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TERMINAL REPORT

A. BASIC INFORMATION

1. Project Title:

   Climate-Resilient Agri-fisheries (CRA) Assessment, Targeting & Prioritization for the Adaptation and Mitigation Initiative for Tarlac Province

2. Proponent (s):
   Project Leader: Lilibeth B. Laranang
   Designation: Director Rootcrops Research and Training Center
   Organization: Tarlac Agricultural University
   Address: Camiling, Tarlac

3. Implementing Agency
   Lead Agency: Tarlac Agricultural University
   Head of Agency: Max P. Guillermo
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   Collaborating Agency: DA-Regional Field Office 3 (AMIA)
   LGUs and POs of Tarlac
   CIAT

4. Project Duration
   Approved Duration (Y/M): 12 months (1 July 2016 – 31 July 2017)
   Actual Duration (Y/M):
   Start Date of Implementation: 1 July 2016

5. Project Site(s)
   Province : Tarlac
   City/Municipality: 1 City and 17 Municipalities

6. Project Funding
   Total Approved Budget: PHP 1,000,000.00
   Total Amount Released: PHP 1,000,000.00
   Agency Counterpart: PHP 390,192.00 (20% of the salary of the project team)
   Actual Expenses:

6. RDE Agenda Addressed: climate change vulnerability and adaptive capacity assessment

7. Expected Technology or Information : climate change adaptation technologies; identification of vulnerable communities
8. Description of Technology/Information :
9. Target Beneficiaries/Users: Farmers and fisher folks, Policy makers
10. Tags/Keywords: climate change, smart agriculture, CRA

B. TECHNICAL DESCRIPTION

I. 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 SCCO), AMIA Phase 1 in 2015-16 to implement 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 is also designing complementary activities for building appropriate climate responsive DA support services.

With AMIA Phase 2 in 2015-2016, the next big challenge is making 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 in Tarlac province as the initial target site for action learning, supported by an integrated package of climate services and institutions, within a broader food system/value chain setting. The program is launching an integrated and multi-stakeholder effort to operationalize CRA at the community level in 10 target regions.

The AMIA2 program framework consists of 9 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 would be designed towards operationalizing the AMIA framework.

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 framework provides overall guidance in the planning and design of research and development interventions in 10 target regions.

1. Region I Ilocos
2. Region II Cagayan Valley
3. Region III Central Luzon
4. Region IVA Southern Luzon
5. Region V Bicol
6. Region VI Western Visayas
7. Region X Northern Mindanao
8. Region XI Southern Mindanao
9. Region XVIII Negros Island
10. Region XII

Successful implementation of AMIA2 at the regional level requires the strong collaboration and support of key research and development institutions within the region. This proposed project enables AMIA2 to establish and mobilize regional teams, each led by a local State University/College (SUC), and in partnership with the corresponding Department of Agriculture - Regional Field Office (DA-RFOs).

Potential Impact or Goal

Operationalized AMIA strategies in managing climate risk in Tarlac province.

Outcome or General Objective/Purpose

Established and mobilized team in Region III for AMIA 2.

Expected Output or Specific Objectives

1. Enhanced capacities of AMIA partner organizations in Region 3.
2. Geospatially referenced data on climate-risks for Reion 3 (Tarlac)
3. Profile on community's CRA strategies is generated
4. Data on CRA practices analyzed for costs-benefits & trade-offs

Scope and Limitations/Constraints: Province-wide

II. Review of Related Literature

The impacts of climate change are now realities. Philippines is one of the top 12 countries at highest risk to climate change according to World Bank. Since the issue of "global warming" came about, scientists were able to monitor evidences of climate change such as intense and longer droughts, increase in temperature and decrease precipitation, and increase in sea surface temperature and frequent heat waves, among others. According to experts, climate change affects not only the welfare of the earth's ecosystem, but also health, livelihood, social systems and economy. Agriculture is one of the most vulnerable sectors on the impacts of climate change and farmers who are directly dependent on their survival to their lands are also the most affected. As such, support systems should be provided to them to reduce the impacts of climate change.

The Climate Change Commission published the National Climate Change Action Plan 2011-2028 as a response to climate change. It recognized that the country is highly vulnerable to risks and natural hazards. The action plan addresses climate change risks to food security. The World Bank identified that 50.3 percent of the country's total land area and 81.3 percent of its population are vulnerable to natural disasters. According to the Bureau of Agricultural Statistics in 2010, the agriculture sector produced 15.77 million metric tons of rice, 6.37 million metric tons of corn, 60.9 million metric tons of other crops, and 4.20 thousand metric tons of livestock and poultry. This shows that agriculture remains the country's backbone for sustainable attainment of food security. It employs about one-third of the total employment in the sector, and contributes about 18 percent to gross domestic. The CCC estimates that damages from disasters, which are generally climate-related, are borne by agriculture every year. From 1990 to 2006, for instance, data show that of the P12.43 billion average annual value of damages to agriculture for the period, 70.3 percent were caused by typhoons, 17.9 percent by drought, and 5 percent by floods. The action plan outlines the direction the country must tackle as a response to current situation and projected effect of climate change in the Philippines especially in the agricultural sector.

Studies on the impact, mitigation, and adaptation practices in Central Luzon are limited in the province of Nueva Ecija.

III. Methodology

The project sought 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

These project components were designed to be 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.

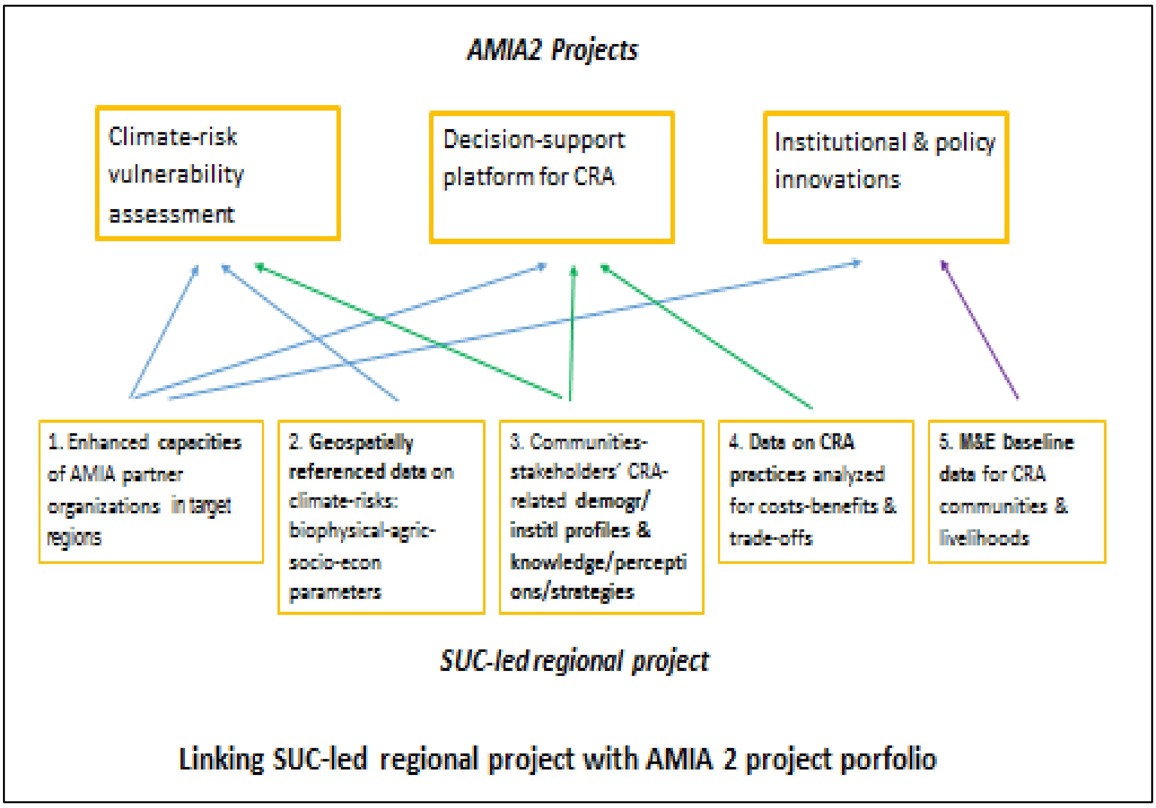


Figure 1. Framework of AMIA 2 project

Component 1 - Capacity strengthening for CRA research & development

A series of trainings, workshops and learning events were organized for AMIA2 project teams. These were focused on three key methodologies: 1) CRVA, 2) CRA prioritization, and 3) CRA M&E.

The project likewise 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.

Component 2 - 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 used 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.

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 as in identifying CRA prioritization and planning.

These activities were guided by process facilitation using the MaxEnt and CBA Tool developed by the AMIA2 projects on CRVA and CRA decision-support platform.

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.

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

Component 5. AMIA baseline study for monitoring and evaluation

This component is currently being conducted by the AMIA2+ project, spearheaded by the Department of Agriculture Regional Field Office (RFO3). They already conducted a provincial consultation and identified CRA communities for piloting. The town of Victoria was chosen because of its high vulnerability and willingness of its local government to support the piloting.

Table 1. Objectives, Activities, and Outputs of AMIA 2

Objectives	Activities	Outputs
1. To strengthen capacities for CRA methodologies of key research and development organizations in the region.	1.1 Capacity strengthening on CRVA 1.2 Capacity strengthening on CRA prioritization 1.3 Capacity strengthening on CRA knowledge hub development 1.4 Capacity strengthening on CRA M&E	Enhanced capacities of AMIA partner organizations in the region
2. To assess climate risks in the region's agri-fisheries sector through geospatial & climate modelling tools.	2.1.Collection of secondary data for exposure-sensitivity 2.2.Collection of secondary-primary data for adaptive capacity 2.3.Preliminary data analysis 2.4.Cross-regional/national data analysis workshop	Geospatially referenced data on climate-risks: biophysical-agricultural-socioeconomic parameters
3. To determine local stakeholders' perceptions, knowledge & strategies in adapting climate risks	3.1.Regional-level CRVA stakeholders' validation 3.2.Community-level CRVA stakeholders' validation 3.3.Regional-level CRA stakeholders' validation 3.4.Community-level CRA stakeholders validation	Local stakeholders' CRA-related demographic/institutional profiles & knowledge/perceptions/ strategies
4. To document and analyze local CRA practices to support AMIA2 knowledge-sharing and investment planning.	4.1 Key informant survey on CRA practices 4.2 Cost-benefit and trade-off analyses 4.3 National knowledge-sharing event on CRVA and CRA 4.4 Planning workshop for AMIA2+	Analyzed costs-benefits & trade-offs of data on CRA practices

IV. Results and Discussion

During the project's implementation, the International Center for Tropical Agriculture (CIAT) and the Department of Agriculture-Bureau of Agricultural Research, conducted several training-workshops to equip the research teams from the ten collaborating SUCs with knowledge and skills needed to fully implement the project. Table 2 shows the list of capability building seminar, training and workshop attended by the proponents of the project.

Table 2. Training, Seminars and Workshops participated in by the Project Team

Title	Date	Venue
Training on Climate Risk Vulnerability Assessment	June 6-8, 2016	Torre Venezia Hotel, Quezon City
Cost- Benefit Analysis (CBA) on Climate Resilient Agriculture Practices	August 6-8, 2016	Torre Venezia Hotel, Quezon City
Methodology for Evaluating Social and Environmental Benefits, in Agricultural Systems	December 2, 2017	Tarlac Agricultural University, Camiling, Tarlac
Climate Risk Vulnerability Assessment (CRVA) Mapping & and Adaptive Capacity Mapping	January 10-12, 2017	SEARCA, UPLB, Los Banos, Laguna
AMIA2-CIAT Project: Results Sharing and Validation Workshop on CRVA & CRA Decision Support	February 6-7,2017	Parklane International Hotel, Cebu City
Workshop on Finalizing Results on CRA and Prioritization and Extended CBA	March 1-3, 2017	B Hotel, Quezon City
Completion Review of BAR Funded Climate Change Projects	May31-June 2, 2017	Partido State University, Goa, Camarines Sur
AMIA2-CIAT Project: Workshop on Outcome Monitoring and Evaluation of Community-Based Action Research	June 21-22, 2017	Sequoia Hotel, Quezon City

CLIMATE RISK VULNERABILITY ASSESSMENT (CRVA)

Tarlac is basically an agriculture-based economy, located in the heart of Central Luzon with a total Land Area of 305,345 ha, constitutes 16.75% of the regional land area and 1.0 % of the total national land area with 112,997.57 hectares concentrated on agricultural production. Rice and corn are the top 2 commodities planted in the province planted in 2 to 3 cropping a year. There are 102,178.06 ha planted to rice, which are irrigated, rainfed and in upland areas. On the other hand, there are 16,458.98 ha planted to corn. Of these, only a small portion, are planted with white corn while the rest are planted with the yellow corn.

With this vast track of land concentrated in agriculture, Tarlac likewise grows lowland vegetables and rootcrops. Of the lowland vegetables grown in the region, tomato occupies the largest area with 215.81 has while sweetpotato is the largely grown rootcrop with a production area of 3,641.58 ha. Both crops are grown after rice usually during the onset of the dry season when rice has been harvested. Orchard occupies 10,498.65 hectares planted with our local fruit trees. The most common is mango that is planted in an area totalling to 2,5,660.03 has. Figure 2 show the production areas of the priority crops in every municipality of the province.

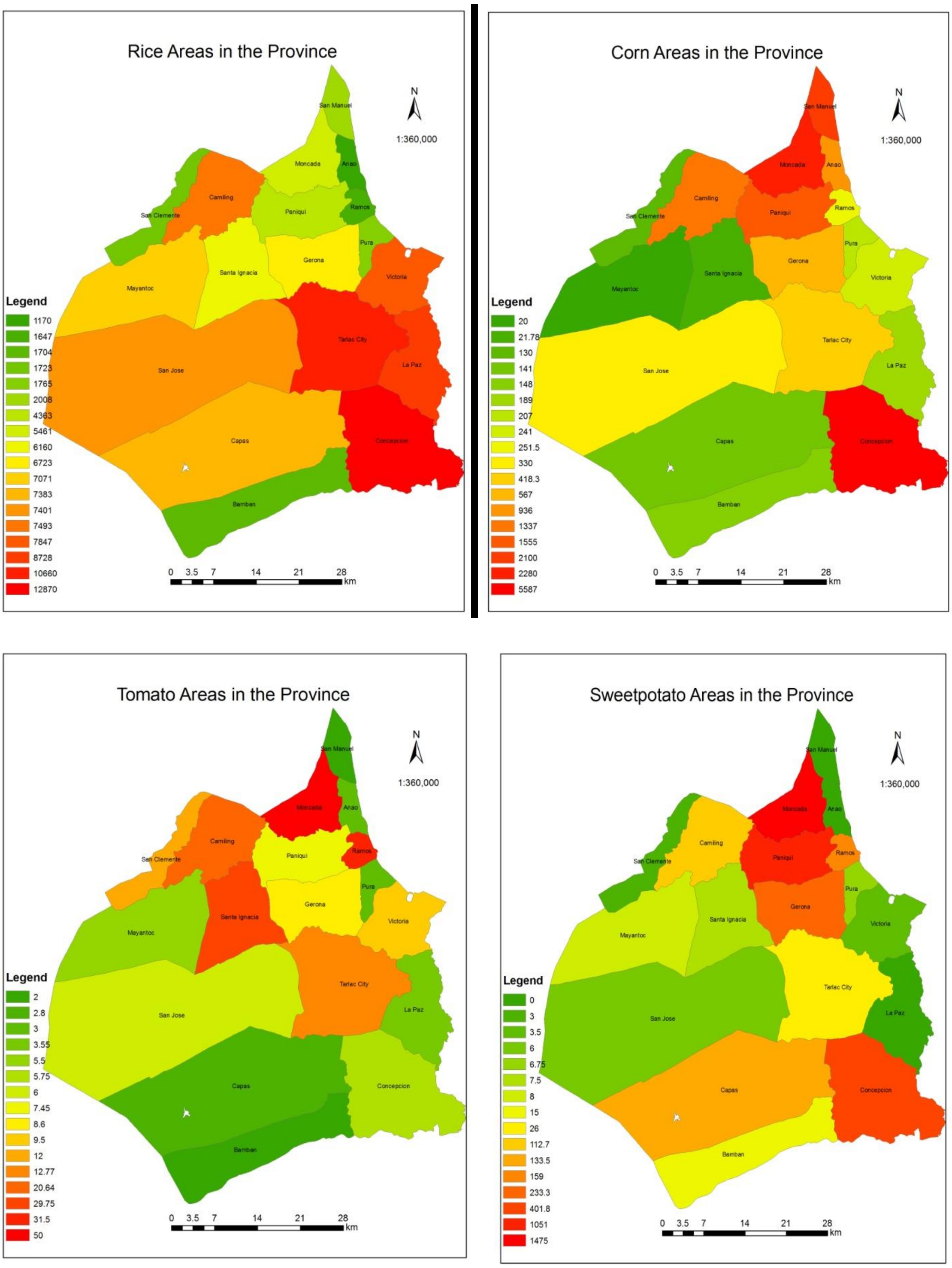


Figure 2. Areas of the Priority Crops in the Province

One of the components of the project is to assess the vulnerability to climate risks of the region's agri-fisheries sector specifically in Region III wherein the pilot areas are in Tarlac province.

The vulnerability mapping was based from the Climate-Risk Vulnerability Assessment (CRVA) framework presented in Figure 3 and Figure 4 shows the CRVA flowchart. It started with the identification of the vulnerability determinants (exposure, sensitivity, and adaptive capacity) and their respective indicators. This framework was the standardized procedure being followed by different regions. Figure 4 shows the detailed flowchart of the CRVA framework specifies the data needed and the procedures to be done to have the vulnerability map. Data collection started in gathering the primary and secondary data, that includes those from focus group discussion (FGD), key informant interviews (KII) and municipality surveys.

The identified priority crops of the province are rice, corn, tomato, and mango. Sweetpotato was an additional crop prioritized by the team because it is one of the crops planted on the second cropping season after rice and corn.

