Climate-Resilient Agri-fisheries (CRA) Assessment, Targeting & Prioritization for the Adaptation and Mitigation Initiative (AMIA) Phase 2 in Cebu Province (Central Visayas Region)

TERMINAL REPORT

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COMPLETION REPORT

BASIC INFORMATION

Title of the Project: Climate-Resilient Agri-fisheries (CRA) Assessment, Targeting & Prioritization for the Adaptation and Mitigation Initiative (AMIA) Phase 2 in Cebu Province (Central Visayas Region)

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Implementing Agency
Lead Agency: Visayas State University
Collaborating Agency: Department of Agriculture Regional Field Office VII

Project Duration
Approved Duration: June 2017 – May 2018
Actual Duration: July 1, 2017 – August 31, 2018
Start Date of Implementation: July 1, 2017

Project Site
Province: Region VII, Province of Cebu
City/Municipality: All cities and municipalities of Cebu
Geocode 0722

Project Funding
Budget Requested: PhP 999,770.08
Total Amount Released: PhP 99,770.08
Actual Expenses
Unliquidated Balance

RDE Agenda Addressed: Development of Unified Vulnerability Suitability Assessment (VSA) for all areas; Development of crop modelling tools for predictive use especially for high value crops
Expected Technology/Information: Climate-resilient agri-fisheries (CRA) technologies and practices in Central Visayas Region in support of AMIA2+
Potential Impact: Climate-resilient agriculture and fishing communities in Cebu Province – Central Visayas Region
Target Beneficiaries/Users: Agriculture and fishing communities in Central Visayas, Planners, and Department of Agriculture
Tags/Keywords: Climate-resilient; agriculture; fishery; adaptation; mitigation; vulnerability exposure

ABSTRACT

The agriculture sector nowadays is greatly affected by climate changes wherein farmers' which are dependent on this sector is increasingly getting more vulnerable to its associated effects. In effect, the identification of vulnerable areas has become an urgent issue that resulted into the implementation of this project. The result of this undertaking offered solution to the said dilemma as this had examined the level of agriculture sector in Cebu province. This study focused on the determination of vulnerability level of cities and municipalities in the province with emphasis on corn, rice, banana, mango and cassava. The study also documented the climate-resilient practices in the province adopted by farmers as mitigation to the aforesaid phenomenon. The results of the study were translated into index maps using quantum geographic information systems (QGIS) technology indicating the level of vulnerability of the province to climate-change induced stressors.

Tags: Climate-resilient; agriculture; fishery; adaptation; mitigation; vulnerability exposure

RATIONALE

The Adaptation and Mitigation Initiative in Agriculture (AMIA) seeks to enable the Department of Agriculture (DA) to plan and implement strategies to support local communities in managing climate risks – from extreme weather events to long-term climatic shifts. Spearheaded by the DA System-wide Climate Change Office (DA SWCCO), AMIA Phase 1 in 2015-16 urgently implemented its activities to strengthen DA's capacity to mainstream climate change adaptation and mitigation strategies in its core functions of R&D, extension, and regulation. It also emphasize in designing complementary activities for building appropriate climate responsive DA support services.

With AMIA Phase 2 in 2015-16, the next big challenge is pursuing climate-resilient agri-fisheries (CRA) an operational strategy through field-level action that directly involves, and impacts on the livelihoods of, farming communities. AMIA2 aims to invest in the launching of CRA communities - as the initial target sites for action learning, supported by an integrated package of climate services and institutions, within a broader food system/value chain setting. The program launched an integrated and multi-stakeholder efforts to operationalize CRA at the community level in nine (9) target regions. As such, this AMIA2 program framework consists of 8 key clusters of inter-related activities, whose cumulative and combined results are envisioned to help AMIA achieve its goal for 2016 and beyond. For each cluster, a set of projects and activities were designed towards operationalizing the AMIA framework that consists of eight clusters as such:

Cluster 1: Enabling environment

Cluster 2: Vulnerability assessment and risk targeting

Cluster 3: Developing knowledge pool of CRA options

Cluster 4: CRA community participatory action research initial phase

Cluster 5: Enhancing services and institutions

Cluster 6: Integrating CRA in food systems and value chains

Cluster 7: Implementing CRA on scale

Cluster 8: Knowledge Management for results

The AMIA2+ and its framework provides overall guidance in the planning and designing research and development interventions in seven (7) target regions. These target regions are as follows:

1. Cordillera Administrative Region
2. MIMAROPA Region
3. Region VII: Central Visayas
4. Region VIII: Eastern Visayas
5. Region IX: Zamboanga Peninsula
6. Region XIII: CARAGA
7. Autonomous Region in Muslim Mindanao

Successful implementation of AMIA2+ at the regional level requires strong collaboration and support of key research and development institutions within the region. This project enables AMIA2+ to establish and mobilize regional teams, each led by a local State University/College (SUC), and in partnership with the corresponding entity, the Department of Agriculture - Regional Field Office (DA-RFOs). However, the implementation of this undertaking should follow in determining the strength, weaknesses, opportunities and threats (SWOT) in the project site specifically Cebu province. Thereby, analysis of SWOT was the main activity in the attainment of its objectives.

SWOT Analysis

Strengths: DA's nation-wide network of regional AMIA focal points, AMIA1 outputs serve as initial approximation of climate-risk vulnerability. With this, DA-SWCCO benefits from the increasing participation by state universities and colleges that brings more academic and research skills on climate change research.

Weaknesses: AMIA1 outputs primarily focus on risk exposure (hazard), data sources and analytical methods need further validation and higher-level resolution. Despite the efforts on data collection in AMIA2, the project still face limited availability of data, especially on crop occurrences and adaptive capacity.

Opportunities: Climate-change adaptation provides top priority agenda of the broader agri-fisheries sector in the country

Threats: Negative impacts of climate change is detrimental to the entire environment and/or ecosystem. Critical challenges require immediate responses and actions in solving and/or mitigating climate change. Good relationship between SUCs and DA-RFOs should be in place to make sure that project outputs are used.

Potential Impact

CRVA results are critical to AMIA's next-stage planning and design of a multi-regional project for action research and development to build CRA communities. The resulting information would support AMIA strategic decisions in targeting key climate risk in specific communities of priority commodities/systems/landscapes in each region. It also guides AMIA in establishing the framework for result-based monitoring and evaluation of AMIA achievements, i.e. community level outcomes, and responsive policies and institutions.

General Objective

The general objective is to assess, target and prioritize climate-resilient agri-fisheries (CRA) research and development in Region VII in support of AMIA2. However, the in-lined outcomes of the project are as follows:

1. Strengthen capacities of CRA methodologies for the key research and development organizations in the region;
2. Assess climate risks in the region's agri-fisheries sector through geospatial and climate modeling tools;

3. Determine local stakeholders' perceptions, knowledge and strategies for adapting to climate risks;
4. Document and analyze local CRA practices to support AMIA2 knowledge-sharing and investment planning;
5. Provide support to DA-RFO7 by providing data in establishing AMIA baseline for outcome monitoring and evaluation (ME) of CRA communities and livelihood.

Expected Output of Specific Objective

At the end of the project, it is expected that

1. The project partners like the DA-RFO7 and the Provincial Agriculture Office (PAO) will learn various tools used for climate-risk vulnerability assessment like climate sensitivity analysis, exposure from climate-related hazards and adaptive capacity;
2. The project will produce "Climate-risk vulnerability maps" reflecting 2030 and 2050 predicted climatic changes;
3. Document farmer's knowledge and perceptions of various CRA practices tested by farmers.
4. Document farmer's CRA practices and cost-benefit analysis of selected CRA practices;
5. Developed appropriate monitoring and evaluation tools for climate resilient livelihood and communities.

Scope and Limitations

The project is being piloted in the province of Cebu covering all municipalities and cities. However, random sampling of beneficiaries was done in the identified municipalities during the conduct of the survey.

REVIEW OF RELATED LITERATURE

The Central Visayas (Region VII) is one of the fastest growing regions in the entire Visayas with Cebu City as the main hub of commerce and industry. Aside from the booming local industries, the relevance of foreign investors in the export-industries in Cebu City (and Mactan Island) is evident. The top relevant export products in this region are semiconductors, electronic watches, electrical equipment, cameras and furniture. The largest foreign markets are the USA and Japan. Total export sales in this region exceeded $2.0 Billion in 1998, representing close to 7% of the total Philippine exports. The exports are increasing with an average growth rate of more than 12% over the past five years" (DTI Cebu).

As of August 1, 2015, Central Visayas has a population of 6,041,903 comprising Cebu, Bohol and Negros Oriental (POPCEN 2015). While the total agricultural land area is 522,483 ha., comprising temporary crop land (346,719 ha.), idle land (4,465 ha.), permanent crop land (132,942 ha), meadows and pasture (1,453 ha.), forest land (1,985 ha.), and other land (35,562 ha.). The total area and average area per farm/holding is 427,464,000, 292,571.40 ha., and 0.684 ha., respectively (PSA, 2012). The top agricultural crop is palay and corn with production (in metric tons) of 347,697 and 173,225, respectively. However, in 2013, production in agriculture declined by 0.13 percent. The crops subsector, which accounted for 36.59 percent of the regions agricultural output recorded a 1.46 percent increment in output. On the other hand, the fisheries subsector posted a production cut by 2.35 percent (countrystat.psa.gov.ph). The major commodities of the region are hog, chicken, palay, chicken egg, sugarcane and mango. Hog and chicken production ranked fifth in the national production while, sugarcane and mango ranked third overall.

Currently, with the creation of the Negros Island Region, Central Visayas is composed of three provinces only – Cebu, Bohol, and Siquijor Island. In 2011, a study conducted by the WWF-Philippines and BPI Foundation Inc., relative to Business Risk Assessment and Management of Climate Change Impacts, Cebu City scored 6.55 in vulnerability and then exposed to all six climate scenarios listed in WWF study. It is ranked sixth out of 16 cities in terms of vulnerability to climate change impacts. With the aforementioned scenario, Tan (2015) said, “Cebu City is a resource-scarce city wherein he emphasized that the populace must learn to produce more with using less resources.”

Cebu City is generally characterized by having narrow coastal plains with rugged mountains and limestone plateaus, barely 15% of the city’s total land area sits on flat terrain. With much of its land area categorized as steep slopes, it is not considered an agricultural center especially that its uplands are also highly vulnerable to rain induced landslides. Besides, one of the problems of metropolis Cebu is saltwater intrusion due to excessive groundwater extraction. Recent studies showed that saltwater intrusion has been reported to attain at 5 km from its shore. It was reported that Cebu City will likely find itself caught in a “climate sandwich” as saltwater intrusion advances, sea level rise and more intense typhoons lash the coastline with storm surge. The fisheries of Cebu have long exceeded maximum sustainable yields, which can be attributed to increase in sea surface temperature, ocean acidification coupled with increased population.

According to WWF-Philippines the key drivers to the development of the province are Governance and Water Resources Management. In response to the climate change adaptation, several agencies and institutions including DA, ATI, DENR and even Metro Cebu Water District formulated strategies such as reforestation of watershed areas, planting of drought-tolerant crops, establishment of water catchments, capability building at the local level on DRRM-CCA (Blasco, 2014, Salvacion, 2008, Soliva, 2016). Despite the efforts made by the Department of Agriculture-RFO VII through the provincial government, there is still a need to develop a good risk and vulnerability assessment in order to incorporate Climate Change Adaptation (CCA) into Disaster Risk Reduction (DRR) in updating plans for agriculture in the area most especially in solving the issues of water sufficiency.

METHODOLOGY PER OBJECTIVE

The project seeks to contribute to the overall AMIA2 program framework, by contributing specific outputs to targeted national-level research projects. It has five key components:

1. Capacity strengthening for CRA research & development
2. Geospatial assessment of climate risks
3. Stakeholders' participation in climate adaptation planning
4. Documenting & analyzing CRA practices
5. AMIA baseline study for monitoring & evaluation

These project components are designed to directly aligned with the research agenda of three AMIA2+ projects: 1) climate-risk vulnerability assessment (CRVA), 2) decision-support platform for CRA, and 3) institutional and policy innovations.

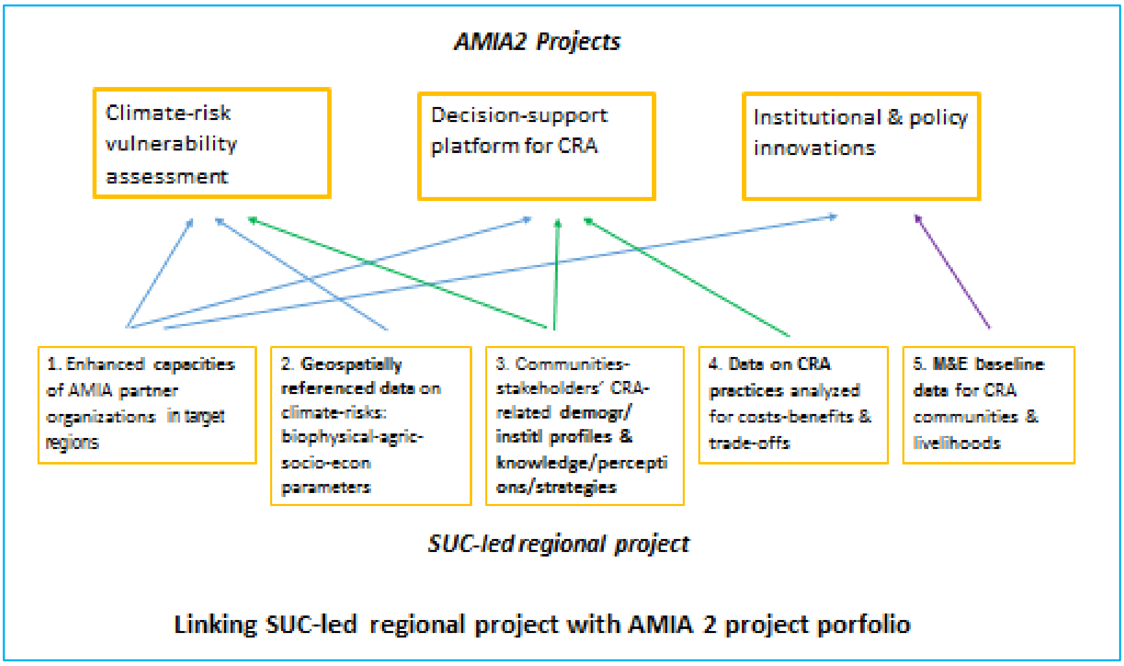

Figure 1. AMIA Project component framework

Capacity Strengthening for CRA Research and Development

The regional project team participated in a series of training, workshops and learning events organized by AMIA2 project. These events focused on three key methodologies: 1) CRVA, 2) CRA prioritization, and 3) CRA M&E. The project provided training support to key research and development stakeholders in the region, by organizing an intra-regional training that covers key learning contents from the national-level training.

Geospatial Assessment of Climate Risks

The regional project team collected and organized geo-referenced data on vulnerability to climate risks of the region's agri-fisheries sector. These datasets from both primary and secondary sources were based on the methodological guidelines provided by the AMIA2 CRVA project – covering climate-risk exposure, sensitivity and adaptive capacity. Preliminary analysis using GIS and climate modelling tools was undertaken at the regional level. The project team also participated in a national-team level joint analysis of cross-regional data.

Stakeholders' Participation in Climate Adaptation Planning

The regional project team organized a series of stakeholders' meetings and focus group discussions to collect supplementary data and validate preliminary results of CRVA as well as to undertake CRA prioritization and planning. These activities were guided by process facilitation and data collection tools developed by the AMIA2 project on CRVA and CRA decision-support platform.

Documenting and Analyzing CRA Practices

The regional project team conducted a semi-structured survey with local stakeholders to identify and document CRA practices, as well as collect existing CRA-relevant statistical and other secondary data. These data were systematized and analysed, using cost-benefit and trade-off analyses tools as input to AMIA2 CRA prioritization and investment planning. These will likewise contribute to developing knowledge products, such as searchable online portal, under the AMIA2 project on CRVA decision-support platform. A national working team, consisting of representatives from regional teams also conducted a joint task in documenting and analyzing the CRA practices.

AMIA Baseline Study for Monitoring and Evaluation

The regional project team have conducted a structured survey in order to collect baseline data in the target CRA communities and livelihoods as identified by AMIA2. This was undertaken following the development of outcome-oriented ME guidelines for CRA, under the AMIA2 project on institutional and policy innovations.

RESULTS AND DISCUSSION

In-lined with the project methodologies and objectives, the project team participated a series of workshops and training led by the Center of International Tropical Agriculture (CIAT) aimed at increasing the Team's capacity in conducting climate-risk vulnerability assessment (CRVA). In 2017, the project team participated the CRVA Workshop and Planning on July 24-25, CRA Decision Support Orientation and Planning Workshop on August 14-15 and AMIA-Wide Coordination Workshop on August 16-18. The team have also conducted an inception and coordination meeting with its partners – the Department of Agriculture, Regional Office 7 (DA-RFO7) officials – to formally present the framework and scope of the project in Cebu.

Crop Occurrence Mapping

The crop occurrence data were collected after the project team's inception meeting with DA-RFO7 officials. The team conducted two Crop Occurrence Workshops and Focus Group Discussion (FGD) on September 21-22, and October 9-10, 2017 respectively in Cebu Business Hotel, Cebu City. The participants of these activities were the Municipal and City Agriculturists of cities and municipalities in Cebu Province. The workshops were co-facilitated by the DA-RFO7 officials with main of purpose collecting crop occurrence data. As to the strategy of the workshops, the participants were tasked to identify and locate which part in the municipality and city that crops such as corn, rice, banana, mango, cassava, sweet potato, pinakbet and chopsuey veggies, coffee and cacao were abundantly grown. The respective participants were given a printed maps of their municipalities and cities overlayed with roads, water systems, and barangay boundaries on 1 X 1 km grid. There were 13 crops identified in Cebu province that are commercially grown by local farmers. However due to resource and time constraints, the team decided to focus the analysis on corn, rice, banana, mango and cassava referred to as prioritized crop commodities.

The municipalities that were not able to participate the workshops were personally visited by the project team. In total, out of the 53 municipalities and cities in Cebu province, the team were able to collect crop occurrence data of 49 municipalities and cities except

Mandaue City, Lapu-Lapu City, Cordova, and Malabuyoc. This is because the land delineation of these places except Malabuyoc are all classified as built-up areas hence no crops were grown. For Malabuyoc, the team was not able to collect data because this municipality did not attend to any workshop nor responded to the formal communications and invitations sent by the project team. Due to this absence of crop occurrence data, the four aforesaid local government units of were excluded in the subsequent analysis.

Figure 2 is a sample crop occurrence markings of the prioritized crop commodities in Cebu province. Each dot in the map represents the location of the priority crops present in every municipalities and cities in the said province. Each dot inside the gridlines represent a specific crop produced for commercial purposes irrespective of its volume of production. Following the collection of crop occurrence points, each crop data point was encoded and validated using satellite images from google earth and ocular site visit in select municipalities and cities of interest. The validation was done to increase the accuracy of data points as this carries a bearing on the results.

Figures 3-7 are the crop occurrence maps of the prioritized crop commodities in Cebu province. Meanwhile, Figures 8-12 shows the crop occurrence points of other crops which are sweet potato, coffee, cacao, pinakbet[1], and chopsuey[2]. It can be observe in these maps that corn has the highest number of occurrence while rice has the lowest in the province. This stark contrast implies that corn is the most prevalent crops in the province while rice is the least. In addition, a concentration of coffee occurrence points were noted at Tuburan, chopsuey in the mountain ranges of Dalagute, Argao and Cebu City while the rest of the aforesaid crops were observed throughout the province.

Table 1 presents the production of the prioritized crop commodities in Cebu province. Data showed that corn has the largest land area devoted for crop production with 61,998.84 hectares (ha.) producing about 1 mt/hectare and 1.74 mt/hectare for OPV white and hybrid

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[1] Pinakbet is collective term used for lowland vegetables that includes squash, eggplant, ampalaya, and string beans.

[2] Chopsuey is for cabbage and carrot

yellow variety respectively. This is followed by cassava (6,773.32 ha.), sweet potato (3,957.19) and smallest area is grown with pinakbet vegetables with only 1,132.34 ha. In terms of annual production, corn achieved the highest production in 2015 and 2016 with both more than 80,000 mt annually. This was closely followed by banana and mango with crop production ranges from 78,378.91 up to 86,438.31 mt a year for the former and 40,831.39 to 53,269.89 mt per year for the later. On the other hand, the lowest production was recorded in coffee with less than six metric tons per hectare.

Table 1. Production volume and physical area of prioritized commodities in Cebu Province

Commodity	**Physical Area (ha)***	**Average Yield (mt/ha)***	**Annual Production (in metric tons)****		
			2015	**2016**	**2017**
Palay	2,549.90	3.10	14,291.00	13,546.00	14,514.00
Corn (OPV White)	59,654.81	0.99	84,300.00	84,346.00	78,209.00
Corn (Hybrid Yellow)	2,344.03	1.74			
Cassava	6,773.32	6.20	20,256.11	17,449.19	16,765.57
Banana	2,135.81	6.21	78,378.91	84,075.08	86,438.31
Sweet Potato	3,957.19	5.33	14,969.18	16,550.24	15,848.84
Pinakbet***	1,132.34	…	13,474.83	13,431.60	13,348.81
Chopsuey***	1,216.41	…	7,577.26	7,455.88	7,452.85
Commodity	**Fruiting Stage**	**Number of Trees Planted**	**Production Volume (2015, 2016, 2017)**		
Mango	Bearing	342,034	53,269.89	40,831.39	42,018.98
	Non-Bearing	168,368	…	…	…
Coffee	Bearing	3,450	3.3	4.11	5.65
	Non-Bearing	17,730	…	…	…
Cacao	Bearing	13,636	18.32	18.67	19.1
	Non-Bearing	35,735	…	…	…

*Source: *DA-RFO7 Cebu provincial agricultural profile, 2014, **PSA, CountryStat*

