CLIMATE RISK VULNERABILITY ASSESSMENT

PROVINCE OF DINAGAT ISLANDS

DEPARTMENT OF AGRICULTURE
REGIONAL FIELD OFFICE XIII

Message

We live in a world where we enjoy the pleasures of nature. We are provided with resources that are abundant and free. But as years pass and human activities are changing, tremendous effects of climate change are dominantly present affecting the availability of resources and poses dramatic loss to the economy.

As we face this very challenging times brought about by the climate change, the Department of Agriculture continues to provide interventions that will develop adaptation and mitigation skills of our farmers and fishers – helping them battle the effects of climate adversities.

I commend the Research Division for producing a comprehensive and holistic analysis of the Climate Risk Vulnerability Assessment (CRVA) in the region. In this report, the vulnerability index in terms of the adaptive capacity, exposure, and sensitivity are presented in details, as well as the factors affecting it.

The CRVA is very relevant for it serves two purpose: (1) as basis in the establishment of AMIA Villages where Climate-Resilient Agriculture (CRA) practices are showcased and (2) as guide in implementing programs and interventions of the Department. Similarly, this also serves as reference for policy-makers, farmers, research institutions, academe, organizations, and interested groups.

May this output further promote the crucial role that R&D plays in developing innovations and enhancing agricultural productivity as well as income of our farmers and fishers in Caraga.

Thank you and Mabuhay! Larga Caraga, Larga!

ABEL JAMES I. MONTEAGUDO
Regional Executive Director

Message

As climate change continues to exert pressure on the livelihoods and agricultural productivity of our farmers, the need to understand the vulnerability of the community is very timely and necessary.

Cognizant of the fact that there have been various programs and interventions geared towards adaptation and mitigation initiatives of our farmers and fishers in Caraga, having this comprehensive CRVA report is in the right direction.

This CRVA output will serve as benchmark of future programs and interventions we will be implementing the region. Considering the present situation and the existing resources available, we can make a huge impact in helping our farmers combat the negative effects of climate change in the future.

Through the AMIA project, the Department of Agriculture envisioned of enabling local communities manage climate risks while pursuing sustainable livelihoods. The information presented in this CRVA will help us determine the highly vulnerable municipality where appropriate climate-smart technologies and practices will be introduced.

I commend the Research Division and everyone behind the completion of this CRVA output deserves applause for their extraordinary effort. I am looking forward to seeing a bright R&D future ahead of us.

Congratulations everyone!

NICANDRO M. NAVIA, JR.
Regional Technical Director for
Research, Regulations & ILD/ AMIA, Focal Person

Message

I take pride in supporting this printed work, a first of its kind in the area of climate vulnerability assessment. As Project Leader and Chief of the Research Division, it's kind of fulfilling to come-up with this comprehensive CRVA analysis of all the municipalities in Caraga.

Considering all the information presented in this comprehensive CRVA output, we hope that this will be used as reference by our Banner Programs and LGUs in their future interventions, target-setting, and prioritization.

As for the AMIA project, this output will be used as basis in developing and promoting climate-resilient agriculture (CRA) through implementing technologies and practices, introducing institutional and social innovations, and accessing climate-relevant support services.

I am grateful to the Climate Resilient Agriculture Office for initiating projects directed towards increasing climate-change resiliency of our farmers.

To our researchers and collaborating LGUs, thank you very much and congratulations. May this output be an important and significant reference for everyone.

ABEL F. WAGAS
Chief, Research Division
AMIA, Project Leader

Acknowledgement

The AMIA Team would like to express its heartfelt gratitude to those personalities behind the success of this CRVA analysis that provides appropriate strategies to responding to the challenging call of climate change.

This book would not be possible without the contribution and commitment of the following departments and personnel:

We are thankful to the Department of Agriculture-Climate Resilient Agriculture Office for designing and funding this project with enormous budget allocation.

To the Department of Agriculture- Regional Office for the unwavering support in implementing this result-based project.

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To the project leader, Chief Abel F. Wagas who consistently monitored the implementation of the project.

To the members of the Technical Working Group (TWG) per Special Order # 11 who untiringly spare their time in attending and supporting AMIA activities.

To the AMIA Technical Staff who perform the data collection, consolidation, and validation to ensure conducive output as a tool for decision-making.

To all the Senior Staff for their continued guidance and supervision in the implementation of all CRVA-related undertakings.

To the concerned LGU's of the Province of Dinagat Islands who undoubtedly provide the data's needed for the creation of CRVA.

It's a wonderful experience to work with you all, you imparted a huge contribution in the success of this project. Thank you and God Bless us all.

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Abstract

This paper provides information on the most vulnerable municipalities to climate change impacts in the Province of Dinagat Islands (PDI) in Caraga region. This assessment was carried out by overlaying climate hazard maps, sensitivity maps, and adaptive capacity maps following the vulnerability assessment framework of the United Nations' Intergovernmental Panel on Climate Change (IPCC). The study used data on the spatial distribution of various climate-related hazards in the province of Dinagat Islands, Philippines. Based on this Climate Risk Vulnerability Assessment (CRVA), Tubajon, Cagdianao, Loreto, and Dinagat are among the highly vulnerable municipalities in the province due to its high exposure to climate hazards as well as their low adaptive capacity and the decreasing suitability of crops to climate variability in the aforementioned municipalities. Considering other factors constant, investing for rice, corn, cassava, and banana will be less favourable in the future. However, such potential impacts could be negated if the LGUs will continue investing in climate-change related programs and interventions that will improve farming practices and those that will facilitate agri-related coping mechanisms and strategies. Several climate-resilient farming technologies requires further verification. A Community Participatory Action Research (CPAR) is highly recommended in coming up with location specific climate resilient adaptation options.

Keywords: climate risk vulnerability, sensitivity index, hazard index, adaptive capacity

INTRODUCTION

The Philippines is now facing the very real impacts of climate change, which threaten to undermine our development prospects and exacerbate the vulnerability of our poorer communities. With projected changes in precipitation, temperature, intensity of tropical cyclones and frequency of extreme weather events, considerable efforts would be required to prepare the Philippines in dealing with the impacts of climate change on the different climate-sensitive sectors (Servando, N.T. in PAGASA, 2011). In addition, extreme weather events such as typhoons, drought, heavy rains, regularly visit the country and many have led to disasters costing the country billions in pesos every year. Of the 20 typhoons that enter the Philippine area of responsibility annually, nine (9) make landfall. Heavy rains from the annual monsoons also cause floods that lead to small and large disasters. El Niño, with its associated drought and floods, visit the country in 2-7 years interval.

The country's agri-fisheries sector is a perennial casualty of these climate-related risks. In the period of 2010 - 2014, loss and damages from climate/weather-induced disasters (FPOPD-DA, 2015) reached a total of Php136 billion or an average of PhP27 billion annually. The increased vulnerability of agri-fisheries communities to climate risks pose as a key challenge in enabling them to pursue more resilient and productive livelihoods, and ultimately rise out of poverty.

In response, the Department of Agriculture has launched the Adaptation and Mitigation Initiative in Agriculture (AMIA) in 2014, with an overall vision of a Philippine agri-fisheries sector that enables local communities to manage climate risks while pursuing sustainable livelihoods. As its overall approach, AMIA develops and promotes climate-resilient agriculture (CRA) through implementing technologies and practices, introducing institutional and social innovations, and accessing climate-relevant support services.

The initial phases of AMIA identified key climate risks and geographic targets across the country through Climate Risk Vulnerability Assessment (CRVA). This is purposely done to assess exposure, sensitivity, and adaptive capacity of the agri-fisheries sector to climate risks in the AMIA target regions; identify and prioritize province-specific climate risks that threaten the resilience of agri-fishery communities; and to plan and design climate-risk responsive research and development interventions to build resilience among agri-fishery communities.

Outputs of CRVA serves as basis in developing CRA-related decision-support tools, preliminary models for community action research, and recommended guidelines for provision of climate information services.

Objectives

The general objective of this study is to identify which municipalities in the Province of Dinagat Islands are the most vulnerable to climate change. It is expected that this information will be useful to policy-makers of the province and the region as well as stakeholders in better targeting their support towards climate change efforts. The specific objectives are as follows:

- To assess exposure, sensitivity, and adaptive capacity of the municipalities to climate risks in the province of Dinagat Islands;
- To show these vulnerable areas in a map for ease of reference of interested parties; and
- To plan and design climate-risk responsive research and development interventions to build resilience among agri-fishery communities.

METHODOLOGY

Study area

This report highlights the CRVA output for the province of Dinagat Islands. The geographic positions of the four (4) outermost points of the Province are shown in Map Profile along with its longitude and latitude (Figure 1). Dinagat Islands is bounded on the north, starting from desolation point, by Surigao Strait; on the east by the Philippine Sea; on the south-east by Dinagat sound; on the south by Gaboc Channel and Nonoc Island; on the south-west by Awasan Bay, Hanigad Island and Hikdop Island; and on the west by Surigao Strait.

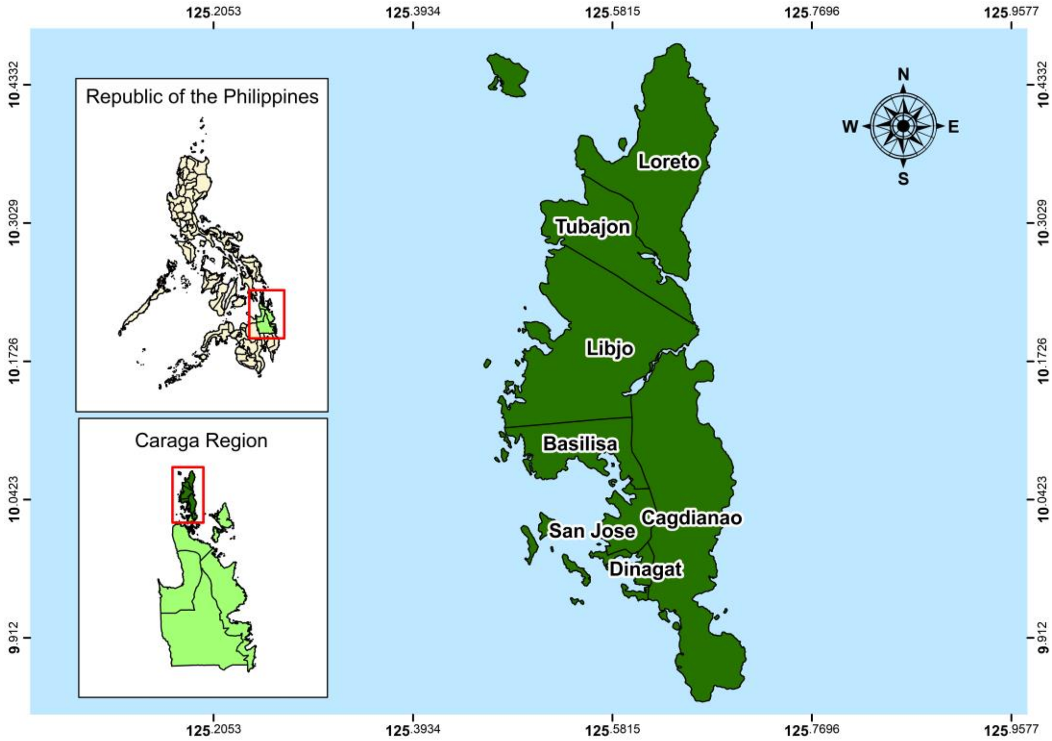


Figure 1. Geographical map of the study area in the province of Dinagat

The CRVA Framework

Climate risk vulnerability is the degree to which an area is susceptible to the adverse effects of climate change, specifically as manifested in increasing weather variability and projected long-term shift in the occurrence of extreme weather events. Analysis is based on the vulnerability assessment framework from the Intergovernmental Panel on Climate Change (IPCC) which define vulnerability as a function of 3 key dimensions namely, sensitivity, exposure, and adaptive capacity as shown in Figure 2. Each key dimension has weighted impact factor depending on the importance attributed to the system. The weighted impact factor used in this particular analysis was patterned from that of CIAT which measures CRVA as follows:

Integrated analysis is done through GIS overlay mapping, which is used to assess spatial patterns and to identify “hotspots” or sensitive areas with significant exposure to climate hazards and low adaptive capacity.

$$Vulnerability = (Exposure * 0.15) + (Sensitivity * 0.15) + ((1 - Adaptive\ Capacity) * 0.70) \quad \text{Equation (1)}$$

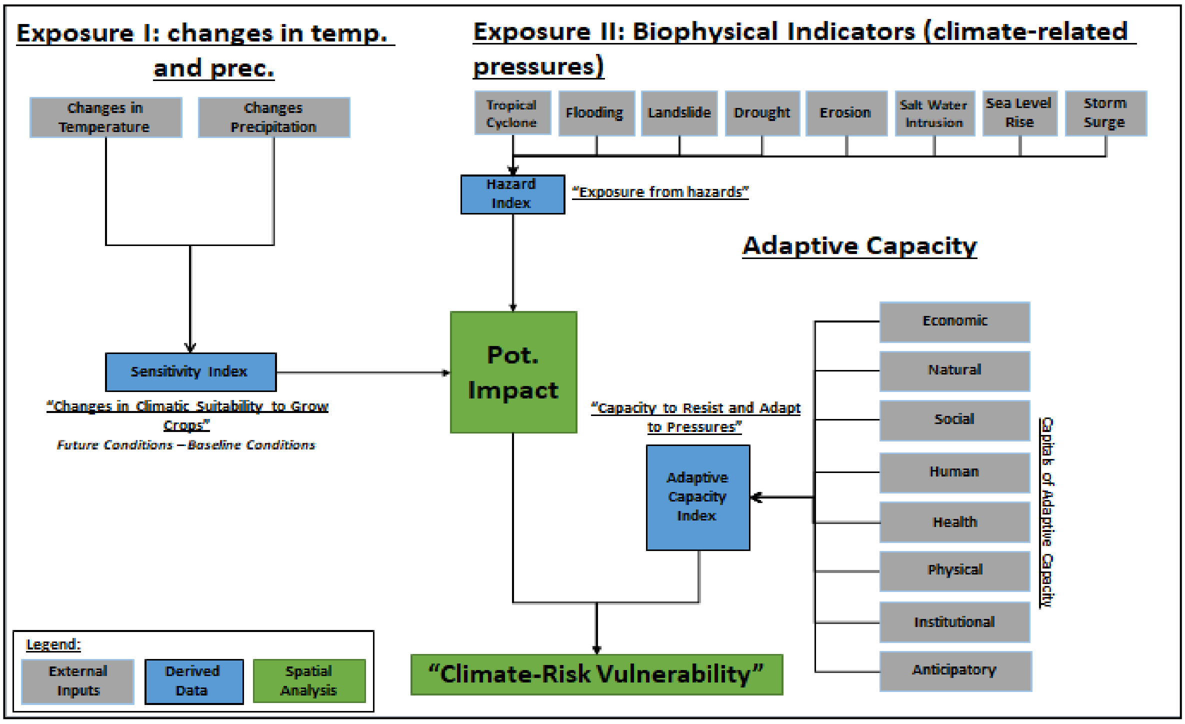


Figure 2. Framework of Climate Risk Vulnerability Assessment

Adaptive Capacity Estimation

The IPCC defined adaptive capacity (AC) as the ability or potential of a system to respond successfully to climate variability and change, and includes adjustments in both behavior and in resources and technologies. Literatures provided different versions of adaptive capacity definition however, most of them emphasized on similar idea- "to cope with the consequences". Adaptive capacity focuses on eight capital indicators namely, economic, natural, social, human, health, physical, anticipatory, and institutional. Proxy variables used for each capital were presented in Table 1.

Figure 3 displays the stages of adaptive capacity estimation which starts with data standardization or normalization of values to cancel out variability of data using the equation below:

$$Norm = \frac{x - x_{min}}{x_{max} - x_{min}} \qquad \textit{Equation 2}$$

where:

x= original value

x_{min}= lowest value in the data set

x_{max}= highest value in the data set

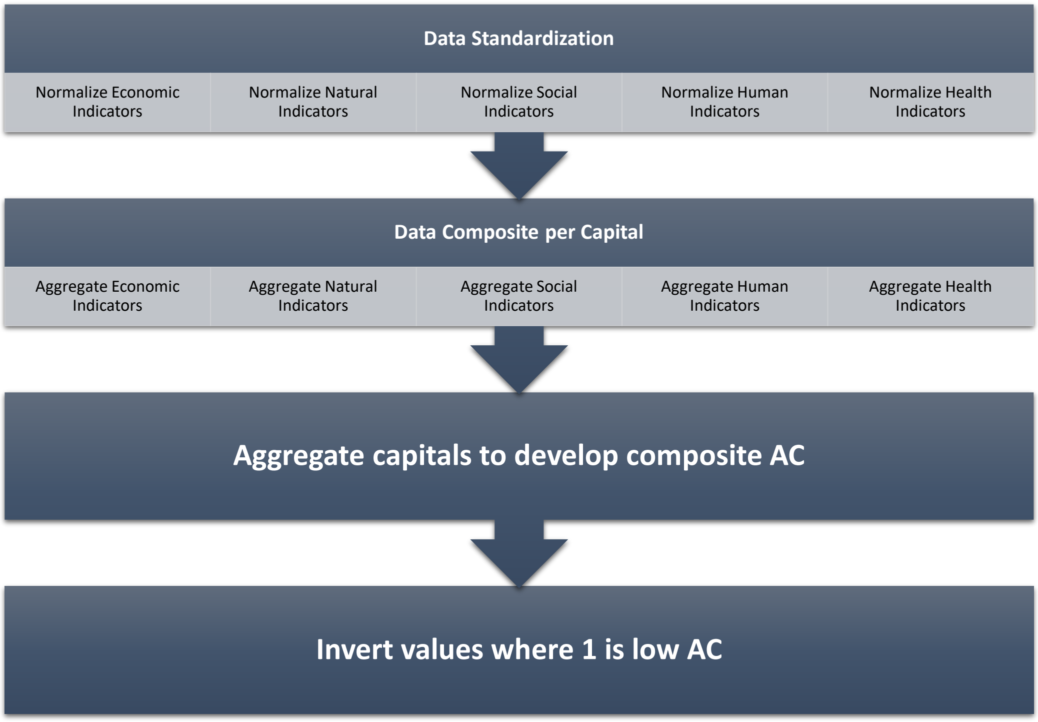


Figure 3. Simplified schematic diagram of AC processing.

Once the values are ready, composite index for each capital is then constructed by getting the average of all indicators. After computing for the composite index, the values will be normalized again for consistency. The composite AC is then derived using the sum function of all capital indices. To account for vulnerability, the AC index is then inverted where 1 is considered as low AC.

Table 1. List of indicators used in measuring adaptive capacity

Economic	Natural	Health	Human	Physical	Social	Anticipatory	Institutional
• Total area planted (top 5 commodities) • Total volume of production (top 5 commodities) • Income class • Total no. of financial institutions • Total no. of finance cooperatives • Total no. of ATMs • % of farmers covered with insurance • % of population employed in agriculture • Minimum wage rate in agriculture • Poverty incidence	• Total service area with irrigation • Total agricultural land area	• Malnutrition rate (No. of children weighed) • No. of health services • No. of health professionals • Local citizens with PhilHealth • Estimated population % of local citizens with PhilHealth	• Literacy rate • Ratio of school teachers to students • Total no. of secondary schools • Total no. of public and private tertiary schools • Total no. of technical vocational schools	• % of farmers owning agricultural land • Average farm size • Total number of livestock owned • % of agricultural area with irrigation • Total no. of concrete roads • % of household with water services % of household with electric services	• % of women officials on government • No. of farmer associations • % of farmers who are members of coops/unions/groups	• No. of MDRRMC registered trainings • % of farmers with access to mobile phones • % of farmers with access to televisions • % of farmers with access to radio • % of farmers with access to internet	• No. of AEWs • % of farmers visited or consulted with AEWs • % of farmers visiting or consulting the AEW of MAO

Crop Sensitivity Assessment

Sensitivity index is defined as the increase or decrease of climatic suitability of selected crops to changes in temperature and precipitation (Burgman, 2002). The Climate Change Commission define it as the degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea level rise).

Adopting the method suggested by the CIAT, the Maximum entropy (Maxent) model was used to compare crop suitability by the year 2050 vis-à-vis the baseline year. Analyzing changes in crop suitability involves a two-step process: The first step is to assess the baseline (current climate condition) crop suitability which is based on the condition that a species is predicted to occur at a particular location if it approximately matches the environmental condition where it is observed. The second step is to predict the location of a species on a particular time slice if it matches the environmental condition where it is observed in the baseline condition. Table 2 presents the 20 bioclimatic variables used to assess climate suitability of crops.

Table 2. Bioclimatic variables used in crop simulation modeling

PARAMETERS	DESCRIPTION
Temperature Related	
Bio_1 – Annual mean temperature	Annual mean temperature derived from the average monthly temperature
Bio_2 - Mean diurnal range	The mean of the monthly temperature ranges (monthly maximum minus monthly minimum).
Bio_3 – Isothermality	Oscillation in day-to-night temperatures
Bio_4 - Temperature seasonality	The amount of temperature variation over a given year based on the standard deviation of monthly temperature averages.
Bio_5 - Maximum temperature of warmest month	The maximum monthly temperature occurrence over a given year (time-series) or average span of years (normal).
Bio_6 - Minimum temperature of the coldest month	The minimum monthly temperature occurrence over a given year (time-series) or averaged span of years (normal).
Bio_7 - Temperature annual range	A measure of temperature variation over a given period.
Bio_8 - Mean temperature of wettest quarter	This quarterly index approximates mean temperatures that prevail during the wettest season.
Bio_9 - Mean temperature of the driest quarter	This quarterly index approximates mean temperatures that prevail during the driest quarter.
Bio_10 - Mean temperature of warmest quarter	This quarterly index approximates mean temperatures that prevail during the warmest quarter.
Bio_11 - Mean temperature of coldest quarter	This quarterly index approximates mean temperatures that prevail during the coldest quarter.
Precipitation Related	
Bio_12 - Annual precipitation	This is the sum of all total monthly precipitation values.

