Climate Risk Vulnerability Assessment

Province of Surigao del Sur

Message

The global issue of climate change brought a great challenge in Agriculture sector. As the leading industry in the Philippines, we are committed to ensure sustainability of foods amidst these climate variations. Agriculture sector will be greatly affected if these problems can't be mitigated.

The Department of Agriculture accepted the challenge by continuous provision of 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 detail, 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.

With this comprehensive output, I hope it will address the crucial role that R&D plays in developing innovations and enhancing the agricultural productivity as well as income of our farmers and fishers in Caraga.

Thank you and Mabuhay! Larga Caraga, Larga!

ENGR. RICARDO M. OÑATE, JR.
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 an 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

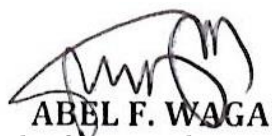
I take pride in supporting this printed work, a first of its kind in the area of climate vulnerability assessment. As Project Leader and Chief of the Research Division, it's kind of fulfilling to come-up with this comprehensive CRVA analysis of all the municipalities in Caraga.

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.

To our Regional Executive Director, Engr. Ricardo M. Oñate, Jr. who undeniably stood as pillar of the department.

To the focal person, RTD Nicandro M. Navia Jr. who endlessly provides inputs to this paper.

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 Surigao del Sur who undoubtedly provide the data's needed for the creation of CRVA.

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF TABLES

Figure	LIST OF FIGURES	Page

Figure	LIST OF APPENDIX FIGURE	Page

Abstract

This paper provides information on the most vulnerable municipalities to climate change impacts in the Province of Surigao del Sur (SDS) 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 Surigao del Sur, Caraga region, Philippines. Based on this Climate Risk Vulnerability Assessment (CRVA), Bayabas, Carrascal and Lingig 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 abaca, banana, coffee, rice and corn 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

Impacts of climate change on food production systems depend primarily on the adaptation measures undertaken by local communities (ICCG, 2016). These adaptation strategies will also apply to the complex issues on water use and food production as affected by climate change. The lack of adaptive capacities of the farmers to cope with such climatic variability increases its level of drought vulnerability. Vulnerability to climate change is defined as: "the degree to which a system is susceptible to and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and adaptive capacity (IPCC, 2007).

In the Philippines, due to its geographical and environmental setting, it has become extremely vulnerable to natural disasters, including the effects of climate change (Senate Economic Planning Office (SEPO), 2013). SEPO (2013) quoted that "The Philippines is one of the most hazard-prone countries in the world." 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 more impoverished communities. With projected changes in precipitation, temperature, the intensity of tropical cyclones, and the frequency of extreme weather events, considerable efforts would be required to prepare the Philippines to deal with the impacts of climate change on the different climate-sensitive sectors (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. The country's agri-fisheries sector is a perennial casualty of these climate-related risks. From 2010 to 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 poses a key challenge in enabling them to pursue more resilient and productive livelihoods and ultimately rise out of poverty.

At the regional scale, it has been reported during 2011-2015, the north-eastern Mindanao region (Caraga) was hit by typhoons that caused tremendous agricultural damage. Typhoons Sendong, Agaton, Pablo, and Senyang have been the most publicized ones that brought disasters to the region. In 2012, Typhoon Pablo caused an estimated PHP 3.6 B damaged in agriculture in Regions 4b, 6, 7, 10, 11 12 and Caraga (NDRRMC, 2012).

In response, the Department of Agriculture 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.

Climate Risk Vulnerability Assessment (CRVA) of AMIA is conducted to guide the AMIA targeting and planning for building the climate-resilient agri-fisheries communities. It determines the impacts of climate change to have complementary plans and implement strategies to support local communities in managing climate-related risks. It also seeks to introduce complementary activities for building appropriate climate-responsive financial and other key support services.

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

Objectives

The general objective of this study is to identify which municipalities in the Province of Surigao del Norte 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:

1. To assess exposure, sensitivity, and adaptive capacity of the municipalities to climate risks in the province of Surigao del Sur;

2. To show these vulnerable areas in a map for ease of reference of interested parties; and

3. To plan and design climate-risk responsive research and development interventions to build resilience among agri-fishery communities.

Methodology

Study Area

Surigao del Sur (Figure 1) is a province in the Philippines located in the Caraga region in Mindanao. Its capital is Tandag City. Surigao del Sur is situated at the eastern coast of Mindanao and faces the Philippine Sea to the east. The province is located along the northeastern coast of Mindanao facing the Philippine Sea. It is bounded on the northwest by the province of Surigao del Norte, on the southeast by Davao Oriental, on the west and southwest by Agusan del Norte and Agusan del Sur. Situated west is the Diwata Mountain Range, isolating the province from the rest of Mindanao. The land area of the province is 4,932.70 square kilometres (1,904.53 sq mi) [11] representing 27.75 percent of the total land area of Caraga Administrative Region and about 5.14 percent and 1.74 percent of the total land area of Mindanao and Philippines, respectively. The province is elongated in shape, extending from the northeastern portion at Carrascal to the southernmost municipality of Lingig. *Source: https://en.wikipedia.org/wiki/Surigao_del_Sur*

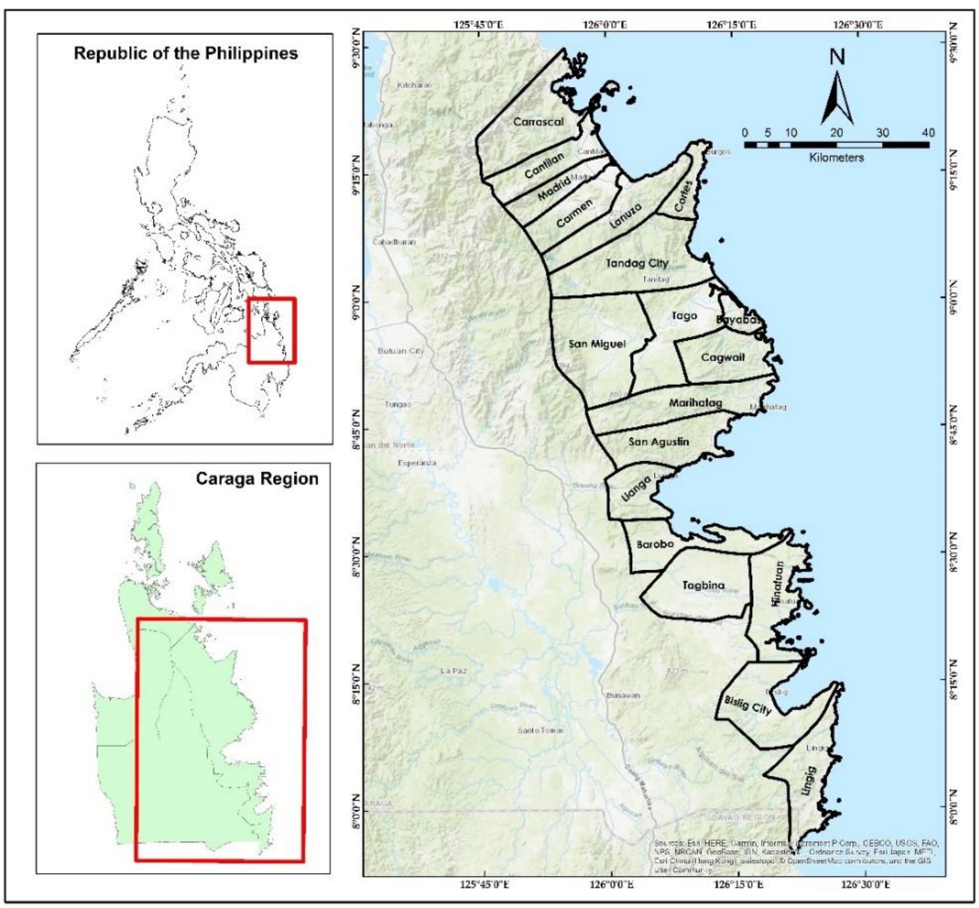


Figure 1. Geographical map of the study area in the province of Surigao del Sur

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:

Vulnerability= (*Exposure* * 0.15) + (*Sensitivity* * 0.15) + ((1- *Adaptive Capacity*) * 0.70) Eq (1)

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 (Eq 1).

