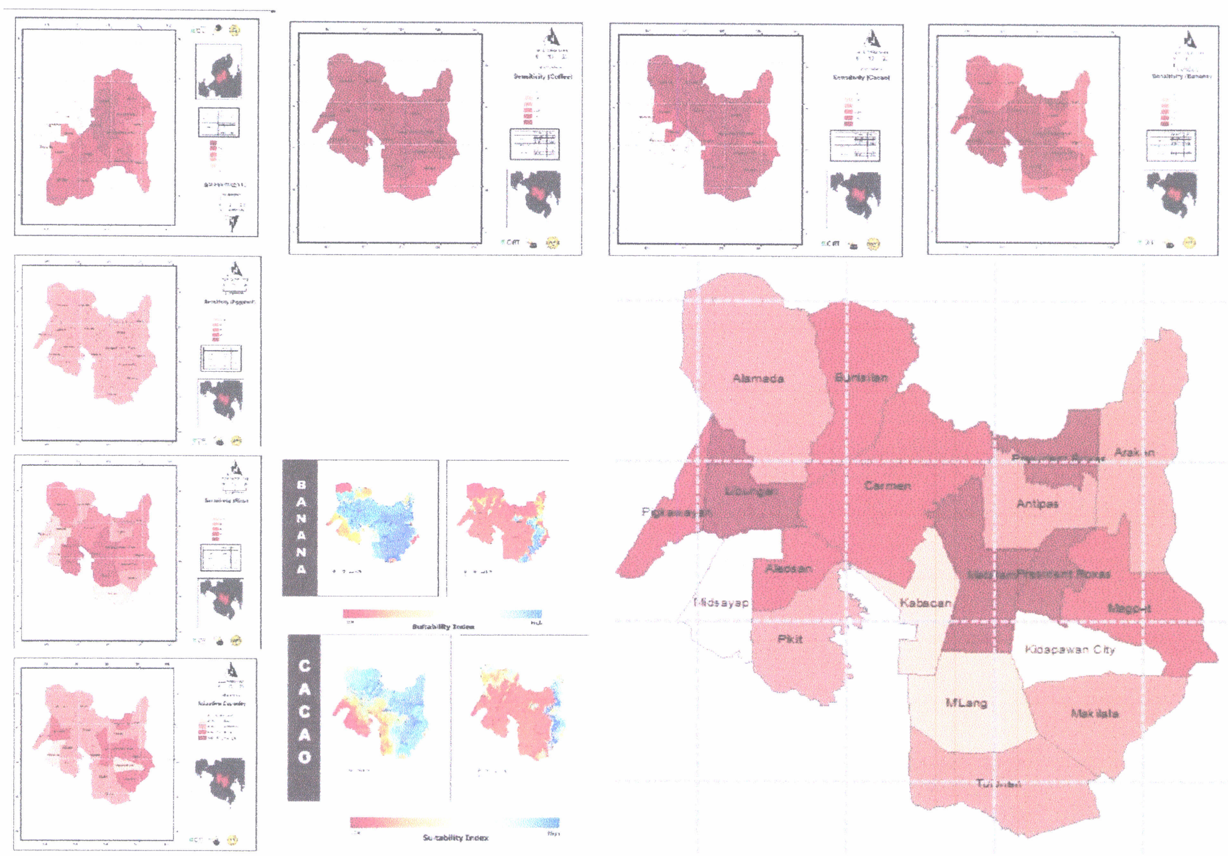
TERMINAL REPORT

Regional Climate-Resilient Agri-Fisheries(CRA) Assessment, Targeting and Prioritization for the Adaptation and Mitigation Initiatives (AMIA) Phase 2 in Cotabato Province



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2017

ABSTRACT

Agri-fishery sector has been exposed to climate change that made it vulnerable. With the advent and existence of climate change affecting the agricultural sector, adaptation and mitigation initiative is essential in developing a climate-resilient sector. Crop modeling using MaxEnt was used in this study for suitability mapping. ARC GIS was used to map the vulnerability indices and Benefit-Cost Analysis (BCA) was used to assess the CRA practices considered in this study.

Results showed that the based on the vulnerability, the Municipality of Libungan, Matalam and President Roxas were highly vulnerable to climate change whole Municipality of Midsayap and Kidapawan were least vulnerable to climate change. Suitability maps, on the other hand, showed that the suitable areas for rice and corn decrease in 2050 given an extreme weather condition. However, 80% of the area of the province is still suitable for rice. The Benefit-Cost Analysis found that both Organic Rice farming and Integrated Rice-Duck Farming System were economically profitable and environmentally profitable making these practices climate-resilient. Findings of the study are essential in policy formulation viz environmental planning for agricultural development. Adopting the practices that are climate-resilient can provide profit and benefits for the farmers and the sector in general.

Keywords: adaptation, BCA, climate change, CRA, IRDFS, MaxEnt, mitigation, organic farming, prioritization

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2.1. INTRODUCTION

RATIONALE

Exposure to climate change is an increasing concern across many sectors in the Philippines. Agriculture sector is not only a fundamental human activity at risk from climate change, but it is the primary driver of environmental and climate change itself (FAO 2012). Agriculture, rural livelihoods, sustainable management of natural resources and food security are key for development and also affected by climate change challenges, thus, successful adaptation and mitigation responses in agriculture can only be achieved within the ecologic, economic and social sustainability goals (FAO, 2012).

By 2050, the growth of population and socio-economic will increase and hence the demand for food as well. In this manner, the Philippines will be at 180 million from 100 million this year when climate impacts may be at their worst (Rudinas et al., 2013). With this trend, climate change will superimpose itself increasing production risk and rural vulnerability especially those areas that are highly exposed to climatic extremes including droughts and flooding, poverty and hunger (FAO, 2012).

According to Easterling et al (2007), climate change impacts include global warming, extreme climate events, undernourishment and reduction of access to and utilization of food. These made some areas vulnerable to climate change.

The Article II of the United Nations Framework Convention on Climate Change (UNFCCC, 2007), the goal is to ensure stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent "dangerous anthropogenic interference with the climate system" (FAO, 2012).

Table 1. Anthropogenic greenhouse gas emissions

2005	G tonnes CO_2 e yr^{-1}	Share %
Global	50	
Agriculture	**5-6**	**10-12%**
Methane	(3.3)	
N2O	(2.8)	
Forestry	**8-10**	**15-20%**
Deforestation	(5-6)	
Decay and Peat	(3-4)	
Total Ag. & For.	**13-15**	**25-32%**

Source: IPCC AR4, WGIII Chapters 8 and 9; UNFCCC 2007 cited by FAO 2012

With the advent and existence of climate change affecting our agricultural sector, it threatens agricultural productivity and stability (Rudinas et al, 2013). Change in the pattern of temperature and precipitation will bring drastic changes in the suitability of crops, thus, altering it cropping pattern and shift in cropping calendar. Aside from this, climate change makes farmers vulnerable to various climate hazards. Thus, there adaptation and mitigation strategies should be known and evaluated. Moreover, with the growing impacts of climate change, existing threats to safety and resilience are being significantly exacerbated, tremendously increasing the vulnerability to those already at risk (IFRC, 2009).

Owing to the fact that in the 21st century, climate change is complex global problem and developing countries are the least responsible for it yet the most at risk to its effect (UNESCO, undated). Climate change studies in the Philippines are emerging fast, focusing on different fields of sciences.

Several climate change and vulnerability assessment (VA) studies (Jose and Cruz, 1999; Badjeck et al., 2010; Sajise et al., 2012; Mamauag et al., 2013; Perez et al. 2013) have in fact been conducted in the Philippines Given the far-reaching adverse impacts of climate change, adaptation must be an integral component of an effective strategy to address climate change, along with mitigation (Lagos, Wirth and El-Ashry, 2009). However, adaptation is not simply a matter of designing projects or putting together lists of measures to reduce the impacts of climate change. Information is crucial to planning for adaptation to climate change. Countries need the capacity and reduces to track meteorological patterns, forecast impacts and assess risk in order to make decisions and provide timely information to their citizens.

Concerns on the impact of climate change on ecosystems and communities that depend on them have taken center stage in many if not all development interventions in recent years. However, the ability to effectively conserve ecosystems and the goods and services these provide depend to a large extent on the ability of the stakeholders to predict the impact of climate change and the communities' adaptive capacities to changes that may occur. Thus conservation efforts and interventions to mitigate the effects of climate change should consider not only the bio-physical factors but also the socio-economic conditions that to a large extent dictate the range of conservation and adaptations measures that could be effectively introduced and sustained over time. Strategies to address climate change are increasingly focused on both reducing emission and adopting to changing climate. This requires identifying and evaluating risks to enhance short-and long-term resilience. Thus, in building a resilient agrifishery sector, adaptation to climate change in developing countries, like Philippines, is vital and must be highlighted to have an urgent priority.

Adaptation and mitigation are two important fundamental concept in dealing with climate change. According to IPCC, adaptation is the adjustment in natural or human system in response to actual or expected climatic stimuli or their effects, which moderate harm or exploits beneficial opportunities (Kabani, undated). Similarly, Mitchell and Tanner (2006) defined adaptation as an understanding of how individuals, groups and natural systems can prepare for and respond to changes in climate or their environment. According to them, it is crucial to reducing vulnerability to climate change.

Mitigation or climate mitigation, on the other hand, is any action taken to permanently eliminate or reduce the long term risk and hazards of climate change to human life, property (Kabani, undated). The International Panel for Climate Change (IPCC) defines mitigation as "an anthropogenic intervention to reduce the source or enhance the sinks of greenhouse gases". The link between the two is that the latter tackles the causes of climate change, the former tackles the effects of the phenomenon.

Box 1. Synergies in adaptation and mitigation

Reducing methane emissions via integrated rice and livestock systems which are traditionally found in West Africa, India, Indonesia and Vietnam, is a mitigation strategy that also results in better irrigation water efficiency – it can also provide new sources of income while improving performance of cultivated agro-ecosystems and enhance human being. Some parts of the Philippines have been practicing an integrate rice-duck farming system.

Reducing N_2O emissions can lead to improved groundwater quality and reduced loss of biodiversity.

Integrates animal manure waste management systems, including biogas capture and utilization, for reductions of CH_4 and N_2O could result in greater demand for farmyard manure and create income for animal husbandry sector where many poor are engaged.

Restoring land by controlled grazing can lead to soil carbon sequestration, have positive impacts on livestock productivity, reduce desertification and also provide social security to the poor during extreme events such as drought.

Practicing agroforestry can promote soil carbon sequestration while also improving agro-ecosystem function and resilience to climate extremes by enriching soil fertility and soil water retention.

Source: Smith et al., 2007 cited by FAO, 2012

As part of climate adaptation and mitigation strategies, climate smart technologies are introduced. It is an important new approach to addressing food and nutritional security on one hand, and adaptation and mitigation on other hand within one framework (World Agroforestry Center, 2016). But, Climate Smart Agriculture (CSA) is not a single specific agricultural technology or practice that can be universally applied (FAO 2013). It is an approach that requires site-specific assessments to identify suitable agricultural production technologies and practices. Scherr et al. (2012) suggested that agricultural systems can achieve climate-smart objectives, including improved rural livelihoods as well as climate change adaptation and mitigation, through adopting a landscape approach.

There were various climate-smart agricultural technologies that have been developed in recent years and have been practiced by some farmers. Some of these are farmer field schools, technological demonstrations and others yet not fully adopted. These technologies are site-specific thus there suitability should also be taken into consideration.

In this light, AMIA 2 was launched in making climate-resilient agri-fisheries (CRA) an operational strategy through field-level action that can directly involve and provide impacts on the livelihood of farming communities.

2.2. OBJECTIVES

The overall objective is to assess, target and prioritize climate-resilient agri-fisheries (CRA) research and development in Region XII in support of AMIA2.

Specifically, the project aimed to (1) strengthen capacities for CRA methodologies of key research and development organizations; (2) assess climate risks in the region's agri-fisheries sector through geospatial & climate modeling tools; (3) determine local stakeholders' perceptions, knowledge & strategies for adapting to climate risk; and (4) document and analyze local CRA practices to support AMIA2 knowledge-sharing and investment planning.

2.3. REVIEW OF RELATED LITERATURE

Climate Risks in Agrifisheries Sector

Agriculture is a major economic sector and a critical source of livelihood in many developing countries. It is particularly exposed to adverse natural events, such as droughts or floods, and the economic costs of major disasters may even increase further in the future because of climate change. This unexpected event can lead farmers to poverty if unchecked. Agricultural insurance is a veritable tool that agricultural producers can potentially use to adapt and mitigate the risks associated with adverse natural events. It is a strategic tool that can complement and enhance risk management activities (Nnadi, et al.,2013).

The agriculture sector plays a critical role in the Philippine economy. First, it provides food and vital raw materials for the rest of the economy. Second, it provides a significant market for the products of the non-agricultural economy, as buyer of farm inputs as well as consumer goods and services produced in the non-agricultural economy. And third, as the sector grows and modernizes in the face of limited supplies of agricultural land, it releases surplus labor to the industry and services sectors (Habito and Briones, 2005).

Climate change is expected to have numerous and complex impacts on water resources, with consequences for agricultural production through changes in crop water requirements, the availability and quality of water, increases the frequency and severity of extreme weather events such as droughts and floods. Three adaptation strategies for agricultural water management identified such as (i) creating and enabling environment to foster on-farm adaptive capacities through policies targeted at innovation, education, and advisory ad extension services;(ii) improving agricultural water management through the development of flexible and robust instruments, such as water pricing and water markets, to deal with both short-run water shortages and long-run water stress; and (iii) developing and improving risk management tools for droughts and floods to ensure that the true cost of risks is signaled to farmers while at the same time improving the efficiency of risk allocation (Hardelin and Lankoski, 2015).

In Nepalese economy, agriculture sector is highly exposed and vulnerable to extreme climate events and the impacts of climate change. Frequent natural disasters like floods, droughts, landslides, intense rain, hailstorms and cold and heat waves are some of the constrains in agricultural production. Climate change impacts often lead to food insecurity for poor and marginalized population groups, including women and children (Selvaraju, 2014).

Research and Development Initiatives for Climate-Resilient Agrifisheries

The Philippines, like many of the world's poor countries, will be among the most vulnerable to the impacts of climate change because of its limited resources. Occurrences of extreme climatic events like droughts and floods have serious negative implications for major water reservoirs in the country. Results showed that changes in rainfall and temperature in the future will be critical to future inflow in the Angat reservoir and Lake Lanao, with rainfall variability having a greater impact than temperature variability (Jose, 1999).

The numerous weather and climate-related natural disasters have impacted in North and Central America, and the Carribean demonstrating how vulnerable local agriculture is to extreme episodic events and expected to increase with climate change. Farmers used various strategies in managing climate risks like farming in multiple locations, diversifying crops and varieties, seeking alternative source of income, and purchasing crop insurance. However, other farmers failed to implement the strategies due to inadequate farmer education and training, lack of tools to help facilitate the practical application of risk management concepts and poor communications between the agrometerological and farming communities (Shannon and Motha, 2015). Through adopting the right measures, managing the climate risks and adapting the challenges posed by increasing climate variability and climate change is possible (Ramasamy, 2014).

Some of the most important impacts of global climate change and food security will be felt among the rural household, predominantly in developing countries. Their vulnerability to climate change comes both from being predominantly located in the tropics and from various socio-economic demographic and policy trends limiting their capacity to adopt to change (Nwanko, 2013).

Analysis of climate change impacts on agriculture is undertaken in two steps namely the ClimateCrop model and adaptive capacity index. The former evaluates crop productivity and water demands as a response to climate adaptation policies and mitigation policies and the latter is developed to evaluate the resilience of regional agricultural systems. The need to respond to the regional risks and opportunities is addressed by evaluating the costs and benefits of a number or technical and policy actions on crop productivity, water demand for agriculture and fertilizer use (Iglesia, 2012).