Sources:*(O'Donell, M and Ignizio, D., 2012)*

Table 2. Bioclimatic variables used in crop simulation modeling-*continued*

PARAMETERS	DESCRIPTION
Bio_13 - Precipitation of wettest month	This index identifies the total precipitation that prevails during the wettest month.
Bio_14 - Precipitation of driest month	This index identifies the total precipitation that prevails during the driest month.
Bio_15 - Precipitation seasonality	This is a measure of the variation in monthly precipitation totals over the course of the year. This index is the ratio of the standard deviation of the monthly total precipitation to the mean monthly total rainfall and is expressed as a percentage.
Bio_16 - Precipitation of wettest quarter	This quarterly index approximates total precipitation that prevails during the wettest quarter.
Bio_17 - Precipitation of driest quarter	This quarterly index approximates total precipitation that prevails during the driest quarter.
Bio_18 - Precipitation of warmest quarter	This quarterly index approximates total precipitation that prevails during the warmest quarter.
Bio_19 - Precipitation of coldest quarter	This quarterly index approximates total precipitation that prevails during the coldest quarter.
Bio_20 - Number of consecutive dry days	Consistent number considered as dry days.

Sources:*(O'Donell, M and Ignizio, D., 2012)*

Generating Exposure Index

Exposure index captures the level of potential exposure to extreme climate- related events such as cyclone, drought, flooding, landslide, sea level rise, severe local storm, storm surge, and wildfire (ADB, 2015). The development of an exposure or hazard index relies on spatial analysis of the weighted combination of different historical climate-related natural hazards in the Province of Dinagat Islands. At least eight hazards were identified for the said provinces and these are tropical cyclone (TC), flood (Fld), landslide (LS), erosion (Ero), drought (Drt), saltwater intrusion (SWI), sea level rise (SLR) and storm surge (SS). The selection of hazards was based on consultation with project partners during the participatory workshop.

Hazards Weights. The hazard weights used in this study was introduced by the lead partner of CIAT. The weights were identified through focus group discussions conducted and were represented by the different SUCs' experts/focal persons. The qualitative assessment using the following criteria 1) probability of occurrence, 2) impact of local household income, 3) impact to key natural resources to sustain productivity (refers to how key resources such as water quality and quantity, soil fertility, and biodiversity are affected), and 4) impact to food security of the country, and 5) impact to national economy. Table 3 summarizes the different weights for each island group in the Philippines. The criteria used also reflect the impact of hazards at different scales from local, landscape, and national level. A spatially-weighted sum was used to develop the hazards index for each island group (Luzon, Visayas, and Mindanao). Thus, in the case of the Agusan del Norte province, the weights of the

Mindanao cluster were adopted. For each municipality in the province, the value of the hazard index was computed and normalized.
Adopting the framework from CIAT, below is the econometric specification for computing hazard index:

$$Hazard_{index} = \sum (TC * 16.95) + (Fld * 15.25) + (LS *14.41) + (Ero*12.71) + (Drt*16.95) + (SWI*10.17) + (SLR* 5.08) * (SS * 8.48) \quad \text{Equation (3)}$$

where:

TC-*Tropical cyclone*; **Fld-***Flood*; **LS-***Landslide*; **Ero-***Erosion*; **Drt-***Drought;* **SWI-***Saltwater intrusion*; **SLR-***Sea level rise* and **SS-***Storm surge*

Five equal breaks were used to geo-visualize the map, and it was classified into 0-0.20 (Very Low), 0.20-0.40 (Low), 0.40-0.60 (Moderate), 0.60-0.80 (High) and 0.80-1.0 (Very High).

Table 3. Hazard weights

Hazards		**ISLAND GROUP**		
		Luzon, %	**Visayas, %**	**Mindanao, %**
1	Tropical cyclone	20	18.21	16.95
2	Flood	19.05	16.4	15.25
3	Landslide	8.27	10.72	14.41
4	Erosion	11.43	12.57	12.71
5	Drought	14.25	16.17	16.95
6	Saltwater intrusion	11.43	7.21	10.17
7	Sea Level Rise	5.71	8.33	5.08
8	Storm Surge	9.52	10.39	8.48

Source: CIAT

AGRO-EDAPHIC PROFILE

Topography

Elevation. The province has a varied terrain ranging from flat, to rugged, to mountainous. The elevation of the eastern part of the province reaches over 900 meters from sea level. The rest of the island is characterized by broken relief or relatively low elevation especially land areas adjacent to the ocean. The highest points of the province are the peaks of Mt. Kambinliw and Mt. Redondo. They are both found in the northern and southern part of the Municipality of Loreto, respectively (PDI Ecological Profile, 2018).

Slope. National Land Use Committee, slope ranges are divided into six (6) categories as presented in Table 4. 0-3% (flat or level land), 3-8% (level of undulating), 8-18% (undulating or rolling), 18-30% (rolling to moderately steep hills), 30-50% (moderately to steeply mountainous and above 50% (very steeply mountainous).

According to PDI Ecological Profile, the slope of the island generally lies between 8% - 18% (Table 4). The western part of the island is composed mainly of very gentle slopes to strongly rolling slopes. Slopes that are 18% and above, or strongly rolling to very steep slopes, are found on the eastern side of the island where the highest points of the province are also located.

Table 4. Slope classification

Municipality	Slope Category (has.)					Total
	0-8%	8%-18%	18%-30%	30%-50%	50% and Above	
Basilisa	4,115.71	5,180.27	906.00	7.21	1.09	10,210.28
Cagdianao	3,777.84	10,234.21	4,745.60	290.15	16.83	19,064.62
Dinagat	1,209.06	678.28	47.38	No data	No data	1,934.72
Libjo	6,745.62	7,855.75	2,058.94	234.16	2.61	16,897.07
Loreto	2,679.02	5,560.63	5,631.73	1,466.19	24.42	15,362.00
San Jose	937.85	1,946.90	206.51	0.54	No data	3,091.80
Tubajon	4,629.53	4,918.80	1,588.21	327.33	7.09	11,470.96

Source: Provincial Planning and Development Office, PDI

Geology

Rock formation and land forms. Based on the geologic map of the island, strike-slip faults concentrating on the central and western part of the island pass through the island. Inferred faults and observed faults run across the island starting from the Southeast of Basilisa running across San Jose and Libjo towards the Northwest of the island. Ultramafic rocks or Basalts make up most of the island. A thrust fault can be found on the southern part of the island in the municipality of Cagdianao and San Jose. In general, the presence of faults in the province limits the development of large infrastructures.

Soil origin and soil types. Generally, Dinagat Islands' soil comes from Ophiolites that are mostly ultramafic including serpentinized dunite, harzburgite with diabase/gabbroic bodies. According to Bureau of Soils and Water Management Studies (BSWM), soils of the highland areas, hills and mountains are of ultrabasic parent material consisting mainly of igneous rocks or volcanic and/or mafic and ultramafic rocks of plutonic origin. The products of these parent materials range from loam, to clay loam and clays with rocky surfaces. Different parent materials from which soils are formed explains the heterogeneity of soils in a given area.

The uplands consist mainly of shale and sandstone. Some areas consist of conglomerates with some alluvium, particularly in in-filled valleys and lime stones, specifically in the mountains and Karst hills between Loreto and Tubajon and on the western side of Libjo. The lowland consists mainly of alluvium parent material and some fluvomarine deposits specifically on beach ridges and swales.

The Dinagat Islands' soil is primarily Dinagat clay loam which comprises 70%, Kabatohan loam 20%, 5% of Bolinao clay steep phase and 5% of other soil classification. Dinagat clay loam is loose, friable fine-granular clay loam and its color ranges from light reddish brown to chocolate brown red. Kabatohan loam soils are dark, red soils which are high in iron (Fe) content particularly found in upland areas. Kabatohan loam is granular in structure, well drained and shows moderate erosion. Bolinao clay is reddish brown, dark

Land resources

Land area and distribution. The province of Dinagat Islands has a total land area of 96,745.85 hectares (Table 5). This represents 5.01% of the Caraga's total land area of 1,930,382.85 hectares. The largest Province in terms of land area is Agusan del Sur with a total land area of 829,719 hectares (42.98%) and the smallest province is Dinagat Islands.

The Province of Dinagat Islands is composed of seven municipalities. The largest municipality in terms of land area is Loreto with a total land area of 25,587.00 hectares (26%) and the smallest municipality is Dinagat with a total land area of 3,287.00 hectares (3%). Land reclamation is currently being undertaken by the province.

Table 5. Land area per municipality

Municipality	Land Area (Has.)	Percent Share to Total
Basilisa	9,268.36	10%
Cagdianao	22,704.53	23%
Dinagat	3,287.00	3%
Libjo	20,748.96	21%
Loreto	25,587.00	26%
San Jose	3,849.00	4%
Tubajon	11,301.00	12%
Total	**96,745.85**	**100%**

Source: NSCB and DENR Caraga, 2018.

Existing general land use

The total land area of the Province of Dinagat Islands is 96,745.85 hectares. Agricultural and forestal lands comprise 35% and 37% of the total land area, respectively. Vast areas devoted for such uses can be attributed to the slope of the province which is characterized by moderately sloping to very steep terrains. Forest Management Bureau

(FMB) has classified lands with 18% and above slopes as permanent forests whereas housing agencies have set 30% slope as limit for urban and agricultural uses. Other land uses, such as built up areas, mining areas, open spaces, tourist zones and infrastructure facilities comprise 28% of the total land area of the province. On the figure shown below, it composed of the crop occurrence markings in the Province of Dinagat Islands of their top commodity in their province namely rice, corn, cassava and banana.

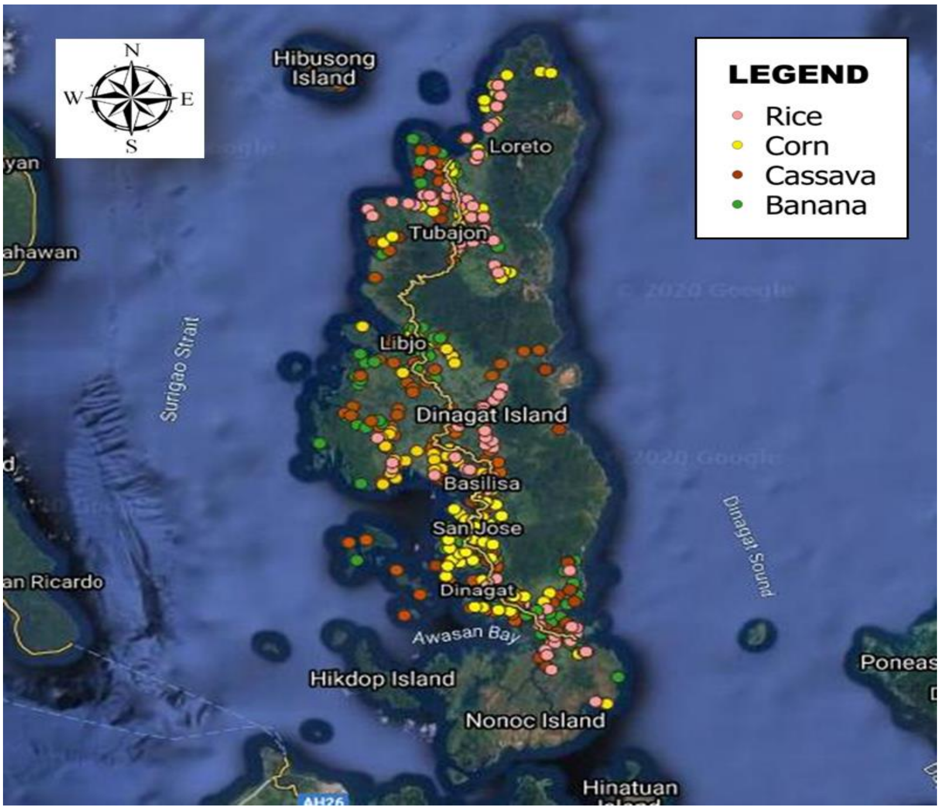


Figure 4. Crop occurrence markings in PDI, 2019.

Production areas

Agricultural area comprises 35% of the total land area of the province (Table 6). This is equivalent to 33,616.91 hectares of agricultural area. The municipality with the largest agricultural area is the municipality of Libjo with 12,509.64 hectares of agricultural land. It is followed by Loreto with an agricultural area of 5,579 hectares. To a certain degree, agricultural croplands are further classified into distinct categories such as areas for annual and permanent crops, irrigated and rainfed, and the like.

The largest forest area is found in the municipality of Loreto with a total of 15,975 hectares of forest land. Most of its land is in the 18%-50% slope range which is described as strongly rolling to mountainous as adopted by the National Land Use Committee (NLUC). Cagdianao is the second largest forest area in the province with 9,532.73 hectares of forest land. The mining industry utilizes 14,108.38 hectares of land or 14.58% of the total land area of the province.
It is the second largest industry, next to agriculture in terms of land area in Dinagat Islands. Large deposits of nickel and chromite can be found in the province particularly in Cagdianao. Because of this, Cagdianao has allotted 9,532.73 hectares of land to be used by the mining industries. Presently, it is the municipality with the largest mining area in the province. The municipalities of Dinagat and Tubajon do not have any data regarding their mining areas in their Comprehensive Land Use Plans (CLUP).

Table 6. Agricultural areas per municipality

Province / Municipality	Land area (ha)	Agricultural (ha)
DINAGAT ISLANDS	**96,745.85**	**33,616.91**
Basilisa	9,268.36	4,592.30
Cagdianao	22,704.53	5,486.00
Dinagat	3,287.00	2,052.00
Libjo	20,748.96	12,509.64
Loreto	25,587.00	5,579.00
San Jose	3,849.00	1,044.97
Tubajon	11,301.00	2,353.00

Source: CLUPs, 2016

Biological features

Terrestrial and freshwater. The Province of Dinagat Islands is part of a big faunal assemblage known as the Mindanao Faunal Province. This faunal province includes other nearby islands such as Bohol, Samar, Leyte, Basilan and other small islands of Mindanao and is characterized by a diversity of birds, mammals and reptiles. The Philippine glossy starling, Philippine bulbul, Philippine turtle dove and the Philippine mallard are few of the species of birds endemic in the islands. As reported by the Rapid Agro- Ecological Appraisal of Dinagat Islands in 1996, there are many other birds that make a distinguishable mark in the avian diversity of the province.

There are also innumerable species of mammals thriving in the islands. These mammals include the Mindanao tree shrew, the flying lemur, Philippine Tarsier, three (3) species of squirrel, one (1) species of bat and (1) species of murrid. Others like the Mindanao gymnure, the bush rat and cloud rat could also be found in the province. However, the faunal diversity of the islands is being threatened as some of its species are rapidly decreasing in number. According to the 1996 Dinagat Islands Field Data, there are six (6) near-threatened and six (6) threatened birds. There are nine (9) rare mammals and two (2) rare reptiles. The people of the province are encouraged to protect not only the endangered fauna but also all animals and their habitats.
On the other hand, freshwater bodies support the aquaculture of the province. These water bodies are very abundant in the Province of Dinagat Islands. Dinagat Islands has three (3) lakes, with a total area of 218.00 hectares, 26 rivers, 14 watersheds, four (4) springs, 58 streams, 14 waterfalls and five (5) creeks, respectively.

Marine and coastal ecosystems. Based on the municipal fisheries profile, the entire province of Dinagat Islands has 76 coastal barangays and eight (8) major fishing grounds. The marine and coastal ecosystems of the province provide the people different species of fish and shellfish. Dilis, tamban and katambak are the three (3) most abundant species that can be found in the waters around the province. As an island province, the main source of livelihood comes from the surrounding waters. Surigao Strait, Dinagat Sound and the Philippine Sea are the main fishing grounds. The western side of the province has a 50 km shoreline while the eastern side has about 40 km stretch of shoreline.
Both coasts are abundant in marine fishing resources because indentions and embankments along the shore provide good habitats for fishes and other sea creatures. Mangrove forests are also the natural habitat of fishes and aquatic life. They are found

within the coast of the island province. These mangrove forests are found in the northern shores of Dinagat islands in Libjo, Tubajon and Loreto.

Climate

Dinagat Islands falls under climate Type II characterized by no pronounced dry season, but with a very pronounced maximum rainfall period from November to February. It has a total annual rainfall of 4,376.70 mm. from the 185 rainy days. The average annual minimum and maximum temperature in 2018 measures to 24.2 degrees Celsius and 31.5 degrees Celsius, respectively. The average annual relative humidity is 83 percent and the average wind speed is one (1) meter per second, (PAG-ASA, Surigao City, 2018).

Atmospheric temperature

According to PAG-ASA, 2018, temperature ranges from a low of 23.3 degrees Celsius in January to a high of 32.7 degree Celsius in May, August and September. In 2018, Its average annual minimum temperature is 24.2°C and its average annual maximum temperature registers at 31.5°C (Table 7). Overall, the average temperature of the province is 27.9°C. In Figure 5, the line graph shows the monthly atmospheric temperature trend in the year 2018 of the province.

Table 7. Monthly atmospheric temperature, 2018, Province of Dinagat Islands

Month	Maximum Temperature (°C)	Minimum Temperature (°C)	Mean (°C)	Dry Bulb (°C)	Wet Bulb (°C)	Dew Point (°C)
January	29.4	23.3	26.3	26.2	24.6	24.0
February	29.9	23.5	26.7	26.4	24.6	23.9
March	30.8	23.8	27.3	27.1	25.0	24.3
April	32.0	24.4	28.2	27.9	25.6	24.8
May	32.7	24.9	28.8	28.7	26.1	25.2
June	32.6	24.8	28.7	28.5	25.9	25.0
July	32.3	24.6	28.5	28.3	25.7	24.8
August	32.7	24.7	28.7	28.6	25.8	24.9
September	32.7	24.6	28.7	28.6	25.8	24.9
October	32.0	24.4	28.2	28.1	25.7	24.9
November	30.8	24.0	27.4	27.3	25.4	24.7
December	29.9	23.7	26.8	26.6	24.9	24.3
Annual	31.5	24.2	27.9	27.7	25.4	24.6

Source: PAG-ASA, Surigao City, 2018.

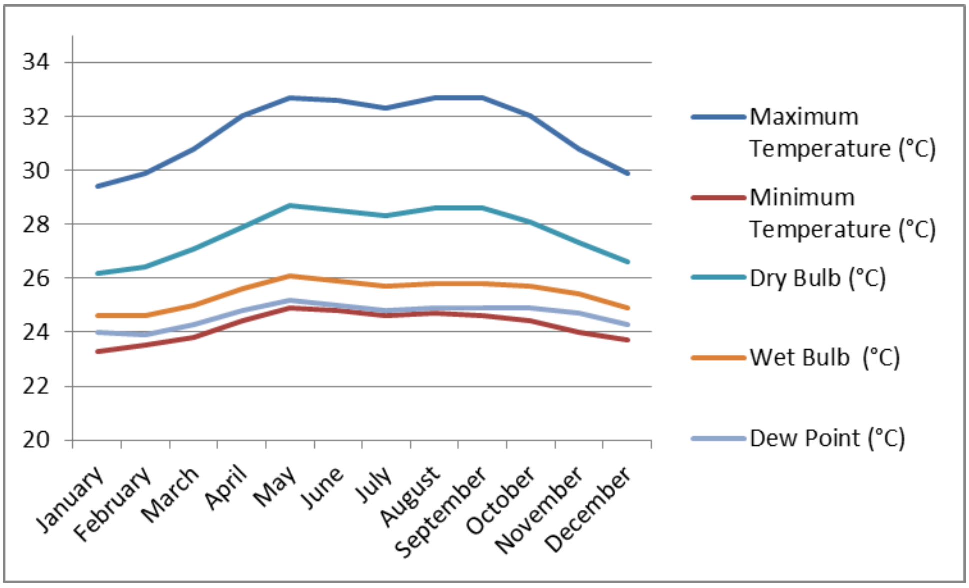


Figure 5. Monthly atmospheric temperature, 2018, Province of Dinagat Islands

Relative humidity. In 2018, the average relative humidity is recorded at 83 percent. The highest relative humidity was observed on January with 88 percent, on the other hand, the lowest relative humidity was observed on August and September.

Natural hazards/constraints

Flood. While most of the areas in the province have undulating terrains, the province experienced floods in the previous years during heavy rains and typhoons. These floods occurred in the low-lying areas of the municipalities of Loreto, Tubajon, Libjo and San Jose. From the Vulnerability Composite Map from Flood Hazard of the province, there are areas in different municipalities identified as vulnerable to flood. However, most areas of the province have moderate vulnerability to flood.

Landslide. Of the 100 barangays of the province, 93 are located on near slopes and have the potential risk to landslide occurrence. Only seven (7) barangays are considered not susceptible to landslide. Furthermore, 72% of the total numbers of barangays are considered highly susceptible to landslide and only 7% are considered low susceptible.

Storm surge. The Province of Dinagat Islands is generally not prone to high degree of storm surges. There are small areas in the municipality of Libjo, Basilisa, Cagdianao and Dinagat that could be affected by moderate degrees of storm surges. However, it may be well to consider this hazard when establishing projects near seashores, particularly in the vulnerable areas.
In 2018, the province experienced a total of five (5) tropical depressions, storms and typhoon. TS Basyang had the highest affected barangays with an estimated housing damage cost of PhP10,000.00, one toppled electric post and one school flooded. However, TD Agaton had the highest cost of damages, wherein housing damages reached to an estimate of PhP140,000.00, government building estimated damage cost of PhP60,000.00, flood control/slope protection/irrigation damage cost of PhP10,000.00 and crops/fruit trees/forestry damage cost of PhP 2,500.00.

