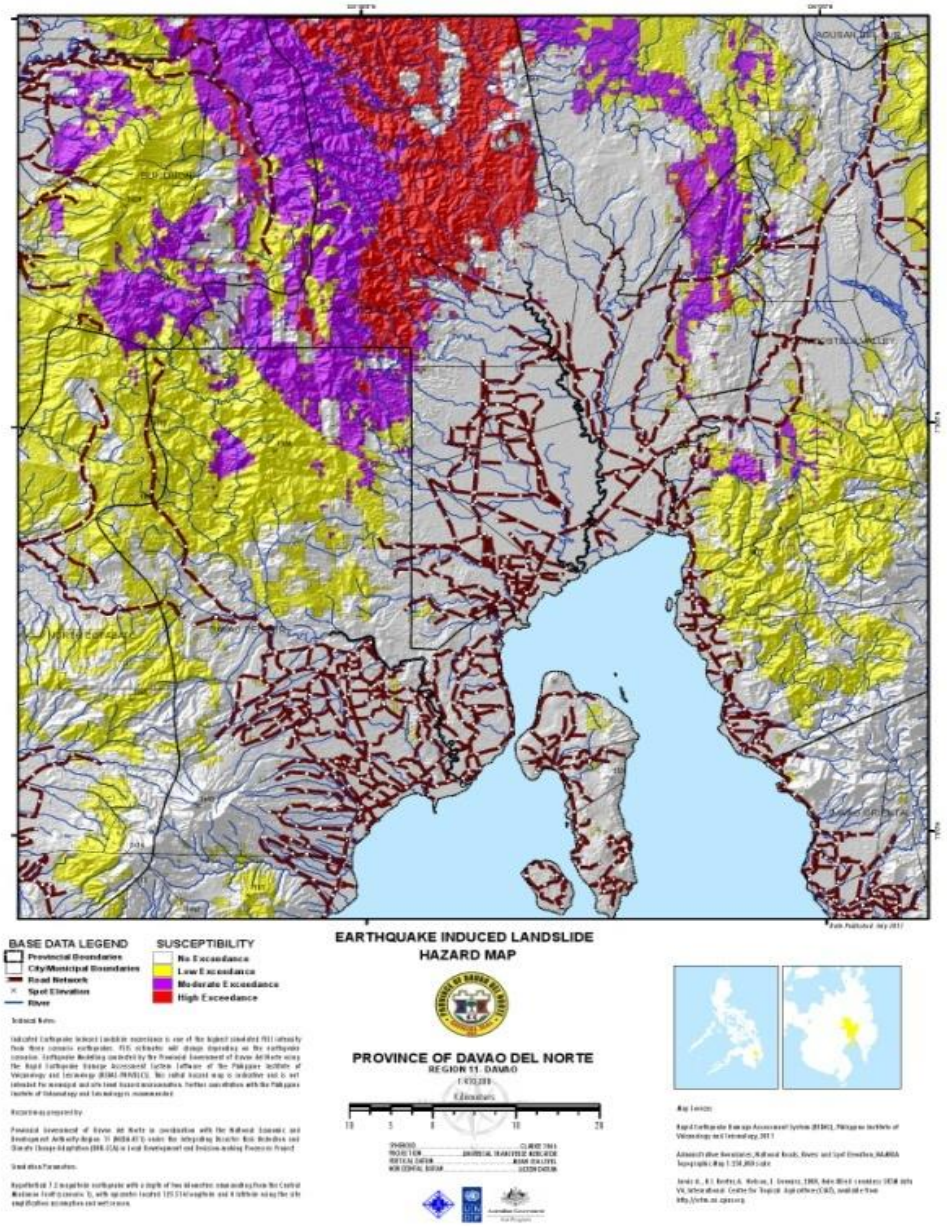
Table No. 23. City/Municipality Susceptible to
Earthquake-Induced Landslide, Davao del Norte

City/Municipality	Exceedance (in sq. km.)				Total
	No	Low	Moderate	High	
Asuncion				2.4913	2.4913
Kapalong			194.3461	320.1038	514.4499
New Corella				22.6721	22.6721
San Isidro				52.9188	52.9188
Talaingod			206.0218	192.9790	399.0008
Island Garden City of Samal		14.5199			14.5199
Davao del Norte		**14.5199**	**400.3679**	**591.1650**	**1,006.0528**

Source: GIS generated, PPDO, Davao del Norte

Out of 3,462.80 square kilometers total land area of Davao del Norte 1,006.0528 square kilometers or 29 % are susceptible to earthquake-induced landslide most of these areas are located in the Municipalities of Kapalong and Talaingod.

Figure No. 14. Earthquake-Induced Landslide Map



Source: PPDO, Davao del Norte

A total of 6,434 hectares agricultural land areas are considered with high exceedance to earthquake induced landslides.

Table No. 24. Agricultural Area Exposed to
Earthquake-Induced Landslide by City/Municipality
Davao del Norte

City/ Municipality	Total Municipal Agricultural Area	Exposed Agricultural Area within HSA	Exposed Agricultural Area within MSA	Exposed Agricultural Area within LSA
Asuncion	18,058.09	246.08		
BE Dujali	8,584.169			
Carmen	14,775.6			
IgaCoS	25,598.35			1,371.31
Kapalong	14,937.3	872.65		
New Corella	9,616.434	539.49		
Panabo City	16,138.56			
San Isidro	12,474.51	3,316.63		
Sto. Tomas	16,002.6			
Tagum City	10,358.97			
Talaingod	4,315.339	1,460.67		
TOTAL	150,836	6,434.54	-	1,371.31

Source: PPDO, Davao del Norte

f. Earthquake-Soil Liquefaction

Soil liquefaction describes a phenomenon whereby a saturated or partially saturated soil substantially loses strength and stiffness in response to an applied stress, usually earthquake shaking or other sudden change in stress condition, causing it to behave like a liquid.

Liquefaction is a process where particles of loosely-consolidated and water-saturated deposits of sand are rearranged into a more compact state. This results in the squeezing of water and sediments towards the surface in the form of “sand fountain” and creating a condition resembling to a “quicksand”. In this phenomenon, the strength of the soil is reduced to a point where it is unable to support structures.

Liquefaction commonly occurs in areas that are water saturated (shallow water table), low-lying and situated in typically loose (unconsolidated) foundation or in sandy or silty deposits. Typical examples of these areas are river banks, abandoned rivers, flood plains, coastlines and swamps.

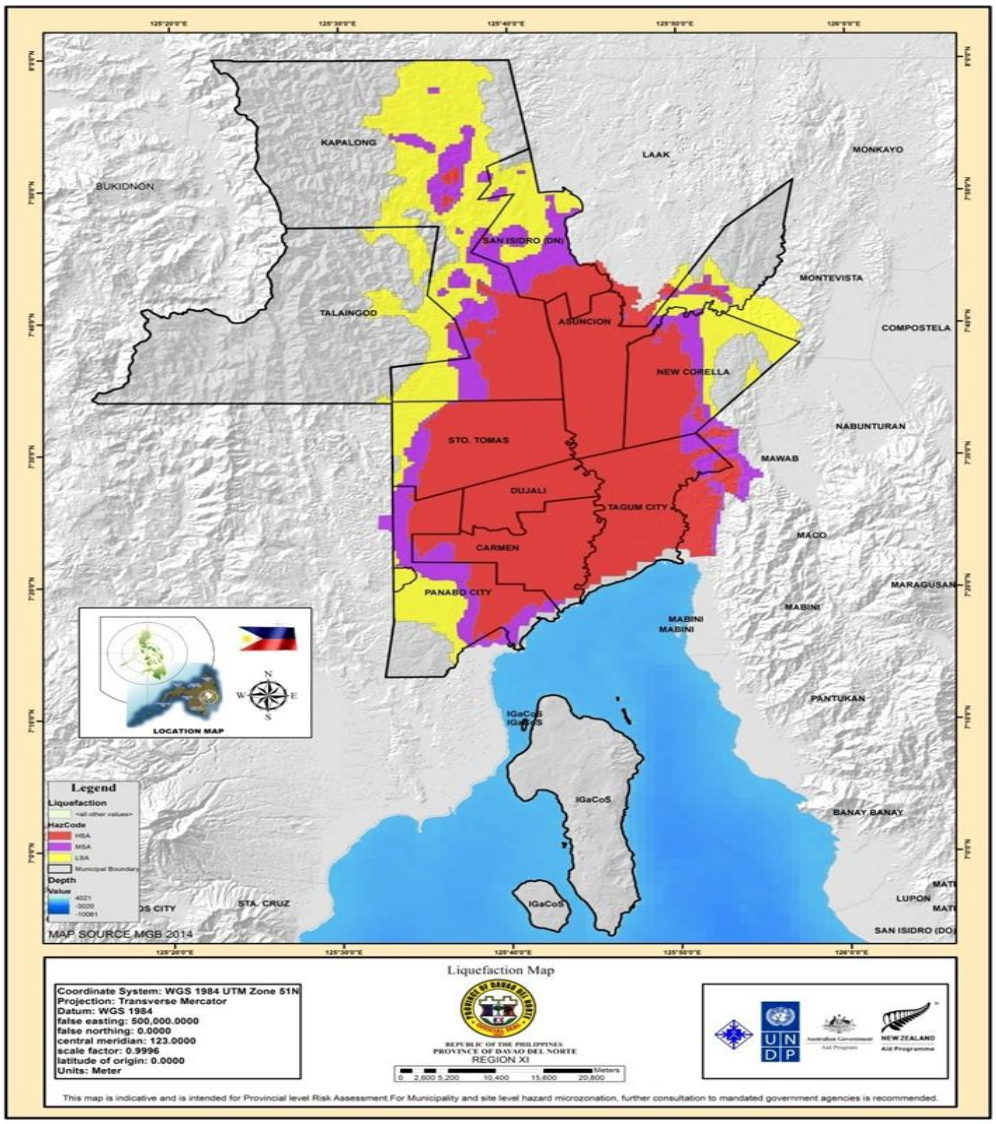
The municipality of Kapalong and San Isidro have the largest area with high susceptibility with 289.00 square kilometers. The other municipalities have either low or moderate susceptibility. The municipality of Carmen and Island Garden City of Samal have no areas susceptible to liquefaction. Detail of liquefaction hazard susceptibility is presented in Table No. 24.