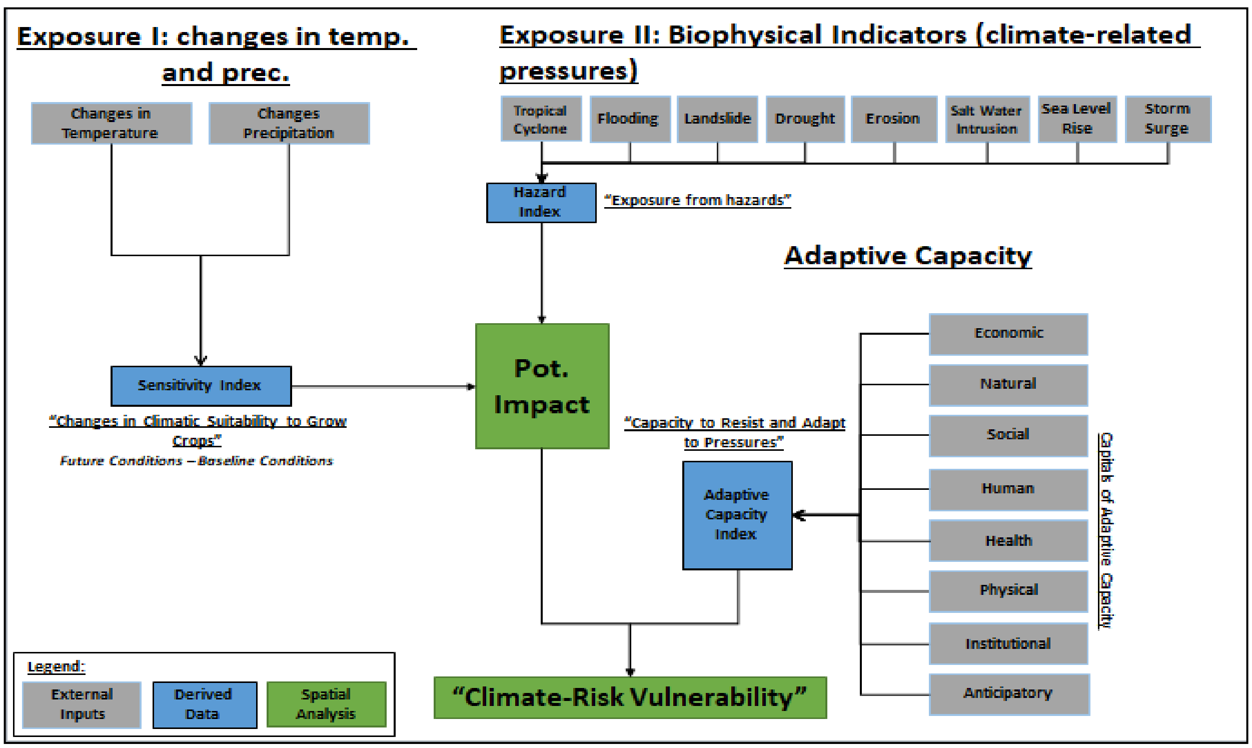


Figure 2. Framework of Climate Risk Vulnerability Assessment.

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:

$$Norm = \frac{x - x_{min}}{x_{max} - x_{min}} \quad \text{Eq (2)}$$

where:

x = original value
x_{min} = lowest value in the data set
x_{max} = highest value in the data set

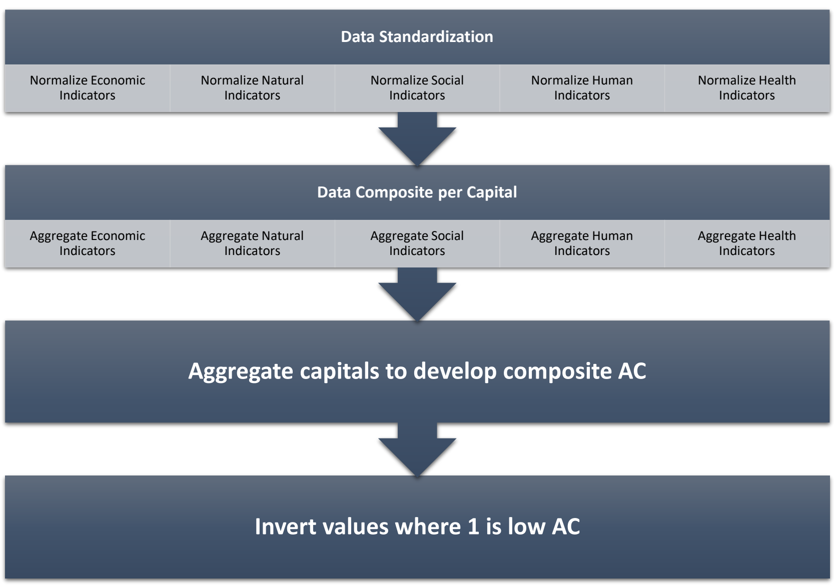


Figure 3. Simplified schematic diagram of AC processing.

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 were 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

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

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.

PARAMETERS	DESCRIPTION
	Precipitation Related
Bio_12 - Annual precipitation	This is the sum of all total monthly precipitation values.
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 Surigao del Sur. At least six (6) hazards were identified for the said province, these are tropical cyclone, flood, sea level rise, erosion, landslide, and storm surge. The selection of hazards was based on the consultation and validation series through online meetings conducted last May 2021 - June 2021 with the project partners from the LGU's in the province of Surigao del Sur.

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 Surigao del Sur 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:

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

where:

TC= Tropical cyclone
LS= Landslide
Drt= Drought
Fld= Flood
Ero= Erosion
SWI= Salt water intrusion
SLR= Sea level rise
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	20.00	18.21	16.95
2 Flood	19.05	16.40	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

Geographic Location

The Province of Surigao del Sur is the 56th Philippine province and is located in the Northeastern coast of Mindanao facing the Pacific Ocean between 125°40' to 126°20' East Longitudes and 7°55' and 9°20' North Latitudes. It is bounded on the Northwest by the Province of Surigao del Norte, on the Southeast by Davao Oriental, on its Eastern side by the Pacific Ocean, and on the West and Southwest by the Provinces of Agusan Del Norte and Agusan Del Sur. This strategic location enables the province to establish favorable economic linkages with other neighboring provinces. Surigao Del Sur has 2 cities and 17 municipalities most of which are located in the coastal areas with Tandag as its capital. These municipalities are subdivided into 309 barangays and have two congressional districts. Capital Tandag City.

Source: https://surigaodelsur.ph/profile/geo-physical-profile/geograpic-location

Land Area

The province has a total land area of 523,050 hectares representing 27 percent of the total land area of Caraga Administrative Region and about 4.07 percent and 1.71 percent of the total land area of Mindanao and Philippines, respectively. It is elongated in shape extending from the northeastern part of Carrascal to the southernmost Municipality of Lingig. It is approximately 300 kilometers in length and 50 kilometers in its widest stretch which runs from Cagwait to San Miguel. Municipal-wise, San Miguel has the biggest land area accounting for 11.08 percent (57,938 hectares) of the total provincial land area while Municipality of Bayabas has the smallest constituting about 0.64 percent (3,366 hectares) only. These are the areas left for future development of the province. Appropriate facilities and infrastructures shall be established in these areas in order to fast track its development. Of the 523,050 hectares land, only 168,544 hectares or 33 percent are classified as alienable and disposable (A and D) while 354,506 hectares or 67 percent are forest land. Tagbina has the biggest share of alienable and disposable land with 23,170 hectares or about 56.52 percent of its land area followed by Hinatuan with 20,035 hectares or 63.56 percent of its land area. Out of the 345,226 hectares, the total forestland is 91 percent (314,339 hectares) which is considered as production forest while the 9 percent (30,887 hectares) belongs to protected forest, 12.68 square kilometers are non-forest agriculture and about 15,497 hectares or 19.4 percent of the forestland are categorized as non-forest (mining) covering small scale activities. As of today, the province still has vast area of remaining old growth and mossy forest.

Source: https://surigaodelsur.ph/profile/geo-physical-profile/land-area

Soil Characteristics

The type of soil in Surigao del Sur is prismatic clay loam with fair organic matter content. It has dark grayish brown color in the surface and reddish brown in the inner portion. It is also characterized as hard in dry condition and easily cracks or triable. The soil texture is coarse or granular and becomes plastic-like or sticky when wet and has PH value of 5.6 to 5.7.
Source: https://surigaodelsur.ph/profile/geo-physical-profile/soil-characteristic

Water Resources

There are big river basins in the province which serve as good source for irrigation. The largest is located in Tago which embraces 30,000 hectares from the municipality of San Miguel down to the coastal town of Tago. The second is that found in Madrid covering 23,657 hectares and the third is in Hinatuan with an area of 18,500 hectares. Watershed areas covering these river basins continue to supply adequate water through the year.
Source: https://surigaodelsur.ph/profile/geo-physical-profile/water-resources

Mineral Resources

Surigao del Sur is endowed with substantial quantities of metallic and non-metallic minerals. Among the metallic minerals are copper, gold, chromite, cobalt, nickel and lead zinc. The non-metallic minerals include limestone, coal and feldspar, clay diatomite/bentomite and coarse/fine aggregates. There are small and large scales mining activities in the province. And twelve (12) mining corporations in the province operating in a largescale mining, namely; Philex Gold Philippines, Inc., located at Lianga and Barobo with an area of 6, 207.62 hectares and on gold exploration stage. Then the Das-agan Mining Corporation situated in Lingig and Barobo with an area of 3,809.54 hectares also on gold exploration stage.