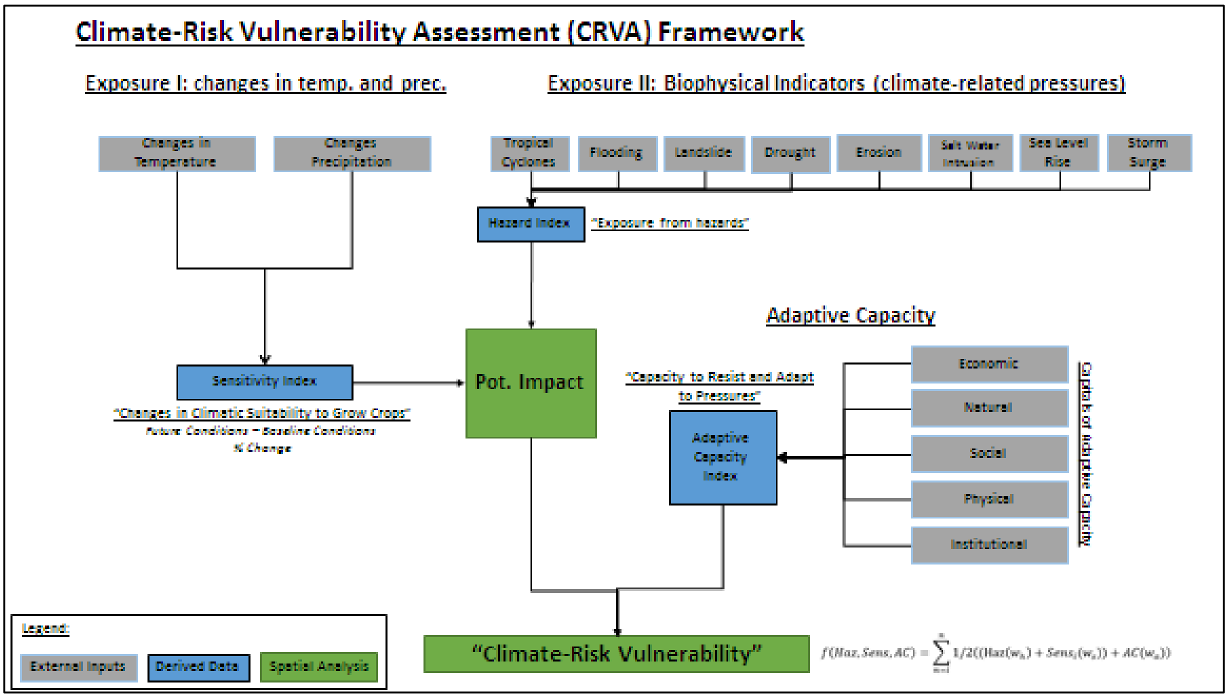


Figure 3. Climate-Risk Vulnerability Assessment (CRVA) Framework

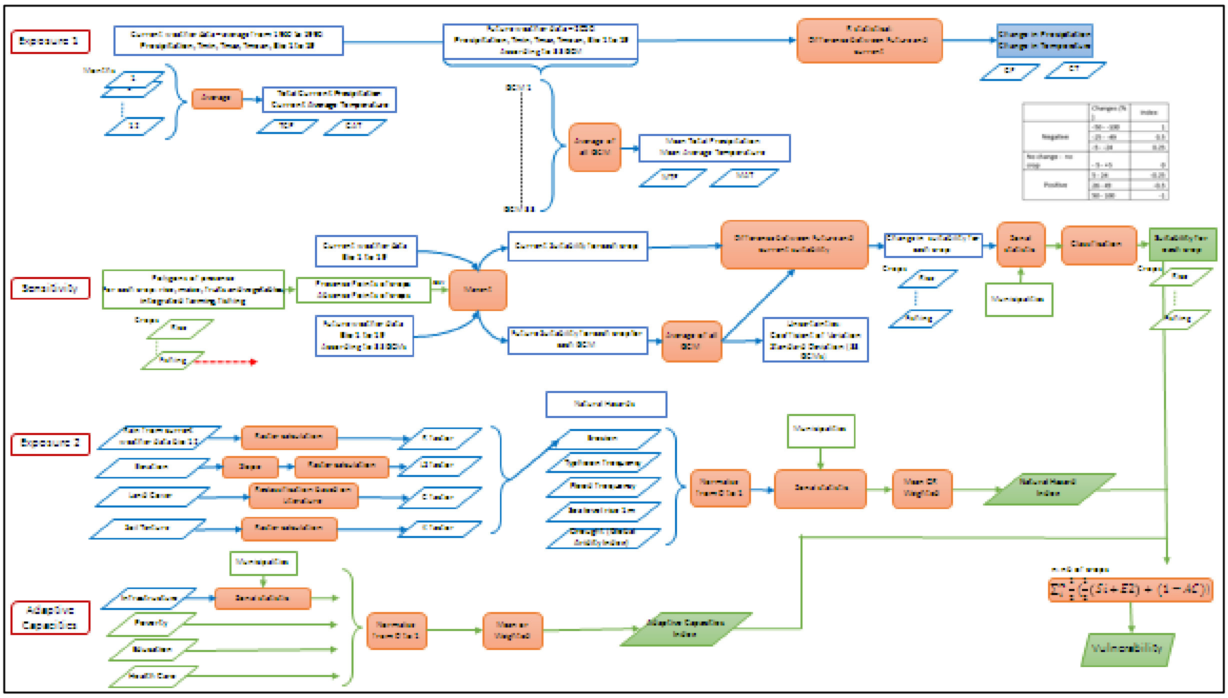


Figure 4. Climate-Risk Vulnerability Assessment (CRVA) Flowchart

A. SENSITIVITY ANALYSIS

Figure 5 shows the flowchart in developing the impact of climate change to crop suitability. To come up with the crop suitability, a crop distribution model was used and the factors associated are the 20 bioclimatic variables and the existing crop location.

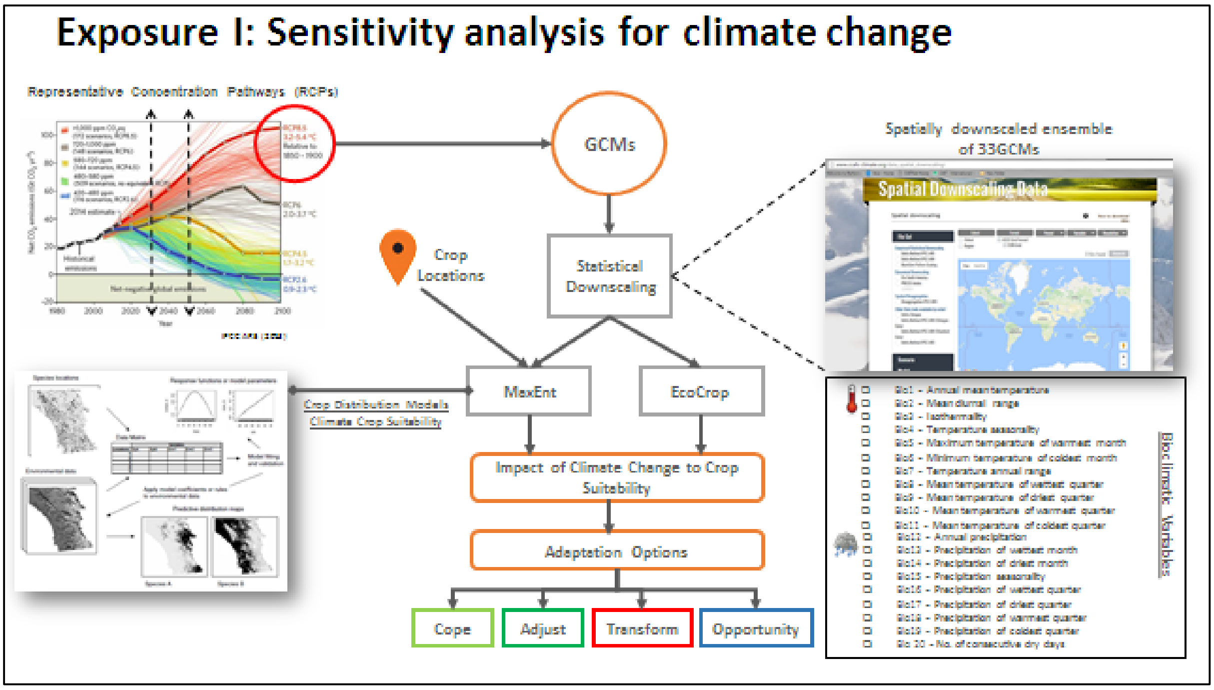


Figure 5. Sensitivity Analysis Flowchart

The projections used in the project were the Representative Concentration Pathway (RCP) 8.5 because it is the most recent and policy relevant based from IPCC AR5 (2013), From the RCP 8.5 projections having an ensemble of 33 GCMs that is based on CMIP5 was used. These were statistically downscaled to 1km resolution and from this GCMs 20 bioclimatic variables are selected as climate parameters (change in temperature and change in precipitation). The 20 bioclimatic variables are shown in Table 3. These are the factors that greatly influence crop growth.

Table 3. The 20 Bioclimatic Variables Used

PARAMETERS (Temperature Related)	**DESCRIPTION** (O' Donnell, M. and D. Ignizio, 2012)
Bio1	Annual Mean Temperature
Bio2	Mean Diurnal Range
Bio3	Isothermality
Bio4	Temperature seasonality
Bio5	Maximum Temperature of Warmest Month
Bio6	Minimum Temperature of Coldest Month
Bio7	Temperature Annual Range
Bio8	Mean Temperature of Wettest Quarter
Bio9	Mean Temperature of Driest Quarter
Bio10	Mean Temperature of Warmest Quarter
Bio11	Mean Temperature of Coldest Quarter
Bio12	Annual Precipitation
Bio13	Precipitation of Wettest Month
Bio14	Precipitation of Driest Month
Bio15	Precipitation Seasonality
Bio16	Precipitation of Wettest Quarter
Bio17	Precipitation of Driest Quarter
Bio18	Precipitation of Warmest Quarter
Bio19	Precipitation of Coldest Quarter
Bio20	No. of Consecutive Dry Days

To identify the current locations of crops production in the province, participatory mapping was conducted. The conduct of the participatory mapping was participated by the Provincial Agriculture Office representatives, City Agriculturist, Municipal Agricultural Officer/ Municipal Agriculturist, and Agricultural Technologist of the different municipalities of the province using the map of the province with fishnet of 1km x 1 km and other features such as roads, rivers, and elevation.

The Maximum Entropy Species Distribution Modeling (MAXENT) was used in the study because it was more precise than the other models. MAXENT software is based on the maximum entropy niches and distributions. From a set of environmental (e.i. climatic) grips and georeferenced occurrence localities, the model expresses a probability distribution where each grid cell has a predicted suitability of conditions for the particular species. To be able to utilize the MAXENT model, it requires the priority crop locations and the 20 bioclimatic variables. This gives the Current Suitability and the Predicted Suitability for each crop then it produces the changes in suitability for each crop to develop the suitability map for each crop. Figure 4 shows the bioclimatic variables that affect each crop suitability.

Table 4. Summary of Bioclimatic Variables in Every Priority Crops Using MAXENT Model

Crop	Mean Area Under Curve	Analysis of Variable Contribution	Bio-Description
Rice	0.975	Bio_19: 47.9	Precipitation of Coldest Quarter
Corn	0.988	Bio_5: 43.7	Maximum Temperature of Warmest Month
Tomato	0.996	Bio_20: 62.7	No. of Consecutive Dry Days
Mango	0.988	Bio_19: 57.1	Precipitation of Coldest Quarter
Sweetpotato	0.993	Bio_19: 58.6	Precipitation of Coldest Quarter

Sensitivity index was used in the sensitivity analysis to determine the sensitivity of crops to changes in temperature and precipitation. The result of the sensitivity analysis of the crops prioritized in the province were shown in Figures 6,7,& 8.

I. RICE

Rice is highly suitable in the province being one of the major rice producers in the region with a total production area of 100,395 ha. Normally, rice is grown during the first cropping season during the months of July to November while corn and sweetpotato are grown after rice. Farmers that have access to irrigation system grow rice twice and sometimes three times.

Figure 6 shows the current and the predicted suitability of rice, as the province is currently highly suitable for rice, however, by 2050, majority of the areas in province are categorized as not suitable for rice production. Based from the MAXENT, the factors affecting the distribution for rice are Bio19, Bio20, Bio5 and Bio14 which are precipitation of coldest quarter, number of consecutive dry days, maximum temperature of warmest month, and precipitation of driest month, respectively. Precipitation of the coldest and driest months has limited amount particularly during the months of October to April causing rice crops to suffer water stress. Although, the province has a total of 2,000 mm of rainfall enough for rice production, the erratic distribution resulting from consecutive dry days or even weeks greatly affects its production.

Predicted suitability of rice shows that the province has an index of 1 (Figure 6) means that the province is highly sensitive to changes in precipitation and temperature making the province not suitable to rice production. Nevertheless, there are researches on improved varieties to deal with limited water or drought tolerance without affecting yield such as the GSR varieties as one solution to the problem of unsuitability.

II. CORN

Corn is the second major crop in the province with a total land area of 20,445.00 ha. Corn is usually planted during the second cropping season after rice. Result of the sensitivity analysis on the current and predicted suitability is shown in Figure 6. Current suitability shows that a large area of the province is highly suitable to corn. However, the majority of these areas planted with corn will no longer be suitable by 2050. Based from the MAXENT, the factors affecting the distribution for corn are Bio5, Bio19, Bio20, Bio14 and Bio20 which are maximum temperature of warmest month, precipitation of coldest quarter, number of consecutive dry days, precipitation of driest month, and precipitation of warmest quarter, respectively. Corn crop is highly sensitive to moisture deficit and most of the factors that influence sensitivity were limited precipitation that is why corn production appears to be not suitable in the province. Increase in temperature also affects the moisture in the soil as the higher temperature increases evaporation.

As shown in Figure 6, the province is highly sensitive to bioclimatic variables that influence corn production since corn is dependent to moisture. However, corn farmers are now engaged in planting improved varieties grown with minimum tillage and managed with flash irrigation to efficiently use irrigation water since high temperature requires frequent irrigation since moisture evaporates rapidly.

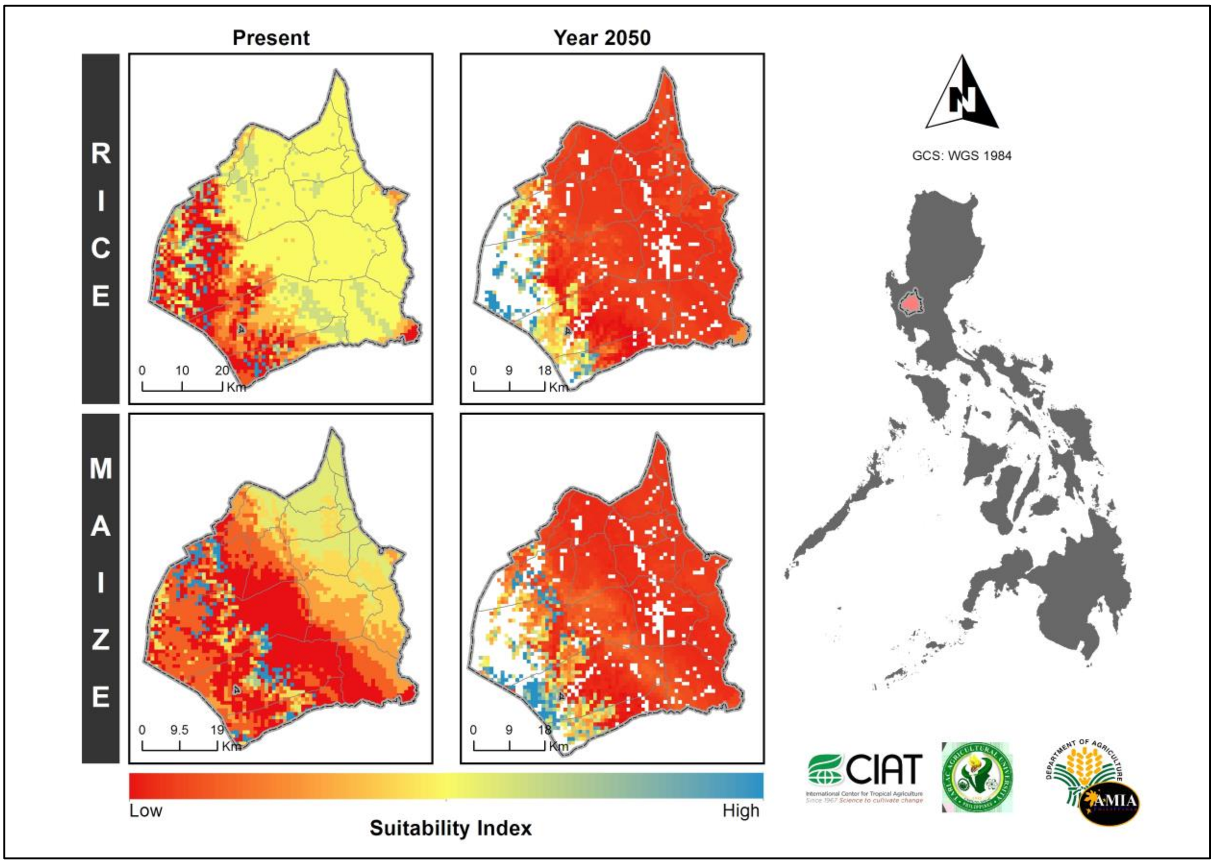


Figure 6. Rice and Corn Suitability Map

III. TOMATO

Tomato is one of the vegetables planted in the province aside from eggplant that has a larger production area because vegetables are planted mostly at the backyard of every household. The area planted with tomato in Tarlac totals to 202.66 ha.

The current and predicted suitability for tomato is shown in Figure 7. Under present conditions, large areas in the province is moderately to highly suitable for tomato production, but by the year 2050 majority of the areas are being categorized as not suitable for tomato production. Results of analysis using MAXENT show that the factors affecting the distribution for tomato are Bio20, Bio17, Bio5, Bio12 and Bio14 which represents the number of consecutive dry days, precipitation of driest quarter, maximum temperature of warmest month, annual precipitation, and precipitation of driest month. Tomatoes are often planted on medium textured and well drained soils that need frequent irrigation since the soil has low water holding capacity. Moisture stress in tomatoes causes shedding of flowers and young fruit, sun scalding and dry rot of fruits. The major factors affecting the distribution for tomato is influenced by precipitation.

The sensitivity analysis for tomato in all municipalities in the province is shown in Figure 7 which is highly sensitive to changes. Tomatoes are deep rooted but planted on sandy to loam soil thus there is a need for frequent irrigation. High temperature promotes rapid evaporation of soil moisture. To minimize volume of irrigation, drip irrigation system may help because it supplies water directly to the roots of the plant which is highly applicable in tomato production. Drip irrigation minimizes the loss of soil moisture thus minimizing moisture stress that affects yield.

IV. MANGO

Mango has a total production area of 2,102.88 hectares. The province is one of the top producers of mango in Central Luzon region. Mango grows almost everywhere having a prominent dry season lasting for more than three months with temperature ranging from 15° C – 37°C. This tree grows best in seasonally wet/dry climate zones of the lowland tropics with much sunshine and a little rain. Based from results of the sensitivity analysis using MAXENT, the factors affecting the distribution of mango are Bio19, Bio5, Bio14, Bio17, and Bio7 or precipitation of coldest quarter, maximum temperature of warmest month, precipitation of driest month, precipitation of driest quarter, and temperature annual range. Temperature is one factor that greatly influence mango distribution. If temperature exceeds 40°, it will lead to sunburn of fruits, stunting of the tree, flower abortion during flowering stage, loss of pollen viability and occasionally, seedless fruit development.

From the current situation, the province is moderately to highly suitable to mango production compared to year 2050 when majority of the areas are categorized to be no longer suitable for mango production as shown in Figure 7. Most municipalities in the province were highly sensitive to changes. Interculture in orchards help in water movement in soil and facilitates water retention and in controlling some of the insect pests.

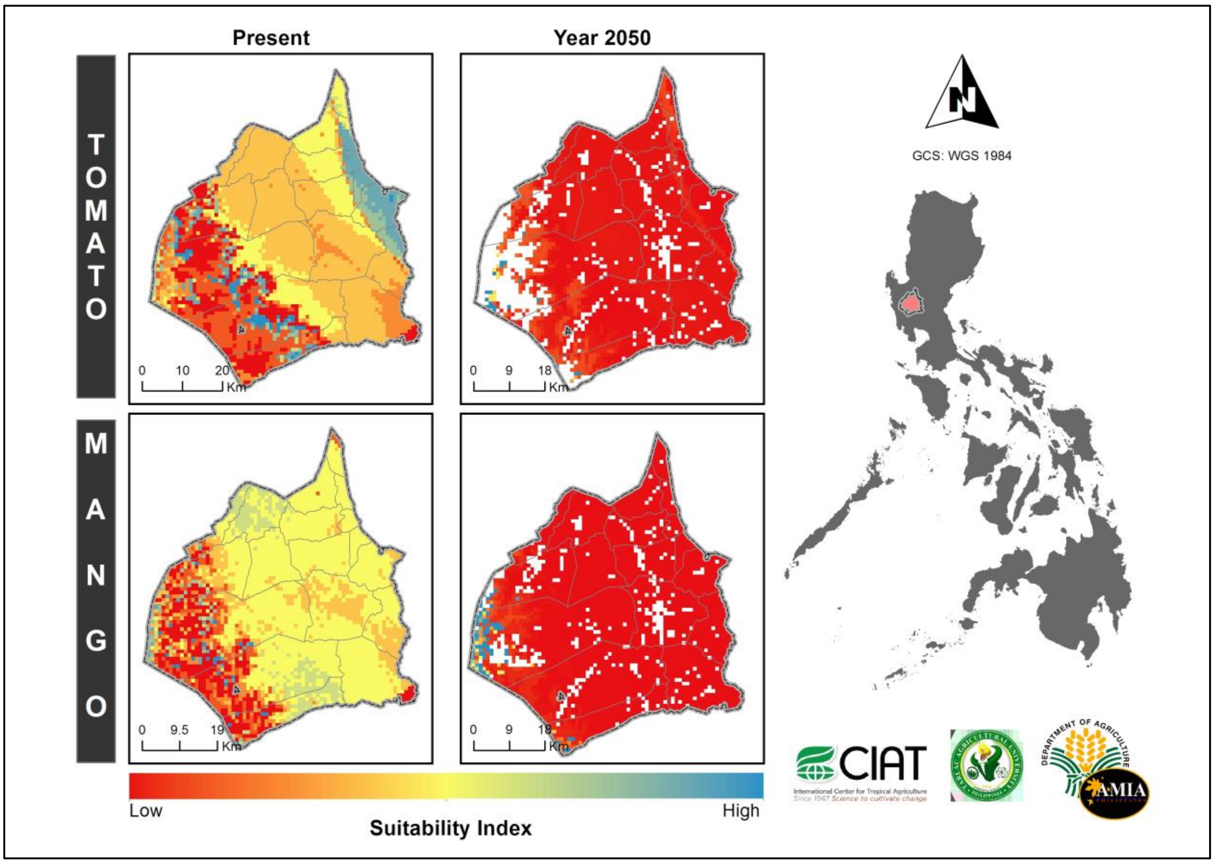


Figure 7. Tomato and Mango Suitability Map

V. SWEETPOTATO

At present, a total of 3,511.33 hectares in Tarlac is planted with sweetpotato. This crop is planted after rice and/or after corn. Sweetpotato crop can grow easily and is drought-and-heat tolerant with few pests and diseases. Based from the MAXENT, the factors affecting the distribution for sweetpotato are Bio19, Bio5, Bio16, Bio17 and Bio7 which are precipitation of coldest quarter, maximum temperature of warmest month, precipitation of wettest quarter, precipitation of driest quarter, and temperature annual range. Sweetpotato is of tropical origin that adapt well to warm climates and grow best during summer thus high temperature and low precipitation have lesser effect on its production

Figure 8 shows the current and predicted suitability of sweetpotato. Current situation of sweetpotato production is from low suitability to highly suitable. However, for the year 2050, majority of the areas are being categorized as highly suitable which means that it is less sensitive to bioclimatic changes.