****Pinakbet (squash, eggplant, ampalaya, string beans) Chopsuey (cabbage, carrot)*

… data not available

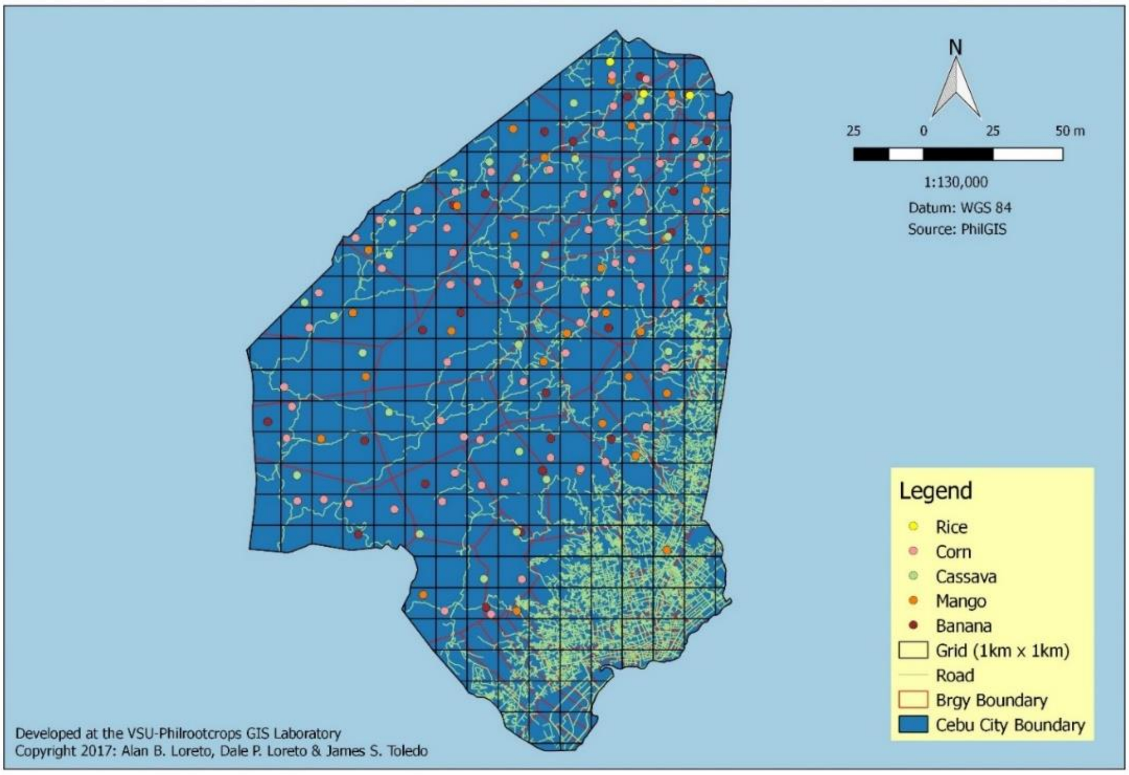

Figure 2. Crop occurrence output of Cebu City, Cebu Province

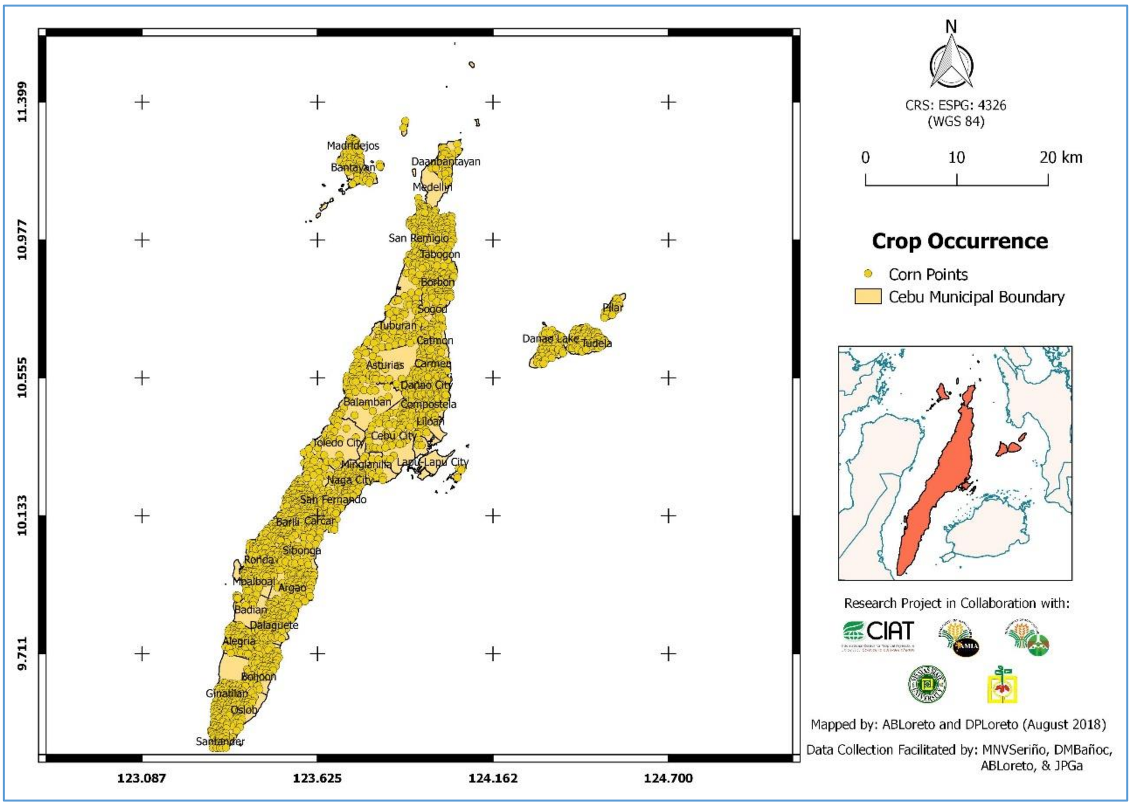

Figure 3. Corn crop occurrence points in Cebu Province

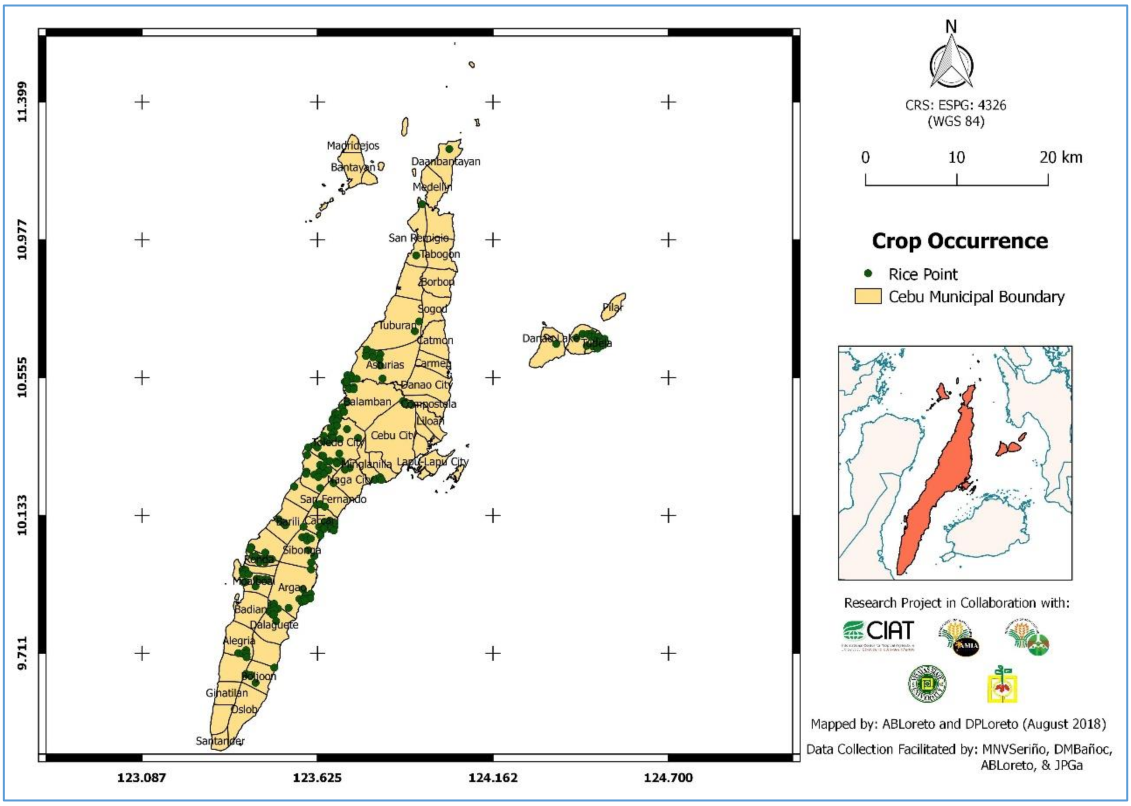

Figure 4. Rice crop occurrence points in Cebu Province

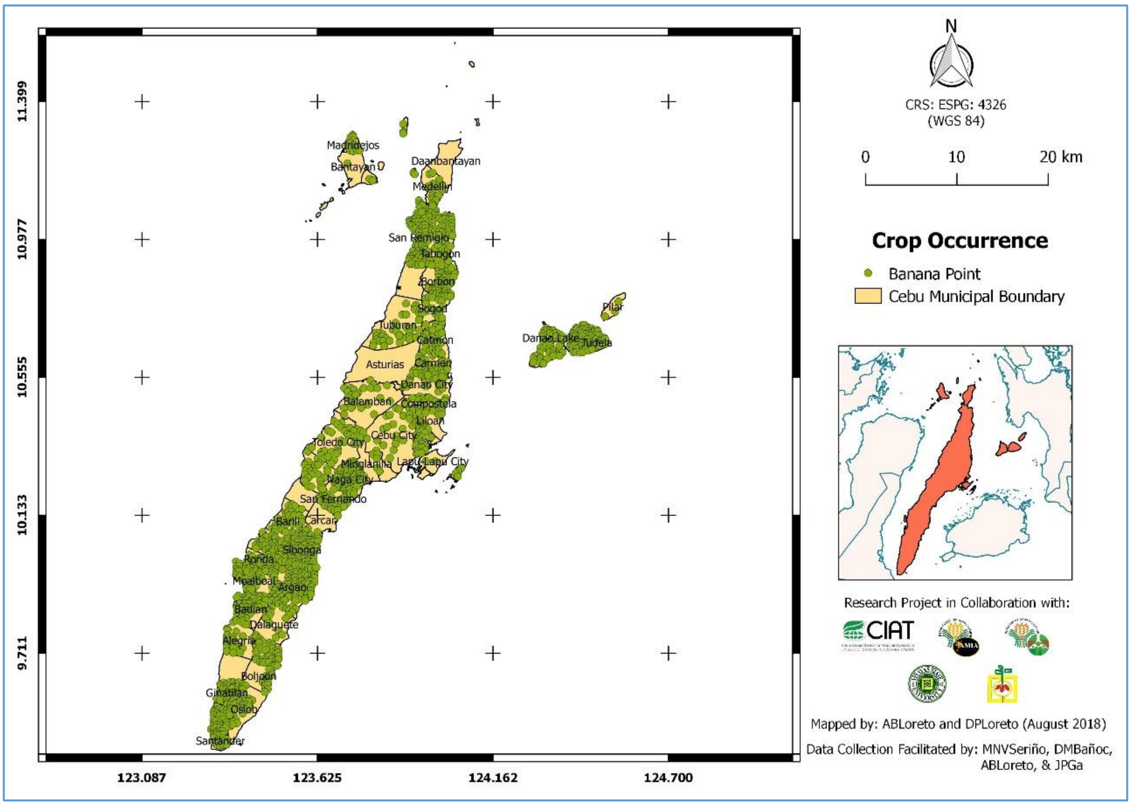

Figure 5. Banana crop occurrence points in Cebu Province

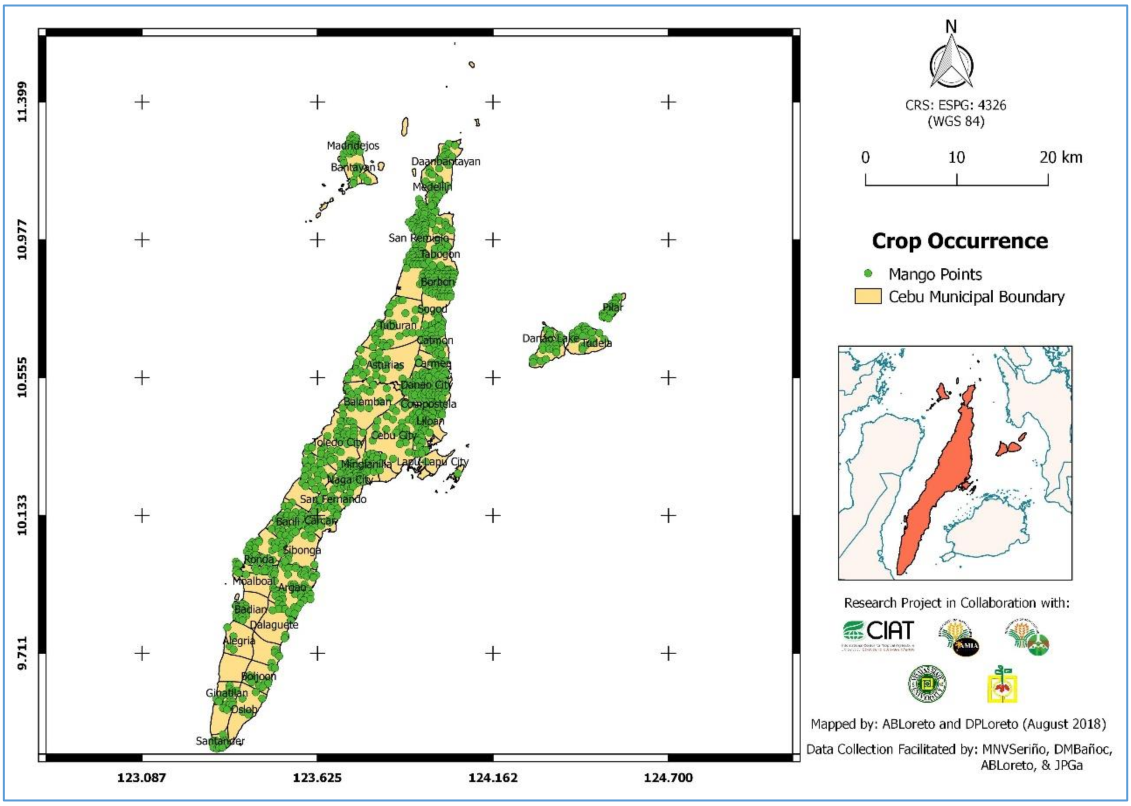

Figure 6. Mango crop occurrence points in Cebu Province

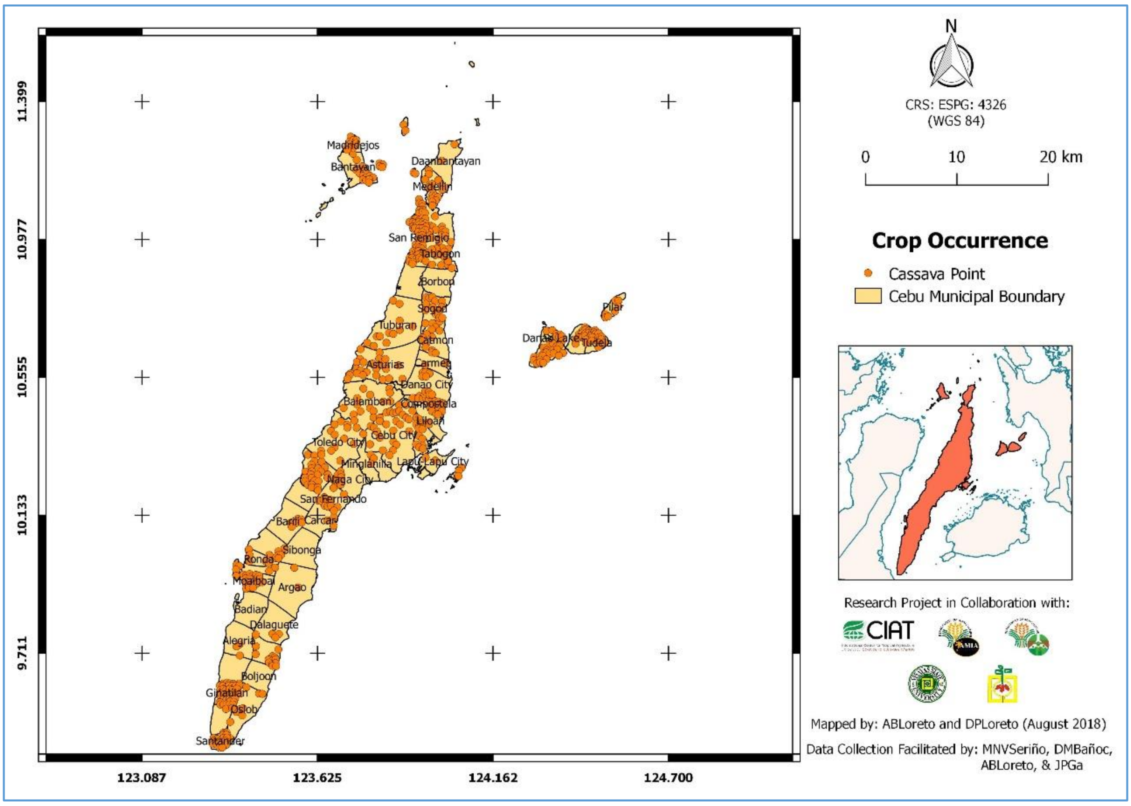

Figure 7. Cassava crop occurrence points in Cebu Province

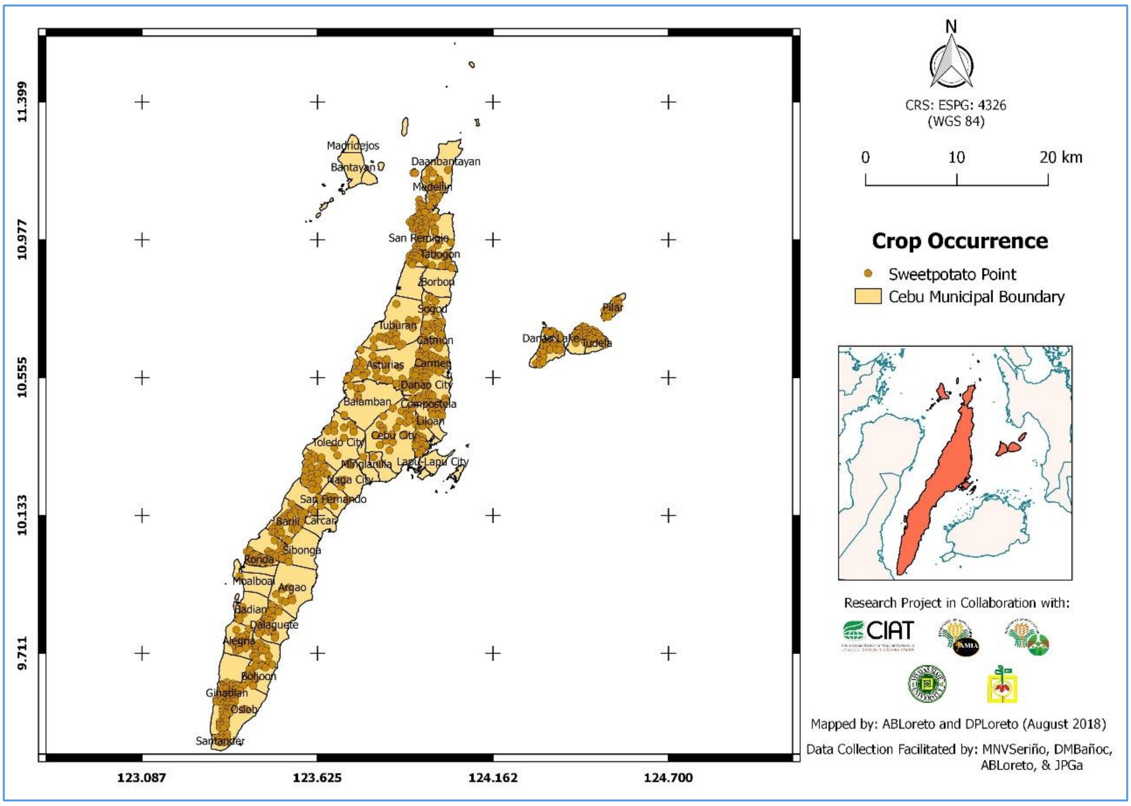

Figure 8. Sweet Potato crop occurrence points in Cebu Province

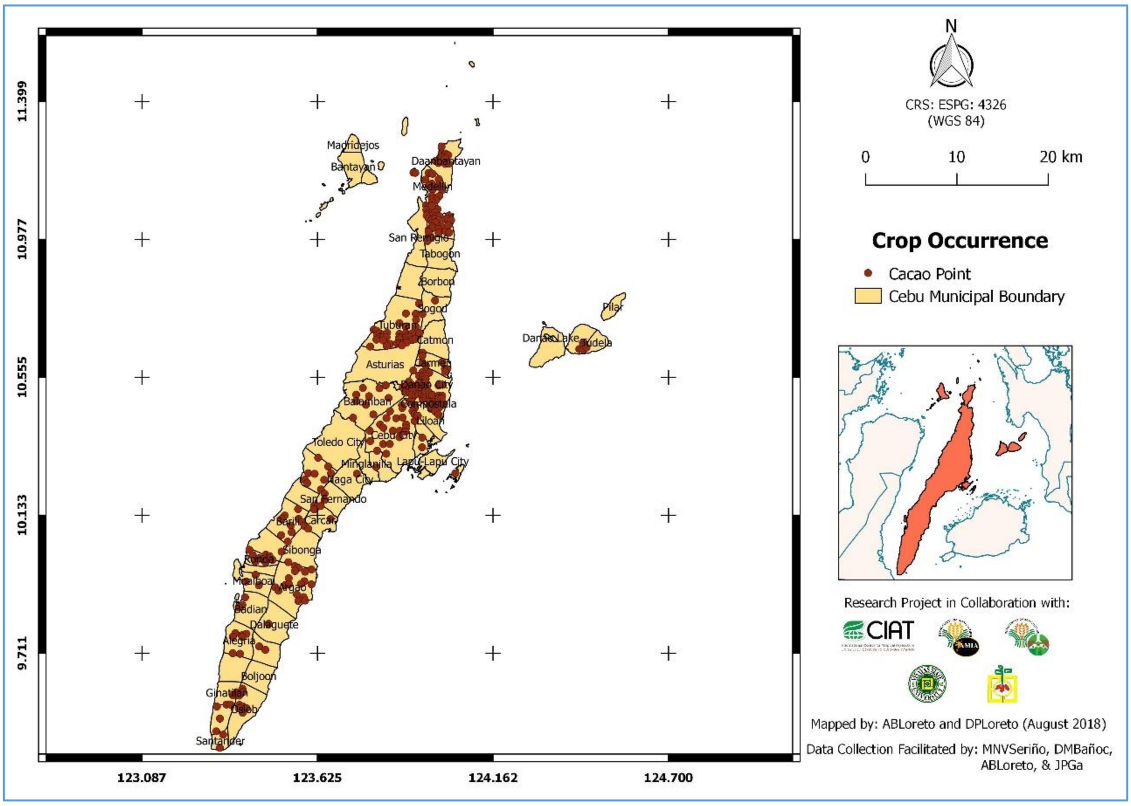

Figure 9. Cacao crop occurrence points in Cebu Province

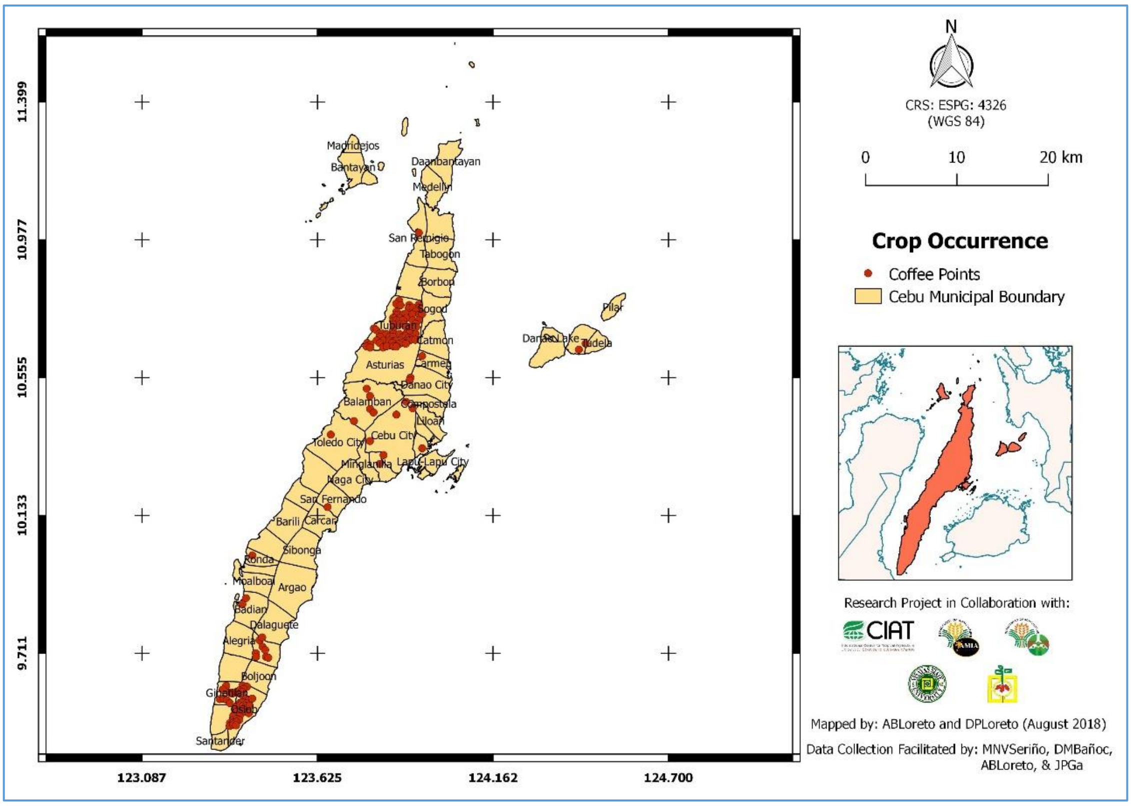

Figure 10. Coffee crop occurrence points in Cebu Province

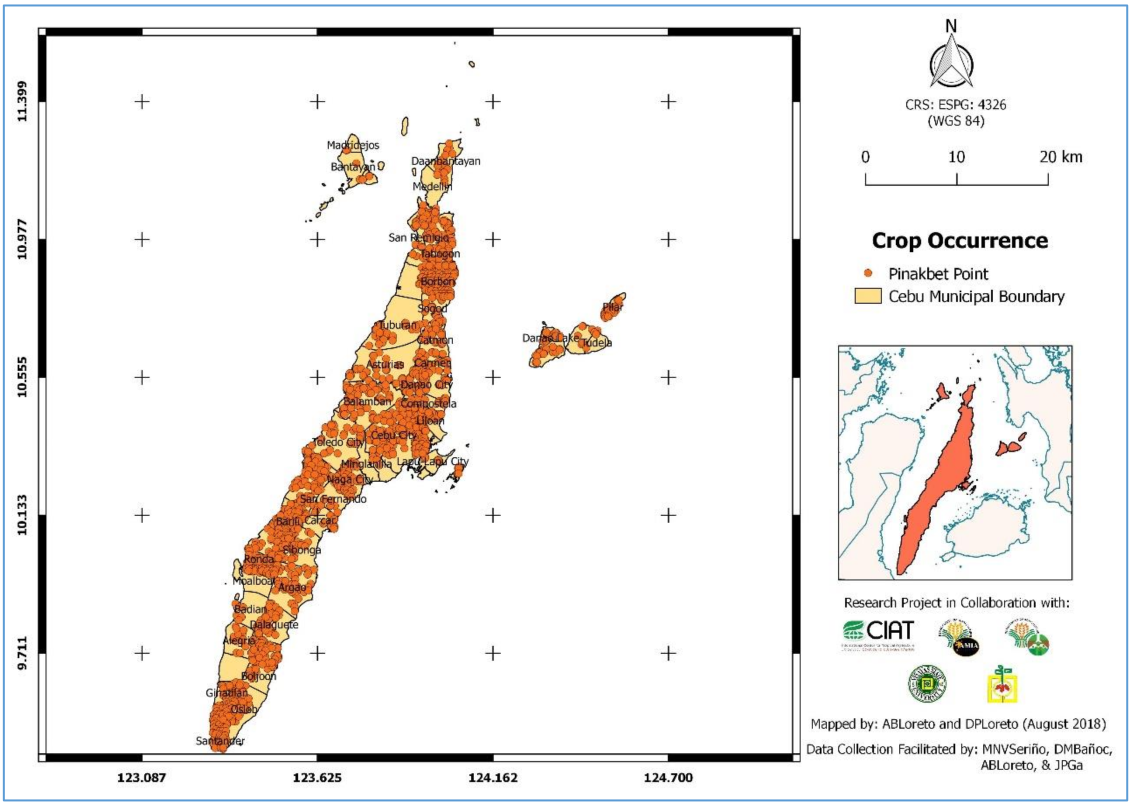

Figure 11. Pinakbet crop occurrence points in Cebu Province

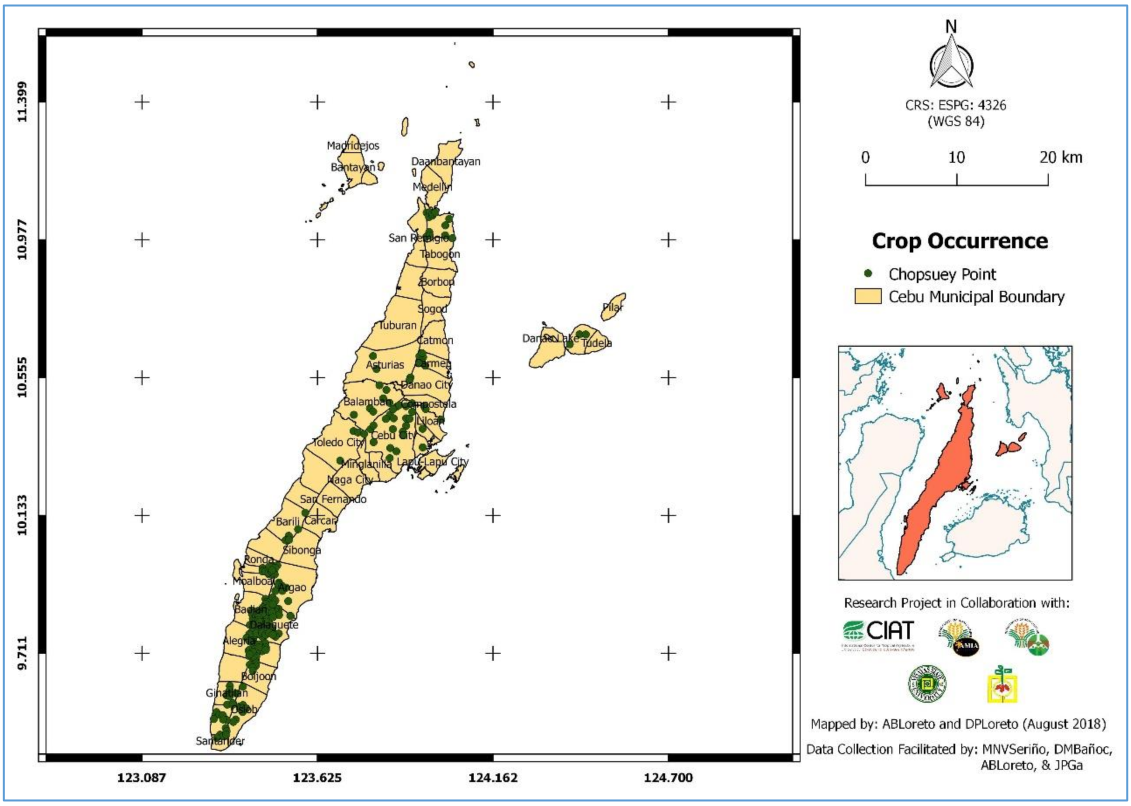

Figure 12. Chopsuey crop occurrence points in Cebu Province

Climate Change Sensitivity

In looking at the sensitivity of the prioritized crop commodities in Cebu province, the collected crop occurrence data along with the 20 bio-climatic indicator accessed from WorldClim were analyzed using Maximum Entropy (MaxEnt) modeling software. MaxEnt analyzes the sensitivity of crops to bio-climatic factors based on its distribution or occurrence. Location and images of crops was set on 30 seconds resolution or in a 1X1 km grid to increase the accuracy of the modelling results. Of these 20 bio-climatic factors used, eleven (11) were temperature related indicators and nine (9) were for precipitation. The data for each indicator was projected in the year 2050 following IPCC's RCP 8.5 climatic projection in the year 2050. MaxEnt determines which bio-climatic indicators affects the level of sensitivity of a particular crop commodity. In a broad sense, high level of sensitivity implies big changes in climatic suitability to grow crops. Changes in climatic suitability implicates further that in the future, current suitability of areas may turn unsuitable, less suitable, or highly suitable. In addition, results of the sensitivity analysis may reveal similar or the same indicators affecting the highest for each crops, however it is important to note that the direction of effect could be different. Such effect could be favorable to one but is devastating to the other.

Table 2 presents the top three (3) bio-climatic indicators with most percentage contribution to the level of sensitivity for each crop in the province. It showed that Precipitation of Wettest Quarter (Bio16) with 29.7% contributed the highest to the sensitivity level of corn in Cebu province while Precipitation Seasonality contributes rice sensitivity level by 27%. The value of Precipitation of Wettest Quarter and Precipitation Seasonality implicates that the increase in frequency of the two aforesaid indicators will have the highest bearing on the production of corn and rice in 2050. The same bio-climatic indicator affecting corn was also found to be affecting banana, cacao, and pinakbet the highest among the twenty indicators with 31.3%, 33.3%, and 27.9% contribution to its sensitivity level respectively. Isotermality (Bio3) or the quotient between Mean Diurnal Range and Temperature Annual Range have the highest effect on mango. For rootcrops, cassava and sweet potato were found to be affected the highest by the same three (3) bio-climatic indicators. These indicators were the Mean Diurnal Range, Precipitation of Wettest Quarter, and Precipitation of Coldest Quarter. Meanwhile, coffee and chopsuey were found to be affected greatly with precipitation related indicators. The complete listing of the twenty bio-climatic variables and its corresponding percentage contribution to sensitivity level foe each crop can be found in Appendix 12.

After determining the bio-climatic indicators predicted to affect the priority crops in Cebu province in the year 2050, the result was translated into maps. This was done to locate the areas to which the crops are more sensitive and not. Figures 13-17 showed the results of the sensitivity analysis of the five prioritized crop commodities. Corn sensitivity index map reflected in Figure 13 shows moderate sensitivity of the crop in Cebu province. For rice, Figure 14 showed that in some part of the province the crop is very highly sensitivity to changes in precipitation. The same map showed that rice's sensitivity in the province is clustered rather than equally distributed. The mid-part of Cebu province starting from cities of Cebu and Toledo going North up to Borbon have very low sensitivity level. However, municipalities following Cebu City going South up to Alcantara attained very high sensitivity while the rest of south except Samboan and Santander has very low sensitivity. For fruitcrops, mango in Figure 16 appeared more sensitive than banana (Figure 15) with sensitivity values that fall within the category of very high to high except in the municipalities of Daanbantayan and San Remegio which only recorded moderate sensitivity level. For Banana, the southern part of Cebu province shows higher sensitivity when compared with the northern part of the province. However in the municipalities of Camotes Island, all except Pilar have very high sensitivity level.

For cassava (Figure 17), the Municipalities of Tuburan along with Sogod and the rest of the municipalities in the northern have very low sensitivity level including Bantayan Island. In general, reflecting cassava sensitivity Figure 17 indicated that southern part of Cebu province, is relatively sensitive to climatic changes compared to the mid and northern parts except Cebu City, Lapu-Lapu City, Cordova, Catmon, Carmen, and in the municipalities in Camotes Island such as Tudela, Poro, and Pilar.

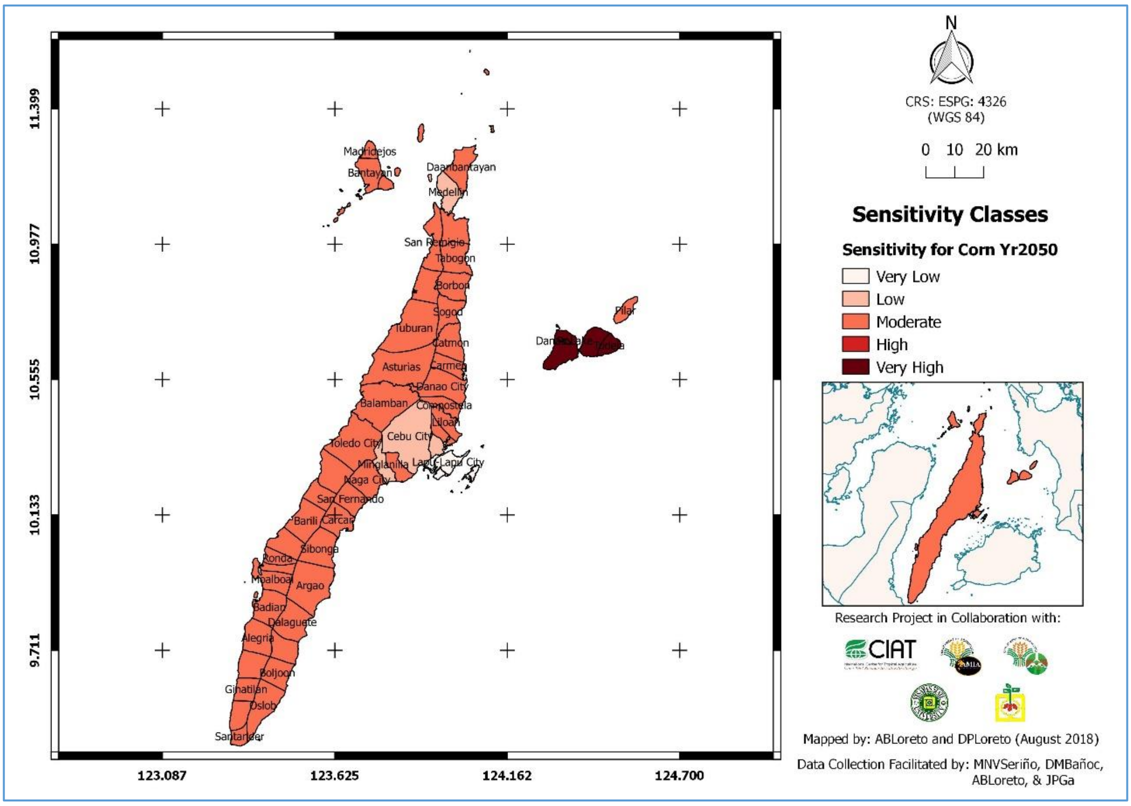

Figure 13. Corn sensitivity map of Cebu Province in year 2050

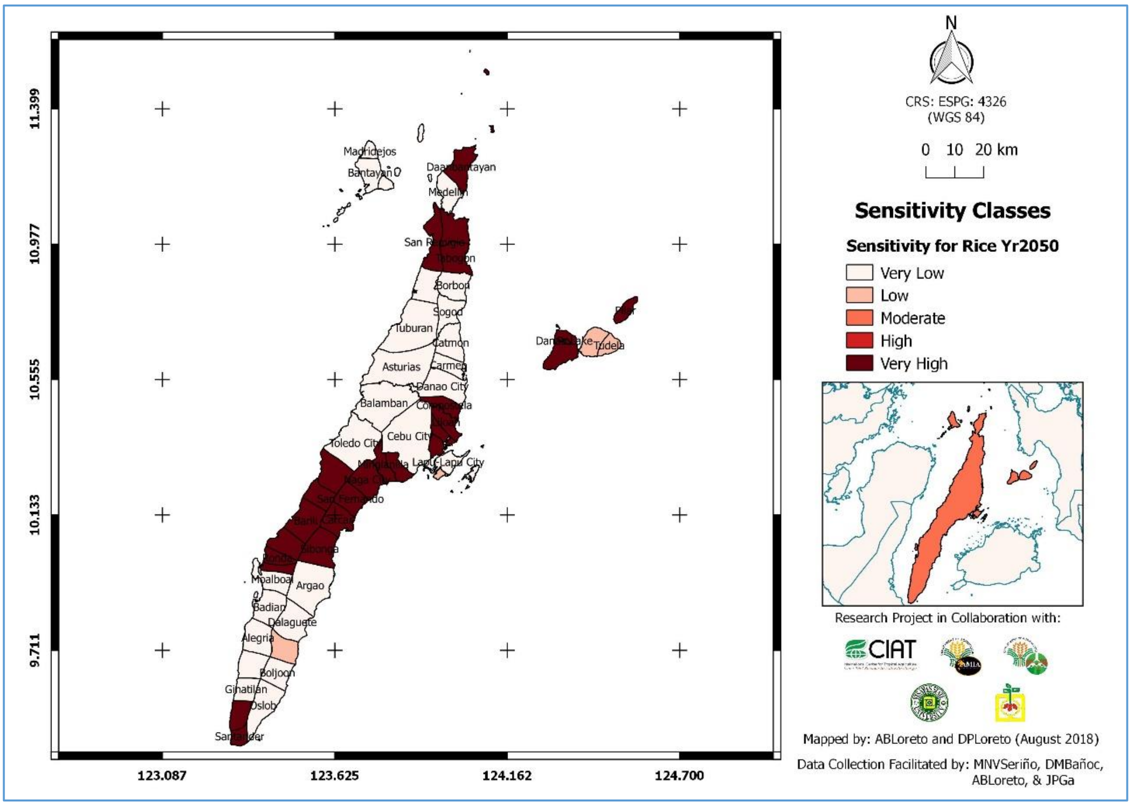

Figure 14. Rice sensitivity map of Cebu Province in year 2050

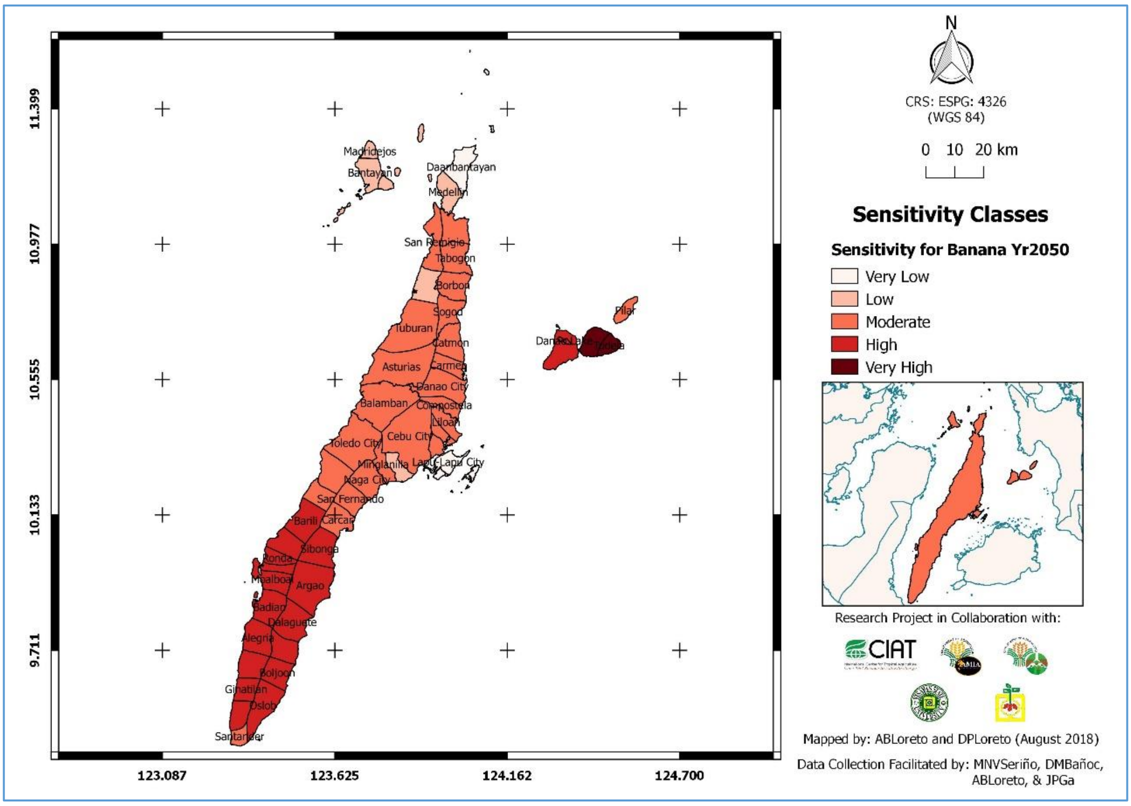

Figure 15. Banana sensitivity map of Cebu Province in year 2050

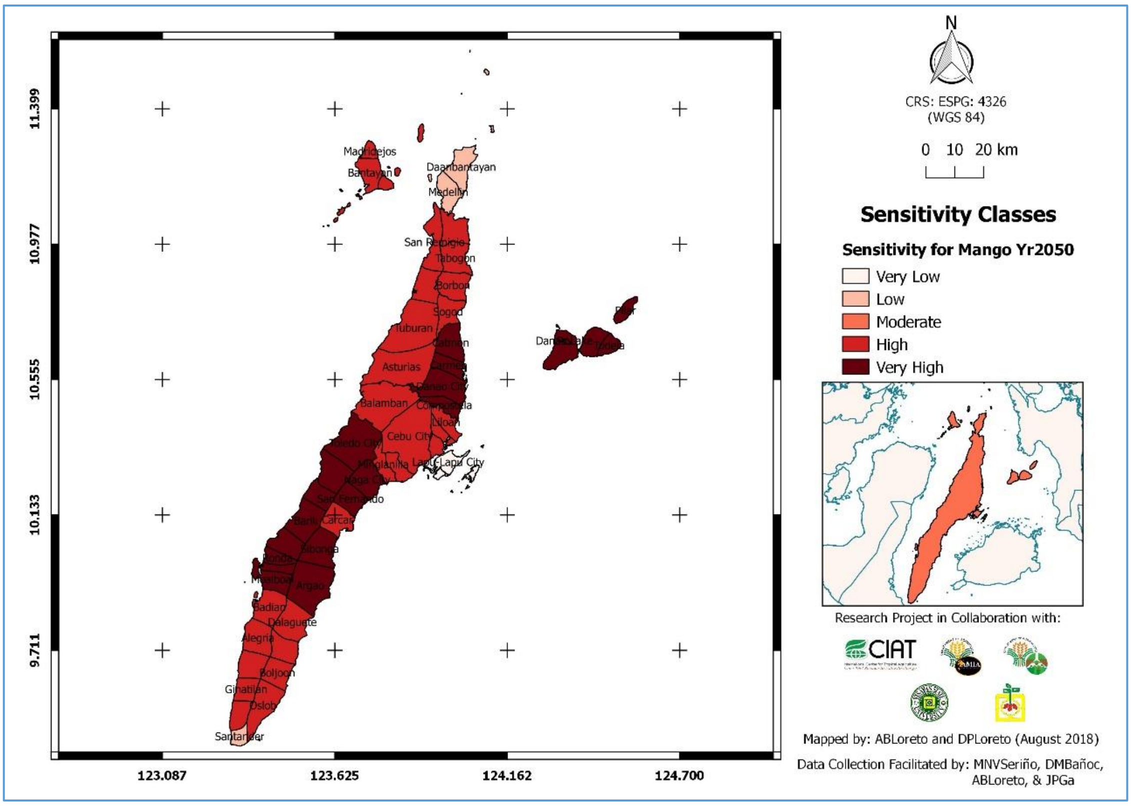

Figure 16. Mango sensitivity map of Cebu Province in year 2050

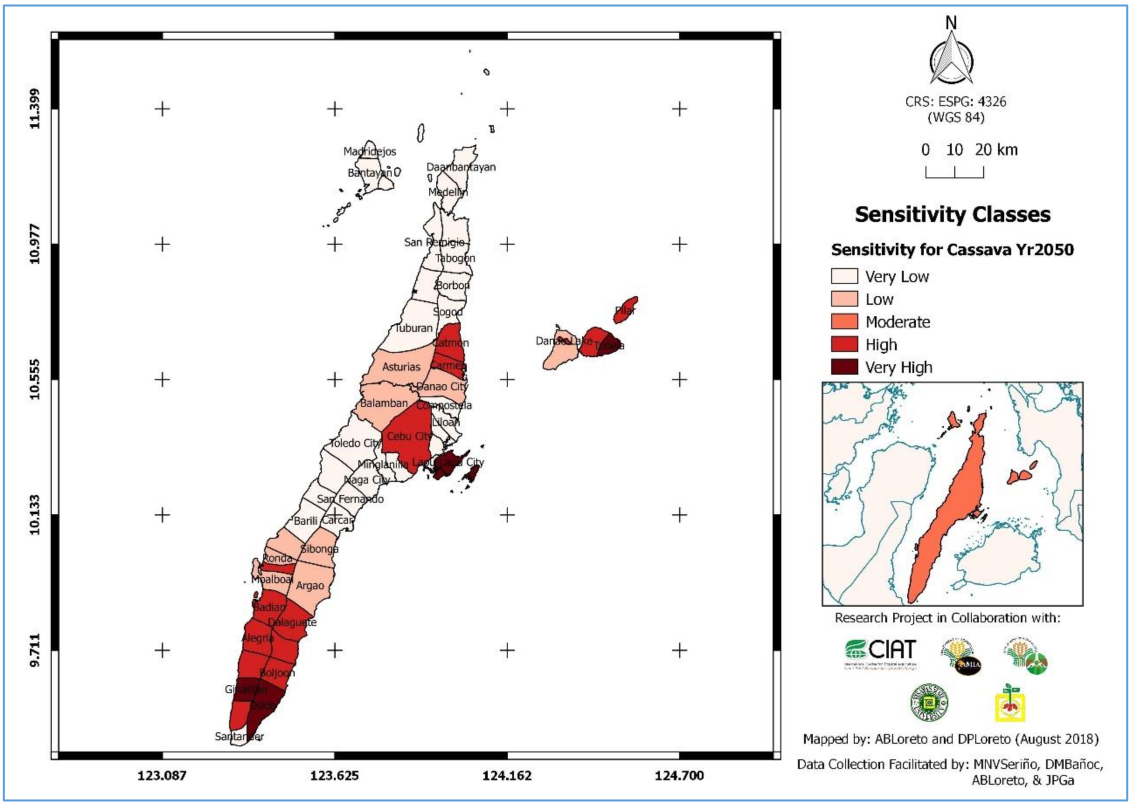

Figure 17. Cassava sensitivity map of Cebu Province in year 2050

The following maps shows the crop sensitivity index of commodities other than priority crops in Cebu province. Though wasn't part of the project's deliverables, the team did similar analysis since they were able to collect crop occurrence data. Figure 18 shows the sweet potato sensitivity index map of Cebu province. Generally, the map indicated that sweet potato has high sensitivity to changes in temperature and precipitation in the province especially in the municipality of Balamban going up to the northern part of the province. For cacao, Figure 19 showed high to very high sensitivity of the crop throughout the province. The areas with highest sensitivity level for cacao was noted at Cebu City up to the northern part of the province. A similar condition was observed was observed for coffee in Figure 20. However, the area with highest sensitivity level of the crop was noted most at the southern part of the province.

For vegetables, Figures 21 and 22 show the sensitivity index map of chopsuey and pinakbet of Cebu province respectively. In this study, chopsuey was used by the researcher as a collected term for cabbage and carrots while pinakbet for squash, eggplant, ampalaya, and string beans. Chopsuey was observed being planted in the mountain ranges of Cebu province particularly in Dalaguete, Argao and Cebu City. Meanwhile, pinakbet vegetables were commonly planted in low elevation areas through the province. Relative to climate sensitivity, chopsuey appeared to be more sensitive to changes in temperature and precipitation than pinakbet.

Table 2. Top 3 bio-climatic indicator with most percentage contribution to sensitivity index of crops in Cebu Province

Sensitivity Indicator	Percentage Contribution of Bio-Climatic Indicator to Crop Sensitivity Level									
	Corn	Rice	Banana	Mango	Cassava	S.Potato	Cacao	Coffee	Chopsuey	Pinakbet
Mean Diurnal Range (BIO2)	19.3	12.5	24.1		30.9	25.4				14.7
Isothermality (BIO3)				32.7			16.7			
Temperature Seasonality (BIO4)				15.1						
Temperature Annual Range (BIO7)		16.8								
Precipitation Seasonality (BIO15)		27						23		
Precipitation of Wettest Quarter (BIO16)	29.7		31.3		23.5	23.8	33.3	12.9	16.8	27.9
Precipitation of Coldest Quarter (BIO19)	20.6		17.5	12.3	13.5	12	18	17.8	21.3	19.5
Number of consecutive dry months (BIO20)									24.1	

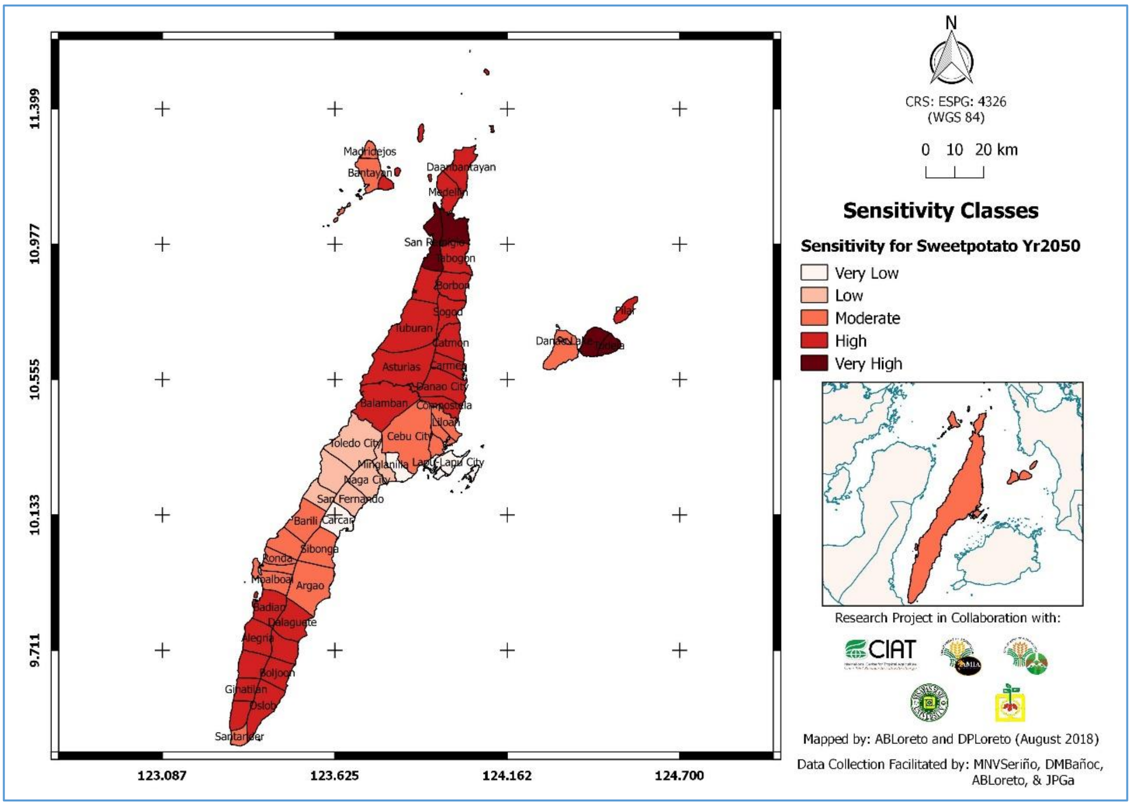

Figure 18. Sweet potato sensitivity map of Cebu Province in year 2050

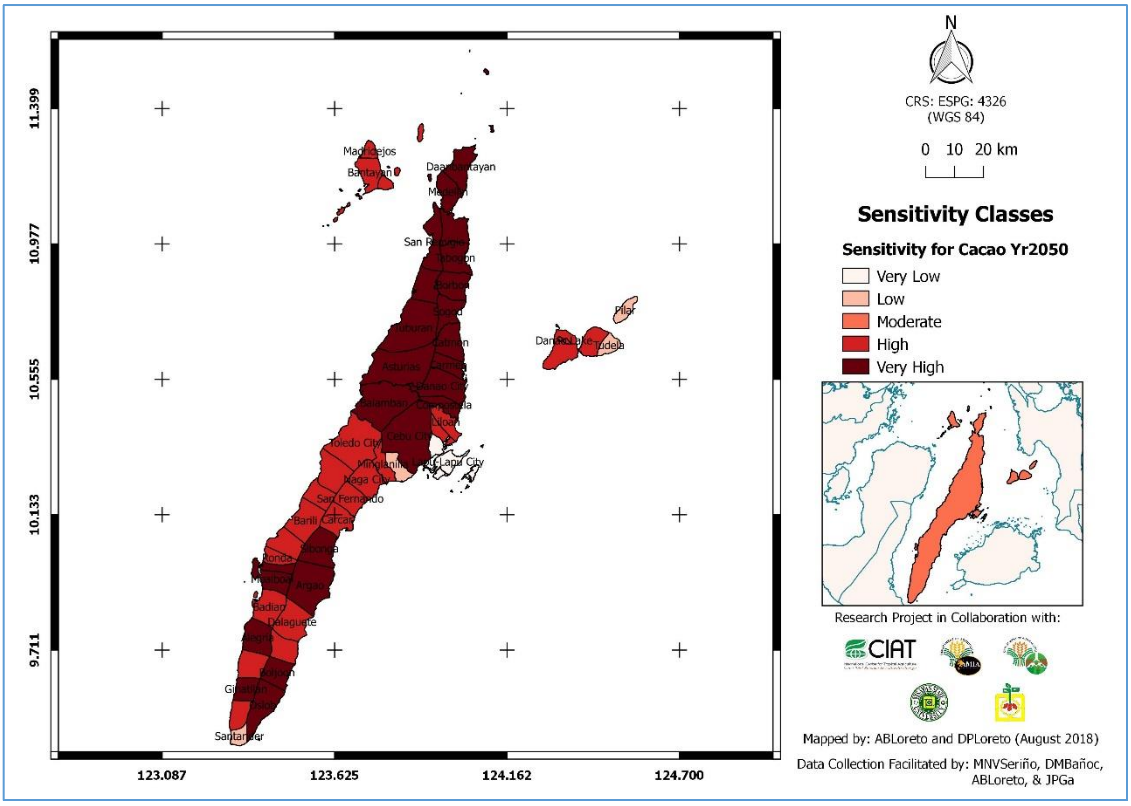

Figure 19. Cacao sensitivity map of Cebu Province in year 2050

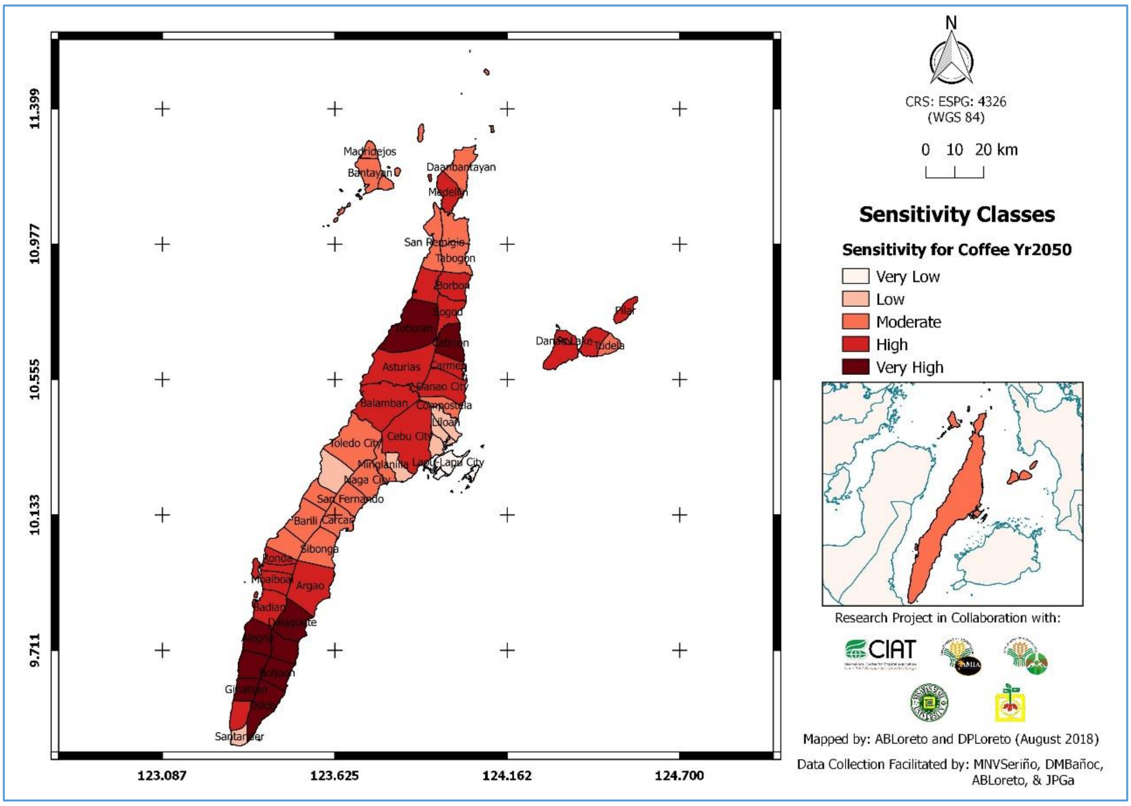

Figure 20. Coffee sensitivity map of Cebu Province in year 2050

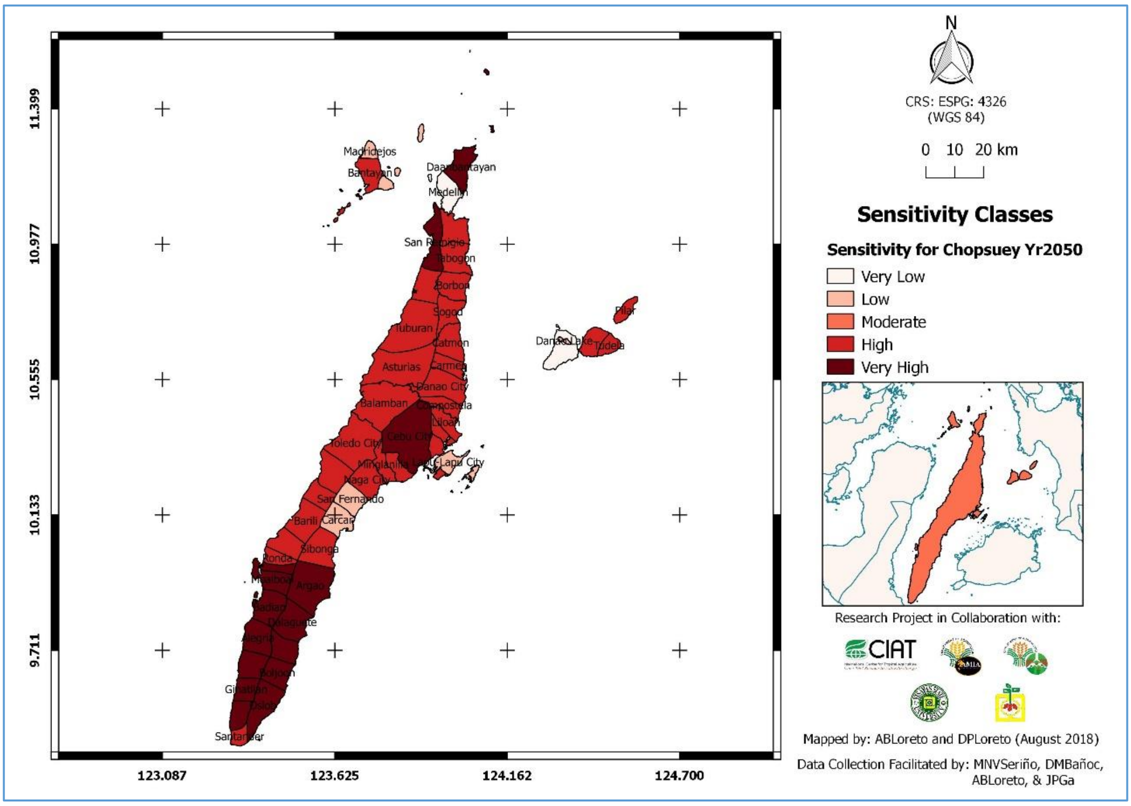

Figure 21. Chopsuey sensitivity map of Cebu Province in year 2050

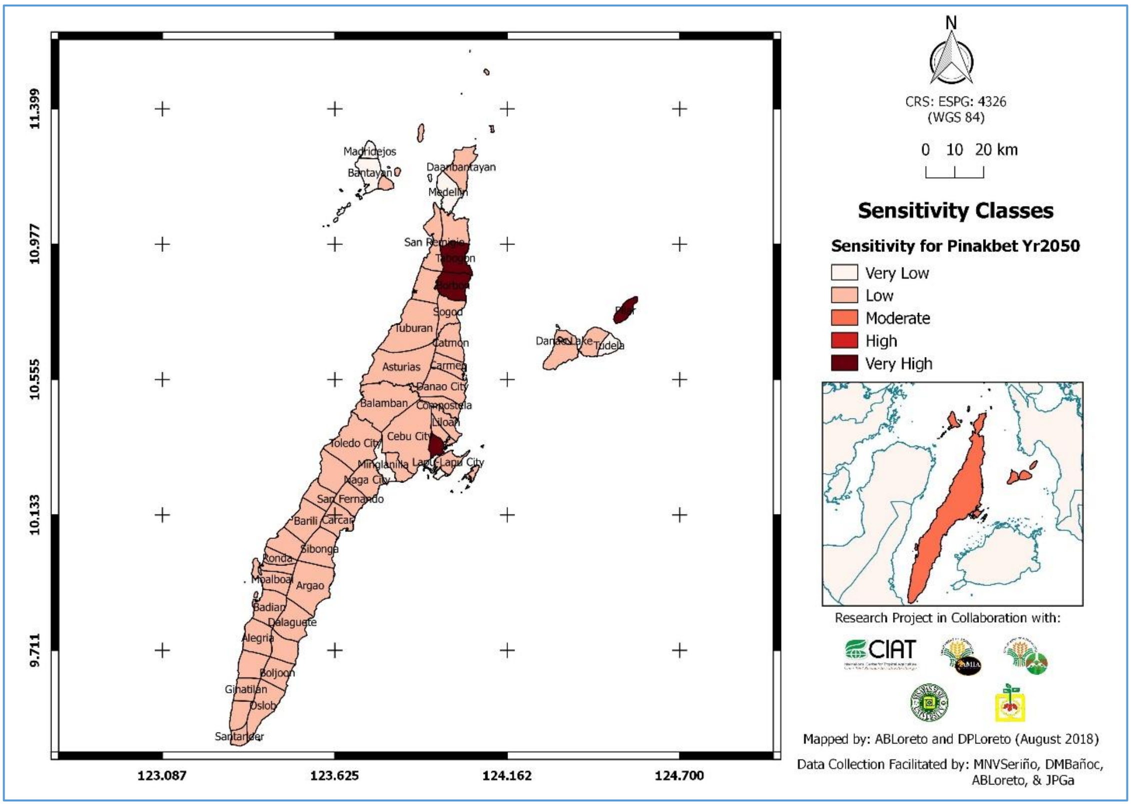

Figure 22. Pinakbet sensitivity map of Cebu Province in year 2050

Climatic Suitability

After determining the climatic sensitivity of the identified crop commodities of Cebu province in the year 2050, current suitability was subtracted to the projected suitability. The result gives the area of class suitability in Cebu province. Figure 23 presents a map showing the climatic suitability of corn and rice in Cebu province. It shows a side-by-side comparison of the crops suitability in the present and future conditions using the sensitivity results. In the present condition, areas suitable for corn were noted throughout the province as represented by blue color. Using the sensitivity results for future projections, corn suitability in Cebu province drop tremendously turning most areas in the province unsuitable for the crop. For rice, the same figure indicated an increase of suitability of the crop. This result was quite unexpected considering that Cebu province is generally unsuitable for rice. The lack thereof of abundant water source makes it difficult to produce rice in the province. However, due to the projected increase in temperature, seasonal precipitation in the province is expected to increase providing much needed water to grow rice.