2.4. METHODOLOGIES

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

Each of this components were strategically done using the following methodologies as elaborated below:

Component 1 - Capacity strengthening for CRA research & development

The regional project team participated in a series of trainings, workshops and learning events organized by AMIA2 projects. These focused on two key methodologies: 1) CRVA, and 2) CRA prioritization.

The project also 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 trainings. The intention of the trainings and meetings was to make the stakeholder's understand the methodologies, and the purpose of the project.

Component 2 - Geospatial assessment of climate risks

The regional project team collected and organize geo-referenced data on vulnerability to climate risks of the region's agrifisheries sector. These datasets, from both primary and secondary sources, was based on the methodological guidelines provided by the AMIA2 CRVA project – covering climate-risk exposure, sensitivity and adaptive capacity.

Figure 1. Participants doing crop occurrence map

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.

In carrying out this objective, the project team initiated a crop occurrence mapping workshop participated by municipal agriculturist. The purpose of the workshop is to collect points of crop occurrence of the crop considered in the study. It also aimed to categorize the yield per crop as high, medium and low. There should be at least 70 or more points per crop to be generated so that it can be used in the crop modelling using the MaxEnt.

The MaxEnt species/crop distribution modelling was used to generate crop climate and climate change suitability for the province. The result of the modelling was used to present the exposure 1 of the CRVA component.

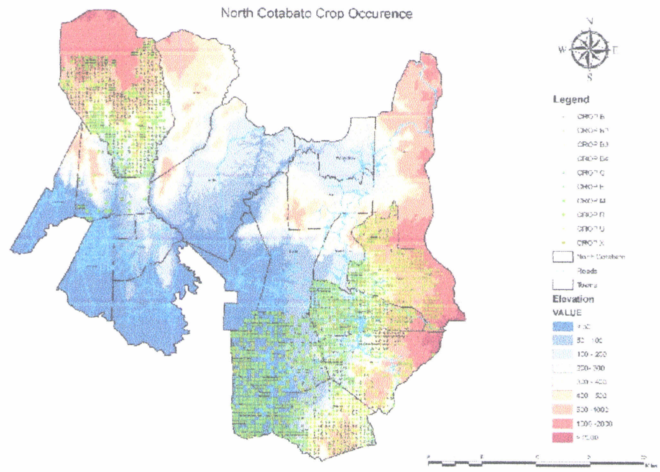


Figure 2. Sample crop occurrence map in North Cotabato

This creates a crop suitability comparing the present suitability and the projected suitability in 2050 using the Representative Concentration Pathways (RCP) and in this study, the research team used the RCP 8.5.

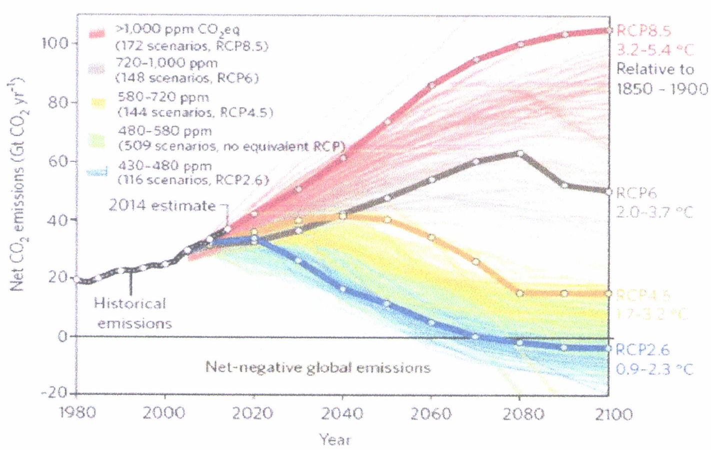


Figure 3. Representative Concentration Pathways (IPCC AR5, 2013)

Moreover, in the analysis of Climate-Risk Vulnerability Assessment (CRVA), the CRVA framework developed by CIAT was used to generate the CRVA maps for the province. In addition, the procedural steps is also presented in the Figure 4.

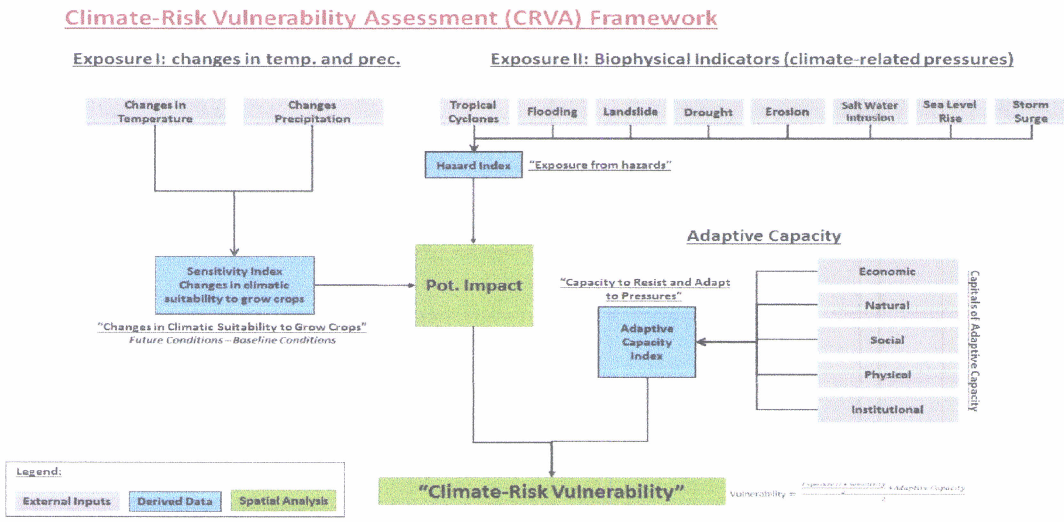


Figure 4. Climate-Risk Vulnerability Assessment Framework

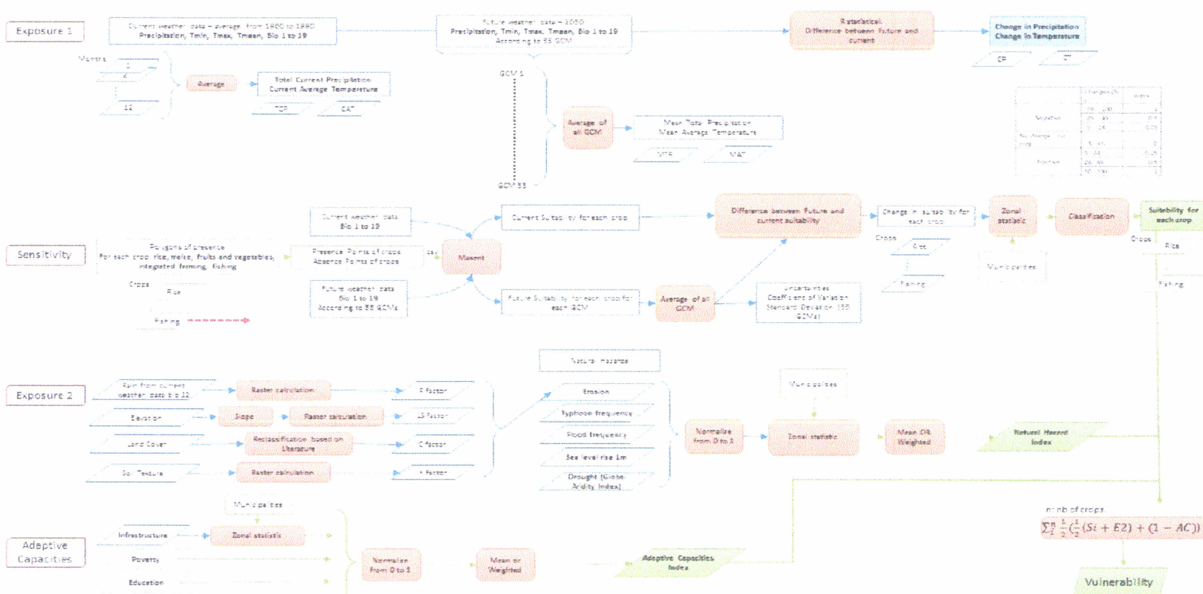


Figure 5. CRVA Procedural Step

Following the definition of vulnerability by the IPCC (2001), vulnerability is a function of exposure, sensitivity and adaptive capacity. Exposure is the nature and degree to which a system is exposed to significant climatic variations. Sensitivity, on the other hand, is the degree to which a system is affected, either adversely or beneficially by climate-related stimuli. Adaptive capacity is the ability of a system to adjust to climate change (Piya et al., 2012).

Mathematically, in this study, the vulnerability takes a function of:

$$V = \sum_{n=1}^{n} 1/2((Haz(w_h) + Sens_i(w_s) + AC(w_a))$$

where V is the vulnerability index; *Haz* is used to measure exposure component of the vulnerability index which represents the changes in climatic variables and occurrences of extreme climatic events in the province; *Sens* is the sensitivity index; and *AC* is the adaptive capacity; the w_S are the weights for hazard, sensitivity and adaptive capacity.

As to the hazard representing the exposure index, it is a composite of various climate hazards affecting the province. For Cotabao province it is a composite of 5 climate hazards as shown in Table 2. Each province were asked to rate the effect of the hazards to assign weights. Table 2 shows the rating given by the project team for each criteria. The hazard data were generate from an open source databases and from AMIA 1 outputs. Spatial weighting analysis was used to integrate the assigned weights. See Figure 5 for the procedure in arriving the hazard index (Exposure II)

Table 2. Impact of Climate Hazards on Agri-fishery Landscapes

	Impact of Agri-fishery landscapes					Weight
Exposure II:Bio-Physical	Probability of Occurrence	National Economy	Food Security	Household Income	Key Natural Resources to Sustain Productivity	
Erosion	5	1	2	2	5	16
Landslide	3	1	2	3	4	14
Flood	5	2	3	4	4	19
Drought (Agricultural or Hydrological)	3	3	4	5	3	19
Typhoon	3	2	3	4	3	16
Others: Pest and Diseases	5	2	3	4	1	16

In the adaptive capacity, data were generated from various secondary and primary sources. A municipal survey was carried out to generate the data needed on six capital assets of the municipality. These six capital assets were Economic, Human, Infrastructure, Institutional, Natural and Physical assets. Source of secondary data were the Socio-demographic profile of the Province, the National Competitive Council of the Philippines (NCCP), Philippine Statistical Authority (PSA) and National Mapping and Resource Information Authority (NAMRIA). The Principal Component Analysis (PCA) was used to explore the geographic variances, correlation and feature importance of data across municipalities and indicators. The shortlisted indicators were cross checked and some more variables were included to complete the representation of other AC capitals. A workshop was initiated to convene experts to discuss and decide for a common value/rate for each indicator. The values of the indicators were integrated in the shapefile municipal boundaries.

As to the sensitivity index, the procedure is shown in Figure 5. MaxEnt was used in generating an index using the crop occurrences as mentioned in the previous section. The projection was based on the IPCC AR5 and RCP 8.5 was used because it is most recent and policy relevant. The RCP 8.5 is described as the worst case scenario of climate change as shown in Figure 3. The GCM models were based on the CMIP 5 which is an ensemble of 33 GCMs that this study used. The crop presence data were spatially downscaled to 1km resolution and 20 bioclimatic variables were used. This means that physiological constraints by species and effect of climate change on species distribution can be imposed.

However, due to various indicators used and the composition of the vulnerability takes different values, there is a need to normalize so as to bring the values of indicators within a comparable range (Nelson et al., 2010b; Gbetibuo & Ringler, 2009; Vincent, 2004). Normalization is done by subtracting the mean from the observed value and dividing the standard deviation for each indicator. Mathematically, it can be written as:

$$V_n = \frac{\theta - \bar{X}}{\sigma}$$

where V_n is the normalized value; θ is the observed value; $\bar{X}$ is the mean value; and σ is the standard deviation.

Finally, the vulnerability index for each municipality is calculated as:

$$V_i = E + S - AC$$

where Vi is the vulnerability index; E is exposure index; S is sensitivity index and AC is the adaptive capacity index. However, to have an equal breaks analogous to the indicators, the vulnerability index was normalized so to fit with the five equal breaks as 0-20 (very low), 0.21-0.40 (low), 0.41-0.60 (moderate), 0.61-0.80 (high) and 0.81-1.00 (very high). These five ranges were used arbitrarily to all indices.

Component 3 - 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 to undertake CRA prioritization and planning.

These activities were guided by process facilitation and data collection tools developed by the AMIA2 projects on CRVA and CRA decision-support platform. The validation protocol was developed and hence, it is enumerated below.

Moreover, municipal survey was carried out in order to gather relevant data on the stakeholder's level of perception and knowledge on climate change. The survey was participated by the municipal agriculturist, municipal disaster risk and reduction officer and farmer representative. A survey questionnaire was developed in order to measure the level of perception, level of knowledge and to document the various indigenous practices as strategies in coping with the effect of climate change. The survey questionnaire consisted of close-ended and open-ended questions to determine the respondents' perceptions and knowledge on climate change.

Respondents were asked also to rate their over-all knowledge and perception on climate change using a percentage score before and after the project. A total of 75 respondents were taken into consideration composed of local government unit worker such as municipal agriculturist, municipal disaster risk reduction officer, municipal planning officer, provincial agriculturist, crop specialist, fishery specialist and farmers.

Component 4 - Documenting & 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. A desk review was also done to compare the data needed.

These data were systematized and analysed, using cost-benefit and trade-off analyses tools as input to AMIA2 CRA prioritization and investment planning. These likewise contributed to developing knowledge products, such as searchable online portal, under the AMIA2 project on CRVA decision-support platform.

In doing the CBA using the tool provided by CIAT, the team did a survey comprised of 100 farmers of conventional rice farming. Conventional rice farming was used as the base practice to be compared by two rice farming systems namely: Organic rice farming (biodynamics for rice) and integrated rice-duck farming. The details of which were discussed in the preceding section. Key informant interviews and secondary data sourcing were used to generate the information for these two climate-resilient agricultural practices.

2.5. RESULTS AND DISCUSSIONS

2.5.1. Capacity Building of Stakeholders

2.5.1.1. *CBA Workshop and CRA Training*

The International Center for Tropical Agriculture (CIAT) is leading a research on: 1) Climate-Risk Vulnerability Assessment (CRVA) and 2) Decision-support platform for Climate-Resilient Agriculture (CRA). This is part of the Adaptation and Mitigation Initiative in Agriculture (AMIA) Project of the Department of Agriculture (DA) that would support local communities to plan and implement strategies in managing climate risks – from extreme weather events to long-term climatic shifts.

CIAT in collaboration with the Department of Agriculture – Systems-wide Climate Change Office (SWCCO) with Regional Field Units (RFUs), State Universities and Colleges (SUCs), University of the Philippines Los Banos Foundation, Inc. (UPLBFI), and International Institute of Rural Reconstruction (IIRR) are working on 10 regions in the country.

The Decision-support platform for CRA Project aims to develop an evidence-based, decision-support platform to support in-country investment prioritization of CRA practices.

Specifically it aims:

1. To determine the country-wide status of risk-based CRA approaches and initiatives, including potential entry points for CRA out-scaling in target agri-fisheries communities;

2. To establish a country-relevant CRA knowledge hub of locally to globally proven practices, as reference guide for climate-resilient agri-fisheries communities; and
3. To analyze and recommend prioritized CRA options for evidence-informed investment planning and decision-making by key stakeholders.

Project outputs, such as CRA country profile, ex-ante CBA analysis of CRA practices, and knowledge products (e.g., compendium of CRA practices, CRA investment portfolios/policy briefs), would be of immediate, critical use to AMIA. investments to establish climate-resilient agri-fisheries communities, such as:

1. Next-stage regional level and commodity/systems-specific planning to design and implement AMIA interventions for establishing climate-resilient communities;
2. Refining the climate-responsiveness of AMIA integrated support services (e.g., climate finance and insurance) and institutional capacities (e.g., local governance); and
3. Planning and implementing an evidence-based monitoring and evaluation system to track and document AMIA contributions to resilience building in country's agriculture sector.