SOCIO-ECONOMIC PROFILE

Population and social profile

Total population. Total Population refers to all persons in the territory at a specified time. Coverage includes both national and aliens; native and foreign born persons; internees, refugees, and any other group physically present within the borders of a country within a specified time. The province of Dinagat Islands recorded a total population of 127,152 in the 2015 Census of Population (Table 8). In the province male outnumbered female by 2,420. Basilisa posted the highest population where male is higher by 638 than female. In contrary, only in the Municipality of San Jose where female outnumbered male by 485. The other five municipalities have more male population than female.

Population density. Among the municipalities in the province, San Jose was the most densely populated with 801 persons per square kilometer. This is more than five (5) times the population density of the province. Of the region's 88 municipalities in 2015, San Jose was also the most densely populated, followed by Dinagat with 498 persons per square kilometer. In contrary, Loreto was the most sparsely populated municipality in the province with 60 persons per square kilometer and it ranked 9th on the most sparsely populated municipality in the region.

Table 8. Population size, land area, population density by municipality: 2015

Province/ Municipality	Population	Land Area (sq. km) a1/ a2/ a3/	Population Density (persons/sq. km)
DINAGAT ISLANDS	**127,152**	**817.47**	**156.00**
Basilisa	36,88	102.46	360.00
Cagdianao	16,81	196.57	86.00
Dinagat	10,63	21.36	498.00
Libjo	17,76	180.57	98.00
Loreto	9,31	155.82	60.00
San Jose (Capital)	27,48	34.31	801.00
Tubajon	8,28	126.38	65.00

Sources: Philippine Statistics Authority, 2000 and 2010 Census of Population and Housing, and 2015 Census of Population and Land Management Bureau

Household population. The household population by age group, sex, and by municipality in 2015 from which the province recorded 126,933 household population, (*Philippine Statistics Authority, 2015 Census of Population).* Of the household population, 32.83 percent were under 15 years of age or 41,668; Children below 5 years old comprised the 10.75 percent of the province' entire household population; the working-age-group accounted for 60.04 percent of the household population; and Senior Citizens constitutes 10.29 percent of the household population; same with the total population, there were more males than females in the province, with the males comprising 51 percent. There were more male than female population aged 0-4 years old, 0-14 years old, 15-64 years old, 18 years old and over. While among the senior citizens, female (53.75 percent) outnumbered the males (46.25 percent).

Urban rural distribution. Out of the 100 barangays in 2015, there were three (3) barangays classified as urban barangays in the province, namely: Valencia, Cagdianao; Esperanza, Loreto; and Poblacion, San Jose. The remaining 97 barangays were the rural barangays. The level of urbanization or the proportion of the urban population to the total population of the province in 2015 was 6.5 percent. This means that out of the 127,152 population in the province, 8,262 were living in areas classified as urban. The rural population or those who lived in areas classified as rural numbered 118,890 which accounted the 93.5 percent of the total population. In 2010, the level of urbanization of the province was 6.2 percent, (*Philippine Statistics Authority, Various Census Reports; Percent Urban computed).*

Health personnel and facilities. Health Facility refers to building or edifice used for healthcare services.[3] Out of the 100 barangays in the Province of Dinagat Islands, there were 34 Barangay Health Stations and 953 Barangay Health Workers. Each municipality has a ratio of more than five (5) barangay health workers per barangay. Each municipality has also one (1) Rural Health Units. Among the municipalities, Tubajon has the least number of personnel in the health center. There are three district hospitals in the province. DDH serves Cagdianao, Dinagat and San Jose; ADH serves Basilisa and Libjo; and LDH serves Loreto and Tubajon.

In October 23, 1972, the Dinagat Island Emergency Hospital came into existence through Republic Act No. 6611, with a DOH license to operate as a 25 bed capacity hospital. The bed capacity was increased from 25 to 75 after four years of hospital existence. Dinagat Island Emergency Hospital was once a national institution, until April 26, 1993 when it was devolved to the provincial government of Surigao del Norte. At the outset of devolution, Local Health District System was implemented, thus the hospital was renamed Dinagat District Hospital. Since thereon, its performance was noted to decline by time for doctors preferred to work in the city particularly in national entities but others ventured as private medical practitioner. Henceforth, the bed capacity of DDH was lowered to 30 as level 1 hospital by DOH. Currently, due to lack of manpower the DOH License to Operate for Dinagat District Hospital is 10 beds infirmary hospital, delivering ClinicalLaboratory examinations, Pharmacy, Dietary, CSR, Nursing, Admin., Dental, In-patient and Out-Patient Services.

Albor District Hospital is one of the District Hospital owned and manage by Province of Dinagat Islands located at Central Health Zone of this province. One of the common needs is to continuously address the leading causes of morbidity and mortality in the Central Area Health Zone. Albor District Hospital is an Infirmary Level with 10 Bed capacity and 29 manpower. In order to comply the DOH Requirement for license to operate, Job Orders were hired.

Natality. In 2018, births were recorded according to the place of occurrence. The province has a total live births of 994; 51 percent were male and 49 percent were female. Approximately, three (3) percent of the live births had low birth weights (less than 2,500 grams) and one (1) percent has unknown weights. This implies that approximately one (1) in every 36 babies born had low birth weights. According to the World Health Organization, underweight babies have greater risk of stunting; closely linked to high rates of neonatal mortality and ill health later in life; and developmental and health problems including diabetes and cardiovascular diseases. Of the total live births, 45 percent were delivered by doctors, four (4) percent were delivered by nurses, 43 percent by midwives, eight (8) percent by hilot/TBAs and one (1) percent by others. Approximately 91 percent of births were attended by skilled birth attendants. For the three consecutive years the number of live births decreased. The recorded 994 live births in 2018 decreased by 750 and 912 from that of 2017 and 2016, respectively, (*PDI Provincial Health Office. 2018)*.

Morbidity. In 2018, the first ten cause of morbidity in the province were Upper Respiratory Tract Infection (URTI), hypertension, fever, Sexually Transmitted Diseases, Diabetes Mellitus, Acute Rhinitis, Skin lession, Skin allergy, Urinary Tract Infection and dehydration. Upper Respiratory Tract Infection (URTI) was the leading cause of morbidity in the province with 3,380 number of cases. It is an irritation and swelling of the upper airways with associated cough which involves the nose, sinuses, pharynx, larynx, and the large airways.

Mortality. Hypertension was the leading cause of mortality in the province with 53 number of cases. Hypertension is a condition in which the blood vessels have persistently raised pressure. The blood vessels carries blood to all parts of the body. To prevent or treat hypertension, it is advised by WHO to eat healthy, limit alcohol consumption, exercise, lose weight and limit smoking.

Education. In the 2015 Census of Population, educational attainment statistics was obtained by asking the highest educational attainment of persons five (5) years old and over. With this, there were 113,498 in the age bracket. Of the total population aged five years and over, 11.9 percent completed at most elementary education, 19.0 percent had finished at most high school, 6.1 percent were academic degree holders, 0.9 percent were post-secondary. On the other hand, undergraduates in elementary, high school and college accounted 31 percent, 17.8 percent and 7.6 percent, respectively. Among those with college/academic degrees, females (59.6 percent) outnumbered males (40.4 percent). Similarly, there were more females (58.4 percent) than males (41.6 percent) among those with post baccalaureate courses. On the other hand, among the 51,620 household population 5 to 24 years old in 2015, 70.36 percent are currently attending school. This entails that 29.64 percent are currently not attending school. Those 15 to 19 years old are supposed to be in school. However, 37.47 percent are currently not attending school.

Number of teachers and ratio to pupil/student. Class size affects pupils/students learning development. In S.Y. 2017-2018, the standard teacher-pupil ratio is 1:31 for elementary; and the teacher-student ratio for Junior High School level is 1:36 and 1:31 for Senior High School; but before S.Y. 2017-2018, the ratio is 1:45. The number of authorized positions for teacher in the province is increasing for the three consecutive school years for both elementary and secondary; all of them were actually teaching. In the province, the teacher-pupil/student ratio is within the standard.

Number of classroom and ratio to pupil/student. According to DepEd, there shall be one classroom per 50 pupils/students (1:50). In elementary, there was an increased in the number of classrooms from SY 2016-2017 to SY 2017-2018. These led to the improvement of the classroom to pupil ratio from 1:23 to 1:18. While in secondary, there was a decreased in the number of classrooms. As a result, there was an increased in the classroom to student ratio; from 1:20, 1:21 in S.Y. 2016-2017 and SY 2016-2017 and S.Y. 2017-2018, respectively.

Local economy

Rice production, consumption and sufficiency level. In 2018, the province accounted 11,343.69 metric tons of rice. This converted to 6,751.28 metric tons of rice using 65% milling recovery (Table 9). The area harvested was recorded to 3,381.10 hectares. With the total rice production and the total area harvested, the province has an estimated average yield of 3.36 metric tons per hectare. Among the municipalities, Libjo has the highest production. In contrast, San Jose has the lowest rice production. On average, a person could consume 114.61 kilogram of rice in a year. With a recorded minimal annual population growth rate of 0.05% from 2010-2015 PSA census of population result, OPAg used the 2015 Census of Population result to estimate the consumption requirements of rice in the province. With this, the estimated consumption requirement for rice is 14,572.89 metric tons. The province is deficit by 7,821.61 metric tons to meet the consumption requirements for rice. Hence, the sufficiency level is only 46.33 percent.

Table 9. Rice production, area harvested, average yield, rice utilization and milling recovery by Municipality: 2018

Province/ Municipality	Rice production (MT)	Area harveste d (ha)	Average yield (MT/ha)	Rice utilization (MT)			Milling recovery (65%) (MT)
				Seed used	Feeds/ wastes	Net food disposition	
DINAGAT ISLANDS	11,343.69	3,381.10	3.36	219.77	737.34	10,386.58	6,751.28
Basilisa	1,688.59	526.00	3.21	34.19	109.76	1,544.64	1,004.02
Cagdianao	917.85	309.50	2.97	20.12	59.66	838.07	544.75
Dinagat	354.34	140.05	2.53	9.10	23.03	322.20	209.43
Libjo	5,601.14	1451.00	3.86	94.32	364.07	5,142.75	3,342.79
Loreto	1,226.90	421.00	2.91	27.37	79.75	1,119.79	727.86
San Jose	69.42	20.80	3.34	1.35	4.51	63.56	41.31
Tubajon	1,485.45	512.75	2.90	33.33	96.55	1,355.57	881.12

Source: Office of the Provincial Agriculturist, PDI

Corn production, consumption and sufficiency level. In 2018, the corn production was recorded at 329.18 metric tons with 130.96 hectares of area harvested (Table 10). The average yield was 2.51 metric tons per hectare. Using the 70% milling recovery, the province accounted 230.43 metric tons of corn. Among the municipalities, Basilisa has the highest production of corn, recorded at 115.84 metric tons. This comprised 50 percent of the province' total production of corn. The per capita consumption of corn is 4.646 kilograms. With this, the consumption requirement is estimated at 590.75 metric tons for the whole province. All of the municipalities were corn deficit in 2018 which led to a sufficiency level of only 39.01 percent.

Table 10. Corn Production, Area Harvested, Average Yield and Milling Recovery by Municipality: 2018

Province/ Municipality	Corn production (MT)	Area harvested (ha)	Average yield (MT/ha)	Milling Recovery (70%) (MT)
DINAGAT ISLANDS	**329.18**	**130.96**	**2.51**	**230.43**
Basilisa	165.48	63.77	2.59	115.84
Cagdianao	12.10	7.10	1.70	8.47
Dinagat	7.73	7.12	1.09	5.41
Libjo	72.18	22.80	3.17	50.53
Loreto	21.10	9.80	2.15	14.77
San Jose	12.98	5.06	2.57	9.09
Tubajon	37.61	15.31	2.46	26.33

Source: Office of the Provincial Agriculturist, PDI

Cassava production, consumption and sufficiency level. The per capita consumption of cassava is 15 kilogram. With this, the estimated consumption requirements was 1,907.28 metric tons. Production is greater than the consumption requirement. A surplus of 541.82 metric tons led to a sufficiency level of 128.41 percent (Table 11).

Table 11. Cassava production, area harvested and average yield: 2018

Province/Municipality	Production (MT)	Area harvested (ha)	Average yield(MT/ha)
DINAGAT ISLANDS	2,449.10	233.80	10.48
Basilisa	508.50	36.90	13.78
Cagdianao	432.50	38.40	11.26
Dinagat	487.60	064.60	7.55
Libjo	146.40	24.00	6.10
Loreto	409.00	36.70	11.14
San Jose	34.10	4.50	7.58
Tubajon	431.00	28.70	15.02

Source: Office of the Provincial Agriculturist, PDI

Banana production, consumption and sufficiency level. In 2018, PDI accounted a total production of 829.65 metric tons of cardava banana harvested in 75.70 hectares of land (Table 12). With this, the average yield was recorded at 10.96 metric tons per hectare. The production for all types of banana excluding cardava was 1,084.04 metric tons with a harvested area of 121.16 hectares. Therefore, the average yield was 8.95 metric tons per hectare. The per capita consumption of banana other than cardava was 11.18 kilograms in 2018, which estimated the consumption requirement at 1,421.56 metric tons. Since the production is lower than the consumption requirement, there was a deficit of 337.53 metric tons of banana (all types) province-wide. Overall, the sufficiency level was 76.26 percent. It could be noted that the municipality of Dinagat, Libjo, Loreto and Tubajon surpassed their consumption requirements but the overall production cannot sustain the total consumption requirement of the province.

Table 12. Banana production, area harvested and average yield: 2018

Province/ Municipality	Production (MT)	Harvested Area (ha)	Average Yield (MT/ha)
DINAGAT ISLANDS	**829.65**	**75.70**	**10.96**
Basilisa	206.40	17.20	12.00
Cagdianao	84.00	7.00	12.00
Dinagat	70.00	7.00	10.00
Libjo	168.00	14.00	12.00
Loreto	96.00	8.00	12.00
San Jose	103.25	14.00	7.38
Tubajon	102.00	8.50	12.00

Source: Office of the Provincial Agriculturist, PDI

Livestock and poultry

In the province, there were four (4) types of livestock raised (Table 13). This includes carabao, cattle, goat/sheep and hog/swine. Among the livestock, hog/swine has the highest production that accounted to 786 metric tons; using the farm gate price, the value of hog/swine amounted to 81,720,420 pesos. In 2018, the province has recorded production in chicken, chicken eggs and duck. Among the poultry products, chicken meat has the highest production that reached to 152.94 metric tons. The estimated amount of the total production of chicken using the farmgate price reached to 24,213,460 pesos.

Table 13. Livestock & poultry production: January - December 2018

Type	Classification		Production		Product market
	Backyard	Commercial	Volume (MT)	Value (PhP) Farm gate price	
1. Livestock					
a. Carabao	1,519.00	0	9	(97.75)879,750.00	Local
b. Cattle	267.00	0	7	(99.37)695,590.00	Local
c. Hog/Swine	6,956.00	200	786	(103.97)81,720,420.00	Local
d. Goat/Sheep	2,160.00	17	12	(181.85)2,182,200.00	Local
2. Poultry					
a. Chicken / Native & Broiler	40,279.00	0	152.94	(158.32)24,213,460.00	Local
b. Duck	2,714.00	0	7.66		Local
c. Chicken eggs / layer	9,432.00	No data available	145.49		Local

Source: Provincial Veterinary Office; Philippine Statistics Authority

Fisheries

Of the 100 barangays, 81 are coastal barangays. There were recorded 10,160 households engaged in fishing. There were 7,460 recorded fishermen, 2,057 motorized bancas and 1,267 non-motorized bancas in the province, excluding Basilisa. Among the municipalities, Libjo has the highest number of households engaged in fishing while Tubajon has the least number of fishing households (Table 14).

Table 14. Fishery Profile as of December 2018

Province/ Municipality	Total number of barangays	Number of coastal barangays	Number of fishing households	Number of fisherman	Number of bancas	
					Motorized	Non-motorized
DINAGAT ISLANDS	**100**	**81**	**10,160**	**7,460***	**2,057***	**1,267***
Basilisa	27	22	1,643	No data	No data	No data
Cagdianao	14	14	1,691	1,760	630	270
Dinagat	12	11	1,106	1,408	302	535
Libjo	16	10	1,946	1,088	210	49
Loreto	10	10	698	925	125	176
San Jose	12	8	1,499	1,399	390	65
Tubajon	9	6	603	880	400	172

Source: Provincial Fisheries Profile; MLGU Food Security Plan Excluding Basilisa*

Infrastructure and utilities

Road classification. The Province of Dinagat Islands has a total road network of 626.12 kilometers as of 2018 (Table 15). Approximately, 17 percent is classified as national road, 14 percent is under provincial road, 7 percent is classified as municipal road and 62 percent is under barangay road. Among the municipalities in the province, Loreto has the longest total road network of 126.84 kilometers while Dinagat has the shortest, with 57.42 kilometers.

Table 15. Inventory of roads by classification: as of 2018

Province / Municipality	Length of road (km)				Total length (km)
	National	Provincial	Municipal	Barangay	
DINAGAT ISLANDS	**104.38**	**89.81**	**46.52**	**385.41**	**626.12**
Basilisa	21.10	29.27	0.49	67.85	118.7
Cagdianao	9.46	3.64	3.84	52.64	69.58
Dinagat	13.16	5.16	2.98	36.13	57.42
Libjo	27.93	24.05	4.07	59.28	115.34
Loreto	3.76	7.81	27.49	87.78	126.84
San Jose	11.01	19.88	1.51	26.74	59.14
Tubajon	17.96	0.00	6.16	54.98	79.11

Source: Provincial Planning and Development Office, PDI

Road surface and road condition. Concrete-paved roads constitute 194.24 kilometers of the total road network; gravel roads have total length of 253.35 kilometers; earth roads constitute 169.97 kilometers, and limestone constitutes 4.71 kilometers. Concrete-paved roads are mainly located in urban centers. On the other hand, unpaved roads dominate the relatively mountainous and rugged terrain of the province. Of the total road length, 29 percent is in good condition and 22 percent is in fair condition. Meanwhile, 42 percent of the total road length is in bad condition and six (6) percent is in poor condition.

Provincial Core and Non-core Roads. Core roads as defined by DILG are roads connecting important locations and/or components of the economic drivers of the province such as agro-industry and other key production areas, logistic hubs, eco-tourism, and social services, among others. In the province, there were 13 roads identified as Core Roads, this summed to 60.189 kilometers among which Plaridel-Arellano-Magsaysay-Osmeña-Quezon-Sto.Niño Road (PAMOQS has the longest length. On the other hand, the province has six (6) non-core roads. These accounted to 29.62 kilometers. Garcia - Plaridel Road has the highest length of 9.01 kilometers.

Bridges. There is 747.97 linear meters of permanent bridges existing along national roads as of 2018. These road segments have been constructed and maintained by the Department of Public Works and Highways (DPWH), Dinagat Islands District. About 82 percent of the total lengths of the bridges are made up of concrete and 18 percent are made up of steel. There are 40 bridges connecting the national roads of the province. On the other hand, there are eight (8) bridges along the provincial roads with a total length of 143.42 linear meters. All of these are made of timber.

Agricultural support facilities. As of 2018, there were 24 rice mills and seven (7) corn mills in the province; one (1) cold storage in San Jose; 73 multi-purpose drying pavement which includes flatbed dryer, multi-purpose drying pavement, collapsible dryer, elevated solar tunnel dryer and agricultural warehouse/storage; and 216 agricultural machineries. Among the municipalities, Basilisa has the highest number of agricultural support facilities with a total of 93. Meanwhile, Dinagat has the least with 20 agricultural support facilities.

Domestic water supply. The domestic water in the whole province is delivered in three (3) different levels of services. These levels are categorized as:

a. Level I: This level refers to the point sources which are either safe or unsafe, through the distribution system constructed in places that for every 25 households, there is only one source.
b. Level II: This level consists of communal faucets with an average of five (5) households served per faucet.
c. Level III: This level is the piped systems with individual household connections supplying 4,716 households per system.

Level I water supply facilities or point source systems are common in rural barangays. Majority of these systems are privately owned. Most of the facilities are either shallow or deep wells equipped with hand pumps or developed springs. Rain collector is also used in some areas. The Level II water supply systems or communal faucets are designed for barangay level water supply, which have limited service coverage and supply capacity. Level II systems make use of springs or deep wells as sources. In the province, the Level III water system is established and operated by San Jose Water District.

San Jose Water District identified five (5) water sources, namely: Mangkuno spring (Intake 1), kamgong Spring (Intake 2) and Cuarenta Spring (Intake 3) located at Brgy. Cuarenta, San Jose, Dinagat Islands; Palu-12 Intake Box Located at Palu 12, Doña Helene, Basilisa, Dinagat Islands; and Manoligao-Rock fill Barage Located at Manoligao, Del Pilar, Cagdianao,Dinagat Islands. According to San Jose Water District, the diesel fueled pumping equipment operates only 8 hours per day with estimated 50 cubic meters of water generated per hour.

As of 2018, there were 2,864 number of connections in water district's record among which 2,591 were residential, 57 were commercial, 72 were industrial and 144 other not elsewhere classified. Residential has an average consumption of 1,140 cubic meters, while commercial and industrial building has 50 m^3 and 63 m^3, respectively.