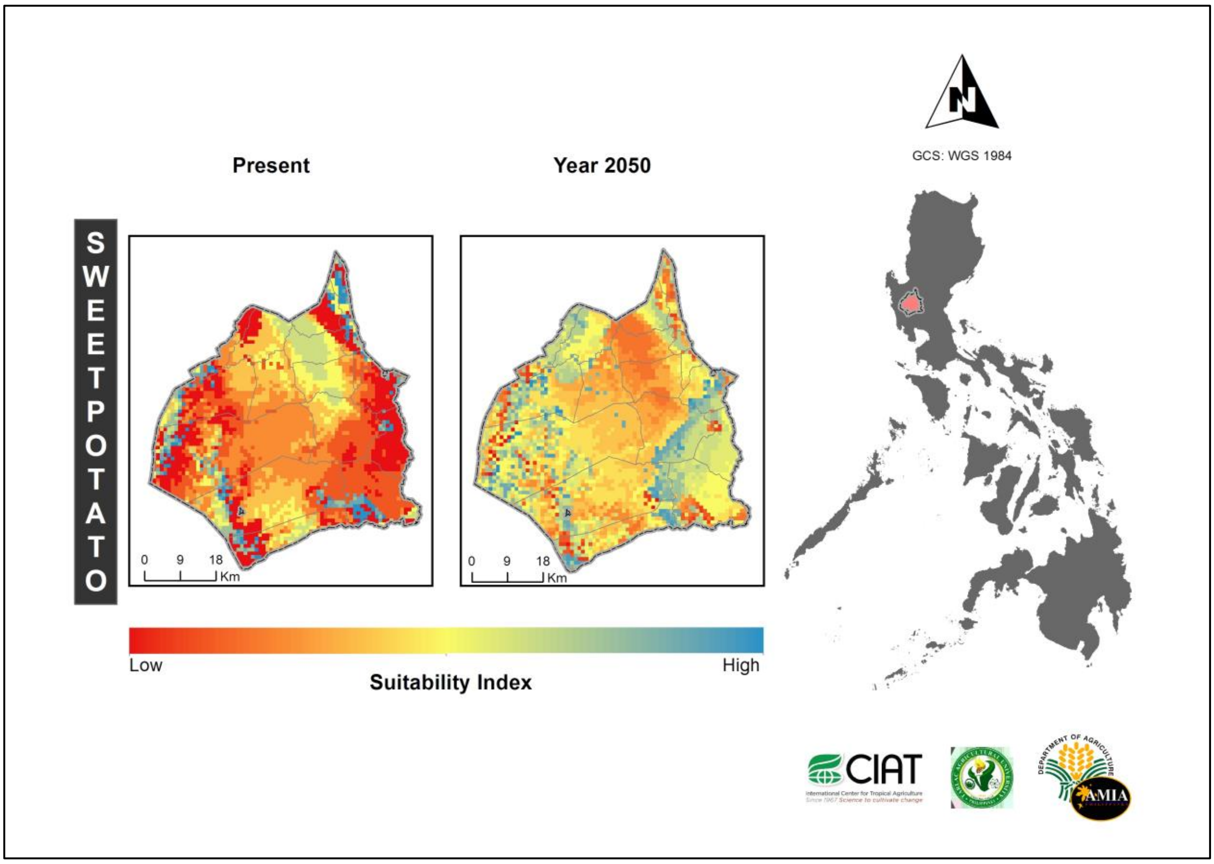


Figure 8. Sweetpotato Suitability Map

Aggregated Sensitivity Index of Crops

The aggregated sensitivity of crops for rice, maize/corn, tomato, mango, and sweetpotato are given equal weights of 20% as shown in Figure 9. It appears that the sensitivity index of the province generally ranges from -5% to -50% which means that it is sensitive to highly sensitive as influenced by the bioclimatic variables. On the other hand, improved varieties of crops, water conservation and soil conservation technologies that are being practiced by farmers mitigate the effect on crop yield.

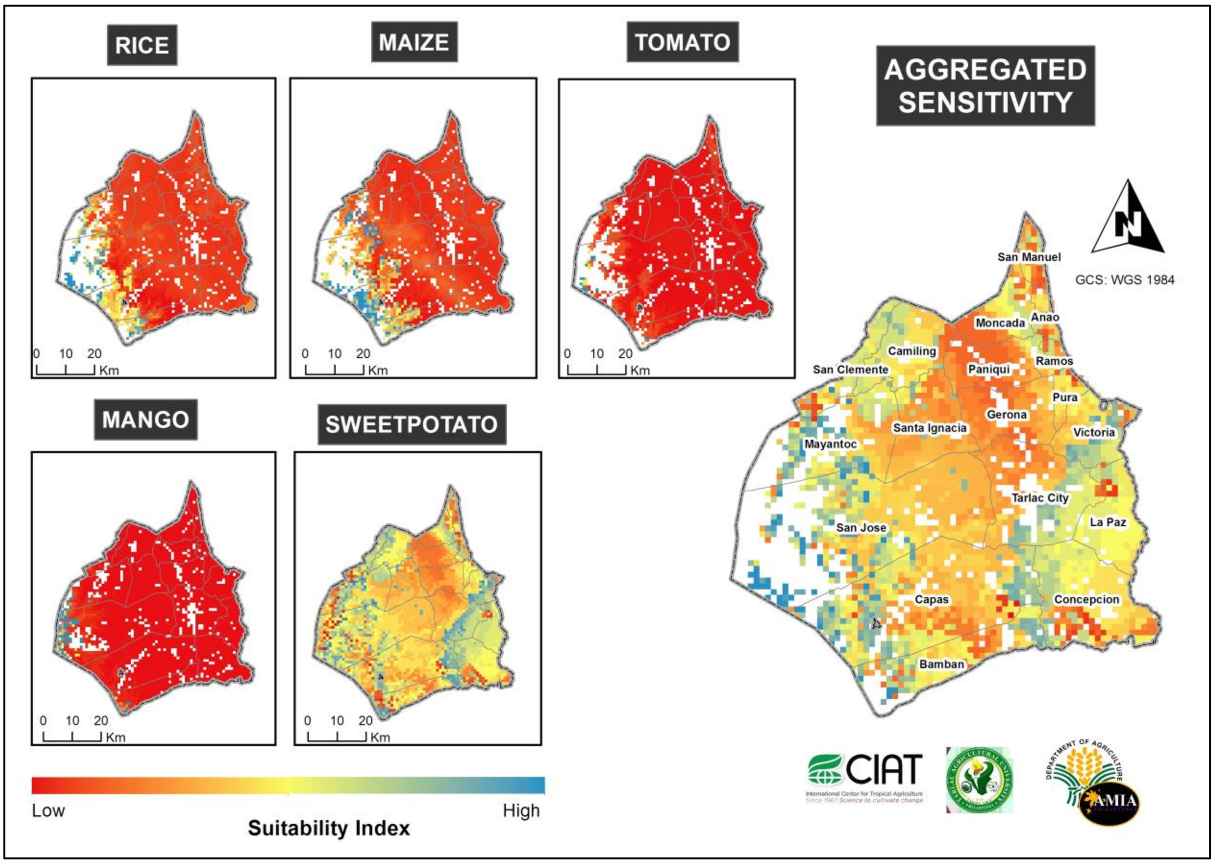


Figure 9. Aggregated suitability map of selected crops in Tarlac

B. HAZARDS

The following natural hazards were considered in the assessment of the vulnerability of the province. This was considered as the province is frequently experiencing these phenomena. These hazards data were gathered from different agencies as shown in Table 5.

The natural hazards considered in this project are typhoon, flood, sea level rise, drought, and erosion to come up with the natural hazards index.

Table 5 Hazard Dataset

HAZARD	DATA TYPE	COVERAGE	SOURCE	ACCESS
Typhoon	Continuous	Global	UNEP	Free
Flooding	Boolean	Philippines	AMIA1 Multi-Hazard Map	EULA covered
Drought	Boolean	Philippines	AMIA1 Multi-Hazard Map	EULA covered
Erosion	Boolean	Philippines	AMIA1 Multi-Hazard Map	EULA covered
Landslide	Boolean	Philippines	AMIA1 Multi-Hazard Map	EULA covered
Storm Surge	Boolean	Philippines	AMIA1 Multi-Hazard Map	EULA covered
Sea Level Rise	Boolean	Philippines	AMIA1 Multi-Hazard Map	EULA covered
Salt Water Intrusion	Boolean	Philippines	AMIA1 Multi-Hazard Map	EULA covered

I. Cyclone/Typhoon

The number of tropical cyclones that passes through Tarlac province ranges from 16 to 25 per year. The occurrence of tropical cyclone is more frequent during the 1st cropping season from June to October when large amount of rainfall and strong winds cause damages to standing crops. Tropical cyclone during November to May is frequent with stronger winds and more intensity of rainfall for a short period of time.

II. Flood

From the onset of the rainy season, whether there is a tropical cyclone or monsoon rain, the amount of rainfall for a week or two can cause flooding particularly to lowland areas. The province is the catchment basin of rainfall from part of Pangasinan, part of Nueva Ecija and part of Bulacan.

III. Erosion

Erosion occurs from the higher elevation with rolling to steep slopes on the part of the province with mountains.

IV. Drought

Areas in the province that usually suffers from drought are the areas that are located in the uplands and without irrigation system. In addition, the limited rainfall that starts from the month of November affects crops that are planted late in the 1st cropping season.

To come up with the natural hazards index, the natural hazards were considered which are typhoon, flood, sea level rise, drought, erosion. In the case of Luzon Island, typhoon, flooding and drought are considered to be of greatest importance.

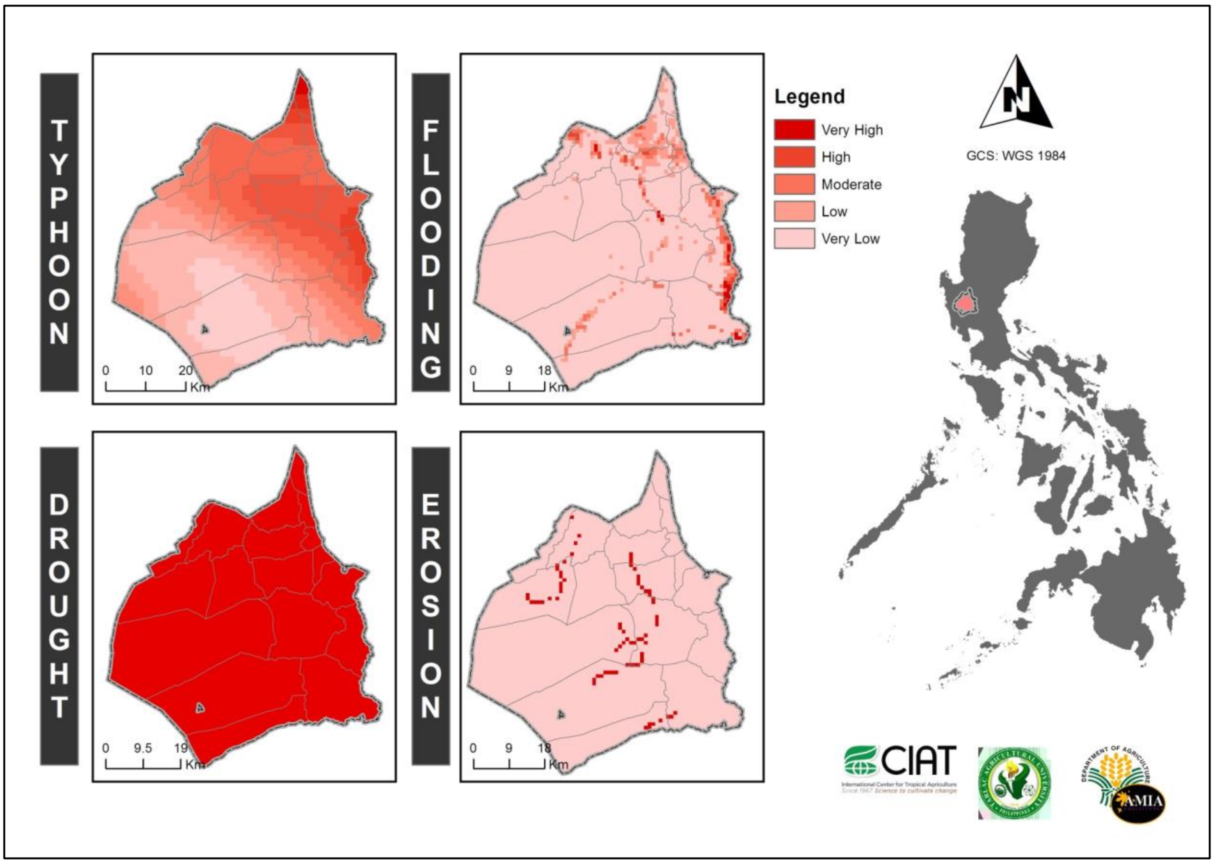


Figure 10. Hazards (Typhoon, Flood, Erosion and Drought) Map for Tarlac Province

On the other hand, the team come up with the hazard index specifically for Tarlac province. The four main hazards in the province with the corresponding weights are shown in Table 5. The hazards that were added to come up with the hazard vulnerability index are tropical cyclone/typhoon, flood, drought and erosion which are given the corresponding weights of 35%, 35%, 27% and 3%, respectively shown in Figure 11.

Weights (%) →	35	35	27	3				
Criteria	**Typhoon**	**Flooding**	**Drought**	**Erosion**	**Landslide**	**Storm Surge**	**Sea Level Rise**	**Salt Water Intrusion**
Probability of Occurrence	5	5	3	3				
Impact to Local Household Income	5	5	4	1				
Impact to Key Natural Resources to Sustain Productivity (i.e., water quality & quantity, biodiversity, soil fertility)	5	5	4	2				
Impact to Food Security of the Luzon	5	5	4	1				
Impact to Nat'l Economy	5	5	4	1				

Scale: Local ↓ Nat'l

Weighting the natural hazards into a climate risk exposure
Probability of occurrence: { 5 = once in every year,
3 = once in every 5 years,
1 = once every 10 years or less}

Impact: { 5 = Disastrous,
4 = Significant,
3 = Moderate
2 = Minor
1 = Insignificant}

Figure 11. Weighted Hazard Index for Tarlac

Aggregated Hazards

The aggregated hazards based from the hazard index of Luzon composed of Typhoon, Flood, Drought and Erosion has the weights as illustrated in Figure 11. Figure 12 depicts the municipalities which are very highly vulnerable to hazards. These are the municipalities of Camiling and Sta.Ignacia followed by the municipalities of Paniqui, Gerona, and Capas to be high vulnerability.

The areas of San Manuel, Anao, Moncada, and La Paz are highly vulnerable to hazards. These areas experiences flooding on the onset of monsoon rain especially during typhoon because of geographically low areas of the province and become the catchment basin of the nearby provinces.

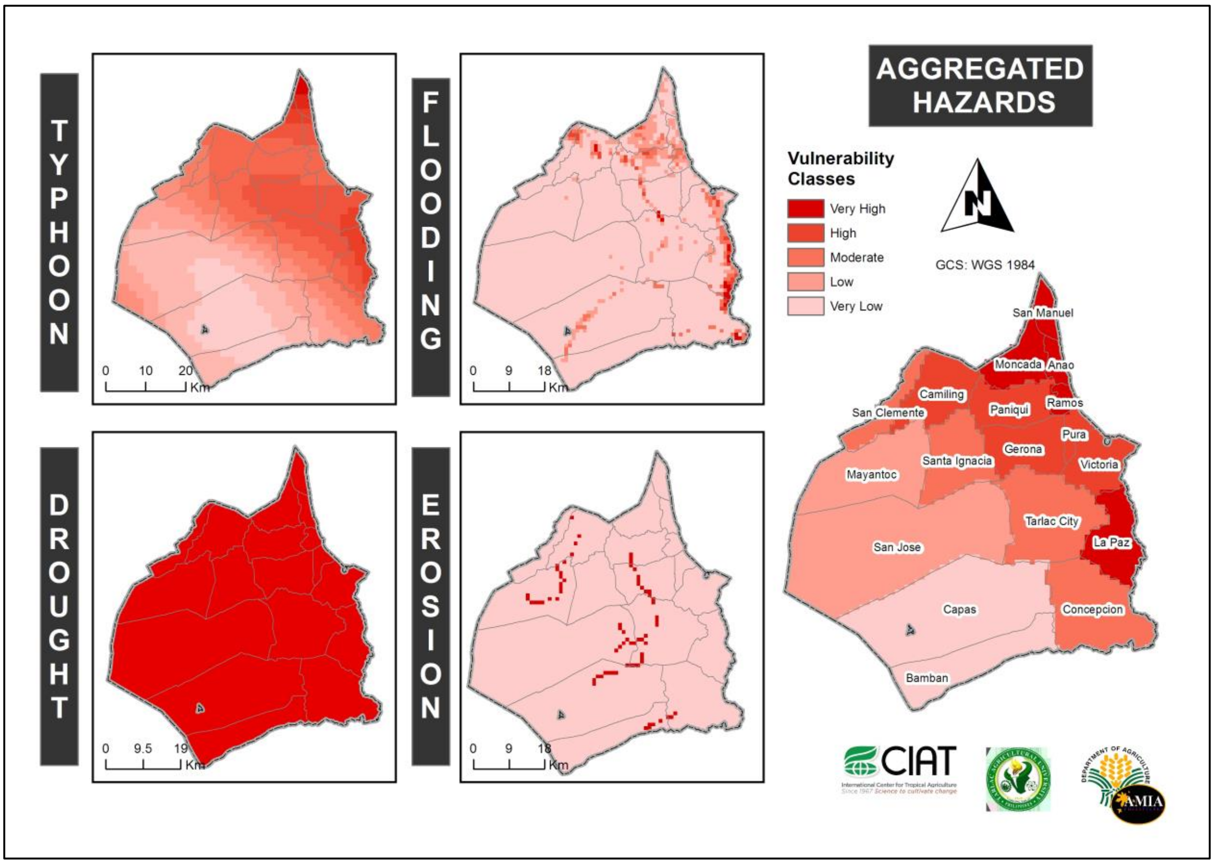


Figure 12. Aggregated Hazard for Tarlac Province

C. ADAPTIVE CAPACITY

Table 6 shows the adaptive capacity indicators considered in the assessment of the province's readiness to withstand the effects of climate change. These seven capitals are economic, natural, human, physical, anticipatory, social and institutional.