A training on Cost-Benefit Analysis (CBA) of CRA Technologies and Practices was conducted last 4-6 August 2016 at Hotel Torre Venezia, Quezon City, Metro Manila. The objectives of the training are:

1. To strengthen capacities of regional teams in conducting CBA based on the recommended methodological guidelines/tool;

2. To discuss and confirm the regional teams and their corresponding tasks in Decision-support platform for CRA; and

3. To update progress and general planning for CRVA and Decision-support platform for CRA.

A total of 33 participants from 10 regions are present in the training. Half of them are women. Fourteen are from DA-Regional Field Offices (RFOs) and 19 are from SUCs (see annex 2). Participants from the SUCs are Socio-economists (10), Agri-crops/systems Specialists (6), and Project Leaders (3).

Figure 6. Phot of the participants during the training

A pre- and post-training evaluation questionnaires were completed by the participants. Level of familiarity with the concept of CRA and CBA was increased after the training by 30% and 24%, respectively (Table 3). The average rating of the training is “good” (Table 4).

Table 3. Participants' level of familiarity with CRA and CBA concept.

Level of familiarity	Before	After	Difference
CRA	2.56	3.33	0.77 (30%)
CBA	2.69	3.33	0.64 (24%)

Table 4. Participants' average satisfaction rating.

Criteria	Average Rating
1. How well did the training achieve its objectives?	3.78 (Good)
2. How useful was the materials being provided?	3.96 (Good)
3. Was the length of the training sufficient?	3.37 (Average)
4. Was the content of the training well organized?	3.78 (Good)
5. Was the flow of the training properly executed?	3.74 (Good)
6. How clear and understandable were the discussions?	3.59 (Good)
7. How well the training met your expectations?	3.59 (Good)
8. How effective were the presenters?	3.59 (Good)
9. How readable and clear were the presentations?	3.26 (Average)
10. How comfortable was the venue for you?	4.41 (Good)
Average	**3.71 (Good)**

2.5.1.2. *Socio-Cost Benefit Workshop*

The International Center for Tropical Agriculture (CIAT) and the Department of Agriculture – Strengthening Implementation of Adaptation and Mitigation Initiative in Agriculture (DA-AMIA) project conducted two workshops on (1) validating smartness assessment of CRA practices, and (2) sharing preliminary results of CRA prioritization and extended CBA last 28-30 November 2016 at the Green Sun Hotel in Makati City.

These workshops were organized with the goal to validate results of the Climate-Resilient Agriculture (CRA) or Climate-Smart Agriculture (CSA) Country Profile in the Philippines. Experts coming from different institutions and specializations together with representatives from the DA Regional Field Offices (RFOs) and partner State Universities and Colleges (SUCs) were invited to participate during the said workshops.

The first workshop focused on assessing climate-smartness of existing and potential agricultural practices for selected production systems and regions. It was facilitated by Dr. Godefroy Grosjean, Climate Policy Expert at CIAT Asia in Hanoi. Nineteen participants coming from the academe and other research organizations brainstormed in selecting and evaluating different CSA practices for different production systems and commodities.

Participants were grouped based on the production system and commodity they specialize in and were tasked to assess the "climate-smartness" of existing and potential agricultural practices by following these steps:

Step 1: Validate the production system-specific practices (name, details)

Step 2: Define the scope of the assessment (Geographical region)

Step 3: Assess the general characteristics of each practice in the production system group

Step 4: Assess the smartness levels using CSA indicators for each practice and regions in the production system group (done individually)

After the group and individual activities, participants also engaged in a holistic discussion by sharing their evaluations per group and individually. Many questions were raised and addressed during the open forum at the end of the whole day workshop.

The second workshop which focused on sharing preliminary results of CRA prioritization and extended CBA was facilitated by Dr. Stanley Karanja, Agriculture Development Economist at CIAT Africa in Uganda and Ms. Le Ngoc Lan, Agricultural Economist at CIAT Asia in Hanoi. Six participants coming from three selected regions in the Philippines (Iloilo, North Cotabato, and Negros) took part in the two days' workshop. The first day of the workshop started with Dr. Stanley's presentation on the introduction of externalities and social profitability aspects of Cost-Benefit Analysis (CBA) where he discussed about the general background of CBA, the types of externalities, and the valuing of externalities. This presentation was then followed by a discussion on the sample CBA of CRA practices in Ghana where he added further information and gave a more in depth discussion by showing an example of valuing externalities of organic farming and improved seeds in Ghana.

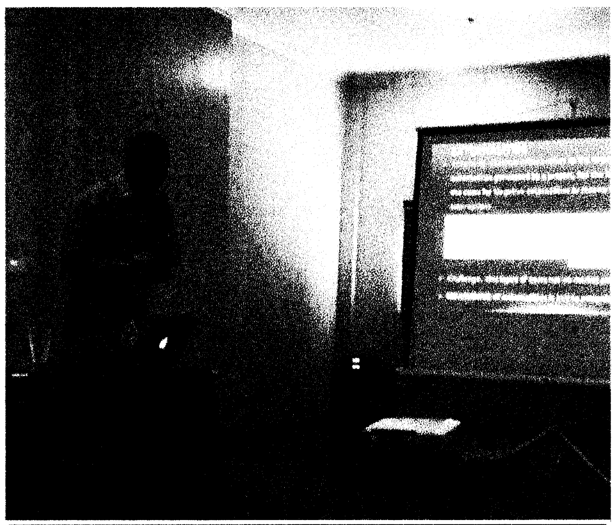


Figure 7. Dr. Stanley giving his lecture on Externalities

After the lecture on valuing externalities, Ms. Lan demonstrated to the participants how to input the collected data on the online CBA tool which will be found on the CIAT website. Different kinds of data gathering/collecting techniques on externalities valuation were also given emphasis by Dr. Stanley during the first day of the workshop. Here, types of data sources (primary and secondary) were discussed as well as the corresponding limitations, issues, and/or problems.

The first day of the workshop was concluded with the first group activity which is a scoping exercise on the externalities of selected CSA practice.

The second and last day of the workshop continued with the remaining activities for the group. The second part of the group exercise was to plan and strategize data collection of externalities which was done on the first half of the day and was followed by their presentation on planning and strategy in the afternoon.

Figure 8. Photo of the participants

The last part of the workshop showcased an online lecture of Prof. Nicholas Hanley from the University of St. Andrews, Scotland on the overview of methodologies on valuing environmental and social externalities in CBA.

CIAT's workshops on validating smartness assessment of CRA practices, and on extended CBA training are just two out of four workshops that the organization plans to conduct for the CRA Country Profile. Other workshops are on designing the knowledge hub for CRA communities, and assessing key policies to CRA.

2.5.1.3. *Participatory Mapping and Data Collection*

In order to carry out the objective of mapping the location of maps, the team called a participatory mapping workshop attended by municipal agriculturists. The team provided a map of the province and the participant plotted or locate the various crops planted in the province. This activity was done in order to come a geospatial map of crop occurrences that was used in generating maps for sensitivity and vulnerability.

There should be at least 70 or more points per crop to be generated so that it can be used in the crop modelling using the MaxEnt. At the end of the activity, the team had come up with various crop occurrence maps of the following crops:

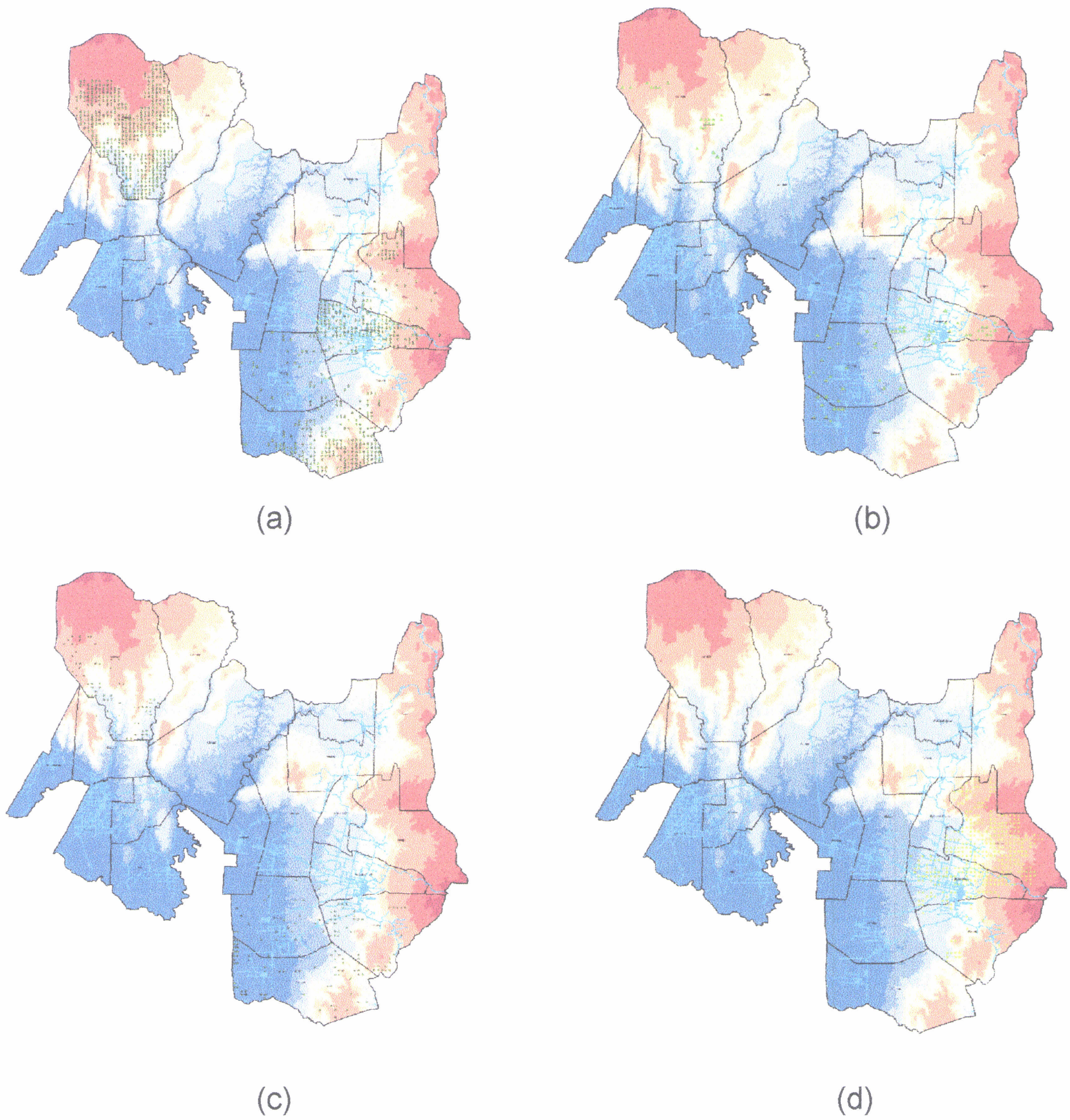
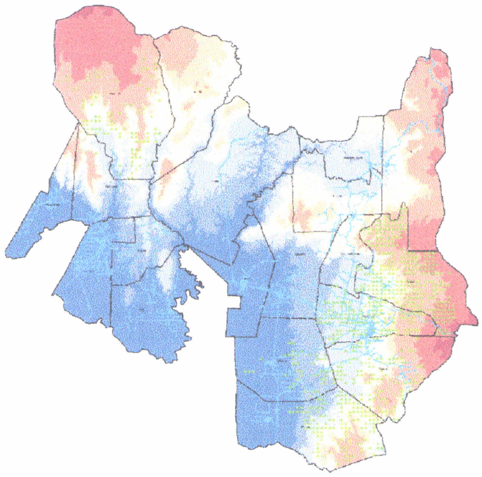
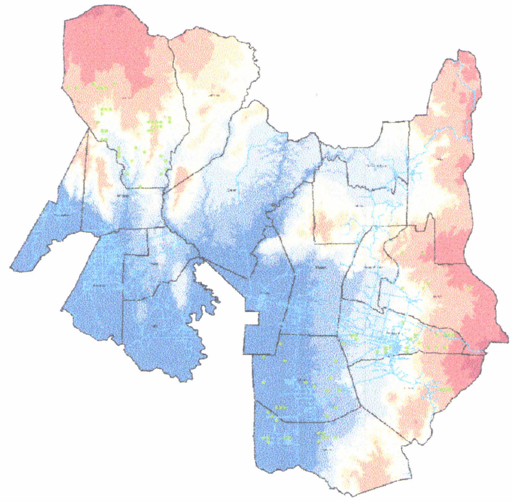


Fig. 9 (a) Crop occurrence of corn; (b) crop occurrence of eggplant

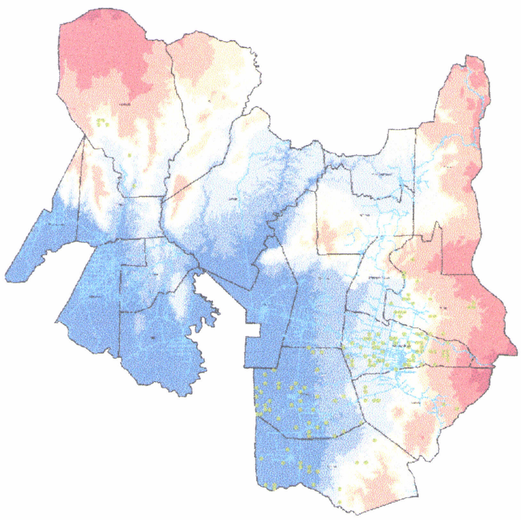
(c) crop occurrence of Lakatan Banana; (d) Crop occurrence of Cavendish



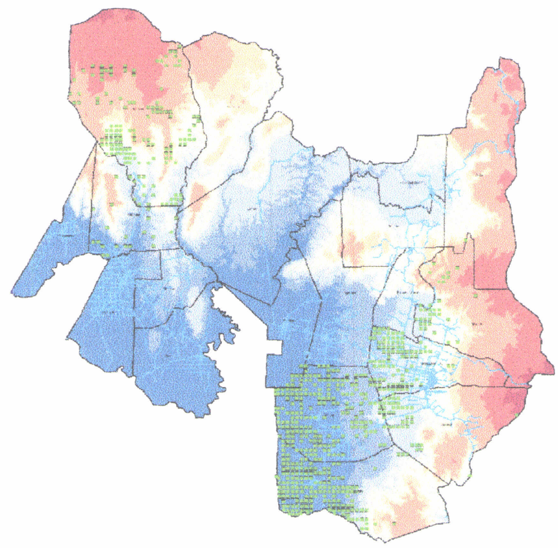
(e)



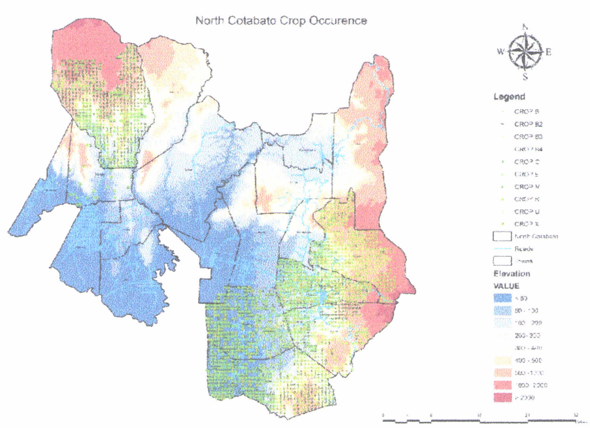
(f)



(g)



(h)



(i)

(e) Crop occurrence of rubber; (f) crop occurrence of nappier

(g) crop occurrence of tilapia; (h) Crop occurrence of rice; (i) crop occurences of crops in Cotabato Province

Further, stakeholders were enjoined in the planning and implementation of the project. They were part as respondents of the study. Data were collected through an interview with these stakeholders which included municipal agriculturist, municipal disaster risk reduction and management officer, planning and development officers and farmers of various crops. This interview helped the research team to evaluate their level of understanding about the project as well as climate change. Results of this interview is presented in later section.