Electric power supply

Power utilities. The power supply of the province is provided by the National Power Corporation and distributed by Dinagat Islands Electric Cooperative (DIELCO). This system is governed by Presidential Decree No. 269 under the supervision and assistance of the National Electrification Administration (NEA). It is operated by three (3) generating sets located in Loreto and five (5) generating sets in San Jose Power Station serving the seven (7) municipalities. As of 2018, there was a total installed capacity of 6,375 KW, higher by 1,500 KW than 2017; and total dependable capacity of 5,730 KW, higher by 1,500 KW than 2017. In addition, there were 4,769 electric posts and 100 streetlights.

Transportation

Land and sea transportation. In 2017, there is one (1) bus terminal, five (5) terminals for passenger van, 34 terminals for jeepney including multicab, and eight (8) terminals for tricycles. There is one (1) terminal for ships; there are 22 for passenger bancas; and 475 for motorized means of transportation not elsewhere classified.

Efficiency in the shipping and port services has become a major consideration in promoting the domestic and international trade and tourism development of the Province of Dinagat Islands. There are 65 seaports existing and operating in the province as of 2016. Five (5) of these ports are privately owned while 21 municipal ports are utilized as terminal ports of ferries coming to and from the island and transporting passengers and goods to the province. An additional of 35 ports is located in the different barangays of each municipality which also functions as municipal ports. There are three (3) anchorage areas and only one (1) beaching area that can be found in Loreto. Some of these ports have a need for thorough maintenance, facility improvement and expansion, so as to improve the present condition of the fishing industry being a major source of income for the people of Dinagat Islands. Also, there is a necessity to increase the capacity of these ports to handle the increasing volume of sea traffic and to accommodate the inter-island vessels docking onshore to the island. Ferry services have become the major means of transport of goods and commodities for the island province.

Safety and comfort in sea travel is a main consideration for travelers. Thus, imposed berthing and port terminal service like porter age provide convenience to the commuting public coming to and from the different parts the province. In 2018, there were 1,707 domestic ship calls, lesser by 271 than 2017. In addition, there were 323 roro ship calls in 2018, higher by 71 than 2017. A total of 294,187 passengers were recorded in 2018, higher by 51,773 passengers than the 2017 record.

Communication facilities. Different communication facilities are found across Dinagat Islands. There are seven (7) post offices/sub-offices in the province. The postal communication services especially in the remote areas are affected by lack of letter carriers and mail delivery vehicles. The construction of cellular communication sites by the two major telecommunications company, namely, SMART and GLOBE which provides mobile connections to a number of subscribers in every municipality, has increased telecommunications connectivity in the province. The provision of adequate communication facilities enhances the viable potentials of the province for agri-fishery, mining and tourism industries by connecting remote areas to the urban economic centers.

Postal services are available in every municipality. Each municipality has one (1) post office. NEWS MPC is a telecommunication provider and is run by a local cooperative, cable television connection and internet connection. The cooperative also operates a local television channel.

In 2016, there are 17 and in 2018 Libjo has one (1) internet café. The Provincial Government of Dinagat Islands established one (1) FM station, The Mystical FM or DXDI 100.1 FM which can be found at Brgy. Cuarinta , San Jose. This is managed by the Provincial Information Office. The establishment of the FM station has a greater help for the dissemination and delivery of important information, news, programs and services to the constituent of the province.

Waste disposal system. Every Local Government Unit needs to follow a controlled dump site facility system with the implementing rules and regulations of the Republic Act 9003 or Philippine Ecological Solid Waste Management Act. The Provincial Government of Dinagat Islands strengthened the solid waste management system through Executive Order No. 07-006 Series of 2015. This encourages the seven municipalities to establish solid waste management facilities in their respective areas. The solid waste management facilities are composed of Material Recovery Facilities (MRF), Sanitary Land Fill (SLF), Composting Facilities, Junk Shops and among others.

According to PENRO-LGU, there is one sanitary landfill located at San Jose. In 2015-2018, the disposed solid waste reached to 66,962 kilograms. The sanitary landfill served 5,832 households. The other municipalities established residual containment areas. Basilisa has the highest solid waste generated at 97,494 kilograms. In 2018, the total garbage collected reached to 38,879.96 kg., this is higher by 1,394.96 kg. than 2017.

RESULTS AND DISCUSSION

Adaptive Capacity

The adaptive capacity to climate change of the system or community is influenced by the diversity of their existing resources and have access to (Defiesta et al., 2014). These indicators are important factors that determine resiliency to shocks such as climate variability or change. They comprise the assets or activities that reduce risks, smoothen consumption and maintain standard of living in the event of catastrophes or disruptions in farming (Ellis, 2000). All other things being the same, communities with more resources will most likely be able to adapt better to climate change.

Figure 6 presents the spatial analysis of all capitals as well as the aggregated adaptive capacity index for the province of Dinagat Islands. Data indicated that Libjo, San Jose, and Basilisa are the highly adaptive municipalities within the province concerning economic, natural, social, human, physical, anticipatory and institutional capitals. This information implies that these three municipalities have had great coping mechanisms or strategies to respond to climate-related hazards. The municipality of Cagdianao was found to have the weakest adaptive capacity in terms of economic and human capital while Basilisa is the most vulnerable in terms of health resources. In terms of natural resources, the municipality of Dinagat was observed to have the lowest adaptive capacity, while Libjo and Loreto are weakest in terms of institutional and anticipatory, respectively. Although San Jose had high overall adaptive capacity, it's social and physical capitals are not that strong. Overall, results show the need for the respective local government units (LGUs) to focus on improving their coping mechanisms by adding or improving their services and interventions in their respective communities affected by climate-related pressures.

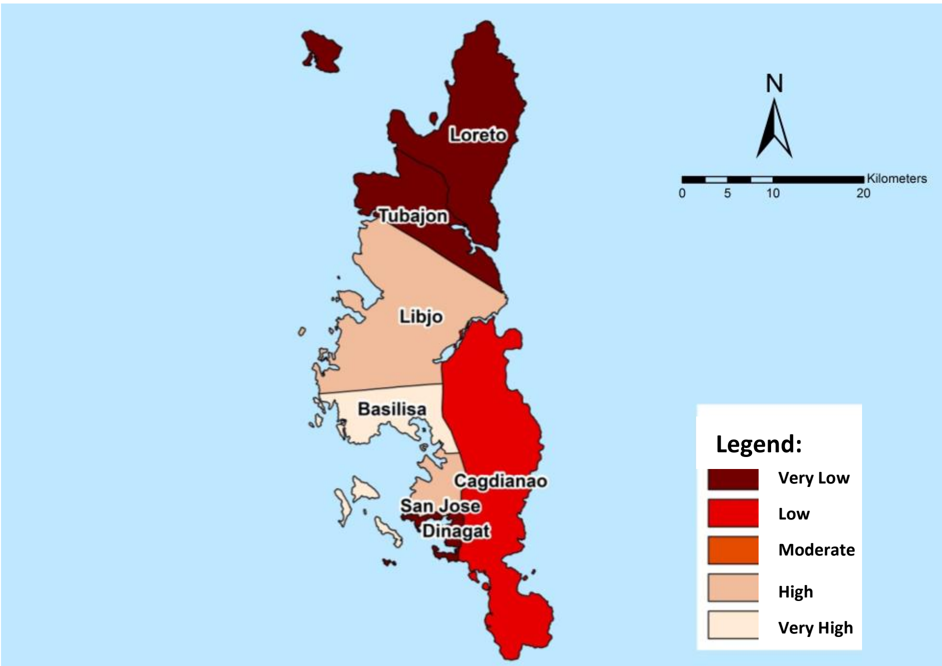
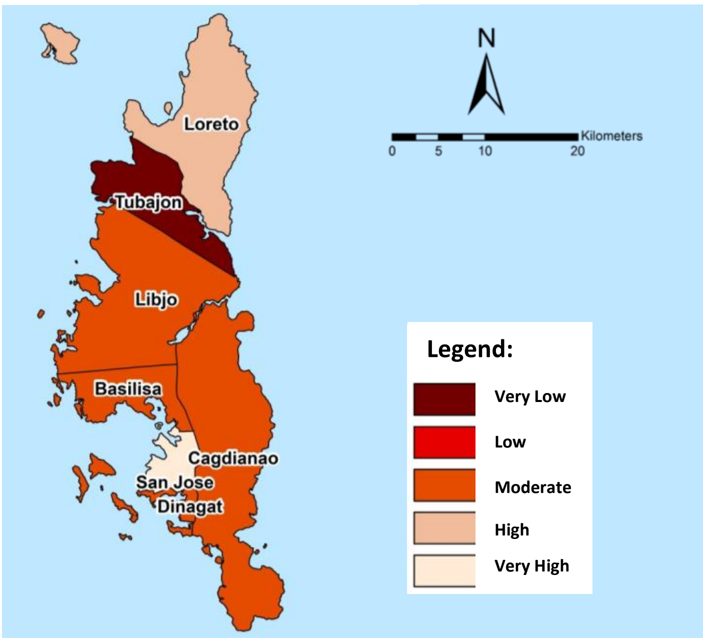


Figure 6. Adaptive capacity map for the province of Dinagat Islands

Economic Capital. The ability of the community to cope with and respond to change depends heavily on access to, and control over economic resources (Daze, et al., 2009). Typically, it is the poorest that are most vulnerable to the impacts of climate change and wider developmental pressures, in large part because of their lack of, or restricted access to, economic assets and resources. In the case of Dinagat Islands (Figure 7a), the municipality of Tubajon was observed to be the most vulnerable to climate change in terms of economic resources with 0.00 economic capital index while San Jose was observed to be the most adaptable municipality with 1.0 economic capital index. The vulnerability of Tubajon (Figure 7b) is likely due to high poverty incidence in the municipality with 42% (rank 3rd among all municipalities) and low percentage of farmers covered with insurance with 11.1% as compared to Dinagat, Tubajon, and San Jose with 49.6%, 16.5%, and 12.8%, respectively. High poverty incidence implies that the community in general lacks available and access to appropriate resources that may significantly limit the ability of a system to cope with the effects of climate change and wider development pressures (Jone, et.al., 2010).



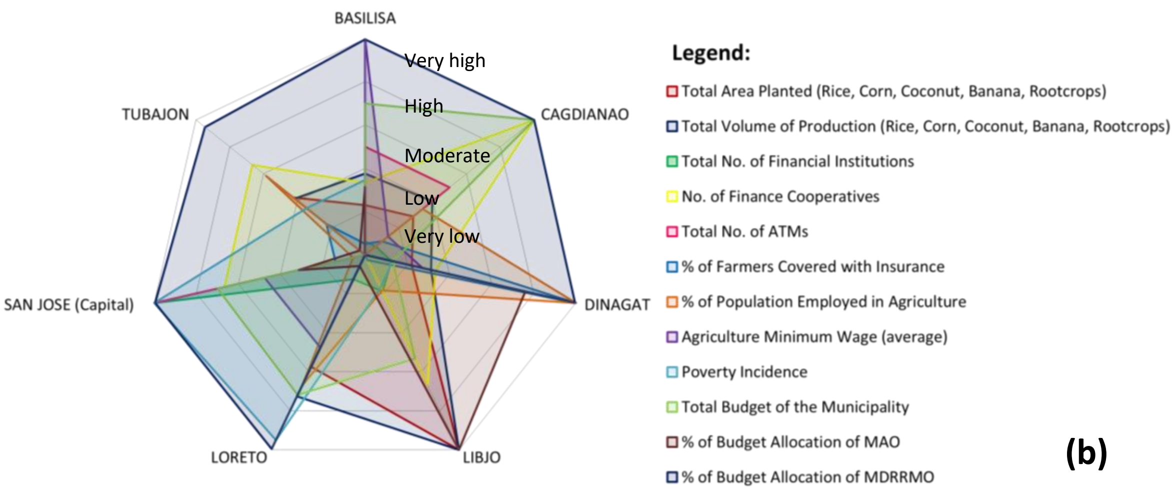


Figure 7. Economic capital map (a) and radar map (b), 2019

Natural Capital. Natural capital includes the land, water and biological resources that farm households use to generate livelihoods (Ellis, 2000). Generally, it is the community with limited access to irrigation system and those with smaller production area are most vulnerable to the climate threats and environmental hazards. This is further supported with the trend observed in PDI as Dinagat municipality (Figure 8a) was found to have the lowest natural capital index of 0.01 followed by the municipality of San Jose with 0.03 and Cagdianao with 0.16. Meanwhile, Libjo and Basilisa were observed to have better adaptability in terms of natural capital with 1.0 and 0.75 natural index, respectively. This is because Libjo and Basilisa (Figure 8b) were both have better irrigation system and larger agricultural area. It is a common knowledge that access to irrigation system facilitates good productivity thus, enabling the ability of a system to cope with the effects of climate change.

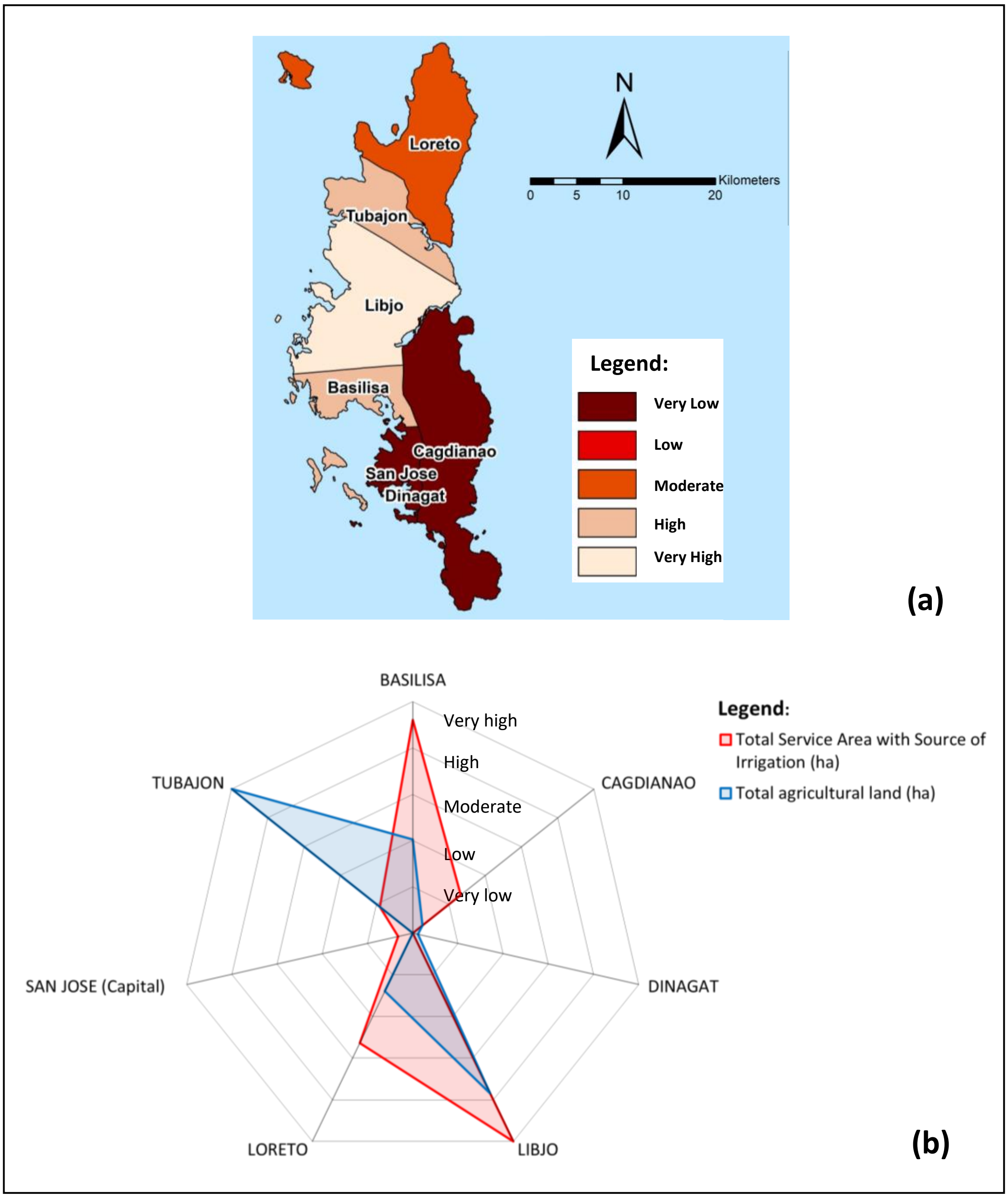


Figure 8. Natural capital map (a) and radar map (b), 2019

Social Capital. Social capital is made up of the networks and relationships between individuals and social groups that facilitate economic well-being and security hence, considered as critical component of adaptive capacity (Adger, 2003). Women and farmer groups play important role in enhancing the community's adaptive capacity to climate change.

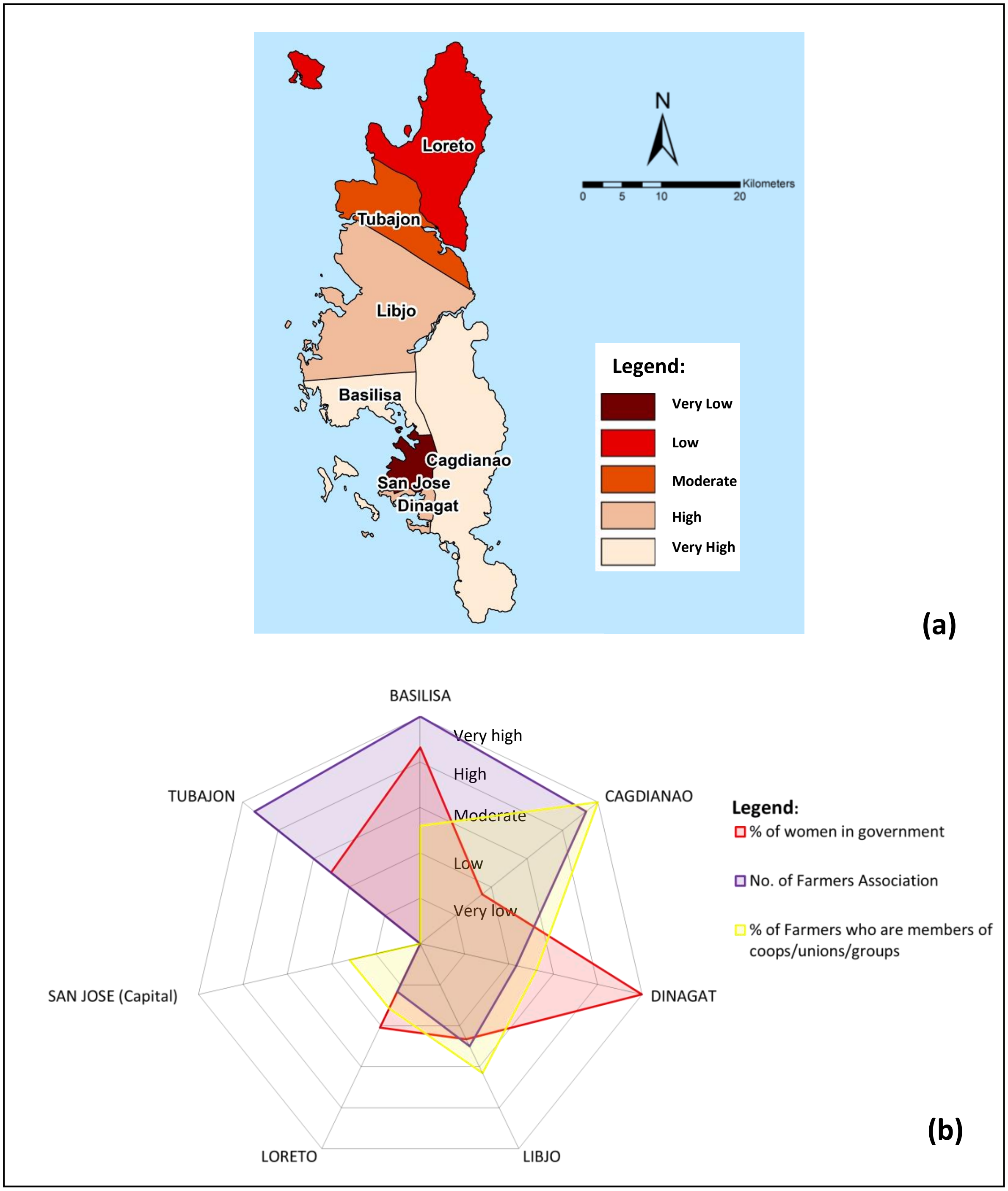


Figure 9. Social capital map (a) and radar map (b), 2019

The study of Muthoni and Wangui (2013) indicated that the role of women extends from family units to the community level where they contribute in all the major spontaneous and planned strategies that the village has taken up in response to a changing climate among other drivers. Membership to a farmers' organization is another sub-indicator of information resource. Affiliations to social groups provide farmers access to useful information for climate change adaptation that may be exclusively available only to group members. Group membership can also be a significant avenue for knowledge sharing among farmers about effective adaptation practices. These indicators are the very reason why Basilisa (1.0) and Cagdianao (0.95) have better social capital index over other municipalities especially the San Jose (0.00) and Loreto (0.31) (Figure 9a) . This is likely due to the fact that involvement of women in the government decision-makings as well as presence of more farmer associations in their locality and higher percentage of farmers who are member of groups and/or associations are consistently observe in these municipalities. There might be scenarios where municipality of Dinagat (Figure 9b) got the highest number of women officials but in some indicators, the said municipality is not having good numbers thus, Basilisa and Cagdianao outperformed the rest of the municipalities when it comes to social capital resources.