The climatic suitability of mango and banana in the year 2050 shows similar characteristics with corn. The two fruitcrops showed in Figure 24 a projected decrease in suitability .However, comparing the two, the decrease in mango was predicted to be more pronounce than in banana. Reflected in Figure 25, the suitability of sweet potato was predicted to decrease due to changes in temperature and precipitation. The predicted climatic suitability of sweet potato in the northern part was gone completely especially in norther and southern parts of the province. Remaining areas with moderate suitability for the crop in future condition were seen at the southern-mid part of the province. In the same figure, the predicted suitability of cassava in the province shows a promising result. Areas in the province that has a moderate suitability in present condition was predicted to turn into highly suitable areas. The increase in suitability was attributed to the increase in temperature which favors production of the crops.

A similar condition with corn was predicted for coffee and cacao reflected in Figure 26. Due to changes in temperature and precipitation, the suitability of coffee and cacao decreases significantly. For chopsuey and pinakbet, Figure 27 showed an immense decrease in suitability. The suitable and existing areas for chopsuey vegetables in the present condition was predicted gone completely in the year 2050. Similar condition was for pinakbet vegetables where suitable area was predicted to significantly decrease in the coming years.

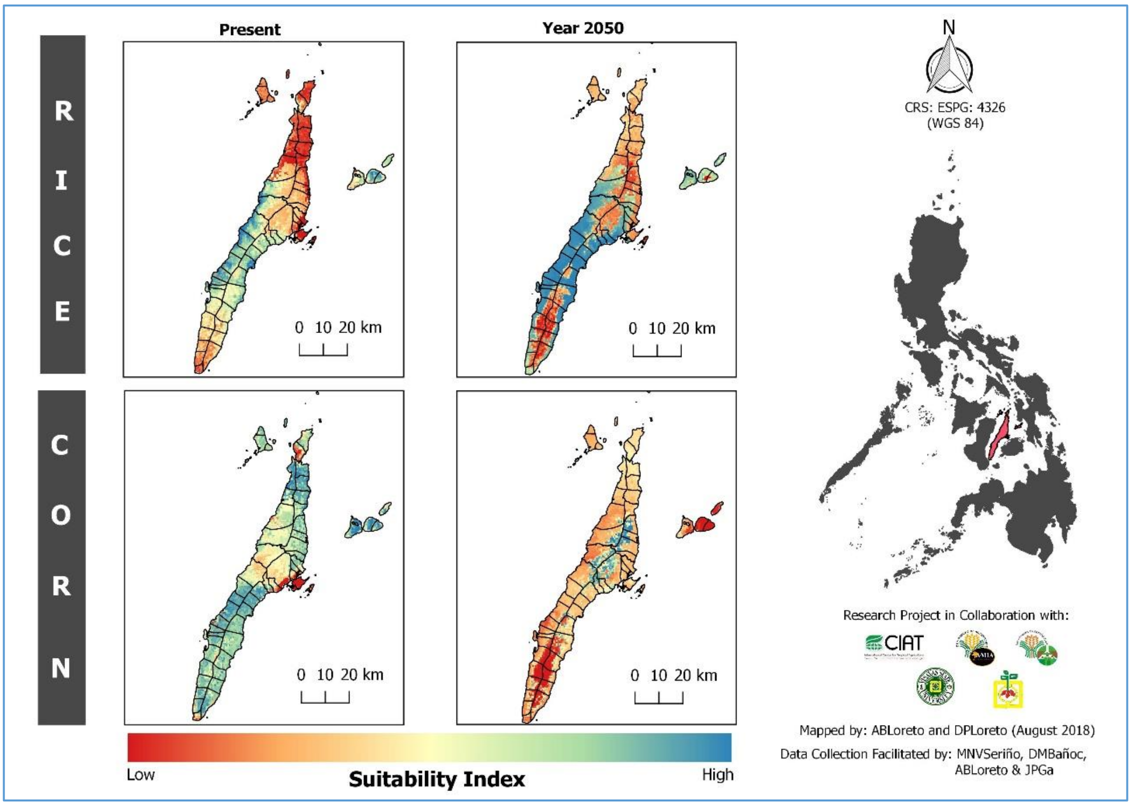

Figure 23. Climatic suitability index map for rice and corn of Cebu province

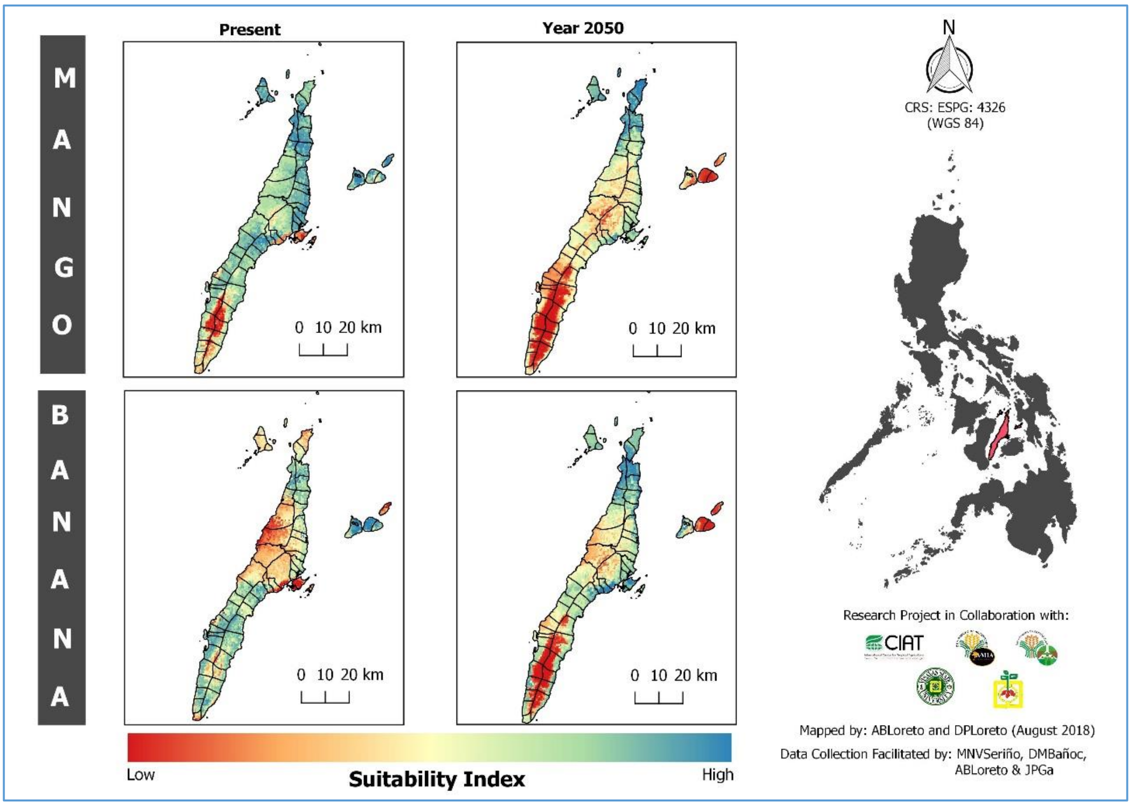

Figure 24. Climatic suitability index map for mango and banana of Cebu province

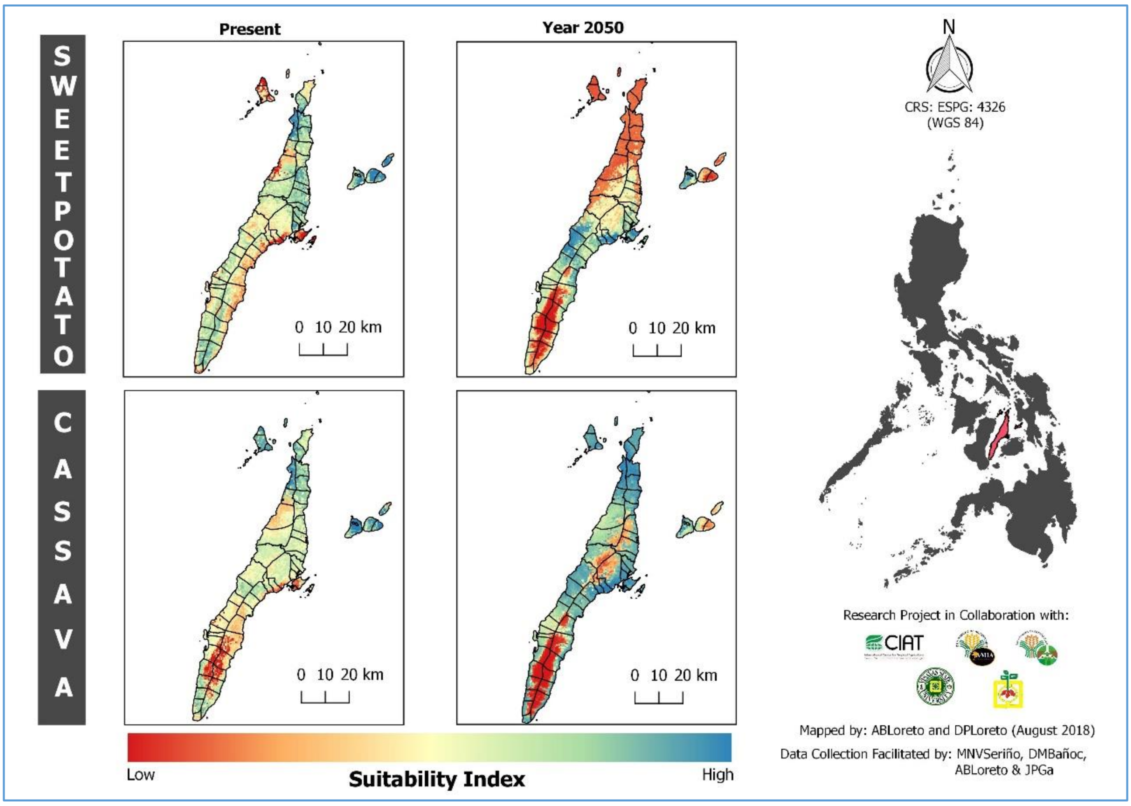

Figure 25. Climatic suitability index map for sweet potato and cassava of Cebu province

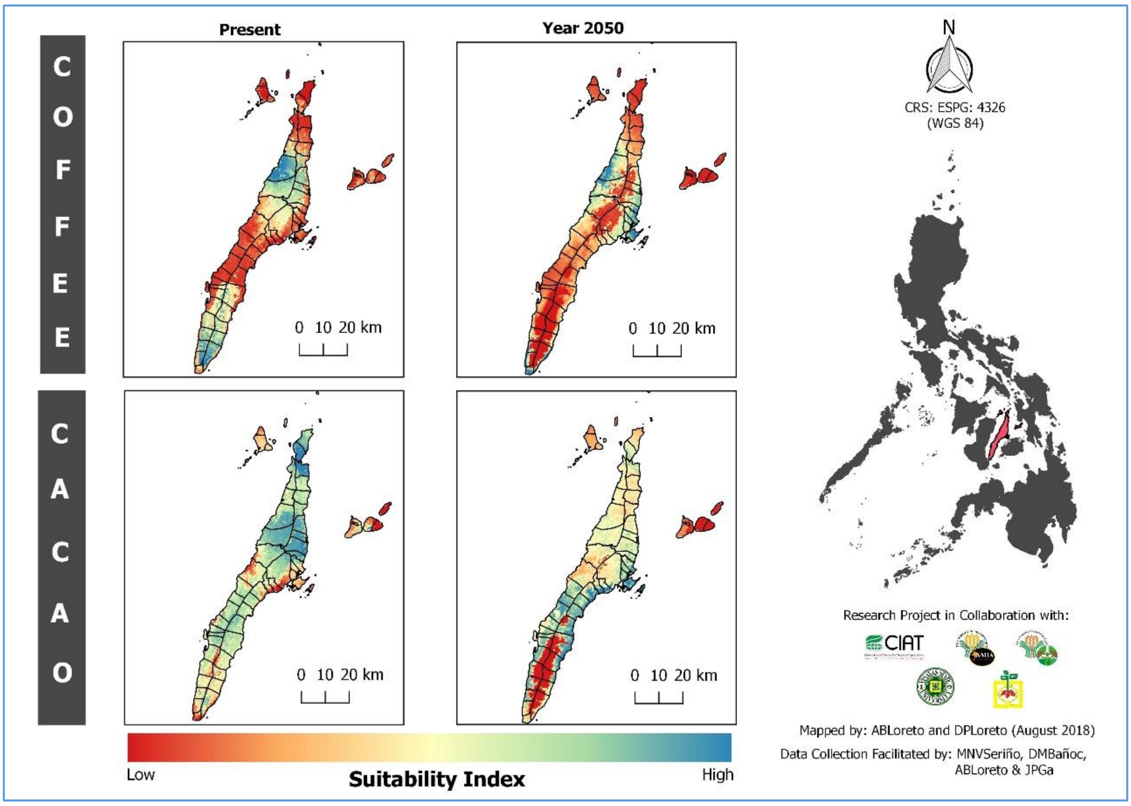

Figure 26. Climatic suitability index map for coffee and cacao of Cebu province

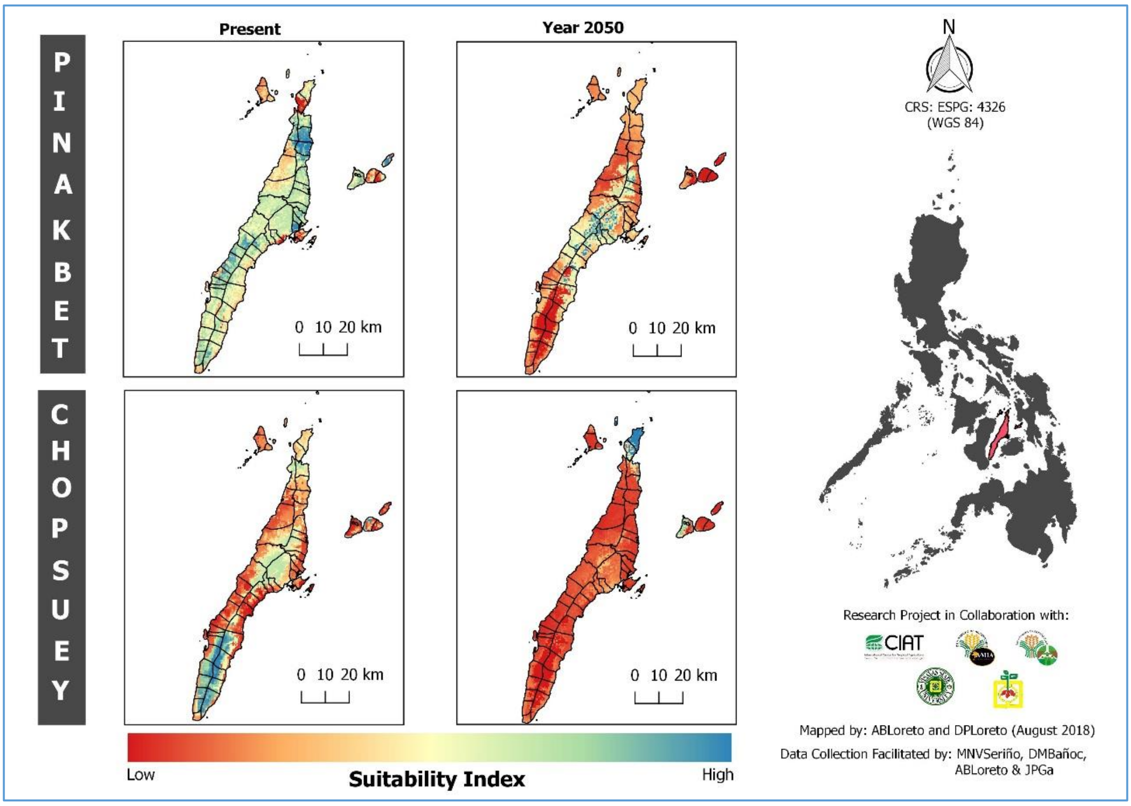

Figure 27. Climatic suitability index map for pinakbet and chopsuey of Cebu province

Climate-Change Hazard

In estimating the hazard index for Cebu province, the researchers have considered eight different natural hazards. Hazard index is a composite value of weight assigned to each hazards in each region: Luzon, Visayas, and Mindanao. Each of the assigned value of weight was based on hazard occurrence and degree of its individual effect. Typhoon and storm surge, for instance. As reflected in Table 3, the hazard has a higher weight assigned to it Luzon with 20% when compared to Visayas and Mindanao with only 18.21% and 16.95, respectively. This is because typhoon affects more frequently in Luzon than in Visayas and Mindanao. Meanwhile, because Visayas region is collection of islands they are more exposed to storms surge than Luzon and Mindanao hence, a higher value was assigned. The value of weights for each hazard were derived through experts' opinion coming from several government agencies, NGOs, academics, and students convened by CIAT in a focus group discussion.

Table 3. Hazard weight assignment by island group

HAZARDS	**ISLAND GROUP**		
	Luzon (%)	**Visayas (%)**	**Mindanao (%)**
Typhoon	20.00	18.21	16.95
Flood	19.05	16.40	15.25
Drought	14.25	16.17	16.95
Erosion	11.43	12.57	12.71
Landslide	8.57	10.72	14.41
Storm Surge	9.52	10.39	8.47
Sea Level Rise	5.71	8.33	5.08
Saltwater Intrusion	11.43	7.21	10.17
Total	**100.00**	**100.00**	**100.00**

Source: CIAT Philippines

In this study, the researcher used the weights assigned for Visayas since Cebu province belongs to this region. Figure 28 presents the resulting composite hazard index of Cebu province using the prescribed weights. Hazard index map showed that areas in the mid-part and northern part of the province were more exposed to natural hazard relative to the southern part. In these area, most municipalities and cities have high to very high hazard indices. The radar plot shown in Figure 29 indicated the hazards that contributed to these high index value. Looking at specific hazard exposure, Figures 30 and 31 showed that almost all parts of Cebu province are prone to soil erosion and landslide except Lapu-Lapu and Mandaue City, Cordoba and Bantayan Island. Meanwhile, the cites of Cebu and Toledo, the municipalities Pinamungahan, Balamban, Asturias, Tuburan and Carmen were noted as the most exposed to aforementioned hazards. One probable reason is the topography of the areas mentioned. Since these places have steep slopes to rolling terrain wherein landslide and soil erosion incidence may happen anytime.

The very high exposure to flooding was noted in Mandaue City (Figure 32), which is due to its low elevation and land delineation. The massive transformation of built-up areas in Mandaue City transformed its natural landscape into a cemented jungle. Then, the natural discharge of excess water through soil absorption is hampered which results to flooding. Besides, the city is also experiencing high exposure to saltwater-intrusion (Figure 36) but lesser compared to Cebu City which is reported to be very high.

In the northern part of the province (Figure 33), the hazardous impact of typhoon or cyclone is notably affecting the municipalities of Daanbantayan, San Remegio and Medellin along with Bogo City and Tudela in the island of Camotes. This high to very high exposure to hazards of the aforesaid places is attributed to their exposure to typhoons. Since these places are located within the “typhoon lane”, it is not surprising that they frequently experienced more typhoons annually than that of the other parts of the province. In 2013, during the onslaught of Typhoon “Yolanda”, which is said to be the strongest Typhoon ever recorded that made its landfall, only the aforesaid municipalities and cities were gravely affected by said malady. For drought conditions, similar figure indicated that the Municipality of Tudela in the island of Camotes being the most exposed (Figure 34). Although not as much with Tudela, drought appears to be affecting also the Municipalities of Pinamungahan, Borbon and Tabogon. Storm surge were seen affecting Cordova, and Lapu-Lapu City (Figure 35) while presence of salt-water intrusion was noted in the Cities of Cebu and Mandaue.

In terms of hazards ranking as to which is the most devastating, Table 3 presents the responses of municipal and city agriculturists for the entire Cebu province. This information was collected during the conducted focus group discussion through questionnaire formulated by CIAT (Appendix 31). In the said questionnaire, the ranking of hazards were categorized based on its individual impacts (a) disastrous, (b) significant), (c) moderate, (d) minor and (e) insignificant as observed in the province. Relative to its intensity of impact, among the seven identified hazards, typhoon was recorded the most devastating. The information presented in the same table showed that typhoon has the most negative bearing to income which is reported as disastrous (24%), significant (26%), and moderate (26%) by the participants. It was also described as the most-frequently occurring hazard affecting the province with 82% reported probability of occurrence of “once a year or more”. Typhoon is followed by flooding (63%), soil erosion (47%), drought (50%), landslide (34%), sea-level rise (26%), salt-water intrusion (16%), and storm surge (5%) with reference to “once a year or more” probability of occurrence. However, with respect to their impact to income, typhoon is the most disastrous followed by drought with 13% of the respondents reported the hazard as disastrous, 37% significant and 29% moderate. Relative to impacts to key natural resource and national economy, drought was reported to be the most disastrous while Typhoon was most devastating relative to food security. The rest of the information are reflected in the same table.

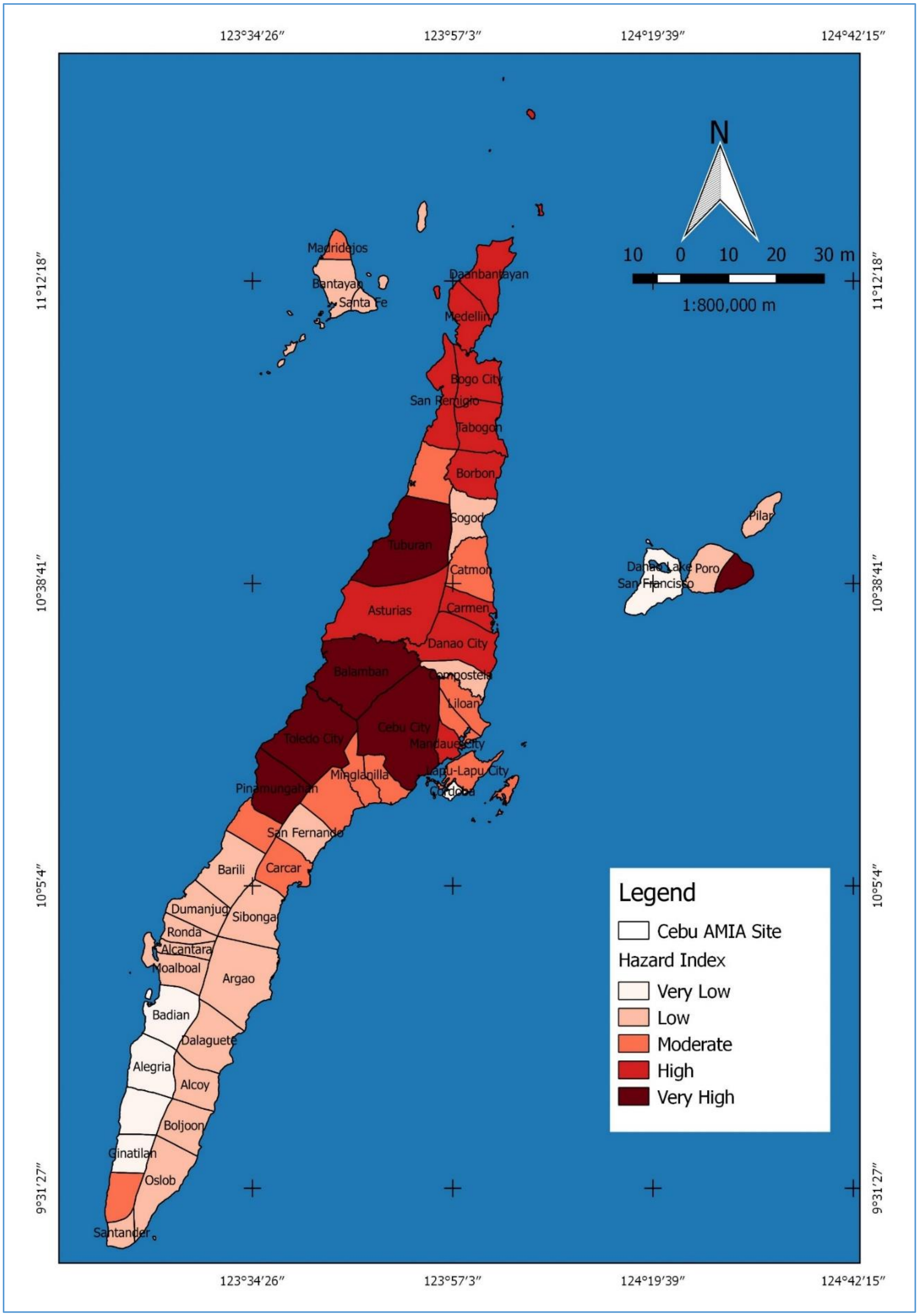

Figure 28. Cebu province hazard index map

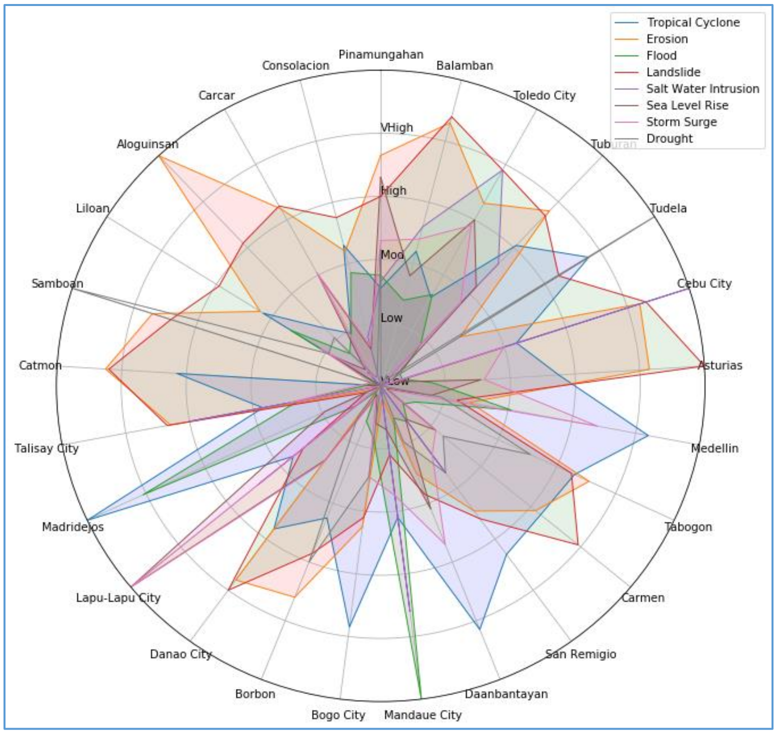

Figure 29. Radar plot of the municipalities and cities in Cebu Province with high to very high hazard index

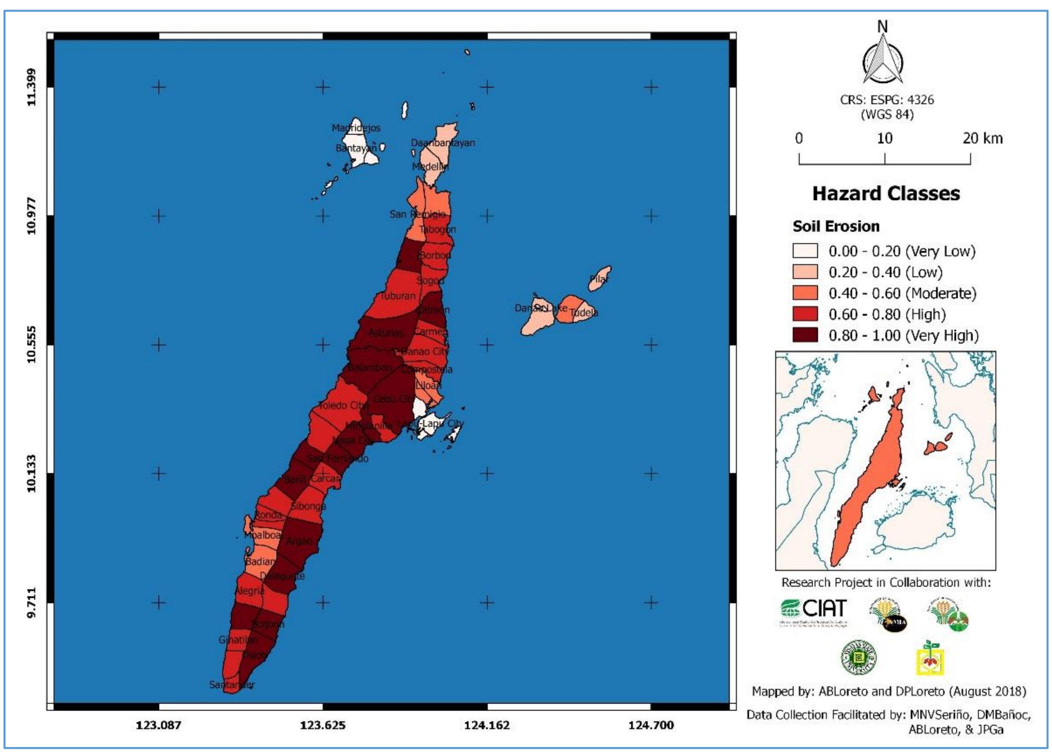

Figure 30. Soil erosion map of Cebu Province

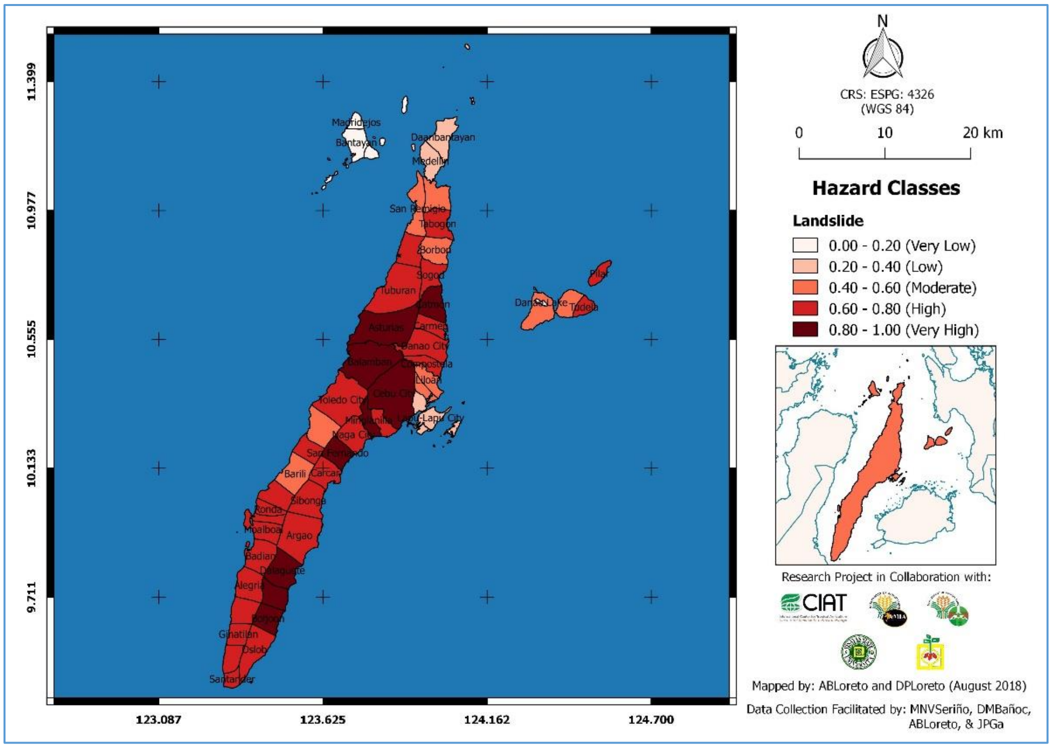

Figure 31. Landslide map of Cebu Province

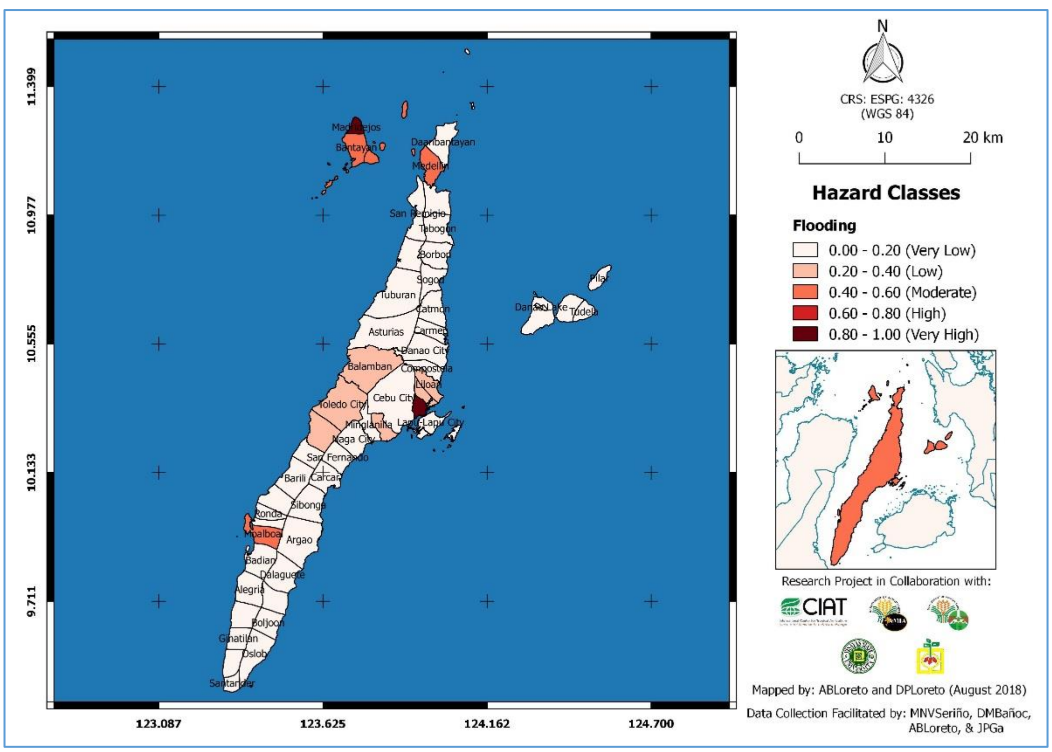

Figure 32. Flooding map of Cebu Province

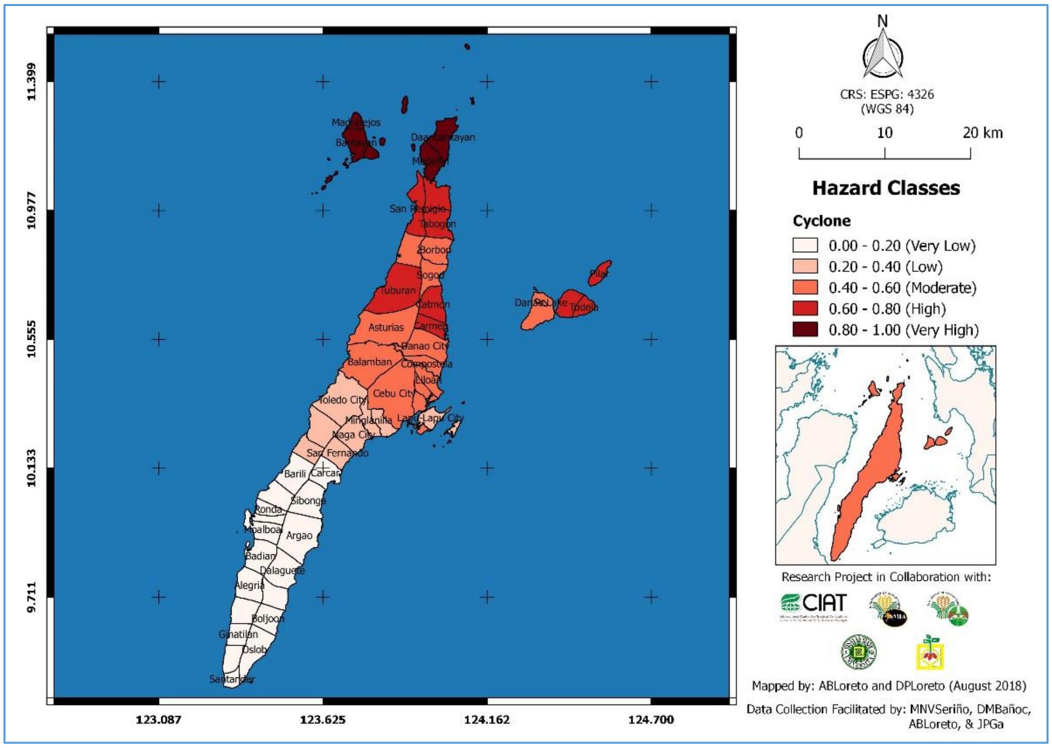

Figure 33. Cyclone map of Cebu Province

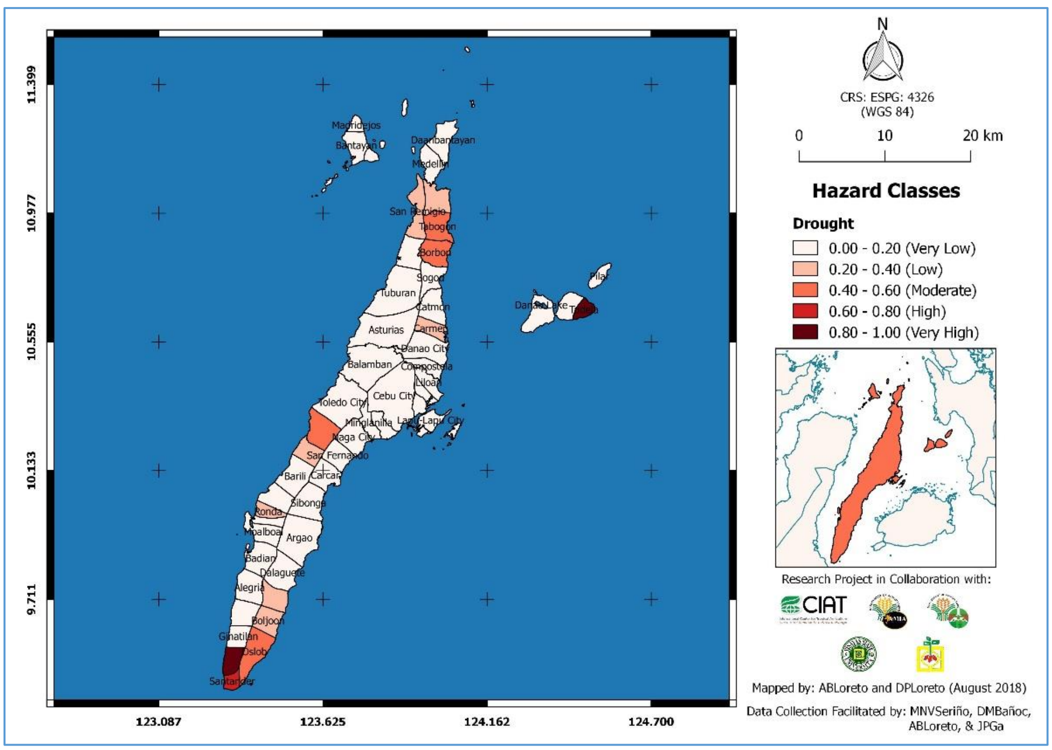

Figure 34. Drought map of Cebu Province

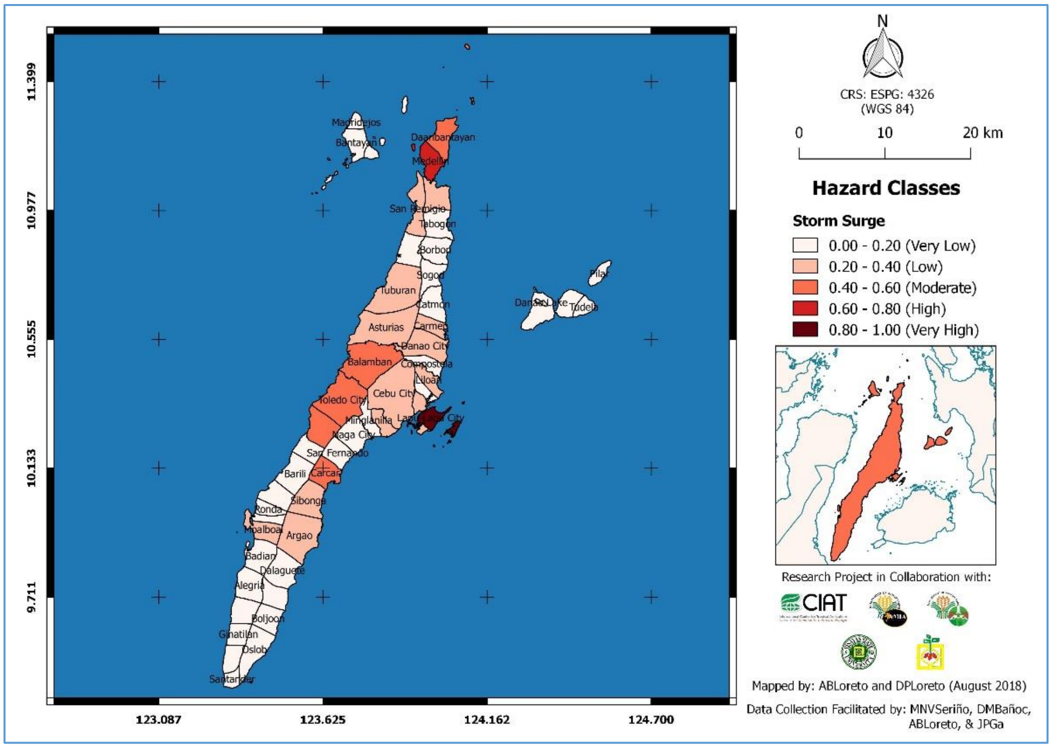

Figure 35. Storm surge map of Cebu Province

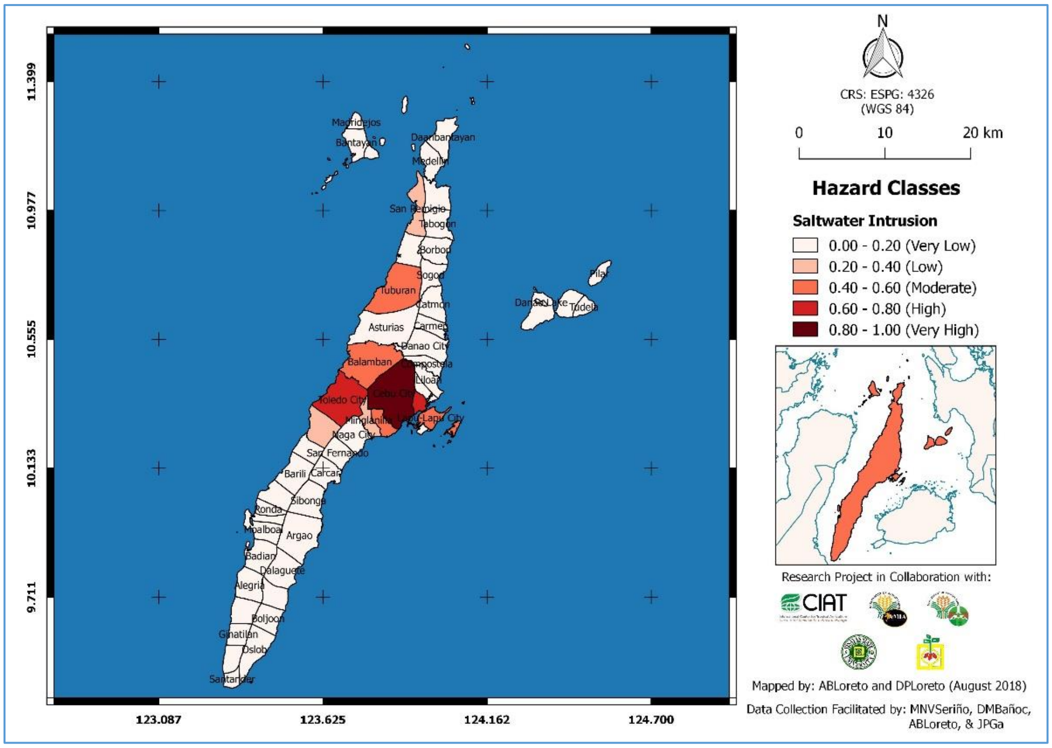

Figure 36. Saltwater intrusion map of Cebu Province

Table 4. Climate-change related hazards occurrence and magnitude of its effects in Cebu Province