2.5.2. Climate Risk Vulnerability Assessment

2.5.2.1. Crop Suitability Assessment

Figure 10 shows the suitability of Cotabato Province for tomato production. Almost 60% of the province at present has lower suitability. This includes the municipalities of Pigcawayan, Midsayap, Aleosan, Pikit, Kabacan, Matalam, M'lang, Tulunan, and Makilala. However, Banisilan, Arakan, Maikilala, and Magpet are still suitable for tomato production Alamada, President Roxas, Antipas, and some areas of Carmen are moderately suitable.

It can be predicted that after 33 years, suitability of Cotabato Province for tomato production will keep on decreasing. There will still be part of Banisilan, Arakan, Magpet, and Makilala that remains highly suitable for tomato production.

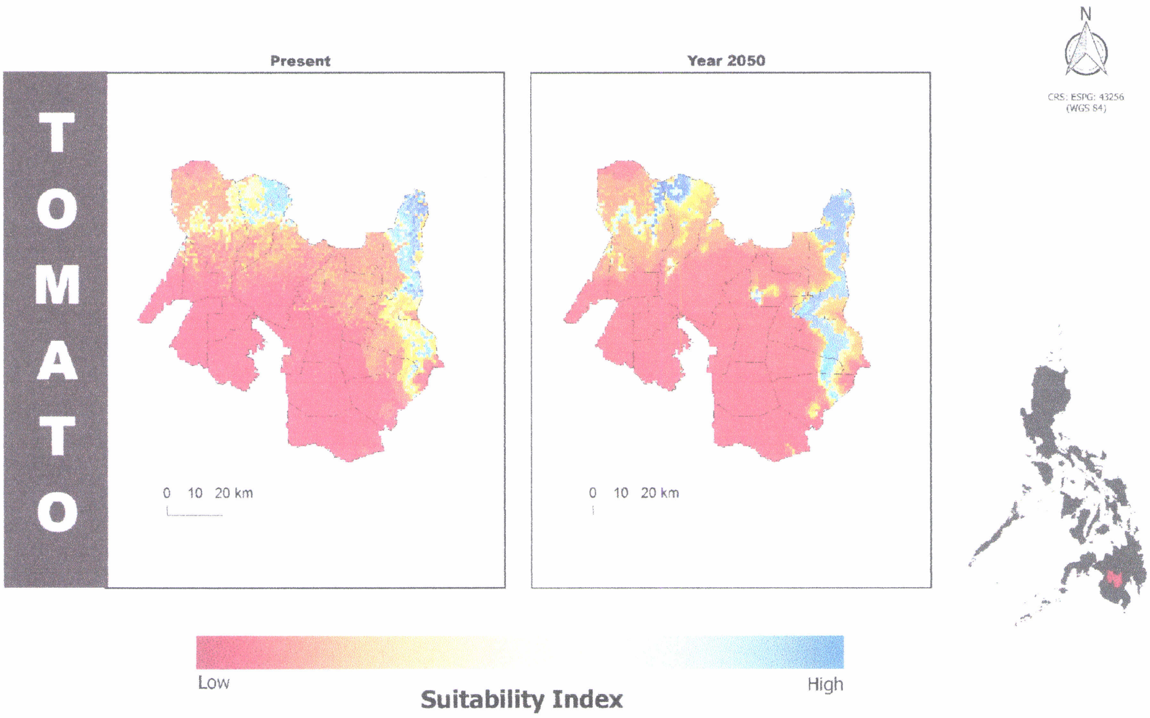


Fig. 10 Suitability of Cotabato Province for tomato production

Figure 11 shows the suitability of Cotabato Province for banana production. Currently, the province is still highly suitable for banana production, but there were areas at Alamada, Magpet and Arakan that has lower suitability. It is predicted that after 33 years, almost 80% of the province will be affected and becomes less suitable for banana production. There will still be areas on Eastern part, particularly in Magpet, Makilala, and some areas in Antipas, Kidapawan and Tulunan, and some areas in Pigcawayan, Libungan, Alamada, Banisilan, and Carmen, that are still highly suitable.

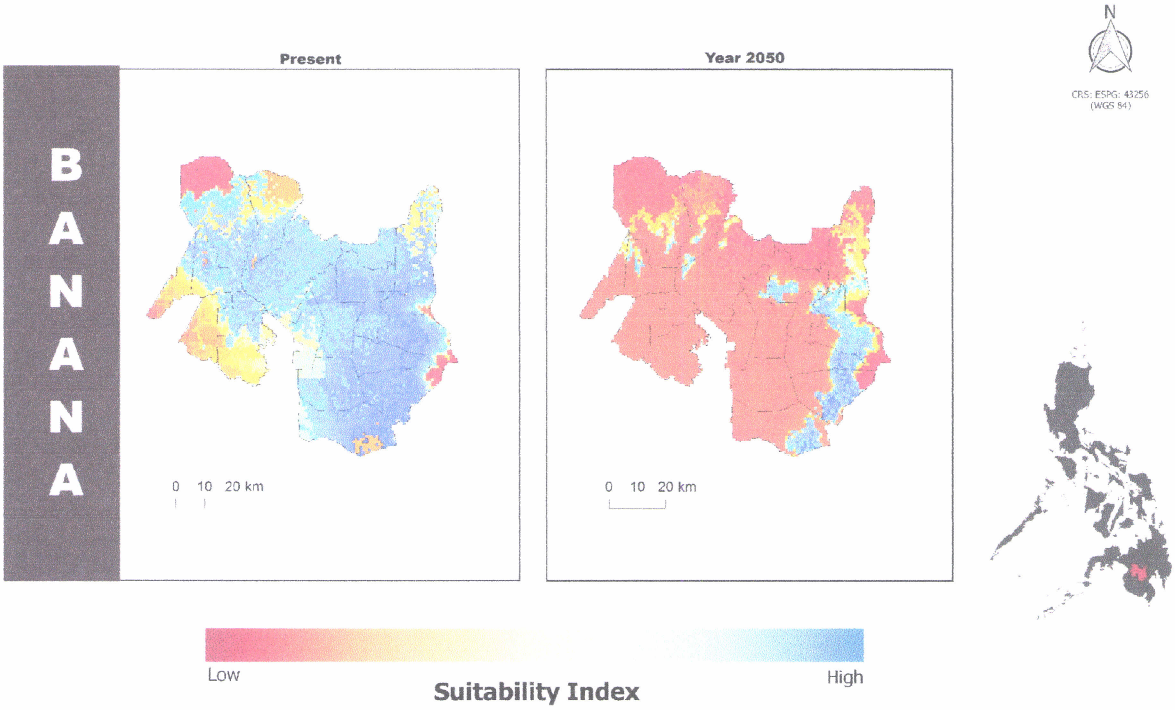


Fig. 11 Suitability of Cotabato Province for banana production

Figure 12 shows the suitability of Cotabato Province for cacao production. About 60% of the municipalities in the province are currently highly suitable for cacao production. This includes the municipalities of Banisilan, Arakan, President Roxas, Antipas, Magpet, Kidapawan, Makilala, and some areas in Alamada, Carmen, Matalam, M'lang, and Tulunan. Midsayap, Pigcawayan, and Pikit are less suitable for cacao production.

After 33 years, about 16% of the province remains highly suitable for cacao production, and that includes Arakan, Magpet, Makilala, and some areas in Kidapawan. Alamada and Banisilan are still suitable but with lower suitability. The rest of the municipalities become less suitable for cacao production.

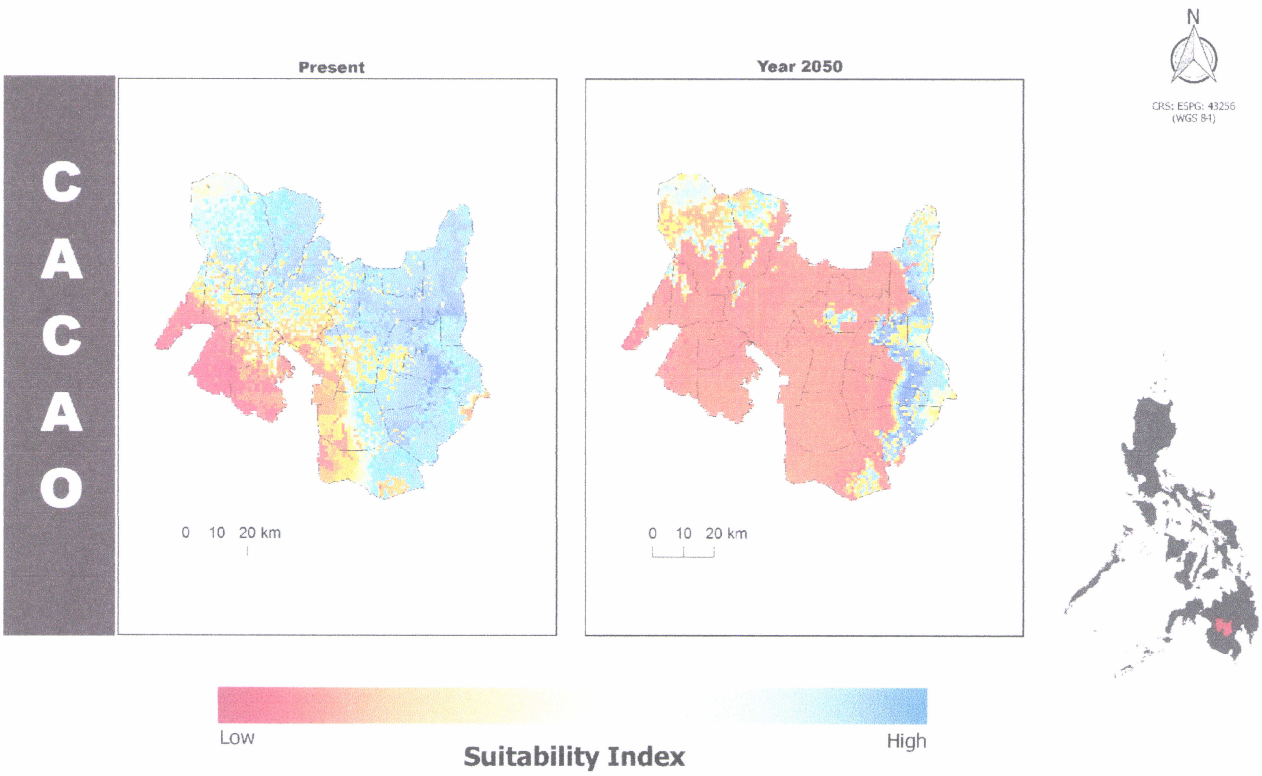


Fig. 12 Suitability of Cotabato Province for Cacao production

Figure 13 shows the suitability index of Cotabato Province for coffee production. The map shows that Alamada, Banisilan, President Roxas, Arakan, Antipas, Magpet, Makilala and Kidapawan, and some areas in Carmen are highly suitable for coffee production. However, Pigcawayan, Midsaap, Libungan, Pikit, and Kabacan have very low suitability; while M'lang and Tulunan are moderately suitable.

After 33 years, only Arakan, Magpet, Makilala, Banisilan, and few areas from Alamada, and Antipas remain suitable for coffee production, while the rest of the municipalities become less suitable. A small portion of Pigcawayan, Midsayap, and Tulunan has the least suitability.

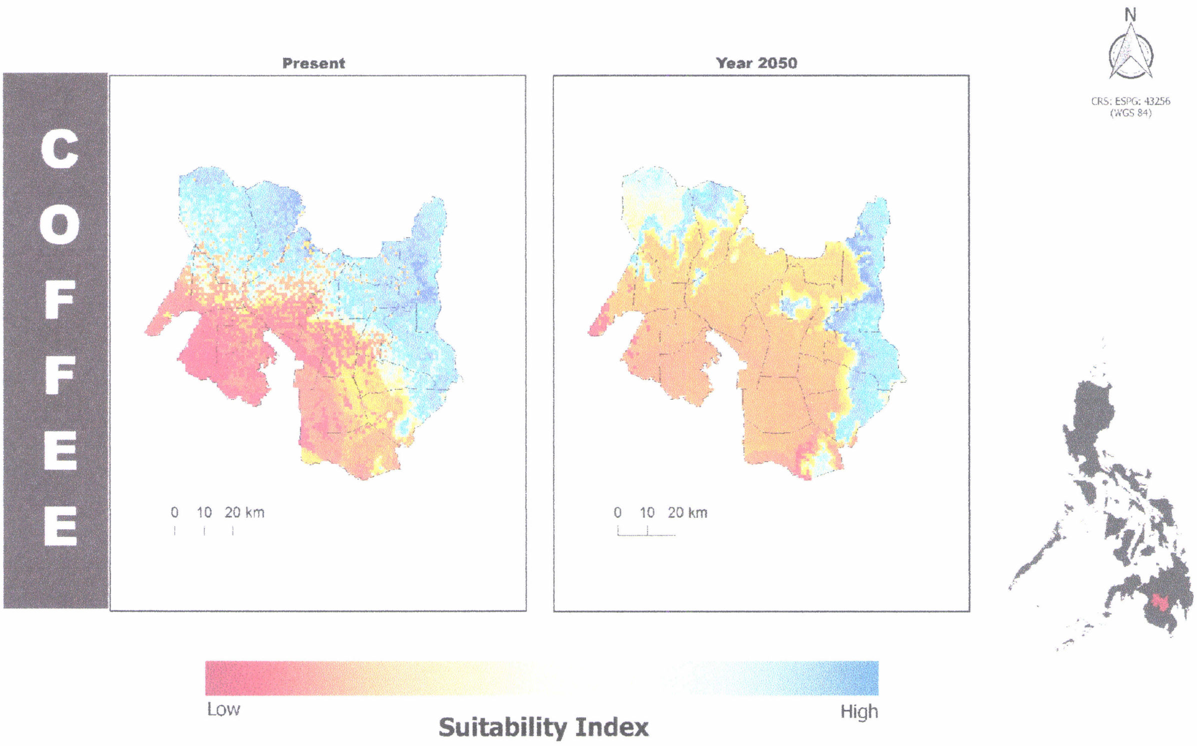


Fig. 13 Suitability of Cotabato Province for coffee Coproduction

Figure 14 shows the suitability of Cotabato Province for mango production. The map shows that only Banisilan is highly suitable for mango production at present. A part of Alamada, Carmen, President Roxas and Arakan are moderately suitable. The rest of the Municipalities are less suitable for mango production. In 2050, only part of Banisilan and few areas in Arakan remain suitable for mango production. Some areas in Magpet Kidapawan, and Makilala becomes moderately suitable, while the rest of the municipalities become less suitable for mango production.