Human Capital. Human capital has also been identified as a critical determinant of adaptive capacity and behavior as it captures the inherent adaptive capacity of the vulnerable population. Generally, it is viewed that more educated households have better access to information and technologies and are better able to exploit these resources in adapting to climate change. The study of Wamsler et al. (2012) which assessed the role of schooling for increasing societies' adaptive capacities found that respondents with lower education were more likely to see their surroundings as risk free, whereas those with higher education were more aware of existing risks. According to the book of Kumar et al. on "Globalization and the Poor in Asia: Can Shared Growth be Sustained?", an entity's vulnerability decreases with increase in both literacy levels and expenditure on education. Variables that contributed to human capital strength of a community such as literacy rate, ratio of school teacher to students, total number of secondary schools, total number of tertiary schools, and total number of technical vocational schools were considered in this analysis.

Results indicated that San Jose being the capital municipality was found to have high human capital index (1.0) followed by Basilisa with 0.56. Cagdianao, Dinagat, and Tubajon on the other end got the lowest human capital index with 0.00, 0.02, and 0.09, respectively (Figure 10a). San Jose (Figure 10b) had the most number of technical vocational schools, the only municipality with tertiary school, has high ratio of teachers to students, and has good literacy rate hence, found to be highly adaptable in terms of human capital since overall investment in education is mostly concentrated in San Jose as compared to other municipalities.

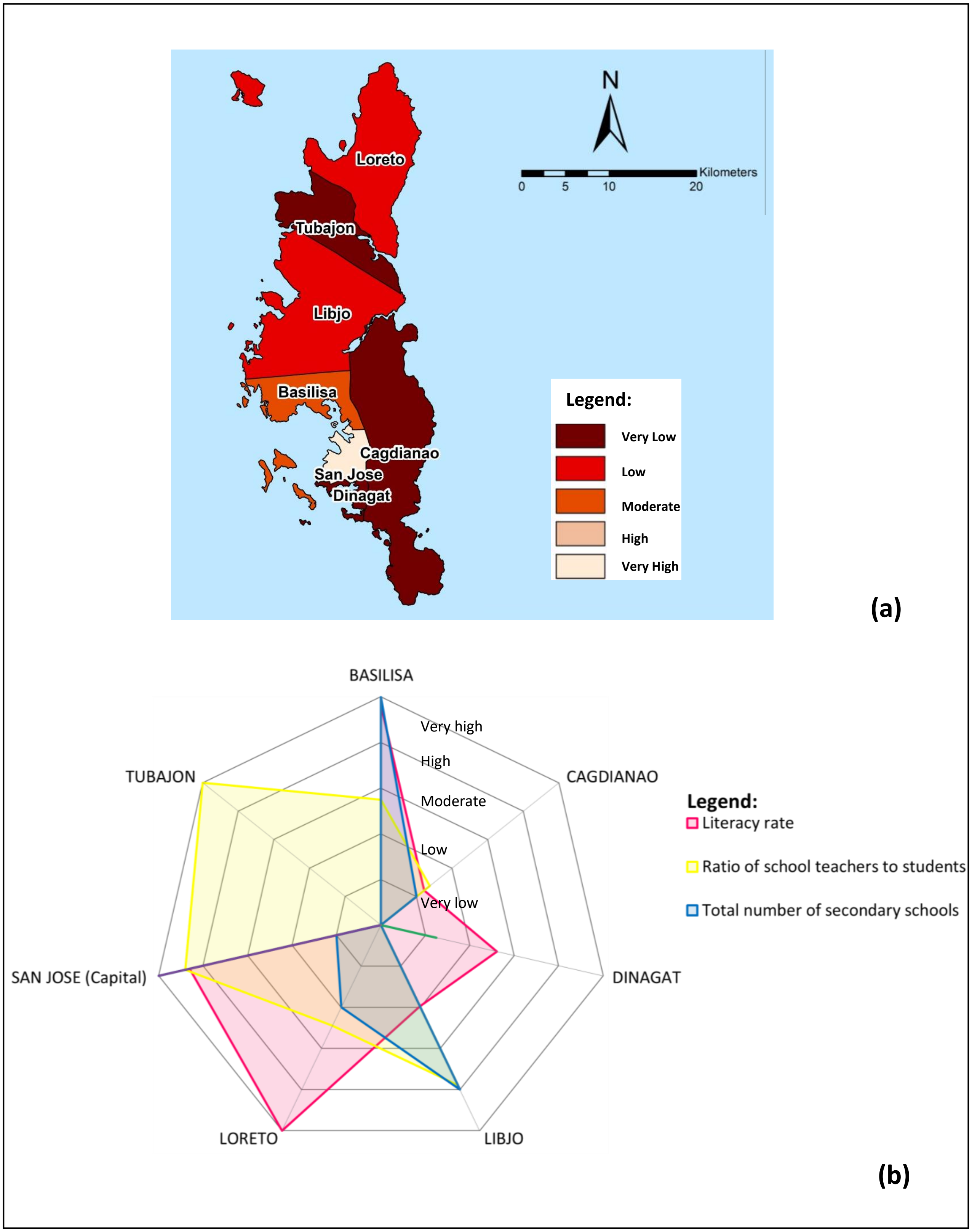


Figure 10. Human capital map (a) and radar map (b), 2019

Health Capital. Health capital and adaptive capacity are interlinked. High nutrition status and overall health of the population is a main determining factor of climate vulnerability. Poor nutrition can result in diminished productivity, which in turns lowers the adaptive capacity of the entire community.

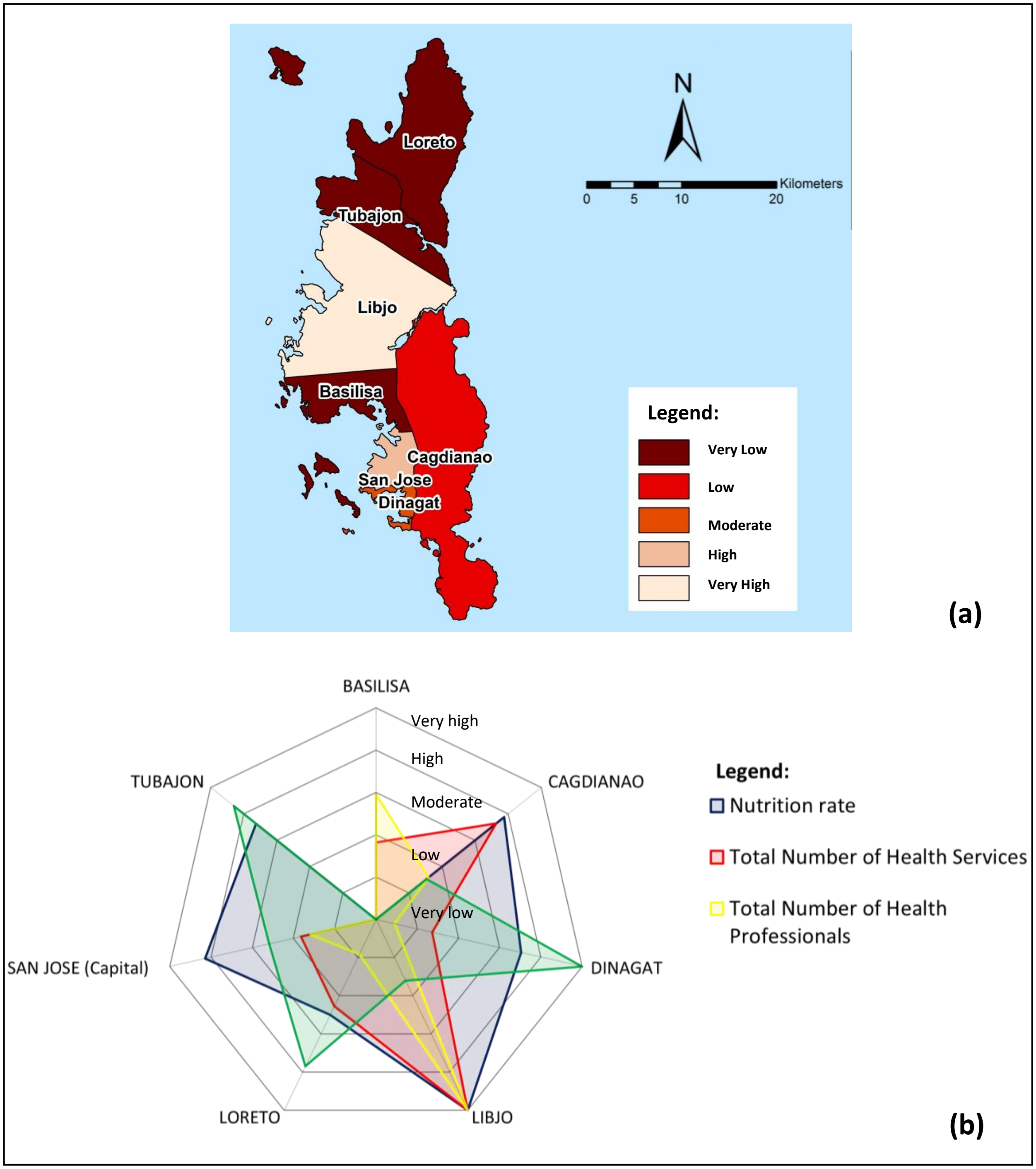
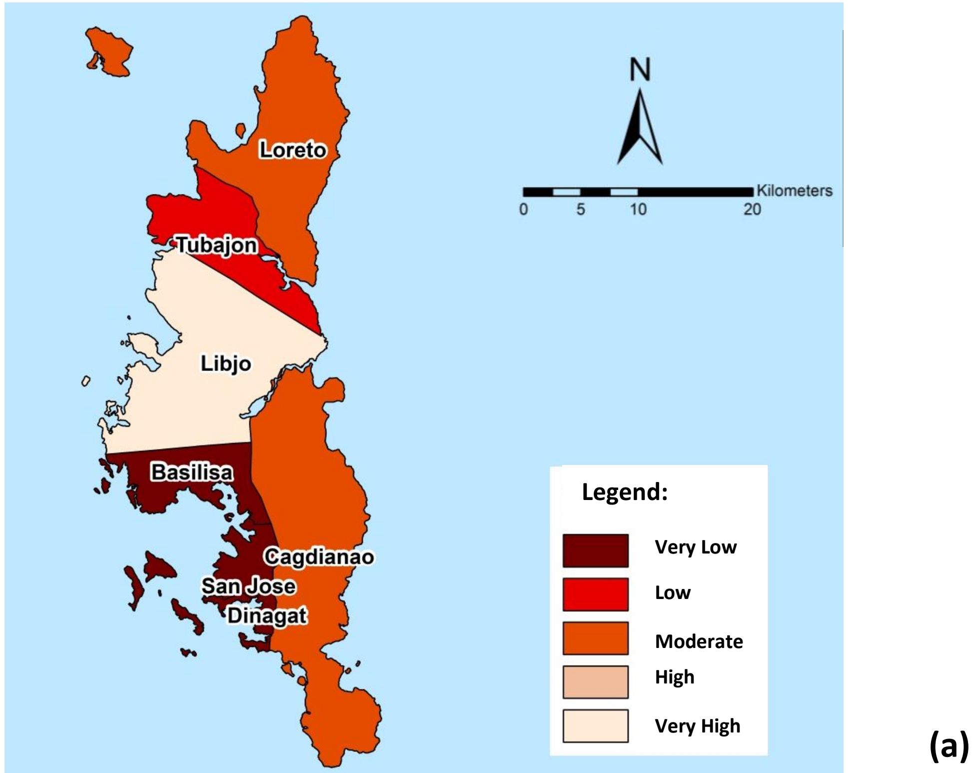


Figure 11. Health capital map (a) and radar map (b), 2019

The same case was observed in PDI as those municipalities with high nutrition rate are generally the ones who are highly adaptable in terms of health resources. For instance, the municipality of Libjo and San Jose (Figure 11a) are observed to have high nutrition standing not to mention the fact that they are also the ones with most number of health services and health professionals.

As a result, these municipalities turned out to be the top two adaptable municipalities in terms of health resources with 1.0 and 0.63 health capital index, respectively while Basilisa and Tubajon (Figure 11b) are the top two weakest municipality when it comes to adaptability with respect to health resources. Enabling wide access to healthy and nutritious food as well as access to health insurance and services makes the population more resilient to climate change. Thus, accounting for health capital in measuring the adaptive capacity of a system is significant and necessary.

Physical Capital. Physical resources refer to capital created by economic production processes, such as roads, machinery, and tools (Ellis 2000).The physical resources sub-indicators such as farm size, farm ownership, irrigation source, and number of farm implements and livestock owned, household water and electric services are considered to have significant role in the adaptive capacity of a system or community. For instance, farm ownership allows owners some privileges to farm infrastructure such as construction of shallow tube wells which is not allowed for non-owners (Eakin and Bojorquez-Tapia 2008). This enables farm owners to combine a set of physical resources such as irrigation and farm tenure to carry out strategies to adapt to climate change. Thus, it is assumed that adaptive capacity increases with increase number of the aforementioned resources. Data gathered in PDI (Figure 12a) indicated that Libjo is highly adaptable to climate change in terms of physical capital (1.0 index) followed by Cagdianao (0.73) and Tubajon (0.37). It is interesting to note that San Jose (Figure 12b) being the capital municipality was observed to be the most vulnerable to climate change with respect to physical resources. This is likely since the municipality has the least percentage of farmers owning agricultural land, least number of livestock owned, least percentage of households with potable water services, has least total length of concrete roads, and has low percentage of irrigated agricultural area.



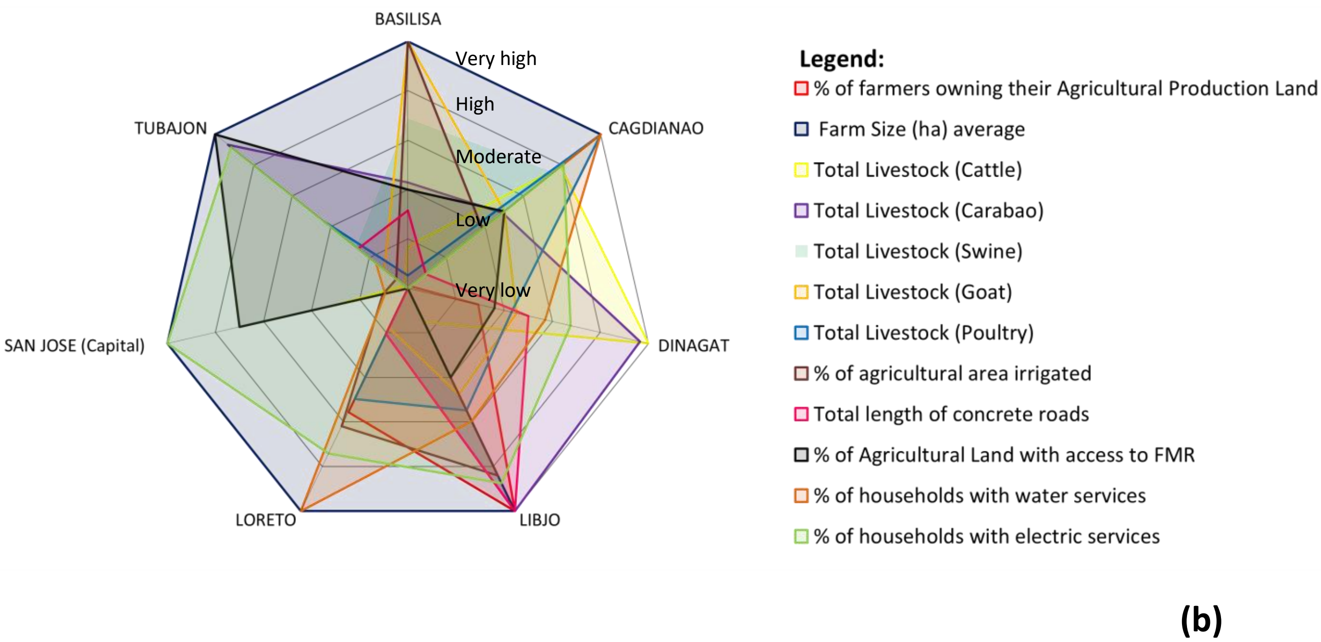


Figure 12. Physical capital map (a) and radar map (b), 2019

Anticipatory Capital. Kellet and Peters (2014) define anticipatory capacity as the ability of social system to anticipate and reduce the impact of climate variability and extremes through preparedness and planning. It is seen in proactive action before foreseen event to avoid upheaval, either by avoiding or reducing exposure or by minimizing vulnerability to specific hazards.

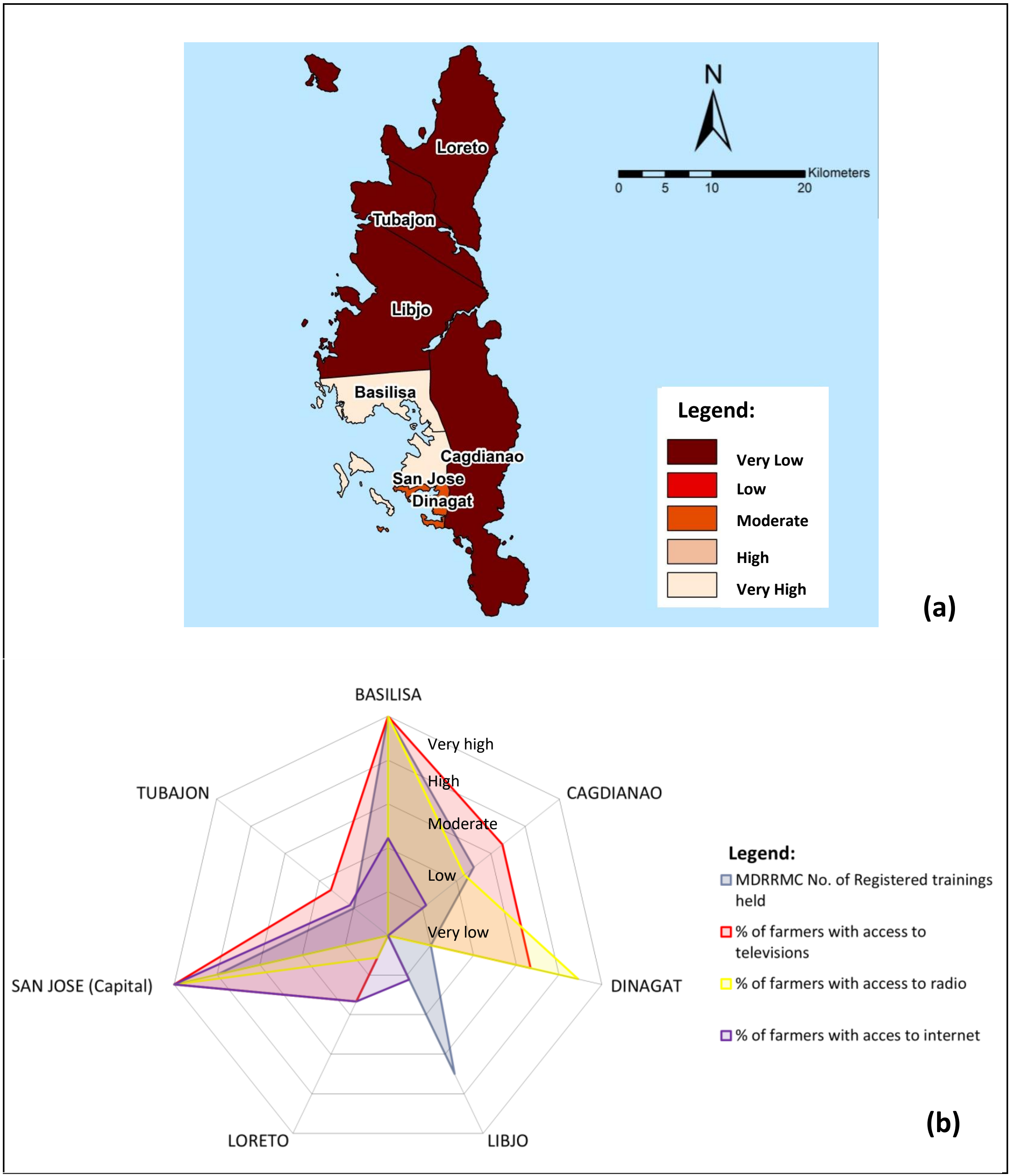
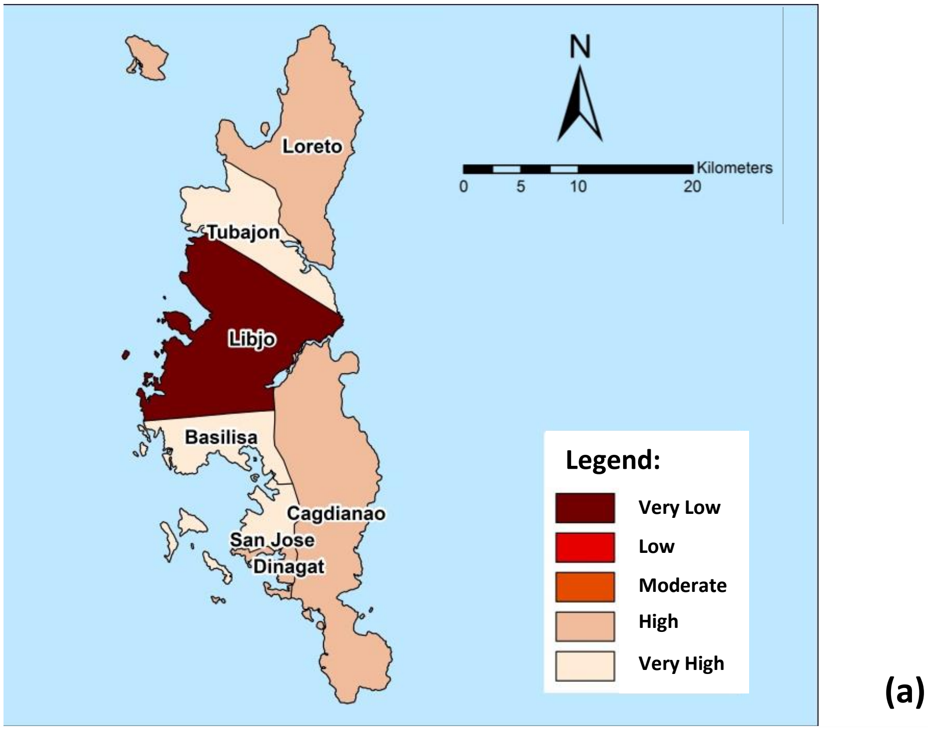


Figure 13. Anticipatory capital map (a) and radar map (b), 2019

The sub-indicators of information resources include training on farming, technical assistance from the government, participation in farmers' organization, and number of sources of climate information. These are the avenues by which farmers can derive pertinent information that strengthen their ability to adapt to climate change, either directly from training, sources of climate information, or indirectly through interactions and knowledge-sharing with other farmers. As for the data gathered in PDI, it was observed that San Jose (Figure 13a) is the most adaptable to climate change in terms of anticipatory resources. This is expected since being the capital municipality, it is the number one recipient of climate-change related trainings and 100% their population already have access to information modalities such as mobile phones, televisions, radio, and internet. Loreto (Figure 13b) on the other end was found to have the lowest adaptive capacity in terms of anticipatory resources due to their quite low number of registered MDRRMC trainings and low percentage of population with access to mobile phones, televisions, radio and internet.