Occurrence/Impacts	Typhoon	Flooding	Drought	Soil Erosion	Landslide	Storm Surge	Sea Level Rise	Saltwater Intrusion
Once a year or more	31 (82%)	24 (63%)	19 (50%)	18 (47%)	13 (34%)	2 (5%)	10 (26%)	6 (16%)
Once in 5 years	6 (16%)	6 (16%)	16 (42%)	9 (24%)	10 (26%)	4 (11%)	3 (8%)	4 (11%)
Once in 10 years or less	1 (3%)	5 (13%)	2 (5%)	5 (13%)	6 (16%)	13 (34%)	15 (40%)	12 (32%)
No response/NA	0(0%)	3 (8%)	1 (3%)	6 (16%)	9 (24)	19 (50%)	10 (26%)	16 (42%)
Impact to Local Household Income								
Disastrous	9 (24%)	8 (21%)	5 (13%)	3 (8%)	2 (5%)	2 (5%)	1 (3%)	2 (5%)
Significant	10 (26%)	5 (13%)	14 (37%)	4 (11%)	3 (8%)	4 (11%)	2 (6%)	1 (3%)
Moderate	10 (26%)	8 (21%)	11 (29%)	8 (21%)	6 (16%)	3 (8%)	7 (18%)	5 (13%)
Minor	7 (18%)	9 (24%)	6 (16%)	13 (34%)	13 (34%)	5 (13%)	8 (21%)	4 (11%)
Insignificant	1 (3%)	4 (11%)	0 (0%)	4 (11%)	5 (13%)	7 (18%)	9 (24%)	10 (26%)
No response/NA	1 (3%)	4 (11%)	2 (5%)	6 (16%)	9 (24%)	17 (45%)	11 (29%)	16 (42%)
Impact to Key Natural Resources								
Disastrous	2 (5%)	2 (5%)	6 (16%)	3 (8%)	2 (5%)	1 (3%)	2 (5%)	2 (5%)
Significant	15 (40%)	9 (24%)	11 (29%)	4 (11%)	2 (5%)	5 (13%)	1 (3%)	3 (8%)
Moderate	10 (26%)	12 (32%)	11 (29%)	7 (18%)	7 (18%)	3 (8%)	5 (13%)	1 (3%)
Minor	10 (26%)	8 (21%)	7 (18%)	13 (34%)	13 (34%)	5 (13%)	9 (24%)	9 (24%)
Insignificant	0 (0%)	3 (8%)	1 (3%)	5 (13%)	5 (13%)	7 (18%)	10 (26%)	9 (24%)
No response/NA	1 (3%)	4 (11%)	2 (5%)	6 (16%)	9 (24%)	17 (45%)	11 (29%)	14 (37%)

Occurrence/Impacts	Typhoon	Flooding	Drought	Soil Erosion	Landslide	Storm Surge	Sea Level Rise	Saltwater Intrusion
Impact to Food Security of the Country								
Disastrous	5 (13%)	4 (11%)	3 (8%)	3 (8%)	1 (3%)	1 (3%)	1 (3%)	1 (3%)
Significant	20 (53%)	7 (18%)	15 (40%)	3 (8%)	4 (11%)	3 (8%)	1 (3%)	2 (5%)
Moderate	6 (16%)	10 (26%)	7 (18%)	12 (32%)	9 (24%)	6 (16%)	9 (24%)	4 (11%)
Minor	5 (13%)	10 (26%)	9 (24%)	8 (21%)	8 (21%)	5 (13%)	5 (13%)	5 (13%)
Insignificant	1 (3%)	3 (8%)	2 (5%)	6 (16%)	7 (18%)	7 (18%)	10 (27%)	11 (29%)
No response/NA	1 (3%)	4 (11%)	2 (5%)	6 (16%)	9 (24%)	16 (42%)	12 (32%)	15 (40%)
Impact to the National Economy								
Disastrous	9 (24%)	4 (11%)	7 (18%)	3 (8%)	1 (3%)	1 (3%)	0 (0%)	1 (3%)
Significant	12 (32%)	7 (18%)	8 (21%)	4 (11%)	6 (16%)	7 (18%)	1 (3%)	2 (5%)
Moderate	7 (18%)	7 (18%)	7 (18%)	10 (26%)	6 (16%)	6 (16%)	10 (26%)	5 (13%)
Minor	3 (8%)	7 (18%)	7 (18%)	6 (16%)	6 (16%)	8 (21%)	4 (11%)	3 (8%)
Insignificant	5 (13%)	8 (21%)	6 (16%)	9 (24%)	10 (26%)	0 (0%)	12 (32%)	12 (32%)
No response/NA	2 (5%)	5 (13%)	3 (8%)	6 (16%)	9 (24%)	16 (42%)	11 (29%)	15 (40%)

Note: Percentage and total may not add up due to rounding; Number of Respondents - 38

Climate-Change Adaptive Capacity

The calculation of adaptive capacity (AC) values was based on eight capitals namely: economic, social, natural, human, health, physical, institutional, and anticipatory of which each has each own number of indicators. Each corresponding indicators of the AC capitals are reflected in the Appendix 31. In the estimation, each capital was assumed to have an equal bearing on the AC level which implicates that regardless of their individual number of indicators, its value of sub-index are equal. The value of AC measures how well a specific unit or entity adapt and/or respond to different climate-induced stressors. AC values of each municipalities and cities in Cebu province was subtracted to the values of sensitivity and exposure. Hence, high AC would mean less vulnerability and high resilience to climate-related hazards.

The resulting AC in the municipalities and cities of Cebu province were illustrated in Figure 37. The reflected AC categories were derived from the data gathered on the internet and government line agencies, technical partners and KII of selected respondents. Due to the differences in scale of the indicators, the collected values were normalized. Table 5 presents the municipalities and cities in Cebu with the highest and lowest adaptive capacity level, percentage of dependence to agriculture sector and income classification. Based on the result, Cebu City has the highest adaptive capacity to climate change while the municipality of Alegria has the lowest.

Looking at the other values reflected in Table 5, one implication that can be drawn is that adaptive capacity level is correlated negatively with the dependence of agriculture while positively to the income class. Resulting values reflected in the same table implies that municipalities and cities with high-income classification and low dependence on agriculture is more adaptable to changes in climate hence less vulnerable to its associated effects. This is because high income associates with high revenue collection which can be used for welfare programs such as health, education, and other institutional services. This in turn results to low poverty incidence and unemployment rate. Since some of these factors were included as indicators to capitals such as health, human and economic hence, the AC of high-income municipalities in Cebu province are high. Looking at the index maps of the eight AC capitals presented in Figures 38-45, it can be noticed that Cebu City scored the highest in most capitals which explains it has the highest adaptive capacity in the province.

Table 5. Top Municipalities/Cities with Highest and Lowest Adaptive Capacity Level in Cebu Province by income class and level of dependence in agriculture

Municipality/City	Adaptive Capacity (AC)	AC Category	Dependence on Agriculture (%)	Income Class
Cebu City	1.00	Very High	18	Highly Urbanized City
Bantayan	0.79	High	75	1st Class
Madridejos	0.67	High	50	4th Class
Carcar City	0.65	High	10	5th Class City
Mandaue City	0.64	High	1	Highly Urbanized City
Cordoba	0.64	High	25	3rd Class
Asturias	0.62	High	70	3rd Class
Lapu-Lapu City	0.60	High	35	Highly Urbanized City
Daanbantayan	0.60	High	50	1st Class
Consolacion	0.56	Moderate	10	1st Class
Minglanilla	0.21	Low	5	1st Class
Tuburan	0.20	Low	16	2nd Class
San Fernando	0.19	Very Low	38	2nd Class
Barili	0.17	Very Low	40	2nd Class
Alcantara	0.17	Very Low	40	5th Class
Boljoon	0.16	Very Low	80	5th Class
Aloguinsan	0.16	Very Low	30	4th Class
Pinamungahan	0.15	Very Low	62	2nd Class
Catmon	0.05	Very Low	45	4th Class
Alegria	0.00	Very Low	90	4th Class

Note: Low figures indicate low level of adaptive capacity while high indicates the opposite

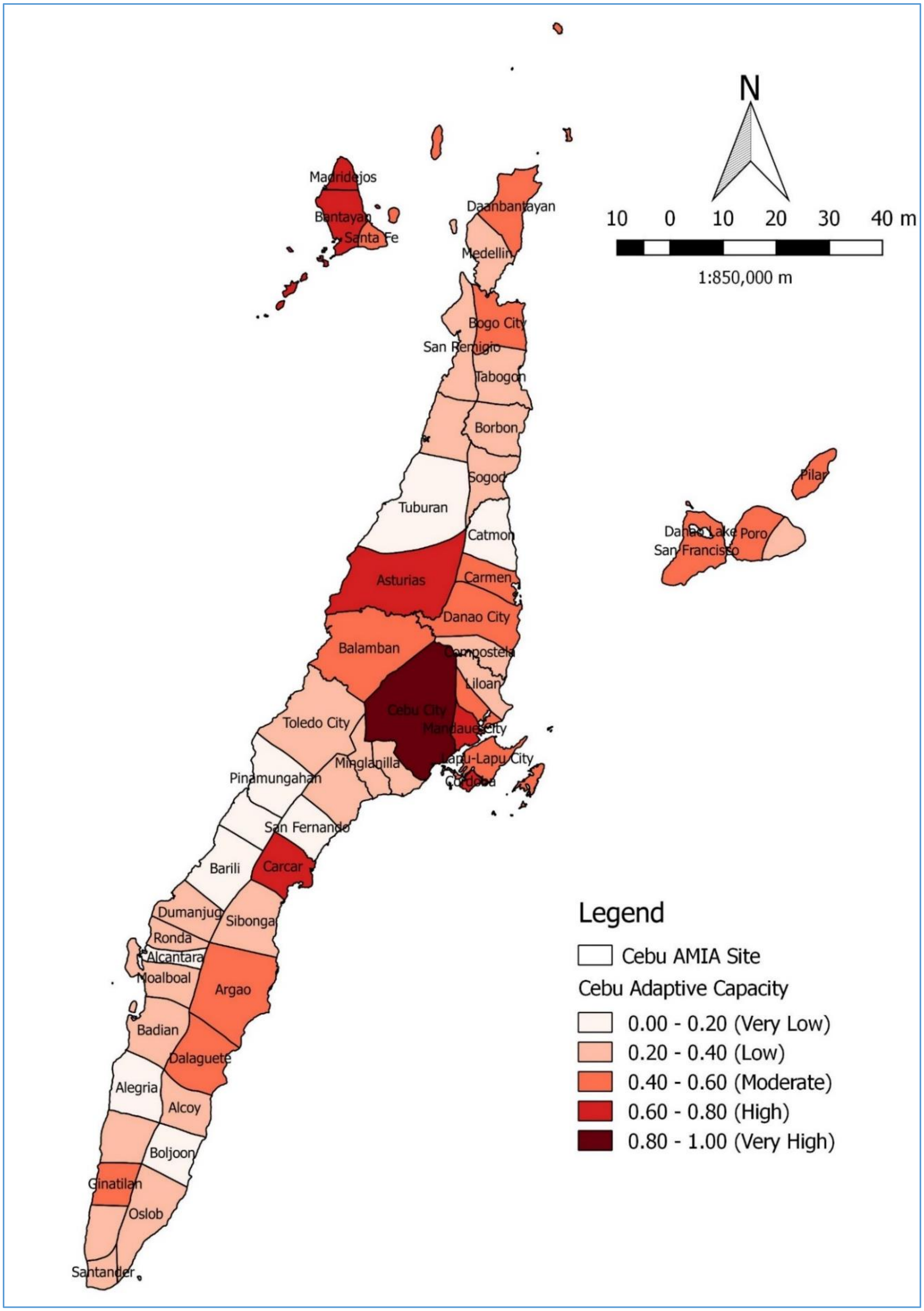

Figure 37. Adaptive capacity index map of Cebu Province

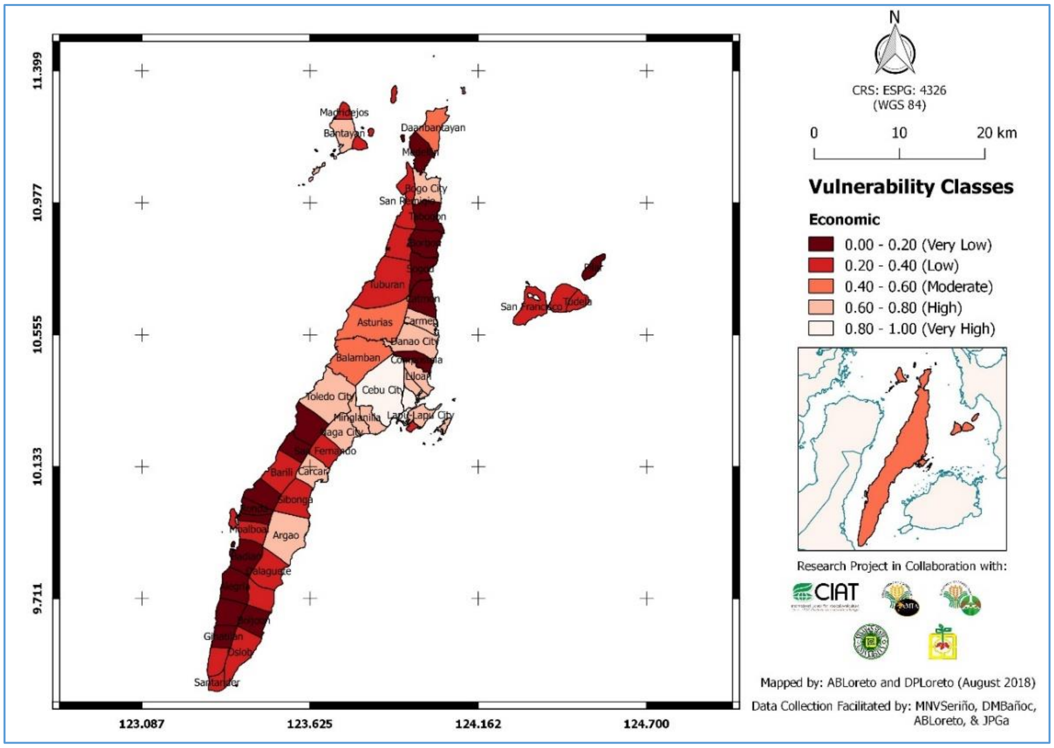

Figure 38. Economic capital index map of Cebu province

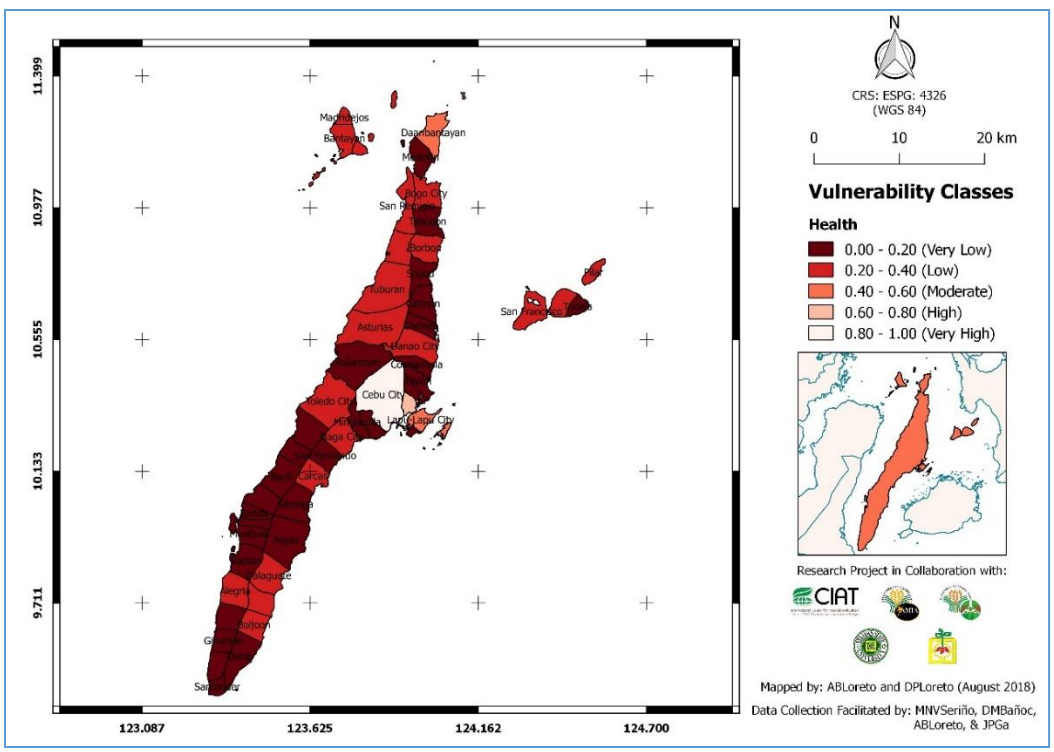

Figure 39. Health capital index map of Cebu province

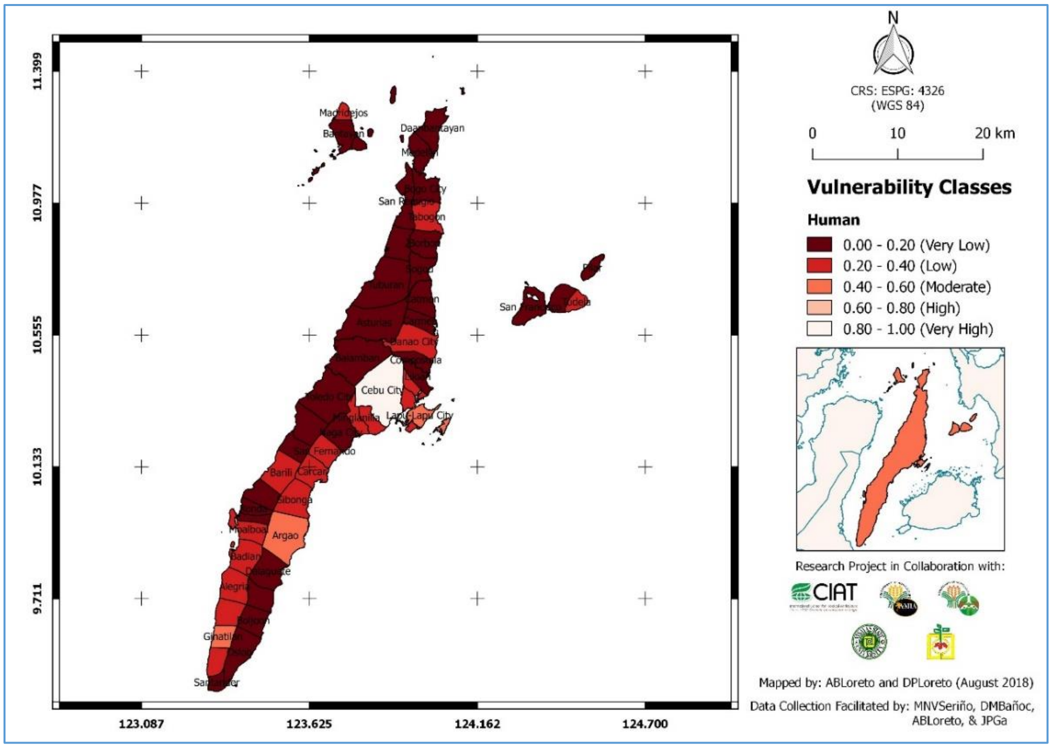

Figure 40. Human capital index map of Cebu province

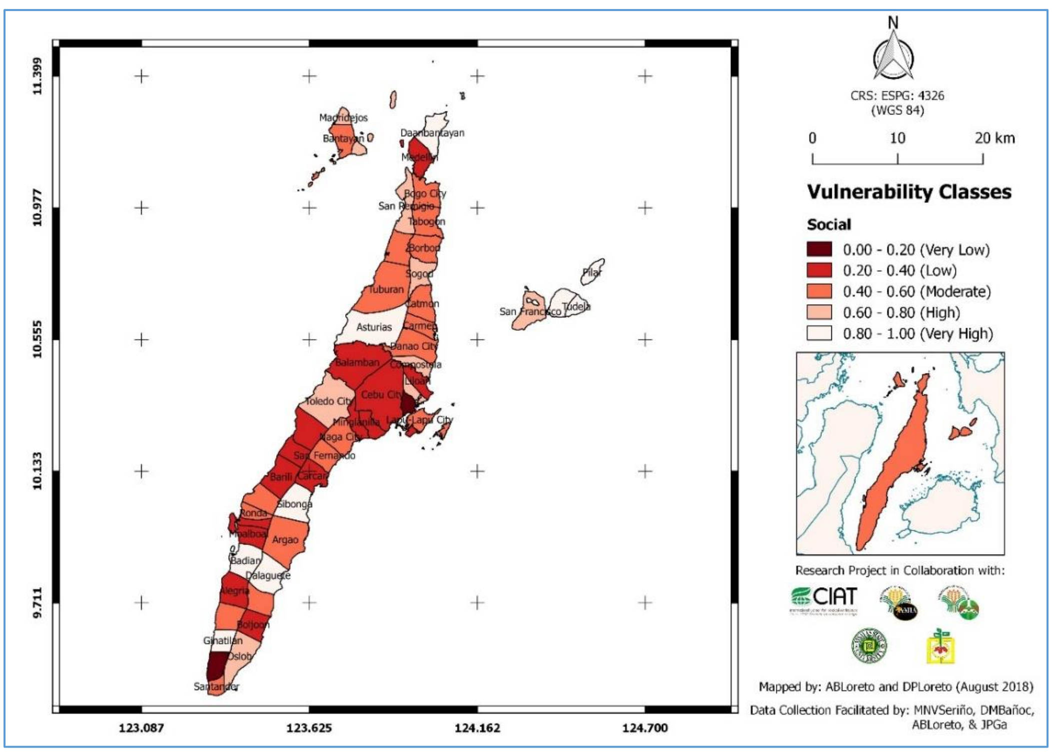

Figure 41. Social capital index map of Cebu province

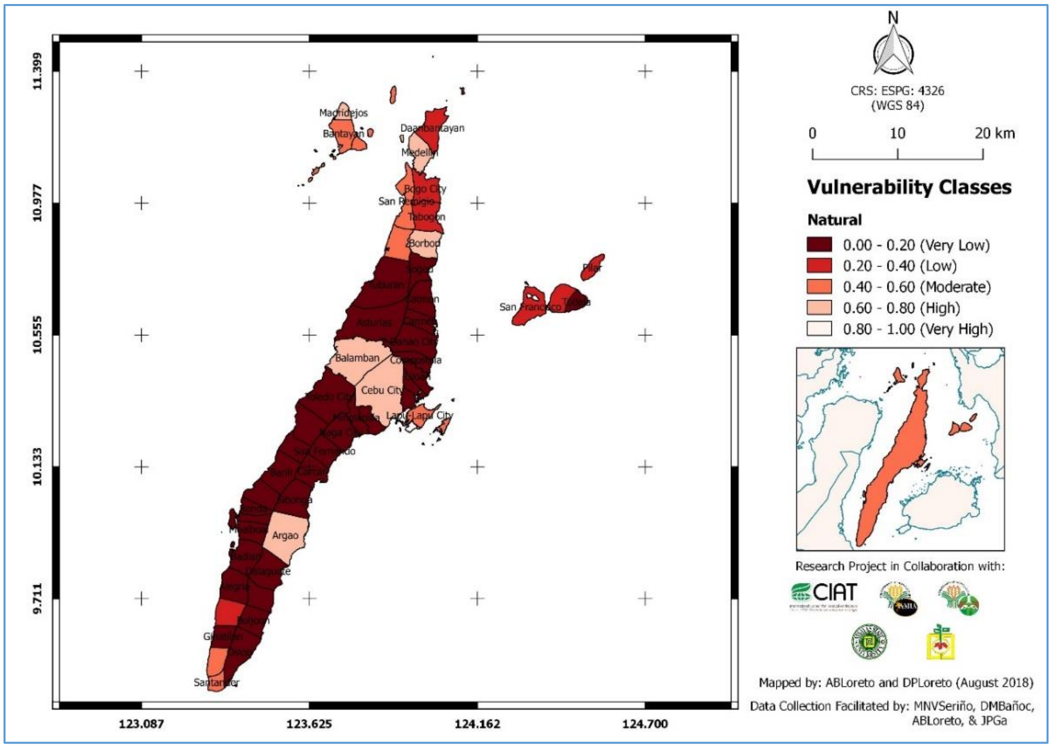

Figure 42. Natural capital index map of Cebu province

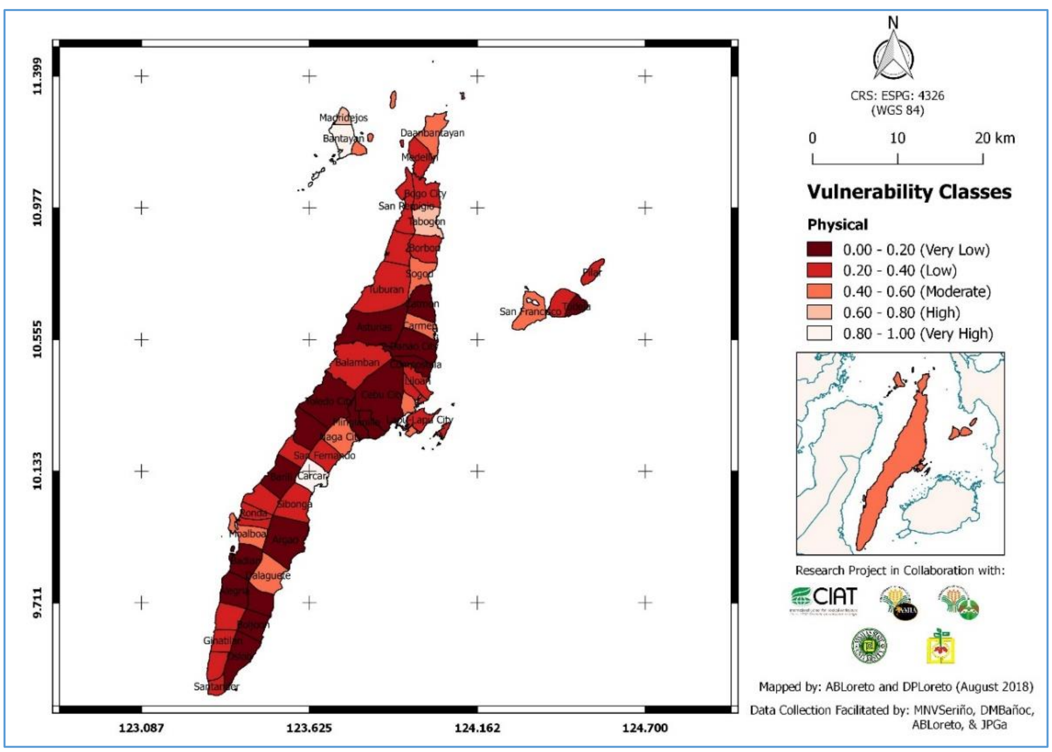

Figure 43. Physical capital index map of Cebu province

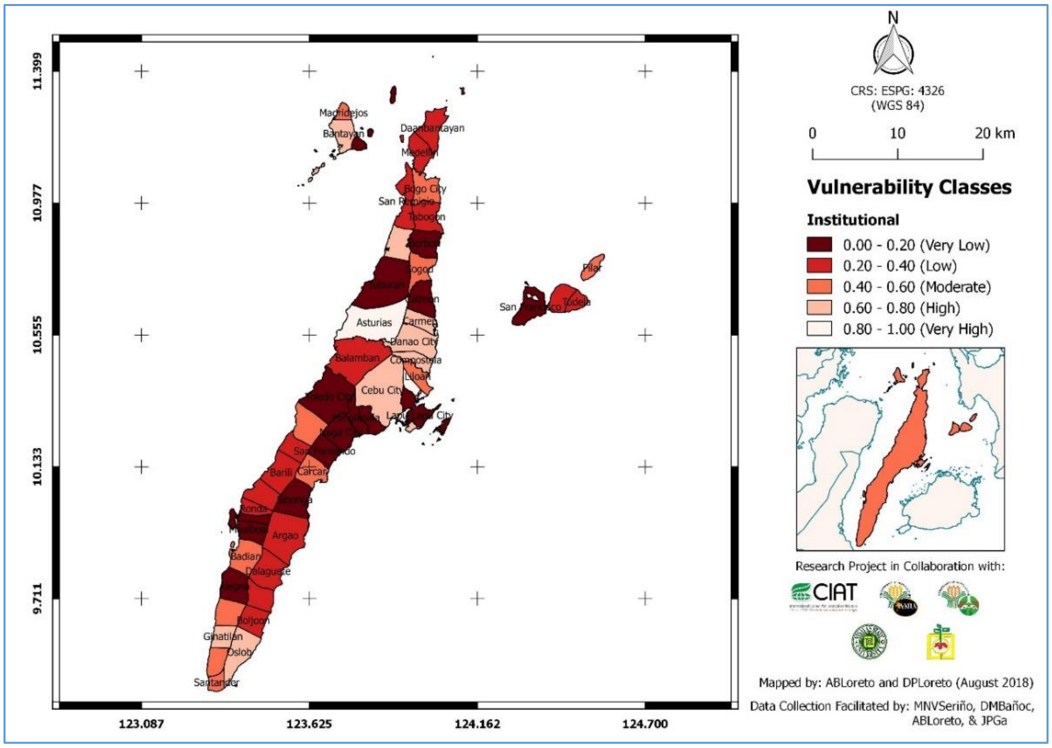

Figure 44. Institutional capital index map of Cebu province

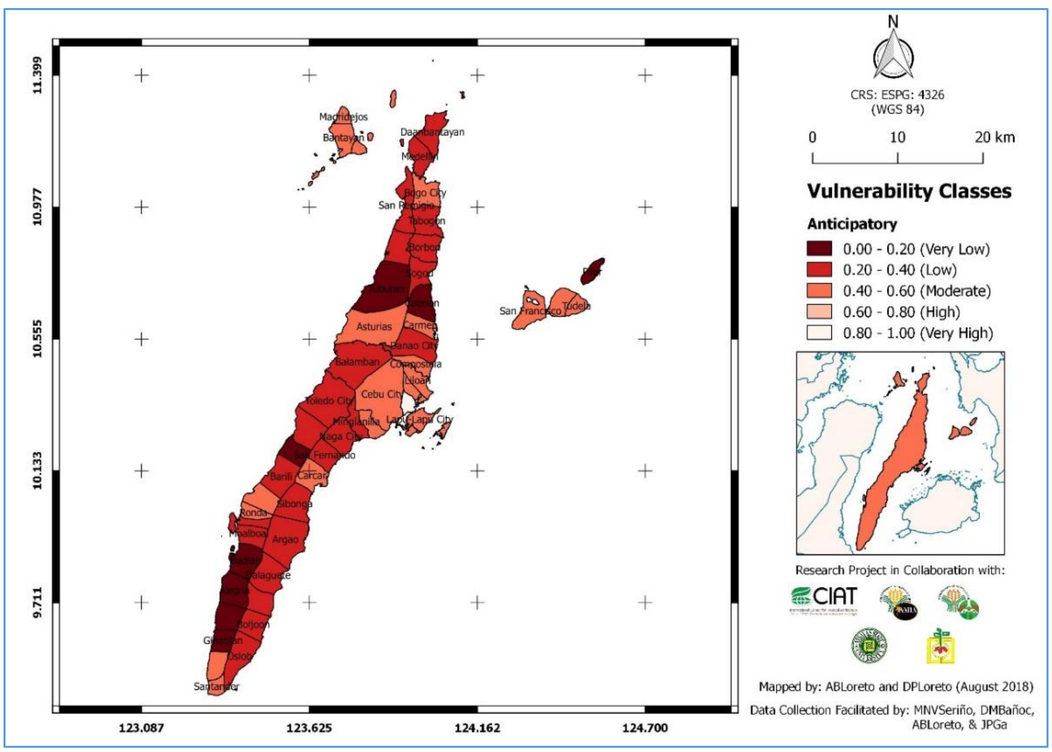

Figure 45. Anticipatory capital index map of Cebu province

Climate Change Vulnerability

Using the estimated values of sensitivity, exposure, and adaptive capacity, the vulnerability of agriculture sector in Cebu province was determined. The vulnerability analysis was conducted using three different combinations of weight assignments for sensitivity, exposure and adaptive capacity. Since the concept of vulnerability is subjective and relative in nature, a numerous basis for estimation emerged from online literatures. The most common weight assignments for sensitivity, exposure and adaptive capacity were 15-15-70, 25-25-50, and 30-30-40. Due to this lack of concession to which weights assignments is best, the technical partners of the study made a consultation with experts and have decided to use the 15-15-70 weight combination for sensitivity, exposure and adaptive capacity. This weight combination was selected because of its optimistic nature. Since sensitivity and exposure were both uncontrollable, the experts assigned higher weight for adaptive capacity to give leeway for adaptation and mitigation efforts of the government to combat climate change.

Despite coming up with the preferred and recommended weight combination for the vulnerability analysis, the team decided explored all three. This was done to have broader perspective of the overall result. In addition, the researchers also did an analysis for a shorter time period projected in the year 2030 using 15-15-70 weight combination. This was done after the consultation with DA-RFO7 in Cebu. They requested to have a prediction nearer than the approved and agreed projection in 2050. The result of the 2030 predicted vulnerability scenario for all crops included in Cebu Province can be found in the appendix 25-29. The results of the analysis for time both periods returned a very similar vulnerability condition. Rice and corn vulnerability, for instance in the year 2030 and 2050, were found to almost the same. The reason of these similarities however can be easily spotted on the data. Since the adaptive capacity indicator used for both time periods are the same, it’s not surprising to have these results since the aforesaid index carries 70% of the total index value of the vulnerability level.

Figures 46 illustrates the vulnerability of agriculture sector in Cebu province under 15-15-70 condition. This suggest that the assigned weights were 15% for sensitivity, 15 for exposure and 70 for adaptive capacity. As reflected in the same figure, the municipalities of Pinamungahan, Aloguinsan, Alcantara, Alegria, Boljoon, Tuburan and Catmon have a very high vulnerability to climate change while Cebu City and Municipality of Bantayan have very low vulnerability to the aforesaid condition. This vulnerability category implies that in times of disaster, Cebu City and Bantayan recovers easily compared to municipalities scored very high vulnerability regardless of the disaster's magnitude.

Looking at the specific vulnerabilities of the prioritized crop commodities, Figures 47, 48, 49, 50, and 51 showed that farmers planting corn, rice, banana, mango, and cassava were most vulnerable in places with low adaptive capacity. Vulnerability index maps for sweet potato, coffee, cacao, pinakbet and chopsuey were also reflected in Figures 52-56, respectively. Cebu City scored very low vulnerability consistently in all prioritized crops while the municipality of Pinamungahan, Aloguinsan, Alcantara, Alegria, Boljoon, Tuburan, Catmon remained high to very high. This result is not surprising since this combination, assumes 70% for adaptive capacity in which the resulting highly vulnerable communities scored low to very low. What is surprising however is the vulnerability indices of cassava. Unlike the other prioritized crop commodities which indicated similar unpleasant conditions of vulnerability in most areas, cassava showed a better result. Figure 50 showed that cassava is less vulnerable to climate-change in Cebu province relative to other prioritized crop commodities. The moderate to low sensitivities of cassava to changes in precipitation and temperature throughout the island province made it resilient to unfavorable climate hence less vulnerable to climate change. The vulnerability of the rest of municipalities and cities in the province of Cebu is reflected in the aforesaid maps.

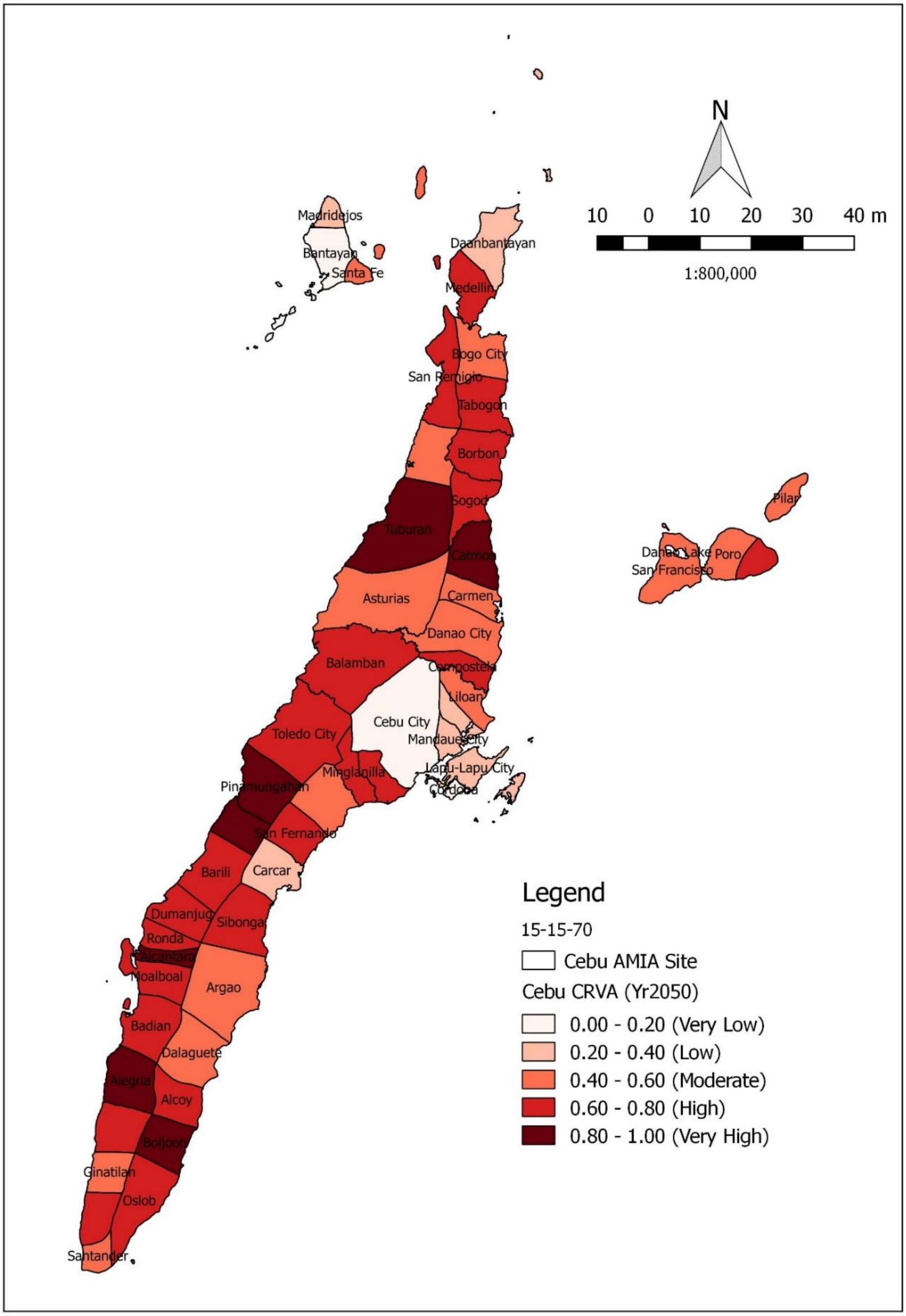

Figure 46. Vulnerability index map of Cebu province in year 2050 using 15-15-70 weight assignments of sensitivity, exposure and adaptive capacity