Table 6. Adaptive Capacity Indicators

CAPITALS	INDICATORS
Economic	% of water and sanitation per household
	% of electricity per household
	% of diversified income and off-farm income
	% of agricultural insurance
	% of subsidy on seed
	% of employment in agriculture
Natural	% of agricultural land
	% of groundwater availability
	% on reliable water for irrigation
Social	Farmers/irrigator association
	Cooperatives
	Civil Society organizations
	% of farmers members of coops/unions/groups

	% of women in government
Human	Hospital
	Rural health unit
	Brgy. health stations
	Doctor
	Nurse
	Medical technologist
	Dentist
	Midwives
	Sanitary inspector
	Brgy health worker
Physical	Farm size (ha)
	Equipment available in the area
	Livestock owned
	% of farmers with access to irrigation
	Postharvest infrastructure
	Input dealers
	Road network
	% of farmers with market access
Anticipatory	Disaster Preparedness Committee
	Early Warning System
	Seminars and Drills
	Evacuation Equipment
	Fire truck
	Fireman
Institutional	Government/CSO programs for climate change
	Government response to previous shocks
	% of farmers visited by agricultural extension officer

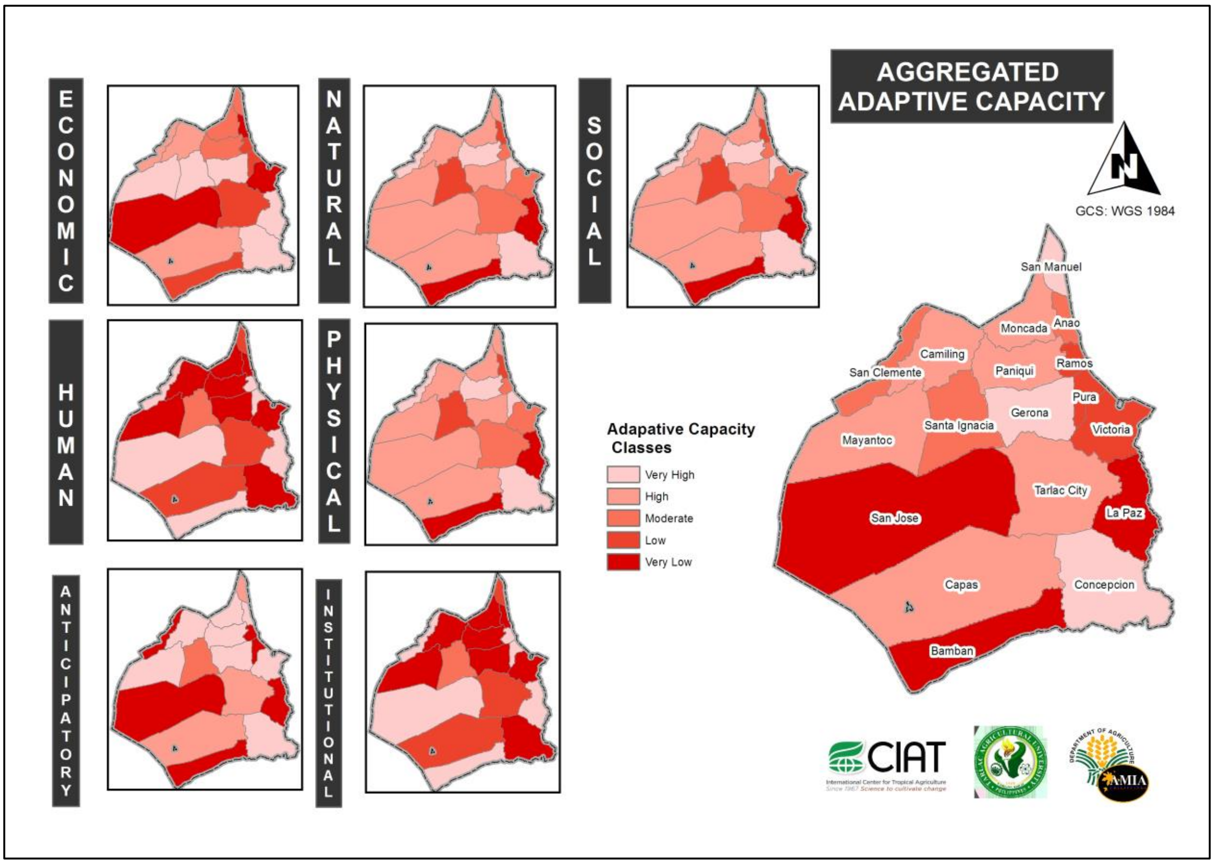


Figure 13. Adaptive Capacity Map of Tarlac

Adaptive Capacity Index

Figure 13 on the adaptive capacity illustrates the economic, natural, human, physical, anticipatory, social and institutional capital of every municipality. These seven (7) capitals of the adaptive capacity were given the same weight to come up with the aggregated adaptive capacity map.

The adaptive capacity of the province shows the readiness to adapt to climate risk. Concepcion and Gerona were found to have very high adaptive capacity while the municipalities of Ramos, San Jose, La Paz, and Bamban have very low adaptive capacity.

D. CLIMATE-RISK VULNERABILITY

The climate-risk vulnerability map was developed by adding the sensitivity index, hazard index and the adaptive capacity index with their corresponding weights. A national experts' meeting composed of agriculturists, policy makers, and scientist, agreed the 15-15-70 percentage of weight for the sensitivity, hazard and adaptive capacity, respectively. The formula used in the development of climate-risk vulnerability map is stated below:

Climate-risk vulnerability = Sensitivity index*0.15 + Hazard index*0.15 + Adaptive capacity index*0.70

Figure 14 show the vulnerability to climate-risk is very high in the municipalities of Ramos, Bamban and La Paz; high in San Jose, Victoria and Pura; lowest in Tarlac City. The factor that has the major contribution in the vulnerability assessment is the adaptive capacity given a weight of 70% compared to sensitivity and hazards with 15% weights each. The perspective of giving a high percentage to the adaptive capacity is the thought of the ability of every municipality being able to cope with extreme events like temperature, rainfall, typhoon, flood, drought, erosion and other natural hazards because these municipalities are equipped with facilities and structures, and services for the adaptation.

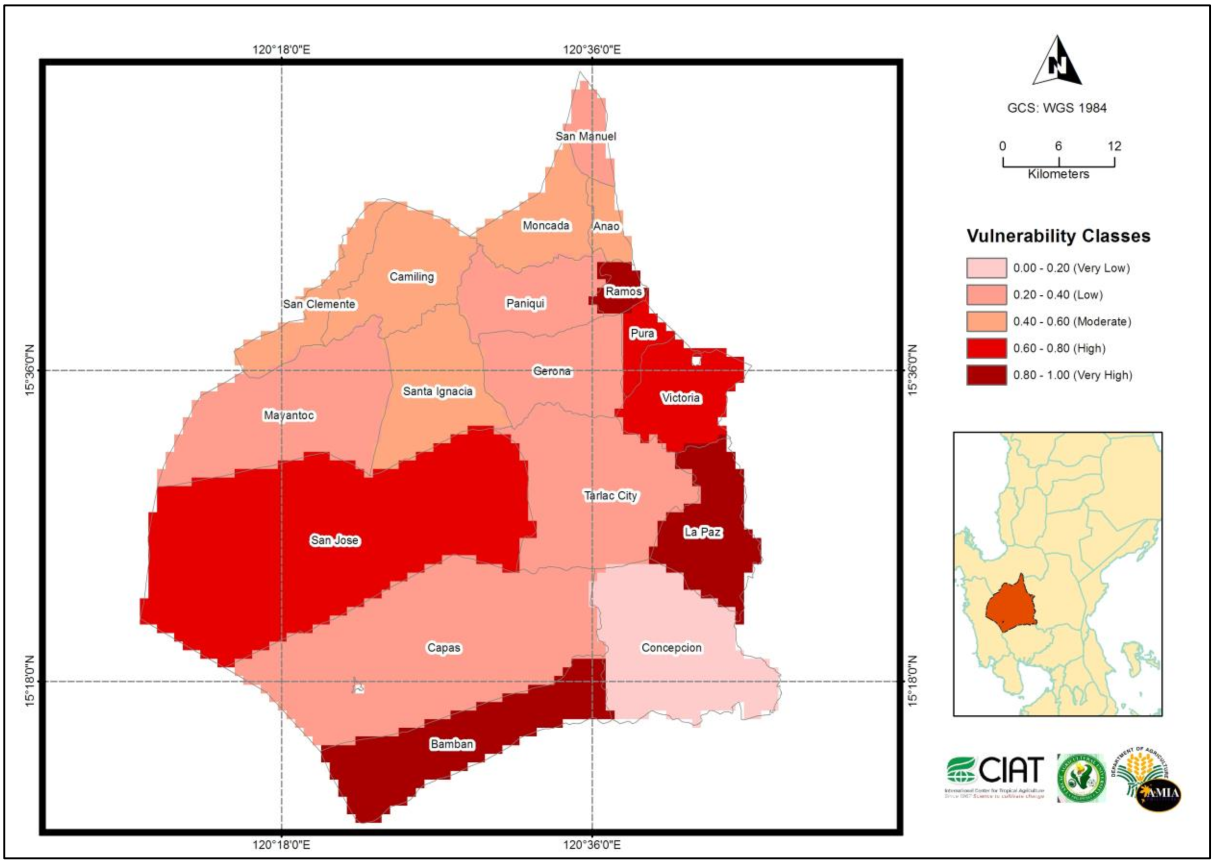


Figure 14. Climate-Risk Vulnerability Map of Tarlac

The maps developed in the CRVA assessment was presented to a focus group discussion (FGD) with the stakeholders from the Provincial Agriculture Office (PAO), Municipal Agriculture Office (MAO), Farmers and other agencies. From the FGD and field visit conducted the participants agreed that the maps developed are similar to the actual situation in their municipality.

The municipality of Victoria was chosen as the pilot smart village in the province of Tarlac. Based from the result of the climate-risk vulnerability map it is considered as one of the high vulnerable municipalities that was sensitive to changes in climate, vulnerable to hazards and has less adaptive capacity to cope up with these phenomenon. Victoria was a 2nd class municipality of the province of Tarlac with 26 barangays and located at the eastern part of the province. Majority of the total land area was devoted to agricultural activities and livestock production.

E. COST-BENEFIT ANALYSIS (CBA) OF CRA PRACTICES

Table 7. Summary of CRA Practices in Tarlac

	CRA Practice
Organic agriculture	Vermiculture, Bokashi, MRF
Climate smart varieties/ lines	GSR lines, RC 23
Water conservation technology	AWD, SWIP, SFR
Adaptive crop calendar/Crop switching	Early planting season (May)
Soil conservation technology	Minimum Tillage, Zero tillage
Intercropping/ Crop Rotation	Rice-Corn-Sweet potato
Community-based management	Farmer Field School
Improved housing	Tunnel Type
Biodigester	Present in 5 towns
Crop insurance/ weather adverse condition insurance	PCIC, cooperatives, micro lending institutions

Table 7 shows the identified climate-resilient practices in the province of Tarlac. These were gathered from a series of Focus Group Discussions with municipal agriculturists, representatives of the Office of the Provincial Agriculturists and Local Farmer Technicians.

From the list of CRA practices, key informants identified three priority practices: climate smart varieties, crop rotation, and water conservation technology particularly the alternate wet and dry method (AWD) as shown in Table 8. The interview guide provided by

CIAT was modified to fit the scope of the study before it was given to the group of key informants. Data gathered were used in the evaluation of CRA practices using the CBA Tool.

Table 8. Prioritized CRA practices in Tarlac

Practice	Rank
Climate Smart Varieties	1
Crop Rotation	2
Water Conservation Technology	3
Organic Agriculture	4
Soil Conservation technology	5

Validation of data was done in three separate occasions in 2016: November 25, November 29 and December 6. Seventy one (71) municipal agriculturists, farmer leaders and farmer technicians participated in the Focus Group Discussions. The cost and benefits derived from the CRA practices were confirmed. These data were used to analyse the profitability and sustainability of the CRA practice.

The three were prioritized because of the immediate effects and perceived potential benefits to the farmers, food security and, mitigation and adaptation to climate change.

A. Climate Smart Varieties

Yield of crops is affected by extreme changes in climatic conditions such as flooding, and drought and attack of insect pests and diseases.

Farmers and agricultural technologists favor climate smart varieties because of its high yield and its capacity to withstand varied climatic conditions. The Green Super Rice lines (GSR 8, 15, 21, and 22) earned special mention among farmers who have experienced growing it due to its resiliency especially during typhoons and floods, drought, and attack of insect pests and diseases. Farmers who planted GSR lines attested the resilience of these lines to typhoon and submergence. Yield was not likewise affected.

BtGt (*Bacillus thuringiensis Gt),* an improved variety of corn, is high in yield, resistant to corn borer, and tolerant to glyphosate/herbicide making it environment-friendly because of less pesticide usage. Yield in field trials ranged from 12-16 tons, an increase of 4 tons from the traditional corn variety.

B. Crop Rotation

Crop rotation was chosen mainly because farmers could switch from rice to other crops (corn, sweet potato, etc.) depending on availability of water, soil conditions, and other climactic factors. Crop rotation also means reduction in pest occurrence due to non-availability of the host.

Likewise, crop rotation is a highly favored CRA practice because of its efficiency in conserving soil nutrients, minimizing the emergence of pests and diseases, and increasing income if cropping sequence is properly chosen. At least four major crops are presently grown in rotation to rice: corn, sweetpotato, mungbean and other vegetables.

Corn is largely grown after rice in the municipalities of San Manuel Moncada, Concepcion and Paniqui. Sweetpotato, mungbean, yambean and other vegetables are other choices. Sometimes, these crops are grown instead of corn or these are planted after corn harvest depending upon the availability of water.

Sweetpotato and mungbean are rotated with rice because aside from being important cash crops in the province, it requires less fertilizer, less pesticides and minimal irrigation, if ever the residual soil moisture is not enough, thus, giving farmers higher income on a hectare basis. Planting is usually done during the months of December to April. Planting these crops enhances the soil and gives green manure in time for the next planting season.

C. Water Conservation Technology

To address problems on scarcity of water supply or limited access to water sources in the upland, rainfed, and other areas, water conservation technologies are resorted to. The Alternate Wet and Dry (AWD) Method was specially mentioned because it utilizes materials readily available and can be constructed easily by the farmer. Some parts of the province depend on shallow tube wells and Tarlac Ground (TG) water as their main source of irrigation. In these areas, one of the main expenses incurred by farmers is gasoline that is used to run pumps. This practice was chosen because it allows farmers to irrigate at the proper time. The intermittent drying of fields enables the farmers to save on time and money.

This practice saves at least 96 liters (approx. P3,600) on fuel alone versus the traditional practice of continuous flooding. Farmers' experiences reveal that there is no significant difference in terms of output produced per hectare.

Other CRA practices like organic agriculture (especially vermiculture) and soil conservation technology (minimum tillage) was also mentioned but for the purpose of prioritization of immediate needs and food security the top three practices was evaluated for this study. Combination of practices was also evident in some areas of Tarlac. San Manuel, for example, is currently using crop rotation (rice-corn-mungbean or rice-corn-sweetpotato), minimum tillage, and organic fertilizer in most of its agricultural land.

The group came up with investment briefs intended for policy makers as guide in prioritizing climate smart agricultural practices in the province (Figure 15).

Figure 15. Investment briefs for climate smart agriculture.

IV. Conclusion and Recommendations

For the prioritization of CRA practices, the following are recommended for researchers, policy makers, farmers and local government units;

- To maximize the potentials of climate smart varieties, it should be implemented in combination with other practices such as crop rotation, and application of organic fertilizers.
- Continuous research to develop CSA varieties to raise the income of farmers and mitigate the effects of climate change in the agricultural sector.
- AWD could be utilized in areas where water is scarce; shallow tube wells are available, and Tarlac groundwater as source of water irrigation.
- Efficient in terms of fuel consumption because it maximizes the use of water without sacrificing the quantity of output.
- Multi-stress varieties of rice especially drought- tolerant may be used in combination with AWD, to increase the harvest and income of farmers.
- Apart from the use of CSA varieties, rotating rice with corn, sweetpotato, or mungbean is also recommended.
- The application of organic fertilizer is recommended in areas with rice-corn-corn cropping pattern since corn consumes large amount of nutrients from the soil.
- Rice-Corn-Mungbean or Rice-Corn-Sweetpotato cropping pattern instead of Rice-Corn-Corn to lessen the use of inorganic fertilizer and maintain the productivity of the soil. Rice-Sweetpotato or Rice-Mungbean may likewise be followed.
- Additional 9kg input of micronutrients from the organic fertilizer helps in the development of the bushel making it bigger and heavier.

Table 9. CRA practices and technologies being adopted by farmers in Tarlac province

CRA practices and technologies being adopted	Anao	Bamban	Capas	Concepcion	Gerona	La Paz	Mayantoc	Moncada	Paniqui	Pura	Ramos	Santa Ignacia
Climate smart varieties	Drought resistant	Rc 218, Rc 160, Rc 222	Rc 222, Rc 218, Rc 160, Rc 342, GSR 15, 12, 1	Hybrid	Jasmin, Dinorado, Sampaguita	SO 8, Rc 218, Rc 160, Rc 222, GSR, Rc 158	Hybrid rice, SL 8H, Rc 124H, Rc 10	Rc 222, Rc 160, Rc 218SR, 122, Rc 260H, Rc 238	Rc 282, Rc 280, Rc 348	Rc 18, Rc 222, Rc 216, Rc 308	Rc 222, Rc 216, Rc 18, Rc 160, Rc 124H	Drought resistant: Rc 23, PSB 192; Early maturing: Rc 110, Rc 152
Organic agriculture/Permaculture/GAP	26 farmer-beneficiaries on vermiculture /vermibed; sales from January-May 2016 - PhP18,171	Famer-produced vermiculture ; PhP200-300 per bag	Farmer-produced; 7 has; PhP400 per bag(50kg)	Vermiculture	Bukashi	n/a	Biofertilizer , vermicompost, organic farming	Windrow composting, effective microorganisms	Vermicompostin g	Compost (from MRF); municipal-produced, PhP150 per bag	Vermiculture; farmer-produced, for their own use; there are associations who signified intent to produce	Vermiculture
Water conservation technology	STW, SDD, AWD: 7-11 days	SWIP, STW, Drip irrigation	SWIP, STW, drip irrigation, project SFR (small farm reservoir)	STW	SRI, STW, SFR, AWD	AWD, STW, SFR, open source	SWIP, STW, CIS, PESOS, SFR	SWIP, AWD, STW, Drip irrigation	STW, SWIP	STW, AWD	SWIP, AWD, STW (some owned, some given), deep wells (NIA), SSIS-FAO funded, river (double loading)	SFR, STW, SWIP, NIA-CAMRIS, NIS
Adaptive crop calendar/Crop switching	Early planting season	Rainfall pattern; rice-rice, rice-corn, rice-vegetables	3 times cropping (depending on source of water); Jul/Aug -		Cropping pattern, cropping calendar	Early planting before flood; rice-rice-mung	n/a	Based on weather forecasting , if La Niña - earlier, if drought -	Wet season (Mar 15 - Sep 15), Dry (Sep 16	Depending on source of water (rainfed	Early planting to avoid typhoon season; Rice-rice;	n/a

CRA practices and technologies being adopted	Anao	Bamban	Capas	Concepc ion	Gerona	La Paz	Mayantoc	Moncada	Paniqui	Pura	Ramos	Santa Ignacia
			rice; western: mais-rice, cassava-rice, peanut-rice			bean, rice-corn		alternatives (mung bean), green manuring process - conditioning of soil to increase fertility of soil	onwards)	vs STW)	rice-yellow corn; rice-vegetables; rice-sweet potato/mung bean/peanut	
Soil conservation technology	Minimum tillage	Contour cropping	Contour cropping, minimum tillage		Contour cropping	n/a	Direct seeding, minimum tillage	Minimum tillage, zero tillage (herbicides used to kill weeds)	Control irrigation	n/a	Planted mangoes, bamboo, banaba, along river banks to prevent soil erosion	Direct seeding
Intercropping	Mango-rice; mango-corn	Corn-mango, peanut	Vegetable-vegetable		Calamansi, string bean, chili	Vegetable-vegetable, rice-corn, rice-vegetable, rice-lady's finger	Veggie-corn	HVCC: eggplant/tomato, beans, rice/corn	Rice/string bean/eggplant	n/a	Small scale: mais and rice (seedlings only); calamansi and rice and assorted vegetables	Rice-veggies
Community-based management	n/a	n/a	Farmer leaders		n/a	n/a	n/a	Barangay conducts FFS		n/a	Demo farm - Palayamanan: FLT-managed; CSO - civil society, NGOs, barangay agri council,	n/a

CRA practices and technologies being adopted	Anao	Bamban	Capas	Concepcion	Gerona	La Paz	Mayantoc	Moncada	Paniqui	Pura	Ramos	Santa Ignacia
											coops, assoc of farmers, women and youth	
Improved housing (livestock/fisheries)		Airconditioned	Airconditioned (private/commercial farms - PMI)		Airconditioned livestock farm	Airconditioned	n/a	Airconditioned; dispersal program	Goats: from grazing to housed, nappier production; chicken: aircon housing	n/a	Airconditioned	n/a
Biodigester	2 biodigesters from DOST given to farmers	n/a	Biodigester		Composter	n/a	n/a	Biodigester		n/a	n/a	n/a
Aquasilviculture/Mangrove and Seaweed conservation	n/a	n/a	n/a		n/a	n/a	n/a	n/a		n/a	n/a	n/a
Alternative feeds (livestock/fisheries)	n/a	Organic	Food for native pigs		For native pigs, free-ranging	Sweet potato, corn, water spinach, banana trunk, vegetables	n/a	Forage; plants nappier; Jeffrey Lim - supplier of seeds	Water spinach, rice bran, forage, leftovers	Water spinach	Peanut leaves, sweet potato twines, hay, water spinach	n/a