The other one is the North Dinagat Mineral Resources, Corp., in the Municipality of Carrascal with an area of 2,320.09 hectares on chromite exploration stage. Another one is the Ludgoron Mining Corporation located in the Municipality of Carrascal with an area of 3,248.06 hectares on nickel exploration stage. Then three (3) areas for CTP Construction and Mining Corporation all are operating in the Municipality of Carrascal with an area of 4,547.76 hectares on nickel mining, the other one is 321.40 hectares still on nickel mining and the last one is 3,564.00 hectares on gold mining. Then the Phigold Metallic Ore, Inc., in the Municipality of Barobo with an area of 449.49 hectares on gold but the area is under construction and development. And the Consolidated Ores Philippines, Inc., in Manhulayan, San Miguel with an area of 1,953.00 hectares but exploration activity is temporarily stopped. Then the Carac-an Development Corporation in Cantilan and Carrascal

with an area of 4,860.00 hectares on nickel exploration stage. Then the Marc Ventures Mining & Development Corporations, located at Carrascal and Cantilan with an area of 4,799 hectares operating on gold mining. The last one is the Carrascal Nickel Corp. (CNC), located in Carrascal with an area of 4,547.70 hectares which is on nickel mining.
Source: https://surigaodelsur.ph/profile/geo-physical-profile/mineral-resources

Climate

The province falls under Type II climate of the Philippines, characterized by rainfall distributed throughout the year, although there is a distinct rainy season which begins from the month of November and ends in March. However, the climatic behavior of the province for the past few years has shown variations wherein the onset of the rainy seasons no longer occurs on the usual time. Months with low rainfall are from July to October with September as the driest month. Wet months are from November to June with January as the wettest month. *Source: https://en.wikipedia.org/wiki/Surigao_del_Sur*

Land Suitability

It may be observed that from among the land suitability classes in the A & D land, the area suitable for tree and vine occupies the biggest area with 591.83 and are mostly found in all the municipalities in the province. Land suited for cultivated annual crops covers a total area 77.324 sq. kilometers mostly located in the municipalities of Tagbina and Lingig. Areas suited for rice summed up to 220.05 sq. kilometers. Meanwhile, land suitable for protection forest covers a total area of 1,248.81 sq. kilometers and are mostly located in, Bislig City, Lianga, Tandag, San Agustin, San Miguel, Hinatuan, Cagwait and Marihatag.
Source: https://surigaodelsur.ph/profile/geo-physical-profile/land-suitability

SOCIO-ECONOMIC PROFILE

Health

With the onset of devolution in 1992, the operationalization of our hospitals and rural Health Units has indeed suffered a tremendous setback in terms of services due to lack of technical capabilities and financial capacity to manage public health services and hospital operations.

However, the general picture slowly improved with some considerable gains through the assistance of some foreign assisted health programs as well as DOH-initiated programs. But somehow, other issues and concerns have to be attended to especially the fact that health is not a priority among most Local Chief Executives. Insufficient budget in some major issue to contend with especially on the MOOE part.

To ensure and sustain quality of care in health services, there is a need to attend to the following issues, such as inadequate health monitoring system, absence of barangay/municipal health plans, the need to strengthen two-way referral system, inadequate human resource capability, health workers' non-availment of Magna Carta benefits and most of all the strengthening of Local Area Health Development Zones in terms of implementation.
Source: https://surigaodelsur.ph/profile/social-sector/health

Education

There are public and private schools in the province offering elementary and secondary courses. There are also non-formal education, pre-school and special education for the disabled, impaired, autistic mentally retarded children.

The Schools Division of Surigao del Sur is composed of 26 school districts covering 412 elementary schools, 65 secondary schools 5 of this are CHED supervised vocational/technical schools. These 26 school districts are managed by their respective school principals, as school administrators while the school district supervisor handle the institutional and curricular supervision. Private schools, on the other hand, numbered 27. Eight are offering elementary courses while the 19 offer courses.

In the rural areas where enrolment is low, combination/multi-grade class programs are being institutionalized. These classes served as an alternate delivery system adopted to provide access to quality education for school children living in the remote areas. So far, we have 207 schools with 401 multi-grade classes & the enrolment reached a headcount of 15,295 pupils.

The opening of SPED classes from pre-school to grade six were initiated as mandated in DECS Order No. 108, s., 1999, to strengthen special education for the gifted/fast learners and talented pupils. The SPED Center is stationed at Tandag Central Elem. School while other SPED classes are also organized in the 15 (out of 26) schools districts throughout the school's division.

With the aggregate bulk of enrolment, and considering depreciation of some volume of old textbooks, which needs replacement, there is a shortage of 318,652 usable (old edition) textbooks, and 386,492 new generation textbooks. This is the computed need at 6-8 subjects as against the total 657,571 enrolled textbooks.

There are 9 colleges in the province, three (3) of which are public, the Surigao del Sur Polytechnic State college (SSPSC) in Tago the LGU-initiated, self-liquidating community college named as University of Southeastern Philippines (USP) in Bislig and another USP campus in Hinatuan, both are external campuses of USP in Davao City. The remaining six (6) colleges are private, four (4) of which are sectarian while the other two (2) are non-sectarian, viz: the St. Theresa College (STC) in Tandag, the St. Michael's College (SMC) in Cantilan, John Bosco College (JBC) in Bislig, St. Vincent de Paul, Andres Soriano College (ASC) and Southern Technological Institute of the Philippines (STIP) all in Mangagoy, Bislig City. All these colleges tried their best to cater to the educational aspirations of the people and they offer programs which are affordable by them. They likewise envisioned producing responsive, employable and competitive graduates who shall serve as agents for social transformation.

However, most of these institutions cannot be compared with established colleges and universities in the cities in terms of facilities, since they are still young and developing and they are faced with the great challenge of attaining excellence in all their programs while remaining as affordable institutions of higher learning. They are experiencing the difficulties of a neophyte trying to fit into the role of an established SUC. Perhaps, those are the very reasons why incoming college students migrate to big cities like Manila, Cebu, Davao and Cagayan de Oro where big colleges and universities offer a wide array of courses and vast opportunities for them to choose. There are also vocational courses offered by the different SSPSC campuses under the secondary education supervised by the CHED, namely: SSPSC Campuses in Cagwait, San Miguel, Lianga, Tagbina and the SSIT in Cantilan.

Vocational courses offered are in accordance with their specialization. Trade and Industry in Cagwait Campus, Agri-forest Science Center in San Miguel Campus, Aquamarine Technology in Lianga Campus Agricultural Business in Tagbina and Industrial Technology in Cantilan Campus.

Another agency which is mandated to provide relevant accessible, high quality and efficient technical education and skills development is Technical Education and Skills Development Authority or TESDA. This institution is composed of the National Manpower & Youth Council (NMYC), Bureau of Technical Vocational Education of the DECS (BTVE) and the Office of the Apprenticeship, Bureau of Local Employment, and DOLE, merged into one body. TESDA now serves as the manager of the Technical Vocational Educational Training Sector. However, TVET is sometimes undertaken in State Universities & Colleges (SUC's) under the supervision of the CHED.

At present, there is no TESDA administered schools and colleges in the province of Surigao Del Sur, however, it has managed to operate in our II TVET institutions, the SSPC college cluster (the different municipalities already mentioned), five (5) campuses in Cantilan, Tago, Cagwait, San Miguel, Lianga and Tagbina and in private colleges; namely: St. Theresa College, Tandag, St. Michaels College, Cantilan, San Vincent de Paul College, John Bosco & Southern Technological Institute of the Philippines all in Bislig City.

Some problems/limitations experienced by TESDA in its operation is the lack of classrooms/laboratory shops, limited courses offered due to absence of trainers to handle trainings, no available positions/items.

Despite this dilemma besetting TESDA, it has managed to operate and has catered the simple ambition of our Out-of-School Youth, the unemployed, jobless mothers, Balikbayan Overseas Workers. Though limited, it dreamed to open a wider door of direction, strong linkages of partnership of the LGUs to pursue its major reforms and orchestrates multi-sectorial efforts towards an independent and sustainable system supportive to the need of the Surigaonon in engaging into a gainful employment & productivity thereby establishing centers of excellence in the institutions it supervised.

Enrollment

The greatest bulk of enrollment was accommodated by the public schools constituting about 93 percent of the total enrollment in SY 2001-2002. Enrollment in the public and private elementary schools summed up to 95,431, public schools registering a total of 93,290 enrollees and 2,141 in the private schools. In the same school year, secondary level, enrolled a total of 27,360 students with 20,905 in the public schools and the 6,455 in the private schools.

On the other hand, enrolment in the vocational education totaled 1,750, females comprise 971 while males numbered 779. Out of the total enrolment, SSIT got the highest with 487 followed by SSPSC Lianga with 458, San Miguel with 184 and the least is Cagwait with 182.

These campuses have played a special role in the development of technocrats of different specialized skills and expertise. Meanwhile, the tertiary level registered a total of 5,298 students. In the same school year, Tandag SSPSC campus got the highest count, reaching 1,563 followed by Cantilan campus with 1,237, then Lianga 582, Tagbina, 243, San Miguel 185 & Cagwait got the lowest with only 98 enrollees.

A number of students in these campuses, took up 2-year technology courses; viz, 235 students in Tandag campus, 343 students in Cantilan campus followed by Lianga campus with 281 head count, then Tagbina got 219 enrollees, 194 in Cagwait and San Miguel SSPSC has 118 head count. About 77.58 percent of the total enrollees took up bachelor's degree.