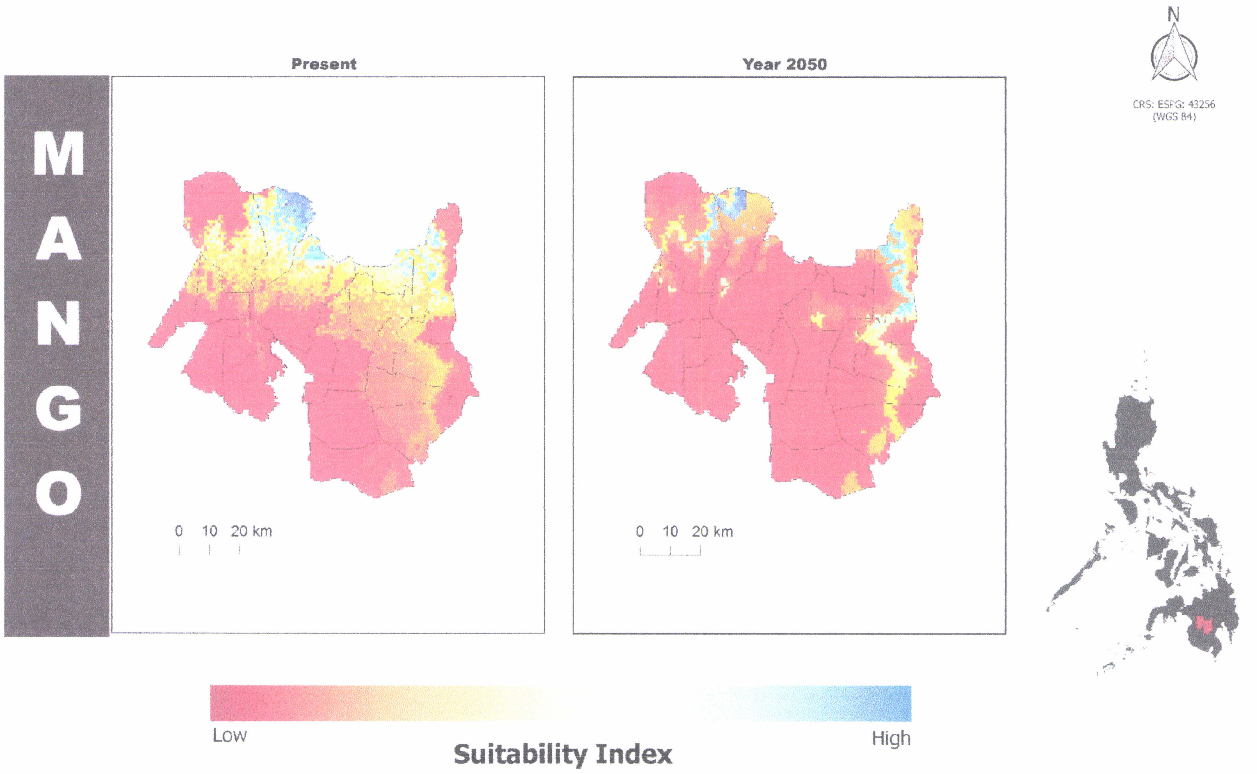


Fig. 14 Suitability of Cotabato Province for mango production

Figure 15 shows the suitability of Cotabato Province for rice production. The map shows that at present, almost 80% of the provinces are still highly suitable for rice production. Almost half of Alamada area, as well as some areas in Arakan, Magpet, Makilala, and Tulunan are less suitable.

As the map shows, it can be predicted that about 20% of the province remains highly suitable for rice production, and that includes Banisilan, President Roxas, and some areas in Alamada, Carmen, Arakan, Magpet and Makilala. Pigcawayan, Municipalities of Midsayap, Aleosan, Pikit, Carmen, Kabacan, M'lang, Matalam, and Tulunan becomes moderately suitable.

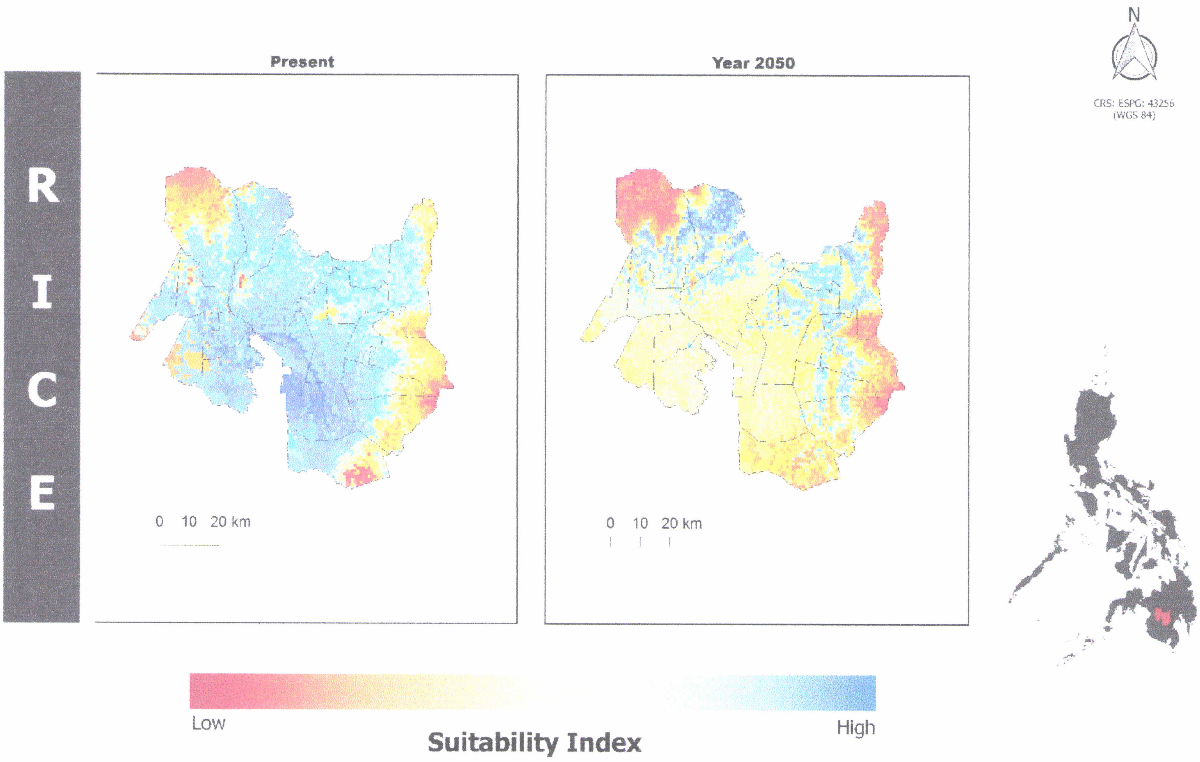


Fig. 15 Suitability of Cotabato Province for rice production

Figure 16 shows the suitability of Cotabato Province for rubber production. Arakan, President Roxas, Antipas, Magpet, Makilala, Kidapawan, Tulunan, and part of Alamada, Banisilan, Carmen Libungan, Pigcawayan, Libungan, Matalam, and M'lang are highly suitable for rubber production at present. Midsayap, Pikit, and some areas in Alamada, and Tulunan are less suitable; while the rest of the areas in the province are moderately suitable.

In 2050, as the map shows, almost 90% of the province will become less suitable. Only a part of Magpet, Kidapawan, Makilala, Tulunan, and few areas in Libungan, Carmen, and Antipas will remain highly suitable for rubber production.

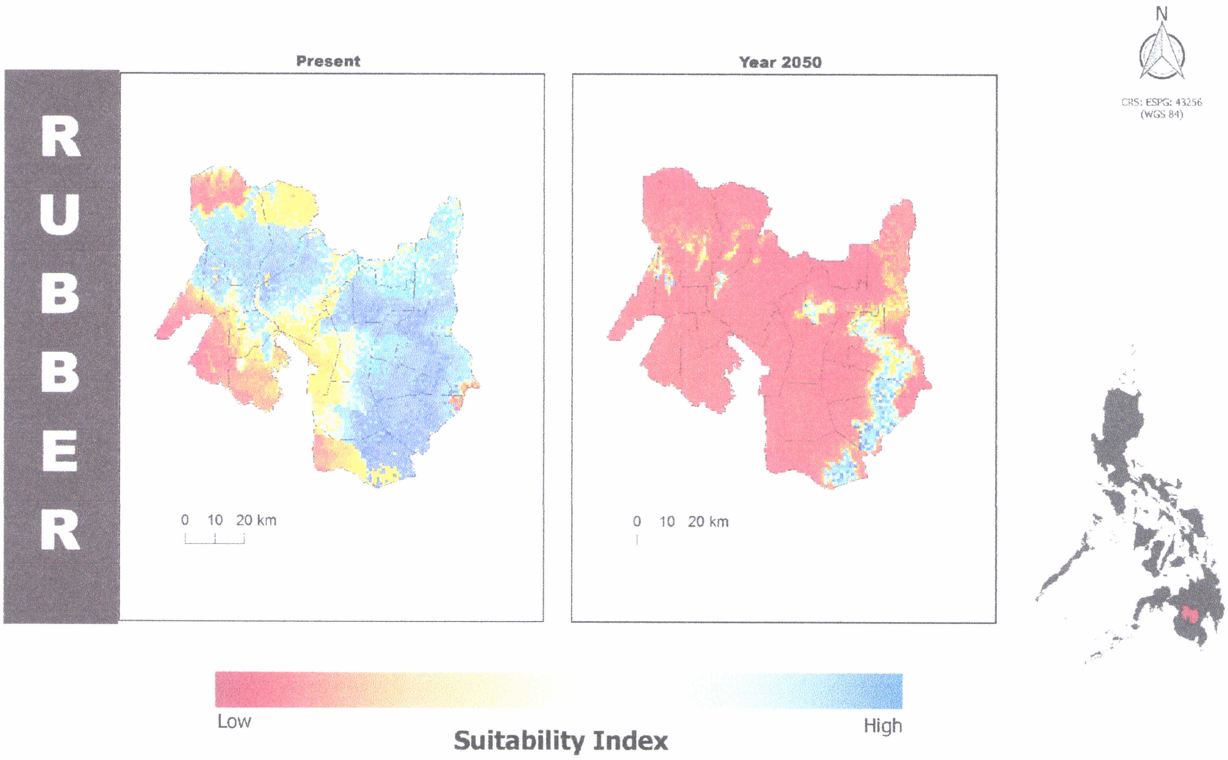


Fig. 16 Suitability of Cotabato Province for rubber production

Figure 17 shows the suitability of Cotabato Province for corn production. Almost 90% of the province are hilghly suitable, only Pigacawayan, Midsayap, Aleosa, Pikit and some part of makilala are less moderate suitable; while the rest of the areas in the province are moderately suitable.

In 2050, as the map shows, almost 80% of the province will become less suitable. Only some part of Carmen, Alamada, Libungan, Antipas, Magpet, and Makilala will remain highly suitable for rubber production. The rest are moderate suitable.

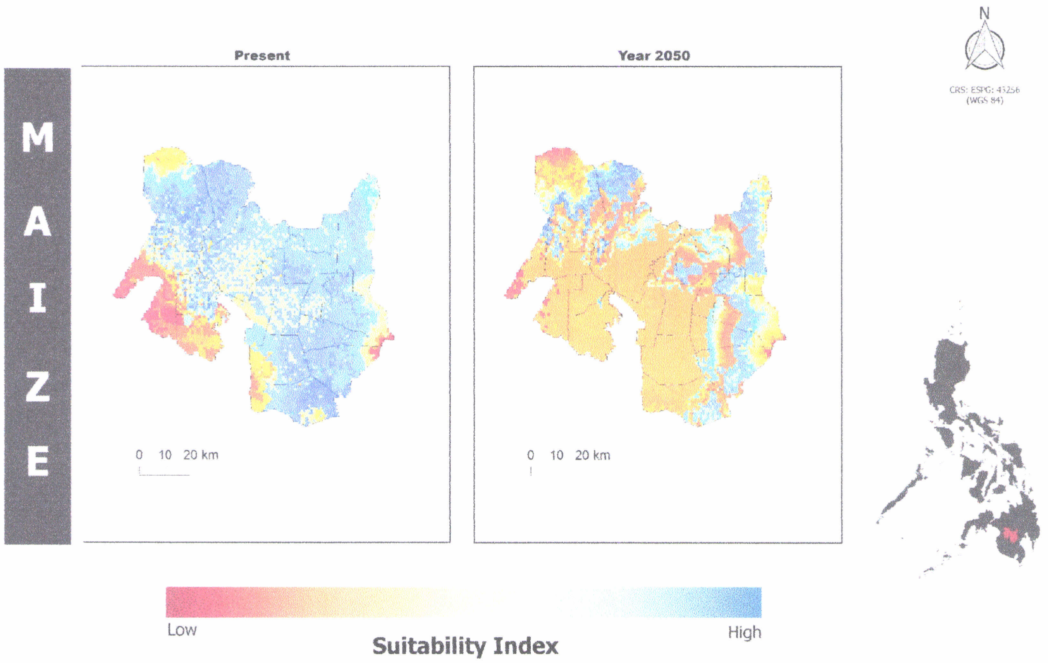


Fig. 17 Suitability of Cotabato Province for corn production

2.5.2.2. Vulnerability Assessment

2.5.2.2.1. Sensitivity Index

Figure 18 shows the sensitivity of Cotabato Province to climate change in terms of tomato production. Municipalities of M'lang (0.5) and Tulunan (0.5) were sensitive to climate change.

Climate change sensitivity of Cotabato Province when it comes to banana production is shown in Figure 17. The entire province is sensitive to climate change, however,the municipalities of Libungan, Carmen, Aleosan, Midsayap, Pikit, Kabacan, M'lang, Matalam, Kidapawan, and President Roxas were most sensitive.

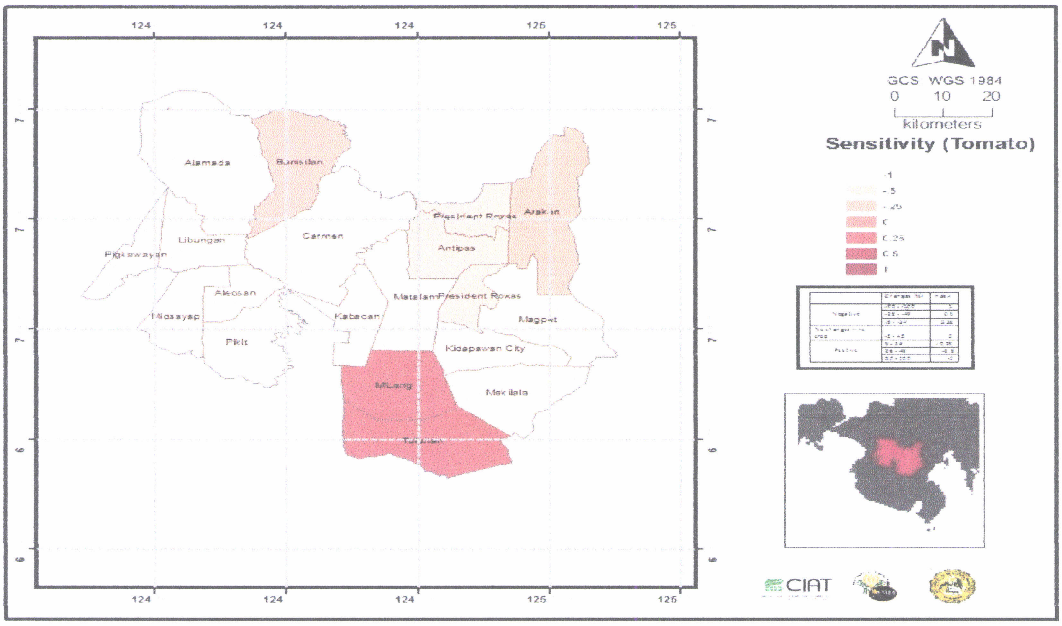


Fig. 18 Sensitivity of Cotabato Province to climate change in terms of tomato production

Figure 19 shows the sensitivity to climate change of Cotabato Province for cacao production. Almost all of the municipalities in the province were sensitive to climate change except for the municipalities of Pigcawayan, Midsayap, and Pikit.