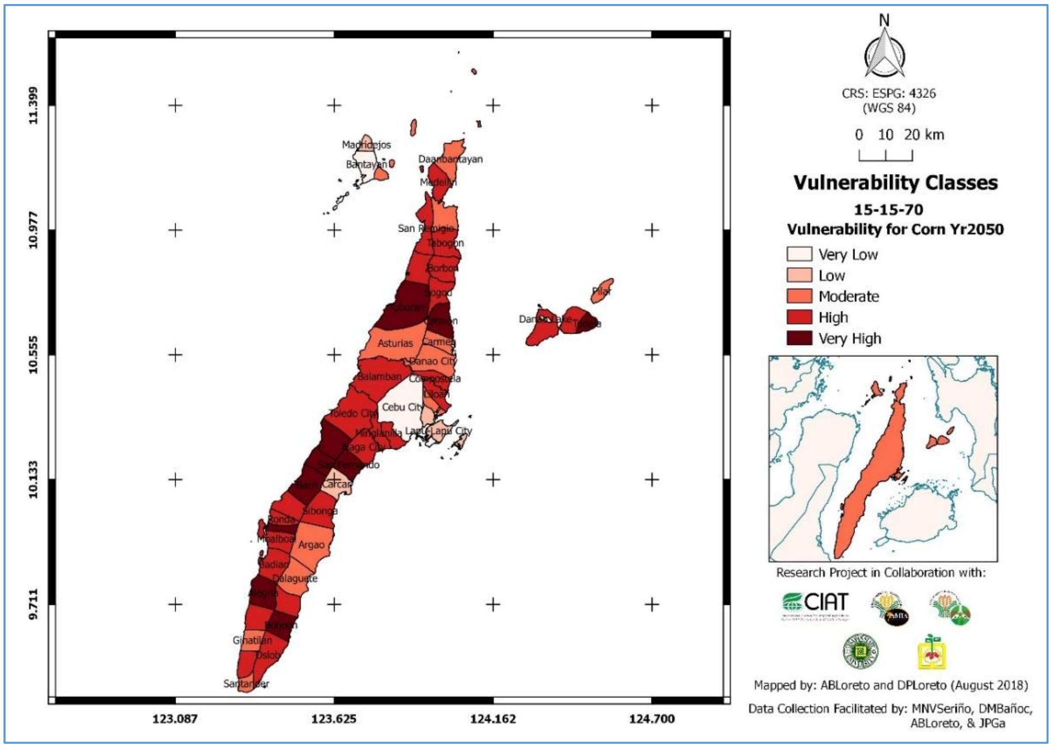

Figure 47. Corn vulnerability index map of Cebu province in the year 2050

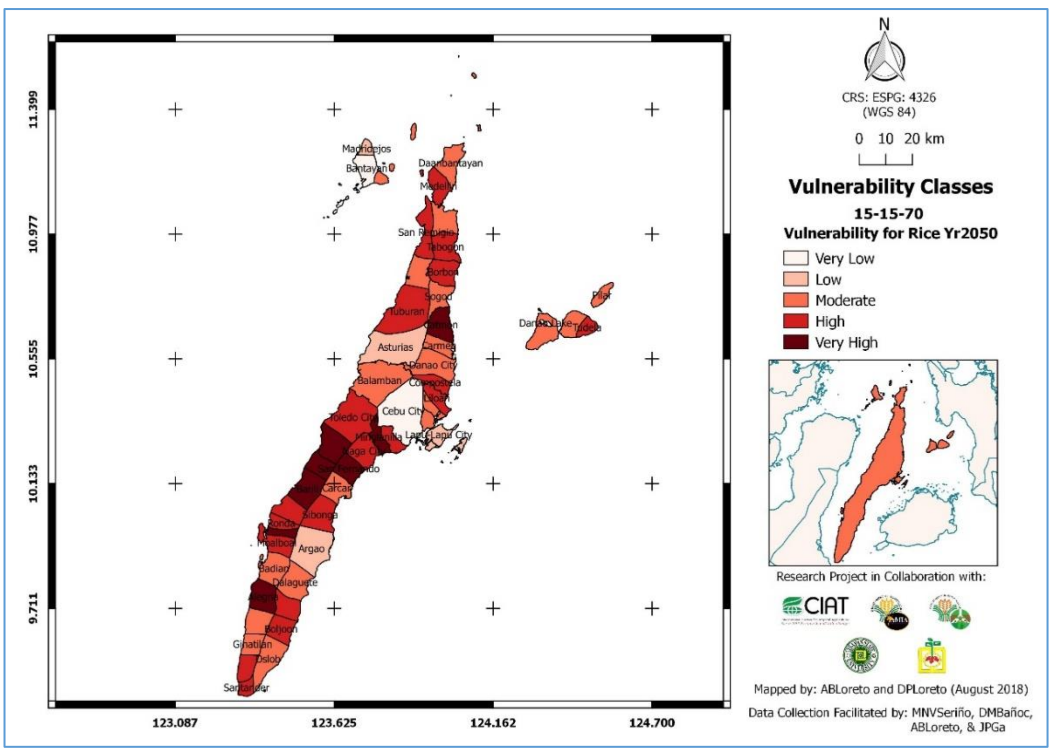

Figure 48. Rice vulnerability index map of Cebu province in the year 2050

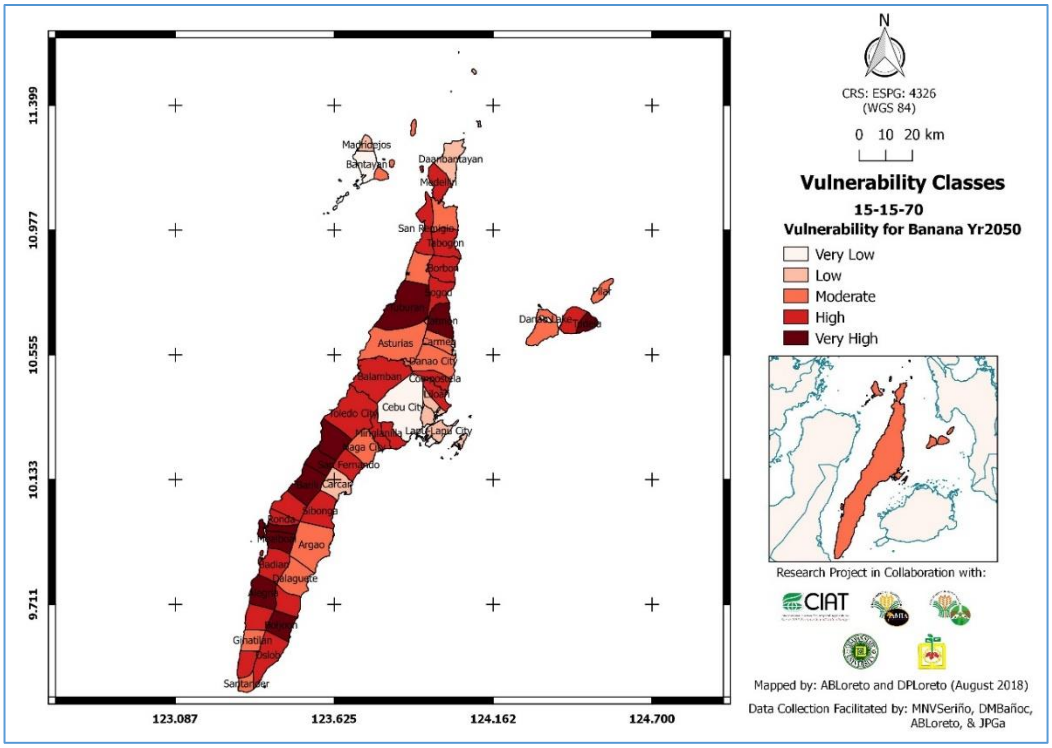

Figure 49. Banana vulnerability index map of Cebu province in the year 2050

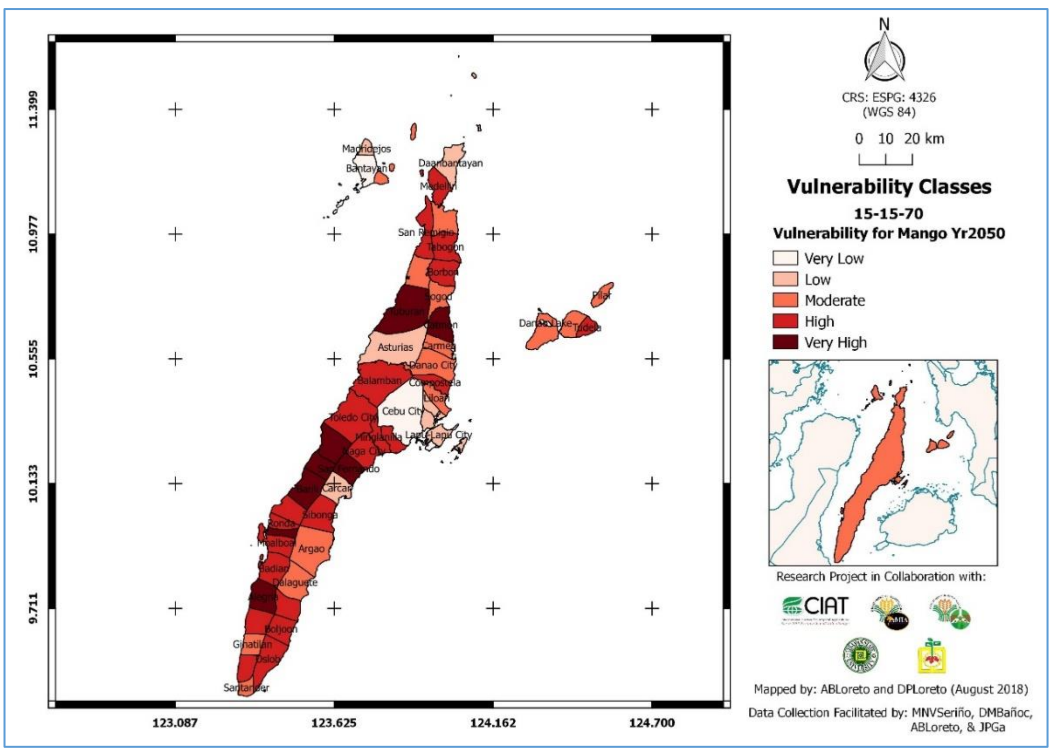

Figure 50. Mango vulnerability index map of Cebu province in the year 2050

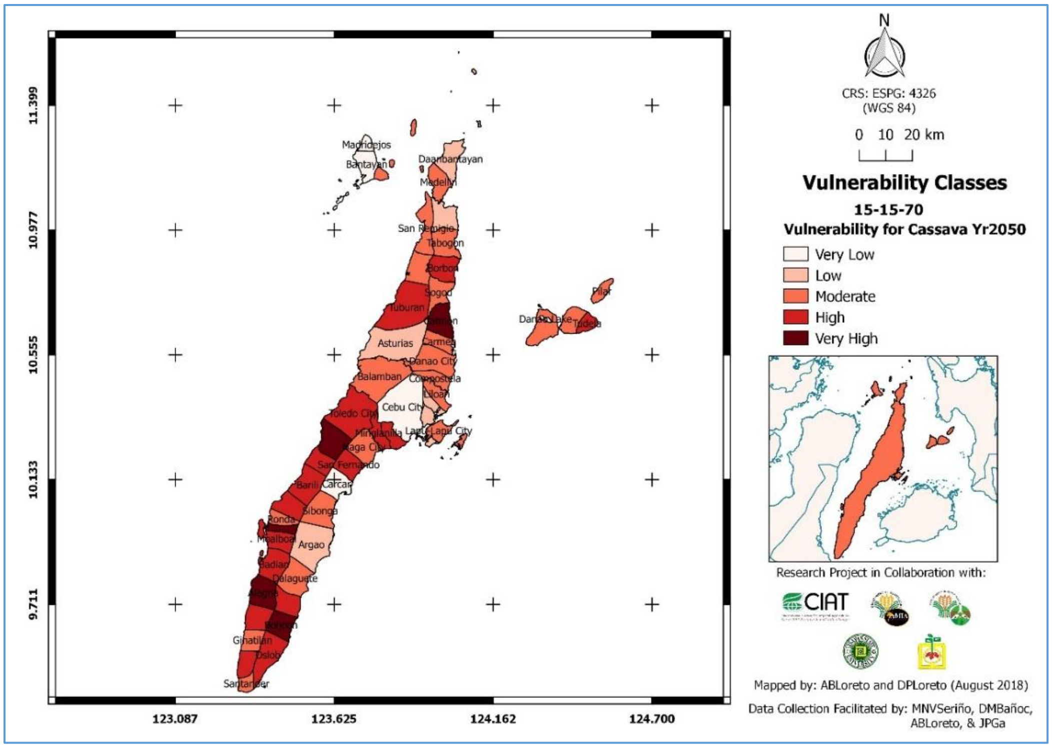

Figure 51. Cassava vulnerability index map of Cebu province in the year 2050

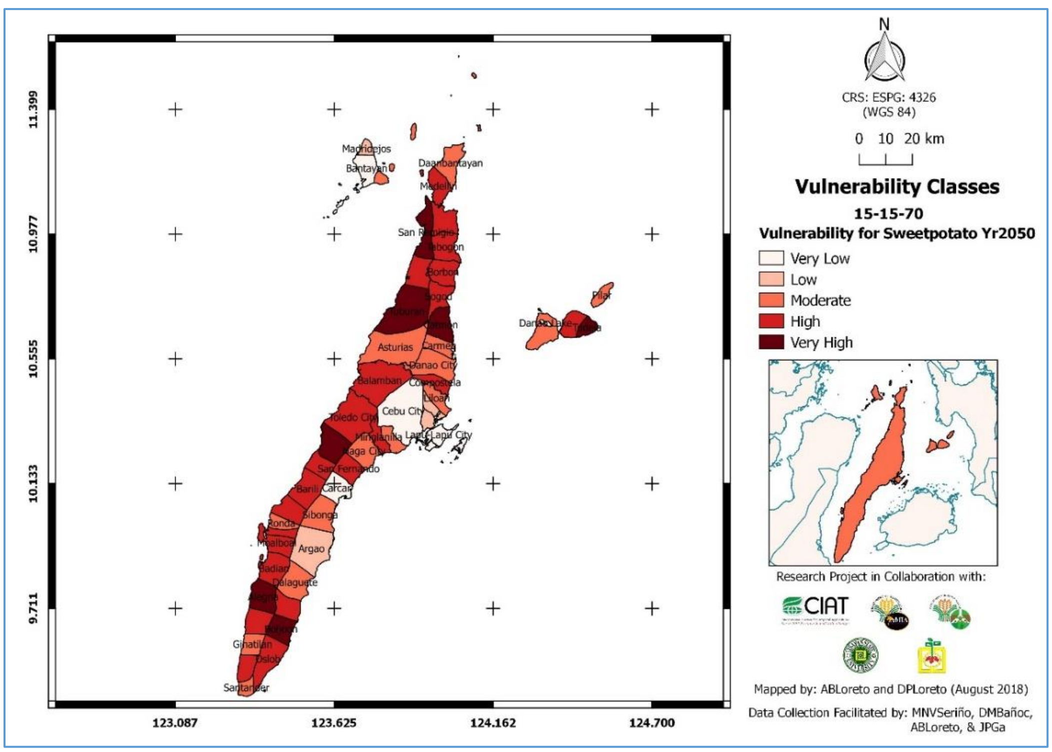

Figure 52. Sweet potato vulnerability index map of Cebu province in the year 2050

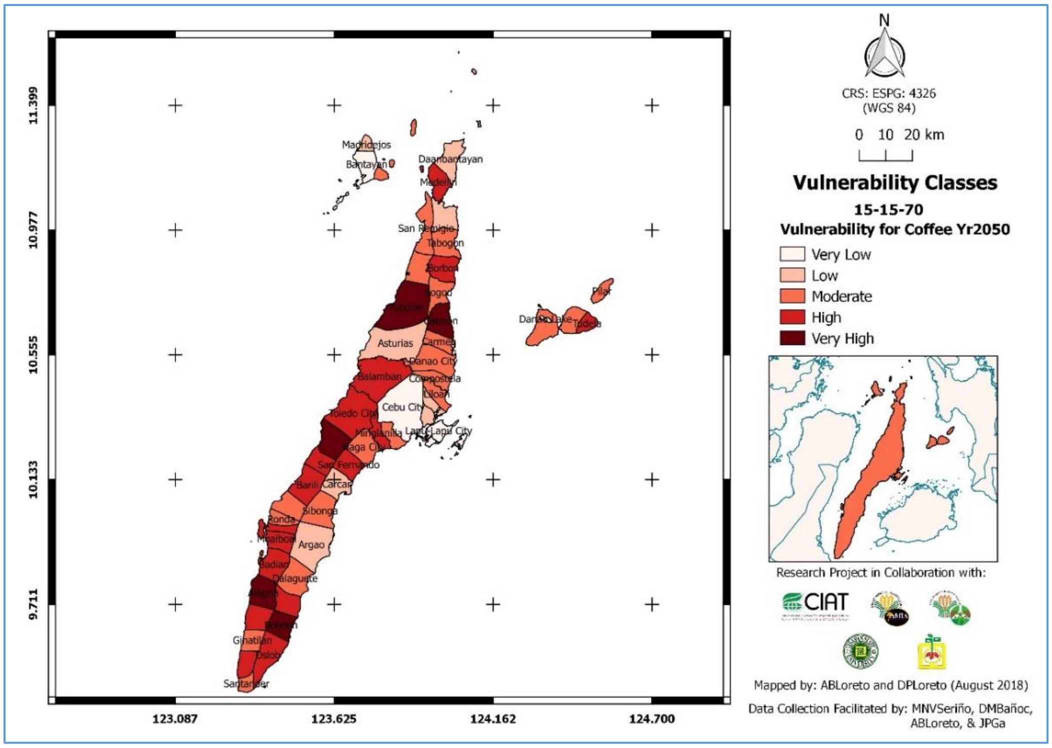

Figure 53. Coffee vulnerability index map of Cebu province in the year 2050

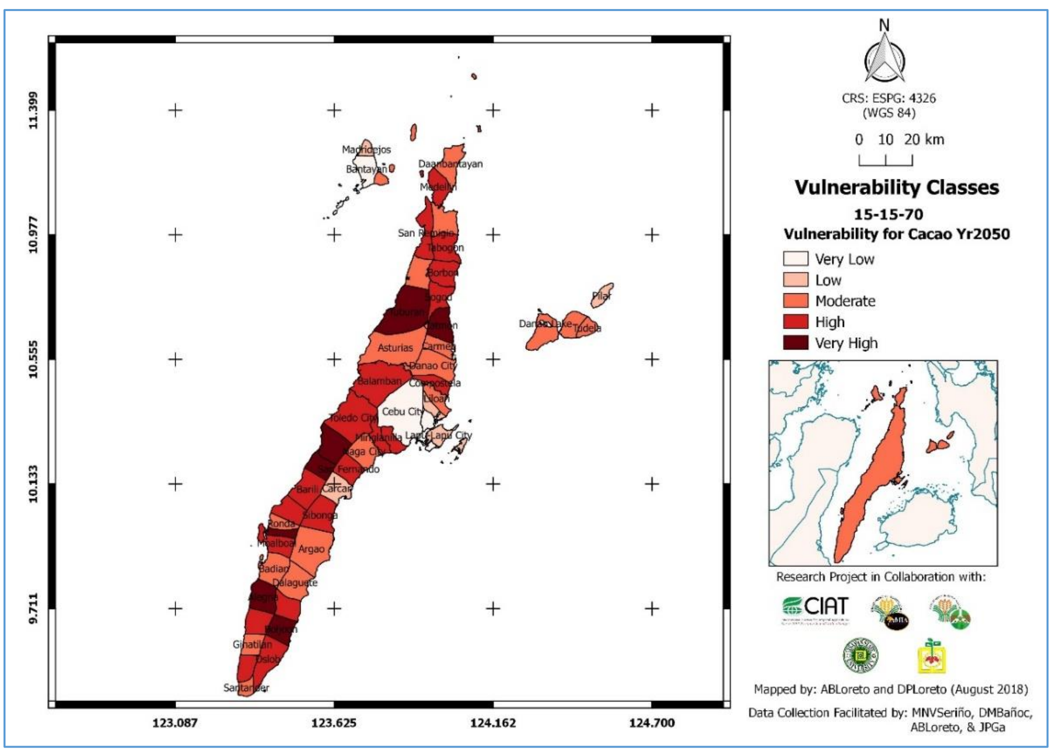

Figure 54. Cacao vulnerability index map of Cebu province in the year 2050

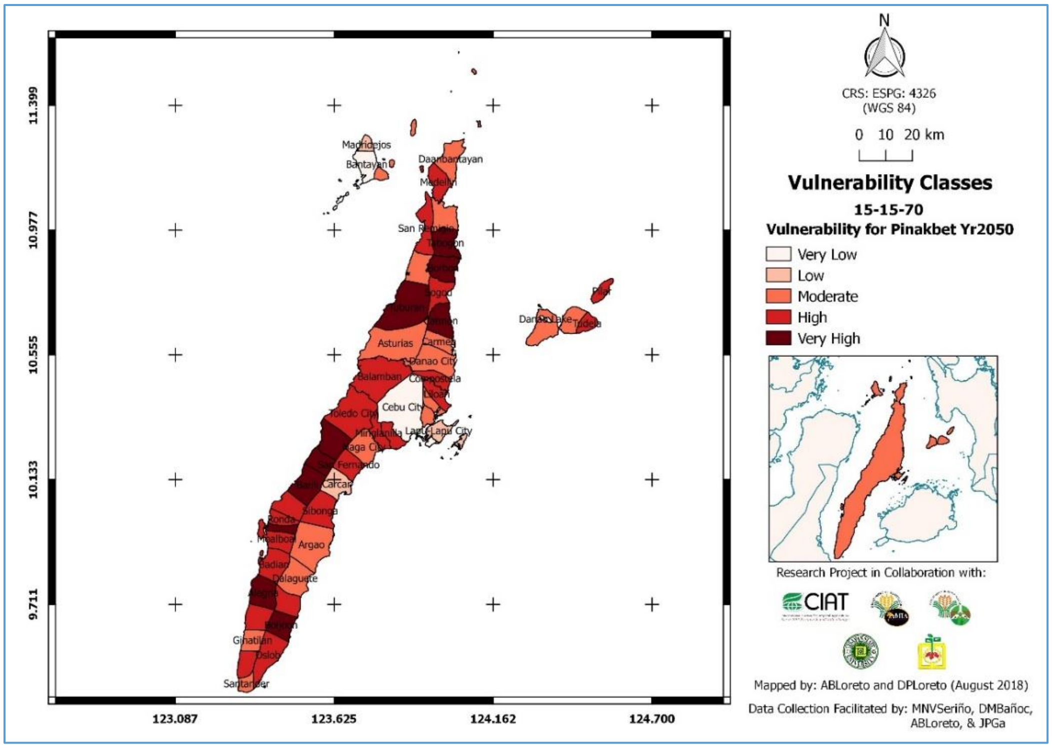

Figure 55. Pinakbet vulnerability index map of Cebu province in the year 2050

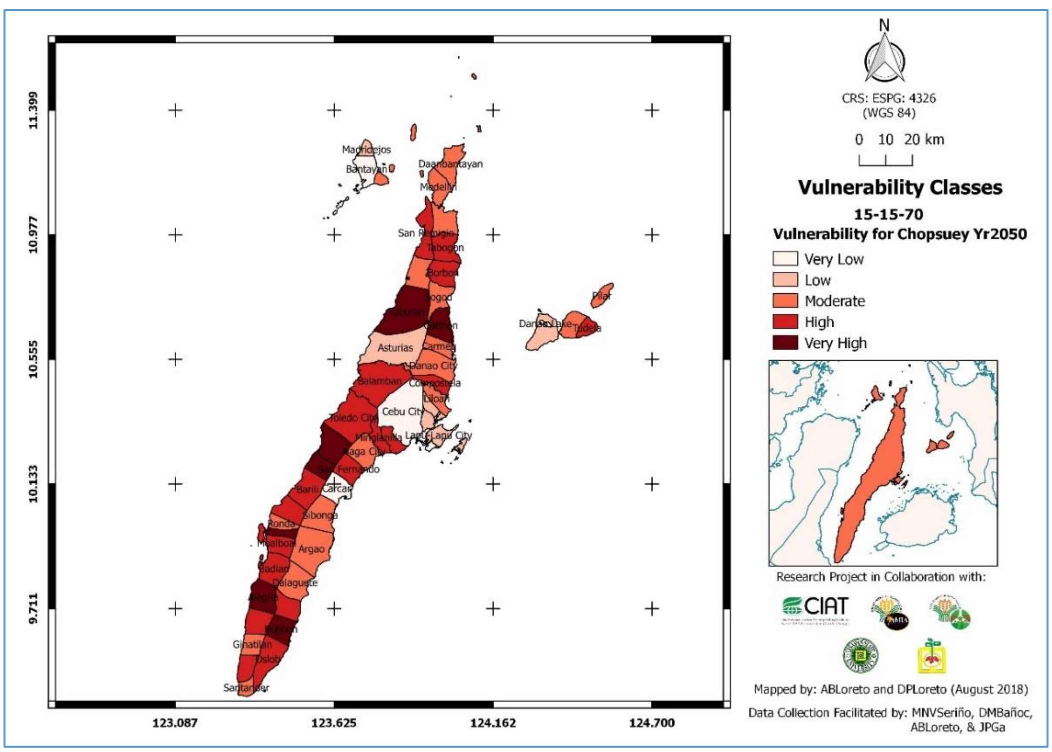

Figure 56. Chopsuey vulnerability index map of Cebu province in the year 2050

Climate-Resilient Agriculture (CRA) Practice Documentation

CRA refers to a broad set of practices that sustainably increase productivity and resilience, reduce and/or remove greenhouse gas emissions (Josh, C. et al 2014). An agricultural practice is considered climate-resilient if it qualifies to the three pillars namely: productivity, mitigation, and adaptation. These three conditions necessitate a particular practice to be more productive, adaptable to changes in temperature while reducing agricultural carbon emission.

Table 5 presents the ten most-common climate-resilient agriculture (CRA) practices in Cebu Province. These practices were considered a climate-resilient since it is believed to have the fitting qualities of a CRA. The CRA practices were identified during the crop occurrence workshop organized by the project team mentioned previously. During this event, a questionnaire was given to each of the participant as the project bio-agricultural systems specialist discussed what agricultural practices are considered climate-resilient. In the questionnaire, each respondent was asked to indicate what barangays in their respective municipality a CRA is being practiced. A sample of their response on the questionnaire is attached in Appendix 5 and below is the tabulated summary of the most prevalent CRA practice in Cebu province.

Investment brief

The identification of the CRA practices in Cebu province is crucial since this will be used as basis for selecting the CRA for the investment brief. Using this result, the project team conferred with DA-RFO7 officials to select two CRA practices most adaptable in the province. Upon the consultation and meeting held in DA-RF07 office and project workshop in SEARCA Dorm at UPLB with CIAT, the team decided to choose corn-peanut rotation and the use of protected cultivation for vegetable production. The corn-peanut rotation was chosen because this province corn is the most prevalent crop being cultivated and crop rotation is the most dominant practice adopted by corn farmers in the area. For vegetables, Lettuce and French Beans were selected since these are the vegetables mainly produced under protected structures and these are among the high-value crops produced in the province.

Corn-Peanut rotation was considered a CRA because rotating corn with peanut improves soil condition through the N-Fixing properties of peanut. Unlike the conventional corn-corn cropping scheme that depletes soil nutrients, the CRA naturally restore soil fertility that improves productivity. Consequently, this reduces fertilizer application that emits carbon. Also, crop rotation scheme is widely noted as effective solution in breaking the cycle of pest and disease incidence in crops. The adaptability of corn-peanut rotation traces back to the cycle of seasons. Since rainy days is not whole-year-round, planting of corn in summer will cause wilting of corn plants. Thus, rotating with peanut and planting it during dry season is an excellent alternative since this crop thrives best under warm conditions. On the other hand, protected cultivation is considered a CRA because planting crops under protected structure improves productivity of crops due to reduction of losses associated with climate, pests and diseases. Due to this technique, planting of crops under protected structure can reduce or minimize the utilization of pesticides.

For the data collection, a farmer interview was conducted. The data collection for corn-peanut rotation was conducted in the Municipality of Daanbantayan while collection of data for vegetable protected cultivation was gathered in Brgy. Mantalungon, Dalaguete, and Sudlon 2, Cebu City. Other details of the data gathering are presented in Table 6.

Table 6. Top 10 climate-resilient agriculture (CRA) practices in Cebu province

Rank	**CRA Practices in Cebu**	**Number of Barangay Practicing**
1	Cropping Systems (i.e., intercropping, multiple cropping, strip cropping and multi storey cropping)	365
2	Agroforestry	256
3	Climate resilient or Tolerant Varieties	201
4	Crop Rotation	200
5	Zero Grazing	178
6	Index-based Insurance Schemes	171
7	Crop-Livestock Farming	165
8	Organic Farming	158
9	Conservation Agriculture	142
10	Traditional Cultivars/ Varieties	123

Table 7. Number of respondents interviewed for the two CRA practices per municipality

Municipality	**Date of data collection**	**CLIMATE RESILIENT AGRICULTURE PRACTICES**				
		Corn-Peanut Rotation	Corn Mono cropping	Vegetable Protective Cultivation	Open field	TOTAL
Daanbantayan	Feb. 20-23	7	11	-	-	18
Dalaguete	Mar. 20-23	-	-	4	10	14
Cebu city	Mar. 20-23	-	-	-	2	2

Cost-Benefit Analysis

The collected data through interview for the two chosen CRA practices were summarized and analyzed using an online tool developed by CIAT. This tool was used for the cost-benefit analysis in determining the profitability of the CRA practices compared to those conventional methods on corn and vegetable farming.

Table 7 presented some highlights of the analysis. The figures reflected in aforesaid table indicated levels of profitability for corn-peanut rotation and vegetable protected cultivation. Based on the results, the CRA practice is a profitable venture for farmers planting corn and vegetables. Both CRA practice has a payback period of three years which indicates the length of time to which farmers can recover investment costs should for the aforesaid CRA practices. In terms capital returns, internal rate of return (IRR) values for corn (51.32%) and vegetable (60.42%) suggests that investing in both undertakings would generate more income than putting the capital on banks at 12% market interest rates compounded annually. Prepared investment brief for corn-peanut rotation and vegetable protected cultivation are attached in the appendices.

Table 8. Cost-benefit result highlights of the CRA practices

Financial Indicators	**CLIMATE-RESILIENT AGRICULTURE (CRA) PRACTICES**	
	Corn-Peanut Rotation	**Vegetable protected Cultivation**
Initial investment requirement per hectare	PhP 30,000.00	PhP 40,000.00
Net Present Value (NPV)	PhP 81,128.20	PhP 63,526.98
Internal Rate of Return (IRR)	51.32%	60.42%
Payback Period (PP)	3 years	3 years

Assumptions: Interest rate – 10%; Investment Period – 10 years

RIDGE-TO-REEF TRANSECT ACTIVITIES OF EXISTING AGRICULTURAL SYSTEMS

Importance of Transect to AMIA

Transect is an option in gathering spatial data in the identified AMIA municipalities and cities by identifying important resources; i.e., crops, livestock, fishes, weeds, soil conditions, cropping systems, farming systems, cropping pattern including climate or weather; topography and other important resources especially related to agriculture and energy in the different ecosystems.

For this undertaking, observations of specific indicators vital for the AMIA project and responses of the populace based on both qualitative and quantitative data were collected on actual observations. The route was identified based on existing resource maps of the entire area. The route selected across municipalities or cities was a representative in the project site. The conduct of transect in collecting relevant data relative to the edaphic factors, cropping systems and identification of most adaptable and/or resilient crops, livestock and other agri-products was important in the final selection of AMIA strategies in enhancing the productivity of crops, livestock, fishery and other resources in the identified AMIA municipalities and cities as reflected in Tables 8 and 9.

Transect Result

During transect activity, Cebu province was subdivided into three component parts; northern, mid and southern part which was vital in the final identification of crops, livestock, and fishery resource most suitable in the abovementioned areas. The province of Cebu has varied agro-ecosystems comprising of mangrove or coastal areas, lowlands, uplands, hillylands and rocky to mountainous areas. Based on transect, the soil type and the dominant crop species, animals and/or livestock, weeds, forest and timber trees and other resources found in the aforesaid component areas are reflected in Table 8.

The dominant soil type in irrigated ecosystem were clay, clay loam, and sandy loam. Clay soil was found mostly in the uplands and hillyland ecosystems with low top soil in the northern part of Cebu province while clay loam was generally found in the uplands most particularly located at low elevation or under hillylands but found in side slopes of the aforesaid ecosystem under the mid-part of the province. However, sandy loam and calcareous soil were found under the low lying or near coastal areas where siltation is dominant in the said areas (Table 8).

For the specific crop components in the province, the most dominant crops grown in all parts; northern, mid and southern parts were coconut, banana, corn, legumes and fruit crops. Vegetables and ornamental plants were dominantly raised in the mid-part and southern part of the island while sugarcane was abundantly grown in commercial basis in the northern part of the island. However, rice is grown mostly in the lowlands in the southern part of the province particularly Argao but nothing under the upland and hillyland ecosystems. Root/tuber crops and bamboos were sparsely planted in almost all ecosystems covering northern, mid and southern parts of the province. However, mangrove trees, coconut and nipa were mostly grown in the coastal areas of northern municipalities of Carmen, Consolacion and other nearby municipalities, and also in the southern parts particularly Santander, Samboan, Alegria and other municipalities in the southernmost part particularly in the 7th district of the province. The promising crop component that demand high production and income for the elite growers is sugarcane. This crop has been grown abundantly under open field conditions in both the uplands and hillylands.

For animal and livestock components, cattle and goats were the dominant animals and/or livestock raised by most populace in the northern and southern part municipalities of the province while poultry was a dominant animal component in the mid-part of the island (Table 8). Carabao is raised only in limited number in the uplands and hillylands in all component parts; northern, mid and southern even if this animal is considered as a lifelong partner of farmers in doing tillage, cultivation, transport and/or hauling of agri-products and/or goods.

The dominant weed species in the transect areas were grasses, sedges and broadleaves, and these were dominant weed types in all ecosystems in the northern, mid and southern parts. Grasses, sedges and limited broadleaves were dominantly grown in the sloping uplands and hillylands while most sedges, ferns and broadleaves were dominating in fertile soils in the lowlands and upland plain particularly those flood-prone areas. However, creeping legumes and ferns are sparsely grown in some farms in uplands and hillylands. This implies that the aforesaid farms are still abundant in nutrients thereby intercropping, relay, strip and sequential cropping with planting of corn and leguminous intercrops i.e., peanut and mungbean are the best strategy for enhancing family's livelihood and income.

The cropping systems dominantly adopted by most farmers in the transect municipalities/cities were mostly intercropping, sole cropping, sequential, alley cropping and strip cropping in the northern parts of the province while multi-storey cropping and mixed cropping in the mid and southern parts of Cebu province. Although multiple cropping system was sparsely observed in the boundaries of each farm parcel in all ecosystems in almost all municipalities in the province. However, a patches of farms also adopting agroforestry particularly in between boundaries of each farm in both upland and hillyland ecosystems were observed in the northern part while this practice was dominant in the mountainous areas in the mid-part and southern part of the province.

Farming system is the main approach adopted by most farmers in all ecosystems and in all component areas wherein planting of coconut, banana, fruitcrops, rootcrops and raising of cattle and/or goats are generally observed regardless of component areas. However, both farming and fishing were the dominant livelihoods of the populace in the coastal barangays mostly in the northern part where most of the populace focused more on farming than that of fishing during the wet cropping season while fishing was mainly focused during the dry season for their existence.

In terms of production constraints, soil erosion was observed most prevalent in the rolling to sloping uplands and hillylands in the northern part but not so much in the southern part because of contour hedgerows used i.e., horse radish tree, leguminous trees etc. However, flooding and drought were noted in the lowlands most particularly in low lying lowlands and upland plains in the northern part of the province. Although low lying uplands in northern municipalities were severely affected by flooding during the wet season while sloping uplands and hillylands were extremely affected by limitation of soil moisture during the dry season.

Based on the result of transect, some CRA strategies are identified to cope with the upcoming environmental problems. Integrated Farming Systems (IFS) is the most applicable farming endeavor that was adopted in all ecosystems particularly in all municipalities in the northern, mid-part and southern parts of the province.

In lowland ecosystems however, the most recommended farming practice was palayamanan, with the integration of animals and/or livestock in the system especially in the rainfed lowland ecosystem. In sloping uplands and hillylands areas however, Sloping Agricultural Land Technology (SALT) was strongly recommended. While for boundaries of each farm parcel, the adoption of alley cropping is highly encouraged in all areas, namely; northern, mid and southern portion in order for the family to avail of timber or forest trees for their own utilization and additional income.

About cropping systems, the most dominant cropping systems practiced by farmers were sole cropping, alley cropping, strip cropping and intercropping followed by multi-storey cropping system. However, sole cropping, alley cropping and intercropping were mostly adopted under the uplands and hillylands while multi-storey cropping was commonly practiced under the steep slope hillylands and mountainous areas. Banana, fruitcrops, corn and other annual crops were mostly interspaced under coconut while rice was only adopting a monocropping scheme under lowland irrigated ecosystem. For multi-storey cropping system under uplands and hillylands, coconut was grown as the main crop while it was interspaced with banana, fruitcrops, plantation crops and other annual and perennial crops in order to enhance farmers' crop productivity and apparently income.

For the livelihood of the populace, Farming, Fishing and Business Enterprises were the common livelihood of the Cebuanos. However, working abroad was the dominant livelihood in the northern and mid-part of the people in the province while vending was mostly participated endeavor by the majority of southern and mid-part Cebuanos comparing the northern part populace in the province.

Relative to production constraints, drought and flooding were the common problems faced by most farmers during the dry and wet seasons, respectively inflicting damage to their grown crops mostly in the lowlands and upland plains. However, drought was the primary crop production constraint in the uplands, and this was more severe in the northern municipalities than that of the mid-part and southern part of the province.

Based on transect, Integrated Farming System (IFS) was the most recommended production strategies in the lowlands covering all component areas, namely northern, mid and southern part. Intercropping, strip, and relay cropping systems were the applicable cropping strategies for the uplands and hillylands. While SALT technologies, multi-storey cropping and adopting the zero/ minimum tillage are the recommended options in minimizing adverse effects on soil erosion, landslides and soil degradation that caused reduction of soil fertility in the hillyland ecosystem for the entire province, thereby reducing crop productivity and income to highlanders.

With this present scenario on climate change nowadays, Climate Resilient Agriculture (CRA), Sustainable Agriculture (SA), Agri-tourism are the most appropriate approaches and strategies in alleviating crop productivity and augmenting their income on paving the way for improving the quality of life of rural and fisherfolks under the different component areas. Crop-animal integration was the most common farming systems in all areas. However, cattle is the dominant animal for raising in the northern part, hogs and poultry in the mid-part while mixture of cattle, goats and poultry were the animal components feasible in the southern part of the province.

Table 9. Result of transect conducted in Cebu province

Indicator	Component Areas in Cebu Province		
	Northern part	**Mid-part**	**Southern part**
Cities/municipalities in Cebu province	Consolacion until Daanbantayan including Bantayan Island	Cebu City including Mandaue, Lapu-lapu, Toledo and Asturias	Talisay City, Naga City, Barili until the southernmost municipalities of Santander & Samboan
Soil Texture (dominant)	Clay, Clay loam & Silty clay loam	Clay, Clay loam & Silty clay loam	Clay, Clay loam, Sandy clay loam
Soil Color (dominant)	Black, Light brown, Reddish brown, Black with porous white stones	Black, Reddish brown, Light brown	Black, Light brown porous white stones
Existing Major Crops (dominant)	Coconut, Banana, Corn, Legumes, Rootcrops, Sugarcane, Bamboo	Vegetables, Corn, Banana, Rootcrops, Ornamental, Legumes, Coconut, Fruitcrops	Vegetables, Coconut, Banana, Corn, Rootcrops, Fruitcrops, Legumes
Existing Animal Components (dominant)	Cattle, Goats, Hogs	Poultry, Hogs, Goats, Cattle	Goats, Cattle, Hogs, Poultry
Existing Weeds	Grasses, Sedges & Broadleaves	Grasses, Sedges & Broadleaves	Broadleaves, Grasses & Sedges
Existing Cropping Systems (dominant)	Alley cropping, Sole cropping, Intercropping, Relay, Strip cropping	Intercropping, Mixed cropping, Sole cropping, Strip cropping, Multi-storey cropping	Agroforestry, Multi-storey, Intercropping, Sole cropping, Strip cropping
Present Livelihood (dominant)	Farming, Fishing, Business & OFWs	Business, OFWs, Farming, Fishing	Farming, Business, Fishing, Vending
Production constraints	Typhoons, Flooding and Drought	Drought, Flooding, Soil Erosion, Landslide	Drought, Landslide, Soil Erosion
Recommended Farming Systems	IFS, Crop-livestock integration (cattle), Fishery+Poultry, SALT	IFS, Crop-animal integration (hogs, poultry), SALT	IFS, Crop-mixed animal integration (cattle+goats+poultry), SALT
Recommended Production and Business Strategies	Climate Resilient Agriculture (CRA), Sustainable Agriculture (SA), Agri-tourism, Poultry, fastcraft making, Tourism	CRA, SA, Agri-enterprise, Agri-Tourism, Furniture making, Business processing services, Handicraft, Heavy industries	CRA, SA, Agri-fishery-tourism, ship building, Tourism

Table 10. The identified crops, fishery and animal/livestock suitable and most suitable in the component areas in Cebu province

Indicator	Component Areas in Cebu Province		
	Northern part	**Mid-part**	**Southern part**
Suitable crops	Sweet potato, Yautia, Peanut, Mungbean, Fruitcrops & Bamboo	Peanut , Mungbean, Banana, Rootcrops & Lanzones	Peanut, Mungbean, Rootcrops, Corn, Rice, Ornamental, Mango, Rambutan & Bamboo
Most suitable crops	Sugarcane, Coconut, Banana, Corn, Cassava	Vegetables (leafy and fruit), Ornamentals, Corn, Fruitcrops (Mango, Rambutan)	Vegetables, Coconut, Banana, Lanzones
Suitable fishery undertaking	Fishing and dried fish making	Fish canning, Aquaculture	Aquaculture, Fishing
Most suitable animal/livestock	Poultry, Cattle	Hogs, Poultry	Goats, Hogs, Poultry

Table 11. Result of soil analysis in the different sampling locations in Cebu province

Location	Physical and Chemical Analyses				
	Soil Texture	**pH**	**% OM**	**Phosphorus (mg kg-1)**	**Potassium (ppm)**
Saksak, Dalaguete, Cebu	Clay Loam	7.76	7.76	50.50	203.00
Langkas, Dalaguete, Cebu	Clay Loam	7.92	8.54	129.60	427.00
Mantalongon # 1, Dalaguete	Clay	4.68	2.21	9.30	243.00
Mantalongon # 2, Dalaguete	Clay	5.24	2.95	75.20	247.00
Ablayan, Dalaguete, Sebu	Clay	6.87	3.66	104.00	292.00
Dumalan, Dalaguete, Cebu	Clay	6.60	4.73	16.50	103.00
Tabon, Dalaguete, Cebu	Clay	6.72	7.58	82.40	377.00
Obo, Dalaguete, Cebu	Clay	8.36	5.77	12.40	48.00
Sudlon 1, Cebu City	Sandy Loam	6.78	3.44	106.40	58.00
Babag, Cebu City	Sandy Loam	5.81	1.97	29.70	233.00

SUMMARY OF SIGNIFICANT FINDINGS

This study determined the vulnerability of agriculture sector in Cebu Province to climate-related stressors such as typhoon, flooding, drought, soil erosion, landslide, salt-water intrusion, sea-level rise and storm surge. The assessment of vulnerability to aforesaid stressors focuses on farmers planting prioritized crop commodities in the province such as rice, corn, mango, cassava, and banana. Other important crops in the province were also included in the analysis such as sweet potato, coffee, cacao, pinakbet, and chopsuey vegetables. In the estimation process, the study used the bio-climatic factors, hazards data, and socio-economic indicators as basis for determining the levels of sensitivity, exposure and adaptive capacity to which collectively translates to vulnerability of farmers in Cebu Province. The estimated vulnerability indices were illustrated as maps using quantum geographic information (QGIS) which represents the level of vulnerability of each city and municipality in the province.

Results showed that municipalities with high exposure to hazards and have a low adaptive capacity such as Pinamungahan, Tuburan and Catmon were among the most vulnerable in the province. Meanwhile, the cities of Lapu-Lapu, Mandaue, Cebu and the municipality of Bantayan which have high adaptive capacity were the least vulnerable. One noticeable influencing factor observed was the high negative correlation between income class and vulnerability level. The municipalities and cities with the high-income class were less vulnerable compared to low-income class municipalities.

In the context of hazard ranking relative to its effect to agriculture sector in the province, typhoon was ranked first. This hazard affects mainly the mid and northern part of island province including the islands of Camotes and Bantayan. In terms of prevalence, soil erosion and landslide were the most common as hazard data shows. This was primarily due to the landscape of the central part of Cebu which was characterized by rolling mountains and steep slopes stretching from north to the south. The incidence of salt-water intrusion was noted the most in Cebu City, flooding in Mandaue City, storm surge and sea-level rise in Lapu-Lapu City and Cordoba, and drought in the municipality of Tudela.

Meanwhile, observations from ridge-to-reef transect activities revealed that coconut, banana, corn, legume, rootcrops, were cultivated throughout the province but sugarcane was observed mostly in the northern part. Rice was grown sparsely in mid and northern parts while corn was observed in all parts of the province. Chopsuey veggies were cultivated in higher elevation areas in Dalaguete, Argao, and Cebu City while Pinakbet veggies were planted in low-lying areas in Cebu City. For animal components, cattle, hogs, goats, and poultry were the most common. With regards to cropping practices, alley cropping, sole cropping, intercropping relay, strip cropping and agroforestry, especially in the southern part, were common. In lowland rainfed ecosystems, “Palayamanan” was observed to the most suitable farming practice while sloping agricultural systems (SALT) was suited best in sloping upland and hilly lands in Cebu province.

PROJECT MANAGEMENT

The regional project team will comprise of members from the VSU and the DA-RFO VII, Cebu province. The core of team experts from VSU will cover on a) geo-spatial analysis, b) socio-economics, and c) agriculture/fisheries systems. This arrangement was designed in order to mentor and capacitate the project team members coming from DA RFO VII. Such arrangement was without prejudice to involving more expertise from the collaborating institution or other SUC in the province. One of the team members would serve as project leader, or an additional person designated to serve in this overall coordination role.

In addition, 1-2 members from the DA-RFO will join the project team. The member's key role, besides general CRA/AMIA expertise, will cover in facilitating institutional linkages and coordination for successful implementation of project activities.