Table No. 25. Liquefaction Hazard Susceptibility by City/Municipality
Davao del Norte

Municipality	Exceedance				Total Low (sq.km)
	No (sq.km)	Low (sq.km)	Moderate (sq.km)	High (sq.km)	
Asuncion	283.47	0	0	10.000	293.47
B.E. Dujali	80.00	11.000	0	0	91.00
Carmen	166.25	0	0	0	166.25
Kapalong/San Isidro	608.35	106.000	95.000	289.000	1,098.35
New Corella	291.28	0	0	30.000	321.28
Sto. Tomas	216.41	73.000	30.000	1.000	320.41
Talaingod	340.76	72.000	41.000	1.000	454.76
Island Garden City of Samal	280.71	0	0	0	280.71
Panabo City	142.83	99.000	1.000	11.000	253.63
Tagum City	154.54	0	8.000	0	182.54
Total	**2,584.80**	**361.00**	**175.00**	**342.00**	**3,462.80**

Source: GIS Generated, PPDO, Davao del Norte

Figure No. 15. Liquefaction Hazard Map



Source: PPDO, Davao del Norte

Total agricultural area exposed to liquefaction was calculated at 87,736 hectares representing 58 percent cent of the total agricultural area.

Table No. 26. Agricultural Areas Exposed to Liquefaction
by City/Municipality, Davao del Norte

LGUs	Agricultural Area (has)	Agricultural area Exposed within Highly Susceptible Area	Agri. area Exposed within Moderate Susceptible Area	Agricultural area Exposed within Low Susceptible Area
Asuncion	18,058.085	11,662.525	835.362	1,884.575
B.E. Dujali	8,584.169	8,584.169	0.000	0.000
Carmen	14,775.599	13,682.772	840.630	74.267
Kapalong	14,937.300	10,406.163	3,478.073	1,053.075
New Corella	9,616.434	8,743.862	653.877	218.694
Panabo	16,138.558	5,671.184	3,092.311	3,934.137
San Isidro	12,474.508	3,988.290	4,739.336	3,746.882
Sto. Tomas	16,002.603	15,475.109	527.494	26.542
Tagum	10,358.966	9,456.736	124.930	0.000
Talaingod	4,315.339	66.029	576.954	2,130.994
Davao del Norte	**150,836**	**87,736.839**	**14,868.967**	**13,069.166**

Source: PPDO, Davao del Norte

Built-up areas exposed to liquefaction with high susceptibility was calculated at 20,000 hectares or 85 per cent of the total built-up areas.

Table No. 27. Built-up Areas Exposed to Liquefaction
by City/Municipality, Davao del Norte

City/ Municipality	Built-Up area	Exposed Built-Up Area in High Susceptible Areas	Exposed Built-Up Area in Moderate Susceptible Areas	Exposed Built-Up Area in Low Susceptible Areas
Asuncion	645.651	645.651	0.000	0.000
B.E. Dujali	637.763	637.763	0.000	0.000
Carmen	1,614.959	1,614.959	0.000	0.000
Island Garden City of Samal	1,962.900	0.000	0.000	0.000
Kapalong	1,415.366	1,402.906	0.000	0.000
New Corella	635.920	635.920	0.000	0.000
Panabo	4,910.647	3,374.509	1,270.383	17.576
San Isidro	401.793	0.000	308.234	93.558
Sto. Tomas	2,907.969	2,907.969	0.000	0.000
Tagum	7,202.459	7,167.441	35.018	0.000
Talaingod	299.879	0.000	170.772	129.108
Davao del Norte	**23,273.068**	**20,002.075**	**1,784.407**	**240.243**

Source: PPDO, Davao del Norte

g. Storm Surge

There are no reported storm surge occurrences in Davao del Norte. However, to determine the effect of the storm surge and the extent of flooding if so ever it occurs in the province, a simulation using the worst case scenario (5 meter surge) is done through GIS. The result of the simulation is presented in Table No. 28 and on Figure No. 16.

Table No. 28. City/Municipality with Storm Surge Susceptibility Area
Province of Davao del Norte

City/Municipality	Barangay	Susceptibility Level		
		HIGH (in has.)	MODERATE (in has.)	LOW (in has.)
Carmen	Lapaz	234.662	76.126	68.387
	Taba	452.188	344.722	71.327
	Tuganay	57.341	256.947	97.699
	Guadalupe		14.579	40.189
	Ising		30.55	37.502
	Sto. Nino		6.843	21.436
Total		*744.191*	*729.767*	*336.54*
IGACOS	Adecor	106.814	8.066	2.64
	Audanao	0.215	0.127	0.08
	Balet	37.901	3.731	1.255
	Caliclic	30.531	6.879	1.717
	Camudmud	28.691	4.611	1.869
	Catagman	6.895	2.158	1.349
	Cawag	9.351	0.32	0.04
	Cogon	20.926	2.087	0.92
	Dadatan	9.903	1.401	0.492
	Kinawitnon	12.246	3.441	1.629
	Libertad	13.393	1.994	0.84
	Libuak	60.905	6.413	3.065
	Limao	29.776	5.955	1.762
	Linusutan	12.148	1.685	0.6
	Miranda	24.611	9.024	2.928

Different Sectors Exposed to Climate Change Impacts

Population Exposure

From the result of the maps produced by overlaying the population density map and the flood prone map, there are a total of 181,971 persons in the province that are highly exposed to flood which is 20 percent of the total population. In terms of the most exposed populations, Tagum City with 80,666 population rank first among the local government units in the province.

But in terms of the percentage of population that is exposed to hazard, the municipality of Carmen has the highest percentage with 46 percent. B.E Dujali is at second with 35 percent of its population exposed to hazard. The City of Tagum is the capital of the province and is one of the major growth centers in the province where population is large which is why a large segment of the population is exposed to areas highly susceptible to flood. Being the center of commerce, business and trade, this area becomes magnets for informal settlers seeking jobs in the poblacion. On the other hand, the municipalities of Carmen and B.E Dujali lies on the central broad plain of the province where major rivers traverses.

Table No. 29. Population Exposed to Flood
by City/Municipality, Davao del Norte

City/ Municipality	Total Population	Population Affected within the Flood Prone Areas	Population Exposure within the Flood Prone Areas	Population Exposure within Flood Prone Areas (in %)
Asuncion	55,844	7,270	14,500	25.0
B.E. Dujali	28,339	3,177	10,223	35.0
Carmen	69,199	7,688	31,881	46.0
Kapalong	68,261	1,881	3,482	2.0
New Corella	50,699	4,938	11,083	21.0
San Isidro	25,548	470	714	2.0
Sto. Tomas	109,269	2,592	13,134	12.0
Talaingod	25,566	0	0	0.0
Island Garden City of Samal	95,874	0	0	0.0
Panabo City	174,364	2,279	16,288	9.0
Tagum City	242,801	6,443	80,666	33.0
Davao del Norte	**945,764**	**36,738**	**181,971**	**20.0**

Source: GIS generated data based on the Population Density and Flood Prone Maps, PPDO Davao del Norte

Agriculture Exposure and Other Hazard Implications

The potentials of the Province in agriculture are reflected through its vast area devoted to agricultural activities. Agricultural land use accounts for 47.30% (150,836 hectares) of the total land area of Davao del Norte of which 30,687.79 hectares or roughly 20% is highly at risk to flood. The Municipality of Carmen being a low lying area has the highest susceptibility to flood with 46% exposure percentage or around 6,908.99 hectares of its agricultural area. Tagum City and New Corella has almost 50% of its total agricultural area expose to flood. Please refer to Table No. 12.