Gross Participation Rate

Participation Rate in the elementary schools was placed at 88.07 percent in SY 2001-2002, public schools registering the highest participation rate with 88.07 percent. Public secondary school is in no better position than its elementary school counterpart. Participation Rate is lower than the elementary level with 64.13 percent, public secondary with 52.56 percent and 11.57 for private secondary schools.

Source: https://surigaodelsur.ph/profile/social-sector/education

Agriculture

Crops

The Crops Development Zone delineated in SAFDZ covers 140,354 hectares cultivated with coconut, as major crop and other commodities like rice, corn, abaca and high value commercial crops such as banana, coffee and durian. These products exhibited potential for high production, quality of processed by-products and obviously high market price. The support facilities and services that are in place enable the sector to gain access in regional market centers as in the case of durian, coffee, banana, corn, copra and palay which are now traded outside the province. The total Network of Protected Areas for Agriculture and Agri-Industry Development (NPAAAD) covers around 170,064 hectares wherein SAFDZs are delineated. The remaining NPAAAD of 22,558 hectares are those areas delineated for watershed development, agro-forestry and as expansion to the production areas already developed.

Livestock

On the other hand, the livestock industry has kept in pace with the crops sector having supported by the National Government through the Medium-Term Livestock Development Program (MTLDP) with components like animal upgrading services, animal health and regulatory, credit facilities and other service facilities. In the SAFDZ Map, the livestock area covers 1,965 hectares available for forage and pasture development aside from the areas under coconut that can also be utilized for forage production.

Fisheries

Meanwhile, the province's geographical location exhibits a comparative advantage in terms of the vastness of aquamarine fishery resources endowed to it by nature. Its elongated shape stretches a total shoreline length of 487.7 kilometers, covering 16 municipalities and one city which are coastal while two are landlocked.

Fishery production areas delineated under the SAFDZ registered a total of 5,183 hectares of which brackish water aquaculture accounts to 3,024.86 hectares, freshwater areas 87 hectares, Mari culture 516.15 hectares and the remaining 1,555 hectares are potential for aquaculture development. The present level of aquaculture productivity ranges from 0.5-1.2 mt. per hectare per year at which 5,927.59 mt accounted to brackish water production, 43.5 mt. to freshwater and 9,238 mt. to Mari culture. Marine fishery resource on, the other hand, consist of municipal and commercial fisheries whose production level is pegged at 32,073 mt. and 2,980 mt., respectively. Supply and demand for fish and other agricultural crops.

At present, there are 26 fish sanctuaries maintained provincewide with a total of 2,375 hectares. Other support facilities and services identified are the presence of fishery institutions such as the SSPSC Campuses in Anibongan, St. Christine and Poblacion, Lianga; Gamut, Barobo; Portlamon, Hinatuan; and Sto. Niño, San Agustin. Provincial Fish Nursery at Gamut, Tago caters fingerling requirement of fish farmers provincewide. The Provincial Red Tide/Marine Biotoxin Testing Center located at PFARO, Tandag caters red tide toxin analysis. Prawn hatcheries located at Dawis, Mabua, Rosario, Tandag; Mawis and Portlamon at Hinatuan and Sabang, Lingig also respond to the prawn fry requirements of fishpond operators.

The private sector played a great role in propelling the development of crops, livestock and fishery industries, thus, organization of industry councils, farmer-coops and Rural-Based Organizations (RBOs) have been instituted to cater a dynamic and participatory economic undertaking. There are 16 Municipal Fisheries and Aquatic Resources Management Councils (MFARMCs), 145 BFARMCs, two (2) IFARMCs and one (1) CFARMC organized in the province.

Source: https://surigaodelsur.ph/profile/economic-sector/agriculture

Results and Discussion

Adaptive Capacity

Adaptive Capacity (AC) is the property of a system to adjust its characteristics or behaviour to expand its coping range under existing climate variability or future climate conditions. In practical terms, adaptive capacity is the ability to design and implement effective adaptation strategies or react to evolving hazards and stresses to reduce the likelihood of the occurrence and/or the magnitude of harmful outcomes resulting from climate-related hazards. The adaptation process requires the capacity to learn from previous experiences to cope with current climate and apply these lessons to cope with future climate, including surprises. The AC indicators were clustered into eight (8) capitals such as Economic, Natural, Social, Human, Health, Physical, Anticipatory and Institutional.

Figure 4 revealed that there were three (3) municipalities classified as very high AC index, these are Tandag City, Bislig City and Cantilan. Tandag City is the most adaptive municipalities in the province of Surigao del Sur, where it is the 5th component class city and as the center for governance and commerce in the said province. The classification status validates the adaptive capacity of the city to withstand hazards pressures. The high coping mechanisms available for Economic [1.0], Natural [0.19], Social [0.67], Human [0.46], Health [0.76], Physical [0.64], Anticipatory [0.81], and Institutional [0.87] made the city as topped most adaptive city in the province.

On the other hand, the overall capacity index shows that 7 out of 19 or 37% of the municipalities have a low to very low adaptive capacity index. This low AC index classification are the municipalities of Lingig [0.31], Lanuza [0.29], Carmen [0.28], Marihatag [0.26], and Lianga [0.31], while, Bayabas [0] and Carrascal [0.14] belonged to very low AC index. The municipality of Bayabas (5th class municipality) is classified as very low AC index among the 19 municipalities of the said province. It can be noted that there were six capitals this municipality revealed with very low index, these are Economic [0.13], Human [0.04], Physical [0], Anticipat ory [0.1], Natural [0.17], and Institutional [0.07].

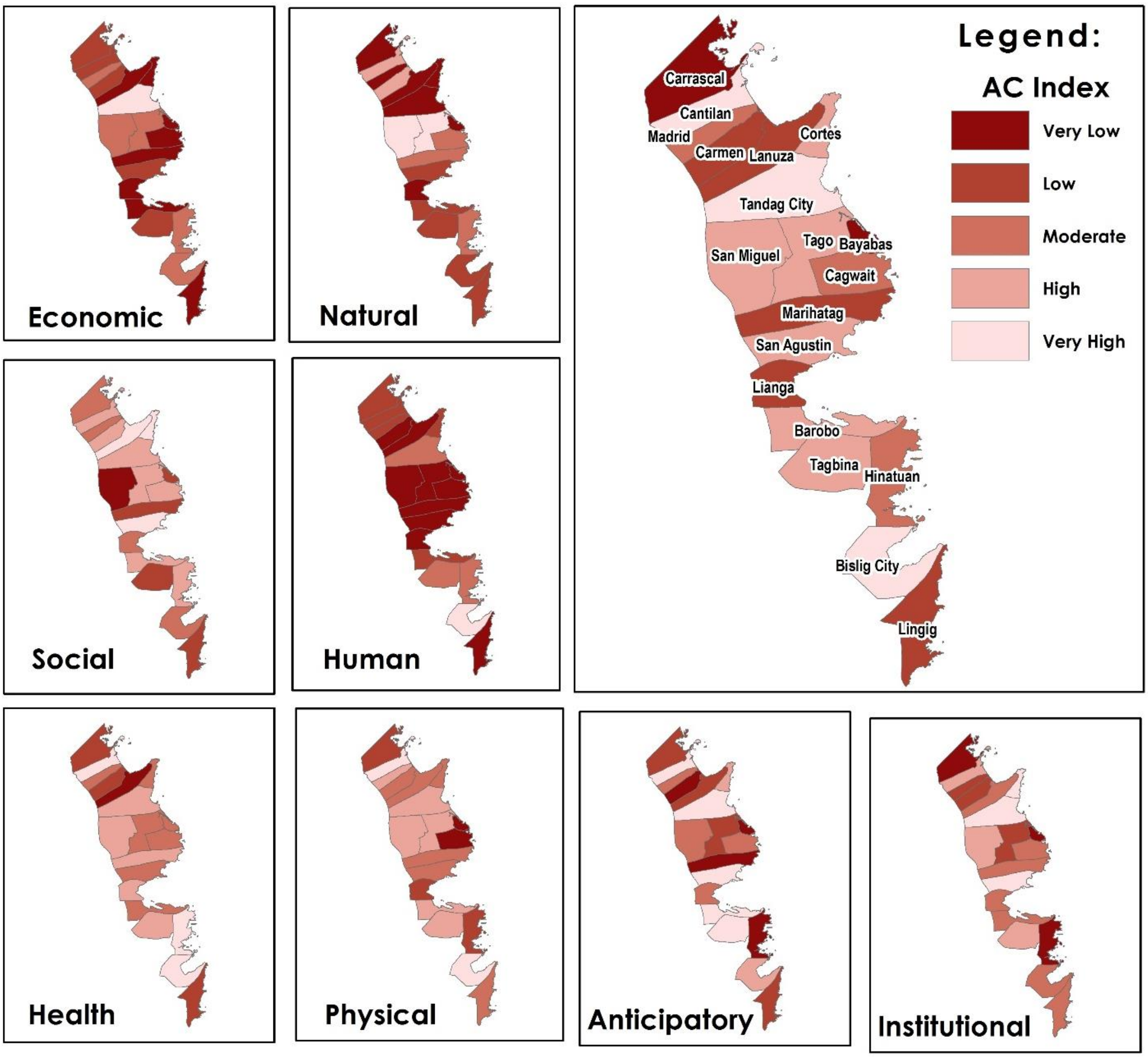


Figure 4. Adaptive Capacity Index in Surigao del Sur

The results suggested the local government units (LGUs) under low AC need to improve their coping mechanisms by adding or increasing their services and interventions in the communities affected by climate-related pressures.