Institutional Capital. An area with well-developed social institutions is typically better able to respond to changing environment than those with less effective social institutions. For instance, those with more number of AEWs in the municipality will in turn have better services of providing technical assistance to the community in terms of farming practices that are adaptable to climate change. Equally, this will translate to better frequency of consultation between AEWs and farmers, thus, resulting to enhanced overall adaptive capacity of the farmers. In the case of San Jose and Tubajon (Figure 14a) were found to have the strongest adaptive capacity in terms of institutional capital while Libjo was considered as the weakest.

Poor adaptive capacity of Libjo when it comes to institutional capital (Figure 14b) is mainly due to their low number of AEWs relative to the other municipalities as well as low percentage of farmers visiting to the Municipal Agriculture Office (MAO) or consulting with the technician. Strong networks with the AEWs suggest better adaptive capacity of the system to respond to the challenges of changing circumstances. However, weak links among these institutions implies poor adoption of climate-smart practices thus, constrain adaptive capacity and increase vulnerability.



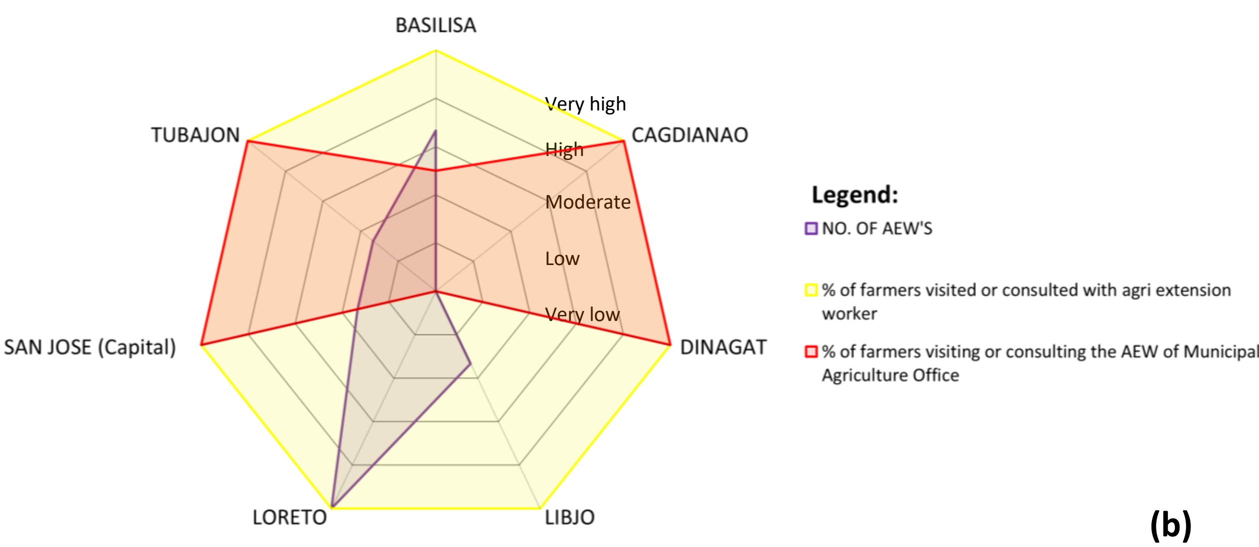


Figure 14. Institutional capital map (a) and radar map (b), 2019

Sensitivity Index

This section presents the climatic suitability of the selected priority crops in the province of Dinagat Islands (i.e., rice, corn, banana, and cassava) by year 2050 through climate modelling and use of species distribution model. Overall, crop sensitivity index suggests a decreasing suitability of rice and corn in major areas of the province while banana and cassava production are highly suitable in the future. Considering other factors constant, decreasing climatic suitability of the aforementioned commodities implies that their yields are expected to decline in the future. However, such future impacts could be negated if the government will continue to invest on programs and interventions that is directed on development and dissemination of climate-smart farming practices that promote healthy soil and efficient use of water.

Rice. Overall, the province of Dinagat is observed to have decreasing climatic suitability for rice due to changes in precipitation and temperature in the future. Specifically, major areas in Loreto, Tubajon, Libjo, and Cagdianao showed a decreasing climatic suitability pattern for rice while majority areas in Libjo, San Jose and Dinagat are favorable for rice production in the future (Figure 15b). Rice commodity in Dinagat Islands (Figure 15c) appears to be suitable based on the results given. It shows that the island averages from moderate to suitable except for municipality of Dinagat which determine to be non-productive to rice in the year 2050. Loreto and Cagdianao aligned to be moderately suitable while the other four municipalities which are Tubajon, Basilisa, Libjo and San Jose are suitable for rice commodity.

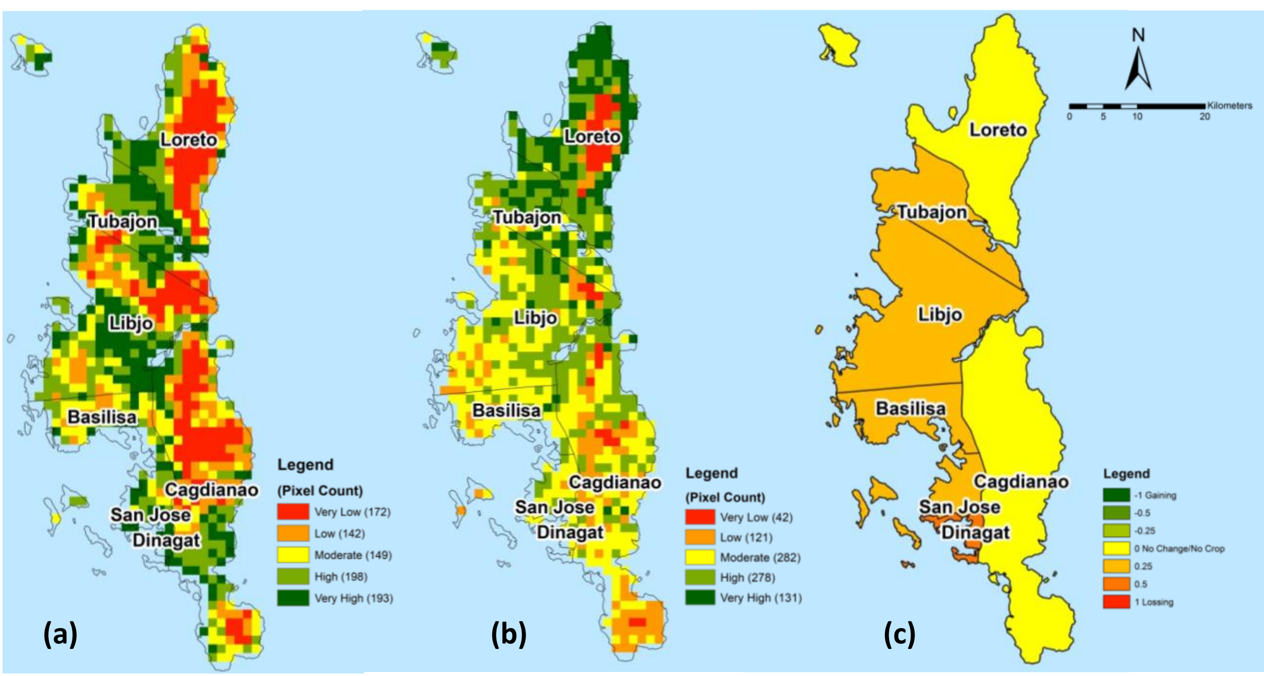


Figure 15. Sensitivity index map for rice (a) current, (b) future map and (c) sensitivity index

Corn. Corn crop simulation in the province shows significant decrease in climate suitability. For instance, from being highly favorable to corn production in the current (Figure 16a) scenario, majority of areas in Loreto, Libjo, and Cagdianao are expected to be highly affected in terms of corn in the future (Figure 16b). On the other hand, some areas in Libjo, San Jose, and Dinagat are showing favorable suitability of corn in the future. For corn commodity in the province of Dinagat Islands (Figure 16c), it shows that in the year 2050 corn will be suitable in all areas. The municipality of Loreto, Tubajon, Libjo and Cagdianao appears to be moderately suitable while the remaining municipalities which are Basilisa, Dinagat and San Jose classified as suitable based on the legends of the map.

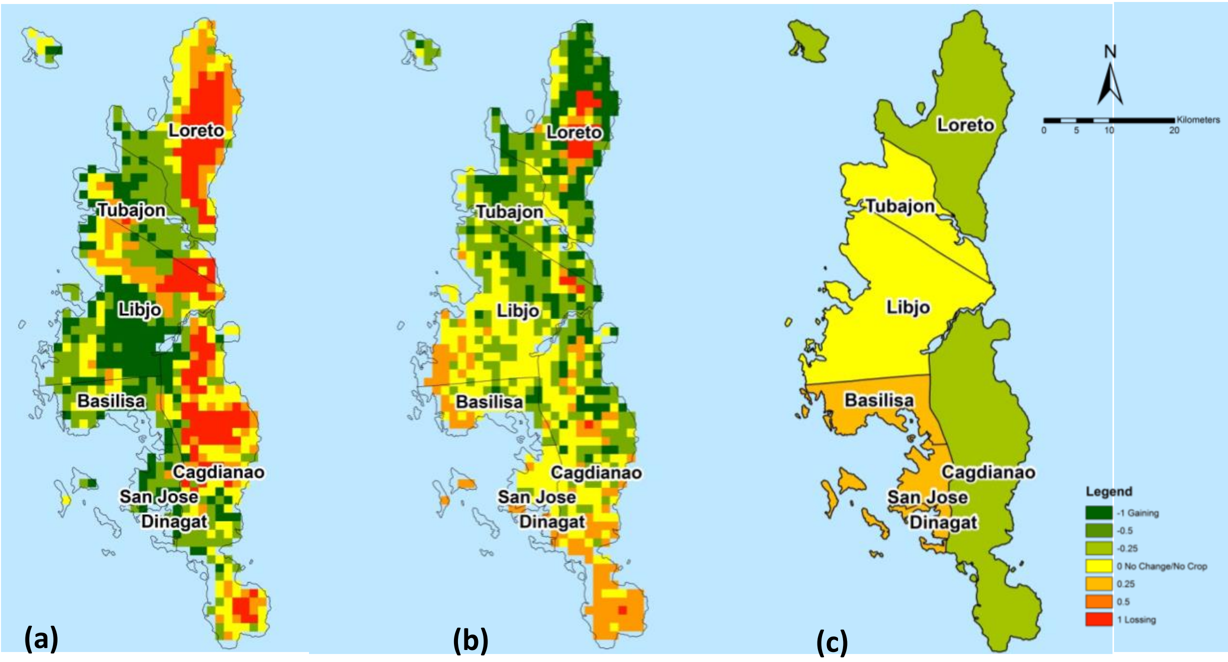


Figure 16. Sensitivity index map for corn (a) current, (b) future map and (c) sensitivity index

Banana. The crop simulation for banana has indicated positive results for those currently non-suitable areas such as Tubajon, Libjo, San Jose, and Dinagat (Figure 17a). However, as for areas which are currently suitable for banana - some areas of Loreto and most parts of Cagdianao, they are expected to experience negative impacts of climate change in the future (Figure 17b). Banana commodity in the municipality of Basilisa, Dinagat and San Jose (Figure 17c) classified as not suitable areas while the other municipalities averages to be suitable for banana production. Loreto is the more suitable areas in the province then followed by Tubajon, Cagdianao and Libjo as a suitable for the said commodity

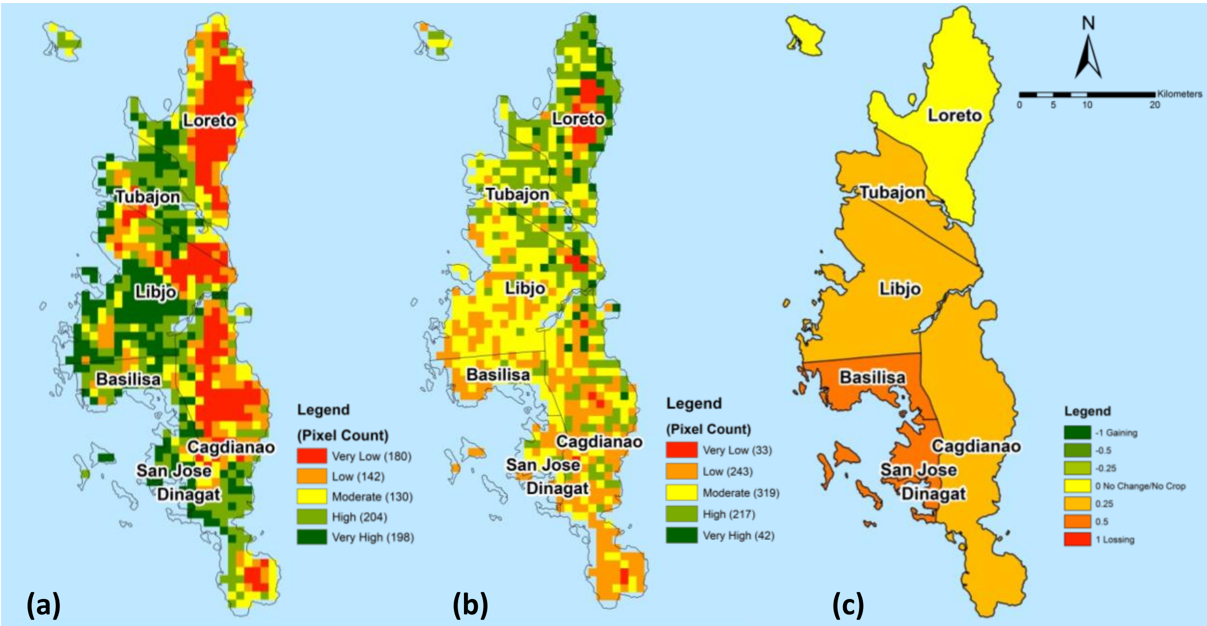


Figure 17. Sensitivity index map for banana (a) current, (b) future map and (c) sensitivity index

Cassava. In this map of sensitivity index shows that there are areas in Dinagat Islands decreases its suitability while the other increases. Loreto (Figure 18a) is the only is the municipality shows suitability in cassava for the year 2050 while the other decreases. The municipality of Dinagat shows negative result and tells us that cassava crop is no longer suitable to in the next 30 years (Figure 18b). In cassava commodity map gives suitable result in many areas in the province of Dinagat Islands (Figure 18c). According to the map it dictates to be moderately suitable in the north part of the island which is the municipality of Loreto, while Tubajon, Libjo, Basilisa and Cagdianao. The municipality of San Jose and Dinagat are the two areas classified as not suitable to grow cassava.

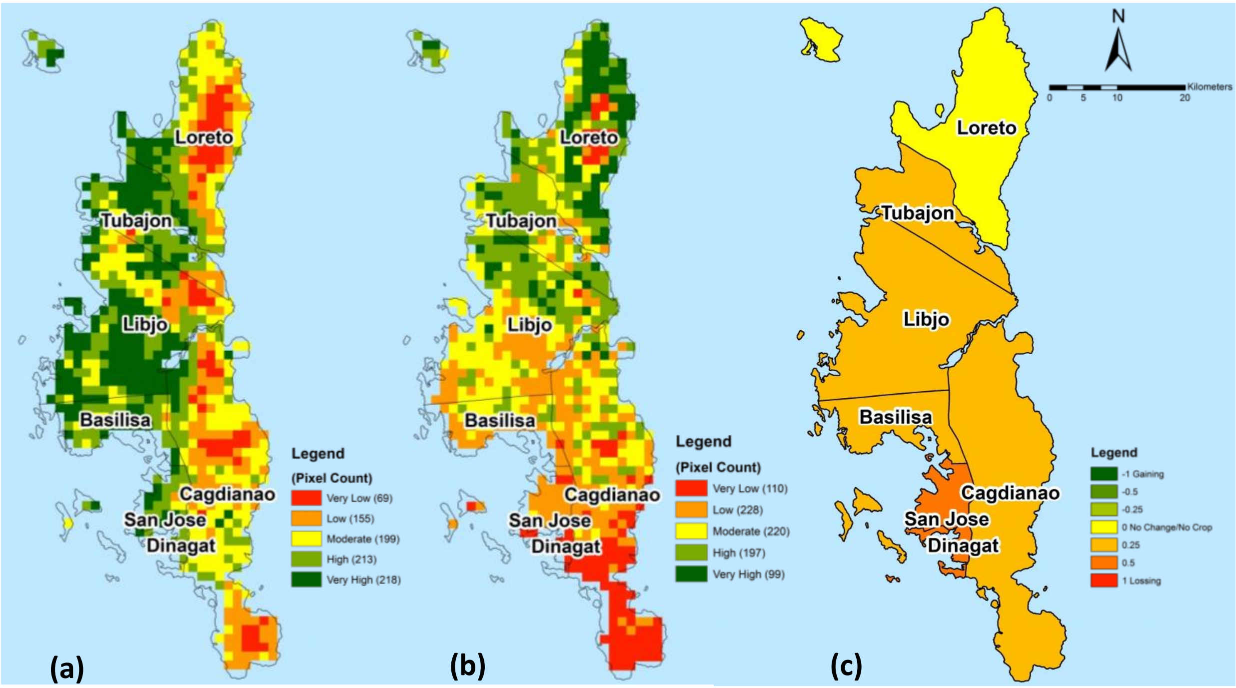


Figure 18. Cassava climatic suitability (a) current, (b) future map and (c) sensitivity index

Hazard Index

The degree of exposure to hazards across seven municipalities of the Province of Dinagat Islands is presented in Figure 19. Information gathered indicated that PDI in general has high vulnerability to climate extreme events such as typhoons and landslide due to its proximity to the country's typhoon belt. Among the seven municipalities, Libjo is the most susceptible to extreme events with 1.0 hazard index rating followed by Loreto with 0.84. The municipality of Dinagat and San Jose are the least vulnerable to climate hazards with 0.47 and 0.59 hazard index rating, respectively.

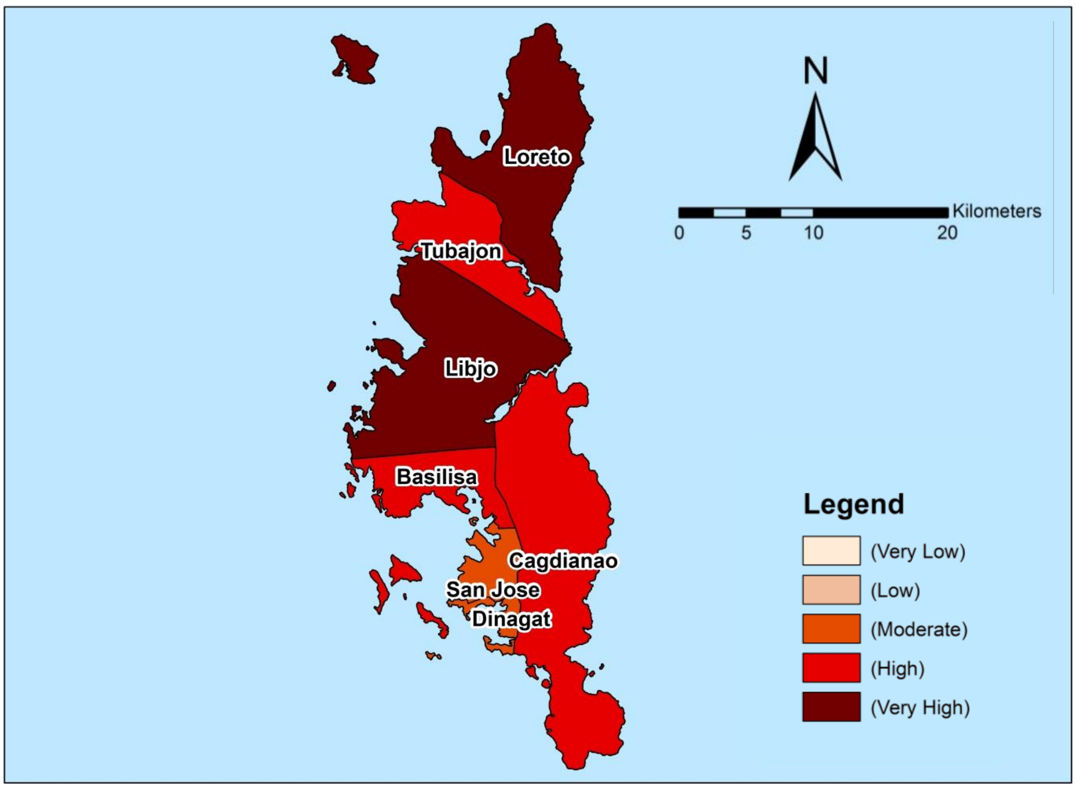


Figure 19. Hazard index map for the province of Dinagat Islands

In particular, very high exposure incidence of tropical cyclone (Figure 20a) and landslide (Figure 20b) are observed in all part of the province except for Dinagat with lower level of exposure vis-à-vis the rest of the municipalities. Very high level of drought (Figure 20c) is also observed in Libjo while medium level of drought is observed in Tubajon and Loreto. In terms of soil erosion, the municipality of Cagdianao (Figure 20d) is the most vulnerable with high level of soil erosion index. The rest of the municipalities are still susceptible to soil erosion but at on a lower index level than that of Cagdianao. Salt water intrusion, flood, sea level rise and storm surge (Figure 20e) are still experienced in the province but on a non-significant level.