Natural disasters, such as, floods, drought and typhoons, challenge agricultural production. Because agriculture relies on the weather, climate, and water availability to thrive, it is easily impacted by natural events and disasters. Agricultural impacts from natural events and disasters most commonly include: contamination of water bodies, loss of harvest or livestock, increased susceptibility to disease, and destruction of irrigation systems and other agricultural infrastructure. These impacts can have long lasting effects on agricultural production including crops, forest growth, and arable lands, which require time to mature. Learning how to prepare for and recover from natural events and disasters will decrease their long-term effects on agriculture and the environment.

Earthquakes can strike without warning and cause dramatic changes to the landscape of an area that can have devastating impacts on agricultural production and the environment. These impacts could include loss of harvest or livestock and destruction of irrigation systems and other agricultural infrastructure.

Drought's most severe effects on agriculture include water quality and quantity issues. Other impacts include decreased crop yields, impact to feed and forage, and altered plant populations. Estimated damage to agriculture brought about by typhoon Pablo in December 2012 is the highest so far in the Province at 2.81 Billion Pesos.

Vulnerability of Forestry Sector to Flooding

In determining vulnerability of forestry sector to flooding, the indicators used for sensitivity are vegetation types and slope class. For exposure indicators, extent and number of settlements and population at floodplains at risk, and extent agricultural areas at risks are used. And for the adaptive capacity, indicators used reforestation efforts and solid waste disposal and management.

Municipality of Talaingod has high vulnerability to flooding considering that some of the head of the major rivers are within the municipality. Moreover,

majority of the areas classified as forestland have either grass or shrubs in it. Forest areas are considered secondary growth.

The rest of the municipalities have moderate vulnerability to erosion except for B.E Dujali, IGACOS and San Isidro with low vulnerability. The unsustainable farming practices in the uplands where soil erosion control measures are not fully adapted, and the denuded forestlands contributed to river siltation thus making rivers to swell during heavy rains.

3.3 Summary and Findings of Vulnerability Assessment

Underlying factors causing floods in the province include overflows of the river /waterways systems, failures of dike, heavy rains, rapid scouring of river banks, realignment of the river system, meandering river system, and heavily silted rivers and waterways because of surface run-offs which decreases its carrying capacity. Based on the result of the river tracking conducted in the major rivers of the province, river re-alignments have been observed in the various sections of the river systems.

Figure No. 16. River-Realignment of Libuganon River (2013)

Degraded environment / denuded upland areas and rapid urbanization also contributed to the flooding problem of the area. Improper solid waste management resulted to clogging of drainage. Agricultural wastes also hamper the river system and its infrastructure.

Among the conditions contributing to the vulnerability of the province to disasters include the vast low lying areas, settlements along riverbanks, houses made of light materials, poverty incidence and infrastructure facilities near riverbanks.

Table No. 30. Level of Vulnerability of Flooding
(Sensitivity, Exposure and Adaptive Capacity)

City/ Municipality	Sensitivity Value (Weighted Average)	Exposure Value (Weighted Average)	Adaptive Value (Weighted Average)	Vulnerability Index (Weighted Average)	Vulnerability Category
Asuncion	0.226	0.126	0.196	0.547	*Moderate*
B.E Dujali	0.000	0.142	0.196	0.338	*Low*
Carmen	0.237	0.160	0.196	0.593	*Moderate*
IGACOS	0.044	0.084	0.224	0.357	*Low*
Kapalong	0.297	0.068	0.196	0.560	*Moderate*
New Corella	0.253	0.152	0.196	0.602	*Moderate*
Panabo City	0.187	0.106	0.196	0.489	*Moderate*
San Isidro	0.038	0.085	0.196	0.319	*Low*
Sto. Tomas	0.111	0.085	0.196	0.392	*Moderate*
Tagum City	0.049	0.162	0.224	0.435	*Moderate*
Talaingod	0.361	0.053	0.196	0.610	*High*

Source: PPDO, Davao del Norte

Summary

Table 24 shows the summary of hazards that may affect each municipality / city in the Province. Municipalities within specified districts usually experience similar hazards because of shared geographical and physical characteristics. For instance, all municipalities in the first district are prone to earthquake induced landslides though these municipalities are not the only ones experiencing ground shaking. Moreover, though all municipalities except for Talaingod and Island Garden City of Samal are susceptible to flooding due to rainfall, only Kapalong, Talaingod, Asuncion, San Isidro, New Corella and Santo Tomas are high susceptible to rainfall induced landslides.

Table No. 31. Summary of Hazard that may Affect Davao del Norte

City/ Municipality	Flooding	Rain-Induced Landslides	Earthquake Ground Shaking	Earthquake-Induced Landslides	Earthquake-Soil Liquefaction
District I					
Asuncion	√	√	√	√	√
Kapalong	√	√	√	√	√
New Corella	√	√	√	√	√
San Isidro	√	√	√	√	√
Tagum City	√		√		
Talaingod		√	√	√	√
District II					
B.E. Dujali	√		√		
Carmen	√		√		
IGaCoS			√		
Panabo City	√				√
Sto. Tomas	√	√	√		√

Considering the Island Garden City of Samal and the coastal areas of Tagum City, Carmen, and Panabo City, storm surge, sea level rise and coastal erosion may have a high probability of occurrence. Meanwhile, tsunami is most likely to affect the coastal areas of IGACOS and the open sea.

3.4 Vulnerability and Cross-Sectoral Analysis

Table No. 32. Hazard/Disaster Impacts on Areas and Population
(Vulnerability Assessment)

DD/ YEAR	HAZARD	HAZARD EVENTS & DESCRIPTION	AFFECTED LGU'S	AFFECTED BRGYS	OTHER EFFECTS:		
					AFFECTED INDIVIDUALS	AFFECTED FAMILIES	DAMAGES TO AGRICULTURAL INFRASTRUCTURE, FAMILIES FORESTRY, POLITICAL, SOCIAL, COASTAL/MARINE HABITATS (INDICATE COST IF AVAILABLE)
Jan. 9-25, 2014	LPA/ Typhoon	TD Agaton	Asuncion	17	22,960	4,592	Agriculture : P 144, 697, 434.00
		Torrential Rains	New Corella	8	3,220	644	
		River Flooding	Kapalong	14	4,940	1,320	Infrastructure: P 39, 503, 520.00
		Landslide	Tagum City	6	1,987	614	
			Carmen	10	1,040	208	
			B.E.Dujali	4	5,415	1083	
			Sto.Tomas	4	4,175	873	
		TOTAL	7 LGU's	63	43,737	9,334	
Feb. 19-21, 2014	Typhoon	CRISING (Torrential Rains) River Flooding	Kapalong	13	29, 796	9125	
			Asuncion	20	55,075	11, 508	Agriculture : P 128, 065,014.25
			Carmen	8	21, 045	4, 209	
			B.E.Dujali	4	12, 200	2,440	Infrastructure: P 14, 470,000.00
			Sto.Tomas	3	7,400	1,480	
		TOTAL	5 LGU's	48	62,475	13,045.00	
		Landslide	New Corella	1	780	156	
			Tagum City	7	18650	3730	
		TOTAL	2 LGU's	8	19,430.00	3,886.00	

DD/ YEAR	HAZARD	HAZARD EVENTS & DESCRIPTION	AFFECTED LGU'S	AFFECTED BRGYS	OTHER EFFECTS:		
					AFFECTED INDIVIDUALS	AFFECTED FAMILIES	DAMAGES TO AGRICULTURAL INFRASTRUCTURE, FAMILIES FORESTRY, POLITICAL, SOCIAL, COASTAL/MARINE HABITATS (INDICATE COST IF AVAILABLE)
April 17, 2014	Localized Thunderstorm	Torrential Rains with gustiness Urban Flooding	Tagum City	10	324 evacuated Individuals	69	No damaged reported
June 20, 2014	Localized Thunderstorm	Heavy Rains Landslide	Tagum City	1	4	1	1 - Totally damaged residential Crops: 15 - coco trees, 8 durians, 1 - joey oak, 1 jack fruit, blocked road way
June 24, 2014	Localized Freak Tornado	Strong Winds	B.E. Dujali	1	54	12	Damaged Houses: P 195, 000.00 Totally : 5 Partially: 8
July 1, 2014 July 28, 2014	Localized Thunderstorm Armed - conflict	Dike failure flooding Social Unrest	Carmen Kapalong	3 1	1,155 9, 474	231 1,595	Agriculture: 93 Has. Number of Casualties 3-Dead Male 10-male injured, 3-Male missing