Hazard Index

Hazard is a source or a situation with the potential for harm in terms of human injury or ill-health, damage to property, damage to the environment, or combination of these (dmp.wa.gov.au). Based on the consultation and validation series through online meetings conducted last May-June 2021 with the project partners from the LGU's in the province of Surigao del Sur. There were six hazards identified in the province of Surigao del Sur, these are tropical cyclone, flood, sea level rise, erosion, landslide, and storm surge. All hazard data were sourced-out from the International Center for Tropical Agriculture (CIAT), an authorized data provider. The combination of these all-natural hazards had been used to estimate the extent each municipality of the said province by using its hazard weights.

Figure 5 showed the hazard index map of Surigao del Sur. As mentioned in the previous section, six (6) hazards were identified in the said province. The presence of major river basins in the respective municipalities across the province is attributed to high exposure to flooding incidence. The major river basins identified are the Tandag river basin, Tago river basin, Hubo Otieza river basin, Hinatuan river basin, and Bislig river basin. Almost all areas in the said province are exposed to tropical cyclone as these areas are facing the open sea. Sea level rise incidence is due to the river network connection towards Surigao del Sur. The rising level of the seawater will significantly affect the river tributary and adjacent areas of the riverbanks.

On the other hand, Tago, Hinatuan, and Bislig have high exposure to sea level rise and storm surge. In terms of soil erosion hazard, all areas except in the municipalities of San Miguel, Tagbina, and Bislig are exposed to erosion. Generally, the overall hazard index showed that all areas across the province except the municipality of Tagbina are exposed to hazards (total combined effect).

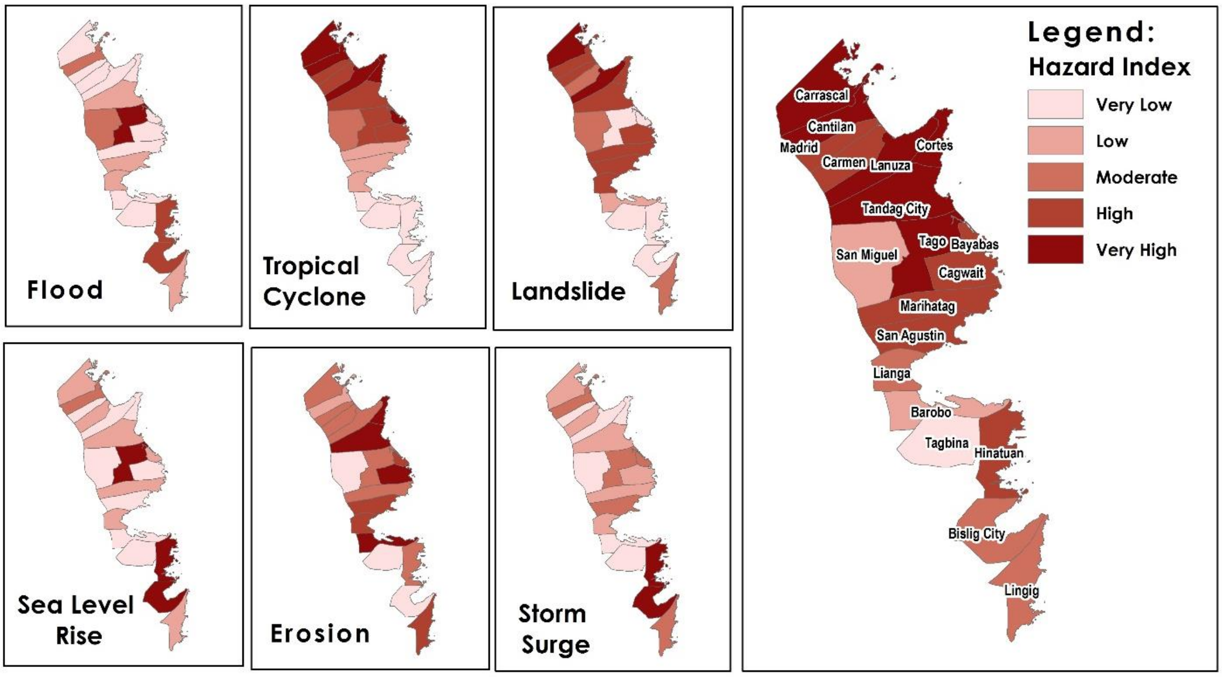


Figure 5. Hazard index map in Surigao del Sur

Sensitivity Index

In the province of Surigao del Sur, the results revealed that each crop varies its suitability on its adverse effect due to climate variability. For this province, the municipalities of San Miguel, Marihatag, and San Agustin have greater losses its suitability (Figure 6) across five identified priority crops (i.e., abaca, coffee, corn, banana, and rice) while some municipalities vary their suitability (gaining/no change/loss) of the respective crops. In contrast, some municipalities such as Tandag City, Cortes, Lanuza of the said province have gained or maintained their suitability in the upcoming years. The changing climate in the year 2050 has to do with the suitability effect of the crops in the said province.

Abaca. The northern and southern parts of Surigao del Sur showed less crop sensitivity (gaining) to changing climate environmental conditions (Figure 6a). However, a remarkable change in a negative direction as manifested in the central part of the said province reflects a higher impact on climate change (loss suitability). These municipalities of San Miguel, Marihatag, San Agustin, Lianga, and Tagbina showed high sensitivity. An overall suitability map showed that the province of Surigao del Sur is gaining or maintaining its suitability for Abaca crop outnumbered the negative impact (loss) based on the number of municipalities.

Coffee. Generally, the suitability index result (Figure 6b) showed that most of the municipalities of Surigao del Sur are suitable for coffee production to changing climate in the future (year 2050) except in the southern part of the province, which manifested as high sensitivity (loss). An overall suitability map (Figure showed that the said province is notably suitable for coffee production).

Corn. Corn is another important cereal in the country. It is one of the primary commodities of Surigao del Sur Province and other provinces of Caraga. The overall suitability map of corn crop (Figure 6c) showed a remarkable high sensitivity where 8 out of 19 (42%) municipalities in the said province, particularly in Carascal, Cantilan, Madrid, San Miguel, Tago, Barobo, Tagbina, and Hinatuan, are losing their suitability in the coming years. On the other hand, most of the province's municipalities are gaining or maintaining (less sensitive) their suitability in the coming years (less sensitive). An overall suitability map showed that the said province is notably suitable for corn production. However, LGUs might pay attention to the areas identified as high sensitivity to climate change to cope with the future negative impacts.

Banana. The suitability of bananas in the province of Surigao del Sur (Figure 6d), particularly in the municipalities of Cantilan, Madrid, Tandag City, San Miguel, Tago Marihatag, and San Agustin showed a great influence on sensitivity (loss in suitability) in the year 2050. The unfavorable climate conditions and a reduction in yield for the banana industry in these municipalities are expected. On the other hand, other municipalities showed less sensitivity with a positive suitability outcome (no change or gain). Bayabas, Cagwait, and Lingig municipalities have gained climatic suitability for bananas, while the rest have maintained their suitability. The modeled future climate condition in the said municipalities are favorable for the banana crop.

Rice. The varied suitability result for rice crop are evenly distributed across the province of Surigao del Sur. Most municipalities located in the central part of the said province particularly in Madrid, San Miguel, Marihatag, Cagwait, San Agustin, Lianga, and Lingig are crop sensitive to climate change. As a whole, it implies the favorable suitability of rice crop (gain/maintain) as manifested in the map (Figure 6e).

The sensitivity results in Surigao del Sur emphasize the need for improvement in crop management, better provision and optimize the utilization of the water for irrigation and increase adaptation strategies to cope up such increasing climatic pressures that might affect the agricultural productivity.