Team Position	**Name/Institution**
Project leader	Alan B. Loreto (Ag. Engg – GIS & Prec. Agri.)
Socio-economist	Moises Neil V. Seriño (Development Economics)
Agriculture/fisheries specialist	Dionesio M. Bañoc (Bio-Agricultural Science)
Science Research Assistant	Jade P. GA
DA-RFO collaborating staff	Maria Chona Maleza

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APPENDICES

Appendix 1. Documentation picture of the activities conducted and trainings attended

Courtesy call of VSU AMIA Team and DA-RFO7 officers with the Municipal Agriculturist of Daanbatayan during the conduct of farmer interview for the CRA corn-peanut intercropping.

Interview of farmers practicing protected cultivation in Mantalungon, Dalaguete, Cebu for the CRA Vegetable Protected Cultivation.

AMIA Project Team together with the vegetable farmer in the showcasing his farm in Sudlon 2, Cebu City.

Interview of farmers open field cultivation in Mantalungon, Dalaguete, Cebu for the CRA Vegetable Protected Cultivation.

Cost-Benefit Workshop using the tools provided by CIAT at SEARCA-Guest House in University of the Philippines Los Baños, Laguna.

Farmer in Sudlon 2, Cebu City, watering her lettuce under open field cultivation.

Interview of farmers open field cultivation in Mantalungon, Dalaguete, Cebu for the CRA Vegetable Protected Cultivation.

Courtesy call of VSU AMIA Team and DA-RFO7 officers with the Municipal Mayor of Daanbatayan Hon. Vicente M. Loot during the conduct of farmer interview for the CRA corn-peanut intercropping.

VSU AMIA Team and DA-RFO7 official together with the municipal agricultural and city agriculturist during the crop occurrence workshop held at the Cebu Business Hotel.

Municipal and city agriculturist locating the crops on the maps during crop occurrence workshop held at the Cebu Business Hotel.

Municipal Mayor of Alegria, Cebu (center) together with the project team headed by Prof. Alan B. Loreto and DA-RFO7 partner represented by Ms. Maria Chona Maleza during the field validation in Cebu.

Appendix 2. Corn sensitivity index by ranking, municipality, and city of Cebu Province.

Municipality	Sensitivity Index	
	Value	Legend
Poro	1	Very High
San Francisco	1	Very High
Tudela	1	Very High
Alcantara	0.5	Moderate
Alcoy	0.5	Moderate
Alegria	0.5	Moderate
Aloguinsan	0.5	Moderate
Argao	0.5	Moderate
Asturias	0.5	Moderate
Badian	0.5	Moderate
Balamban	0.5	Moderate
Bantayan	0.5	Moderate
Barili	0.5	Moderate
Bogo City	0.5	Moderate
Boljoon	0.5	Moderate
Borbon	0.5	Moderate
Carcar	0.5	Moderate
Carmen	0.5	Moderate
Catmon	0.5	Moderate
Compostela	0.5	Moderate
Consolacion	0.5	Moderate
Daanbantayan	0.5	Moderate
Dalaguete	0.5	Moderate
Danao City	0.5	Moderate
Dumanjug	0.5	Moderate
Ginatilan	0.5	Moderate
Liloan	0.5	Moderate
Madridejos	0.5	Moderate
Malabuyoc	0.5	Moderate
Moalboal	0.5	Moderate
Naga City	0.5	Moderate
Oslob	0.5	Moderate
Pilar	0.5	Moderate
Pinamungahan	0.5	Moderate
Ronda	0.5	Moderate
Samboan	0.5	Moderate
San Fernando	0.5	Moderate
San Remigio	0.5	Moderate
Santa Fe	0.5	Moderate
Santander	0.5	Moderate
Sibonga	0.5	Moderate
Sogod	0.5	Moderate
Tabogon	0.5	Moderate
Tabuelan	0.5	Moderate
Talisay City	0.5	Moderate
Toledo City	0.5	Moderate
Tuburan	0.5	Moderate
Cebu City	0.25	Low
Mandaue City	0.25	Low
Medellin	0.25	Low
Minglanilla	0.25	Low
Cordoba	0	Very Low
Lapu-Lapu City	0	Very Low

Appendix 3. Rice sensitivity index by ranking, municipality, and city of Cebu Province

Municipality	Sensitivity Index	
	Value	Legend
Alcantara	0.5	Very High
Aloguinsan	0.5	Very High
Barili	0.5	Very High
Bogo City	0.5	Very High
Carcar	0.5	Very High
Compostela	0.5	Very High
Consolacion	0.5	Very High
Daanbantayan	0.5	Very High
Dumanjug	0.5	Very High
Liloan	0.5	Very High
Mandaue City	0.5	Very High
Minglanilla	0.5	Very High
Naga City	0.5	Very High
Pilar	0.5	Very High
Pinamungahan	0.5	Very High
Ronda	0.5	Very High
Samboan	0.5	Very High
San Fernando	0.5	Very High
San Francisco	0.5	Very High
San Remigio	0.5	Very High
Santander	0.5	Very High
Sibonga	0.5	Very High
Tabogon	0.5	Very High
Talisay City	0.5	Very High
Alcoy	0	Low
Cordoba	0	Low
Poro	0	Low

Municipality	Sensitivity Index	
	Value	Legend
Tudela	0	Low
Alegria	-0.25	Very Low
Argao	-0.25	Very Low
Asturias	-0.25	Very Low
Badian	-0.25	Very Low
Balamban	-0.25	Very Low
Bantayan	-0.25	Very Low
Boljoon	-0.25	Very Low
Borbon	-0.25	Very Low
Carmen	-0.25	Very Low
Catmon	-0.25	Very Low
Cebu City	-0.25	Very Low
Dalaguete	-0.25	Very Low
Danao City	-0.25	Very Low
Ginatilan	-0.25	Very Low
Lapu-Lapu City	-0.25	Very Low
Madridejos	-0.25	Very Low
Malabuyoc	-0.25	Very Low
Medellin	-0.25	Very Low
Moalboal	-0.25	Very Low
Oslob	-0.25	Very Low
Santa Fe	-0.25	Very Low
Sogod	-0.25	Very Low
Tabuelan	-0.25	Very Low
Toledo City	-0.25	Very Low
Tuburan	-0.25	Very Low

Appendix 4. Banana sensitivity index by ranking, municipality, and city of Cebu Province.

Municipality	Sensitivity Index	
	Value	Legend
Poro	1	Very High
Tudela	1	Very High
Alcantara	0.5	High
Alcoy	0.5	High
Alegria	0.5	High
Argao	0.5	High
Badian	0.5	High
Barili	0.5	High
Boljoon	0.5	High
Dalaguete	0.5	High
Dumanjug	0.5	High
Ginatilan	0.5	High
Malabuyoc	0.5	High
Moalboal	0.5	High
Oslob	0.5	High
Ronda	0.5	High
Samboan	0.5	High
San Francisco	0.5	High
Sibonga	0.5	High
Aloguinsan	0.25	Moderate
Asturias	0.25	Moderate
Balamban	0.25	Moderate
Bogo City	0.25	Moderate
Borbon	0.25	Moderate
Carcar	0.25	Moderate
Carmen	0.25	Moderate
Catmon	0.25	Moderate

Municipality	Sensitivity Index	
	Value	Legend
Cebu City	0.25	Moderate
Compostela	0.25	Moderate
Consolacion	0.25	Moderate
Danao City	0.25	Moderate
Liloan	0.25	Moderate
Mandaue City	0.25	Moderate
Minglanilla	0.25	Moderate
Naga City	0.25	Moderate
Pilar	0.25	Moderate
Pinamungahan	0.25	Moderate
San Fernando	0.25	Moderate
San Remigio	0.25	Moderate
Santander	0.25	Moderate
Sogod	0.25	Moderate
Tabogon	0.25	Moderate
Toledo City	0.25	Moderate
Tuburan	0.25	Moderate
Bantayan	0	Low
Madridejos	0	Low
Medellin	0	Low
Santa Fe	0	Low
Tabuelan	0	Low
Talisay City	0	Low
Daanbantayan	-0.25	Very Low
Lapu-Lapu City	-0.25	Very Low
Cordoba	-0.5	Very Low

Appendix 5. Mango sensitivity index by ranking, municipality, and city of Cebu Province

Municipality	Sensitivity Index	
	Value	Legend
Alcantara	0.5	Very High
Aloguinsan	0.5	Very High
Argao	0.5	Very High
Barili	0.5	Very High
Carmen	0.5	Very High
Catmon	0.5	Very High
Compostela	0.5	Very High
Danao City	0.5	Very High
Dumanjug	0.5	Very High
Moalboal	0.5	Very High
Naga City	0.5	Very High
Pilar	0.5	Very High
Pinamungahan	0.5	Very High
Poro	0.5	Very High
Ronda	0.5	Very High
San Fernando	0.5	Very High
San Francisco	0.5	Very High
Sibonga	0.5	Very High
Toledo City	0.5	Very High
Tudela	0.5	Very High
Alcoy	0.25	High
Alegria	0.25	High
Asturias	0.25	High
Badian	0.25	High
Balamban	0.25	High
Bantayan	0.25	High
Bogo City	0.25	High

Municipality	Sensitivity Index	
	Value	Legend
Boljoon	0.25	High
Borbon	0.25	High
Carcar	0.25	High
Cebu City	0.25	High
Consolacion	0.25	High
Dalaguete	0.25	High
Ginatilan	0.25	High
Liloan	0.25	High
Madridejos	0.25	High
Malabuyoc	0.25	High
Mandaue City	0.25	High
Minglanilla	0.25	High
Oslob	0.25	High
Samboan	0.25	High
San Remigio	0.25	High
Santa Fe	0.25	High
Sogod	0.25	High
Tabogon	0.25	High
Tabuelan	0.25	High
Talisay City	0.25	High
Tuburan	0.25	High
Daanbantayan	0	Low
Medellin	0	Low
Santander	0	Low
Cordoba	-0.25	Very Low
Lapu-Lapu City	-0.25	Very Low

Appendix 6. Cassava sensitivity index by ranking, municipality, and city of Cebu Province

Municipality	Sensitivity Index	
	Value	Legend
Cordoba	0.5	Very High
Ginatilan	0.5	Very High
Lapu-Lapu City	0.5	Very High
Oslob	0.5	Very High
Tudela	0.5	Very High
Alcantara	0.25	High
Alcoy	0.25	High
Alegria	0.25	High
Badian	0.25	High
Boljoon	0.25	High
Carmen	0.25	High
Catmon	0.25	High
Cebu City	0.25	High
Dalaguete	0.25	High
Malabuyoc	0.25	High
Pilar	0.25	High
Poro	0.25	High
Samboan	0.25	High
Argao	0	Low
Asturias	0	Low
Balamban	0	Low
Danao City	0	Low
Dumanjug	0	Low
Moalboal	0	Low
Ronda	0	Low
San Francisco	0	Low
Sibonga	0	Low

Municipality	Sensitivity Index	
	Value	Legend
Aloguinsan	-0.25	Very Low
Bantayan	-0.25	Very Low
Barili	-0.25	Very Low
Bogo City	-0.25	Very Low
Borbon	-0.25	Very Low
Carcar	-0.25	Very Low
Compostela	-0.25	Very Low
Consolacion	-0.25	Very Low
Daanbantayan	-0.25	Very Low
Liloan	-0.25	Very Low
Madridejos	-0.25	Very Low
Mandaue City	-0.25	Very Low
Medellin	-0.25	Very Low
Minglanilla	-0.25	Very Low
Naga City	-0.25	Very Low
Pinamungahan	-0.25	Very Low
San Fernando	-0.25	Very Low
San Remigio	-0.25	Very Low
Santa Fe	-0.25	Very Low
Santander	-0.25	Very Low
Sogod	-0.25	Very Low
Tabogon	-0.25	Very Low
Tabuelan	-0.25	Very Low
Talisay City	-0.25	Very Low
Toledo City	-0.25	Very Low
Tuburan	-0.25	Very Low

Appendix 7. Sweet potato sensitivity index by ranking, municipality, and city of Cebu Province

Municipality	Sensitivity Index	
	Value	Legend
Bogo City	1	Very High
Poro	1	Very High
San Remigio	1	Very High
Tudela	1	Very High
Alcoy	0.5	High
Alegria	0.5	High
Asturias	0.5	High
Badian	0.5	High
Balamban	0.5	High
Boljoon	0.5	High
Borbon	0.5	High
Carmen	0.5	High
Catmon	0.5	High
Compostela	0.5	High
Daanbantayan	0.5	High
Dalaguete	0.5	High
Danao City	0.5	High
Ginatilan	0.5	High
Malabuyoc	0.5	High
Medellin	0.5	High
Oslob	0.5	High
Pilar	0.5	High
Samboan	0.5	High
Santa Fe	0.5	High
Sogod	0.5	High
Tabogon	0.5	High
Tabuelan	0.5	High

Municipality	Sensitivity Index	
	Value	Legend
Tuburan	0.5	High
Alcantara	0.25	Moderate
Argao	0.25	Moderate
Bantayan	0.25	Moderate
Barili	0.25	Moderate
Cebu City	0.25	Moderate
Consolacion	0.25	Moderate
Dumanjug	0.25	Moderate
Liloan	0.25	Moderate
Madridejos	0.25	Moderate
Mandaue City	0.25	Moderate
Moalboal	0.25	Moderate
Ronda	0.25	Moderate
San Francisco	0.25	Moderate
Santander	0.25	Moderate
Sibonga	0.25	Moderate
Aloguinsan	0	Low
Minglanilla	0	Low
Naga City	0	Low
Pinamungahan	0	Low
San Fernando	0	Low
Toledo City	0	Low
Carcar	-0.25	Very Low
Cordoba	-0.25	Very Low
Talisay City	-0.25	Very Low
Lapu-Lapu City	-0.5	Very Low

Appendix 8. Coffee sensitivity index by ranking, municipality, and city of Cebu Province

Municipality	Sensitivity Index	
	Value	Legend
Alcoy	0.5	Very High
Alegria	0.5	Very High
Boljoon	0.5	Very High
Catmon	0.5	Very High
Dalaguete	0.5	Very High
Ginatilan	0.5	Very High
Malabuyoc	0.5	Very High
Oslob	0.5	Very High
Tuburan	0.5	Very High
Alcantara	0.25	High
Argao	0.25	High
Asturias	0.25	High
Badian	0.25	High
Balamban	0.25	High
Borbon	0.25	High
Carmen	0.25	High
Cebu City	0.25	High
Danao City	0.25	High
Medellin	0.25	High
Moalboal	0.25	High
Pilar	0.25	High
Poro	0.25	High
Ronda	0.25	High
Samboan	0.25	High
San Francisco	0.25	High
Sogod	0.25	High
Tabuelan	0.25	High

Municipality	Sensitivity Index	
	Value	Legend
Aloguinsan	0	Moderate
Bantayan	0	Moderate
Barili	0	Moderate
Bogo City	0	Moderate
Carcar	0	Moderate
Compostela	0	Moderate
Daanbantayan	0	Moderate
Dumanjug	0	Moderate
Madridejos	0	Moderate
Minglanilla	0	Moderate
Naga City	0	Moderate
San Fernando	0	Moderate
San Remigio	0	Moderate
Santa Fe	0	Moderate
Sibonga	0	Moderate
Tabogon	0	Moderate
Toledo City	0	Moderate
Tudela	0	Moderate
Consolacion	-0.25	Low
Liloan	-0.25	Low
Mandaue City	-0.25	Low
Pinamungahan	-0.25	Low
Santander	-0.25	Low
Talisay City	-0.25	Low
Cordoba	-0.5	Very Low
Lapu-Lapu City	-0.5	Very Low

Appendix 9. Cacao sensitivity index by ranking, municipality, and city of Cebu Province

Municipality	Sensitivity Index	
	Value	Legend
Alcantara	0.5	Very High
Alegria	0.5	Very High
Argao	0.5	Very High
Asturias	0.5	Very High
Balamban	0.5	Very High
Bogo City	0.5	Very High
Boljoon	0.5	Very High
Borbon	0.5	Very High
Carmen	0.5	Very High
Catmon	0.5	Very High
Cebu City	0.5	Very High
Compostela	0.5	Very High
Daanbantayan	0.5	Very High
Danao City	0.5	Very High
Ginatilan	0.5	Very High
Medellin	0.5	Very High
Moalboal	0.5	Very High
Oslob	0.5	Very High
San Remigio	0.5	Very High
Sibonga	0.5	Very High
Sogod	0.5	Very High
Tabogon	0.5	Very High
Tabuelan	0.5	Very High
Tuburan	0.5	Very High
Alcoy	0.25	High
Aloguinsan	0.25	High
Badian	0.25	High

Municipality	Sensitivity Index	
	Value	Legend
Bantayan	0.25	High
Barili	0.25	High
Carcar	0.25	High
Consolacion	0.25	High
Dalaguete	0.25	High
Dumanjug	0.25	High
Liloan	0.25	High
Madridejos	0.25	High
Malabuyoc	0.25	High
Minglanilla	0.25	High
Naga City	0.25	High
Pinamungahan	0.25	High
Poro	0.25	High
Ronda	0.25	High
Samboan	0.25	High
San Fernando	0.25	High
San Francisco	0.25	High
Santa Fe	0.25	High
Toledo City	0.25	High
Pilar	0	Low
Santander	0	Low
Talisay City	0	Low
Tudela	0	Low
Cordoba	-0.25	Very Low
Lapu-Lapu City	-0.25	Very Low
Mandaue City	-0.25	Very Low

Appendix 10. Pinakbet sensitivity index by ranking, municipality, and city of Cebu Province

Municipality	Sensitivity Index	
	Value	Legend
Borbon	1	Very High
Mandaue City	1	Very High
Pilar	1	Very High
Tabogon	1	Very High
Alcantara	0.5	Low
Alcoy	0.5	Low
Alegria	0.5	Low
Aloguinsan	0.5	Low
Argao	0.5	Low
Asturias	0.5	Low
Badian	0.5	Low
Balamban	0.5	Low
Barili	0.5	Low
Bogo City	0.5	Low
Boljoon	0.5	Low
Carcar	0.5	Low
Carmen	0.5	Low
Catmon	0.5	Low
Cebu City	0.5	Low
Compostela	0.5	Low
Consolacion	0.5	Low
Daanbantayan	0.5	Low
Dalaguete	0.5	Low
Danao City	0.5	Low
Dumanjug	0.5	Low
Ginatilan	0.5	Low
Lapu-Lapu City	0.5	Low

Municipality	Sensitivity Index	
	Value	Legend
Liloan	0.5	Low
Malabuyoc	0.5	Low
Moalboal	0.5	Low
Naga City	0.5	Low
Oslob	0.5	Low
Pinamungahan	0.5	Low
Poro	0.5	Low
Ronda	0.5	Low
Samboan	0.5	Low
San Fernando	0.5	Low
San Francisco	0.5	Low
San Remigio	0.5	Low
Santa Fe	0.5	Low
Santander	0.5	Low
Sibonga	0.5	Low
Sogod	0.5	Low
Tabuelan	0.5	Low
Talisay City	0.5	Low
Toledo City	0.5	Low
Tuburan	0.5	Low
Bantayan	0.25	Very Low
Cordoba	0.25	Very Low
Madridejos	0.25	Very Low
Medellin	0.25	Very Low
Minglanilla	0.25	Very Low
Tudela	0.25	Very Low

Appendix 11. Chopsuey sensitivity index by ranking, municipality, and city of Cebu Province

Municipality	Sensitivity Index	
	Value	Legend
Alcantara	0.5	Very High
Alcoy	0.5	Very High
Alegria	0.5	Very High
Argao	0.5	Very High
Badian	0.5	Very High
Boljoon	0.5	Very High
Cebu City	0.5	Very High
Daanbantayan	0.5	Very High
Dalaguete	0.5	Very High
Ginatilan	0.5	Very High
Malabuyoc	0.5	Very High
Moalboal	0.5	Very High
Oslob	0.5	Very High
Samboan	0.5	Very High
San Remigio	0.5	Very High
Aloguinsan	0.25	High
Asturias	0.25	High
Balamban	0.25	High
Bantayan	0.25	High
Barili	0.25	High
Bogo City	0.25	High
Borbon	0.25	High
Carmen	0.25	High
Catmon	0.25	High
Compostela	0.25	High
Consolacion	0.25	High
Cordoba	0.25	High

Municipality	Sensitivity Index	
	Value	Legend
Danao City	0.25	High
Dumanjug	0.25	High
Liloan	0.25	High
Mandaue City	0.25	High
Minglanilla	0.25	High
Naga City	0.25	High
Pilar	0.25	High
Pinamungahan	0.25	High
Poro	0.25	High
Ronda	0.25	High
Santander	0.25	High
Sibonga	0.25	High
Sogod	0.25	High
Tabogon	0.25	High
Tabuelan	0.25	High
Talisay City	0.25	High
Toledo City	0.25	High
Tuburan	0.25	High
Tudela	0.25	High
Carcar	0	Low
Lapu-Lapu City	0	Low
Madridejos	0	Low
San Fernando	0	Low
Santa Fe	0	Low
Medellin	-0.25	Very Low
San Francisco	-0.25	Very Low

Appendix 12. Percentage contribution of bio-climatic indicators to the sensitivity level of crops in Cebu Province

Sensitivity Variable	**S. Potato**	**Rice**	**Pinakbet**	**Mango**	**Corn**	**Coffee**	**Chopsuey**	**Cassava**	**Cacao**	**Banana**
Annual Mean Temperature (BIO1)	0.1	0	0.0	0.1	0.0	0.3	11.5	0	0.2	0
Mean Diurnal Range (BIO2)	25.4	12.5	14.7	15.1	19.3	2.8	3.8	30.9	11.6	24.1
Isothermality (BIO3)	8.6	8.5	12.7	32.7	5	6.4	0.8	11.3	16.7	1.7
Temperature Seasonality (BIO4)	0.9	1.1	0.2	0.9	0.4	0.9	0.2	0.4	0.1	0.4
Max Temperature of Warmest Month (BIO5)	1.3	9.1	0.2	0.8	0.7	0.4	3.8	1.4	0.5	0.3
Min Temperature of Coldest Month (BIO6)	0.1	0.1	0.2	0.1	0	0.8	3.1	0	0.6	0
Temperature Annual Range (BIO7)	0.6	16.8	0.2	0.5	0.1	1.5	0.5	0.7	1.7	0.4
Mean Temperature of Wettest Quarter (BIO8)	0.2	0.1	0.2	0.3	0	0.1	0.4	0.2	0	0
Mean Temperature of Driest Quarter (BIO9)	2.3	5.1	7.1	2.2	4.1	11.8	3.4	1.2	1.8	2.4
Mean Temperature of Warmest Quarter (BIO10)	0.1	0.8	0.6	0.1	0	0.2	1.5	0.1	0.2	0
Mean Temperature of Coldest Quarter (BIO11)	0.1	0.4	0.1	0.1	0	0.4	0.8	0.1	0	0.1
Annual Precipitation (BIO12)	1.7	1.3	0.6	12.3	1.2	1	0.3	1.8	1.1	1.3
Precipitation of Wettest Month (BIO13)	0.6	0.8	3.2	0.5	1.6	4.7	1	0.2	0.5	1.6
Precipitation of Driest Month (BIO12)	7.3	6.9	6.2	6.8	7.7	6.5	0.2	6.9	8.6	10.8

Sensitivity Variable	**S. Potato**	**Rice**	**Pinakbet**	**Mango**	**Corn**	**Coffee**	**Chopsuey**	**Cassava**	**Cacao**	**Banana**
Precipitation Seasonality (BIO15)	8.8	27	2.1	0.9	3.2	23	4.6	4.3	1.1	1.6
Precipitation of Wettest Quarter (BIO16)	23.8	0.8	27.9	11.5	29.7	12.9	16.8	23.5	33.3	31.3
Precipitation of Driest Quarter (BIO17)	1.9	0.9	1.8	0.5	3.1	1.5	1	1.2	0.8	4.4
Precipitation of Driest Quarter (BIO18)	2.4	0.6	1.7	1.3	2	2.1	0.8	1.7	2.9	2.1
Precipitation of Coldest Quarter (BIO19)	7.3	6.9	19.5	12.3	20.6	17.8	21.3	13.5	18	17.5
cons_dry_months_v2 (BIO20)	1.8	0.1	0.8	0.8	0.6	4.9	24.1	0.3	0.2	0

Appendix 13. Hazard index, hazard category by ranking of municipalities and cities in Cebu Province

Municipality	Hazard Index	Category	Natural Hazard							
			Typhoon	Soil Erosion	Flooding	Landslide	Salt-Water Intrusion	Sea-Level Rise	Storm Surge	Drought
Pinamungahan	1.00	Very High	0.31	0.73	0.35	0.60	0.33	0.66	0.46	0.43
Balamban	0.94	Very High	0.44	0.86	0.28	0.88	0.52	0.36	0.48	0.00
Toledo City	0.94	Very High	0.32	0.66	0.33	0.78	0.78	0.60	0.58	0.04
Tuburan	0.87	Very High	0.61	0.76	0.18	0.74	0.53	0.43	0.36	0.03
Tudela	0.84	Very High	0.76	0.29	0.07	0.65	0.00	0.05	0.00	1.00
Cebu City	0.81	Very High	0.44	0.84	0.07	0.86	1.00	0.04	0.40	0.00
Asturias	0.77	High	0.55	0.83	0.16	1.00	0.01	0.31	0.32	0.00
Medellin	0.77	High	0.84	0.28	0.41	0.24	0.00	0.16	0.68	0.19
Tabogon	0.74	High	0.66	0.71	0.12	0.65	0.00	0.02	0.03	0.51
Carmen	0.71	High	0.64	0.62	0.09	0.79	0.00	0.22	0.22	0.25
San Remigio	0.71	High	0.66	0.49	0.14	0.52	0.34	0.13	0.27	0.34
Daanbantayan	0.68	High	0.83	0.30	0.11	0.37	0.00	0.42	0.54	0.19
Mandaue City	0.68	High	0.42	0.04	1.00	0.22	0.72	0.14	0.35	0.00
Bogo City	0.65	High	0.77	0.45	0.17	0.42	0.00	0.12	0.29	0.29
Borbon	0.65	High	0.45	0.72	0.12	0.57	0.00	0.03	0.04	0.60
Danao City	0.65	High	0.56	0.76	0.02	0.80	0.00	0.29	0.30	0.12
Lapu-Lapu City	0.58	Moderate	0.35	0.00	0.10	0.31	0.49	1.00	1.00	0.00
Madridejos	0.58	Moderate	1.00	0.03	0.81	0.05	0.00	0.19	0.00	0.00
Talisay City	0.58	Moderate	0.37	0.66	0.26	0.67	0.60	0.00	0.29	0.00
Catmon	0.55	Moderate	0.63	0.85	0.04	0.84	0.00	0.04	0.06	0.00
Samboan	0.55	Moderate	0.00	0.74	0.01	0.68	0.00	0.00	0.03	0.00
Liloan	0.52	Moderate	0.43	0.44	0.33	0.59	0.00	0.18	0.22	0.19
Aloguinsan	0.48	Moderate	0.25	1.00	0.14	0.62	0.06	0.07	0.04	0.21
Carcar	0.45	Moderate	0.19	0.64	0.19	0.65	0.00	0.40	0.41	0.03
Consolacion	0.45	Moderate	0.46	0.44	0.37	0.55	0.16	0.12	0.13	0.04
Minglanilla	0.45	Moderate	0.34	0.86	0.07	0.83	0.27	0.03	0.11	0.00
Naga City	0.45	Moderate	0.30	0.99	0.09	0.80	0.00	0.04	0.17	0.00
Tabuelan	0.45	Moderate	0.41	0.81	0.13	0.70	0.17	0.05	0.07	0.00
Moalboal	0.39	Low	0.08	0.59	0.48	0.63	0.00	0.20	0.22	0.01
Oslob	0.39	Low	0.00	0.85	0.02	0.72	0.00	0.03	0.06	0.00

Municipality	Hazard Index	Category	Natural Hazard							
			Typhoon	Soil Erosion	Flooding	Landslide	Salt-Water Intrusion	Sea-Level Rise	Storm Surge	Drought
Santander	0.39	Low	0.00	0.65	0.00	0.62	0.00	0.01	0.04	0.00
Bantayan	0.35	Low	0.84	0.11	0.43	0.20	0.00	0.08	0.00	0.00
Compostela	0.35	Low	0.49	0.63	0.08	0.73	0.00	0.03	0.11	0.00
San Fernando	0.35	Low	0.27	0.92	0.02	0.81	0.00	0.04	0.07	0.00
Santa Fe	0.35	Low	0.85	0.09	0.57	0.13	0.00	0.00	0.00	0.00
Sogod	0.35	Low	0.46	0.79	0.08	0.69	0.00	0.01	0.02	0.00
Alcoy	0.32	Low	0.07	0.79	0.00	0.95	0.00	0.01	0.03	0.26
Boljoon	0.32	Low	0.00	0.86	0.02	0.91	0.00	0.01	0.02	0.31
Poro	0.32	Low	0.67	0.41	0.16	0.49	0.00	0.03	0.00	0.06
Ronda	0.32	Low	0.15	0.66	0.08	0.77	0.00	0.08	0.06	0.25
Barili	0.29	Low	0.16	0.95	0.05	0.59	0.00	0.18	0.11	0.01
Dalaguete	0.29	Low	0.07	0.86	0.01	0.90	0.00	0.01	0.07	0.12
Dumanjug	0.29	Low	0.15	0.70	0.14	0.65	0.00	0.14	0.09	0.10
Pilar	0.29	Low	0.79	0.30	0.00	0.61	0.00	0.02	0.00	0.00
Alcantara	0.26	Low	0.12	0.73	0.18	0.70	0.00	0.09	0.08	0.03
Argao	0.26	Low	0.11	0.86	0.03	0.68	0.00	0.08	0.22	0.04
Sibonga	0.23	Low	0.15	0.73	0.05	0.64	0.00	0.19	0.21	0.00
Badian	0.19	Very Low	0.08	0.59	0.05	0.71	0.11	0.11	0.09	0.13
San Francisco	0.16	Very Low	0.55	0.29	0.15	0.45	0.00	0.03	0.00	0.01
Alegria	0.10	Very Low	0.05	0.80	0.01	0.76	0.00	0.00	0.02	0.00
Ginatilan	0.10	Very Low	0.00	0.79	0.04	0.71	0.00	0.00	0.03	0.00
Malabuyoc	0.10	Very Low	0.00	0.84	0.03	0.68	0.00	0.00	0.02	0.03
Cordoba	0.00	Very Low	0.41	0.00	0.06	0.33	0.00	0.17	0.24	0.00

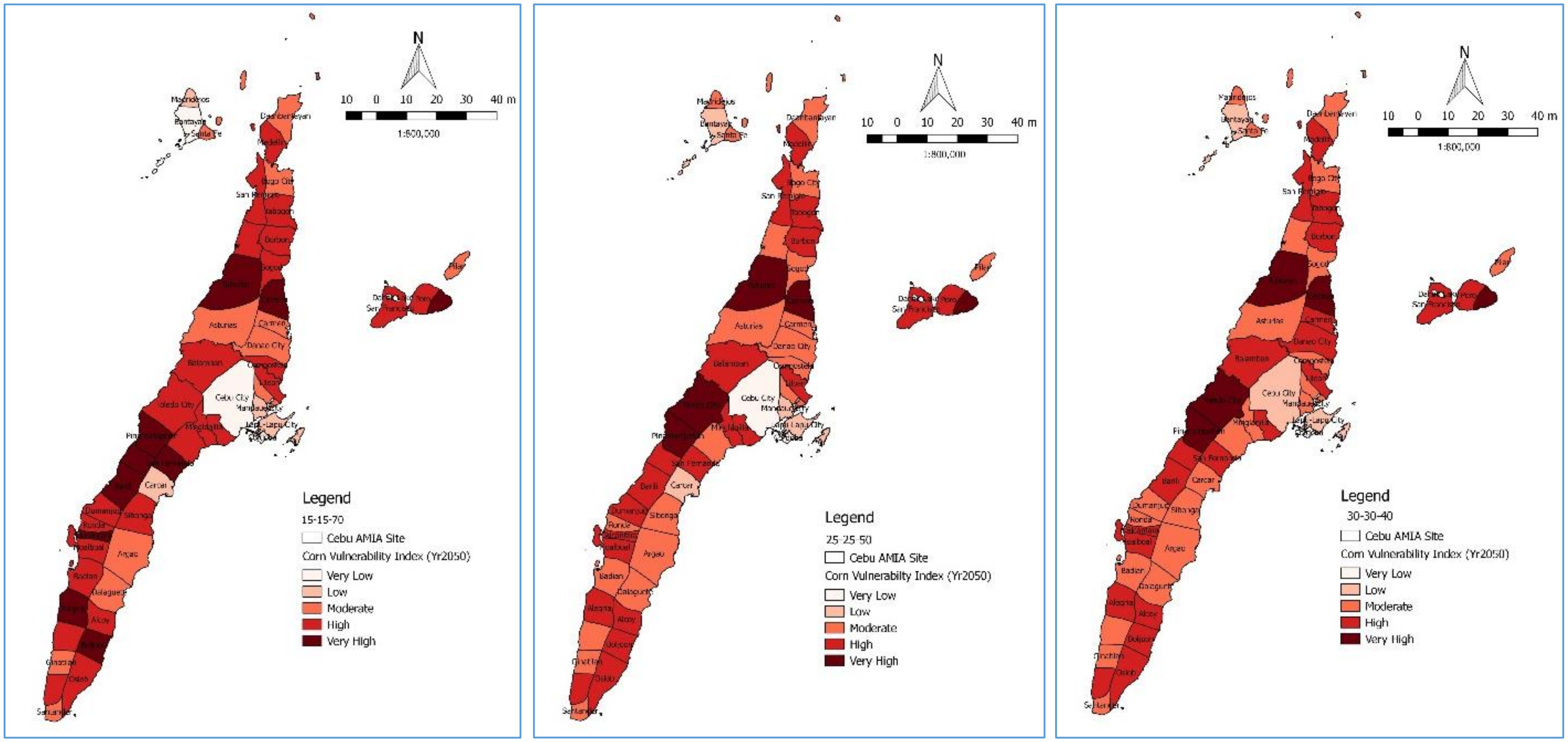
Source: Mines and Geosciences Bureau (MGB) Region 7 for the hazard

Appendix 14. Adaptive capacity capital index ranking (lowest to highest) of cities and municipalities in Cebu Province

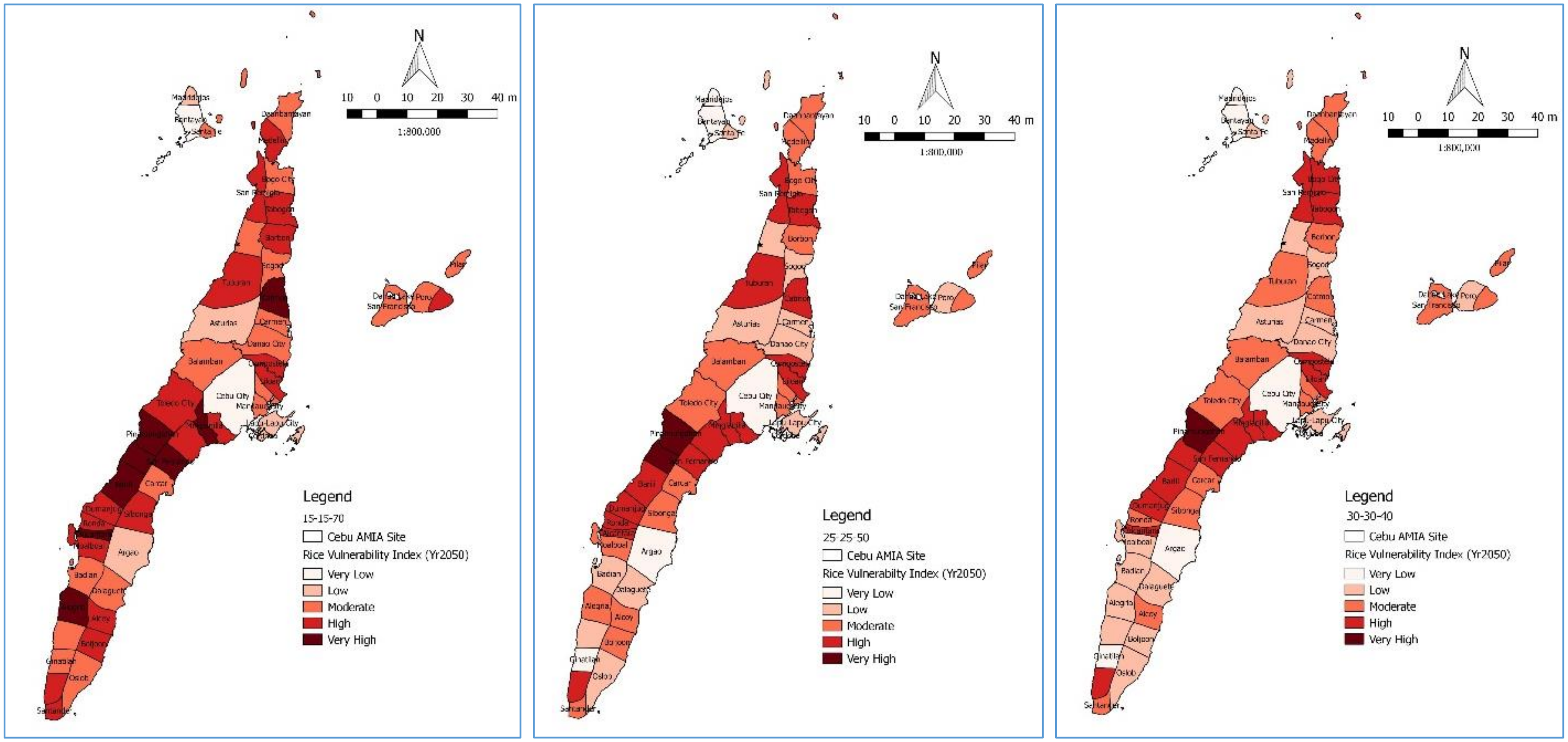
Municipality	Index Value	Category	Capitals							
			Economic	Natural	Social	Human	Health	Physical	Anticipatory	Institutional
Alegria	1.00	Very Low	0.00	0.09	0.35	0.22	0.25	0.06	0.00	0.15
Catmon	0.95	Very Low	0.19	0.07	0.44	0.20	0.10	0.09	0.19	0.02
Pinamungahan	0.85	Very Low	0.14	0.15	0.38	0.00	0.18	0.05	0.38	0.44
Aloguinsan	0.84	Very Low	0.18	0.09	0.32	0.19	0.14	0.40	0.13	0.32
Boljoon	0.84	Very Low	0.03	0.14	0.27	0.19	0.24	0.19	0.38	0.32
Alcantara	0.83	Very Low	0.16	0.20	0.38	0.19	0.18	0.25	0.38	0.07
Barili	0.83	Very Low	0.24	0.05	0.25	0.26	0.19	0.17	0.38	0.24
San Fernando	0.81	Very Low	0.30	0.04	0.51	0.22	0.04	0.27	0.38	0.13
Tuburan	0.80	Low	0.31	0.09	0.56	0.13	0.29	0.22	0.19	0.13
Minglanilla	0.79	Low	0.68	0.15	0.28	0.27	0.09	0.08	0.31	0.10
Alcoy	0.77	Low	0.21	0.13	0.43	0.20	0.25	0.10	0.31	0.39
Malabuyoc	0.77	Low	0.02	0.22	0.50	0.21	0.19	0.29	0.07	0.54
Moalboal	0.77	Low	0.27	0.07	0.40	0.22	0.13	0.48	0.38	0.10
Dumanjug	0.73	Low	0.19	0.11	0.43	0.10	0.20	0.39	0.41	0.37
Oslob	0.71	Low	0.27	0.05	0.66	0.20	0.08	0.00	0.35	0.66
Samboan	0.71	Low	0.21	0.43	0.00	0.23	0.18	0.38	0.41	0.45
Badian	0.70	Low	0.15	0.18	0.95	0.22	0.20	0.17	0.00	0.43
Talisay City	0.70	Low	0.72	0.07	0.28	0.32	0.11	0.16	0.50	0.17
Sibonga	0.69	Low	0.23	0.13	0.98	0.22	0.04	0.29	0.38	0.09
Borbon	0.68	Low	0.16	0.66	0.42	0.11	0.23	0.37	0.38	0.08
Compostela	0.68	Low	0.19	0.01	0.64	0.20	0.08	0.11	0.49	0.66
Ronda	0.67	Low	0.13	0.13	0.59	0.20	0.15	0.38	0.47	0.38
Sogod	0.66	Low	0.11	0.13	0.70	0.10	0.17	0.43	0.38	0.44
Toledo City	0.66	Low	0.75	0.07	0.74	0.17	0.30	0.04	0.25	0.17
Medellin	0.65	Low	0.19	0.70	0.30	0.12	0.17	0.40	0.38	0.24
Tudela	0.63	Low	0.21	0.10	0.95	0.21	0.20	0.10	0.44	0.37

Municipality	Index Value	Category	Capitals							
			Economic	Natural	Social	Human	Health	Physical	Anticipatory	Institutional
San Remigio	0.62	Low	0.22	0.41	0.71	0.12	0.25	0.28	0.33	0.31
Tabogon	0.62	Low	0.15	0.21	0.58	0.26	0.09	0.72	0.34	0.28
Liloan	0.61	Low	0.80	0.00	0.27	0.20	0.14	0.26	0.44	0.55
Naga City	0.60	Moderate	0.69	0.11	0.49	0.17	0.37	0.47	0.38	0.05
Santander	0.60	Moderate	0.25	0.41	0.48	0.19	0.04	0.40	0.44	0.51
Tabuelan	0.60	Moderate	0.23	0.41	0.45	0.00	0.24	0.29	0.38	0.72
Dalaguete	0.59	Moderate	0.40	0.14	0.95	0.05	0.28	0.45	0.25	0.24
Ginatilan	0.59	Moderate	0.09	0.16	0.88	0.42	0.13	0.28	0.13	0.68
San Francisco	0.57	Moderate	0.31	0.31	0.77	0.03	0.34	0.47	0.44	0.17
Santa Fe	0.57	Moderate	0.22	0.50	0.62	0.02	0.37	0.54	0.44	0.13
Pilar	0.56	Moderate	0.17	0.32	0.84	0.13	0.31	0.33	0.19	0.57
Balamban	0.54	Moderate	0.60	0.65	0.38	0.15	0.16	0.33	0.28	0.39
Poro	0.54	Moderate	0.22	0.30	0.89	0.20	0.23	0.38	0.44	0.29
Danao City	0.52	Moderate	0.66	0.13	0.55	0.32	0.33	0.08	0.25	0.71
Argao	0.48	Moderate	0.63	0.61	0.47	0.46	0.19	0.12	0.31	0.38
Carmen	0.47	Moderate	0.70	0.12	0.44	0.18	0.12	0.47	0.50	0.71
Bogo City	0.44	Moderate	0.73	0.34	0.54	0.14	0.22	0.37	0.50	0.51
Consolacion	0.44	Moderate	0.67	0.07	0.75	0.21	0.00	0.32	0.49	0.83
Daanbantayan	0.40	High	0.46	0.28	0.93	0.16	0.58	0.48	0.31	0.31
Lapu-Lapu	0.40	High	0.61	0.55	0.60	0.41	0.53	0.38	0.44	0.00
Asturias	0.38	High	0.41	0.17	1.00	0.10	0.34	0.13	0.44	1.00
Cordoba	0.36	High	0.29	1.00	0.35	0.21	0.13	0.55	0.44	0.69
Mandaue	0.36	High	0.84	0.15	0.16	0.38	0.69	0.44	1.00	0.01
Carcar	0.35	High	0.76	0.10	0.35	0.28	0.38	0.88	0.41	0.55
Madridejos	0.33	High	0.22	0.71	0.65	0.21	0.35	0.78	0.44	0.42
Bantayan	0.21	High	0.61	0.45	0.53	0.17	0.30	1.00	0.44	0.76
Cebu City	0.00	Very High	1.00	0.64	0.30	1.00	1.00	0.04	0.49	0.63