CRA practices and technologies being adopted	Anao	Bamban	Capas	Concepcion	Gerona	La Paz	Mayantoc	Moncada	Paniqui	Pura	Ramos	Santa Ignacia
Weather-index based insurance		PCIC	PCIC, ccop bank, associations		PCIC	PCIC, individual, lending-insurance	n/a	Crop insurance; 99 farmers; 6K - 10K, 50% depending on area		PCIC, lending (TSPI)	PCIC	n/a
Rain protection		Plastic mulch	Plastic mulch		n/a	Plastic mulch (Putrico, Sierra)	Plastic mulch, rice straw, greenhouse/nursery	Plastic for HVCC	After demo only	n/a	n/a	Plastic mulch
Grafting	Kamlong; source of seeds	Mango, rambutan	n/a		n/a	n/a	n/a	Trees; kamlong		n/a	n/a	Kamlong
Hydroponics	n/a	n/a	n/a		n/a	n/a	Diversified farming	n/a		n/a	n/a	n/a
Value-adding/Farm tourism	Processing of essential oils	Agrosite: Anupul, San Roque	Egg products, salted eggs		Demo farm for CRFS (eggplant)	(Supposedly) - okra for canton-making	n/a	Sweet potato wine; buchi		n/a	n/a	n/a
Swimming pond (livestock)		n/a	n/a		n/a	n/a	Clean and green program	n/a		Creek	n/a	n/a
Other practices	n/a	n/a	n/a		SRI (rice technology: one seedling per hill)	n/a	Waste management	n/a	ID system of farmers		n/a	Coop
					Use of organic fertilizer		IP representative in Sangguniang Bayan		Dragon fruit			
					Diversified farming/integrated farming				Organic farming			

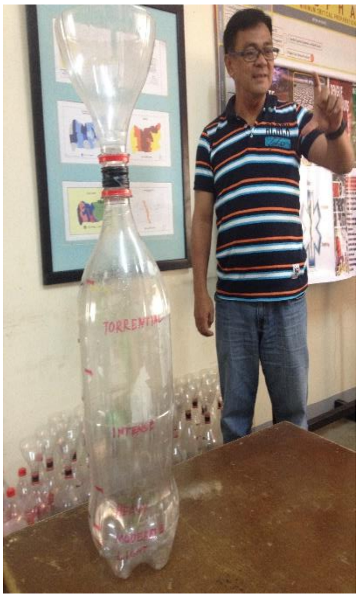
CRA practices and technologies being adopted	Anao	Bamban	Capas	Concepcion	Gerona	La Paz	Mayantoc	Moncada	Paniqui	Pura	Ramos	Santa Ignacia
					Livelihood: organic fertilizer production, dishwashing liquid, alternative health medicine				Pigmented rice			
					Rice Watch since 2009				Haler from Philmic			
					Information center: equipment, climate awareness of farmers							

APPENDICES

PHOTODOCUMENTATION

Participatory Mapping on Crop Occurrence
July 30, 2016/ Provincial Agriculture Office

CRA Practices and Adaptive Capacity



LISTO Program

Paniqui has a pro-active Local Disaster Risk Reduction Management Council. Early warning devices such as color-coded posts & trees, automatic signal system are located in flood-prone areas

VALIDATION OF CRA DATA

Members of the study together with DA-RFO III pose with the participants in the CRVA Validation of Data

Validation of data with farmer leaders, technicians, and municipal agriculturists of Tarlac.

C. PROJECT MANAGEMENT

1. Updated Work Plan Schedule

WORKPLAN SCHEDULE

Starting Date: ***1 July 2016***		**Completion Date:** ***31 July 2017***		**Duration:** ***12 months***				
Activity No.	**Major/Sub-Activity**	**Anticipated Results**	**Lead Responsible Person(s)**	**Resources Required**	**Schedule of activities**			
					Year 1			
					Q1 Jun-Aug	**Q2 Sep-Nov**	**Q3 Dec-Feb**	**Q4 Mar-MAY**
1	Capacity strengthening for CRA Research & Development	Enhanced Capacities of AMIA partner organizations in the region on • Climate Risk Vulnerability Assessment (CRVA) • Climate –Resilient Agri-fisheries (CRA) prioritization	Project Team CIAT					
		• CRA knowledge hub development • CRA Monitoring and Evaluation (M&E)						

Starting Date: *1 July 2016*		Completion Date: *31 July 2017*		Duration: *12 months*				
Activity No.	**Major/Sub-Activity**	**Anticipated Results**	**Lead Responsible Person(s)**	**Resources Required**	**Schedule of activities Year 1 Q1 Jun-Aug**	**Q2 Sep-Nov**	**Q3 Dec-Feb**	**Q4 Mar-MAY**
2	Geospatial assessment of climate risks	Geospatially referenced data on climate-risks	Project Team					
	• Collection of secondary data for exposure-sensitivity	Biophysical-agricultural-socioeconomic parameters	Project Team					
	• Collection of secondary-primary data for adaptive capacity		Project Team					
	• Preliminary data analysis		Project Team					
	• Cross-regional/national data analysis workshop		Project Team					
3	Stakeholders' participation in climate adaptation planning	Local stakeholders' CRA-related demographic/institutional profiles & knowledge/perceptions/strategies	Project Team LGUs Farmers					
	• Regional-level CRVA stakeholders' validation							
	• Community-level CRVA stakeholders' validation							
	• Regional-level CRA stakeholders' validation							
	• Community-level CRA							

Starting Date: *1 July 2016*		Completion Date: *31 July 2017*		Duration: *12 months*				
Activity No.	**Major/Sub-Activity**	**Anticipated Results**	**Lead Responsible Person(s)**	**Resources Required**	**Schedule of activities – Year 1 – Q1 Jun-Aug**	**Q2 Sep-Nov**	**Q3 Dec-Feb**	**Q4 Mar-MAY**
	stakeholders validation							
4	Documenting & analyzing CRA practices	*Analyzed cost-benefits & trade-offs of data on CRA practices*	Project Team					
4.1	Key informant survey on CRA practices	Survey checklist	Project Team					
4.2	Cost-benefit and trade-off analyses	Analytical tools (CBA tool)	Project Team (Economist)					
4.3	National knowledge-sharing event on CRVA and CRA	Workshop	CIAT AMIA Team Project Team					
4.4	Planning workshop for AMIA2+	Workshop	Project Team AMIA Team CIAT					
5	AMIA baseline study for monitoring & evaluation	*M&E baseline data for CRA communities & livelihoods*	Project Team CIAT					
5.1	Survey on target communities & livelihoods	Survey questionnaire	Project Team					
5.2	Cross-regional/national data analysis workshop	Workshop	CIAT Project Team					

fANNEXES

Table 1. Production area (has) of various crops in the different municipalities of Tarlac province

Municipality	Production Area (Has)				
	Rice	Corn	Tomato	Mango	Sweetpotato
Anao	1,170.00	936.00	3.00	13.00	0.00
Bamban	1,704.00	148.00	2.00	551.00	15.00
Camiling	7,493.00	1,337.10	20.64	128.81	112.66
Capas	7,383.00	141.00	2.80	0.00	133.50
Concepcion	12,868.07	5,587.00	5.75	12.41	401.75
Gerona	6,723.35	567.00	8.60	217.38	233.25
La Paz	8,728.21	189.00	3.55	27.00	0.00
Mayantoc	7,071.00	20.00	5.50	75.00	8.00
Moncada	5,461.00	2,279.70	50.00	138.88	1,475.00
Paniqui	4,362.60	1,554.60	7.45	190.47	1,050.67
Pura	1,764.65	207.00	3.00	15.00	6.75
Ramos	1,646.50	251.50	31.50	3,745.00	159.00
San Clemente	1,723.00	130.00	12.00	26.50	3.00
San Jose	7,400.50	330.00	6.00	33.00	6.00
San Manuel	2,008.00	2,100.00	2.00	140.00	0.00
Sta. Ignacia	6,159.80	21.78	29.75	21.78	7.50
Tarlac City	10,664.58	418.30	12.77	182.95	26.00
Victoria	7,846.80	241.00	9.50	141.85	3.50
TOTAL	102178.06	16458.98	215.81	5660.03	3641.58

Source: Provincial Agriculture Office, 2016

Table 2. Yield (tons/ha) of priority crops in the different municipalities of Tarlac province

Municipality	Average Yield (tons/ha)				
	Rice	Corn	Tomato	Mango	Sweetpotato
Anao	5.02	9.80	30.00	4.61	0.00
Bamban	4.00	7.50	3.00	5.00	15.00
Camiling	5.20	7.50	18.00	12.00	20.00
Capas	4.12	4.50	14.00	0.00	20.00
Concepcion	5.02	9.60	9.80	6.70	17.00
Gerona	4.34	8.50	30.00	0.00	15.00
La Paz	4.88	7.82	15.00	5.00	10.00
Mayantoc	4.17	8.00	14.74	0.10	8.70
Moncada	4.25	6.00	8.00	4.20	18.00
Paniqui	4.50	8.00	10.00	0.00	18.00
Pura	4.63	10.00	8.00	5.00	10.00
Ramos	4.55	8.50	10.00	10.00	17.20
San Clemente	4.26	9.00	12.00	20.00	15.00
San Jose	4.06	22.20	15.00	5.00	16.00
San Manuel	6.00	16.00	20.00	1.20	0.00
Sta. Ignacia	4.60	8.50	4.50	5.00	7.50
Tarlac City	4.94	9.23	8.44	17.29	14.76
Victoria	4.94	10.65	9.50	15.20	14.00
AVERAGE	4.64	9.52	13.33	6.46	13.12

Source: Provincial Agriculture Office, 2016

Table 3. Sensitivity Index Criteria

	CHANGES (%)	**INDEX**
Negative	-50 - -100	1
	-25 - -49	0.5
	-5 - -24	0.25
No change - no crop	-5 - +5	0
Positive	5 – 24	-0.25
	25 – 49	-0.5
	50 – 100	-1

Table 4. Luzon Hazards Weights

Weights (%) →	20	19	14	11	9	10	6	11
Criteria	Typhoon	Flooding	Drought	Erosion	Landslide	Storm Surge	Sea Level Rise	Salt Water Intrusion
Probability of Occurrence	5	5	3	3	3	5	1	5
Impact to Local Household Income	5	4	3	3	2	2	2	2
Impact to Key Natural Resources to Sustain Productivity (i.e., water quality & quantity, biodiversity, soil fertility)	4	4	3	3	2	1	1	2
Impact to Food Security of the Luzon	4	4	3	2	1	1	1	2
Impact to Nat'l Economy	3	3	3	1	1	1	1	1

Scale: Local → Nat'l

Weighting the natural hazards into a climate risk exposure

Probability of occurrence: { 5 = once in every year,
3 = once in every 5 years,
1 = once every 10 years or less}

Impact: { 5 = Disastrous,
4 = Significant,
3 = Moderate
2 = Minor
1 = Insignificant}

Table 5. Summary of Adaptive Capacity

Economic													
Municipality	Yield (kg/ha)					Income Level	Households have Running Water & Sanitation	Households have Electricity	Access to Credit	Diversified income and Off-farm income	Agricultural Insurance	Subsidy on Certified Seed	Employment in Agriculture
	Rice	Corn	Tomato	Mango	Sweetpotato								
Anao	5,020	9,800	30,000	4,610	0	5th class	10.00	99.00	1.00	30.00	10.00	20.00	59.27
Bamban	4,000	7,500	3,000	5,000	15,000	2nd class	41.05	93.28	1.00	60.00	5.00	15.00	20.75
Camiling	5,200	7,500	18,000	12,000	20,000	1st class	23.00	91.20	9.00	40.00	40.00	25.18	50.00
Capas	4,120	4,500	14,000	0	20,000	1st class	80.00	99.00	8.00	30.00	20.00	20.00	70.00
Concepcion	5,020	9,600	9,800	6,700	17,000	1st class	41.00	99.00	17.00	55.00	23.27	21.90	45.44
Gerona	4,340	8,500	30,000	0	15,000	1st class	50.00	99.00	9.00	65.00	20.00	20.00	35.31
La Paz	4,880	7,820	15,000	5,000	10,000	2nd class	40.00	86.93	2.00	31.11	20.00	20.00	65.89
Mayantoc	4,170	8,000	14,740	100	8,700	3rd class	20.00	99.00	3.00	40.00	20.00	20.00	60.00
Moncada	4,250	6,000	8,000	4,200	18,000	1st class	67.28	90.00	12.00	20.00	2.59	14.28	80.00
Paniqui	4,500	8,000	10,000	0	18,000	1st class	25.78	96.04	11.00	40.00	3.08	36.82	39.07
Pura	4,630	10,000	8,000	5,000	10,000	4th class	10.00	99.00	1.00	30.00	10.00	15.00	70.20
Ramos	4,550	8,500	10,000	10,000	17,200	5th class	18.82	94.95	1.00	30.00	3.00	20.00	72.31
San Clemente	4,260	9,000	12,000	20,000	15,000	5th class	19.19	90.49	5.00	31.00	10.00	15.00	68.70
San Jose	4,060	22,200	15,000	5,000	16,000	3rd class	10.00	90.00	3.00	48.00	20.00	20.00	52.20
San Manuel	6,000	16,000	20,000	1,200	0	4th class	90.00	99.00	1.00	90.00	40.00	25.00	10.00
Sta. Ignacia	4,600	8,500	4,500	5,000	7,500	2nd class	20.00	95.00	4.00	44.00	15.00	15.00	56.27
Tarlac City	4,940	9,230	8,440	17,290	14,760	1st class	90.00	99.00	11.00	60.00	20.00	20.00	39.84
Victoria	4,940	10,650	9,500	15,200	14,000	2nd class	23.00	91.20	5.00	40.00	26.76	25.18	41.57

Natural															
Municipality	Soiltype	Forest Land	Forest Reserve	Forest for Agriculture	Swamp & Marsh	Grazing & Pasture	Agricultural Land	Build up Area	Military Reservation	Water bodies	Rivers	Creeks	Open Area	Ground-water Availability	Reliable Water for Irrigation
Anao	San Manuel clay loam	0	0	0	0.00	0.00	87.26	5.03	0.00	0.00	0.00	9.00	0.00	90.44	90.44
Bamban	Angeles sandy clayloam, Tarlac clayloam, Tarlac soils	0	28	26	0.51	1.35	11.14	4.11	27.85	39.60	0.00	0.00	0.47	25.00	34.91
Camiling	Victoria soil, La Paz fine sandy loam. Zaragosa clay, Luisita fine sand, Tarlac clayloam	0	0.48	1	0.61	1.90	95.80	16.33	0.00	0.00	0.00	0.00	0.61	7.37	100.00
Capas	Tarlac clayloam, Tarlac soils, Tarlac sandy clayloam, Luisita fine sandy loam, Luisita sandy loam	30	0	0	0.22	25.35	24.31	7.27	0.00	0.00	0.00	0.00	17.87	50.00	76.13
Concepcion	Luisiana fine sand, Angeles sand	0.42	0.00	0.00	0.20	48.00	87.26	0.00	0.00	0.00	0.00	4.00	3.00	45.59	68.89
Gerona	Tarlac clayloam, Tarlac sandy clayloam, La Paz fine sandy loam, Angeles fine sand	0	0	2	7.74	0.00	65.61	21.61	0.00	0.00	0.00	0.00	6.89	54.00	90.55
La Paz	Luisita sandy loam, Luisita fine sandy loam	0	0	0	0.00	0.00	77.49	4.05	0.00	0.00	0.00	0.00	18.46	44.71	41.17
Mayantoc	Tarlac clayloam, Tarlac soils	61	0	0	2.11	10.09	23.49	0.60	0.00	0.00	0.00	0.00	3.03	70.52	71.00

Moncada	San Manuel silt loam, San Manuel silt	0	0	0	0.00	0.00	87.82	0.00	0.00	0.00	7.00	16.00	0.00	100.00	100.00
Paniqui	Tarlac clayloam, San Manuel silt loam, La Paz fine sandy loam	0	0	0	1.01	0.00	77.79	17.78	0.00	0.52	0.00	0.00	0.00	67.49	36.67
Pura	La Paz fine sandy loam	0	0	0	0.40	0.00	56.16	0.00	0.00	0.00	0.00	0.00	0.00	81.06	81.06
Ramos	La Paz fine sandy loam, San Manuel silt loam	0	0.04	0.00	0.00	0.00	86.81	0.00	0.00	0.00	0.00	0.00	0.00	43.73	43.73
San Clemente	Tarlac clayloam, Tarlac soils	0	21	0	0.86	23.79	74.17	2.51	0.00	0.00	0.00	0.00	0.00	12.76	96.38
San Jose	Tarlac clayloam, Tarlac soils, Tarlac sandy clayloam	47	0	0	6.45	9.94	35.83	6.08	0.00	8.60	0.00	0.00	0.00	2.54	46.54
San Manuel	San Manuel silt loam, San Manuel silt	0	0	0	0.60	0.00	89.29	10.11	0.00	0.00	0.00	17.00	0.00	70.72	96.13
Sta. Ignacia	Tarlac clayloam, Tarlac soils, Tarlac sandy clayloam	0	0	6	0.00	14.60	42.17	0.00	0.00	0.00	0.00	0.00	0.00	36.37	90.00
Tarlac City	Luisita sandy loam, Luisita fine sandy loam	0	0.01	0.32	0.32	0.30	60.40	32.86	0.00	0.00	0.00	0.00	4.34	34.41	83.08
Victoria	La Paz fine sandy loam, Luisiana fine sand	0	0	0.14	0.00	0.00	80.14	5.00	0.00	0.00	3.00	7.00	5.00	70.00	25.41

Social

Municipality	Farmers/Irrigators Association	Registered Cooperatives	Civil Society Organization	% of Farmer Members in Coops/Union/Groups	% of Women in Government
Anao	5.00	13.00	9.00	10.79	10.00
Bamban	5.00	3.00	10.00	20.09	20.00
Camiling	8.00	19.00	7.00	12.30	30.00
Capas	6.00	5.00	1.00	8.03	10.00
Concepcion	4.00	4.00	25.00	34.39	11.11
Gerona	11.00	1.00	0.00	0.05	10.00
La Paz	8.00	16.00	0.00	10.00	10.00
Mayantoc	3.00	3.00	0.00	2.54	10.00
Moncada	6.00	7.00	0.00	21.33	10.00
Paniqui	37.00	5.00	4.00	0.00	10.00
Pura	4.00	3.00	5.00	8.47	30.00
Ramos	3.00	4.00	2.00	3.20	10.00
San Clemente	1.00	2.00	10.00	6.79	10.00
San Jose	17.00	1.00	10.00	36.50	20.00
San Manuel	15.00	3.00	16.00	99.71	30.00
Sta. Ignacia	0.00	14.00	3.00	5.54	30.00
Tarlac City	63.00	20.00	27.00	57.82	30.00
Victoria	8.00	19.00	7.00	12.30	11.11

Human															
Municipality	Teacher - Pupil Ratio (Elementary)	Teacher - Pupil Ratio (High School)	Classroom - Pupil Ratio (Elementary)	Clasroom - Pupil Ratio (High School)	Adults in Household	Health									
						Hospitals	Rural Health Unit	Brgy Health Stations	Doctor	Nurse	Medical Technologist	Dentist	Midwives	Sanitary Inspector	Brgy Health Workers
Anao	39	50	49	50	62	0	1	6	1	1	1	1	5	1	50
Bamban	47	30	36	42	58	1	2	8	2	2	0	2	9	0	62
Camiling	31	33	24	45	51	3	2	16	2	2	0	2	17	0	316
Capas	48	38	36	64	50	1	3	11	2	2	0	6	5	0	78
Concepcion	34	18	37	25	48	4	3	19	2	3	0	1	17	0	126
Gerona	33	26	23	56	50	1	3	14	3	3	0	2	15	0	159
La Paz	40	39	29	53	58	1	2	8	2	3	0	1	8	0	125
Mayantoc	37	43	26	33	60	0	1	7	1	2	0	1	3	0	60
Moncada	34	32	24	66	51	0	2	8	2	4	0	1	13	0	85
Paniqui	36	41	29	41	50	3	2	13	1	2	0	1	14	0	121
Pura	30	28	21	37	50	0	1	16	2	7	1	1	7	0	62
Ramos	38	42	43	35	50	0	1	6	1	1	1	1	7	1	50
San Clemente	24	23	17	7	50	0	1	3	1	1	1	1	4	1	45
San Jose	39	35	28	48	50	0	1	5	1	1	0	2	8	0	104
San Manuel	33	32	24	44	50	0	1	3	1	2	1	1	4	1	80
Sta. Ignacia	37	33	28	39	50	0	1	5	1	1	0	1	4	0	95
Tarlac City	32	33	60	60	50	6	10	31	10	23	0	6	38	0	535
Victoria	32	34	36	42	51	0	2	8	2	2	1	1	7	1	166