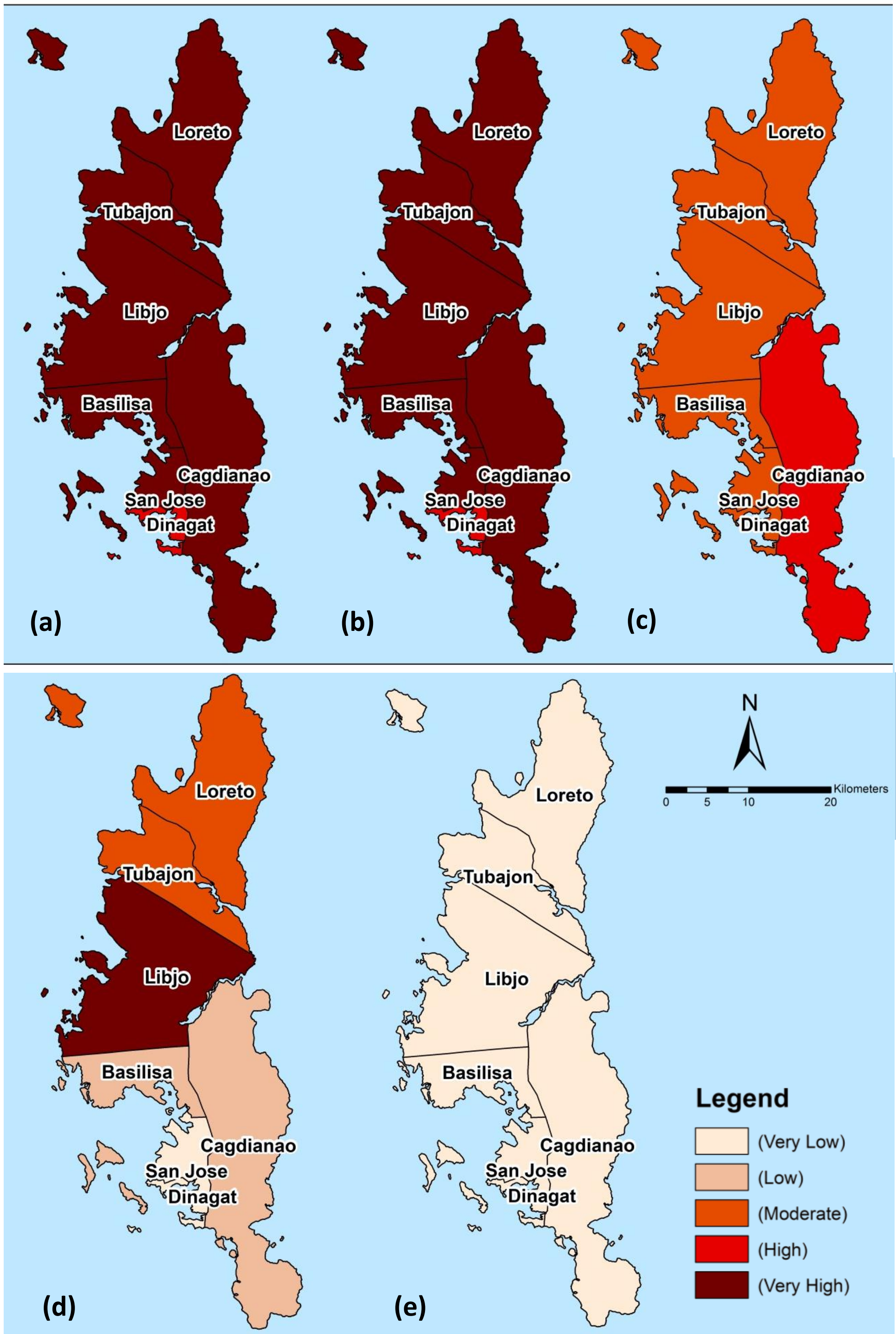


Figure 20. Hazard index map of (a) tropical cyclone; (b) landslide; (c) drought; (d) soil erosion and (e) flood, saltwater intrusion, sea level rise

Vulnerability Index

The vulnerability model was constructed using the GIS platform for the three components namely, sensitivity, exposure, and adaptive capacity.

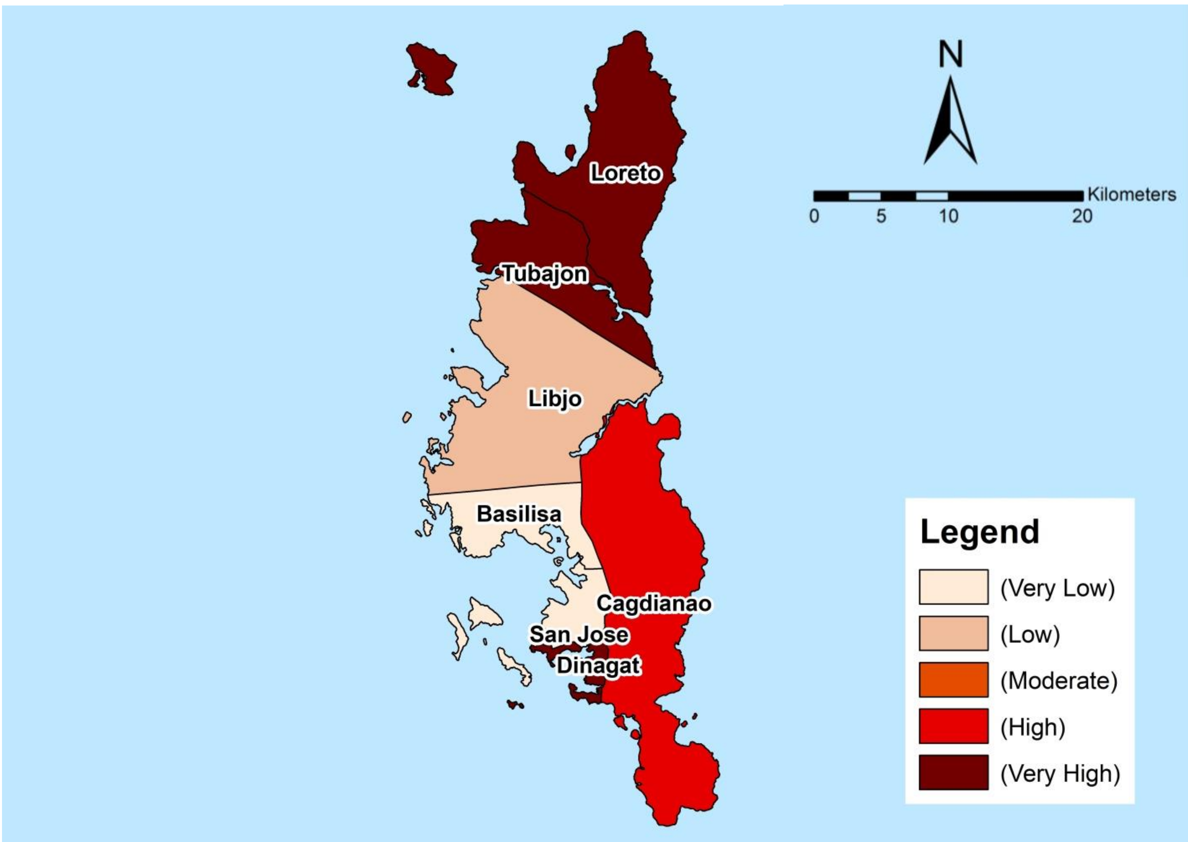


Figure 21. Vulnerability index map for the province of Dinagat Islands

Rice. The vulnerability index for rice indicated that the municipalities of Tubajon and Cagdianao (Figure 21a) are highly vulnerable to climate change due to its very low adaptive capacity despite a very high exposure to climate hazards and a very high sensitivity index of rice in the future (Figure 21b). Rice is also considered vulnerable in Dinagat because of its susceptibility to climate hazards and very low adaptive capacity. The same trend was observed in the municipality of Loreto where rice is also vulnerable, but the degree of vulnerability is lower than that of Tubajon, Cagdianao, and Dinagat.

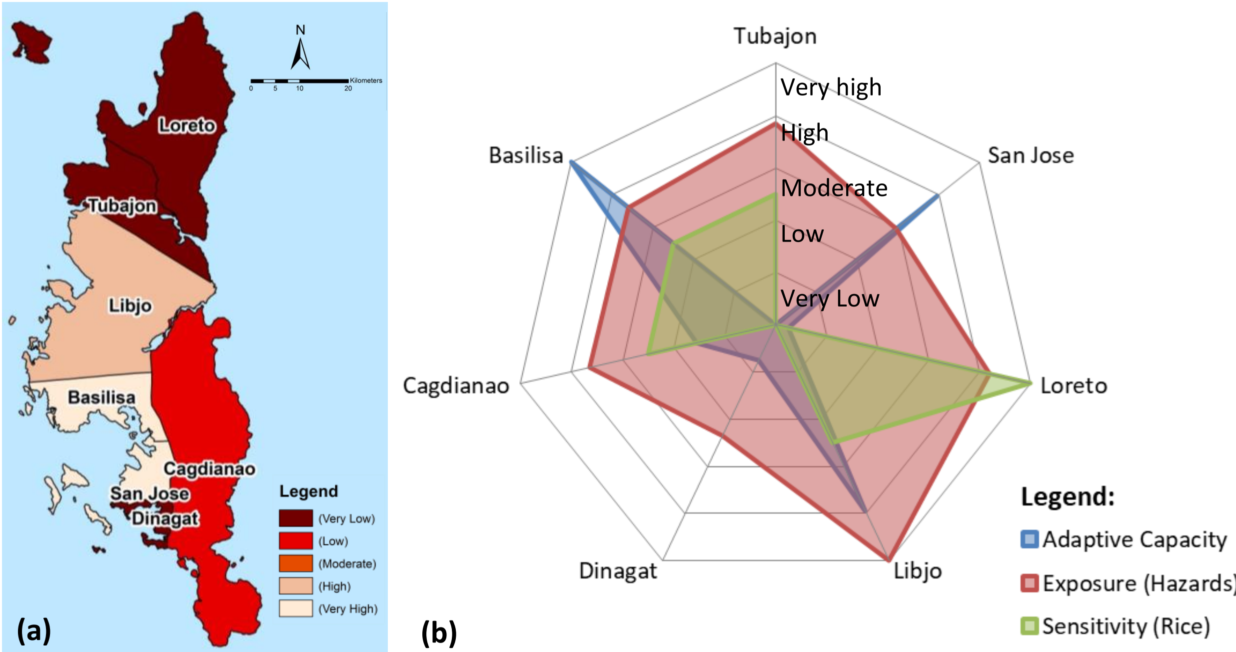


Figure 22. Vulnerability index map for rice (a) and radar map (b)

Corn. Tubajon and Cagdianao (Figure 22a) were also identified as the highly vulnerable municipalities to climate change when it comes to corn production. This can be accounted to very low adaptive capacity along with high exposure to climate hazards and a decreasing suitability of corn to climate change is the future (Figure 22b). Corn is also vulnerable in Dinagat and Loreto while in San Jose and Libjo it is observed to be non-vulnerable.

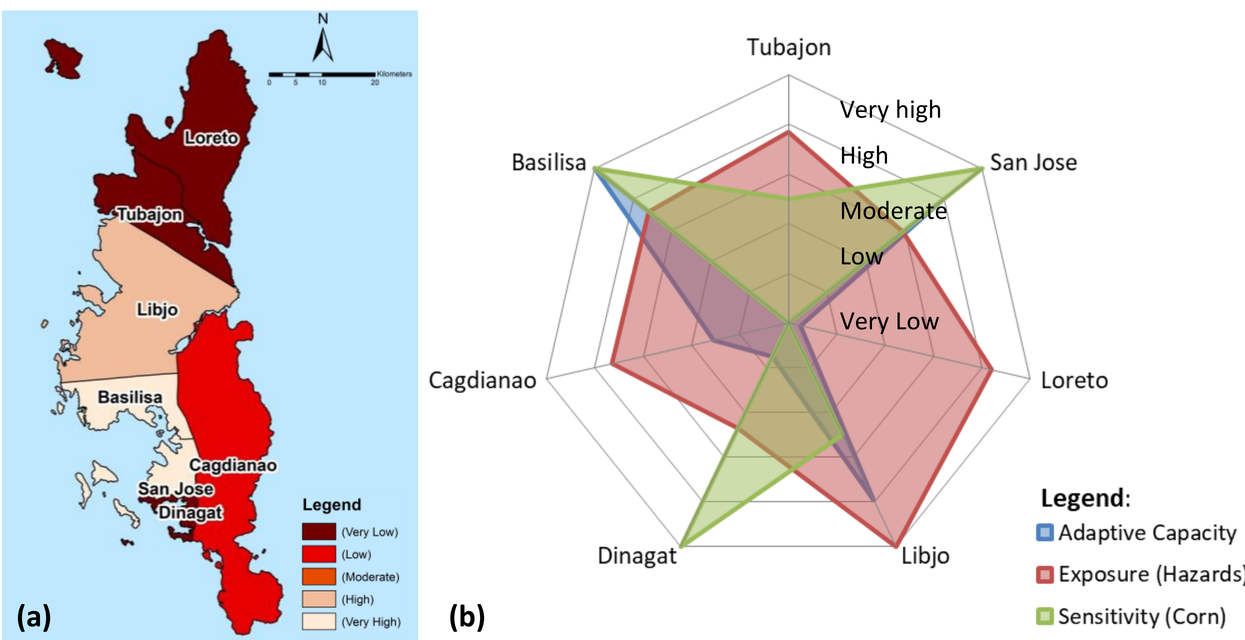


Figure 23. Vulnerability index map for corn (a) and radar map (b)

Banana. Tubajon and Cagdianao (Figure 23a) were also identified as the highly vulnerable municipalities to climate change when it comes to banana production. This can be accounted to very low adaptive capacity along with high exposure to climate hazards and a high sensitivity of banana to climate change in the future (Figure 23b). Banana is also vulnerable in Dinagat and Loreto while in San Jose and Libjo it is observed to be non-vulnerable.

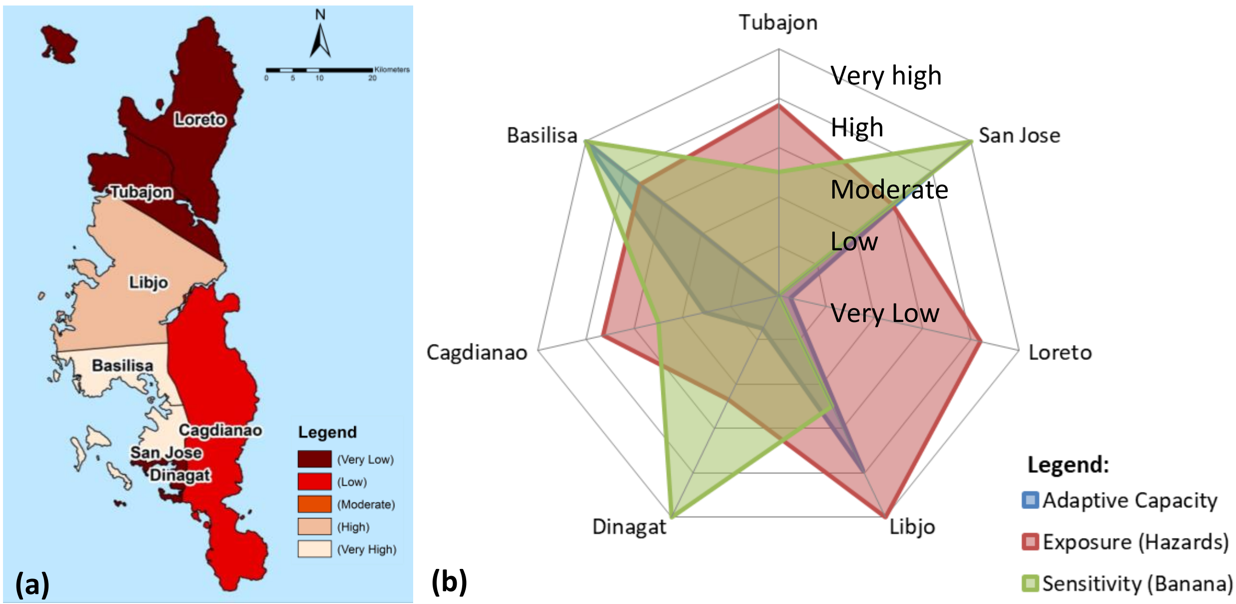


Figure 24. Vulnerability index map for banana (a) and radar map (b)

Cassava. Tubajon and Cagdianao (Figure 24a) remains as the highly vulnerable municipalities to climate change not just for rice, corn, and banana but for cassava production as well. Just like the previous perspective, high vulnerability of cassava (Figure 24b) is also due to susceptibility of these municipalities to climate hazards as well as sensitivity of cassava to changes in bioclimatic and precipitation-related factors.

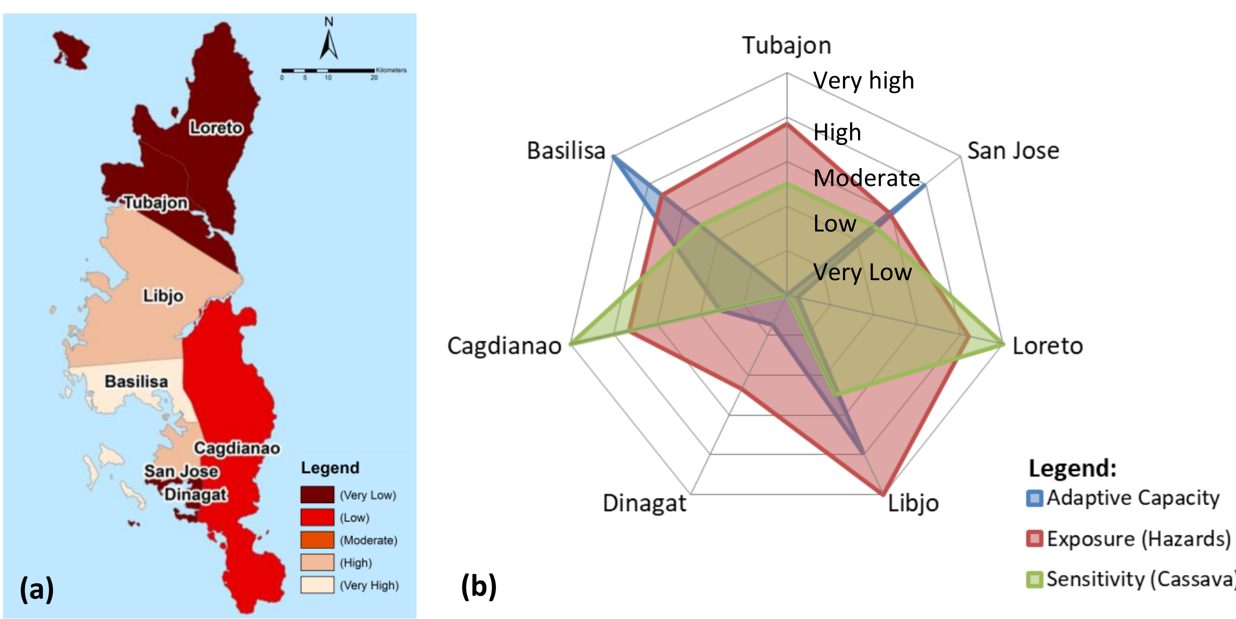


Figure 25. Vulnerability index map for cassava (a) and radar map (b)

CONCLUSION AND RECOMMENDATION

The identification of the areas most vulnerable to climate change risks in Caraga region is among the most urgent of policy needs. This assessment responds to the need by identifying which municipalities in the Province of Dinagat Islands are the most vulnerable to climate change, and producing a map to show climate change vulnerability in the province. Gathered data, at regional, provincial and municipal levels, from various sources and integrated them in a consistent and meaningful manner to produce a map indicating the areas most vulnerable to climate change. Despite data limitations, it is expected that the output of this analysis will be useful to policy-makers and stakeholders in better targeting programs and interventions towards adaptation measures undertaken in the region particular in the Province of Dinagat Islands.

Based on this Climate Risk Vulnerability Assessment (CRVA), Tubajon, Cagdianao, Loreto, and Dinagat are among the highly vulnerable municipalities in the province due to its high exposure to climate hazards as well as their low adaptive capacity and the decreasing suitability of crops to climate variability in the aforementioned municipalities. Considering other factors constant, investing for rice, corn, cassava, and banana will be less favourable in the future. However, such potential impacts could be negated if the LGUs and other government institutions will continue investing in climate-change related programs and interventions that will improve farming practices and those that will facilitate agri-related coping mechanisms and strategies.