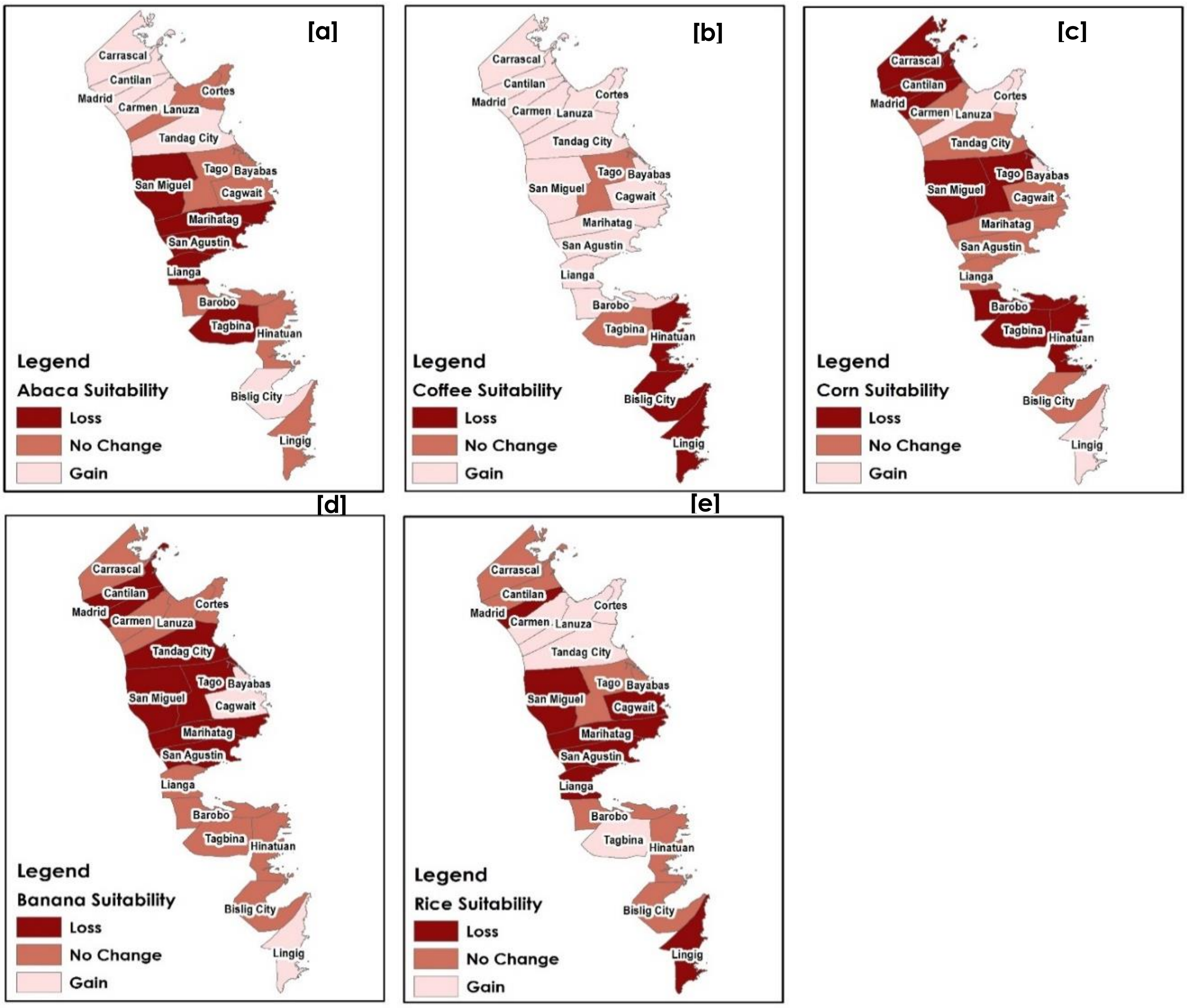


Figure 6. Sensitivity (Suitability) index of abaca [a], coffee [b], corn [c], banana [d], and rice [e] in Surigao del Sur province

Vulnerability Index

The vulnerability model was constructed using the GIS platform to pre-process the spatial and a spatial dataset for the three components: sensitivity, exposure, and adaptive capacity to come with the total climate risk vulnerability assessment (CRVA). Figure 7 to Figure 11 showed the index level maps in the provinces of Surigao del Sur. The potential impact (sensitivity + exposure) in the respective municipalities showed the variations on how the commodities in these areas are exposed and adversely affected by climate change and hazards pressures in the coming years. The total CRV index for the province of Surigao del Sur, highly vulnerable municipalities were Bayabas, Carrascal, Lanuza, Lingig, and Carmen for the abaca, banana, coffee, corn, and rice

The exposure and adaptive capacity component indexes in measuring the vulnerability are common to all commodities in the province of Surigao del Sur. The vulnerability result only varies to the sensitivity status of the commodity. Hence, each commodity has different impact characteristics to handle such adverse effects to climate variability. The radar graph showed in Figure 7b to Figure 11b indicates the impact of the three component drivers (sensitivity, exposure, and adaptive capacity) in measuring the vulnerability status of the five prime commodities in the said province. As observed in Figure 7a to Figure 11a, three municipalities, particularly in Tandag City, Bislig City, and Cantilan are identified as less vulnerable due to their high adaptive capacity across the five commodities. Several areas in the province are highly exposed to hazards such as Tandag City [1.0], Tago [0.95], Carrascal [0.95], Cantilan [0.94], Cortes [0.89], Lanuza [0.80], San Agustin [0.73], Madrid [0.69], Hinatuan [0.68], Bayabas [0.66], and Marihatag [0.61].

Abaca. Figure 7a showed the total vulnerability of Abaca commodity in Surigao del Sur where municipalities of Bayabas [0.79], Carrascal [0.70], and Lanuza [0.63] are the most vulnerable areas due to high exposure to hazards with lower adaptive capacity. It is also shown that Tandag City, Bislig City and Cantilan are less vulnerable among the municipalities in the said province due to its high coping mechanisms. The radar graph showed in Figure 7b indicates that banana crops in several municipalities are highly exposed to different hazards, sensitive to climate variability, and less adaptive are vulnerable.

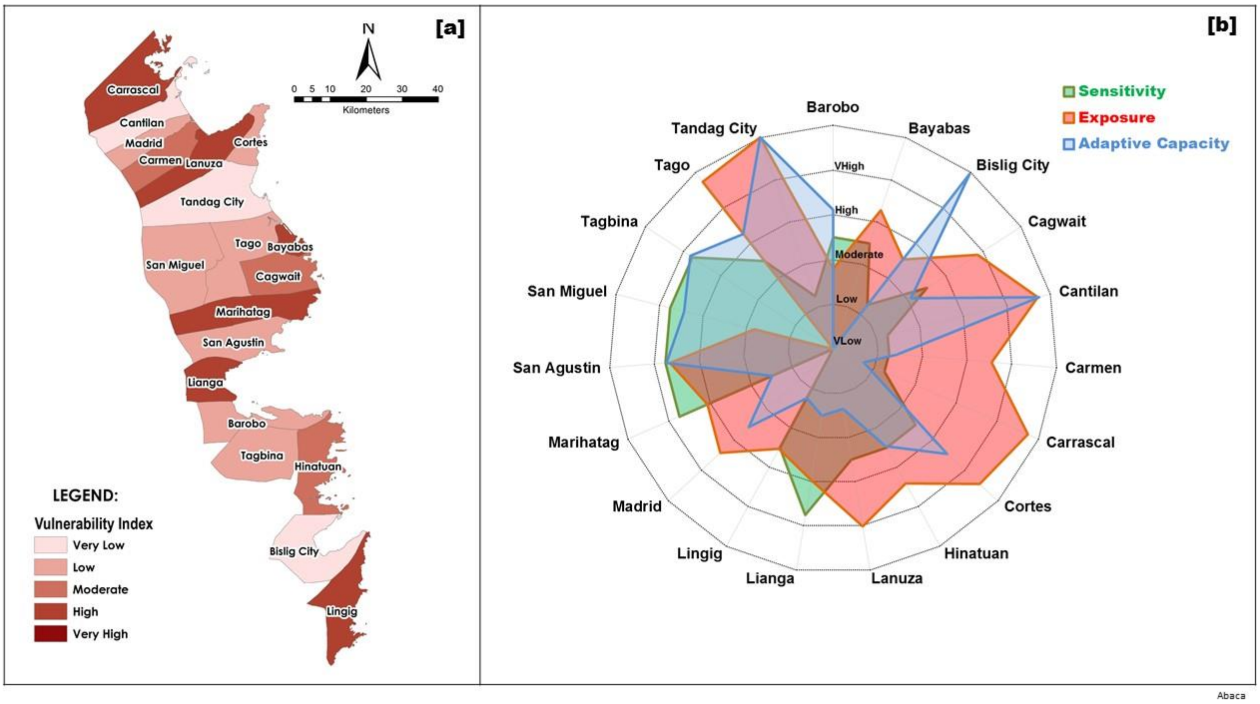


Figure 7. Vulnerability Index Map [a] and Radar Graph [b] for Abaca crop in Surigao del Sur

Banana. In Figure 8a, the Banana commodity in Carrascal, Carmen, Lanuza, Bayabas, and Marihatag are classified as highly vulnerable areas in Surigao del Sur province. The vulnerability classification status is attributed as low AC index and high in hazards exposure. The radar graph (Figure 8b) indicates that the municipality of Bayabas is tagged as the most sensitive (loss) area for Banana production.