Physical									
Municipality	FarmSize	No. of Equipment Available in the Area	No. of Livestock Owned	Access to Irrigation Infrastructure	Access to Postharvest Infrastructure	% of Farmers with Access to Dealers	Road Network	Market Access	% of Whole Production Sold
Anao	0.52	275	8,293	90.44	100	90	12	100	80
Bamban	2.75	68	25,550	85.36	100	90	34.66	60	60
Camiling	1.5	4770	4110	91.80	100	100	124.9	90	90
Capas	2.16	2202	10,113	76.13	100	100	27.17	100	90
Concepcion	2.25	7,393	6,986	76.90	100	100	100	100	90
Gerona	1.77	4752	500	68.69	100	100	78.94	100	90
La Paz	1.66	2966	15,325	95.55	100	100	14.515	95	90
Mayantoc	1.29	1389	8847	67.12	100	100	39.13	90	90
Moncada	1.77	6990	6986	78.49	100	100	42.74	100	90
Paniqui	1.17	2436	11,061	54.99	100	100	26.49	95	90
Pura	0.93	1194	5806	59.00	100	100	25.51	90	90
Ramos	1.06	710	7370	53.27	100	100	14.52	95	90
San Clemente	1.3	455	1844	96.38	100	100	8.58	90	90
San Jose	1.59	305	9695	46.54	100	100	47.09	90	90
San Manuel	1.47	1086	2850	96.13	100	100	20.52	100	90
Sta. Ignacia	1.33	3012	11139	52.38	100	100	59.36	90	90
Tarlac City	1.5	21	8050	78.91	100	100	34.87	100	90
Victoria	1.5	4790	4110	93.38	100	90	85.71	100	90

Anticipatory										
Municipality	Disaster Preparedness Committee	Existing Early Warning Systems	Two-way Radio	Motorized Banca	Evacuation Truck	Seminars & Drills Conducted	No. of Firetrucks	No. of Fireman	Rescue Jeep	Access to Communication
Anao	Yes	No	0	0	1	Yes	1	2	0	10
Bamban	No	No	0	0	0	Yes	2	7	0	30
Camiling	Yes	Yes	0	0	1	Yes	2	7	0	20
Capas	Yes	Yes	0	0	0	Yes	2	12	0	20
Concepcion	Yes	Yes	0	0	0	Yes	3	13	0	30
Gerona	Yes	Yes	0	0	0	Yes	2	8	0	30
La Paz	No	No	0	0	0	Yes	2	9	0	20
Mayantoc	Yes	Yes	0	0	0	Yes	2	5	0	20
Moncada	Yes	Yes	0	0	0	Yes	2	9	0	30
Paniqui	Yes	Yes	0	2	1	Yes	4	9	1	30
Pura	Yes	Yes	5	0	2	Yes	1	5	0	20
Ramos	Yes	No	1	1	0	Yes	2	9	0	20
San Clemente	Yes	Yes	0	0	4	Yes	1	6	0	20
San Jose	Yes	Yes	0	0	0	Yes	0	1	0	20
San Manuel	Yes	No	0	0	0	Yes	1	6	0	20
Sta. Ignacia	Yes	No	0	0	0	Yes	1	7	0	20
Tarlac City	Yes	Yes	0	0	0	Yes	5	15	0	30
Victoria	Yes	Yes	0	0	0	Yes	1	7	0	30

Institutional			
Municipality	Effective Government and/or CSO Program for Climate Change	Adequate Government Response to Previous Shocks	Farmers Visited by/or Consulted with Agricultural Extension Officer
Anao	Yes	Yes	100
Bamban	Yes	Yes	80
Camiling	Yes	Yes	100
Capas	Yes	Yes	90
Concepcion	Yes	Yes	100
Gerona	Yes	Yes	100
La Paz	Yes	Yes	80
Mayantoc	Yes	Yes	95
Moncada	Yes	Yes	100
Paniqui	Yes	Yes	95
Pura	Yes	Yes	80
Ramos	Yes	Yes	80
San Clemente	Yes	Yes	80
San Jose	Yes	Yes	80
San Manuel	Yes	Yes	90
Sta. Ignacia	Yes	Yes	85
Tarlac City	Yes	Yes	90
Victoria	Yes	Yes	100