DD/ YEAR	HAZARD	HAZARD EVENTS & DESCRIPTION	AFFECTED LGU'S	AFFECTED BRGYS	OTHER EFFECTS:		
					AFFECTED INDIVIDUALS	AFFECTED FAMILIES	DAMAGES TO AGRICULTURAL INFRASTRUCTURE, FAMILIES FORESTRY, POLITICAL, SOCIAL, COASTAL/MARINE HABITATS (INDICATE COST IF AVAILABLE)
January 18-23, 2013	TAIL-END OF COLD FRONT	Torrential Rains River Flooding	Kapalong Carmen B.E. Dujali Sto. Tomas Asuncion New Corella Tagum City	14 15 5 10 13 12 11	43,886.00 81,500.00 22,275.00 24,491.00 31,130.00 26,675.00 37,230.00	12613 16300 4,455 5163 6226 5335 7446	Agriculture : P 400, 241, 718.06 Infrastructure: P 85, 760, 000.00
		TOTAL	7 LGU's	80	267,187.00	57,538.00	
February 20, 2013	Localized Thunderstorm	Torrential Rains FLASHFLOOD	Talaingod Kapalong	2 14	4,440.00 7,490.00	888 10,819.00	Agriculture : P 115, 489,129.50 Infrastructure: P 3,090,000.00
		TOTAL	2 LGU's	16	11,930.00	11,707.00	
May 30, 2013	Localized Freak Tornado	Strong Winds	Asuncion	3	42	10	Damaged Houses: P135, 000 Totally: 11 Partially: 8
June 16-19, 2013	Low Pressure Area	Heavy Rains (Damaged Dike) Flood	B. E. Dujali	1	835	167	Agriculture : P 2,861, 232.00 Infrastructure: P 5, 100,000.00

DD/ YEAR	HAZARD	HAZARD EVENTS & DESCRIPTION	AFFECTED LGU'S	AFFECTED BRGYS	OTHER EFFECTS:		
					AFFECTED INDIVIDUALS	AFFECTED FAMILIES	DAMAGES TO AGRICULTURAL INFRASTRUCTURE, FAMILIES FORESTRY, POLITICAL, SOCIAL, COASTAL/MARINE HABITATS (INDICATE COST IF AVAILABLE)
November	Typhoon	Zoraida	New Corella	7	650	130	Agriculture : P 22, 145, 325.00
11-15,		(Torrential Rains)	Sto. Tomas	10	17,700	3,540	
2013			Asuncion	8	7,500	1,500	Infrastructure: P 4, 022, 591.00
		River Flooding	B.E. Dujali	5	9,860	1,972	
			Carmen	2	285	57	
			Kapalong	3	170	34	
			IGACOS	1	200	40	
			Tagum City	5	1,510	302	
		TOTAL	8 LGU's	41	37,875.00	7,575.00	
January	Tail-End of	Torrential Rains	Kapalong	4	1,580.00	389	Agriculture : P 88, 235, 734.00
Nov-17	Cold Front	River Flooding	Tagum City	4	16,255.00	3,251.00	Infrastructure: P 980, 000.00
2012	And		B.E. Dujali	2	115	21	
	Northeast Monzoon		Carmen	5	7,680.00	1,356.00	
			New Corella	5	1,020.00	205	
			Sto. Tomas	3	635	127	
		TOTAL	6 LGU's	23	27,285.00	5,349.00	
November	ITCZ	Torrential Rains	Kapalong	11	7,690.00	2,190.00	Agriculture : P 57,525,653.25
23-26,		River Flooding	Asuncion	15	10,145.00	2,021.00	Infrastructure: P 681,528.00
2012			Sto. Tomas	1	125	25	
			Tagum City	4	431	128	
			Carmen	2	2,393.00	747	
		TOTAL	5 LGU's	33	20,784.00	5,111.00	

DD/ YEAR	HAZARD	HAZARD EVENTS & DESCRIPTION	AFFECTED LGU'S	AFFECTED BRGYS	OTHER EFFECTS:		
					AFFECTED INDIVIDUALS	AFFECTED FAMILIES	DAMAGES TO AGRICULTURAL INFRASTRUCTURE, FAMILIES FORESTRY, POLITICAL, SOCIAL, COASTAL/MARINE HABITATS (INDICATE COST IF AVAILABLE)
November 22, 2012	Armed-Conflict	Social Unrest	San Isidro	3	1,605.00	321	
December 4, 2012	Super Typhoon	PABLO (Torrential Rains and Strong Winds) River Flooding Landslide	Kapalong	14	56,433.00	5,992.00	Agriculture : 2,810,058,132.00 Infrastructure: P 768,269,282.00 Houses: Totally : 764 Partially: 5, 792 Peso value : P 84,369,620.00 Public Schools: Totally: 9 Elem Buildings 2 Day Care Buildings Peso value : P 8,640,000.00
			Asuncion	20	25,300.00	5,060.00	
			New Corella	18	21,300.00	4,260.00	
			Sto. Tomas	5	10,685.00	2,137.00	
			B.E. Dujali	4	32,180.00	6,436.00	
			Tagum City	5	2,595.00	519	
			Carmen	17	16,760.00	3,352.00	
			Panabo	4	225	45	
			IGACOS	4	1,559.00	311	
			San Isidro	12	29,960.00	5,992.00	
			Talaingod	3	12,665.00	2,533.00	
		TOTAL	11 LGU's	106	209,662.00	36,637.00	
December 26-29, 2011	ITZC	Torrential Rains River Flooding	Kapalong	12	9,935.00	1,987.00	Agriculture : P 115,594,477.00 Infrastructure: P 8,956,250.00
			Asuncion	16	20,530.00	4,106.00	
			New Corella	14	9,835.00	1,967.00	
			Sto. Tomas	3	5,085.00	1,017.00	
			B.E. Dujali	3	2,495.00	499	
			Tagum City	9	15,455.00	3,091.00	
			Carmen	6	10,110.00	2,022.00	
		TOTAL	7 LGU's	63	73,445.00	14,689.00	

Source: PDRRMD, Davao del Norte

Capacity **(no data)**

- **List Evacuation centers, hospitals**
- **Carbon sink present**
- **Previous programs undertaken to manage the hazard (before 2015)**
- **Roads and bridges constructed**
- **Other capacities to address climate issues**

CLIMATE CHANGE ISSUES:

- Available carbon emission/greenhouse gas information at the entity level only
- Non availability of scientific information on the effects of climate change

Chapter IV: PLAN OBJECTIVES

Goals

The ultimate goal of any Climate Change Plan is the need to attain sustainable development. This plan is guided by the National Council for Climate Change Policy Framework which defines the seven (7) elements of sustainable development: human security, food security, water sufficiency, environmental and ecological stability, climate friendly industries and services, sustainable energy and knowledge and capacity building. This PCCAP 2018 – 2026 will lay out the foundations on how the area will be planned over the long term to adapt to the opportunities and impacts arising from changes in the climate. Towards this end, the Province of Davao del Norte aims to achieve, the following:

1. To build and strengthen the adaptive capacities of its communities (especially the vulnerable members) to be climate change adaptive and risk resilient through the adoption of sound and practical science-based policies in agriculture, climate change adaptation and disaster risk reduction and management; and,

2. To optimize mitigation opportunities towards people centered, holistic, gender-responsive, equitable, dynamic, judicious and rights-based sustainable development.