The use of early maturing and stress tolerant varieties for rice (e.g.. submergence, salinity, drought and heat tolerance) increases efficient use of nutrient and water and increases crop's resilience to climate shocks since in Dinagat Islands it severely affected to climate extreme events due to its proximity to the country's typhoon belt. Water harvesting technologies (e.g., small water impounding project, alternate wetting and drying, drip irrigation) it ensures water availability, therefore it increases resilience to drought at the same time increases yield and revenues. Adequate source, timing, amount and placement of fertilizers can reduce negative effects of excessive fertilization the application of Site Specific Nutrient Management (SSNM) for corn can also be applied. Agroforestry systems on small-scale farm (e.g., fruit and timber trees around rice fields, and vegetable plot/farms). Although this CRA practice may bring important benefits to the farmers in the said province in increasing their income and yield, resilience to climate shocks and variability and reduced emission. In addition, it also improves soil fertility and water conservation as well as enhance food availability and access, (Dikitanan, et.al., 2017). A good cropping calendar is vital in areas where extreme weather fluctuations usually occur. Farmers should also adapt on how and when to evade the most serious threat of this phenomenon.

Table 17. Cropping calendar of the top 5 commodity in the province of Dinagat Islands

Crops	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lowland rice												
Upland rice												
Corn	Rainy season		Dry season					Rainy season				
Cassava												
Banana												

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APPENDICES

Appendix Table 1. Economic capital indicator by rice and corn production.

Municipality	Rice Production		Corn Production	
	Area harvested (ha)	Total volume of production	Area harvested (ha)	Total volume of production
Basilisa	591.00	1,335,660.00	63.30	155,718.00
Cagdianao	541.75	1,224,355.00	7.15	17,589.00
Dinagat	181.50	410,190.00	8.38	20,614.80
Libjo	958.00	2,165,080.00	13.80	33,948.00
Loreto	381.00	861,060.00	4.80	11,808.00
San Jose	30.50	68,930.00	5.10	12,546.00
Tubajon	376.75	851,455.00	11.40	28,044.00

Source: Municipal Agriculture Offices of PDI

Note: Yield (t/ha) for rice= 2.26; Yield (t/ha) for corn= 2.46

Appendix Table 2. Economic capital indicator by coconut and banana production.

Municipality	Coconut Production			Banana Production	
	Total coconut area(ha)	Total nut production (pcs.)	Total volume of nut production (kg)	Lakatan	Latundan
				Total area planted (ha)	Total area planted (ha)
Basilisa	1,350.00	1,354.548.00	812,728.00	0.50	3.00
Cagdianao	1,705.00	2,266,504.00	1,359,902.40	3.45	2.48
Dinagat	1,625.00	2,064,705.00	1,238,823.00	18.20	13.30
Libjo	4,477.00	5,493,170.00	3,295,902.00	4.50	5.25
Loreto	3,119.00	5,532,586.00	3,319,551.60	No data reported	No data reported
San Jose	975.00	1,342,748.00	805,648.80	No data reported	1.50
Tubajon	2,238.00	1,924,586.00	1,154,751.60	15.00	No data reported

Source: Municipal Agriculture Offices of PDI

Appendix Table 3. Economic capital indicator by banana and rootcrops production.

Municipality	Banana Production			Rootcrops Production	
	Saba/ Cardava	Total area planted (ha)	Total volume of production (kg)	Cassava	
				Area planted (ha)	Total volume of production (ton)
Basilisa	8.00	11.50	30,360.24	32.60	355.70
Cagdianao	1.95	7.88	20,803.36	45.50	171.00
Dinagat	80.70	112.20	296,210.30	66.20	243.40
Libjo	43.00	52.75	139,261.07	24.00	9.50
Loreto	41.00	41.00	108,240.84	54.00	45.00
San Jose	2.50	4.00	10,560.08	7.00	14.10
Tubajon	270.50	285.50	753,725.86	30.20	95.90

Source: Municipal Agriculture Offices of PDI

Appendix Table 4. Economic capital indicator by rootcrops production, total area planted and total volume of production.

Municipality	Rootcrops Production					
	Sweet Potato		Taro		Total area planted (ha)	Total volume of production (kg)
	Area planted (ha)	Total volume of production (ton)	Area planted (ha)	Total volume of production (ton)		
Basilisa	19.00	No data reported	1.00	No data reported	52.60	355,660.00
Cagdianao	7.00	0.10	3.30	0.20	55.80	171,270.00
Dinagat	28.80	184.50	8.60	No data reported	103.60	427,940.00
Libjo	16.00	1.50	7.00	0.10	47.00	12,000.00
Loreto	17.50	0.40	8.80	2.50	80.20	47,900.00
San Jose	6.50	No data reported	2.00	No data reported	15.50	14,140.00
Tubajon	6.50	No data reported	4.00	No data reported	40.70	95,880.00

Source: Municipal Agriculture Offices of PDI

Appendix Table 5. Economic capital indicator by total area planted (rice, corn, coconut, banana, rootcrops), total agricultural land, total volume of production and access to credit

Municipality	Total area planted (rice, corn, coconut, banana rootcrops)	Total agricultural land (ha)	Total volume of production (rice, corn, coconut, banana rootcrops)	Access to credit	
				Number of banks	Other institutions
Basilisa	2,068.40	2,768.20	2,690,127.00	No data reported	5.00
Cagdianao	2,317.50	2,126.60	2,793,919.80	No data reported	5.00
Dinagat	2,030.70	2,070.70	2,393,778.10	No data reported	6.00
Libjo	5,548.50	3,434.50	5,646,191.10	No data reported	7.00
Loreto	3,626.00	2,538.00	4,348,560.40	No data reported	6.00
San Jose	1,030.10	2,029.50	911,824.90	3.00	17.00
Tubajon	2,952.30	3,854.50	2,883,856.50	No data reported	4.00

Source: Municipal Agriculture Offices of PDI

Appendix Table 6. Economic indicator by total number of cooperatives, number of finance cooperatives, total number of ATMS and crop insurance

Municipality	Total number of financial cooperatives	Number of finance cooperatives	Total number of ATMS	Crop Insurance	
				Number of farmers covered with insurance	% of farmers covered with insurance
Basilisa	5	3	1	231	9
Cagdianao	5	5	1	177	11.1
Dinagat	6	3	No data reported	130	49.6
Libjo	7	4	No data reported	95	7.9
Loreto	6	2	No data reported	142	6.8
San Jose	20	4	2	71	12.8
Tubajon	4	4	No data reported	304	16.5

Source: Municipal Planning and Development Offices of PDI

Appendix Table 7. Economic capital indicator by household population, number of employed in agriculture and % of population employed in Agriculture

Municipality	Household Population			Number of employed in Agriculture	% of population employed in Agriculture
	Household population	Number of households	Average household size		
Basilisa	36,885.0	8,855.0	4.3	8.0	0.02
Cagdianao	16,779.0	3,777.0	4.4	11.0	0.07
Dinagat	10,624.0	2,220.0	4.8	16.0	0.15
Libjo	17,697.0	4,103.0	4.3	8.0	0.05
Loreto	9,264.0	2,259.0	4.1	10.0	0.11
San Jose	27,487.0	5,765.0	4.8	8.0	0.03
Tubajon	8,227.0	1,845.0	4.5	8.0	0.10

Source: Municipal Planning and Development Offices of PDI

Appendix Table 8. Economic capital indicator by agriculture minimum wage, poverty incidence, total budget of the municipality, total and % of budget allocation of MAO

Municipality	Agriculture minimum wage	Poverty incidence	Inversed	Total budget of the municipality	Total allocation of MAO	% of budget allocation of MAO
Basilisa	377.00	42.00	58.03	114,707,011.00	3,822,364.50	3.33
Cagdianao	250.00	45.00	54.97	135,059,631.58	3,464,923.64	2.57
Dinagat	270.00	43.90	56.11	76,363,078.00	3,374,651.92	4.42
Libjo	230.00	43.60	56.44	103,374,933.48	5,173,324.00	5.00
Loreto	300.00	36.60	63.37	116,004,158.00	3,138,048.14	2.71
San Jose	300.00	36.20	63.81	114,707,011.00	3,822,364.50	3.33
Tubajon	230.00	42.00	58.03	67,398,367.39	1,781,583.21	2.64

Note: Inversed=100-Poverty incidence

Source: Municipal Agriculture Offices and Municipal Planning and Development Offices of PDI

Appendix Table 9. Economic capital indicator by total and % budget allocation of MDRRMO, natural capital indicator by presence of irrigation, total service area with source of irrigation and total agricultural land

Municipality	Total allocation of MDRRMO	% of budget allocation of MDRRMO	Presence of Irrigation			Total service area with source of irrigation	Total agricultural land
			Communal irrigation system				
			Service area with source of water supply				
			Gravity (service area)	Pump (service area)	Resevoir (service area)		
Basilisa	5,735,350.55	5.00	215.00	0	0	215.00	2,768.20
Cagdianao	6,766,694.90	5.01	80.00	0	0	80.00	2,126.60
Dinagat	3,818,153.90	5.00	25.70	0	0	231.00	2,070.70
Libjo	2,691,247.86	2.60	231.00	0	0	134.00	3,434.50
Loreto	5,800,207.90	5.00	134.00	0	0	134.00	2,538.00
San Jose	5,735,350.55	5.00	39.00	0	0	39.00	2,029.50
Tubajon	3,290,569.00	4.88	63.00	0	0	63.00	3,854.50

Source: Municipal Agriculture Offices of PDI and National Irrigation Administration, Regional Office

Appendix Table 10. Social capital indicator by number of elected officials, number of farmers association, number of farmers

Municipality	Number of elected officials					Number of farmers association	Number of farmers
	Total number of elected officials	Male	Female	% of men in government	% of men in government		
Basilisa	243.00	152.00	91.00	62.55	37.45	37.00	2,581.00
Cagdianao	122.00	82.00	40.00	67.21	32.79	35.00	1,600.00
Dinagat	106.00	65.00	41.00	61.32	38.68	20.00	262.00
Libjo	130.00	86.00	44.00	66.15	33.85	22.00	1,200.00
Loreto	90.00	60.00	30.00	66.67	33.33	14.00	2,100.00
San Jose	108.00	76.00	32.00	70.37	29.63	7.00	556.00
Tubajon	79.00	52.00	27.00	65.82	34.18	35.00	1,837.00

Source: Municipal Agriculture Office, PDI

Appendix Table 11. Social capital indicator by number of farmers association, % of farmers who are members of coop/unions/groups and human capital indicator by educational level, literacy rate and number of teachers

Municipality	Number of farmers association members	% of farmers who are members of coop/unions/ groups	Educational Level		Literacy rate	Number of Teachers
			Literate (10 yrs.old & above)	Total population (10 yrs.old & above)		
Basilisa	1,164.00	45.10	29,139.00	29,476.00	98.86	74.00
Cagdianao	1,240.00	77.50	12,569.00	12,818.00	98.06	71.00
Dinagat	119.00	45.42	8,254.00	8,391.00	98.37	35.00
Libjo	632.00	52.67	13,180.00	13,418.00	98.23	83.00
Loreto	659.00	31.38	6,999.00	7,077.00	98.90	34.00
San Jose	176.00	31.65	21,607.00	21,882.00	98.74	109.00
Tubajon	186.00	10.13	6,144.00	6,283.00	97.79	36.00

Source: Municipal Agriculture Offices of PDI and Department of Education, Regional Office

Appendix Table 12. Human capital indicator by number of students, ratio of school teachers, number of secondary schools, total number of secondary schools, total number of public and private tertiary schools and technical vocational schools

Municipality	Number of students	Ratio of school teachers to students	Number of secondary schools		Total number of secondary schools	Total number of public and private tertiary schools	Number of technical vocational schools
			Private	Public			
Basilisa	1,606	0.05	0	8	8	0	0
Cagdianao	1,622	0.04	0	4	4	0	0
Dinagat	844	0.04	0	3	3	0	1
Libjo	1,729	0.05	0	7	7	0	0
Loreto	746	0.05	1	4	5	0	0
San Jose	2,231	0.05	1	3	4	1	4
Tubajon	772	0.05	0	3	3	0	0

Source: Department of Education, Regional Office

Appendix Table 13. Health capital indicator by malnutrition and nutrition rate, total number of health services and health professionals

Municipality	Malnutrition rate		Nutrition rate	Total number of health service	Total number of health professionals
	No. Of children weighed	Normal			
Basilisa	1,878.00	1,433.00	76.30	11.00	28.00
Cagdianao	2,310.00	2,104.00	91.08	15.00	17.00
Dinagat	876.00	786.00	89.73	10.00	12.00
Libjo	2,268.00	2,163.00	95.37	18.00	32.00
Loreto	1,038.00	891.00	85.84	12.00	14.00
San Jose	2,027.00	1,867.00	92.11	11.00	17.00
Tubajon	689.00	621.00	90.13	7.00	10.00

Source: Rural Health Units of PDI

Appendix Table 14. Health capital indicator by local citizens with PhilHealth

Municipality	Local citizens with PhilHealth						
	Government	Private	Kasambahay	Lifetime	Individually Paying		Sponsored Program
					Overseas Filipino Program	Individially Paying Program	
Basilisa	300	854	8	1,160	110	481	253
Cagdianao	258	1,500	6	583	94	315	521
Dinagat	293	480	3	771	130	202	195
Libjo	291	1,431	5	831	96	304	No data reported
Loreto	241	626	4	661	72	173	368
San Jose	786	1,148	7	1,822	174	888	334
Tubajon	230	663	1	479	54	138	270

Source: PhilHealth Caraga Regional Office

Appendix Table 15. Health capital indicator by local citizens with PhilHealth, estimated population and % of local citizens with PhilHealth

Municipality	Local citizens with PhilHealth			Local citizens with PhilHealth	Estimated Population	% of local citizens with PhilHealth
	Indigent Program		4PC/MCCT			
	Listahan 2	(L1) 4th-6th class)				
Basilisa	4,784	3,806	1,994	13,750	36,855	37
Cagdianao	3,079	No data reported	1,400	7,756	16,779	46
Dinagat	2,123	1,844	1,019	7,060	10,624	66
Libjo	3,678	No data reported	1,622	8,258	17,697	47
Loreto	1,546	1,111	731	5,533	9,264	60
San Jose	4,113	3,688	1,443	14,403	27,487	52
Tubajon	1,367	1,044	885	5,131	8,227	62

Source: Municipal Agriculture Offices of PDI

Appendix Table 16. Physical capital indicator by total agricultural land, % of farmers owning their agricultural production land, farm size and number of livestocks owned

Municipality	Total agricultural land	% of farmers owning their agricultural production land	Average farm size (ha)	Number of Livestock owned		
				Cattle	Carabao	Swine
Basilisa	2,768.20	25.03	0.50	16.00	160.00	926.00
Cagdianao	2,126.60	25.63	0.50	49.00	183.00	974.00
Dinagat	2,070.70	38.17	0.25	60.00	360.00	428.00
Libjo	3,434.50	70.00	0.50	15.00	373.00	1,152.00
Loreto	2,538.00	50.00	0.50	7.00	76.00	568.00
San Jose	2,029.50	25.00	0.50	23.00	No data reported	428.00
Tubajon	3,854.50	30.00	0.50	8.00	348.00	623.00

Source: Municipal Agriculture Offices of PDI

Appendix Table 17. Physical capital indicator by number of livestocks owned, total service area with irrigation, total agricultural land and % of agricultural area irrigated

Municipality	Number of Livestock owned		Total service area with irrigation (ha)	Total agricultural land (ha)	% of agricultural area irrigated
	Goat/Sheep	Poultry			
Basilisa	531.00	865.00	215.00	2,768.21	7.77
Cagdianao	266.00	14.151.00	80.00	2,126.60	3.76
Dinagat	240.00	6,172.00	25.70	2,070.72	1.24
Libjo	253.00	7,811.00	231.00	3,434.47	6.73
Loreto	94.00	7,091.00	134.00	2,538.00	5.28
San Jose	No data reported	127.00	39.00	2,029.50	1.92
Tubajon	65.00	6,250.00	63.00	3,854.47	1.63

Source: Municipal Agriculture Offices of PDI

Appendix Table 18. Physical capital indicator by reliable infrastructure (total length of concrete roads) in km.

Municipality	Reliable infrastructure (Total length of concrete roads) in km			
	National	Provincial	City/Municipal	Barangay
Basilisa	6.00	8.04	2.50	3.16
Cagdianao	No data reported	1.63	No data reported	No data reported
Dinagat	3.41	8.14	No data reported	15.66
Libjo	11.2	6.20	9.4	45.76
Loreto	No data reported	No data reported	6.15	No data reported
San Jose	0.05	1.14	No data reported	0.88
Tubajon	0.25	3.10	No data reported	3.10

Source: Municipal Engineering Offices of PDI

Appendix Table 19. Physical capital indicator by reliable infrastructure (total length of concrete roads) in km.

Municipality	Reliable infrastructure (Total length of concrete roads) in km			Total length of concrete roads
	FMR LGU	FMR PMED	FMR RAED	
Basilisa	2.50	No data reported	No data reported	24.70
Cagdianao	No data reported	2.80	4.31	8.75
Dinagat	No data reported	No data reported	No data reported	37.99
Libjo	9.40	No data reported	1.17	73.73
Loreto	6.15	5.60	5.00	16.75
San Jose	No data reported	No data reported	No data reported	2.07
Tubajon	No data reported	No data reported	No data reported	20.57

Source: Municipal Engineering Offices of PDI

Appendix Table 20. Physical capital indicator % of agricultural land with access to FMR, number of households, household with water services, % of household with water services, household with electric services and % of household with electric

Municipality	% of Agricultural land with access to FMR	Number of households	Household with water services	% of household with water services	Household with electric services	% of household with electric services
Basilisa	70.00	8,588.00	4,084.00	47.55	3,625.00	42.21
Cagdianao	75.00	3,777.00	3,770.00	99.81	3,239.00	85.76
Dinagat	68.00	2,220.00	1,718.00	77.39	1,747.00	78.69
Libjo	70.00	4,103.00	3,230.00	78.72	3,668.00	89.40
Loreto	50.00	2,259.00	2,255.00	99.82	1,857.00	82.20
San Jose	85.00	5,765.00	3,028.00	52.52	5,542.00	96.13
Tubajon	100.00	1,845.00	1,037.00	56.21	1,691.00	91.62

Source: Municipal Planning and Development Offices of PDI

Appendix Table 21. Anticipatory capital indicator % of agricultural land with access to FMR, number of households, household with water services, % of household with water services, household with electric services and % of household with electric services

Municipality	Number of AEW	% of farmers visited/ consulted with agri extension worker	% of farmers visiting or consulting the AEW of Municipal Agriculture Office
Basilisa	5	100	90
Cagdianao	3	100	100
Dinagat	3	100	100
Libjo	4	100	80
Loreto	6	100	80
San Jose	4	100	100
Tubajon	4	100	100

Source: Municipal Agriculture Offices and Municipal Disaster Risk Reduction Management Councils, PDI

Appendix Table 22. Institutional capital indicator by number of AEW, % of farmers visited/consulted with agri extension worker and % of farmers visiting or consulting the AEW of Municipal Agriculture Office

Municipality	MDRRMC no. Of registered trainings	% of farmers with access to mobile phones	% of farmers with access to television	% of farmers with access to radio	% of farmers with access to internet
Basilisa	12	100	100	100	50
Cagdianao	7	80	90	50	30
Dinagat	4	100	90	90	10
Libjo	9	90	70	10	30
Loreto	2	90	80	20	40
San Jose	10	100	100	100	100
Tubajon	4	100	80	10	30

Source: Municipal Agriculture Offices of PDI

Appendix Table 23. Normalized values of economic, natural, social and human of adaptive capacity index

Municipality	Economic	Natural	Social	Human
Basilisa	0.47	0.75	1.00	0.56
Cagdianao	0.43	0.17	0.95	0.00
Dinagat	0.60	0.00	0.79	0.02
Libjo	0.41	1.00	0.62	0.39
Loreto	0.61	0.45	0.31	0.36
San Jose	1.00	0.02	0.00	1.00
Tubajon	0.00	0.66	0.54	0.09

Appendix Table 24. Normalized values of health, physical, anticipatory and institutional

Municipality	Health	Physical	Anticipatory	Institutional
Basilisa	0.00	0.33	0.90	0.83
Cagdianao	0.50	0.73	0.16	0.67
Dinagat	0.47	0.36	0.42	0.67
Libjo	1.00	1.00	0.04	0.44
Loreto	0.40	0.35	0.00	0.67
San Jose	0.45	0.00	1.00	0.78
Tubajon	0.27	0.37	0.14	0.78

Appendix Figure 1. Validation of crop occurrence markings in the municipality of Basilisa, Province of Dinagat Islands

Appendix Figure 2. Validation of crop occurrence markings in the municipality of Cagdianao, Province of Dinagat Islands

Appendix Figure 3. Validation of crop occurrence markings in the municipality of Dinagat, Province of Dinagat Islands

Appendix Figure 4. Validation of crop occurrence markings in the municipality of Libjo, Province of Dinagat Islands

Appendix Figure 5. Validation of crop occurrence markings in the municipality of Loreto, Province of Dinagat Islands

Appendix Figure 6. Validation of crop occurrence markings in the municipality of San Jose, Province of Dinagat Islands

Appendix Figure 7. Validation of crop occurrence markings in the municipality of Tubajon, Province of Dinagat Islands

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