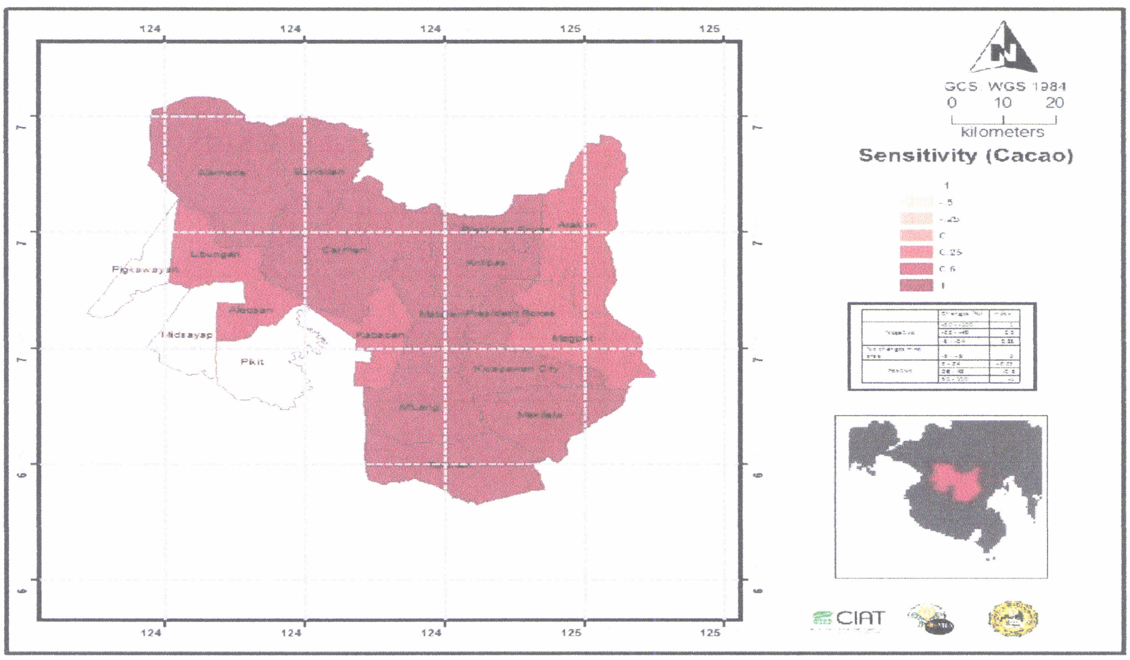


Fig. 19 Sensitivity to climate change of Cotabato Province for cacao production

In Figure 20, the map shows that the entire province is sensitive to climate change when it comes to coffee production. Climate change sensitivity of Cotabato Province in terms of mango production is shown in Figure 12. The municipalities of Midsayap, Pikit, Aleosan, Carmen, Kabacan, Matalam, M'lang, Tulunan, President Roxas, Kidapawan, Pigcawayan, Libungan, and Antipas were sensitive. Alamada, Banisilan, Arakan, Magpet, and Makilala were not sensitive.

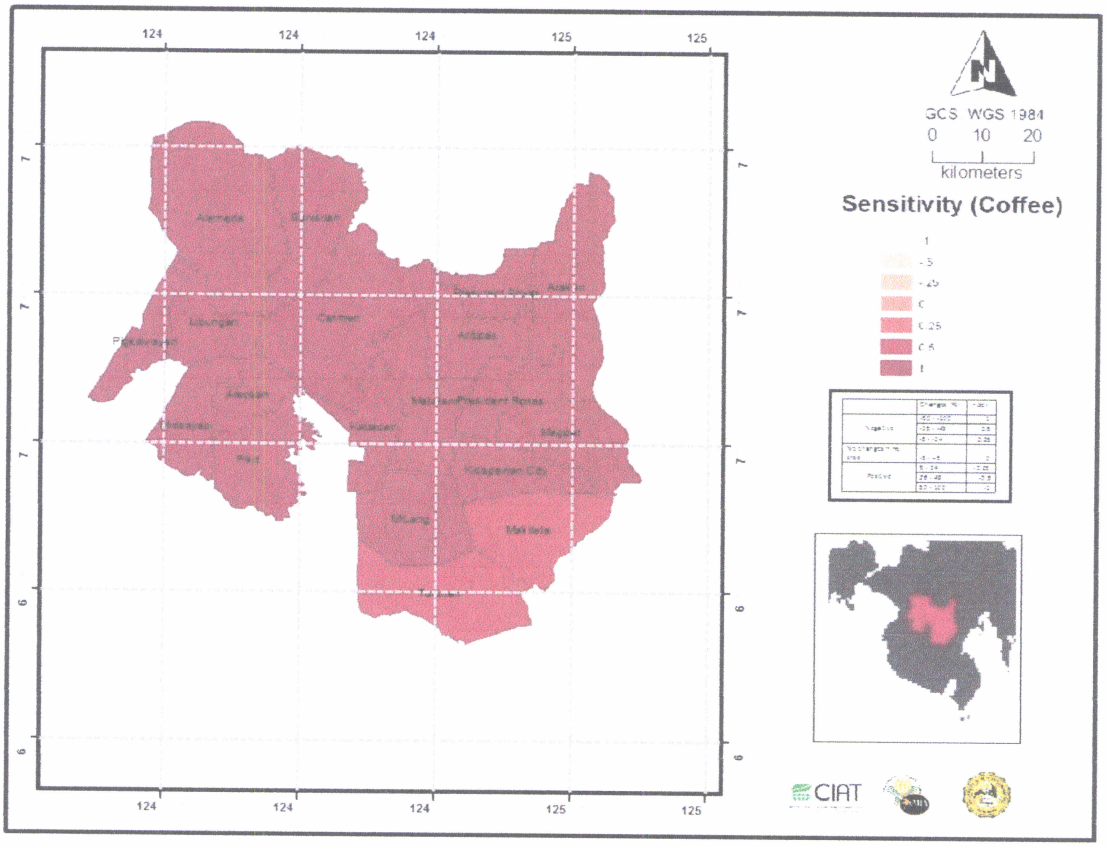


Fig. 20 Sensitivity of Cotabato Province to climate change in terms of coffee production

Figure 21 shows the sensitivity to climate change of Cotabato Province in terms of rice production. Pigcawayan, Libungan, Midsayap, Tulunan, Banisilan, Antipas, and Makilala were not sensitive, while the rest of the municipalities were sensitive.

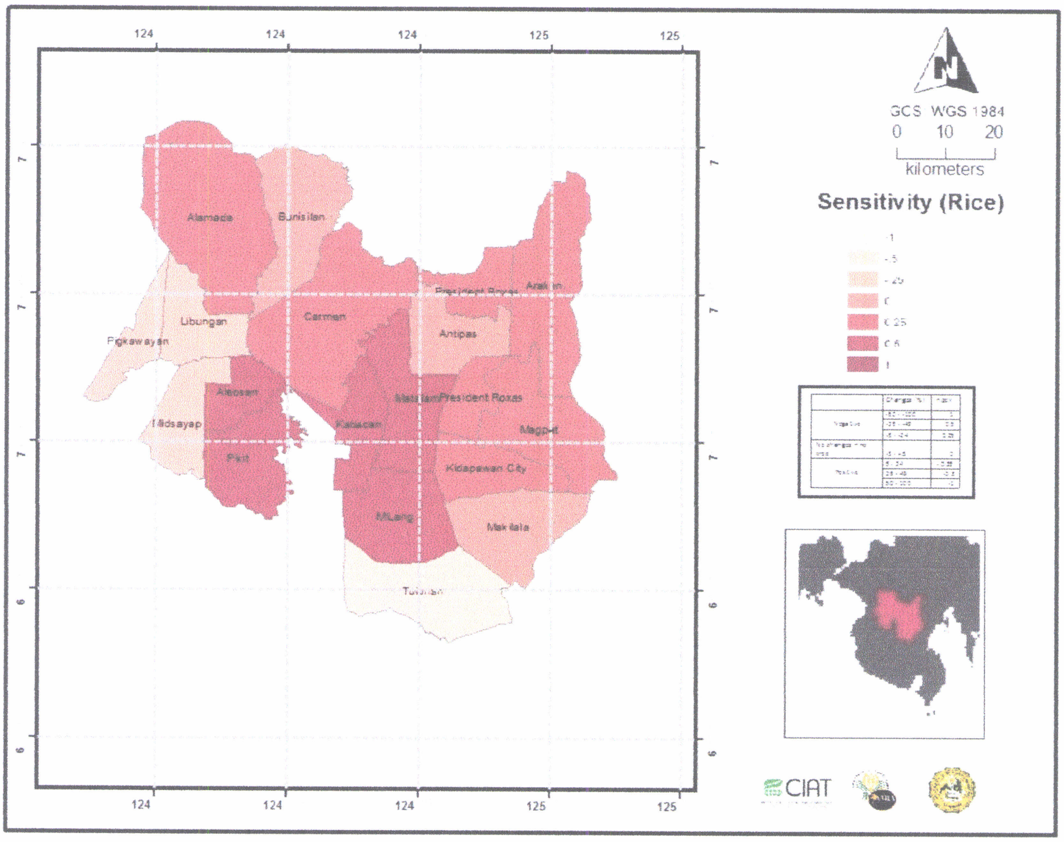


Fig. 21 Sensitivity of Cotabato Province to climate change in terms of rice production

In **Figure 22**, it is shown that Pigcawayan, Midsayap, and Pikit were not sensitive to climate change for corn production. The rest of the municipalities were sensitive.

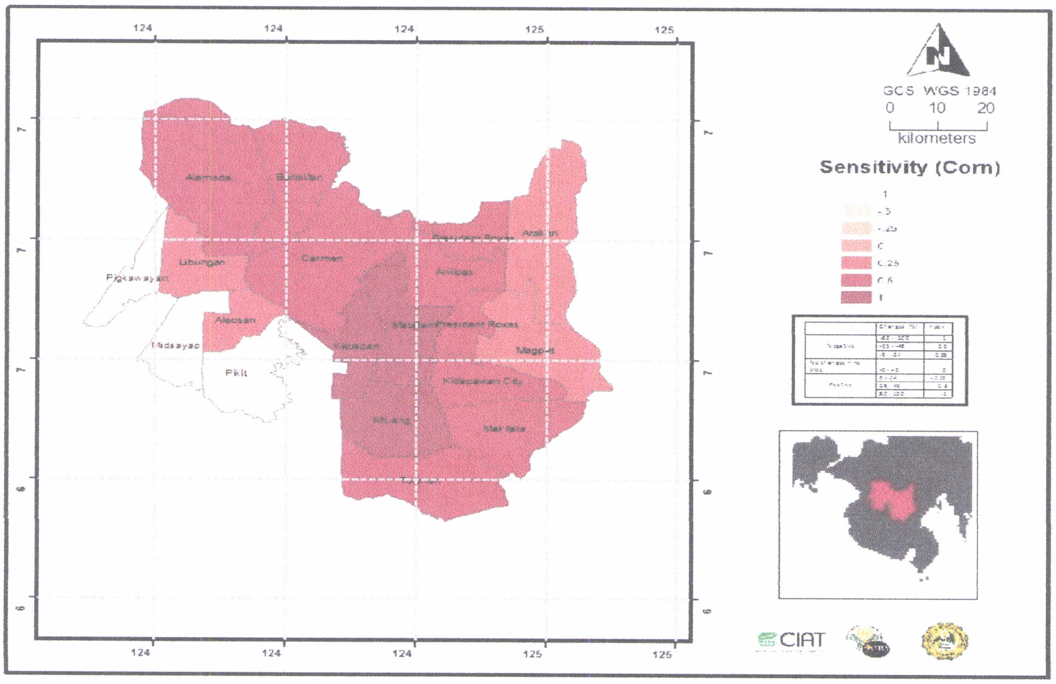


Fig. 22 Sensitivity of Cotabato Province to climate change in terms of corn production

Figure 23 shows that the entire Cotabato Province is not sensitive to climate change when it comes to eggplant production.

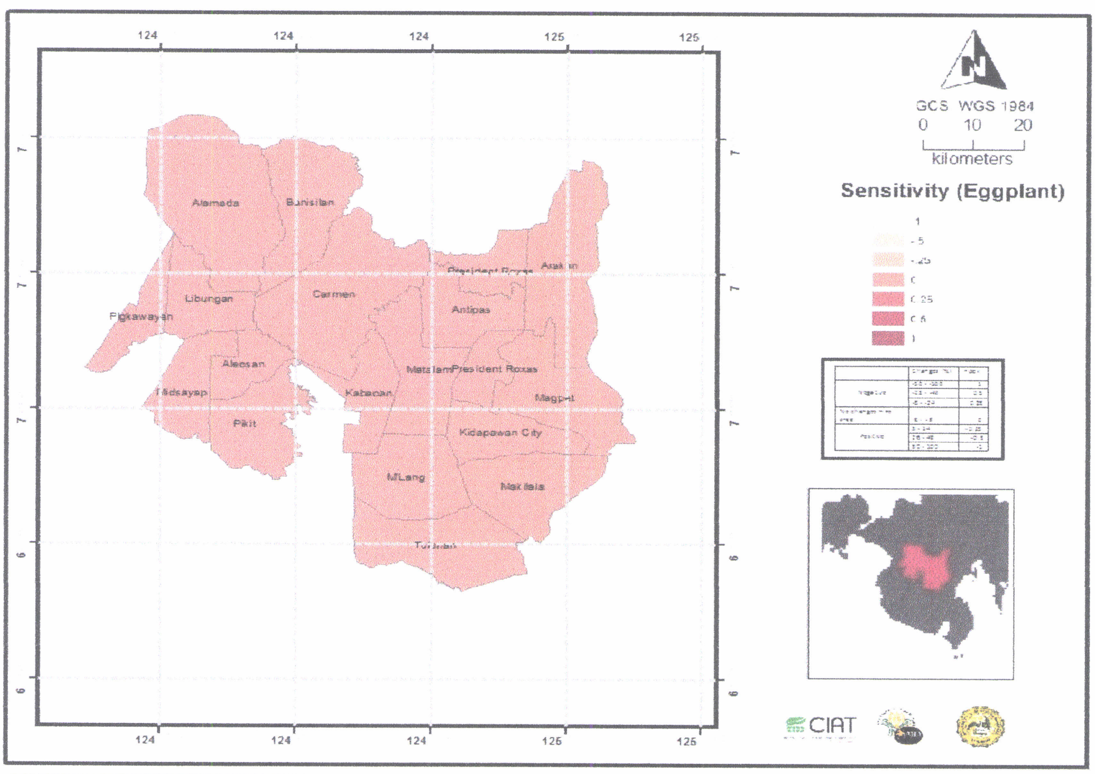


Fig. 23 Sensitivity of Cotabato Province to climate change in terms of eggplant production

2.5.2.2.2. Exposure Index

The municipalities of Pigcawayan, Libungan, Banisilan, Carmen, President Roxas, Matalam, and Antipas were highly exposed to hazards as shown in Figure 24. However, there were municipalities that were least exposed to hazards such as Pikit, M'lang, Tuluna, Kidapawan, and Makilala.

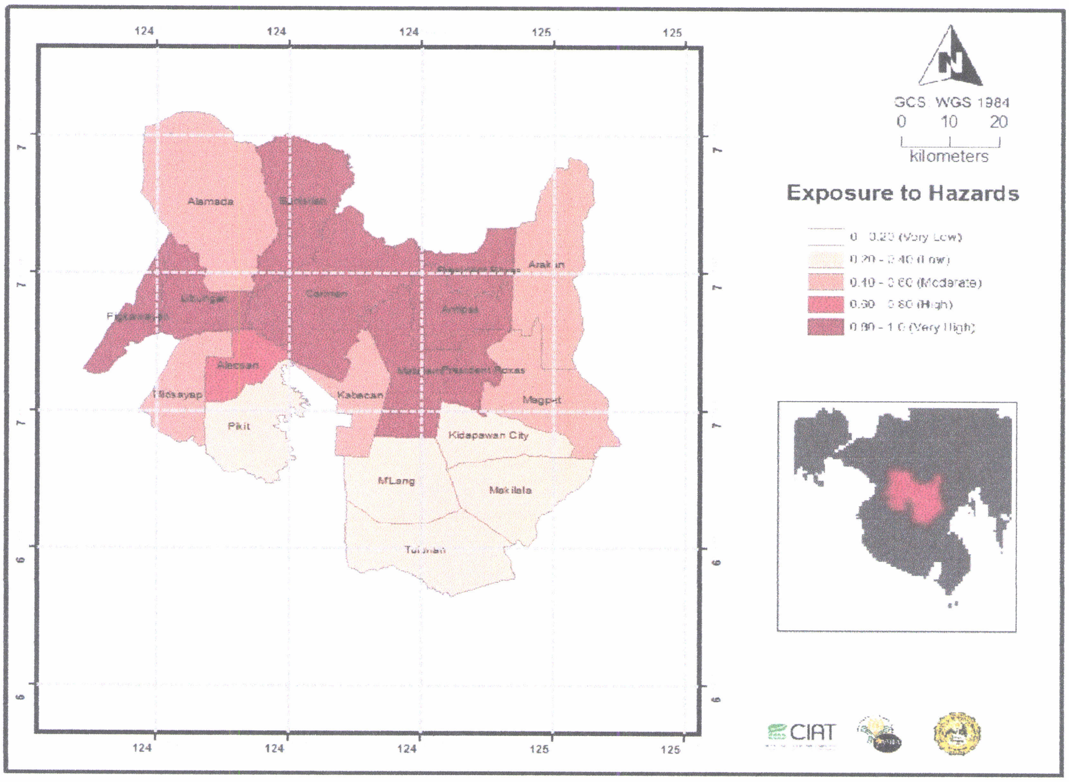


Fig. 24 Exposure to hazards

2.5.2.2.3. Adaptive Capacity Index

Figure 25 shows the adaptive capacity of Cotabato Province to climate change. The map shows that Kidapawan City and Midsayap has the lowest adaptive capacity, while Libungan, Matalam, President Roxas, Magpet and Makilala have the highest adaptive capacity.