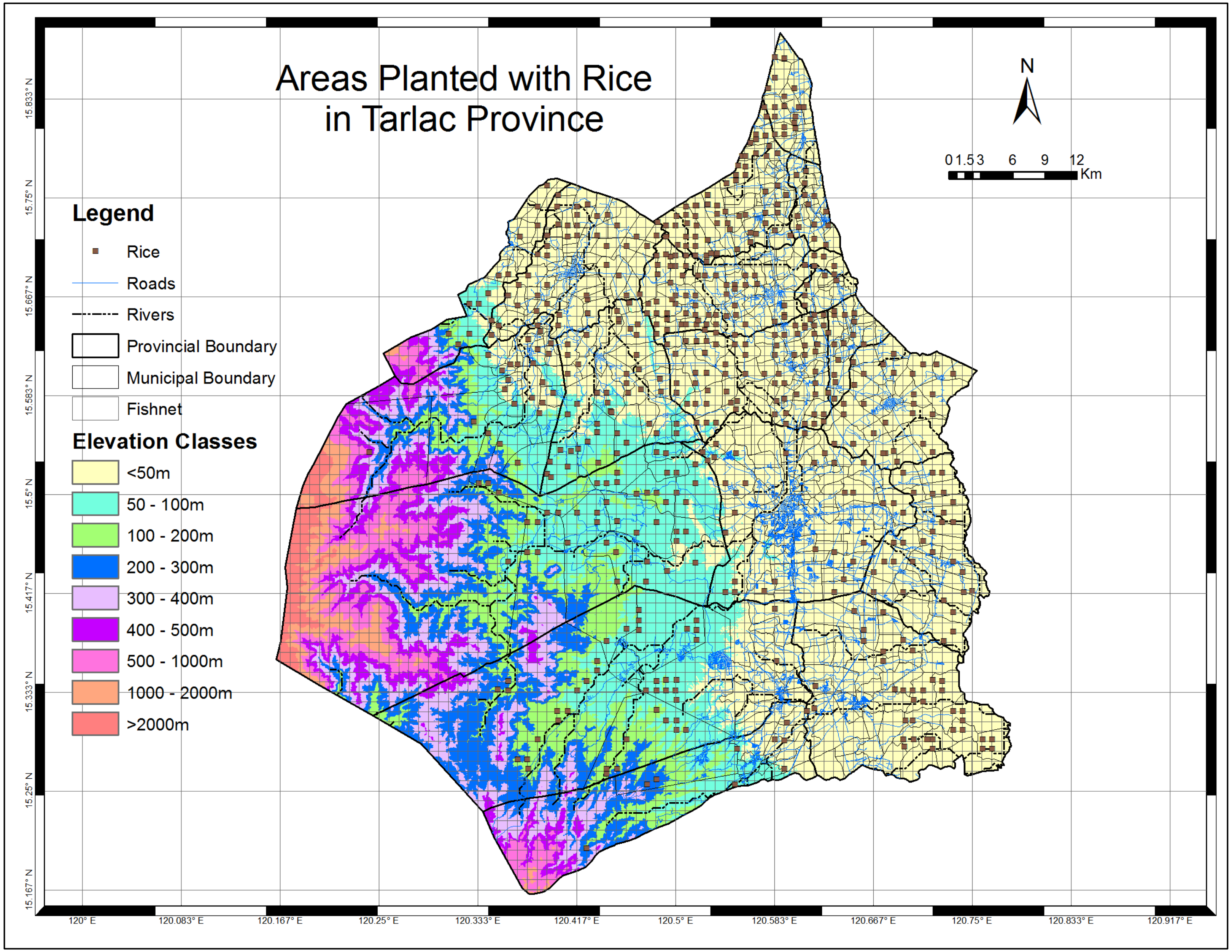


Figure 1. Crop Occurrence for Rice

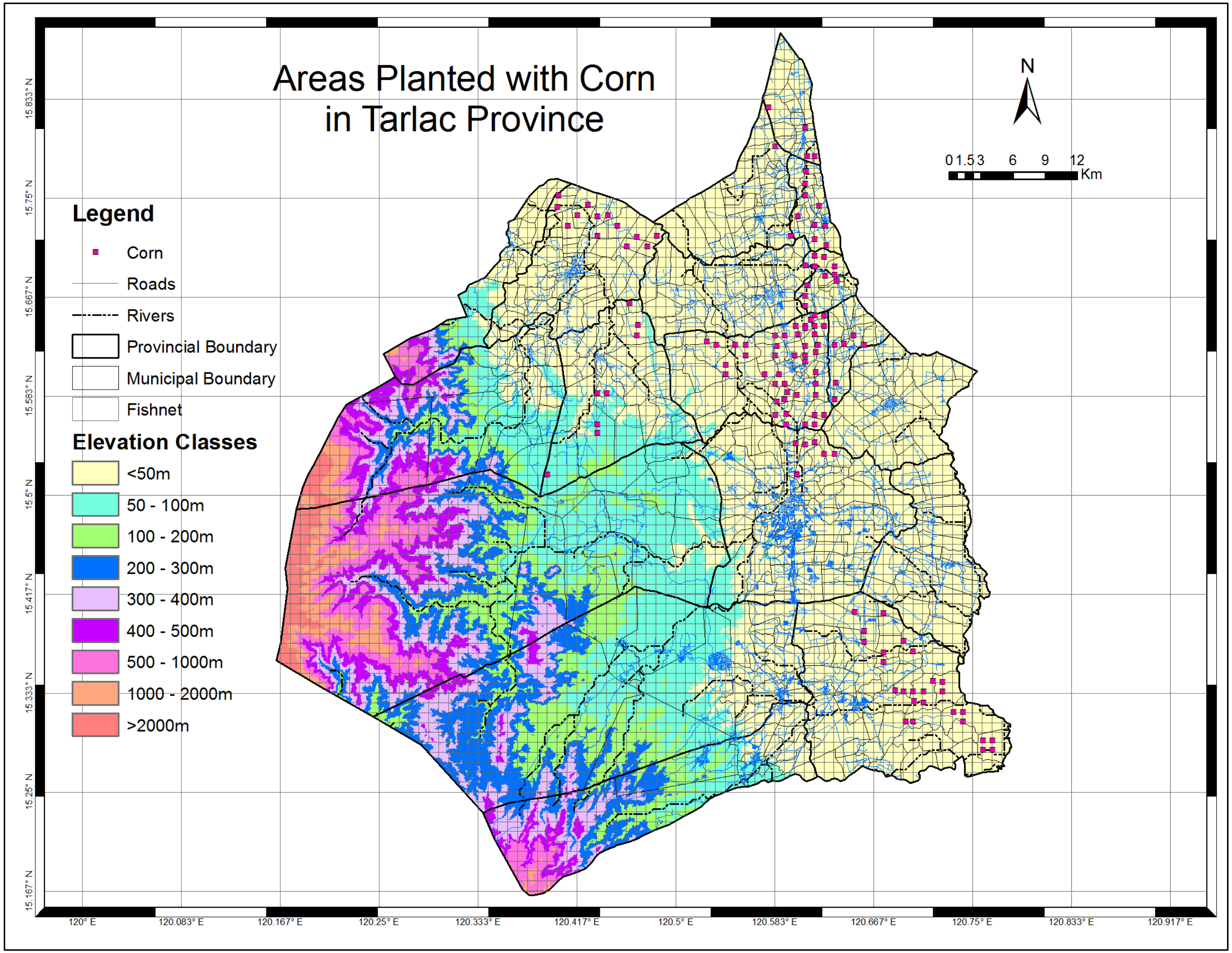


Figure 2. Crop Occurrence for Maize

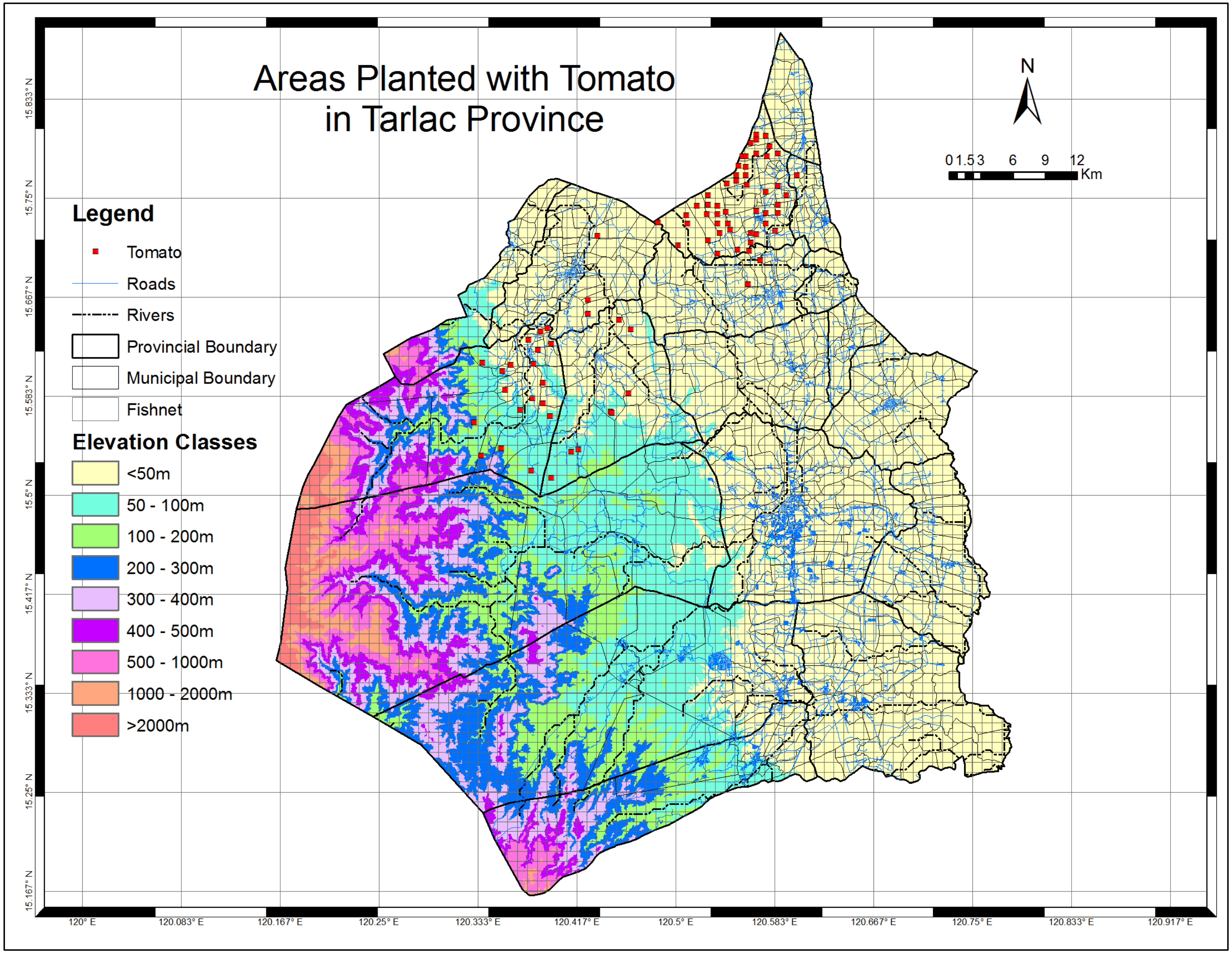


Figure 3. Crop Occurrence for Tomato

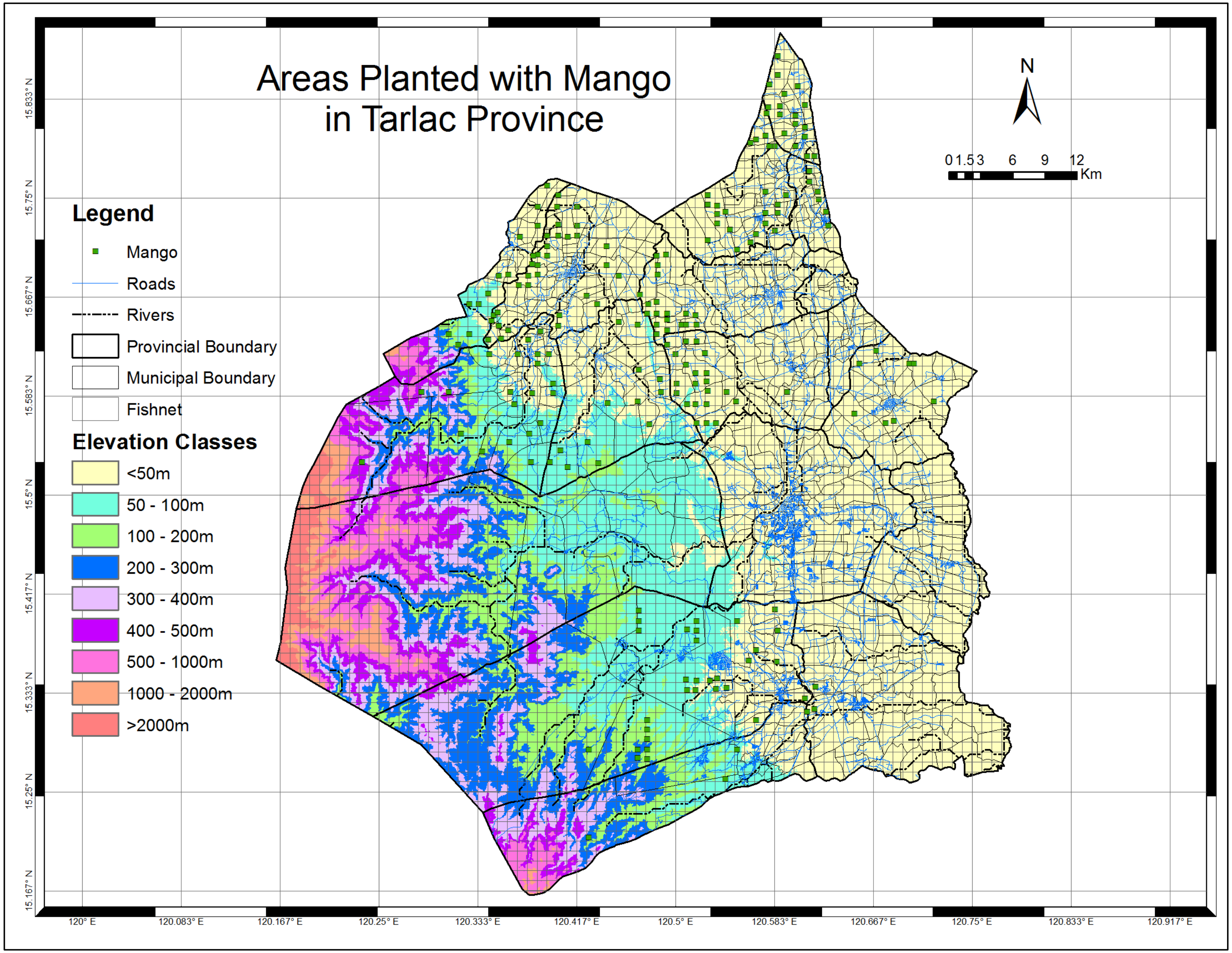


Figure 4. Crop Occurrence for Mango

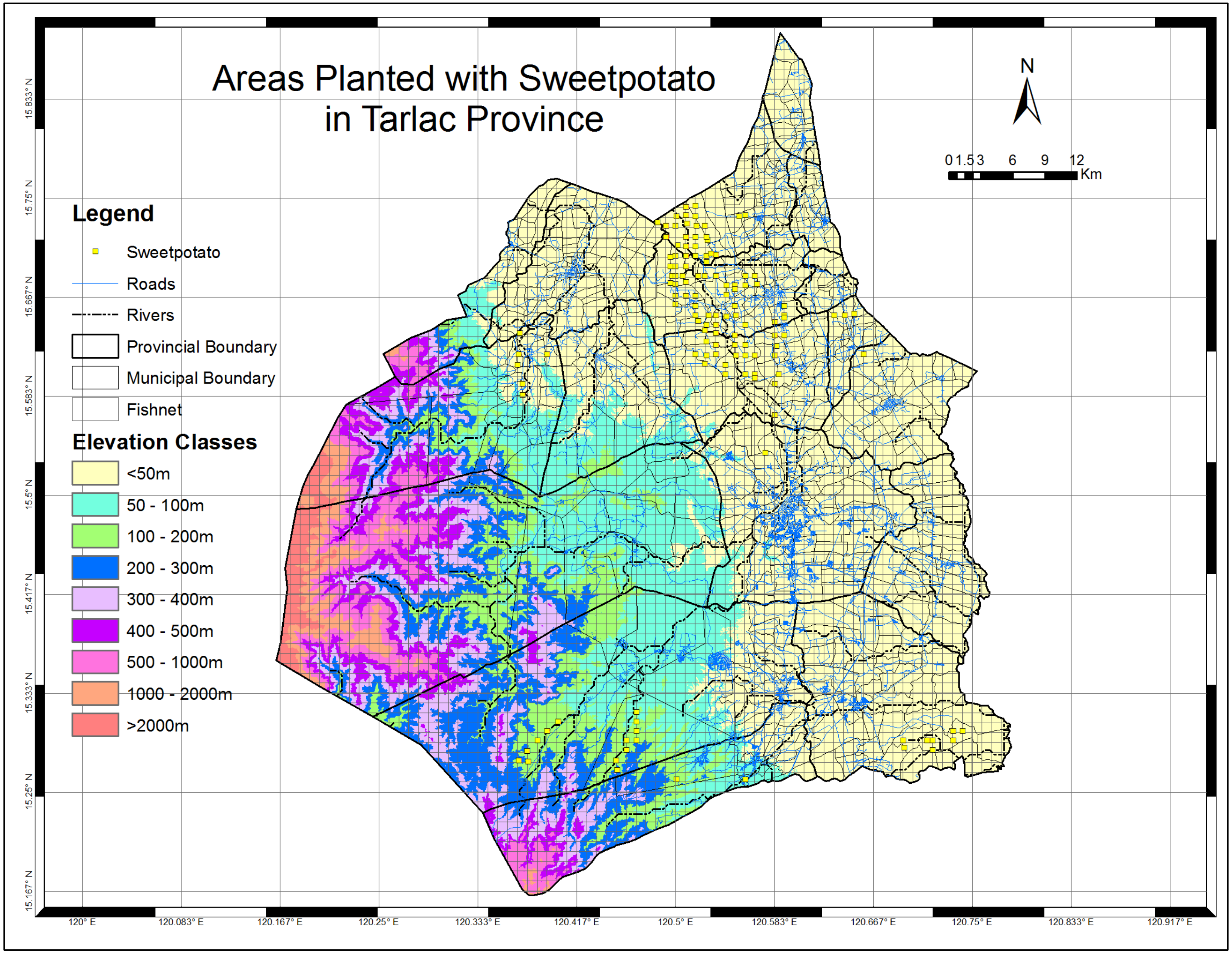


Figure 5. Crop Occurrence for Sweetpotato

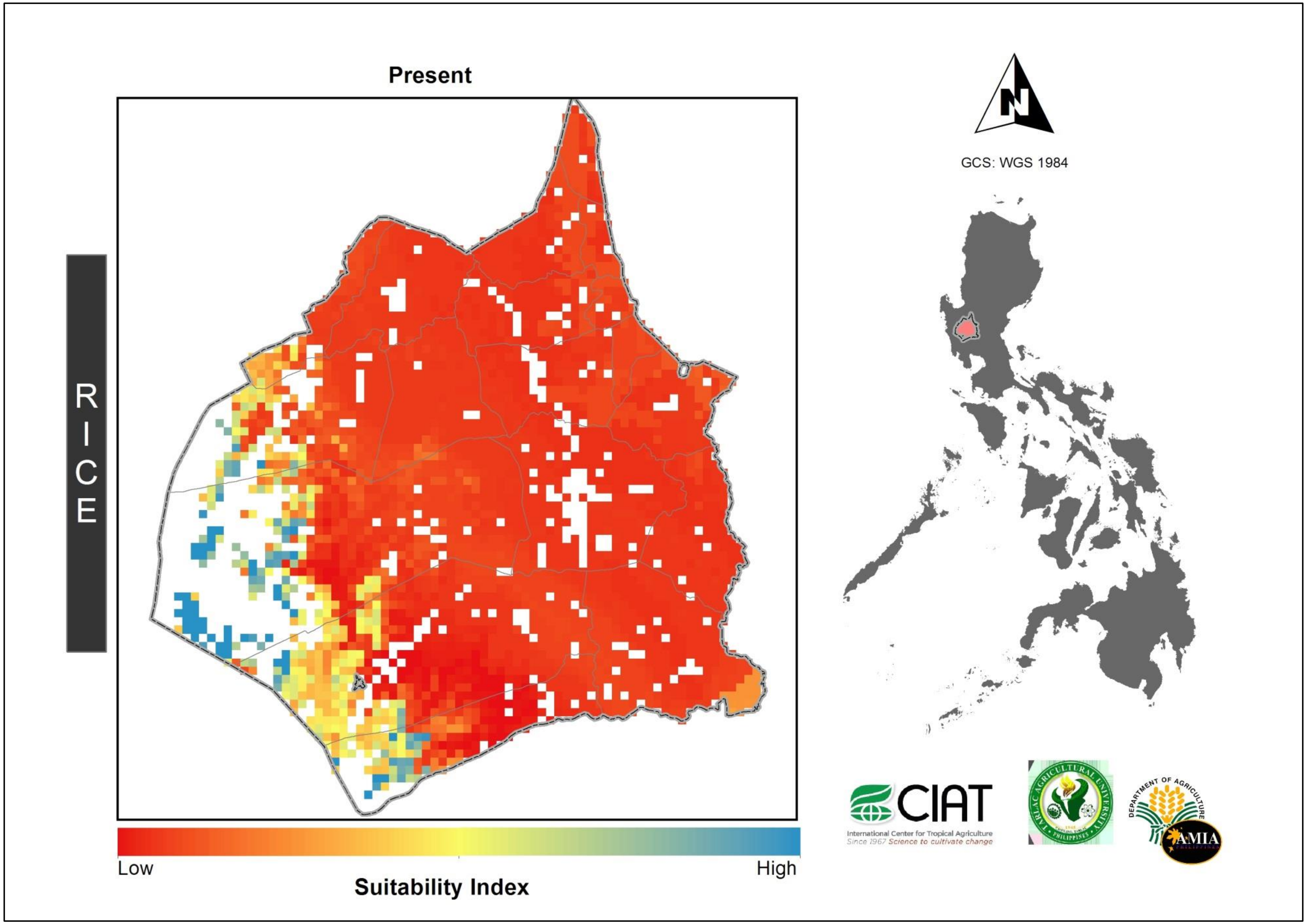


Figure 6. Present Suitability for Rice

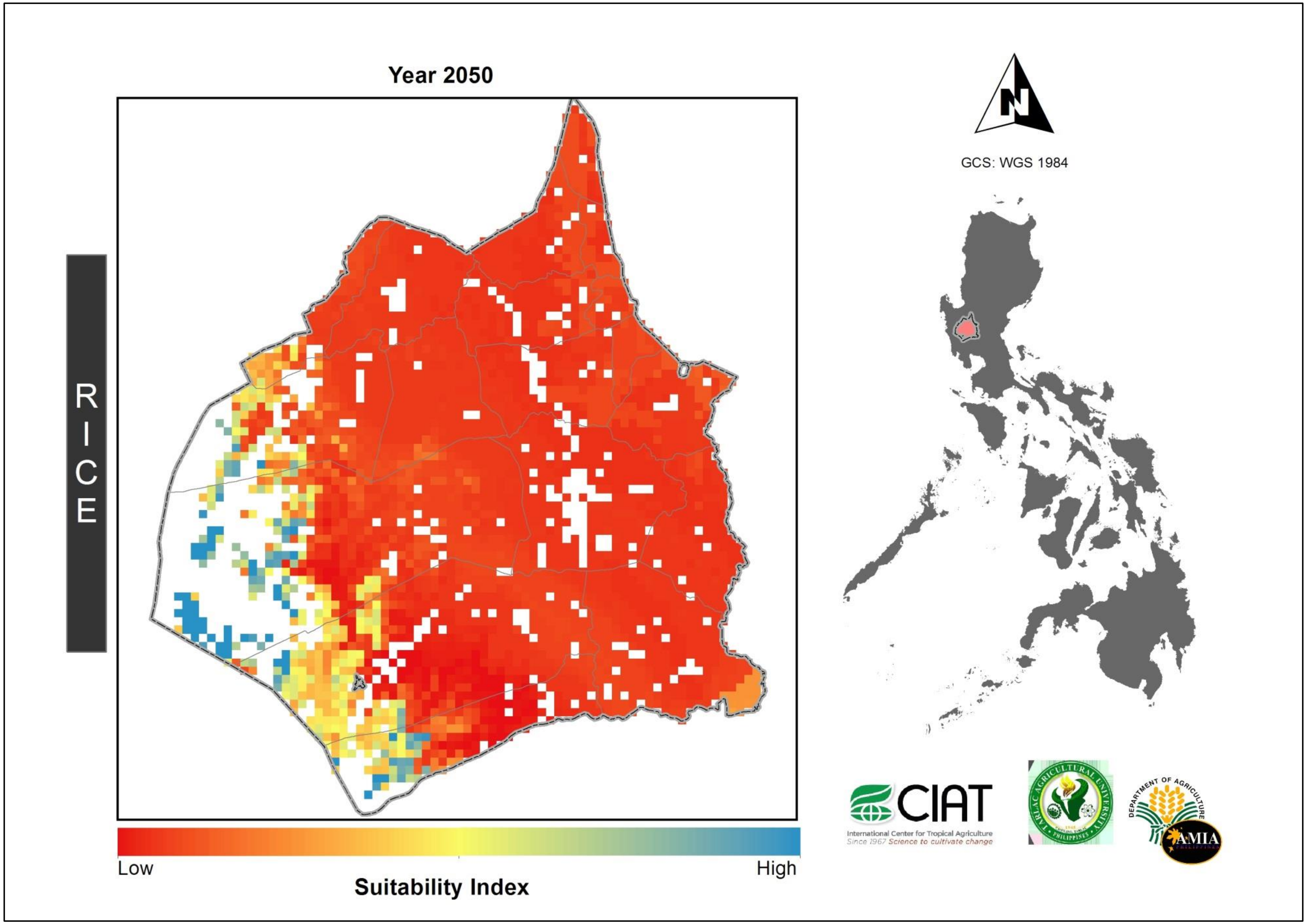


Figure 7. Suitability of Rice for Year 2050

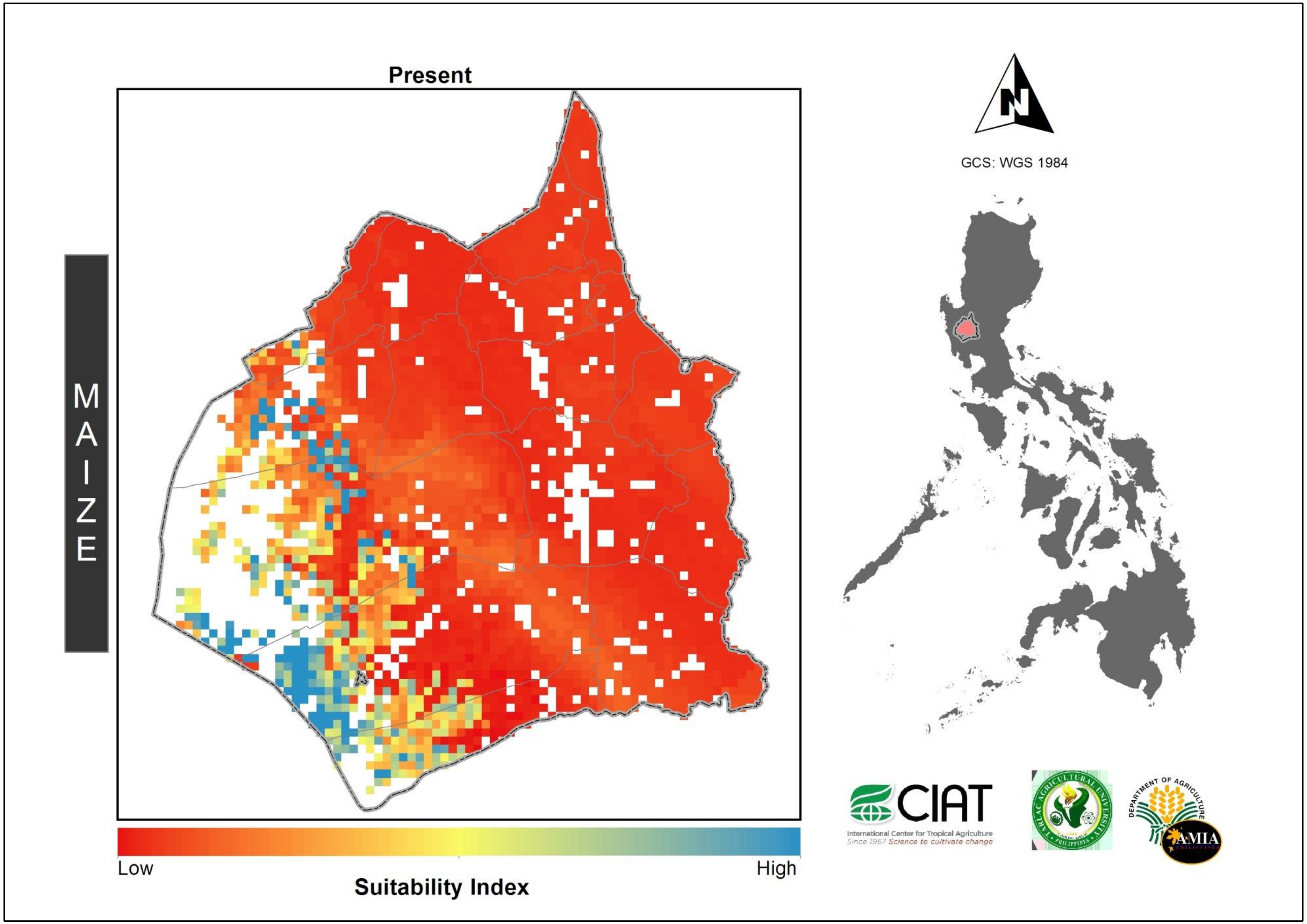


Figure 8. Present Suitability of Maize