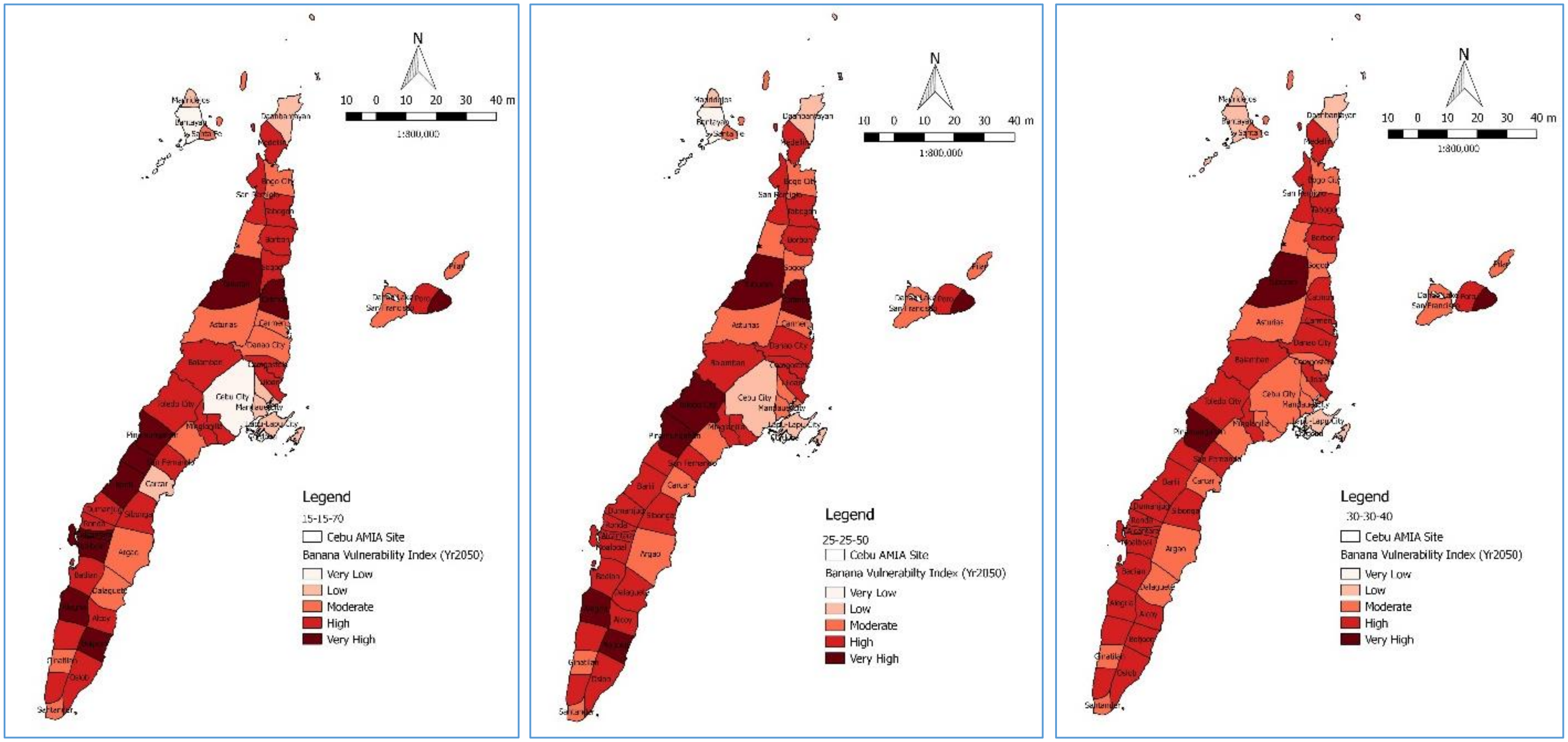
Appendix 15. Vulnerability maps of corn in year using 15-15-70, 25-25-50, 30-30-40 weight assignments of sensitivity, exposure, and adaptive capacity



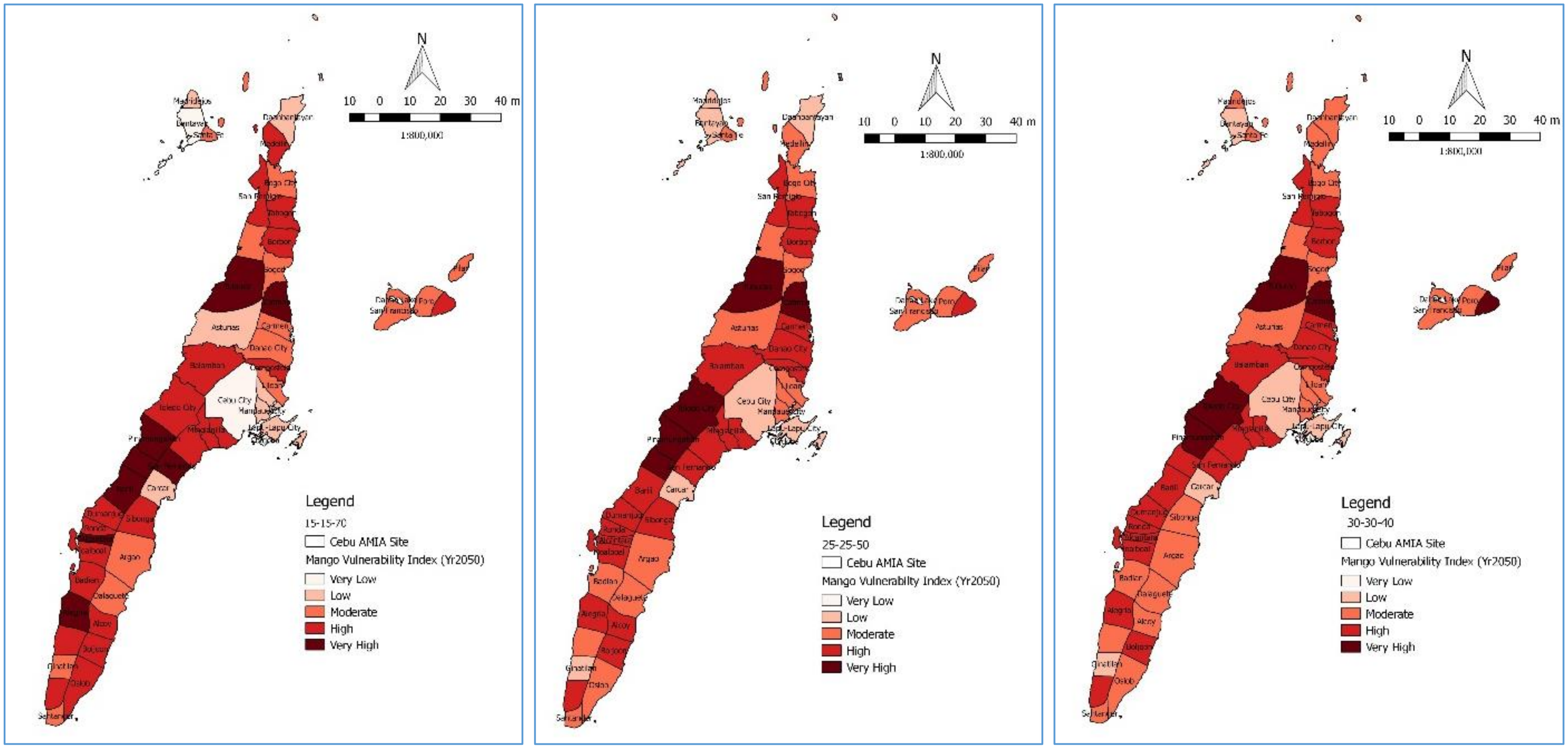
Appendix 16. Vulnerability maps of rice in year using 15:15:70, 25:25:50, 30:30:40 weight assignments of sensitivity, exposure, and adaptive capacity



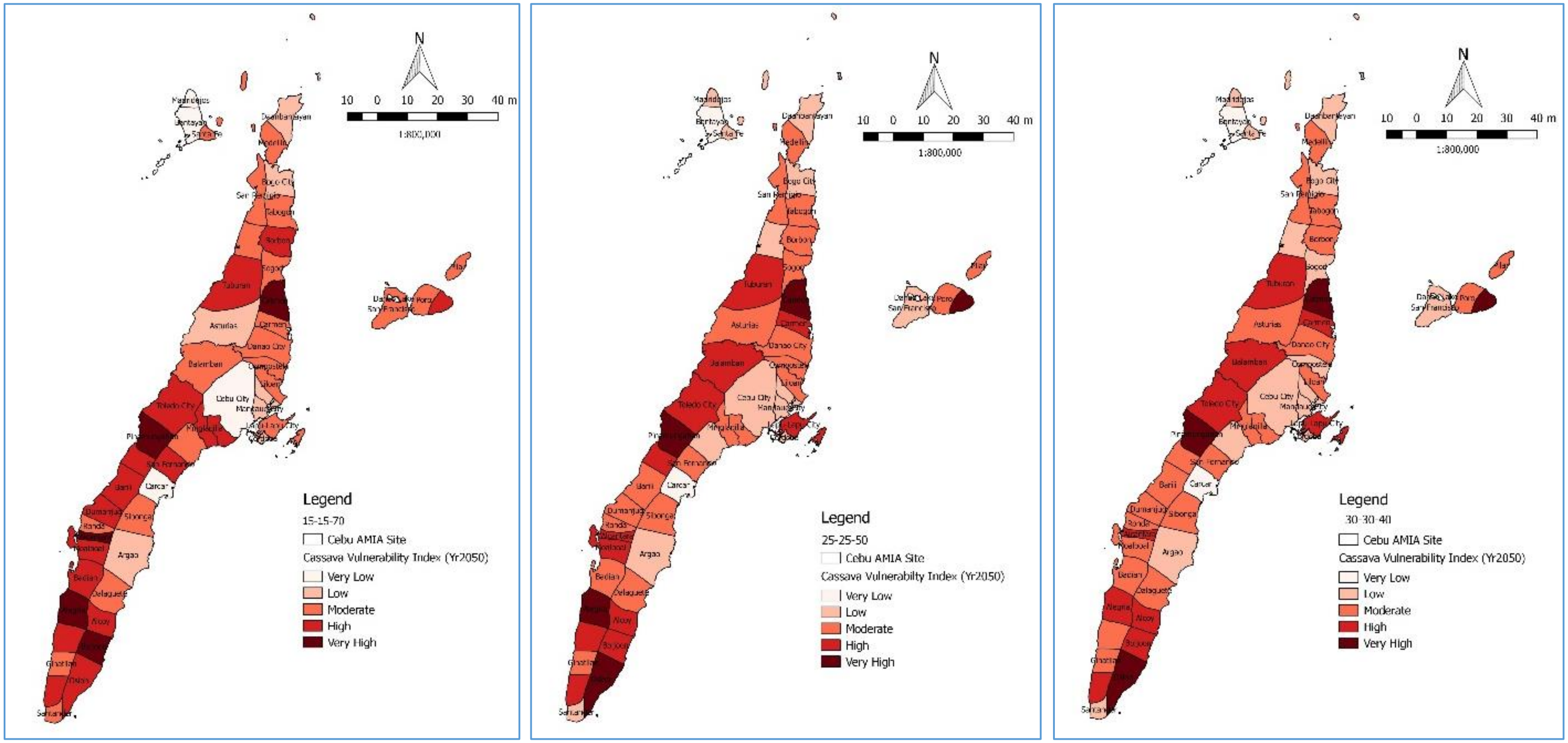
Appendix 17. Vulnerability maps of banana in year using 15:15:70, 25:25:50, 30:30:40 weight assignments of sensitivity, exposure, and adaptive capacity



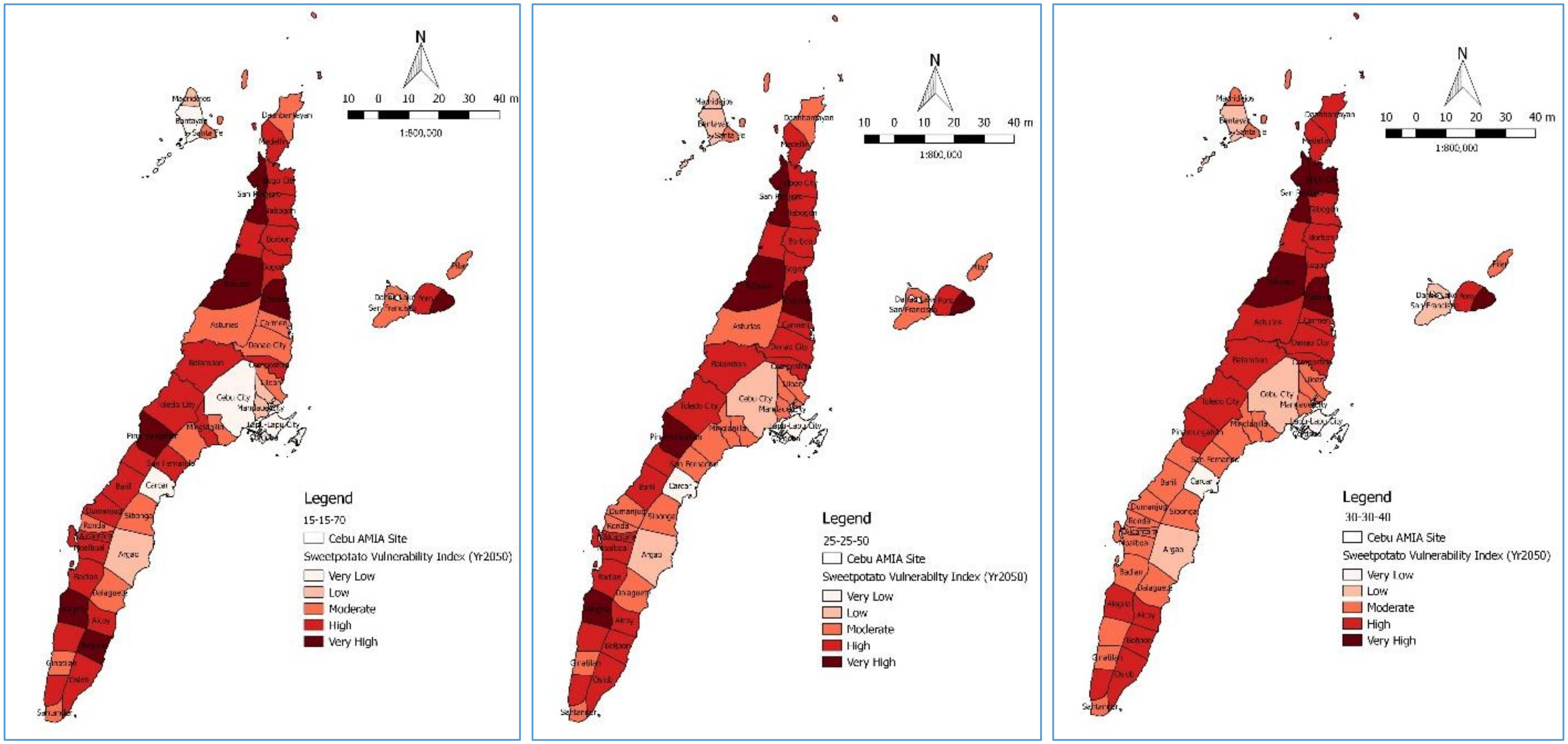
Appendix 18. Vulnerability maps of mango in year using 15:15:70, 25:25:50, 30:30:40 weight assignments of sensitivity, exposure, and adaptive capacity



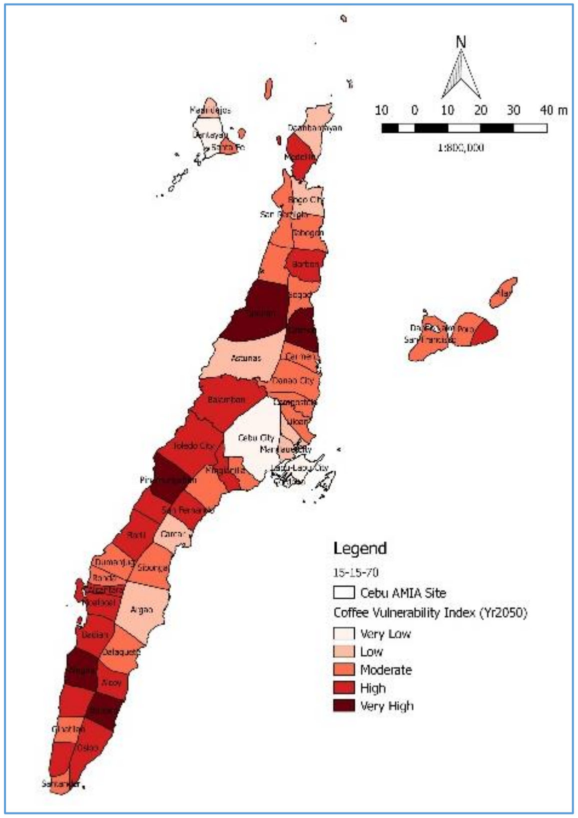
Appendix 19. Vulnerability maps of cassava in year using 15:15:70, 25:25:50, 30:30:40 weight assignments of sensitivity, exposure, and adaptive capacity

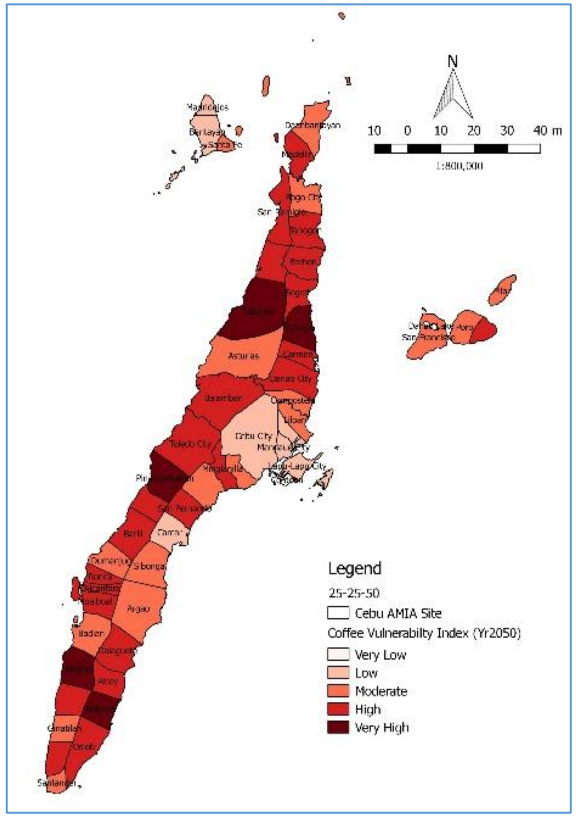


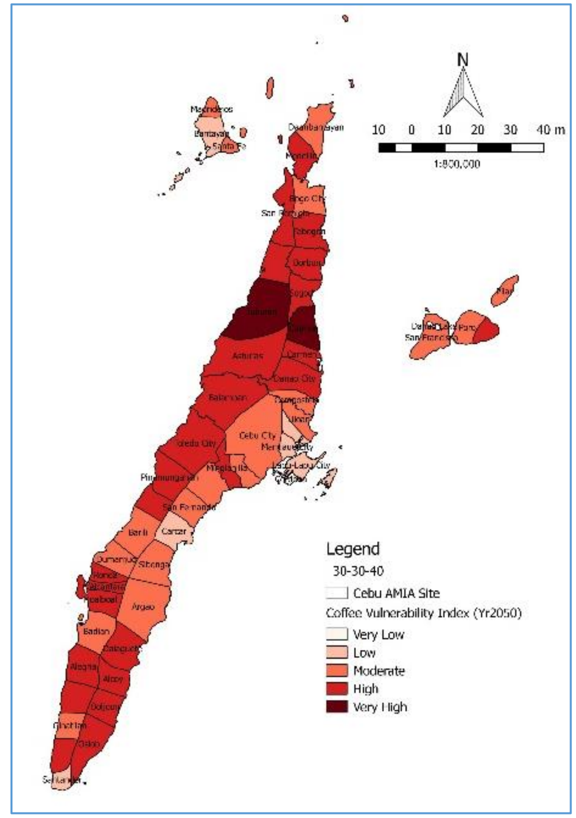
Appendix 20. Vulnerability maps of Sweet Potato in year using 15:15:70, 25:25:50, 30:30:40 weight assignments of sensitivity, exposure, and adaptive capacity



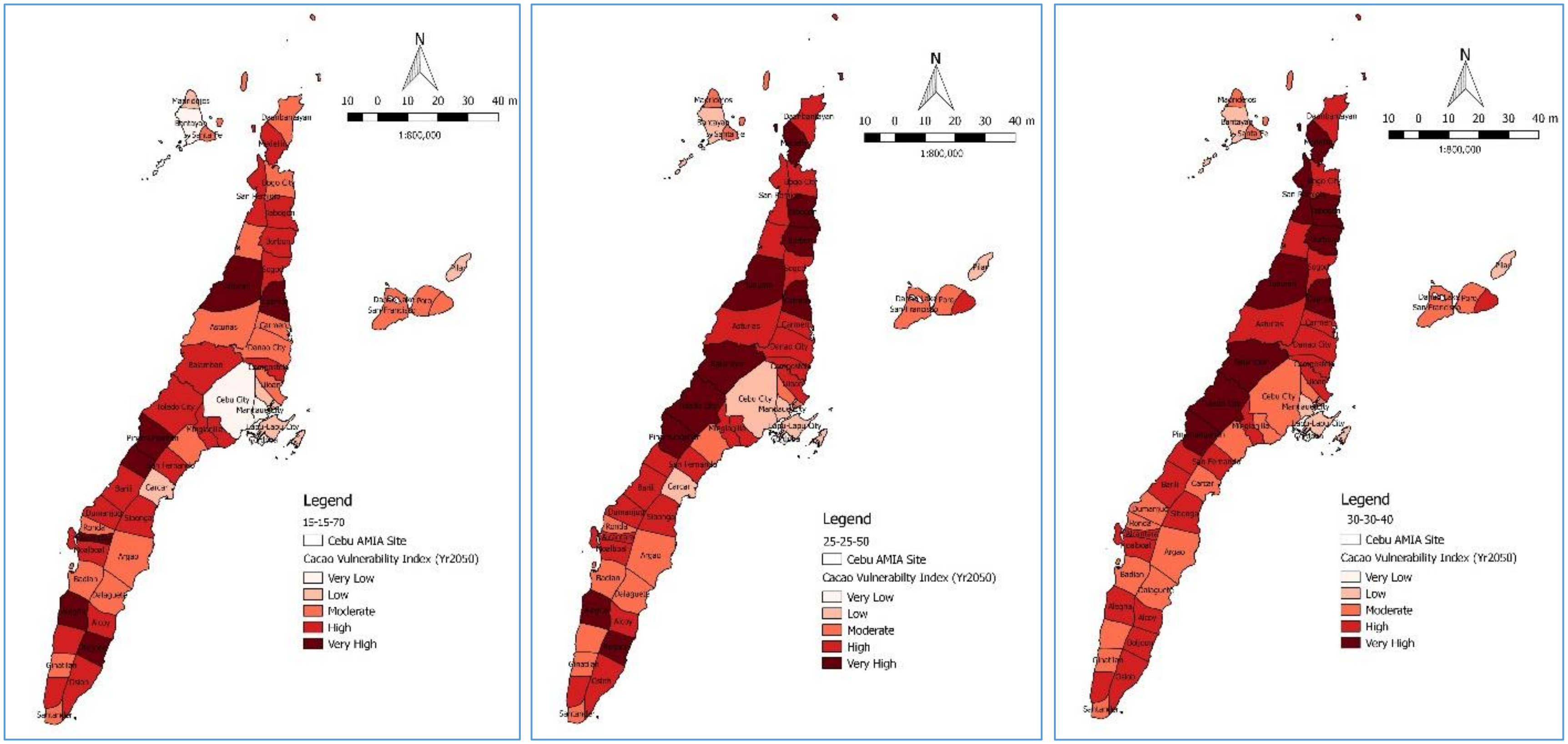
Appendix 21. Vulnerability maps of Coffee in year using 15:15:70, 25:25:50, 30:30:40 weight assignments of sensitivity, exposure, and adaptive capacity



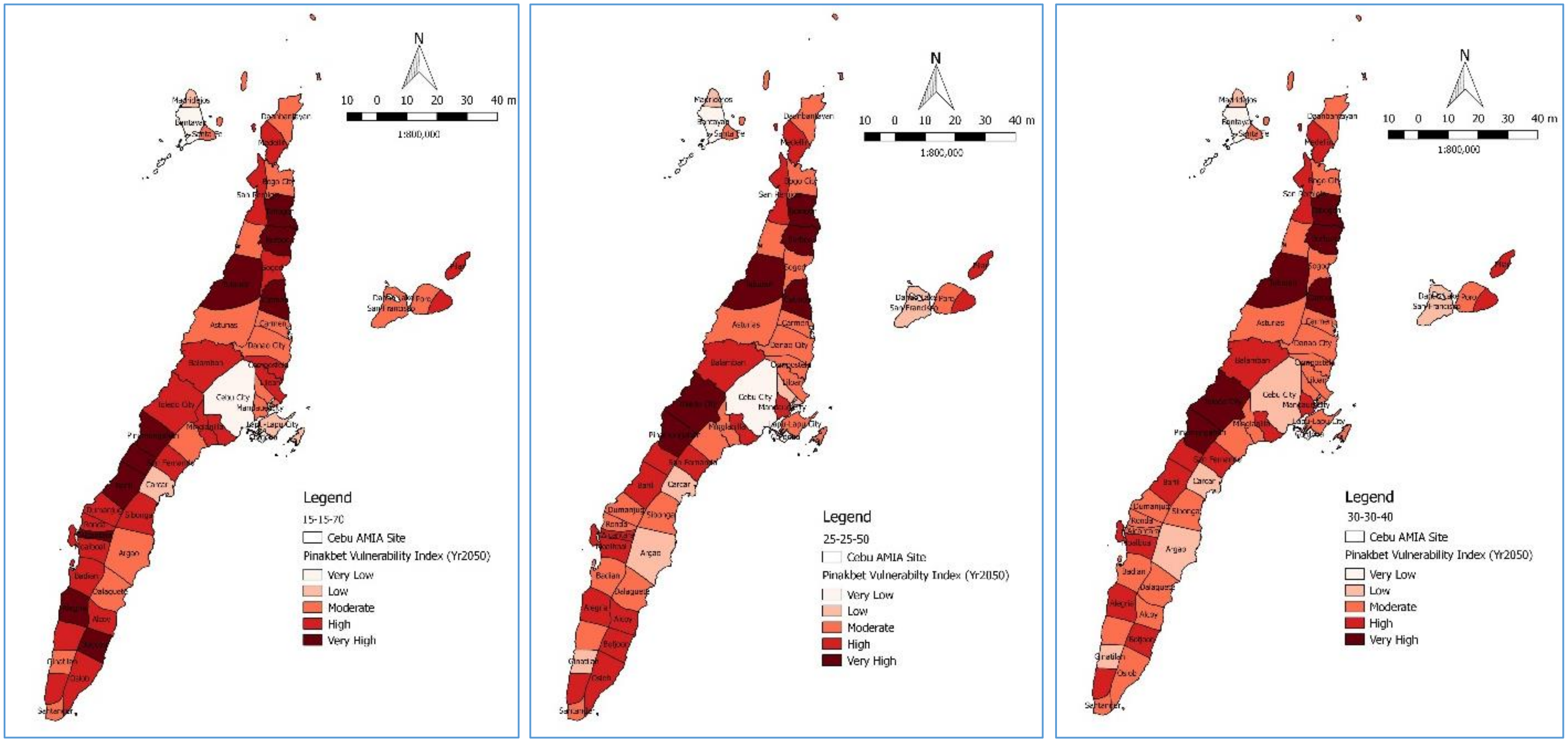




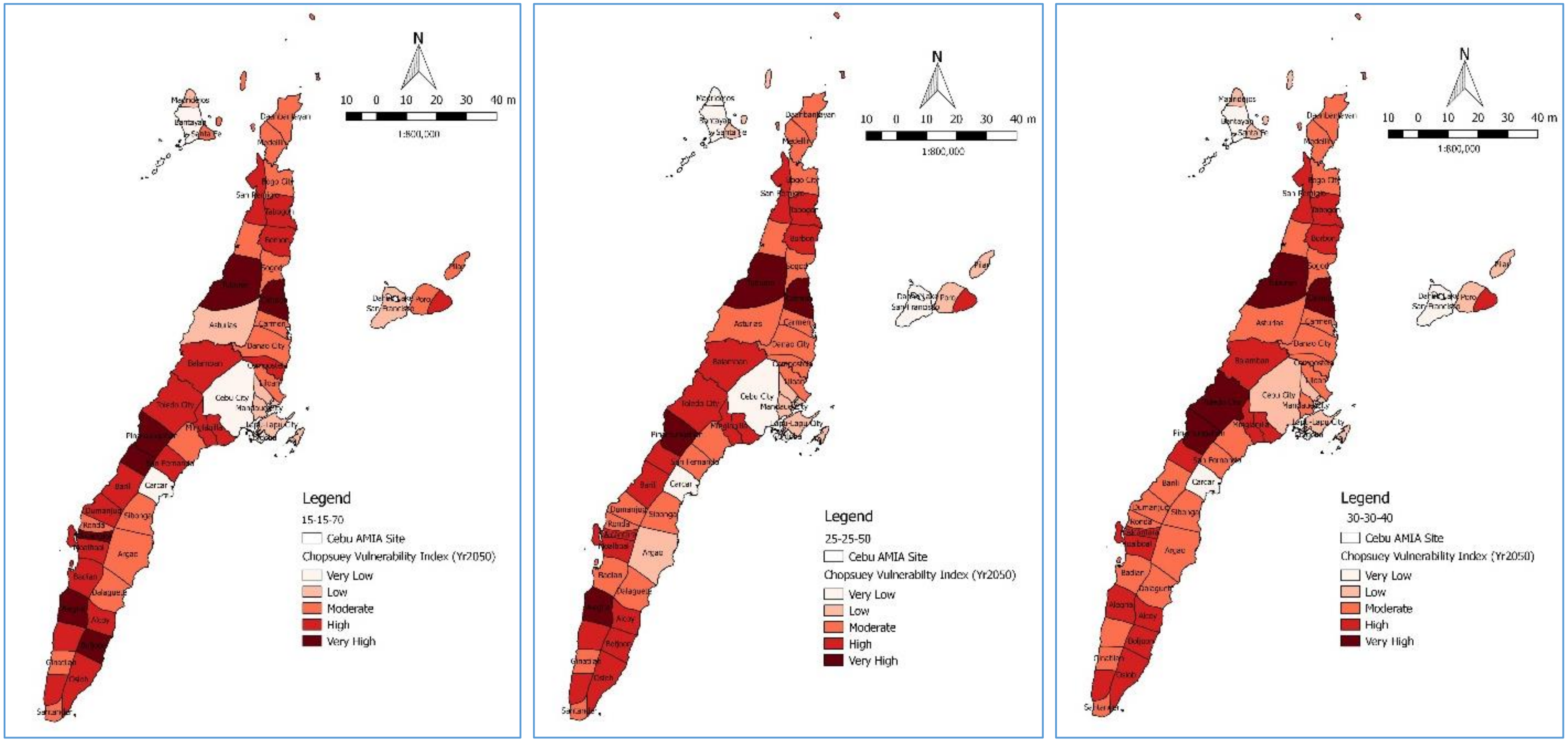
Appendix 22. Vulnerability maps of Cacao in year using 15:15:70, 25:25:50, 30:30:40 weight assignments of sensitivity, exposure, and adaptive capacity



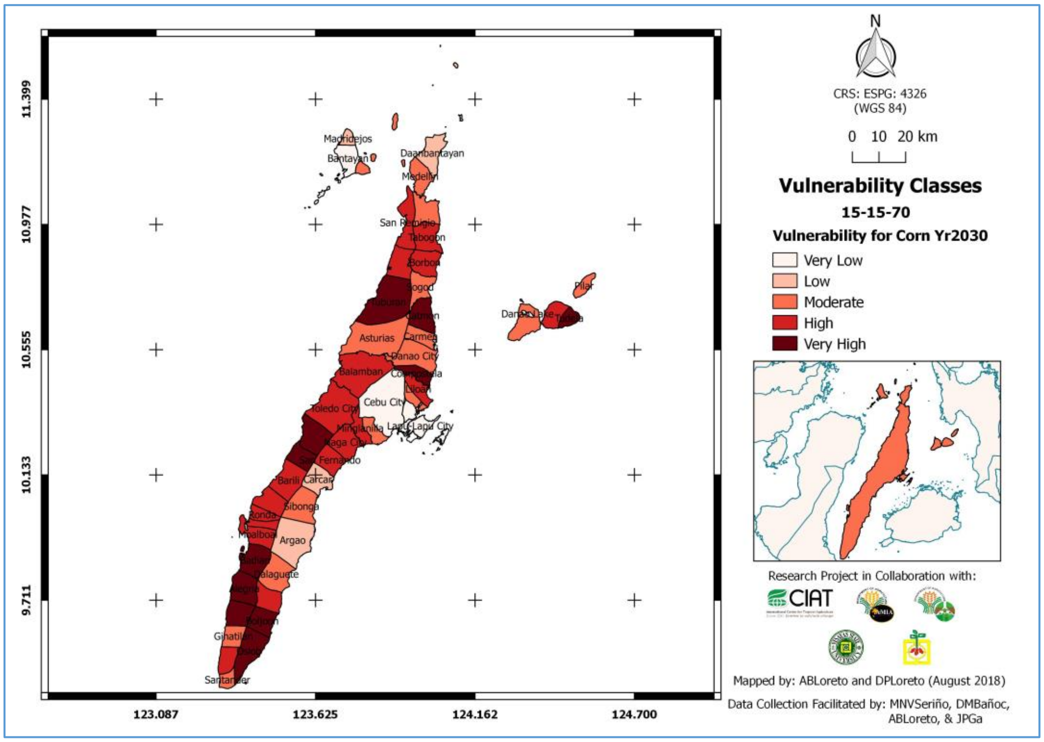
Appendix 23. Vulnerability maps of Pinakbet in year using 15:15:70, 25:25:50, 30:30:40 weight assignments of sensitivity, exposure, and adaptive capacity

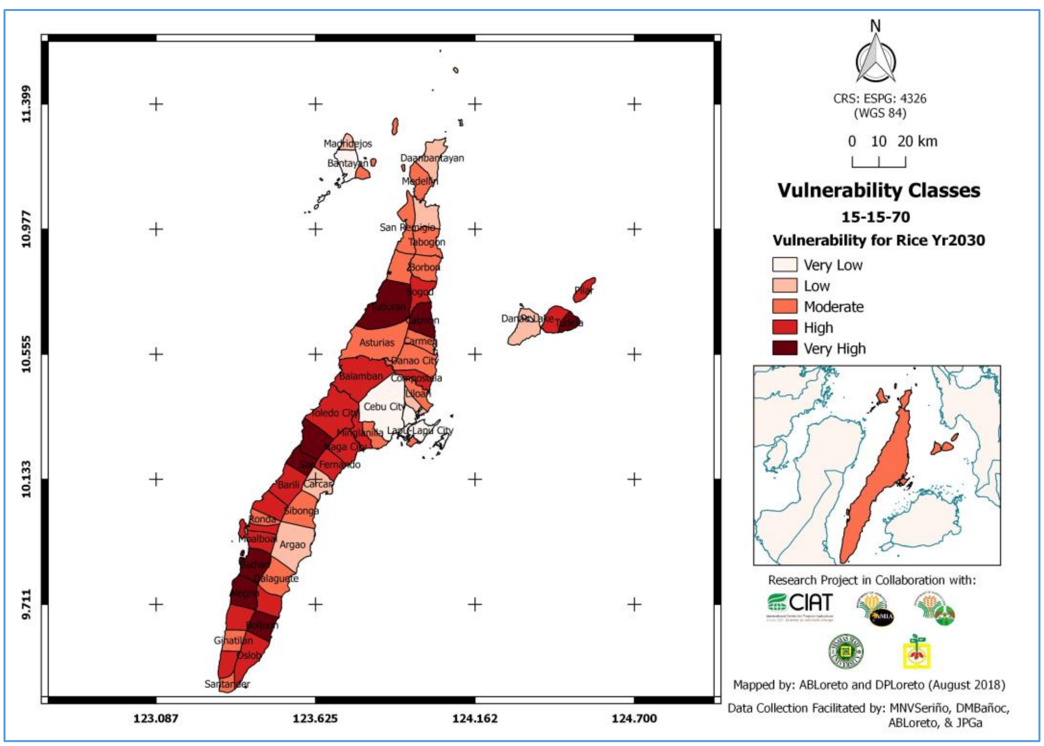


Appendix 24. Vulnerability maps of Chopsuey in year 2050 using 15:15:70, 25:25:50, 30:30:40 weight assignments of sensitivity, exposure, and adaptive capacity

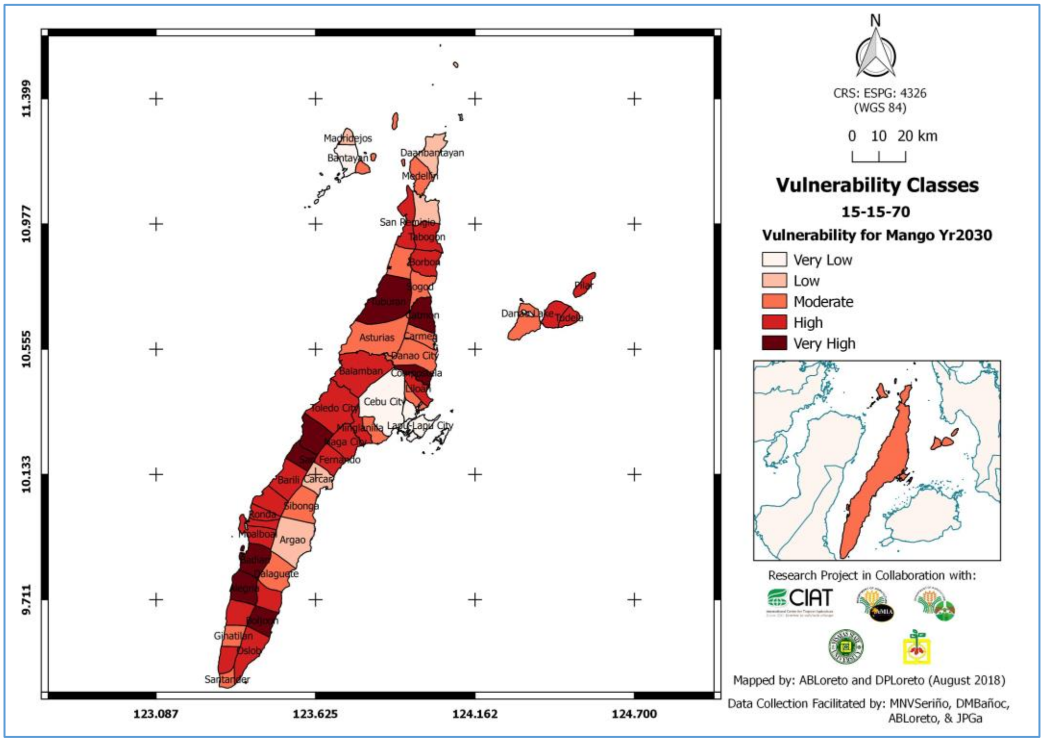


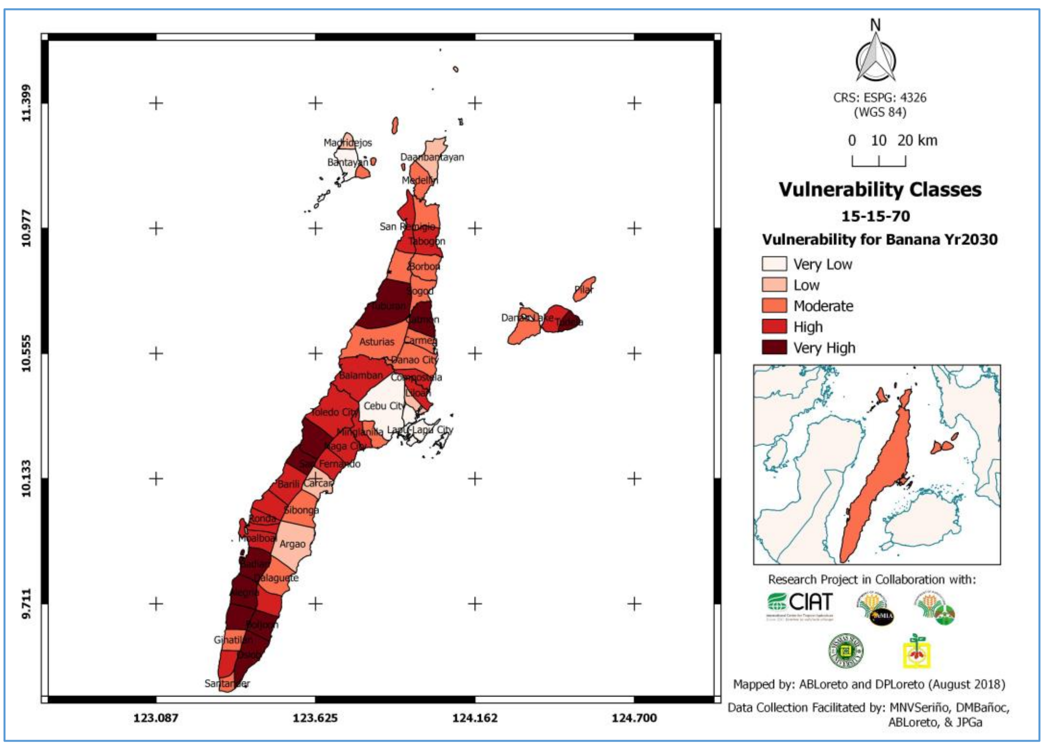
Appendix 25. Corn and Rice vulnerability in the year 2030 using 15-15-70 weight combination.



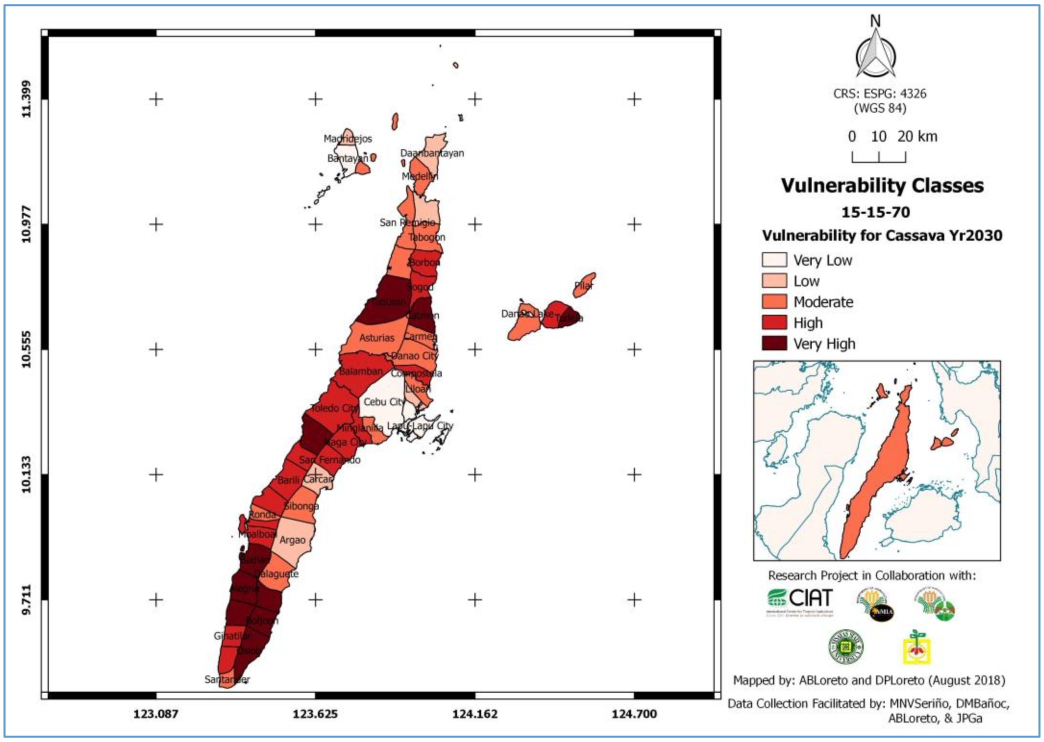


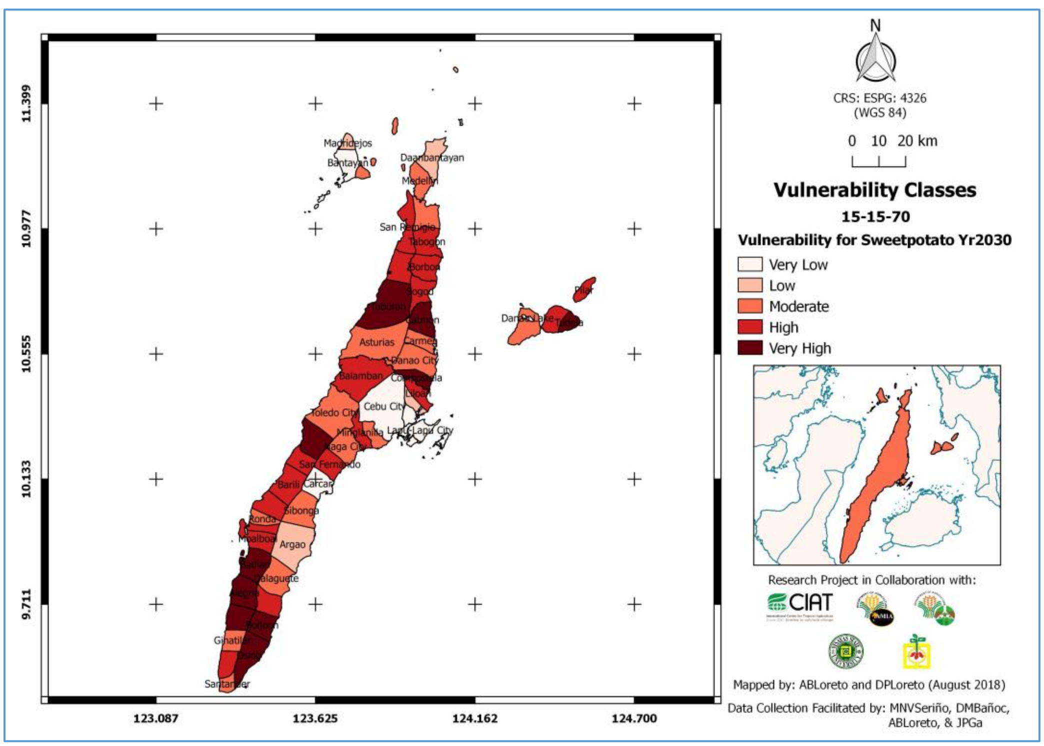
Appendix 26. Mango and Banana vulnerability in the year 2030 using 15-15-70 weight combination.