Objectives

In order to meet the overarching goals of the Davao del Norte CCAP on allowable solutions set out in support of an adaptive and risk resilient communities, the following objectives are defined. These objectives are also consistent with the objectives set forth in the National Climate Change Action Plan These objectives include:

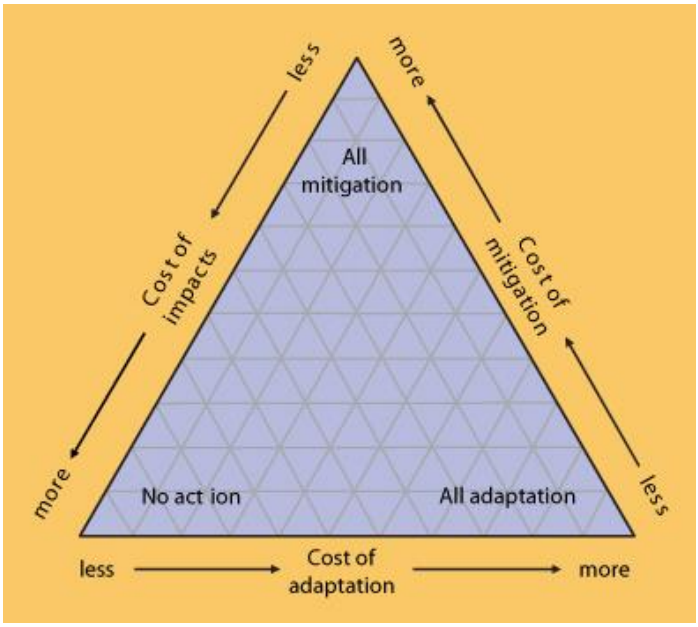
1. To ensure availability, stability, accessibility and affordability of safe and healthy food amidst climate change;
2. To identify adaptation options for existing development in areas with significant vulnerability to impacts likely to arise from changes in the climate;
3. To reduce risks to identified vulnerable groups, as different impacts (and options to manage impacts) will affect parts of the community differently;
4. To ensure the resilience of water resources, manage supply and demand, manage water quality and promote conservation;
5. To restore ecological services;
6. To plan green infrastructures in order to optimise its many benefits and, as part of wider green infrastructure networks, in order to support local biodiversity and healthy living environments, including through providing urban cooling, local flood risk management, carbon sequestration and local access to shady outdoor space;
7. To actively engage stakeholders, that is, ensuring that all relevant parties are aware of the challenge of climate change and committed to addressing it;
8. To ensure participatory strategic planning, implementation and monitoring for climate change by mobilizing stakeholders to create an overall vision; and,
9. to enhance the knowledge on climate change, capacity for climate change adaptation, mitigation and disaster risk reduction

Climate Change Mitigation and Adaptation Initiatives (2018-20260

In general, there are two different strategies when it comes to dealing with climate change. Very broadly, these are mitigation of climate change (trying to stop future warming) and adaptation to climate change (finding ways to live in the warming world). Adaptation is the principal way to deal with the impacts of a changing climate. Formally, adaptation involves developing ways to protect people and places by reducing their vulnerability to climate impacts. For example, to protect against sea level rise and increased flooding, communities might build seawalls or relocate buildings to higher ground while mitigation involves attempts to slow the process of global climate change, usually by lowering the level of greenhouse gases in the atmosphere. Planting trees that absorb CO2 from the air and store it is an example of one such strategy. It must be emphasized that adaptation is a shared responsibility.

Cognizant of this, the Government of Davao del Norte realizes that in order to have successful adaptation and mitigation measures, all the stakeholders have complementary roles to play. Individuals and businesses will often be best placed to make adaptation decisions that reduce climate risks to their assets and livelihoods. More importantly, adaptation and mitigation measures have associated costs. Figure below shows the relationship between undertaking measures and initiatives and inaction. Given the increasing pressure for accountability and transparency, Davao del Norte hopes to be able to undertake adaptation and mitigating measures that have high impact with least cost to the society.

Figure No. 17. Triangle Diagram
Relationship Between Adaptation, Mitigation and Inaction



Source: IPCC Fourth Assessment Report IPCC Fourth Assessment Report https://scied.ucar.edu/longcontent/climate-mitigation-and-adaptation

Table No. 33. Planned adaptation initiatives by component LGUs of Davao del Norte, by stressor (s).

Stressor/s	Program	Adaptation option/strategy/ Projects	NCCAP Priority addressed to	Municipalities	Cost	Implementation Period
Drought	Risk management strategies for adaptation to climate change in the highlands agriculture Or Holistic, Innovative and Integrated Approach for Highly Sensitive Uplands	Expanded rainwater harvesting; water storage and conservation techniques; water re-use; desalination; water-use and irrigation efficiency; leakage reduction; hydroponic farming; bank loans allowing for purchase of rainwater storage tanks; open pond, shift to drought-resistant crops; use of shallow tube wells; rotation method of irrigation during water shortage; construction of water impounding basins; construction of fire lines and controlled burning; adoption of soil and water conservation measures for upland farming. Adjustment of planting dates and crop variety; crop relocation; improved land management, e.g. erosion control and soil protection through tree planting Improved crop and grazing land management to increase soil carbon storage; restoration of degraded lands; improved rice cultivation techniques and livestock and manure management to reduce CH_4 emissions; improved nitrogen fertiliser application techniques to reduce N_2O emissions; dedicated energy crops to replace fossil fuel use; improved energy efficiency; *improvements of crop yields* R&D policies; institutional reform; land tenure and land reform; training; capacity building; crop insurance; financial incentives, e.g. subsidies and tax credits Livelihood	Water sufficiency Food security human security environmental and ecological stability, Knowledge and capacity building.			
Flooding	Pilot program on optimizing resources in climate resilient food production	Relocation Afforestation; reforestation; forest management; reduced deforestation; PES, harvested wood product				

	Sustainable land management project	management; use of forestry products for bioenergy to replace fossil fuel use; *tree species improvement to increase biomass productivity and carbon sequestration; improved remote sensing technologies for analysis of vegetation/soil carbon sequestration potential and mapping land-use change* River Bank Protection; Formulation of a Flooding Plan Develop guidelines on the redesigning, retrofitting or operational modification of infrastructure facilities and utilities Impv't. of roads, drainage and canals within the flood prone barangays; Imprv't of bridges and cross drainage; Desiltation, Rechanneling and clearing of water ways; Revetment of dike along major river banks; Comprehensive river bank assessment Land-use planning programs, e.g. intensifying agriculture and animal husbandry ; Tree planting in woodlots, agroforestry and plantation ; Improved governance in forest management ; Improve domestic energy use and provide alternative energy sources ; Promoting alternative income generating activities; PES				
Landslides		Improved afforestation (establishment of a new forest by seeding or planting non forested land using drone technology); reforestation; forest management; reduced deforestation; harvested wood product management; use of forestry products for bioenergy to replace fossil fuel use Realignment/relocation; design standards and planning				

		for roads, rail and other infrastructure to cope with warming and drainage Integrating climate change considerations into national transport policy; investment in R&D for special situations Diversification of tourism attractions and revenues; Integrated planning (e.g. carrying capacity; linkages with other sectors); financial incentives, e.g. subsidies and tax credits				
Storm Surge **Infrastructure/settlement (including coastal zones)**	Developing core capacity to address climate change adaptation in productive coastal zones	Relocation; seawalls and storm surge barriers; dune reinforcement; land acquisition and creation of marshlands/wetlands as buffer against sea level rise and flooding; protection of existing natural barriers Trainings Formulation of Plans Standards and regulations that integrate climate change considerations into design; land-use policies; building codes; insurance Capacity building for shoreline defense system design; introduction of participatory risk assessment; provision of grants to strengthen coastal resilience and rehabilitation of infrastructures; construction of cyclone-resistant housing units; retrofit of buildings to improved hazard standards; review of building codes; reforestation of mangroves				
Sea level rise		Formulation and Implementation of a Coastal Resource Management Program Adoption of an Emergency Plan as precautionary approaches allowing for the incorporation of emerging trends in climate; building of a storm surge barrier taking a 50 cm sea-level rise into account; use of sand	.			

		supplements added to coastal areas; improved management of water levels through dredging, widening of river banks, allowing rivers to expand into side channels and wetland areas; deployment of water storage and retention areas; conduct of regular (every 5 years) reviews of safety characteristics of all protecting infrastructure (dykes, etc.); preparation of risk assessments of flooding and coastal damage influencing spatial planning and engineering projects in the coastal zone, identifying areas for potential (land inward) reinforcement of dunes. Land acquisition programmes taking account of climate change to acquire coastal lands damaged/prone to damages by storms or buffering other lands; the acquired lands are being used for recreation and conservation); establishment of a 'rolling easement' an entitlement to public ownership of property that 'rolls' inland with the coastline as sea-level rises; other coastal policies that encourage coastal landowners to act in ways that anticipate sea-level rise. Converting over arable farmlands into salt marsh and grassland to provide sustainable sea defences; maintenance and operation of the Barrier that addresses flooding linked to the impacts of climate change; provision of guidance to policy makers, chief executives, and politicians to climate change and the insurance sector				
Waste Management		Landfill CH_4 recovery; waste incineration with energy recovery; composting of organic waste; controlled wastewater treatment; recycling and waste minimisation; *biocovers and biofilters to optimise CH_4 oxidation* Financial incentives for improved waste and				

		wastewater management Renewable energy incentives or obligations health action plans; emergency medical services; improved climate-sensitive disease surveillance and control; safe water and improved sanitation Public health policies that recognise climate risk; strengthened health services; regional and international cooperation				
	Adaptation Learning Program					
	Capacity Building on Using Renewable Energy Resource Assessment Data and Geospatial Analysis					
	Calculating Energy Access, Finance Mobilization, and Projected Emissions Reductions					
Multi stressors	Davao del Norte Strategic Program for Climate Resilience Component 1. Building climate resilience of watersheds in mountainous eco-regions Component 2. Building resilience to climate-related hazards Component 3. Mainstreaming climate change risk management in development Component 4. Building climate resilient					

	communities through private sector participation Component 5. Enhancing climate resilience of endangered species					
	Davao del Norte Adaptation Program					
Transport		Ralignment/relocation; design standards and planning for roads, rail and other infrastructure to cope with warming and drainage Integrating climate change considerations into national transport policy; investment in R&D for special situations				
Energy		Strengthening of overhead transmission and distribution infrastructure; underground cabling for utilities; energy efficiency; use of renewable sources; reduced dependence on single sources of energy and fiscal and financial incentives to encourage use of alternative sources; incorporating climate change in design standards				