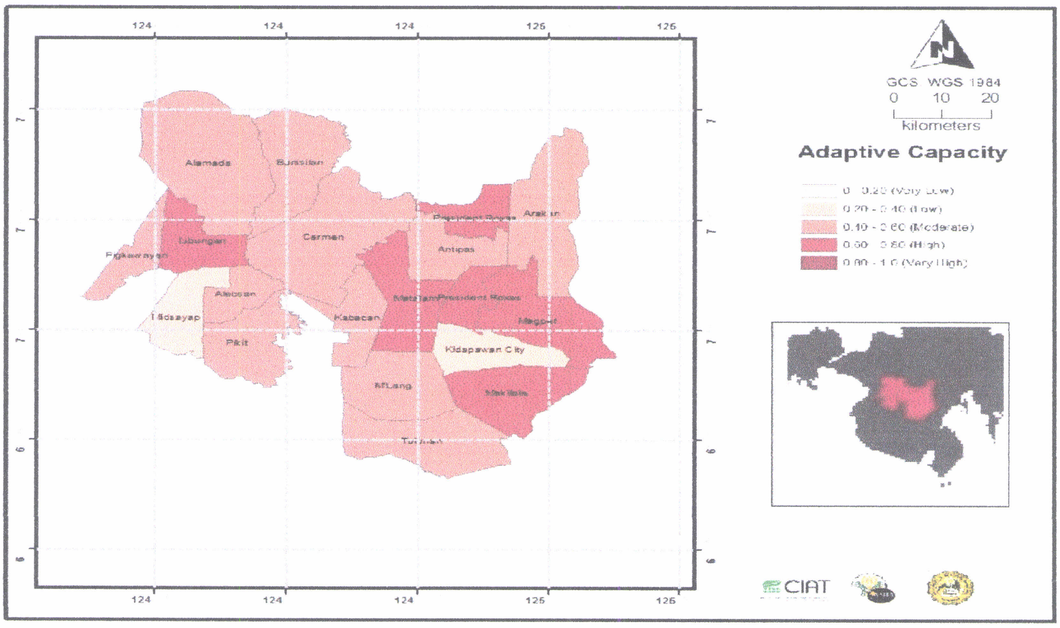


Fig. 25 Adaptive capacity

2.5.2.2.4. Climate Risk Vulnerability

The vulnerability to climate change of Cotabato Province is shown in Figure 26. Libungan, Matalam, and President Roxas were very vulnerable to climate change, while Midsayap and Kidapawan were the least vulnerable.

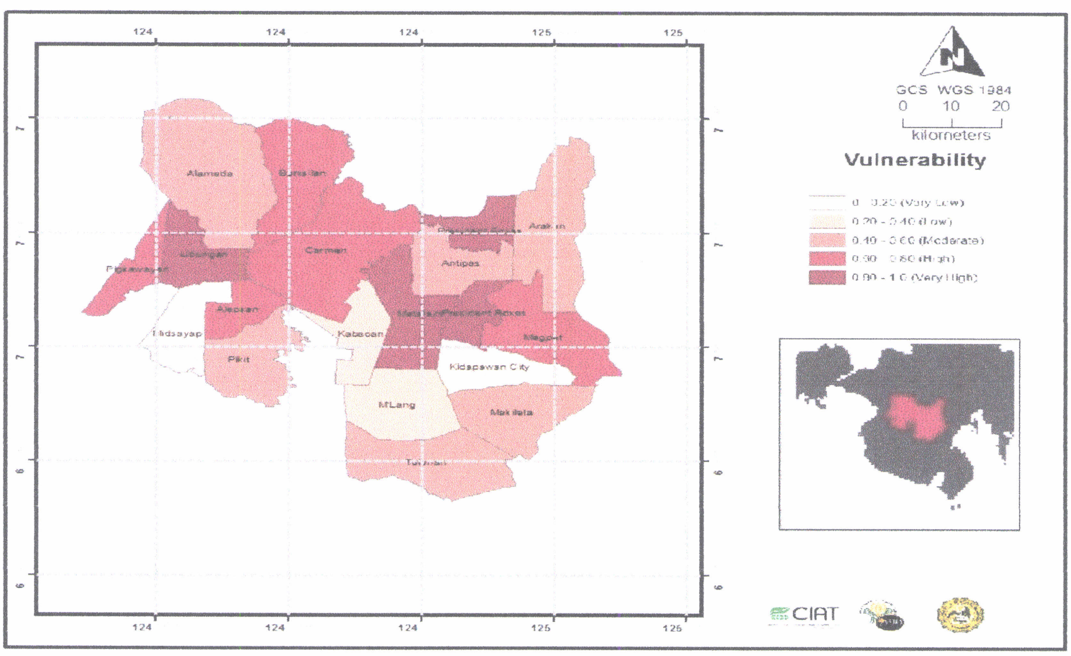


Fig. 26 Vulnerability to climate change

2.5.3. Perception, Knowledge and Strategies of Stakeholders on Climate change

Stakeholders' Knowledge on Climate Change

Table 5 shows that almost all of the stakeholders (farmers, MAs, MPDOs, and MDRRMCs) in every municipality have heard the concept of climate change. Almost all of the stakeholders believed that climate change is the depletion of ozone layer, but for MDRRMCs, they agreed that climate change is a change in climatic parameters. Some of the stakeholders also described climate change as a change from rainfall to sunshine, while there were few who believed that it is an eclipse that occurred some few years ago.

Majority of the stakeholders have heard the concept of climate change from radio and television. Others have acquired knowledge on climate change from acquaintances, while there were some who have heard it from workshops and have read it from newspapers, books and journals.

Almost all of the stakeholders believed that human activities are the cause of climate change; but there were some who also believed that it is because of natural activities.

Before they have heard of the concept on climate change, MDRRMCs have higher level of knowledge of the said concept (ave=4.47), while farmers have the lowest knowledge (ave=3.33) where ten (10) is the highest and one (1) is the lowest. On the average, stakeholders have 3.95 level of knowledge. Their knowledge has increased the time they have read and heard it from the sources stated, and MAs (ave=7.93) have acquired greater knowledge about the concept of climate change by this time, while farmers' knowledge level has increased to 7.33. On the average, stakeholders' knowledge level increased to 7.66.

Table 5. Stakeholders' Knowledge on Climate Change

VARIABLES	Farmers			Municipal Agriculturists			MPDO			MDRRMO		
	FREQUENCY (n=30)	Percentage (%)	Average	FREQUENCY (n=15)	Percentage (%)	Average	FREQUENCY (n=15)	Percentage (%)	Average	FREQUENCY (n=15)	Percentage (%)	Average
1. Number of farmers who have heard the concept t of climate change	27	90.00		15	100		15	100.00		15	100.00	
2. Description of climate change:												
a. A change from rainfall to sunshine	16	53.33		7	46.67		4	26.67		8	53.33	
b. Change in climatic parameters	14	46.67		9	60.00		8	53.33		13	86.67	
c. Eclipse that occurred some few years ago	1	3.33					1	6.67		1	6.67	
d. Depletion of the ozone layer	17	56.67		9	60.00		10	66.67		11	73.33	
3. Sources of Information on climate change:												
a. Newspaper	4	13.33		6	40.00		6	40.00		8	53.33	
b. TV and Radio	24	80.00		10	66.67		9	60.00		11	73.33	
c. Workshops	9	30.00		8	53.33		9	60.00		11	73.33	
d.												

VARIABLES	Farmers			Municipal Agriculturists			MPDO			MDRRMO		
	FREQUENCY (n=30)	Percentage (%)	Average	FREQUENCY (n=15)	Percentage (%)	Average	FREQUENCY (n=15)	Percentage (%)	Average	FREQUENCY (n=15)	Percentage (%)	Average
nternet	6	20.00		8	53.33		6	40.00		12	80.00	
e. Books and Journals	1	3.33		6	40.00		5	33.33		6	40.00	
f. Acquaintances	12	40.00		4	26.67		3	20.00		4	26.67	
4. Causes of climate change:												
a. Human Activities	26	86.67		14	93.33		13	86.67		14	93.33	
b. Natural Activities	4	13.33		1	6.67		2	13.33		1	6.67	
5. Level of knowledge on climate change												
a. Before			3.33			3.73			4.27			4.47
b. After			7.33			7.93			7.53			7.87

Stakeholders' Perception on Climate Change

Majority of the stakeholders perceived that as climate change occurs, there is an increase in rainfall, but there are some who believed that changes in rainfall become erratic as it occurs (Table 6).

Many farmers also believed that as climate change occurs, yields are decreasing as well, while there were few farmers said that it is not always decreasing. Some farmers also agreed that there is no effect in their yield.

As to atmospheric condition, stakeholders said that as climate change occurred, changes in atmosphere also increased. This was observed mostly by the Municipal Agriculturists and Municipal Planning and Development Offices; whereas, farmers and the Municipal Disaster Risk Reduction Management Offices observed that the change in atmosphere was erratic.

The top source of water for the stakeholders were springs, while others supply water from irrigations-NIA, deep wells, water pumps, rain, rivers, falls and water impounding.

Table 6. Stakeholders' Perception on Climate Change

VARIABLES	Farmers FREQUENCY (n=30)	Farmers Percentage (%)	MA FREQUENCY (n=15)	MA Percentage (%)	MPDO FREQUENCY (n=15)	MPDO Percentage (%)	MDRRMO FREQUENCY (n=15)	MDRRMO Percentage (%)
1. Changes in Rainfall								
Increasing	19	63.33	10	66.67	10	66.67	7	46.67
Decreasing	1	3.33	1	6.67	1	6.67	1	6.67
Erratic	10	33.33	4	26.67	4	26.67	6	40.00
2. Effect on Yield								
Increasing	1	3.33	3	20.00	4	26.67	3	20.00
Decreasing	24	80.00	12	80.00	10	66.67	11	73.33
No Effect	5	16.67			1	6.67		
3. Change in Atmosphere								
Increasing	13	43.33		73.33	11	73.33	7	46.67
Decreasing	3	10.00	11		1	6.67		
Erratic	14	46.67		26.67	3	20.00	8	53.33
			4					
4. Water Sources								
Water impounding	1	3.33	1	6.67				
Spring								
Irrigation	10	33.33	3	20.00	5	33.33	3	20.00
Deep well	3	10.00	1	6.67	1	6.67	4	26.67
Rain	1	3.33			2	13.33		
NIA	1	3.33	1	6.67			1	6.67
Water pump	2	6.67	2	13.33				
River	2	6.67			1	6.67	1	6.67
Falls			1	6.67	1	6.67	1	6.67

Stakeholders' Strategies Addressing Climate Change

As the stakeholders' knowledge on climate change increases, they also have learned many ideas and strategies on how to address climate change. Since climate change causes change in rainfall pattern, most of the stakeholders agreed more on the strategy wherein farmers must change crop varieties and cropping pattern. For MDRRMOs they agreed more on the strategy of planting more drought resistant crops. Others also believed that farmers must acquire an irrigation system, or they could plant earlier to avoid drought seasons. There were also some farmers who've said that they need not to do anything to address the problem on climate change as evident in Table 7.

One of the results also of climate change was the drying of streams and/or water sources. With these, MAs, MPDOs, and MDRRMOs were more convinced on improving watershed management and practices. For farmers, they usually practice harvesting of rainwater. Other strategies were also practiced by farmers, such as, construction of wells, and they even travel long distance just to supply water for their farms/crops.

Table 7. Stakeholders' Strategies Addressing Climate Change

VARIABLES	Farmers FREQUENCY (n=30)	Farmers Percentage (%)	MA FREQUENCY (n=15)	MA Percentage (%)	MPDO FREQUENCY (n=15)	MPDO Percentage (%)	MDRRMO FREQUENCY (n=15)	MDRRMO Percentage (%)
1. Change in rainfall pattern:								
a. changing crop variety and cropping pattern	11	36.67	12	80.00	9	60.00	9	60.00
b. planting more drought resistant crops	10	33.33	10	66.67	9	60.00	12	80.00
c. irrigation	7	23.33	7	46.67	4	26.67	7	46.67
d. early planting	3	10.00	5	33.33	5	33.33	3	20.00
e. Nothing	5	16.67						
2. Drying of streams/water source								
a. Harvesting of rain water	12	40.00	5	33.33	2	13.33	7	46.67
b. Construct	7	23.33	7	46.67	5	33.33	5	33.33

VARIABLES	Farmers FREQUENCY (n=30)	Farmers Percentage (%)	MA FREQUENCY (n=15)	MA Percentage (%)	MPDO FREQUENCY (n=15)	MPDO Percentage (%)	MDRRMO FREQUENCY (n=15)	MDRRMO Percentage (%)
ion of wells								
c. Improve watershed management practices	5	16.67	15	100.00	13	86.67	10	66.67
d. Depending on pipes	16	53.33					4	26.67
e. Travelling long distance for water	3	10.00			1	6.67	2	13.33

2.5.4. Economic Analysis of Climate-Resilient Agricultural Practices

2.5.4.1. Organic Rice Farming (Biodynamic)

With an intense application of synthetic or inorganic fertilizer for rice production has led to decrease in soil productivity. This is evident in decrease in yield of rice even there is an increase in the rate of application of synthetic fertilizers. Another side effect of the continuous usage of non-organic fertilizer is the depletion of organic matter which affects the availability of soil nutrients that are helpful for the rice plant. Thus, the use of organic fertilizer has been promoted even the country has a law on organic agriculture. This is to improve and hasten soil nutrient availability but the observable effect can be seen atleast three to five years.

Based on the study of Yamota and Cruz (2007), the adoption of organic rice farming has been contributing to an impresive increase in rice production. It significantly contributed to the increase of yield and thereby productivity of rice as compared to that of the conventional way. Approximately, organic rice farming has been recognized in 30 countries of the world where its share of agricultural land and farms is gorwing. Briones (1999) said that organic rice farming must receive the highest priority since there is no need to buy expensive chemicals and inputs. She also believed that organic products are safer and healthier to consumers.

Biodynamic agriculture is the system being followed by cooperatives like Don Bosco Multipurpose Cooperative, Magsaysay – Davao del Sur cooperative, FDAI – Agusan del Norte, AGUS – Caraga, and to some extent the Bukidnon farmers. The focus of Biodynamic Agriculture is developing and maintaining a healthy soil organism through the use of manure, crop-rotation, covercropping and special preparations/concoctions. The farm is considered as an entire living organism, with the farmer and his practices as playing a vital role to the farm ecosystem. In Don Bosco MPC, for example, farmers plant crops near the farm to drive away pests and use madre de cacao leaves as pesticides. They apply both solid fertilizer (e.g., vermicasts) and liquid fertilizer (Cow and Pat Pit, milk and honey, etc.). The liquid fertilizer is sprayed 10 times in one cropping period. Among the different systems, this is the most labor intensive.