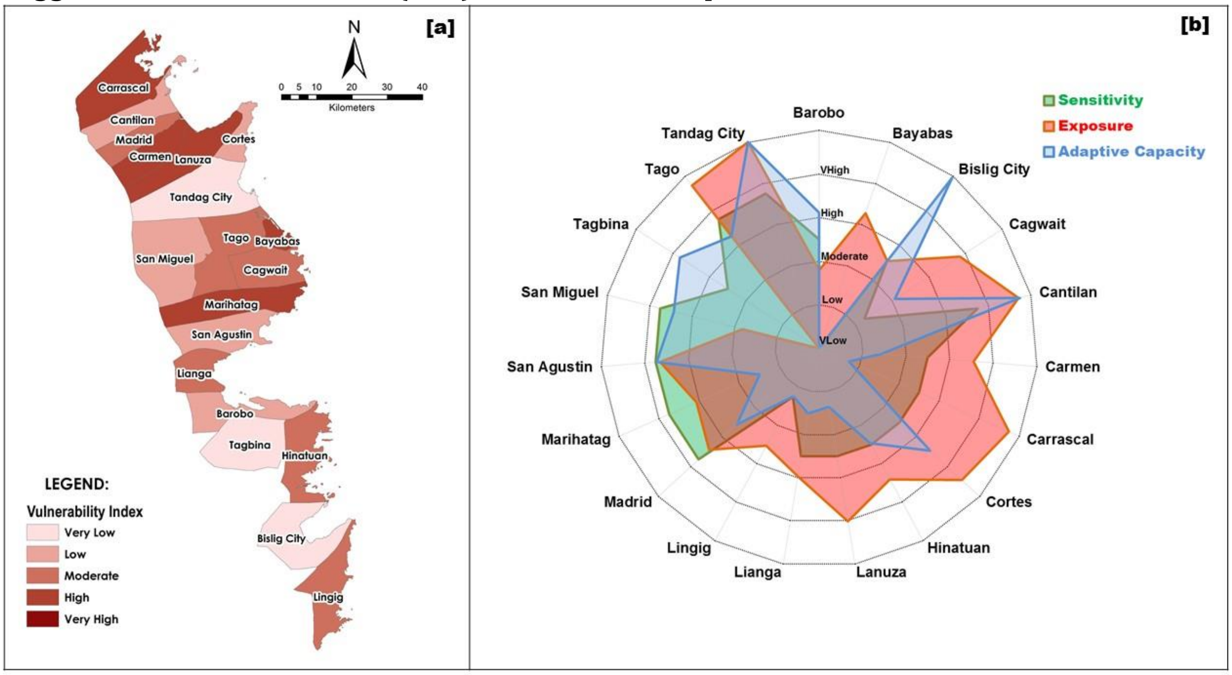


Figure 8. Vulnerability Index Map [a] and Radar Graph [b] for Banana crop in Surigao del Sur.

Coffee. The vulnerability map of the Coffee commodity (Figure 9a) also showed that the municipalities of Bayabas [0.76] and Lingig [0.64] are considered the most vulnerable areas across Surigao del Sur province with very low adaptive capacity. The radar graph (Figure 9b) indicates that four municipalities, particularly in Cantilan, Carmen, Carrascal, and Lanuza, decrease their suitability for coffee production.

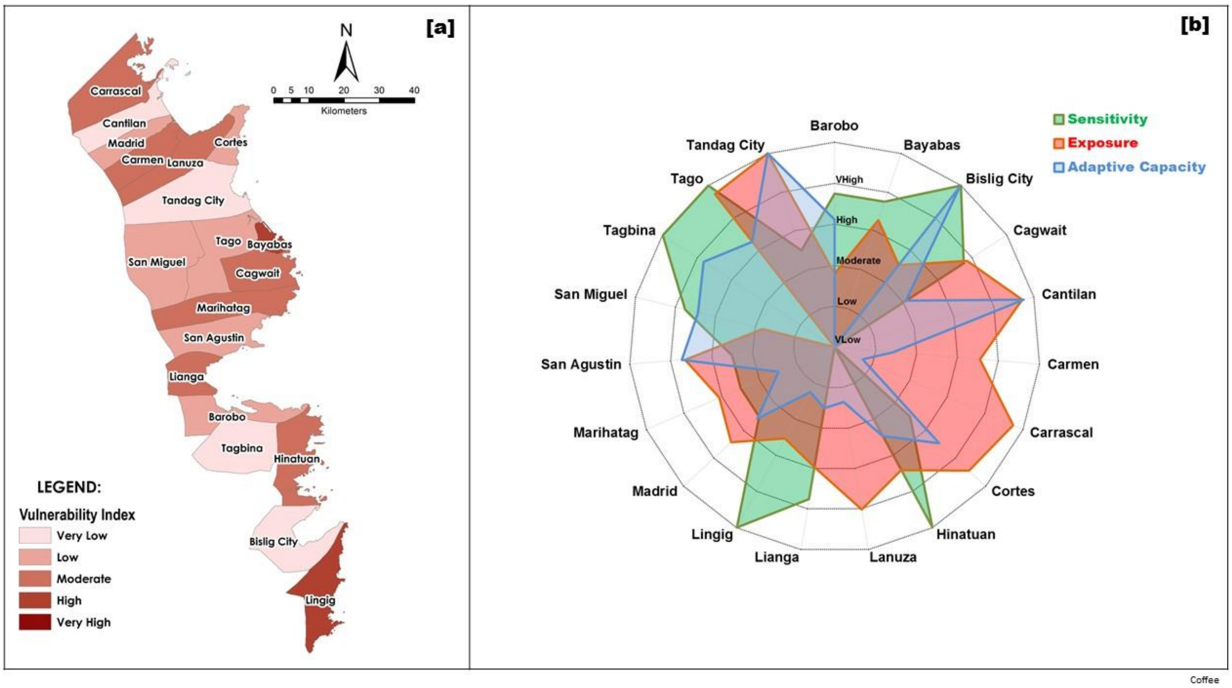


Figure 9. Vulnerability Index Map [a] and Radar Graph [b] for coffee crop in Surigao del Sur

Corn. Corn commodity in the province of Surigao del Sur are highly vulnerable in the areas of Carrascal [0.77], Bayabas [0.76], and Carmen [0.61], as observed in Figure 10a. Generally, the vulnerability map of corn commodity shows to have a moderate to low index and indicates that the said commodity is not highly susceptible to climate-related hazards. Radar graph shows (Figure 10b) that the majority of the areas in the province are suitable (gain) for corn production except in the municipality of Cortes (loss).

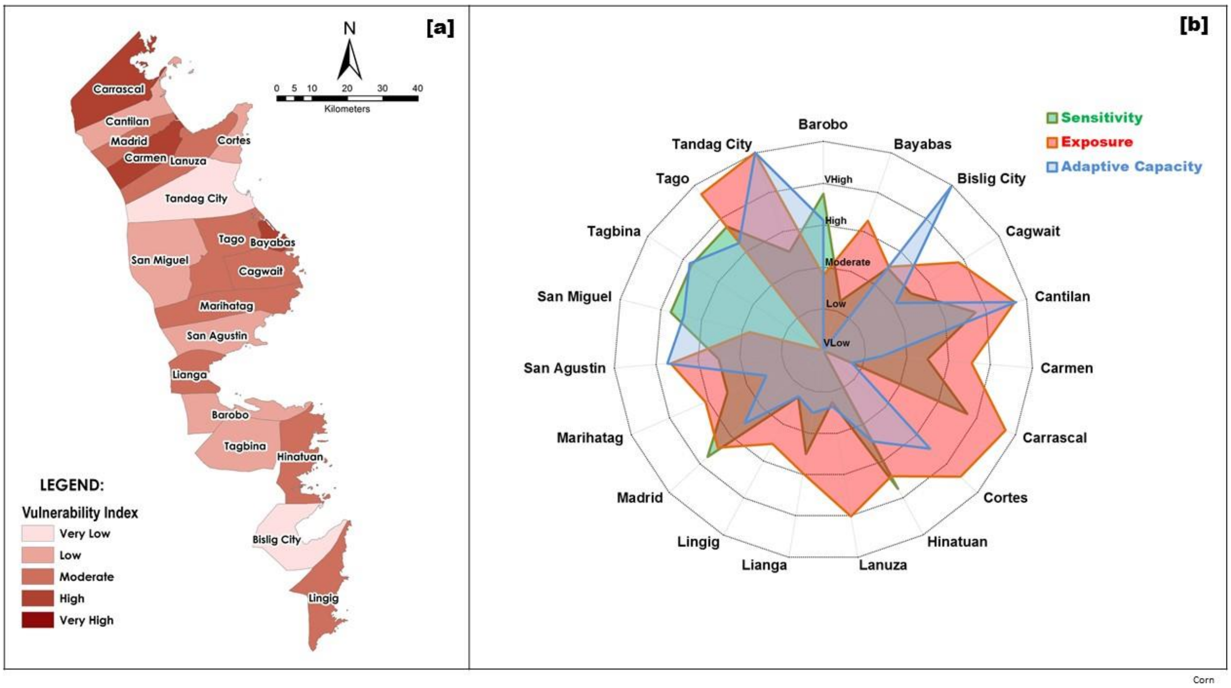


Figure 10. Vulnerability Index Map [a] and Radar Graph [b] for Corn crop in Surigao del Sur

Rice. The municipalities of Bayabas [0.79], Carrascal [0.74], and Lingig [0.64] topped the list of the province's most vulnerable municipalities for rice production, as shown in Figure 11a. On the other hand, in the radar graph shown in Figure 11b, four municipalities are affected: Carmen, Lanuza, Tagbina, and Tandag City are affected by the climate pressures where Rice production in the said areas is susceptible.