Table No. 34. Identified Adaptation and Mitigation Options to CC Hazards/Impacts with Prioritized PPA's
Provincial Government of Davao del Norte

INCREASED TEMPERATURE

PROJECT/ACTIVITY	Target	NCCAP PRIORITY ADRESSED	RESPONSIBLE OFFICE	2015	2016	2017	2018	2019
Advocacy on the implementation of proper land uses by the LGUs particularly the "no build zone" policy	Activities	Human security Knowledge and Development Capacity	PDRRMC	50T	-	-	-	-
Formulation of IRR of the Environmental Code of DDN	1IRR	Environmental and Ecological Stability Knowledge and Capacity Development	PENRO-LGU	50T	-	-	-	-
Formulation of Provincial Solid Waste Management Plan	1 plan	Knowledge and Capacity Development Environmental and Ecological Stability	PENRO-LGU	100 T	-	-	-	-
Formulation of Comprehensive Environmental Management Plan	1 plan	Knowledge and Capacity Development Environmental and Ecological Stability	PENRO-LGU	-	200 T	-	-	-
Formulation of FLUP	1 plan	Knowledge and Capacity Development Environmental and Ecological Stability	PENRO-LGU	200 T	-	-	-	-
Sustainable Upland Development Program	Proj	Knowledge and Capacity Development Environment	PENRO-LGU	1M	1M	1M	1M	1M

		al and Ecological Stability						
Restoration of forest cover in LGUs prone to disaster	Has.	Human Security Environmental and Ecological Stability	PENRO-LGU	2.5 M	2.5 M	2.5 M	2.5 M	2.5 M
Advocacy for the implementation of the building code and the use of green technology.	Activities	Knowledge and Capacity Development Human Security	PEO	50T	-	-	-	-
Botanical Concoction/natural farming technology transfer	10trngs	Environmental and Ecological Stability Food Security Climate Smart Industries and Services	PAGRO	240 T	240 T	240 T	240 T	240 T
Floating Garden Project	Projects	Food Security Environmental and Ecological Stability Climate Smart Industries and services	PAGRO	250 T	250 T	250 T	250 T	250 T
Livelihood projects	No. of proj	Food Security Human Security	PAGRO/ TLDC	500 T	500 T	500 T	500 T	500 T
Provision of drugs and medicines for animal health management	No. of beneficiaries	Food Security	PVO	250 T	250 T	250 T	250 T	250 T

FLOODING CAUSED BY INCREASED PRECIPITATION

PROJECT/ACTIVITY	Target	NCCAP PRIORITY ADRESSED	RESPONSIBLE OFFICE	2015	2016	2017	2018	2019
River Bank Protection	Proj	Environmental and Ecological Stability Human Security Water Sufficiency	PENRO-LGU	250T	250T	250T	250T	250T
Develop guidelines on the redesigning, retrofitting or operational modification of infrastructure facilities and utilities	1 unit	Human Security Knowledge and Capacity Development Climate – Smart Industries and Services	PEO	100T	-	-	-	-
Impv't. of roads, drainage and canals within the flood prone barangays.	proj	Climate – Smart Industries and Services	PEO	1.1M	1M	1M	2M	2M
Imprv't of bridges and cross drainage	Proj	Human Security	PEO	3M	3M	3M	3M	3M
Desiltation, rechanneling and clearing of water ways	Proj	Human Security Water Sufficiency	PEO	5M	5M	5M	5M	5M
Revetment of dike along major river banks	5 proj	Water Sufficiency Human Security	PEO	5M	5M	5M	5M	5M
Comprehensive river bank assessment	1 activity	Water Sufficiency	PEO	100T	-	-	-	-

CALAMITIES BROUGHT ABOUT BY EXTREME WEATHERS (El Niño, La Niña, Typhoon, Earthquake, Flood)

PROJECT/ACTIVITY	Target	NCCAP PRIORITY ADRESSED	RESPONSIBLE OFFICE	2015	2016	2017	2018	2019
Formulation of Provincial Shelter Plan	1 plan	Human Security Knowledge and Capacity Development	PPDO	100T	-	-	-	-
Researches on the impact of climate change	researches	Knowledge and Capacity Development	PGO/ academe/ researcher	1 M	-	-	-	-
Inventory and assessment of existing critical infra facilities and utilities.	No. of facilities	Human Security	PEO	100T	-	-	-	-
Advocacy on the implementation of CCA-DRR adaptive and gender sensitive structures, facilities and utilities	Activities	Human Security	PEO/PGO -GAD	50T	-	-	-	-
Slope Protection in landslide prone barangays using bio-engineering and other technologies.	Proj	Human Security	PEO	1M	1M	1M	1M	1M
Development of DMIS/web-based portal (knowledge center) for online disaster related information.	1 system	Knowledge and Capacity Development	PPDO/PDRRMD	1.6M	-	-	-	-
Establishment of disaster related database	1 database	Knowledge and Capacity Development	PDRRMD	100T	100T	100 T	100 T	100 T
Risk assessment and hazard mapping at the barangay level	25 brgys	Knowledge and Capacity Development Human Security	PDRRMD/ PPDO/LGUs	200T	200T	200 T	200 T	200 T
Seed subsidy program	Farmers	Climate Smart Industries Food Security Human Security	PAGRO	100T	100T	100 T	100 T	100 T
Provision of crop insurance premiums	Farmers	Human Security	PAGRO	1 M	1 M	1 M	1 M	1 M
Livestock genetic upgrading project	Livestock Farmers	Food Security	PVO	500T	500T	500 T	500 T	500 T
Animal Health Care and Disease Program	Livestock farmers	Food Security	PVO	850T	850T	850 T	850 T	850 T
Animal Disease surveillance & monitoring	Livestock farmers	Food Security	PVO	350t	350t	350 t	350 t	350 t

Capacity building for monitoring, forecasting and early warning system	Trngs	Knowledge and Capacity Development	PDRRMD	100T	100T	100 T	100 T	100 T
Installation of emergency sirens in the flood forecasting and monitoring sensors	10 units	Knowledge and Capacity Development	PDRRMD	150T	150T	150 T	-	-
Enhance and institutionalize EWS information sharing and communication system	1 EWS	Knowledge and Capacity Development	PDRRMD	100T	100T	-	-	-
Establish community-based EWS for various hazards	64 EWS	Knowledge and Capacity Development	PDRRMD/ LGUs/ Brgys	100T	100T	100 T	100 T	100 T
IEC thru quad-media	No. of IEC	Knowledge and Capacity Development	PIO	100t	100t	100 t	100 t	100 t
OPLAN-ANDAM activities	20 brys	Knowledge and Capacity Development	PDRRMD/ stakeholders	200T				
CCA-DRR advocacy Program	No. of activities	Knowledge and Capacity Development	PIO/PDRRMD/ PENRO-LGU	3.5M	3.5M	3.5 M	3.5 M	3.5 M
Technical assistance in the formulation of multi-year Barangay DRRM Plan	64 BDRRMP	Knowledge and Capacity Development	LDRRMOs / Brgys/PDRRMD	100T	100T	100 T	100 T	100 T
Capability Program for community based disaster risk reduction and management (barangay DRRMC, officers, responders, trainors and other stakeholders)	25 trngs	Knowledge and Capacity Development	LDRRMOs /Brgys PDRRMD	200T	200T	200 T	200 T	200 T
Rescuelympics	1 activity	Knowledge and Capacity Development Human Security	PDRRMD/ LGUs	300T	300T	300 T	300 T	300 T
Capacity enhancement for DANA/ ICS Teams, Relief Operation Team , Responders , medical/psychosocial service providers, CBDRRM trainors, and Camp Managers	8 trngs	Knowledge and Capacity Development	PDRRMD/ stakeholders	800T	800T	800 T	800 T	800 T
Enhancement of assessment and reporting tools		Knowledge and Capacity Development	PDRRMD /LDRRMOs	50T	-	-	-	-
Augmentation of rescue, operation, training and		Human Security	PDRRMD-PGO	1.2M	2M	2M	2M	2M