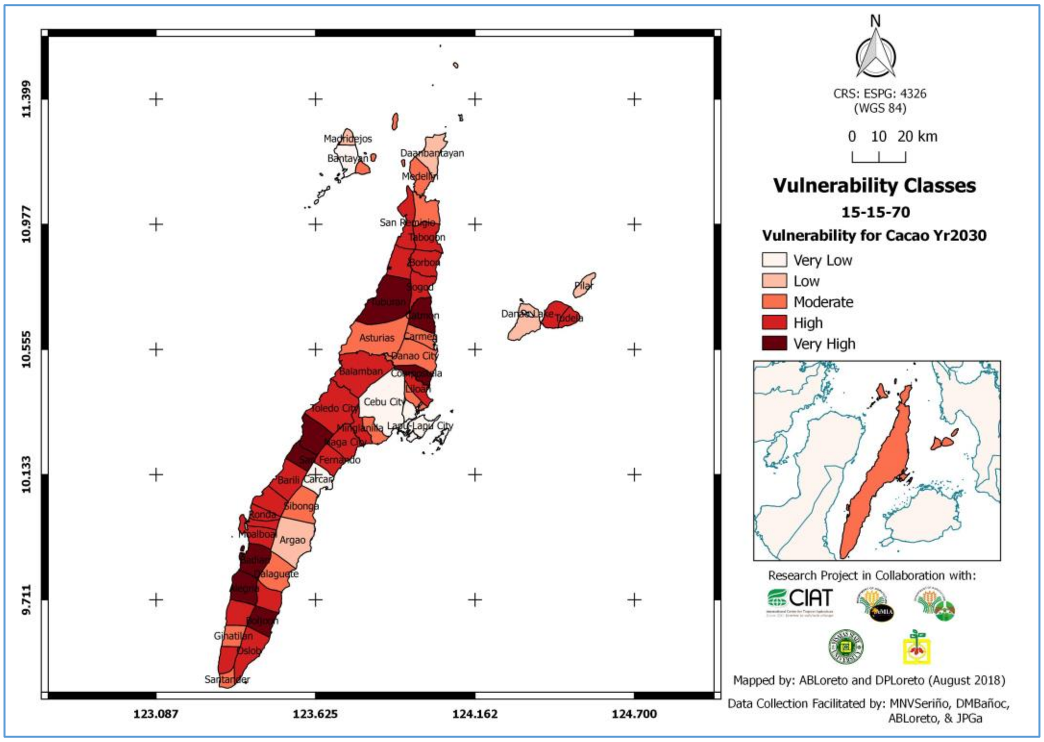


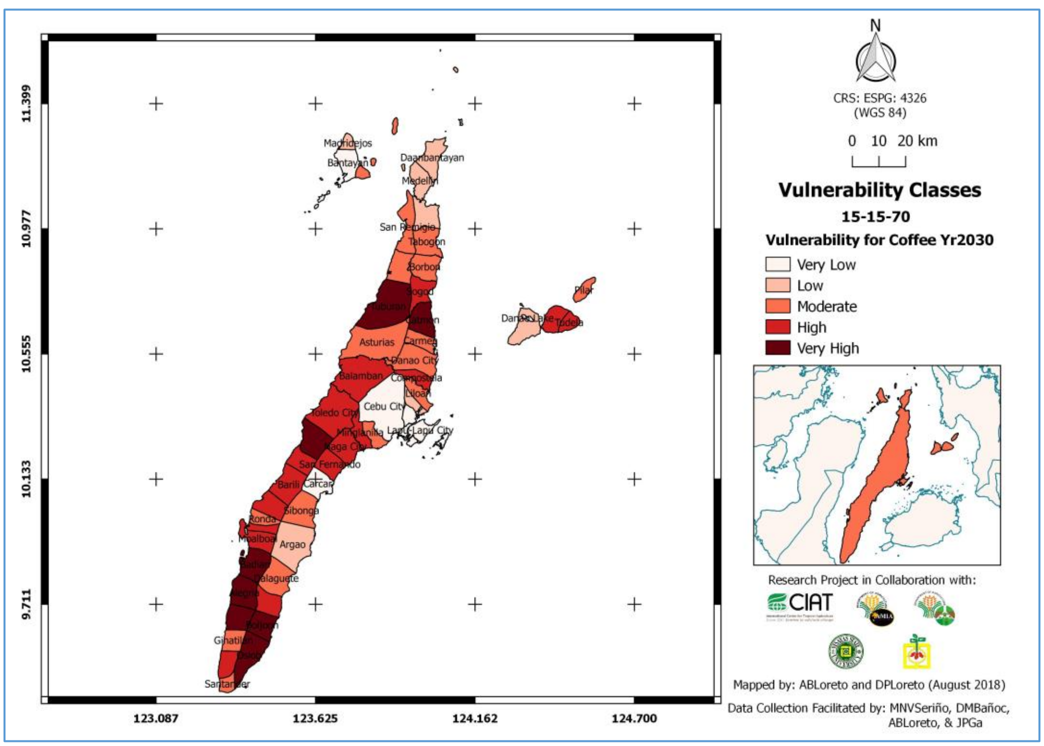
Appendix 27. Cassava and Sweet Potato vulnerability in the year 2030 using 15-15-70 weight combination.



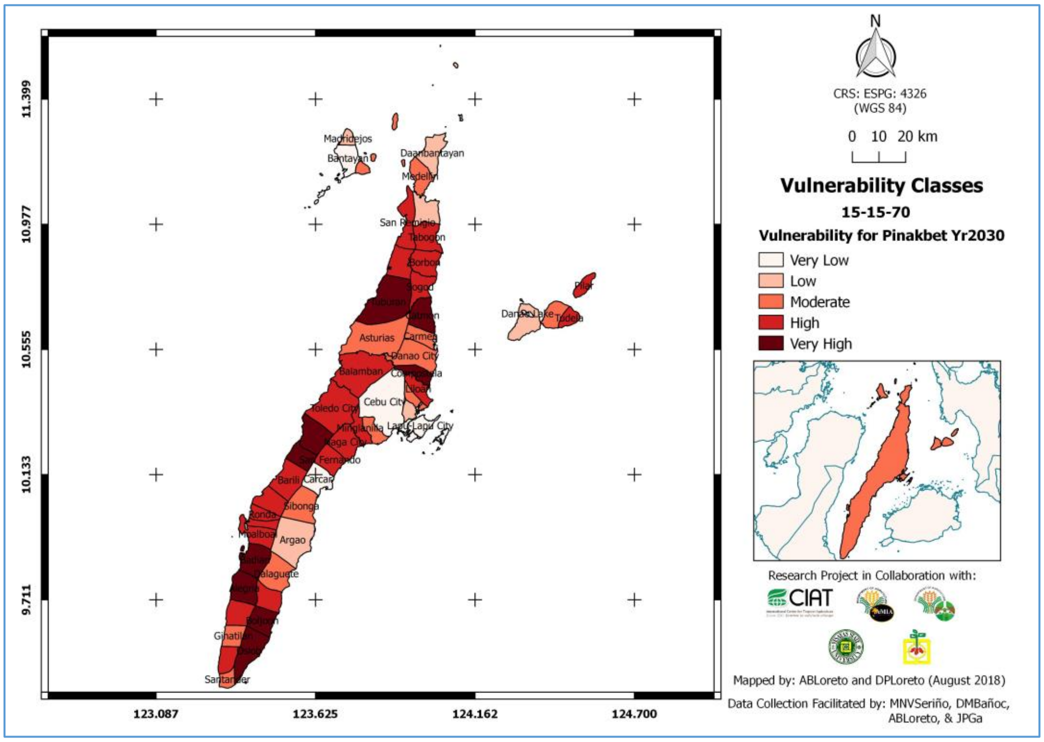


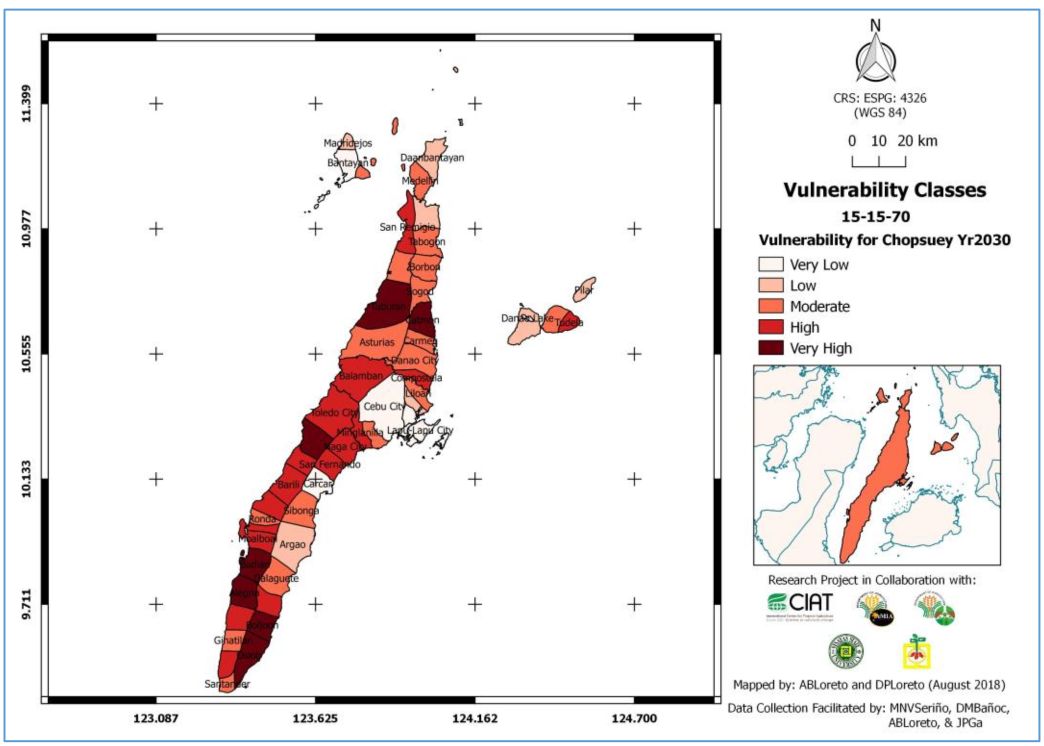
Appendix 28. Cacao and Coffee vulnerability in the year 2030 using 15-15-70 weight combination.





Appendix 29. Pinakbet and Chopsuey vulnerability in the year 2030 using 15-15-70 weight combination.





Appendix 30. Vegetable protected cultivation investment brief

AMIA Phase 2 CBA Investment Briefs

Cordillera Administrative Region (CAR)
- Use of Water Impounding facility in Atok, Benguet
- Blight Tolerant Variety on Potatoes in Buguias, Benguet

Region IVB-MIMAROPA
- Rice-Onion Crop Rotation in Bulalacao, Oriental Mindoro
- Early Maturing Rice in Naujan, Oriental Mindoro

Region VII-Central Visayas
- Corn-Peanut Crop Rotation in Daanbantayan, Cebu
- Vegetable Protected Cultivation in Dalaguete, Cebu

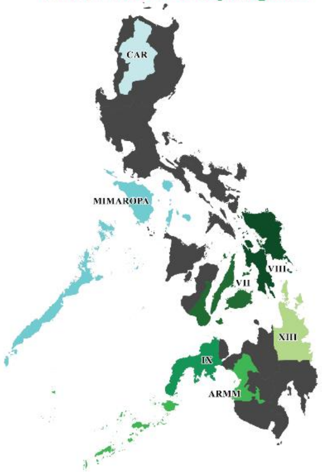
Region VIII-Eastern Visayas
- Alley Cropping Using Pineapple as Hedgerow in Upland Rice Production in Samar Island
- Protected Cultivation of High Value Vegetables in Sta. Rita, Samar

Region XIII-CARAGA
- Corn-Rice-Green Corn Production Rotation in Agusan Del Norte
- Corn-Squash Crop Rotation in Jabonga, Agusan Del Norte

Region IX-Zamboanga Peninsula
- Alternate Wet And Drying for Rice in Zamboanga Sibugay
- Coconut-Yellow Corn Intercropping in Zamboanga Sibugay

Autonomous Region of Muslim Mindanao (ARMM)
- Coconut-White Corn Intercropping in Lanao Del Sur
- Coconut-Banana Intercropping in Lanao Del Sur

AMIA Phase 2 Study Regions



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[1] National Economic Development Authority (NEDA) (2017). Central Visayas Regional Development Plan 2017-2022. Manila, Philippines

[2] Philippine Statistical Authority (PSA) (2016). Major Crop Statistics of the Philippines (2010-2014) Regional and Provincial. Manila, Philippines.

[3] Municipality of Dalaguete (2018). Dalaguete Agri-Fishery Development Plan (2016-2022). Dalaguete, Cebu, Philippines

[4] Santosh, D., Tiwar, K. and Singh, V. (2017). Influence of different protected cultivation structures on water requirements of winter vegetables. International Journal of Agriculture, Environment and Biotechnology. Vol 10(1) pp 93-103.

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This investment brief was produced through the VSU-CIAT partnership under the AMIA Climate Resilient Agriculture Decision Support (CRA-DS) project in Central Visayas Region.

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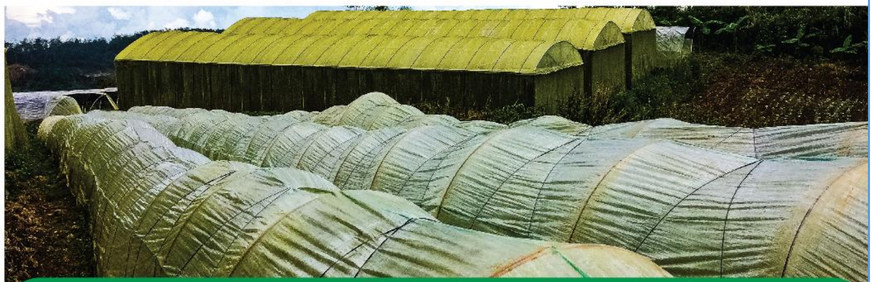
Climate Resilient Agriculture Practices Investment Prioritization



Vegetable Protected Cultivation in Dalaguete, Cebu

Vegetable Protected Cultivation as a CRA Practice

During wet seasons, supply of vegetables drop because of the increased difficulty for farmers to produce quality vegetables. Protected cropping technology using rain shelters has been introduced to protect crops from adverse climatic conditions such as high precipitation. Through protected cultivation, farmers can produce year-round supply of quality vegetables and increase their farm income by capturing higher market prices during unfavorable weather conditions.

Impacts of Vegetable Protected Cultivation on:

Productivity
- Adoption of protected vegetable cultivation has strong potential to generate higher yield even during wet seasons.
- For every 150 m^2 structure, farmers adopting the CRA practice have an average estimated increase in annual yield of 92% compared to farmers using conventional practices.

Adaptation
- Lesser quantities of vegetable were harvested during wet season compared to dry season. With protected cultivation, farmers can produce year-round supply of vegetables.
- Pest and disease occurrences can be reduced.

Mitigation
- Reduced use of inputs such as pesticides and fertilizers can lead to reduction in carbon emissions and can contribute to reducing groundwater contamination through lessened chemical run-offs.

Cost-Benefit Analysis Results Highlights

Yield/ha/yr	With CRA	Without CRA
Lettuce	105 kg	43 kg
French Beans	131 kg	80 kg

Price/kg	Ave.	Min.	Max.
Lettuce	Php 100/kg	Php 70/kg	Php 150/kg
French beans	Php 90/kg	Php 60/kg	Php 100/kg

Initial Investment Requirement/ha
PhP 40,000
USD 779.42

Payback Period
3 years

The estimated cost of PhP 40,000 includes one (1) protected structure for vegetables (with dimensions covering 150 sq.m. and stands more than 6 ft. tall), fertilizers, land cultivation costs, and seeds.

Recommendation

Why invest?
- By investing in protected cultivation, farmers can expect to have increasing farm income through year-round production of vegetables, allowing farmers to capture higher off-season market prices.
- Farmers can better manage pest and diseases using protected structure.

Overview

The Central Visayas region employs around 30% of its workforce in agriculture, forestry and fisheries sector [1]. Roughly 75% of its total vegetable production is contributed by the province of Cebu [2]. However, low productivity, vulnerability to natural disasters, and unsophisticated marketing systems keep vegetable farmers' marginalized and threaten food security.

Vegetable production is limited during wet season because heavy rains cause significant damage to vegetable crops. Protected cropping technology has been introduced to address the inability of farmers to produce vegetables year-round. However, small scale farmers are reluctant to adopt this technology due to its associated investment costs. Hence, this study was conducted in Cebu province to evaluate the profitability of protected cultivation and compare it with open-field cultivation to help farmers, stakeholders and investors make an informed decision. Aside from heavy rains, other production constraints in the region include frequent typhoons, erratic precipitation, widespread insect pest and disease issues, poor access to modern vegetable varieties and cropping inputs, and low skill levels combined with poor distribution systems.

The municipality of Dalaguete, Cebu was chosen as the project site because it has been identified as a major producer of high value vegetables in Cebu province [3].

Vegetable Protected Cultivation

Farmers in Cebu province tend to continue planting even during risky weather conditions to capture higher market prices when supply is low. In effect, they are faced with higher risks of crop damage and capital loss. To address this issue, protected cultivation, which can be in the form of greenhouses, direct covers, and low or high tunnels, is one of the contemporary strategies to minimize crop damages associated with unfavorable climatic conditions.

Protected cropping technology through the use of rain shelters has been introduced in Mantalongon, Dalaguete, Cebu to protect vegetable crops from adverse climatic conditions such as high precipitation, wind, and insects and diseases. Although there is no definite ideal size of rain shelters, farmers in Mantalungon have protected structure that measures more than 6 ft. in height and has a dimension that covers 150 sq. m. The frame is made of round steel pipes and is covered with polyethylene plastic. It can last more than ten years but the plastic cover, which costs PhP 5,000 on the average, is replaced every three (3) years.

WHY IS IT BETTER THAN THE CONVENTIONAL PRACTICE?

- Protected cultivation improves on the conventional practice by providing opportunity for farmers to produce off-season vegetables even during wet seasons. Farmers' potential income can be higher with protected cultivation compared to open field cultivation
- Better management of pest and diseases because it is in a controlled production environment
- Contributes to curbing carbon emissions and improving quality of ground water because of reduced use of pesticides and fertilizers

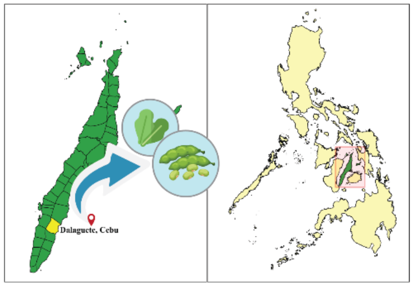
This CRA practice can replace...

- Open field cultivation during wet season
- Watering system through the installation of drip irrigation
- Excessive use of pesticides for crop protection

Reported adoption rate of the CRA practice in places indicated above were based on rough estimation of the Municipal Agriculturist and the research team after site visits.

Current Adoption Rate*	
5%	*Within Cebu City
5%	*Within Argao municipality
5%	*Within Dalaguete municipality

Study Site



Data Gathering

Key Informant Interview (KII)

The CRA practice was identified through the help of experts' opinion. Experts from the academe (professors from Visayas State University) and the government (Department of Agriculture (DA) Region 7) were pooled to provide insights on emerging farm practices that can be considered climate resilient. Results of the experts workshop were also validated through a workshop conducted with 40 Municipal Agricultural Officers (MAO) and agricultural technicians.

Survey

18 farmers interviewed*

*4 adopters and 14 non-adopters

Survey Period: March20-23 2018

Area(s) Covered: Mantalongon, Dalaguete, Cebu

The CIAT CBA Methodology

Cost-Benefit Analysis (CBA) is used to determine the relative profitability of alternative cropping practices, involving the comparison of the annual flows of incremental benefits with that of incremental costs. The CIAT CBA Online Tool analyzes the full benefits and costs of identified practices and adoption response for both individual farmers and at aggregate level for a particular population.

Specifically, the tool can:

1. Quantify economic and some environmental trade-offs of adopting CRA practices.
2. Provide sensitivity analysis
3. Estimate the level of peak adoption

Cost-Benefit Analysis Results

The CRA practice requires an initial investment of PhP 40,000 (USD 779) mainly for the protected structure covering a 150 m^2 farm area and other farm inputs. The cost of rain shelter or protected structure alone is around PhP 25,000 (USD 487). The incremental cost of adoption is mainly due to the cost of structure.

The shift from open field cultivation to protected cropping generates positive incremental benefits because of higher yield and reduced input use. The investment will be recovered by year three. Over a 10-year period, farmers can expect a yearly incremental net benefit of around PhP 14,370 (USD 280).

- Period of Analysis: 10 years
- Discount Rate: 10%
- Exchange Rate: USD 1 = PhP 51.32

Farm-level Analysis

- Initial Investment Requirement/ha: PhP 40,000 / USD 779
- Estimated Annual Incremental Benefit: PhP 14,370 / USD 280
- NPV: PHP 63,527 / USD 1,238
- Payback Period: 3 years
- IRR: 60%
- Social & Envi NPV: PHP 63,556 / USD 1,238
- Social IRR: 61%

Externalities

The adoption of protected cultivation has a positive externality manifested through improved water quality of ground water due to reduced chemical run-off from pesticide and insecticide use [4].

Sensitivity Analysis

The CRA Practice will still be profitable even with...

- Farm Gate Price of Output = ↓ 25%
- Yield Response (productivity) = ↓ 20%

Aggregate Analysis

Current adoption rate	Projected adoption rate	Total area of vegetable production	Aggregate NPV (PhP)
5%	12%	395 ha*	14,140,409

The total area planted with vegetable in Mantalungon was based on the report from MAO of Dalaguete.

Recommendations

Where and when?

Investing in protected cultivation is a profitable decision for farmers engaged in high value vegetable production. It is best suited during wet season from June to December. Southern part of Cebu especially in Dalaguete and Argao municipalities should consider investing in protected vegetable cultivation.

What?

Protected cultivation brings positive stream of benefits for farmers producing lettuce and french beans during wet season. Other high value vegetable crops that will have strong potential for production under protected structure include tomatoes and bell pepper.

Who?

Small scale farmers are encouraged to invest in protected cultivation. Since existing adopters received financial help from the DA for the protected structure, the DA, local government unit and private sector shall continue its efforts to extend financial and technical assistance to other vegetable farmers opting to invest in protected cultivation.

International Center for Tropical Agriculture
Since 1967 / Science to cultivate change

Appendix 31. Adaptive capacity indicators per capital and its source

INDICATORS	DATA SOURCE
ECONOMIC	
Crop production (rice, corn, cassava, camote, pakbet and chopsuey) (In MT)	Cebu Agricultural Profile, DA-RFO7, 2014
Revenue (In Pesos)	Cities and Municipalities Competitive Index CMCI, 2015
Number of financial institutions (count)	
Number of finance cooperatives (count)	
Percentage of farmers with access to crop insurance (%)	Philippine Crop Insurance Corp. PCIC, 2017
Dependence in agriculture (%)	City and Municipal Agriculturists' estimates, 2017
Poverty incidence (%)	Philippine Statistics Authority PSA, 2012
Agriculture minimum wage in agriculture sector (Non-Plantation)	City and Municipal Agriculturists' estimates, 2017
Agriculture minimum wage in agriculture sector (Plantation)	
NATURAL	
Soil organic matter (%)	DA-RFO7 Soil's Laboratory
Forest cover	Centre for International Tropical Agriculture (CIAT)
Total area of marine protected area(s) (In ha)	City and Municipal Agriculturists' estimates, 2017
Percentage of farmers with access to STW (In %)	
Access to reliable water for irrigation	Centre for International Tropical Agriculture (CIAT)
SOCIAL	
Number of registered farmer groups or unions (count)	City and Municipal Agriculturists' estimates, 2017
Percentage of farmers with access to farmer groups or unions (%)	
Percentage of women elected in local government position (%)	Commission on Election (COMELEC)
HUMAN	
Literacy rate	PSA, 2015
Ratio of School Teachers to Students (ratio)	Cities and Municipalities Competitive Index CMCI, 2015
Number of Public Secondary School (count)	
Number of Tertiary School (count)	
Number of Public Technical Vocational School (count)	
Health	
Percentage of Malnourished Children Aged 7 years and Below (%)	National Nutrition Council NNC, 2016
Number of Public Health Services (count)	Cities and Municipalities Competitive Index CMCI, 2015
Number of Health Services Manpower (count)	

INDICATORS	DATA SOURCE
Number of Public Doctors (count)	
Philhealth Membership (Count)	
Age-Dependency Ratio (count)	PSA, 2015
PHYSICAL	
Percentage of farmers owning their agricultural land	City and Municipal Agriculturists' estimates, 2017
Average farm size (ha)	
Distance of farthest barangay to the nearest market (km)	
Number of livestock raised (count)	DA-RFO7, 2017
Percentage of crops irrigated (%)	Centre for International Tropical Agriculture (CIAT)
Road density	
ANTICIPATORY	
Number of climate change related trainings conducted (count)	City and Municipal Agriculturists' estimates through survey questionnaire, 2017
Percentage of the population with access to communication technology	
INSTITUTIONAL	
Percentage of farmers consulted/visited by agricultural extension officers (%)	City and Municipal Agriculturists' estimates through survey questionnaire, 2017
Number of municipal or city agricultural staff/officers (count)	

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CRA Adaptor? (Yes/No). ____________
Enumerator. Cho 2
Date. ____________

"Climate-Resilient Agri-fisheries (CRA) Assessment, Targeting & Prioritization for the Adaptation and Mitigation Initiative (AMIA) Phase 2 in Cebu Province"

Enumerator should read thru the introduction before starting the interview

Greetings!!

I am [**NAME OF ENUMERATOR**], an enumerator for a Department of Agriculture – Bureau of Agricultural Research (DA-BAR) funded project implemented by the Visayas State University. The research will assess the profitability of intercropping corn and peanut or mungbean compared to planting corn alone.

You have been selected as a respondent for the survey. The information gathered from you will be used as basis for creating an investment guide for corn.

09351706714

ASSURANCE OF CONFIDENTIALITY

All responses to the questionnaires will be treated with high degree of confidentiality.

Farmer's Socio Demographic Background

Farmer-Respondent's Name: Lucia Arsenal Tinubdan
Number of Year(s) Farming: Since 17 yrs old
Address: Daantantugun
Farm Practice(s): (1) - Corn Mono cropping; 2 - Corn – Mungbean Rotation; 3 - Corn – Peanut Rotation; 4 – Corn - ________
Sex: F Age: 65 Civil Status: Married
Highest Educational Attainment: Elementary Grad.
Primary Occupation: Farmer
Total Farm Area: 1 ½ ha
How were you involved in farming? (1) – Cultivating own land 2 – Shareholder/ Tenant

Farm Production and Cropping Systems

Crops Planted	Number of Cropping Period per year			Production					
				Estimated harvest per cropping		Total harvest per year	Farm gate Price (Buyers)		Gross Income
	Count	Period 1	Period 2	Sold	Consumed		Corngrits	Tilaob	
Corn monocropping	2	June - Sept	Nov-Feb.	(1st) 3 cavans	1 cavans		1,400 / cavan		
CRA practice				(2nd) 5 cavans	1 cavans		1,400 / cavan		
Corn									
Peanut									
Mungbean									

GENERAL INFORMATION	
CRA Practice	
Description of practice	

ADOPTION COST FLOW				
IMPLEMENTATION PERIOD at year 1 for CORN – LEGUMES ROTATION				
Machinery and Equipment				
Item	Unit	Price of Unit	Monocropping	CRA practice
Pick mattock	Piece			
Plough	Piece	5000		300/day
Carabao	Head			
Scythe (sangalab/sangot)	Piece	200/pc	3 pcs	
Other items:				
Land rent				
Inputs during planting				
Seeds – corn (BISAYA)	kg	(given)	25 kgs	
Chicken dung X	Sack			
Vermicompost X	Sack			
Fermented plant juice X	liter			
Farm compost X	Sack			
Chemical herbicide at clearing X	gallon			
21-0-0 Ammonium	sack	580/sk	5 sk	
46-0-0 Complete	sack	1200/sk	4 sk	
Other inputs:				
Seeds peanut			-	
Seeds mungbean			-	
Services				
Inputs trucking	Sacks			
Animal hauling of inputs	Sacks			
Animal rent	Day			
Other services:				
Labor SURKO		SNACK 300/day	3 days	
Clearing for corn	Md	300/+ 150/day	5 tao * 3 day	
Land cultivation for corn + Mulching	Md	5,000 (linyo)	SUHOL	
Planting for corn	Md	300/+ 150/day	4 tao * 2 day	
Fertilizer application for corn	Md	300/+ 150/day	3 tao * 2 days	
Herbicide application at land X	Md			
Food for hired labor for corn X	person			
Clearing for legumes	Md			
Land preparation for legumes	Md			
Planting for legumes	Md			
Fertilizer for legumes	Md			
Food for hired labor for legumes	person			

MAINTENANCE PERIOD starting year 2 for CORN – LEGUMES ROTATION				
Machinery and Equipment				
Item	Unit	Price of Unit	Monocropping	CRA practice
Bolo	Piece	320/pc	3 pcs	
Sprayer X	Piece			
Shovel	Piece	180/pc	3 pcs	
Rake	Piece			
Hoe	Piece			
Inputs				
Herbicide X	gallon			
Services				
Labor				
Manual weeding	md	300/+ 150/day	2 tao * 2 days	
Composting X	md			
Herbicide application at weeding X	md			
Food for hired labor	person			

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OPERATIONS PERIOD for CORN				
Period when operation cost initiate			2	
Period when operation cost ends			10	
Machinery and Equipment				
Item	Unit	Price of Unit	Monocropping	CRA practice
Inputs				
Sacks	pieces	5/sk	20 sks	
Services				
Shelling fee	Bushels			
Animal hauling of produce	Sacks			
Trucking of produce	Sacks			
HAULING	gasoline	5 liter	50	
Labor				
Harvesting	md	100/day+150/day	4 two * 2 day	
Shelling	md	100/day+150/day	2 two * 2 day	
Food for hired labor	persons			
Lubo Galing (PICK UP)		500	2 two * 2 day	

Note: Only for those practicing Corn – Legumes Crop Rotation – (For monocropping proceed to next table)

OPERATIONS PERIOD- PEANUT				
Period when operation cost initiate			2	
Period when operation cost ends			10	
Machinery and Equipment				
Item	Unit	Price of Unit	Conventional practice	CRA practice
Inputs				
Sack	piece			
Services				
Output trucking	sack			
Labor				
Harvesting	md			
Selling	md			

OPERATIONS PERIOD- MUNGBEAN				
Period when operation cost initiate			2	
Period when operation cost ends			10	
Machinery and Equipment				
Item	Unit	Price of Unit	Conventional practice	CRA practice
Inputs				
Sack	Piece			
Services				
Output trucking	sack			
Labor				
Harvesting	md			
Selling				

1. **Farming Externalities (For adaptors only)**
   1.1. Have you noticed any significant changes to your farm productivity after you adopt corn-peanut/mungbean rotation?
   1 – Yes 2 – No
   1.2. If, yes what are these changes?
   A. ____________________
   B. ____________________
   C. ____________________
   1.3. At what year do you usually observe this changes in your farm? ____________________
   1.4. What made you adopt this kind of crop rotation practice? ____________________

Thank you very much for your cooperation

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CRA Adopter? (Yes/No): ____

Enumerator: Che²

Date: ____

"Climate-Resilient Agri-fisheries (CRA) Assessment, Targeting & Prioritization for the Adaptation and Mitigation Initiative (AMIA) Phase 2 in Cebu Province"

Enumerator should read thru the introduction before starting the interview

Greetings!!

I am [**NAME OF ENUMERATOR**], an enumerator for a Department of Agriculture – Bureau of Agricultural Research (DA-BAR) funded project implemented by the Visayas State University. The research will assess the profitability of integrated pest management (IPM) with the use of bio-controls in vegetables compared to chemical pest controls.

You have been selected as a respondent for the survey. The information gathered from you will be used as basis for creating an investment guide for vegetables.

ASSURANCE OF CONFIDENTIALITY

All responses to the questionnaires will be treated with high degree of confidentiality.

Farmer's Socio Demographic Background

Farmer-Respondent's Name: Ma. Consolacion Oltona

Address: Sitio Alang-alang, Mantalungon

Sex: F Age: 48 Civil Status: M

Highest Educational Attainment: Elem. Grad.

Primary Occupation: Farmer

How were you involved in farming?
1 – Cultivating own land (2) – Shareholder/ Tenant

Number of Year(s) Farming: 14 years old

Pests Control Practice(s): 1 – Bio-controls
2 – Chemical controls
(3) – Bio and chemical controls – Protected
4. Others (specify) ____

Total Farm Area: 1/4 ha

Farm Production and Cropping Systems

Farm sa demo farm — PROTECTED — L, PB, K – 400 per distance / roller × / rules

Crops Planted	Number of Cropping Period per year				Production					
					Estimated harvest per cropping		Total harvest per year	Farm gate Price		Gross Income
Vegetables	Count	Period 1	Period 2	Period 3	Sold	Consumed		Raw	Sorted	
lettuce	3	Mar-Apr	Aug-Oct	Nov-Dec	60 kgs	1 kg		70/kg		
Prince Beans	1		Aug-Nov.		120 kgs	5 kgs		100/kg		
Kamatis			Aug-Nov.		160 kgs	10 kgs		40/kg		

Codes for Vegetables
1 – Cabbage
2 – Ombok
3 – Brocolli
4 – Cauliflower
5 – Eggplant
6 – others, specify

GENERAL INFORMATION	
CRA Practice	PROTECTED – Bio control + chemical
Description of practice	

ADOPTION COST FLOW						
IMPLEMENTATION PERIOD at year 1						
Machinery and Equipment						
Item	Unit	Vegetables See codes above	Price of Unit	Bio-control	Chemical control	Bio and chemical control
Pick mattock (Gabang)	Piece		100			1
Spade (pala)	Piece	All	130			1
~~Hoe~~ Guna	Head		150			2
Scythe (sangalab/sangot)	Piece					
Harrow	Piece					
Plow	Piece					
Plastic Mulch	Piece					
Bamboo poles	Piece					
Nylon and strings	Meters					
Seedling tray	Piece					
Drip hose	Meters					
Sprinkler for irrigation	Unit		70			1
Others Galab			40.80			2
Sprayer			1,200			1
Inputs during planting						
Vegetable seeds	Pack	lettuce, Pechay, K	(200) (1,150) (200)			3, 1.5, 1 pack
Vegetable cuttings	Piece					
Organic inputs						
Chicken dung	Sack					
Vermicompost	Sack					
Farm compost	Sack					
Carbonized rice hull	sack					
Animal Manure	sack					
Other organic inputs:						
Inorganic inputs						
Complete (14-14-14)	sack	L, PB, K	575			1/2 sack, 1/2 sk, 1/2 sk
Urea (46-0-0)	sack	L, PB, K	900/sk			1 sk. (all)
Ammonium sulfate	sack					
Potassium sulfate	sack					
Other inorganic inputs:						
insecticide Silicon		L, PB, K	350/1/4 bot.			1 bottle (1/4 L)
Services						
Inputs trucking	Sacks					
Animal hauling of inputs	Sacks					
Animal rent	Day					
Other services: Hatod [illegible]		L, PB, K				20/transport
Labor						
Clearing/weeding	Md	*	200/two/day			2 two
Land cultivation	Md		200			1 two
Planting/transplanting	Md		200			2 two, 1 day
Fertilizer application	Md	**	200			2 two, 1 day
Herbicide application	Md					
Food for hired labor	person					
Other labor expenses:						
Spray		***	200			1 two, 2 [illegible]

* L – once
PB – once
K – once

** L – 3 times
PB – 3 times
K – 3 times

*** L – 2 times
PB – 2 times
K – 2 times

MAINTENANCE PERIOD starting year 2						
Machinery and Equipment						
Item	Unit	Vegetables See codes above	Price of Unit	Bio-control	Chemical control	~~Bio and chemical~~ control
Bolo	Piece					
Cellophane	Pack					
Newspaper (for covering)	Kilo					
Crate	Unit					
Basket	Piece					
Kaing		L, K	80			1, 1
Salib		PB	10			1
Item	Unit		Price of Unit	Bio-control	Chemical control	Bio and chemical control
Inputs						
Chemical Herbicide				-		-
Chemical Pesticides (Indicate the name of chemicals used)				-	-	-
Insecticide						
Acaricide						
Fungicide						
Bactericide						
Nematicide						
For Mulching				-	-	-
Watering of plants	No of times daily	Thrice daily (all)				2 times (½ da
Volume of water used per application	Gallons					
Biological and Non-Chemical Spray (Indicate the name of chemicals used)				-	-	-
Trichogramma						
Metharhiziumanisopliae (GMF)						
Bacillus thuringiensis (Bt)						
Beuvariabassiana (WMF)						
Organic concoctions (OHN, FPJ, FFJ, LABS, IMO)						
Botanical Extracts (Neem, Panyawan, Chili, Garlic, Lemon grass)						
Vermitea (Brewed or Ordinary)						
Soap Solution						
Pressurized Water Spray						
Wood Vinegar						
Trichoderma						
Services						
Labor						
Manual weeding	md					
Composting	md					
Herbicide application at weeding	md					
Pesticide application	md					
Food for hired labor	person					

OPERATIONS PERIOD	
Period when operation cost initiate	2

Item	Unit	Vegetables See codes above	Price of Unit	Bio-control	Chemical control	Bio and chemical control
Inputs						
Sacks	pieces					
Services						
Sorting of produce X	Bushels					
Animal hauling of produce	Sacks	L	200			1 trip
Trucking of produce	Sacks	L	45/pikupe per	delivery		
Labor				1200		
Harvesting	md	L	200	(Haulers		2 two (3 hrs) *
~~Sorting~~	md	PB	200 +			3 two (1 day) *
Food for hired labor	persons	K	200	100		2 two (4 hrs) *

*L – 3 times
PB – 4 times
K – 4 times

1. Farming Externalities (Farmers using Bio-controls only)

1.1. Have you noticed any significant changes to your farm productivity after you adopt ~~bio-control~~ protected?

(1) – Yes 2 – No

1.2. If, yes what are these changes?

A. Mas mindot lati na ug mag ulan, di daling malata, daghan

B. ang tanom compared sa gawas

C. __________

1.3. At what year do you usually observe this changes in your farm? 2017

1.4. What made you adopt this kind of pest control method? Regulated by Mayor to use protected kanang naa sa ila association

Thank you very much for your cooperation

1,200
2,400
1,600

Appendix 34. Filled-out adaptive capacity questionnaire

MUNICIPALITY	**OSLOB**	
Additional Adaptive Capacity Data		
Institutional	***Measure***	***Response***
Effective government and/or CSO programs for climate change	Yes/No	Yes
Adequate government response to previous shocks	Yes/No	No
Number of DA officers*	Count	5
Access to communication technology: cell phone, internet	% of the population	75%
Percentage of the population employed in the agriculture sector	Percent of the total labor force	55%
Lacking Data	***Measure***	***Response***
Area of marine protected area(s)	In hectares	5 MPA's -81.17 hectares
Number of farmers with access to shallow tube well (STW)	Count	None
Number of registered farmer groups or unions/coops and their respective number of members*(use another sheet if necessary)*	Count	
(DOLE Registered 2 groups farmers)		55 members
(DOLE Registered 6 groups fishermen)		318 members
Number of technical vocational school(s)	Count	None
Number of trainings held relating to climate change in the municipality	Count	3
Estimated percentage of household with water services	Percent	60%
Estimated percentage of household with access to electricity	Percent	65%
Number of elementary and secondary schools in the municipality	Count	12 Elementary 3 Primary 5 Secondary

Prepared by:

jvillaluna

JACQUELINE L. VILLAGANTOL
A.T.

Noted by:

PROCESO R. BOMEDIANO
MAO

Appendix 35. Climate resilient agriculture identification questionnaire

Name of Respondent: ROMMEL PINATIL Municipality: SAN FERNANDO

IDENTIFICATION OF CLIMATE-RESILIENT AGRICULTURE (CRA) PRACTICES IN CEBU PROVINCE

CRA Practices/Technologies		**Check if Yes**	**Barangay(s) where it is located**
Forestry	Agroforestry		
	Use of Living Fences		
Crop Production System	Intercropping	✓	TUBOD, BALUNGAG, BUGHO MAGSICO, LIBURON
	Conservation Agriculture		
	Crop switching	✓	BUGHO, TUBOD, MAGSICO
	Adaptive Crop Calendar	✓	MOUNTAIN BARANGAYS
	Organic Agriculture Practices		
Soil Management	Mulching	✓	TONGGO, TUBOD, BALUNGAG
	Improved Fallow	✓	BUGHO, TUBOD - BALUNGAG LIBURON
Water Management	Terracing	×	~~CABATBATAN~~,
	Drip Irrigation		
	Water Harvesting	✓	MAGSICO, BALUNGAG BUGHO (SWIPS)
Pest and Disease Management	Use of Bio-pesticides		
	Use of Beneficial Organisms		
	RATOONING STONEWALLING	✓ ✓	TUBOD, BALUNGAG, BUGHO CABATBATAN

CRA Practices/Technologies		Check if Yes	Barangay(s) where it is located
Genetic Resource Management	Use of tolerant varieties	✓	BUGHO (BANANA) LIBURON
Livestock	Zero Grazing	✓	LIBURON, TUBOD, MAGSICO, TONGGO, CABATBATAN, BALUNGAG, BUGHO
	Silvopastoral system		
Value Chains	On-farm Value added products		
Fish and Aquaculture	Aquasilviculture	✓	ILAYA, BALUNGAG, BUGHO, CABATBATAN, NORTH POBLACION
Energy	Use of biogas digesters	✓	SANGAT
Climate Risk Management	Meteorological advisories, Early Warning Systems		
Policies and Institutions	Index-based Insurance schemes	✓	MOUNTAIN BARANGAYS LIVESTOCK AND CROPS
	~~Crop~~ Animal Integration farming	✓	BUGHO, BALUNGAG, TUBOD, MAGSICO, TABIONAN, LIBURON