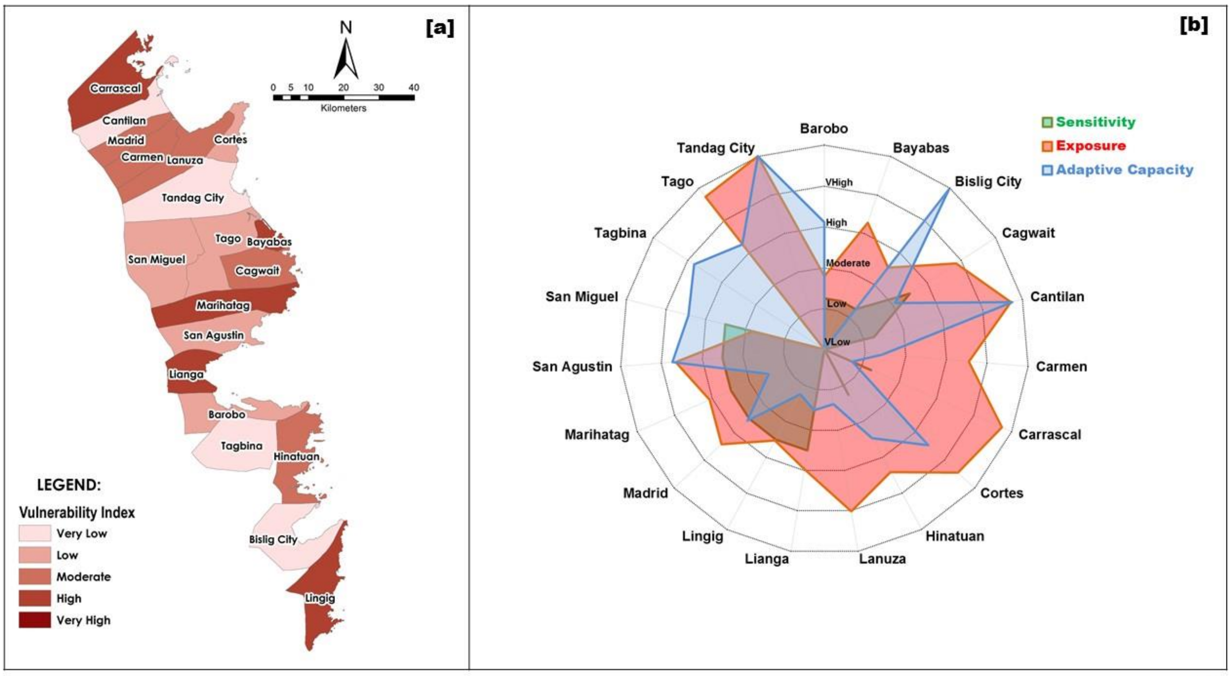


Figure 11. Vulnerability Index Map [a] and Radar Graph [b] for Rice crop in Surigao del Sur

CONLCUSION AND RECOMMENDATION

The identification of the area's most vulnerable to climate change risks in Caraga region is among the extensive work to do. This assessment responds to the need by identifying which municipalities in the province of Surigao del Sur 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 were integrated in a consistent and meaningful manner to produce a map indicating the area's 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 particularly in Surigao del Sur.

Based on this CRVA, the municipality of Bayabas, Carrascal and Lingig were among the highly vulnerable municipalities in the province due to its high exposure to climate hazards particularly low adaptive capacity and the decreasing suitability of crops to climate variability in the aforementioned municipalities. Considering other factors constant, investing for abaca, banana, coffee, rice and corn will be less favorable 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.

Climate Resilient practices are recommended for these municipalities. These practices will be adapted in AMIA Villages that will be established after this CRVA. Several practices such as alternate wetting and drying (i.e., controlled irrigation rather than standard continuous flooding of rice fields), adoption of water-saving technologies (e.g. drainage, drip irrigation), use of traditional and new varieties, plowing techniques, compost application, moderate fertilizer application and planting at moderate density can be applied. According to the article published by Chandra, A. et al. (2017) adaptation of organic farming such as use of rice hull as soil cover improved water use, soil moisture and soil infiltration during dry seasons. Vegetables survived the long drought seasons because grass cover in the topsoil retains moisture. Mitigation and adaptation options were also influenced by farmer knowledge of growing seasons and local climate conditions. By scheduling planting with real-time climate information via seasonal calendars, smallholder farmers were able to coincide with the early or late rainy seasons or avoid disasters. Farmers also reported seasonal calendar better tools for planting under organic agriculture compared to relying on fertilizers and chemicals to mitigate drought effects on high value crops. Use of Site-Specific Nutrient Management (SSNM), Integrated Pest Management (IPM) and use of early maturing and stress-tolerant varieties are best practices for Corn. To further validate these farming practices, Community Participatory Action Research (CPAR) is recommended.

References

Anshory, A. and Francisco, H. (January 2009). Climate Change Vulnerability Mapping for Southeast Asia

Brown, P.R., R. Nelson, B. Jacobs, P. Kokic, J. Tracey, M. Ahmed, and P. DeVoil. (2010). Enabling natural resource managers to self-assess their adaptive capacity. Agricultural System 103:562-568. http://dx.doi.org/10.1016/j.agsy.210.06.004

Chandra, A., Dargusch, P.,McNamara, K.E., Caspe, AM., Databajan, D. (2017). A Study of Climate-Smart Farming Practices and Climate-resiliency Field Schools in Mindanao, the Philippines, Word Development

Dikitanan, R., Grosjean, G., Nowak, A., Leyte, J. (2017). Climate Resilient Agriculture in Philippines

Dulal, H.B., Brodnig, G., Onoriose, C.G., Thakur, H.K. (January 2010). Capitalizing on Assets: Vulnerability and Adaptation to Climate Change in Nepal

Factbook, (2018). Surigao del Norte

Greely, H.T (2001). International Encyclopedia of the Social & Behavioral Sciences

Jones, L., Ludi, E. and Levine, S. (December 2010). Towards a characterization of adaptive capacity: A framework for analyzing capacity at the local level

Lockwood, M., Raymond, C.M., Oczkowski, E. and Morrison (2015). Measuring the dimensions of adaptive capacity: a psychometric approach. Ecology and Society 20(1): 37. http:/dx.doi.org/10.5751/ES-07203-200137

Parker, L., Bourgoin, C., Valle, A.M., Laderach, P. (March 2019) Vulnerability of the Agricultural Sector to Climate Change: The Development of a pan-tropical Climate Risk Vulnerability Assessment to inform sub-national decision making

Pannell, D.J., Marshall, G.R., Barr, N., Curtis, A., Vanclay, F. and Wilkinson, R. (2006). Understanding and promoting adoption of conservation practices by rural landholders. Australian Journal of Experimental Agriculture 46:1407-1424. http://dx.doi.org/10.1071/EA05037

Paquit, J.C., Bruno, A.G., Rivera, T.A., Salingay, R.O. (December 2018). Climate-Risk Vulnerability Assessment of the Agricultural Sector in the Municipality and Cities of Bukidnon, Philippines.https://innspub.net/ijb/climate-risk-vulnerability-assessment-agriculture-sector-municipalities-cities-bukidnon-philippines

Park, S., Howden, M. and Crimp, S. (2012). Informing regional level policy development and actions for increased adaptive capacity in rural livelihoods. Environmental Science and Policy 15:23-27. http://dx.doi.org/10.1016/j.envsci.2011.09.004

Pelling, M. and High, C. (February 2005). Understanding adaptation: What can social capital offer assessments of adaptive capacity?

Nelson, R., Brown, P.R., Darbas, T., Kokic, P. and Cody, K. (2007). The potential to map the adaptive capacity of Australian land managers for NRM policy using ABS data

Wall, E. and Marzall, K. (2006). Adaptive Capacity for Climate Change in Canadian Rural Communities. Local Government Vol. 11, No. 4, 373-397. (http: www.researchgate.net)

World Health Organization (WHO). World health report 2002: reducing risks, promoting healthy life.Geneva, Switzerland, World Health Organization, 2002. (https://www.who.int)

Appendices

Appendix Figure 1. Crop occurrence markings in Bislig, Surigao del Sur

Appendix Figure 2. Crop occurrence markings in Carmen, Surigao del Sur

Appendix Figure 3. Crop occurrence markings in Cortes, Surigao del Sur

Appendix Figure 4. Crop occurrence markings in Lianga, Surigao del Sur.

Appendix Figure 5. Crop occurrence markings in Lingig, Surigao del Sur.

Appendix Figure 6. Crop occurrence markings in Madrid, Surigao del Sur.

Appendix Figure 7. Crop occurrence markings in San Agustin, Surigao del Sur.

Appendix Figure 8. Crop occurrence markings in San Miguel, Surigao del Sur.

Appendix Figure 9. Crop occurrence markings in Tagbina, Surigao del Sur.

Appendix Figure 10. Crop occurrence markings in Tandag City, Surigao del Sur

Department of Agriculture-Caraga
ADAPTATION AND MITIGATION INITIATIVES IN AGRICULTURE

Capitol Drive, Butuan City, Philippines
Telephone: 342 4092
Fax: 341 2114
Email address: caragamia@gmail.com