communication equipment		Knowledge and Capacity Development						
Operationalization of PDRRM Operation Center		Knowledge and Capacity Development	PDRRMD-PGO	7M	7M	7M	7M	7M
Development of Manual of Operation for the Operation Center	1 manual	Knowledge and Capacity Development	PDRRMD	50T	-	-	-	-
Improvement of warehouse	1 proj		PSWDO	150T	-	-	-	-
Construction of Provincial Disaster Training Center	1 proj	Knowledge and Capacity Development	PEO/ PDRRMD	-	2M	-	-	-
Operationalization of the Provincial Disaster Training Center	1 center	Knowledge and Capacity development	PDRRMC/ D	1M	1M	1M	1M	1M
Conduct of simulation exercises	No. of exercises	Knowledge and Capacity Development Human Security	PDRRMD	50T	50T	50T	50T	50T
Contingency Plan formulation	1 plan	Knowledge and Capacity Development	PDRRMC/ D TWG	100T				
Conduct of CCA and DRR education and training in the public and private schools	No. of trngs	Knowledge and Capacity Development	DEP-ED PDRRMD	100T	100T	100 T	100 T	100 T
Updating of directory of DRR key players and stakeholders	No. of directory	Knowledge and Capacity Development	PDRRMD	50T	-	-	-	-
MOA signing with partners and stakeholders	No. of MOA	Knowledge and Capacity Development	PDRRMD/ SP	-	-	-	-	-
Issue public advisories in accordance with the PROTOCOL		Knowledge and Capacity Development	PDRRMD	12T	12T	12T	12T	12T
Activation of the ICS		Knowledge and Capacity Development	LCE	-	-	-	-	-
Relief operation		Human Security	PSWDO	6.2M	6M	6M	6M	6M
Activation of DANA team at all levels		Knowledge and Capacity Development	LCE	800T	800T	800 T	800 T	800 T
Consolidate, analyze and disseminate information using latest DANA tool		Knowledge and Capacity Development	DANA Team/ PDRRMD	-	-	-	-	-
Search, rescue and retrieval operation		Human Security	PDRRMD/ PNP/AFP/ RDR Rescue Team	2M	2M	2M	2M	2M

Coordination with the security sector in emergency relief and rescue operations		Knowledge and Capacity Development Human Security	PSWDO/PNP/ AFP	-	-	-	-	-
Camp management (evacuation center)		Human Security	PSWDO/PHO/SMRP/PNP	70T	70T	70T	70T	70T
Provision of tents and other temporary facilities		Human Security	PSWDO/LGUs	100T	100T	100 T	100 T	100 T
Designation of spaces/area for the elderly, persons with special needs, PWD and children		Human Security	LGUs/ PSWDO	-	-	-	-	-
Designation of space for animals, livestock, pets in the evacuation area		Food Security	PVO	-	-	-	-	-
Provision of relief supplies (food and non-food)	No. of Bene-ficiaries	Human Security	PSWDO	6.2M	6.2M	6.2 M	6.2 M	6.2 M
Conduct of livelihood-oriented activities for the internally displaced persons		Human Security	PAGRO/ PVO/PSWDO	50T	50T	50T	50T	50T
Provision of medicines and other medical supplies	No. of Bene-Ficiaries	Human Security	PHO	500T	500T	500 T	500 T	500 T
Assessment of water quality and implementation of Water, sanitation and hygiene (WASH) project		Water Sufficiency Human Security	PHO	100T	100T	100 T	100 T	100 T
Determination of hospitals to address the casualties		Human Security	PHO/LGU	-	-	-	-	-
Financial assistance to disaster victims	No. of Bene-Ficiaries	Human Security	PSWDO	1M	1M	1M	1M	1M
Activation of partners in the delivery of psychosocial services (government and volunteer groups)		Human Security Knowledge and Capacity Development	PHO/SMRP	-	-	-	-	-
Conduct of traumatic and psychological debriefings		Human Security	PHO/SMRP	100T	100T	100 T	100 T	100 T
Quick damage repairs and road clearing operations		Human Security	PEO	200T	200T	200 T	200 T	200 T
Temporary livelihood and income generating activities (food for work, etc)		Human Security	PSWDO/PAGRO/ PVO	500T	500T	500 T	500 T	500 T

Coordination with utility providers and key stakeholders		Human Security Knowledge and Capacity Development	PEO	-	-	-	-	-
Post DANA activities		Knowledge and Capacity Development	DANA Team	50T	50T	50T	50T	50T
Preparation of Strategic Action Plan		Knowledge and Capacity Development	PPDO/ DANA Team	-	-	-	-	-
Food for work	No. of bene ficiaries	Human Security	PSWDO	400T	400T	400 T	400 T	400 T
Planting material and assistance to affected agricultural food production area	No. of bene Ficiaries	Food Security	PAGRO	275T	275T	275 T	275 T	275 T
Shelter Assistance to disaster victims	No. of bene Ficiaries	Human Security	PSWDO	500T	500T	500 T	500 T	500 T
Rehabilitation of infrastructure projects affected by calamity	No of Prof	Human Security	PEO	5M	5M	5M	5M	5M
Psychological sessions and referrals	No. of Beneficiari es	Human Security	PHO	50T	50T	50T	50T	505
Build capacities of psychosocial care providers	No. of trngs	Human Security	PHO	100T	-	-	-	-
Provision of drugs and medicine	Beneficiari es	Human Security	PHO	250T	250T	250 T	250 T	250 T

SEA LEVEL RISE

PROJECT/ACTIVITY	Target	NCCAP PRIORITY ADRESSED	RESPONSIBLE OFFICE	2015	2016	2017	2018	2019
Coastal Resource Management (Mangrove development)	Proj	Ecosystems and Environmental Stability	PENRO-LGU	500T	500T	500T	500T	500T
Formulation of Coastal Resource Management Project	1 plan	Ecosystems and Environmental Stability	PENRO-LGU		100T	-	-	-
Const. of water breaker and seawall	1 proj	Ecosystems and Environmental Stability	PEO	1M	1M	1M	1M	1M

Greenhouse Gas Inventory: Entity Level

To support better planning for adaptation and mitigation options that the province can implement, the provincial government initiated capacity building efforts related to development of greenhouse gas (GHG) inventory. This is to comply with the Guidelines for the Formulation of the LCCAP provided by the DILG with Memorandum Circular No. 2014-135. The Memorandum strongly suggests LGUs to identify mitigation options to help reduce carbon footprints and contribute to efforts in addressing climate change.

Table No. 35 Inventory of Greenhouse Gas Emissions (Entity Level) by Source, by Provincial Government Offices-PG Center, Davao del Norte

OFFICE	FUEL (in liters) STATIONARY COMBUSTION (t CO2/month*)	MOBILE (in liters) COMBUSTION (t CO2/month*)	ELECTRICITY (in Kilowatt) CONSUMPTION (t CO2/month*)	SOLID WASTE (in Kg) GENERATION (t CO2/month*)	WATER (in Liters) CONSUMPTION (t CO2/month*)
*PADO-IAS	0.0000	0.0000	59.7476	5.5200	0.0964
OSS	0.0000	48.0100	94.4137	3.5400	0.2102
*PACCO	0.0000	17.6000	59.7383	225.5640	0.4380
*PADO-Admin	0.0000	22.8500	59.7476	13.5991	0.3241
*PADO-APAO-Special Programs and Projects Div. and Tourism Div.	0.0000	9.3400	59.7476	4.1160	0.1402
***PADO-CIDD	0.0000	5.9600	48.4606	13.8000	0.1489
PAGRO	4.9119	46.6300	328.9698	45.1068	0.5957
*PASSO	0.0000	46.3300	59.7383	12.1200	0.2540
*PBO	0.0000	6.4800	59.7476	64.7460	0.1314
***PEEDO	7.4440	21.4200	212.5002	3.7200	0.2716
PEO	11.7928	1,041.8500	130.2705	1,260.9600	2.1900
PGSO	29.7761	56.9200	6.5135	282.0000	1.5067
***PHO	0.0000	12.3700	212.5002	16.9200	0.4643
*PHRMO	0.0000	52.6000	59.7476	19.6488	0.3154
PICKMO	0.0171	39.5800	202.7865	16.9500	0.3066
*PLO	0.0000	15.6700	59.7476	18.6150	0.4643
PPDO	0.0000	34.8600	8.7840	26.9400	0.2278
PSYDO	7.4440	13.8500	1,351.0149	52.0200	0.3504
*PTO	0.0000	38.1500	59.7476	86.6400	0.3416
PVO	0.1712	16.6700	24.1931	14.4000	0.1752
VGO	0.0000	178.5200	94.4137	38.1600	0.4380
PSWDO	0.0000	26.0500	35.6941	23.9280	0.2453
PENRO	0.0000	27.8000	71.0532	13.6440	0.2803
PG-DDN (Total)	**61.56**	**1,779.51**	**3,359.28**	**2,262.66**	**9.92**

*Note: * t CO2- carbon emission*
Fuel (in liters) for generator set & LGP
Mobile (in liters) includes diesel, oil, and gasoline for vehicles

As a result of the workshop conducted among the provincial government offices, it showed that within the government center, the top source of GHG emission comes from electricity consumption with an estimated average carbon emission of 3,359.28 per month. This is followed by solid waste generation with an estimated average carbon emission of 2,262.66 per month.