Farmers in irrigated areas are able to plant two crops per year. Although it is possible to do 3 crops per year, this is not allowed under the certification system. As such, Don Bosco and other natural farming practitioners generally have four months lean season. Some farmers also intercrop with monggo both to augment income as well as soil nutrient enhancement strategy. Thus, organic farming was prioritized.

Based on the Philippine Rural Development Program's Value Chain Analysis and Competitiveness Strategy on Organic Rice (2016), organic farmers were confronted with different issues on organic farming. However, these were given close attention and solution to enhance competitiveness in the region. Found in North Cotabato, the Don Bosco Multipurpose Cooperative located in M'lang, Cotabato has a total land area of organic rice of 519 hectares in 2015. The MPC is the only certified organic farms in Mindanao according to the National Organic Agriculture Program. The harvest of that 519 hectares contributed to the 9,696 metric tons of organic rice produced in the province last 2015. It is 51% of the total organic production the country. However, the adoption of organic rice farming is not yet 100%, it is estimated to be 70% of the farmers adopt this kind of farming.

Environmentally and socially, organic farming contributes both postive and negative externalities. Increased soil fertility, more energy efficiency, carbon sequestration, less water pollution, more water capture, increased soil fauna, enhanced biodiversity and reduced soil erosion are among the positive environmental impacts of organic agriculture. However, weighing the positive and negative externalities of organic agriculture/farming, organic rice farming is a best alternative.

2.5.4.2. Integrated Rice-Duck Farming Systems (IRDFS)

The integrated rice-duck farming makes use of the mutually beneficial realtion between ducks and the rice crop to increase rice productivity. In this system, duckilings are allowed to forage in the paddy 10-15 dyas after rice transplanting until the flowering stage about two months later. The forage ducks are meant to 1) remove weeds, 2) eat pest; 3) soften the soil with their bill and feet, thereby relesing trapped nutrients and 4) produced natural fertilizer with their droppings (SATNET Asia, 2015). This is highly supported by the studies of Choi Song Yoel et al. (1996), Hossain et al. (2002) and Foruno (2001) which showed that is a significant decrease in insect population in integerated rice-duck farming as compared to sole rice farming system. The findings of Isobe et al. (1998), Kim et al. (1994) and Choi Song Yoel et al 91996) conforms that duck are an effective biological control of weeds that will grow in the rice field. The study of Hossain et al (2005) found out that 90% of the weeds are kept under control by ducks since they eat young weed plants and weed seeds. With this activity of ducks, it oxygenrates the water and encourage the roots of the rice plants to grow vigorously. Moroever, study of Furono (1996) observed and reported that ducks' movement and feeding activity improves soil's physical property which enhances the rice root system.

As to the yield, Hossain et al. (2005) revealed that rice yields increase by up to 20% which results of 50% higher net returns. This increase is due to higher yield, reduced in production cost and additonal income through the sale of eggs and duck meat. This economic benefit, alongside with the ecological benefit abovementioned, has been a roadmap of introducing and praticing thir rice system in the Philippines. Aside from the ecological or environmental impact of rice-duck farming mentioned above, the reduction of methane gas emitted in the atmosphere is one of the most remarkable contribution of this rice system. Yuan (2008) found out that as compared to rice monoculture, rice-duck farming system reduce emission of greenhouse gas methane (CH_4). In his finding, rice monoculture can emit methane (CH_4) output of 12.56 mg/m^2h as compared to 9.95 mg/m^2h in rice-duck farming system. This result also conforms with the study of Zhang et al (2011) which they have revelaed that the introduction of ducks into a rice farming system reduced the emission of CH_4 into the atmoshpere as compared to that of the conventional farming system.

Countries like Japan, Indonesia and Bangladesh have been promoting and engaging into this kind of rice system. In Japan, this method is popularly known as "Aigamo-rice cultivation" – a simultaneous raising of ducks with rice cultivation. Histoty revealed that rice-duck farming system is a 500-year-old tradition in Japan. It is re-engineered by a Japanese farmer, Mr. Takao Furuno, inot a modern system of organic farming. In Indonesia, the technology was introduced by Indonesian Agency for Agricultual Research and Development (IAARD), Assessment Institute for Agricultural Technology (AIAT) of the Ministry of Agriculture, in Java. Meanwhile, in Bangladesh, it was pioneered joinly by the Bangladesh Rice Reseach Institue (BRRI) and the non-government organization (NGO), Friends in Village Development in Bangladesh (FIVDB). The field research started in July 2001 for three-year period and until today since 2006, the training and extension services for integrated rice-duck faming continues (SATNET Asia, 2015).

Introduced in the Philippines, the integrated rice-duck farming system had been practiced in some parts of the country like in CamSur, Albay, Sorgoson and other parts of Mindanao. Based on the study of the FAO TECA (2014), experiments were conducted in selected provinces of Bicol region namely CamSur, Albay and Sorsogon. Data revealed that with an introduction of ducks in the monoculture rice system, yield increased. The yield of rice-duck farming system is almost twice of that solely rice farming in CamSur and Albay and a meager increase of 0.5 t/ha in Sorsogon in the second cropping as shown in Table 5. In the 3^{rd} crop cylce, yield of rice-duck faming system increased more than in the 2^{nd} crop cycle in CamSur and Albay but decreased in Sorgsogon. Generally, data showed that with rice-duck farming, yield increased as compared to the traditional way of rice farming (SATNET Asia, 2015).

Table 8. Yield from rice-duck farming compared to rice-only farms in the Bicol Region, Philippines (adopted from SATNET Asia Factsheet, 2015)

Location	2nd crop cycle			3rd crop cycle		
	Rice-duck farming		Rice-only farming	Rice-duck farming		Rice-only farming
	Rice (t/ha)	Eggs	Rice (t/ha)	Rice (t/ha)	Eggs	Rice(t/ha)
CamSur	2.7	720	1.8	3.5	280	2.7
Albay	2.7	720	1.8	3.75	309	1.36
Sorsogon	4.5	480	4.0	4.2	275	3.3

The Philippine Agrarian Reform Foundation for National Development (PARFUND) has been teaching rice farmers the Integreated Rice-Duck Farming System or IRDFS. They targeted that this technology will be brought to 1000 hecatres of rice paddies in the Caraga region. Other Philippine provinces that use this technology are the provinces of Bukidnon, Misamis Oriental and Zamboaga del Sur. In 2011, Zamboanga de Sur produced 296,736 metric tonnes of rice which is above the province's taget of 280,000 mt. This has been attributed to the IRDFS. Moreover, in Valencia City, Bukidnon, more than 100 hectaes of rice paddies have been already converted to the IRDFS.

2.5.4.3. Cost-Benefit Analysis of CRA Practices

The adoption of CRA practice needs private initial investment of around 730.18 USD od Php35,319.00 per hectares. There is rice yield difference of 1,848.47 kilogram per hectare and rice-duck farming system yield higher relative to conventional farming. Due to price premium of organic rice, the yield of conventional rice was adjusted. The projected net cash flow of the CRA result profitable from the private point of view with a potential NPV of $1,952.8 and an IRR of 93.01% way above form the 12% discount rate making the CRA practice likely to be adopted by the farmers. Since there is a price premium of organic rice, the initial investment is realized in 3 years. On the other hands, from the point of view of the society in general and by the incorporating the externality (reduction of CH_4 emission), the CRA seems to be highly attractive with a potential NPV of $34,197.75 and quasi-social of IRR > 500%.

Table 9. Cost Benefit Analysis of rice-duck farming

CBA tool Summary Farm (1ha) result	Net present value (NPV)	Internal rate of return (IRR)	Payback Period	Initial Investment	Social NPV	Social IRR	Scenario in the analysis (10 years)	
Unit	US$**	%	years	US$**	US$**	%	Before	After
Value	1,952.8	93.01%	3	730.18	4,197.75	592.81%	Conventional Rice Farming	Rice-Duck Farming
Aggregate analysis CBA tool Summary	Total area of rice	Current adaptation rate	Adoption rate	Aggregate NPV			Period	
	315,690ha*	1%	5%	125,933.28			10 years	

Regional data (source: Philippine Statistical Authority *1 USD = P48.37

In adopting the CRA practice, it requires private initial investment of Php43,379.00 per hectares. The yield on organic rice as compared to conventional rice is comparatively higher of about 84.36% way above from the 12% discount rate making the CRA practice is likely to be adopted by the farmers. Since there is a price premium for organic rice, the initial investment is realized in 3 years. On the other hands, from the point of view of the society in general and by incorporating the externality (reduction of CO2 emission), the CRA seems to be highly attractive with a potential NPV of $,235.25 and quasi-social IRR of almost.

Table 10. Cost Benefit Analysis of organic rice.

CBA tool Summary Farm (1ha) result	Net present value (NPV)	Internal rate of return (IRR)	Payback Period	Initial Investment	Social NPV	Social IRR	Scenario in the analysis (10 years)	
Unit	US$**	%	years	US$**	US$**	%	Before	After
Value	20,064.52	84.36%	3	896.82	3,235.25	169.53	Conventional Rice Farming	Organic Rice Farming
Aggregate analysis CBA tool Summary	Total area of rice	Current adaptation rate	Adoption rate		Aggregate NPV		Period	
	2069ha*	5%			190,197.06		10 years	

*North Cotabato (source: PRDP & PAKISAMA

**1USD=P48.37

In The cost and return analysis in organic rice farming, the total income in one hectare of Palay is Php 79,800.00, the gross profit is 36,421.00 and the production cost per kilogram is Php10.87. In unpolished rice, the total income is Php137,256.00, the gross profit of unpolished rice is 27,216 and the cost per kilogram is Php40.09

Table 11. COSTS AND RETURNS: One Hectare Rice Farm – Biodynamic Agriculture

COSTS AND RETURNS: One Hectare Rice Farm – Biodynamic Agriculture, 2016				
Assumptions				
Yield	4,200 kilograms			
Postharvest Losses (5%)	210 kilograms			
Available for Selling and Own Consumption	3,990 kilograms			
PALAY				
Items	**Unit**	**# of Units**	**Unit Cost (PhP)**	**Total Cost (PhP)**
Income				**79,800**
Sales from Palay	kilograms	3,990	20	79,800
Total Expenses				**43,379**
Materials				**9,765**
Seeds	kilogram	60	30	1,800
Organic fertilizer	bag	10	250	2,500
Concoctions	gallon	6	550	3,300
Irrigation		1	1,500	1,500
Sacks	pieces	67	10	665
Labor				32,018
Land preparation	pakyaw	1	4,500	4,500
Dike repair/cleaning	person days	5	250	1,250

Planting	pakyaw	1	4,000	4,000
Farm maintenance	person days	30	250	7,500
Spraying	person days	8	250	2,000
Harvesting and threshing	pakyaw	1	12,768	12,768
Transportation				1,596
Transportation	bags	67	20	1,330
Hauling	bags	67	4	266
Gross Profit				**36,421**
Production Cost/kg				**10.87**
UNPOLISHED RICE				
Income				**137,256**
Sales from Unpolished Rice	kilos	2,745	50	137,256
Expenses				**110,040**
Cost of Palay	kilos	3,990	20	79,800
Drying	bags	67	30	1,995
Milling	kilograms	2,745	1.75	6,748
Packaging	packaging	110	15	6,748
Labor	person days	10	250	6,748
Administrative and marketing				8,000
Gross Profit				**27,216**
Production Cost/kg				**40.09**
Source: KII/Stakeholders Consultations				

The yield of Integrated Rice –Duck Farming System in one hectare is about 3,750 kilograms. In palay the total income is Php71,250.00, the gross profit is Php35,931, and the production cost per kilo is 9.91. In unpolished rice, the production cost per kilo is Php36.31, the gross profit is Php 35,931.00 and the total income is Php122,550.00

Table 12. One Hectare Rice Farm – Integrated Rice –Duck Farming System, 2016

COSTS AND RETURNS: One Hectare Rice Farm – Integrated Rice –Duck Farming System, 2016				
Assumptions				
Yield	3,750 kilograms			
Postharvest Losses (5%)	188 kilograms			
Available for Selling and Own Consumption	3,563 kilograms			
PALAY				
Items	**Unit**	**# of Units**	**Unit Cost (PhP)**	**Total Cost (PhP)**
INCOME				**71,250**
Palay	kilos	3,563	20	71,250
EXPENSES				**35,319**
Materials				**6,994**
Planting Materials	kilos	40	35	1,400
Duckling	heads	50	40	2,000
Rice bran	kilos	4	500	2,000
Sacks	pieces	59	10	594
Irrigation				1,000
Labor				**26,900**
Land preparation	pakyaw	1	4,500	4,500
Dike repair	person days	6	250	1,500
Planting	person days	8	250	2,000

Farm maintenance	person days	30	250	7,500
Harvesting and threshing	person days	38	300	11,400
Transportation				**1,425**
Hauling	bags	59	4	238
Transportation		59	20	1,188
Gross Profit				**35,931**
Production Cost/kilo				9.91
UNPOLISHED RICE				
Income				**122,550**
Sales from Unpolished Rice	kilos	2,451	50	122,550
Expenses				**88,989**
Palay	kilograms	3,563	20	71,250
Drying	bags	60	30	1,800
Milling	kilograms	2,451	1.75	4,289
Packaging	packaging	110	15	1,650
Labor	person days	8	250	2,000
Administrative and marketing				8,000
Gross Profit				**33,561**
Production Cost/kilo				**36.31**
Source: KII/Stakeholders Consultations				

2.6. CONCLUSION AND RECOMMENDATION

Climate change affects agriculture and food production, hence, its effect can be seen by the rapid change in pest infestation, deceased of plants and various technologies were developed in order to produced climate resilient crop varieties. With this notion, the study was conducted to assess, target and prioritieze climate-resilient agri-fishery (CRA) technologies that can be developed and dessiminated to the end users – farmers, as they were greatly affected by this phenomenon.

The study found out that the perception and knowledge of the respondents about climate change has changed over the years. This can be concluded that because of an effective information dissemination, people have understand the meaning and effect of climate change. By the continued extension of informing these people, human will be equipped, knowledgeable and anticipative of the adverse effect of climate change. Increasing the knowledge of human capital is part of increasing their adaptive capacity, that is, being prepared in times of emergency brought about by changing climate.

In additon, the study also revealed that crops planted in the region such as tomato, corn, rice, cocoa, banana, and coffee were affected by climate change as their suitability of decreased in 2050 in reference to the current year. This means that wiith the use of the maps, farmers will be able to know where will be the best location for planting the said crops thereby avoiding production loss and increased cost due to damages. Proper policy and sound decision making is necessary for future production of these crops. With this changing crop suitability, sensitivity indices of these crops revelaed that these are greatly sensitive to climate change, thus, development of tolerant varieties can be of priority.

Given the far-ranging adverse impacts of climate change, adaptation must be an integral component of an effective strategy to address climate change, along with mitigation. Thus, increasing the adaptive capacity of those municiplaity in the province having low adaptive capacity can be of concern of the local government. Adaptation is essential to reducing humana and social costs of climate change, and to development and poverty alleviation.

Adaptation is about builiding resilience and reducing vulnerability, thus, national agency, particularly the Department of Agriculture and its arm agencies can develop andwidely disseminate technologies for adaptation such as the integrated rice duck farming that is profitable and socially sound investment. By stregthening the Organic Agriculture law coupled with its massive promotion can be of a mitigation step against the ill effect of climate change. The Benefit-Cost Analysis can be a guide for investment.

A national policy that is anticipatory rather than reactive is much needed in order to adhere to the country's policy framework for sustainable development.

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