Table No. 36 Total Carbon Emission (Entity Level) and Carbon Offset Requirement by PG Offices within the Provincial Government Center Davao del Norte

OFFICE	TOTAL CARBON EMISSION (tCO2) per Office	No. of Trees*	No. of Hectares*
*PADO-IAS	65.27	435	0.54
OSS	145.96	973	1.22
*PACCO	302.90	2,019	2.52
*PADO-Admin	96.20	641	0.80
*PADO-APAO-Special Programs and Projects Div. and Tourism Div.	73.20	488	0.61
***PADO-CIDD	68.22	455	0.57
PAGRO	425.62	2,837	3.55
*PASSO	118.19	788	0.98
*PBO	130.97	873	1.09
***PEEDO	245.08	1,634	2.04
PEO	2,444.87	16,299	20.37
PGSO	375.21	2,501	3.13
***PHO	241.79	1,612	2.01
*PHRMO	132.00	880	1.10
PICKMO	259.33	1,729	2.16
*PLO	94.03	627	0.78
PPDO	70.58	471	0.59
PSYDO	1,424.33	9,496	11.87
*PTO	184.54	1,230	1.54
PVO	55.43	370	0.46
VGO	311.09	2,074	2.59
PSWDO	85.67	571	0.71
PENRO	112.50	750	0.94
PG-DDN	**7,463.00**	**49,753.35**	**62.19**

*Note: * assumption of 800 trees per hectare*

The workshop results recommend that the provincial government offices will have to target at least 49,800 trees for planting & growing, equivalent to 63 hectares, to offset carbon emission.

Identified Enabling Requirements

Legislative agenda of the province that supports the climate change adaptation may be obtained from SB - eg. Resolution No 10 series of 2014, PDC Resolution No.10 series of 2014, Resolution No. 154 series of 2015

Davao del Norte is extremely vulnerable to climate change. Since its GDP is associated with climate sensitive activities, particularly agriculture, the local economy and the livelihoods of the people are highly dependent on the climate. Although there are many climate change relevant projects undertaken by the local government in areas as forestry and agriculture, these are under the regular annual programs or projects of government expenditure and activities and are not formally registered as “climate change programs” or adaptation. These include for example integrated water resource management, community forestry programmes and irrigation systems. Very few adaptation interventions that explicitly address future climate risk have been supported by several foreign development partners in various modalities of support but are mostly national in scope. This means there is very little experience of operationalizing the adaptation M&E frameworks for these programs at the local level. This is extremely important considering that monitoring and evaluation of climate change and development programs are keys to accountability, learning and sustainability of the project.

Conducting impact evaluations provides a way to systematically generate knowledge about the magnitude and determinants of project performance, permitting the implementer to refine interventions and introduce improvements into future efforts. As a requirement, effective performance monitoring requires consistent procedures for data collection, analysis, reporting, and review. The focus on evaluation complements and reinforces efforts to improve activity design and the achievement of measurable results. Evaluations measure project effectiveness, relevance and/or sustainability. Hence, there is a need for Davao del Norte to explicitly integrate monitoring and evaluation in its Climate Change Action Plan. Defining, measuring, and evaluating it, however, is methodologically problematic as Climate change adaptation and resilience (CCAR) exhibits a number of characteristics which are not necessarily unique, but do require specific consideration if monitoring and evaluation is going to be effective. These characteristics include:

a. Long timeframes. Climate change is a long-term process that stretches far beyond the span of programme management cycles. The real impact of CCAR interventions may not be apparent for decades.

b. Uncertainty about actual climate change patterns and their effects in a given locale. While climate change will trigger more severe adverse weather events globally, it is unclear exactly how and when changes will unfold, and what their consequences will be in situ. Some locations are also likely to be affected very deeply, but by indirect means.

c. Shifting baseline data and changing contexts. This issue is of particular interest to M&E specialists, and is related to the above two points. The normal approach to programme evaluation includes collecting baseline data against which progress can be tracked. However, climate change itself is both unpredictable and taxing on local ecosystems and populations. Comparison of pre- and post- intervention data thus loses validity.

d. Measuring non-events. Particular adverse weather may not occur during the programme cycle, and ‘success’ may constitute stabilisation or preparedness rather than improved conditions. For example, a programme to improve the disaster management capacity of a local government in a typhoon-prone province will not be tested if no typhoon hits during the actual programme cycle. Meanwhile, in a context of

increasing drought, maintaining rather than improving a community's level of water security may constitute considerable achievement. While this is

may be widely understood among practitioners, it may be difficult to convince sceptical donors or policy-makers with these kinds of results.

e. Lack of universal indicators. While there are clear-cut indicators for climate change itself (e.g. average global temperature or CO2 levels), adaptation and resilience must be grounded in the context, scale, sector, locale, and nature of the endeavour, all of which vary widely. Moreover, many aspects of CCAR are 'soft' (e.g. institutional capacity, behaviour change), and for some key dimensions qualitative assessments are more appropriate or feasible. It may be difficult to aggregate community-level programme indicators to higher scales or, conversely, for national- or international-level ones to capture the effectiveness of CCAR interventions at the individual or household level.

f. Contribution vs. attribution. M&E approaches usually seek to demonstrate that changes can be attributed specifically to a particular endeavour: for example, that a village's improved food security is due to an agency's agricultural extension programme. However, the complexity of climate change adaptation and related interventions require a modified approach to M&E.

Cognizant of these challenges, the formulation of M and E of the Davao del Norte LCCAP needs to demonstrate how their policies or programs contribute to an overall adaptation process that is largely shaped by external factors. This may require more emphasis on process and proxy indicators in order to define and measure achievements or outcomes.

Monitoring and Evaluation Plans and Targets

Monitoring and evaluation (M&E) is built into the Executive and Legislative Agenda, whose focus is on the plan implementation. This section outlines the monitoring and evaluation system of the Local Climate Change Action Plan (LCCAP).

The objectives of M&E are:

b. To enable the province to assess the progress of the LCCAP, vis-à-vis, its targets, objectives and goals, with an established and operationalized systems and structures;

c. To utilize the LCCAP achievements not only for reporting to other project stakeholders but also for understanding the factors that influence performance and for using the lessons learned in future planning and programming; and

d. To promote the culture of performance among project implementers and stakeholders as part of the effort to introduce institutional reforms and innovations in the provincial government.

Monitoring and Evaluation System

M&E will look into LCCAP's accomplishments in relation to its contribution in the achievement of the goals of enhanced economic, environment, social and governance conditions of the province-in pursuance of the Vision of the province.

There shall be templates to develop for the M & E system to ensure the performances of the Provincial Government's efforts in achieving its Vision by gauging the results and outcomes of the various programs, projects and activities implemented. The template shall contain the following information.

a. Clear results expected at the output, outcomes and impact levels.
b. Defined performance indicatorts to measure achievement of the results
c. Quantified targets relating to the indicators to gauge successes
d. Source of information and documents where the performance are recorded and/or Reported
e. The system or procedure how the report/s will be accessed
f. The frequency of accessing the needed reports and information
g. The office or agency responsible in ourcing the reports and information needed

To comprehensively measure the progress of the implementation of the LCCAP, the measurement framework templates shall be developed extensively with the participation of all provincial government's department. As each department has their own mandate to address, the composition will ensure their ownership of the M&E system. Each department by then, will be able to relate to the contents and outcomes of the measurements being done.

Chapter VII: ANNEXES

LIST OF REFERENCES
http://www.ukcip.org.uk/wp-content/PDFs/SEA-Change-UKCIP-MandE-review-2nd-edition.pdf