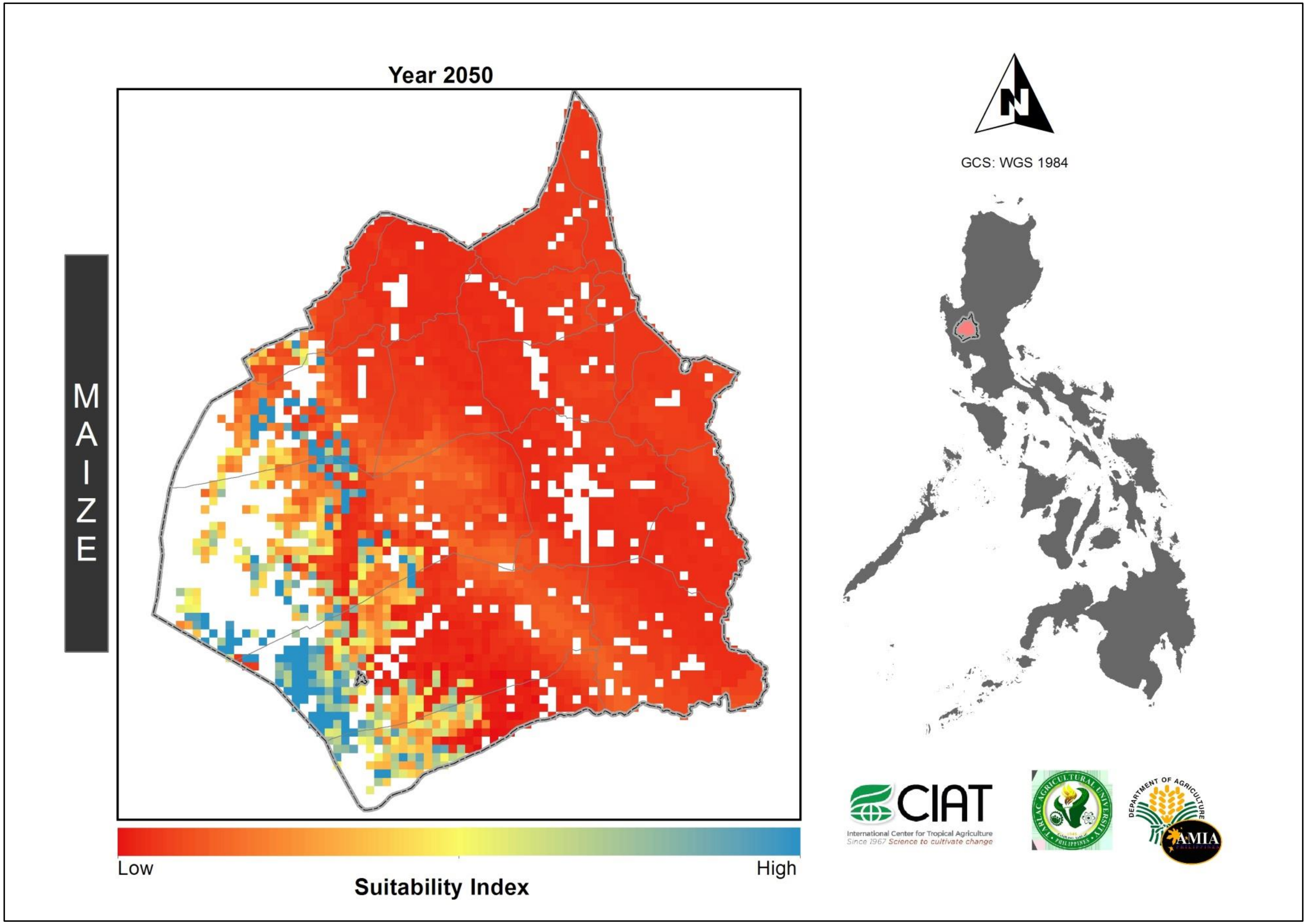


Figure 9. Suitability of Maize for Year 2050

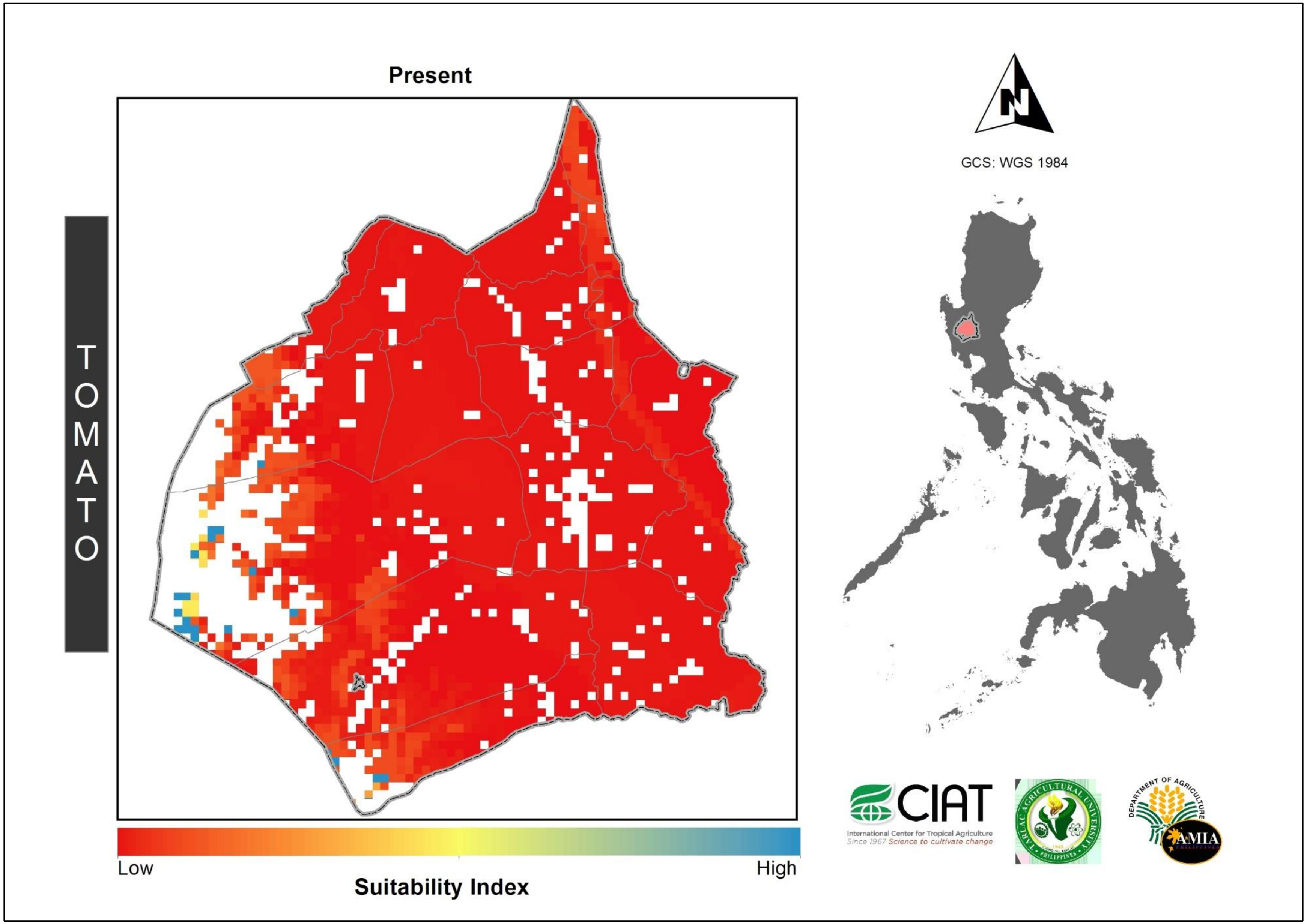


Figure 10. Present Suitability of Tomato

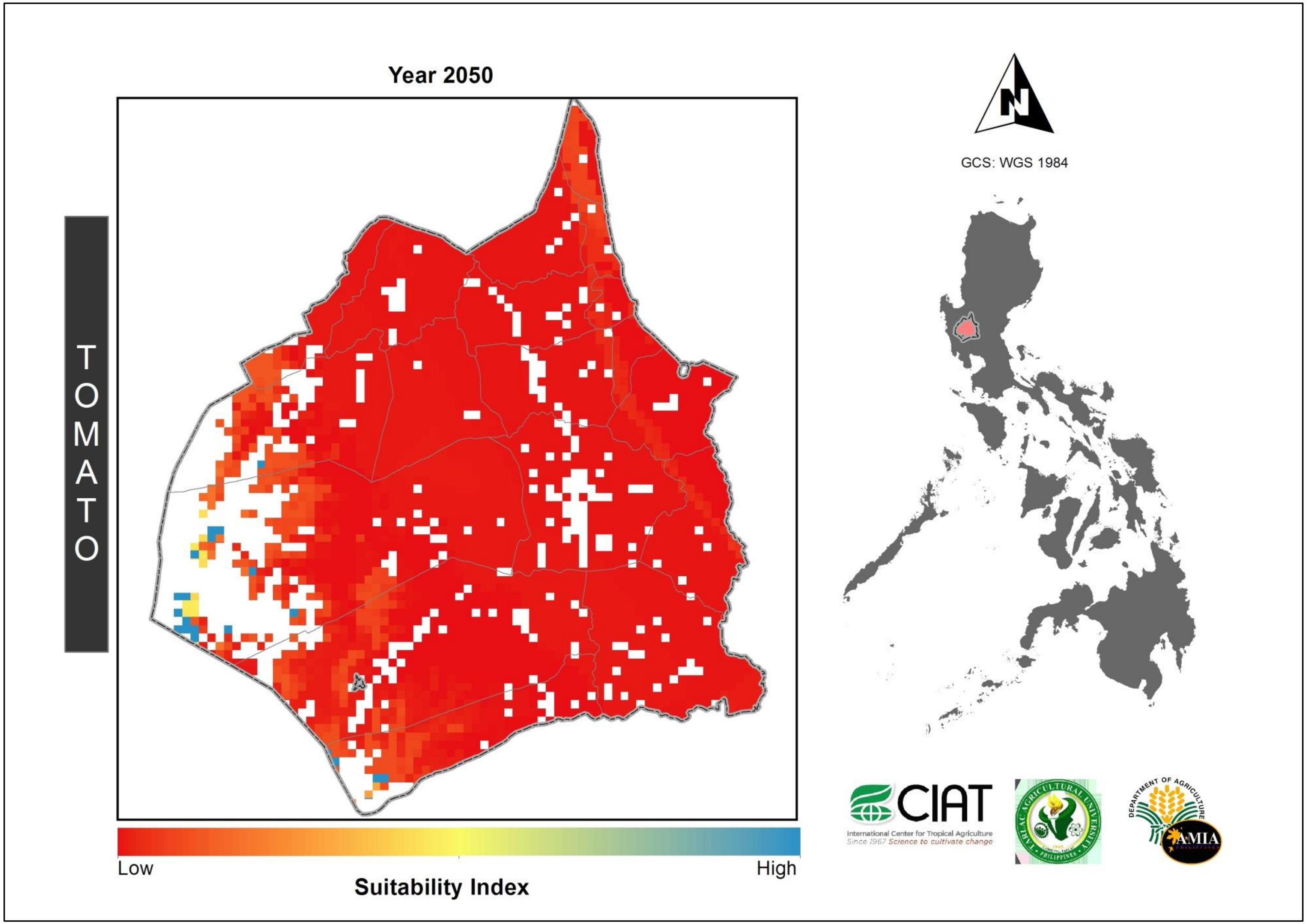


Figure 12. Suitability of Tomato for Year 2050

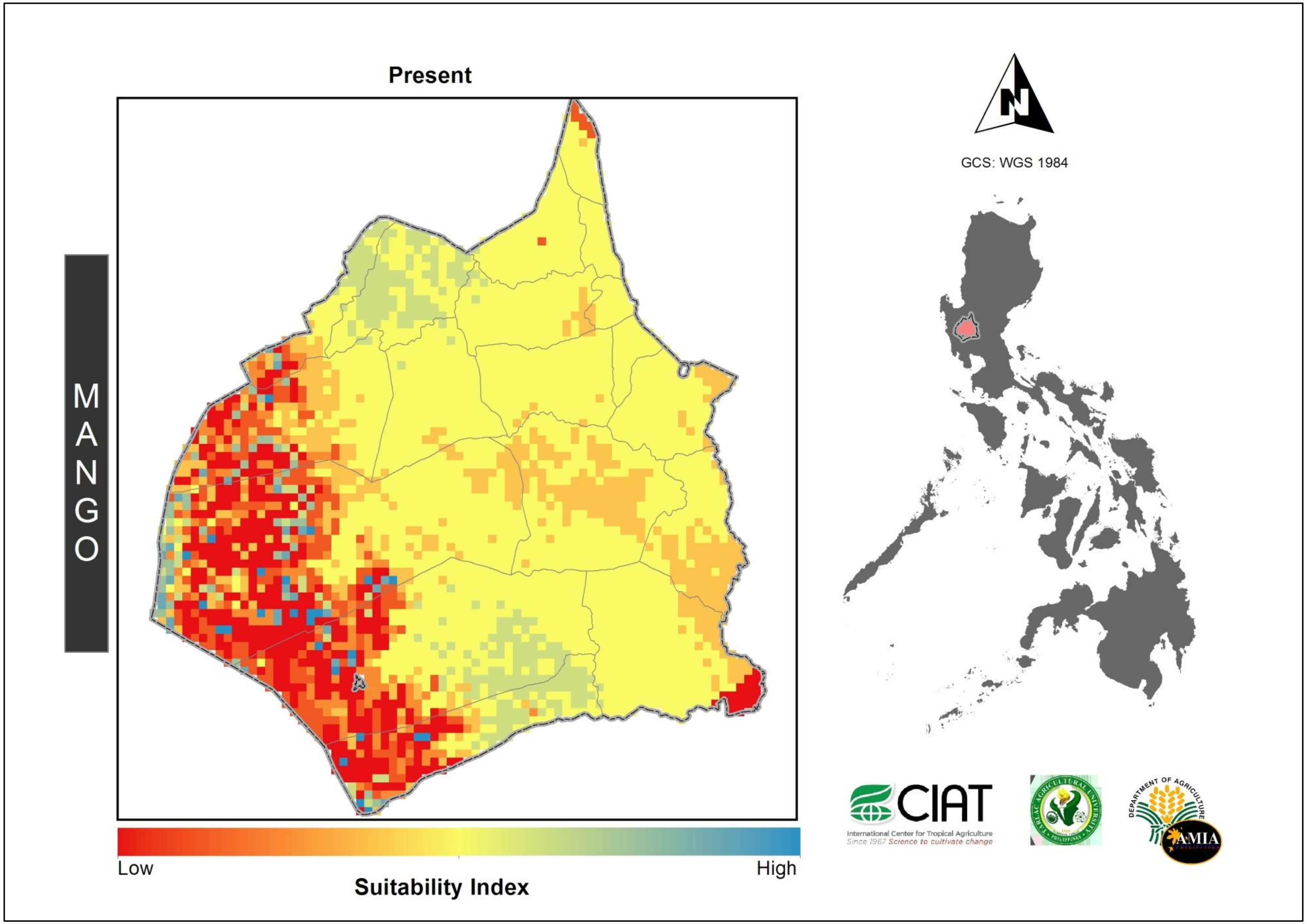


Figure 13. Present Suitability of Mango

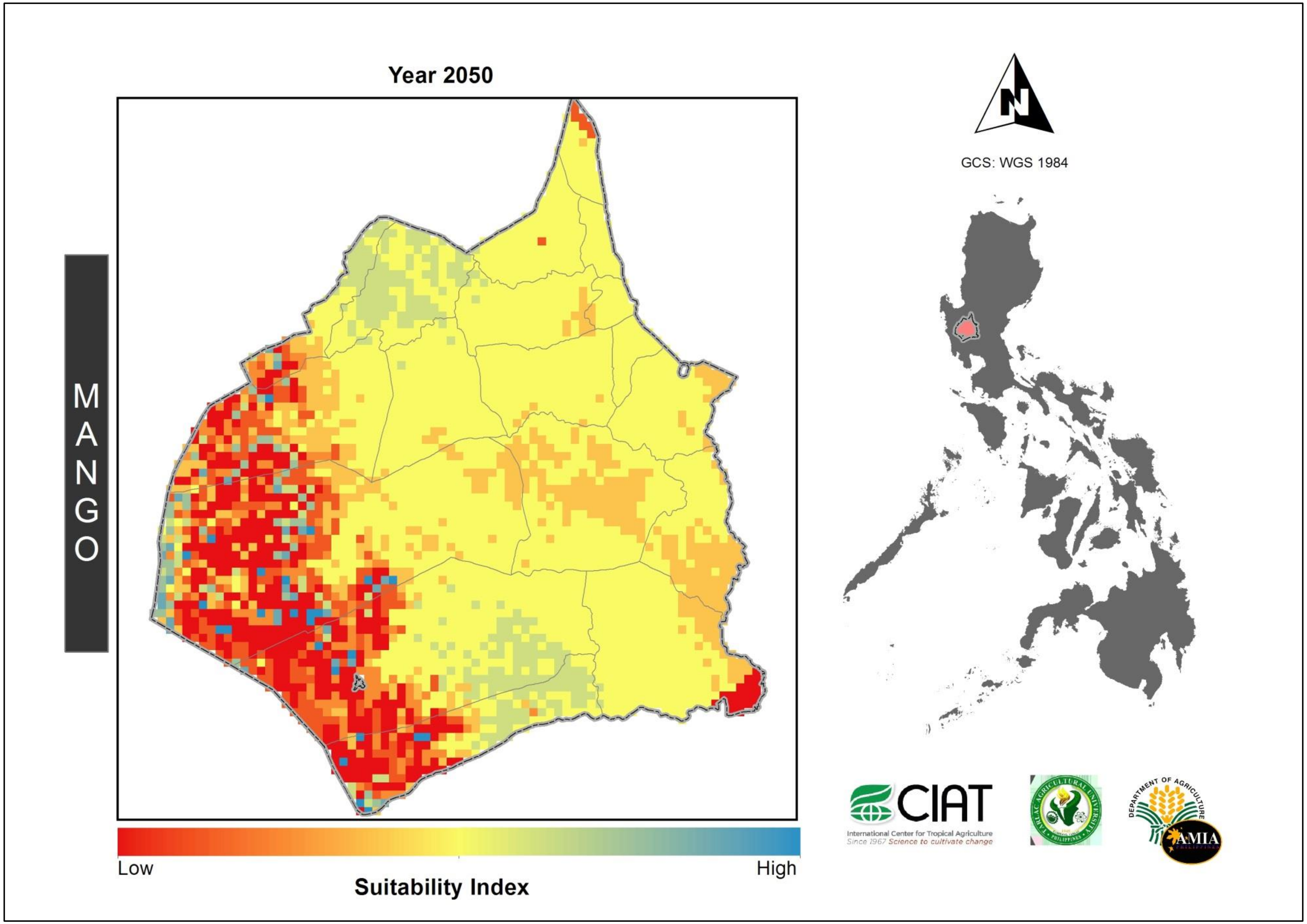


Figure 14. Suitability of Mango for Year 2050

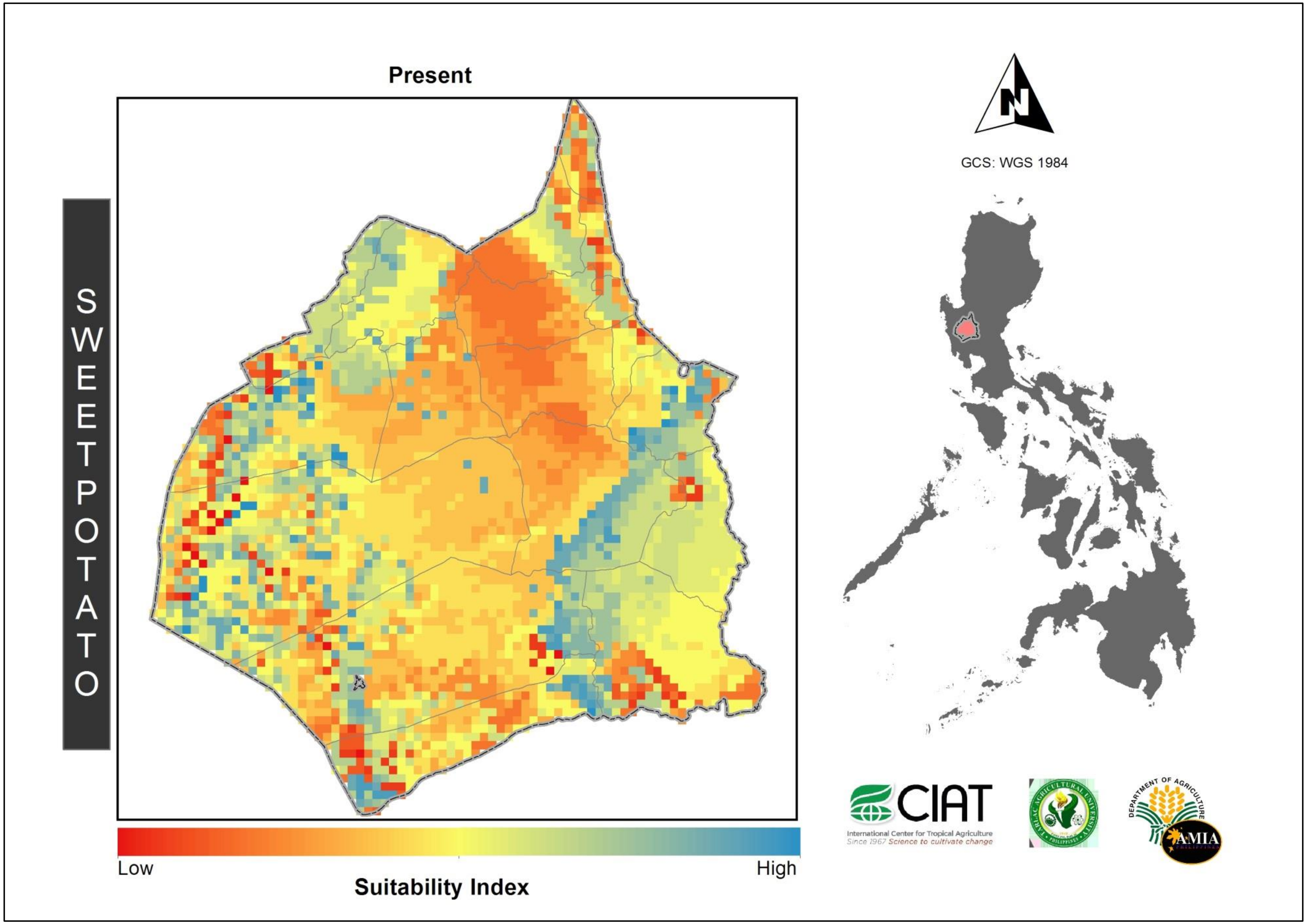


Figure 15. Present Suitability of Sweetpotato

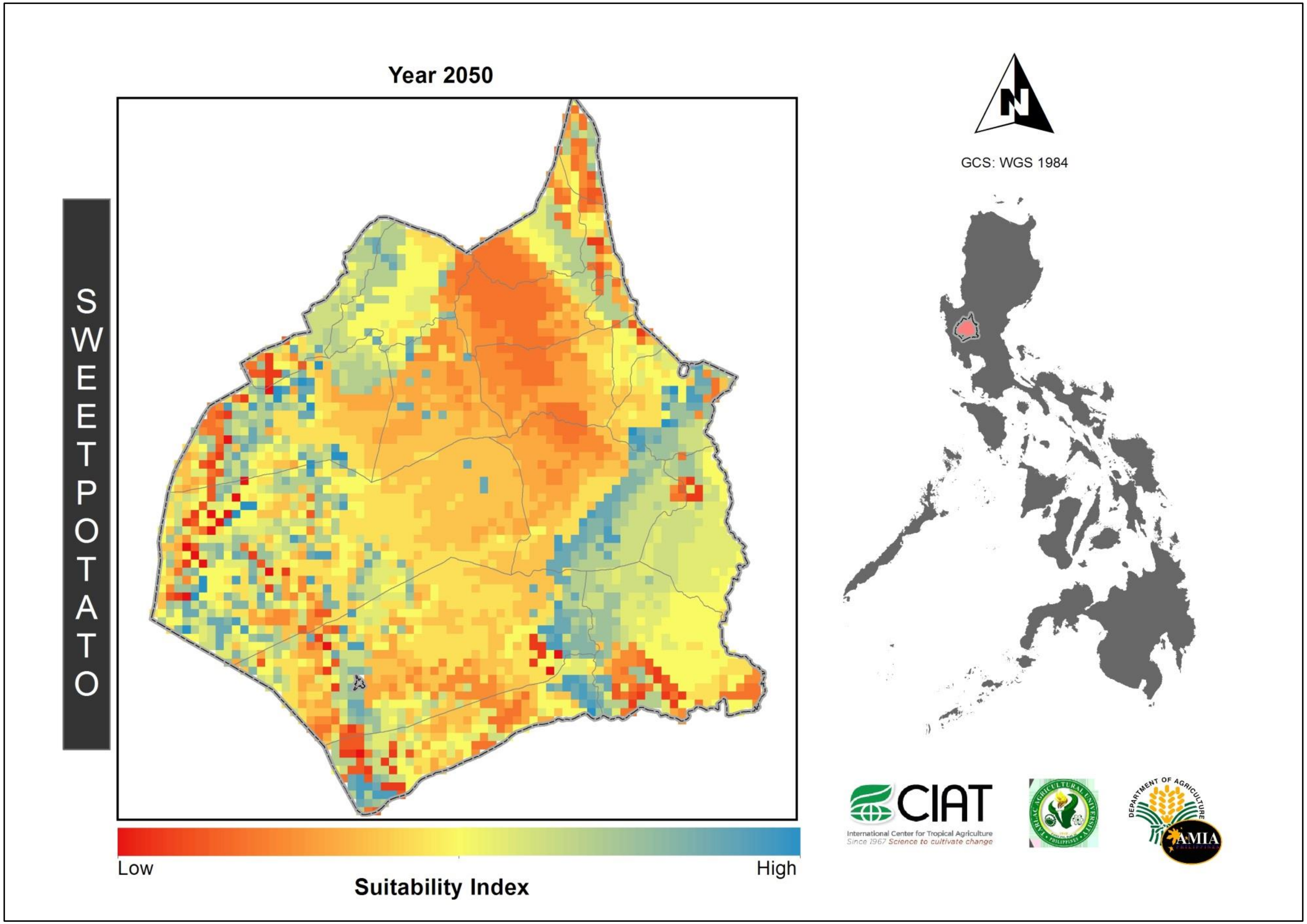


Figure 16. Suitability of Sweetpotato for Year 2050

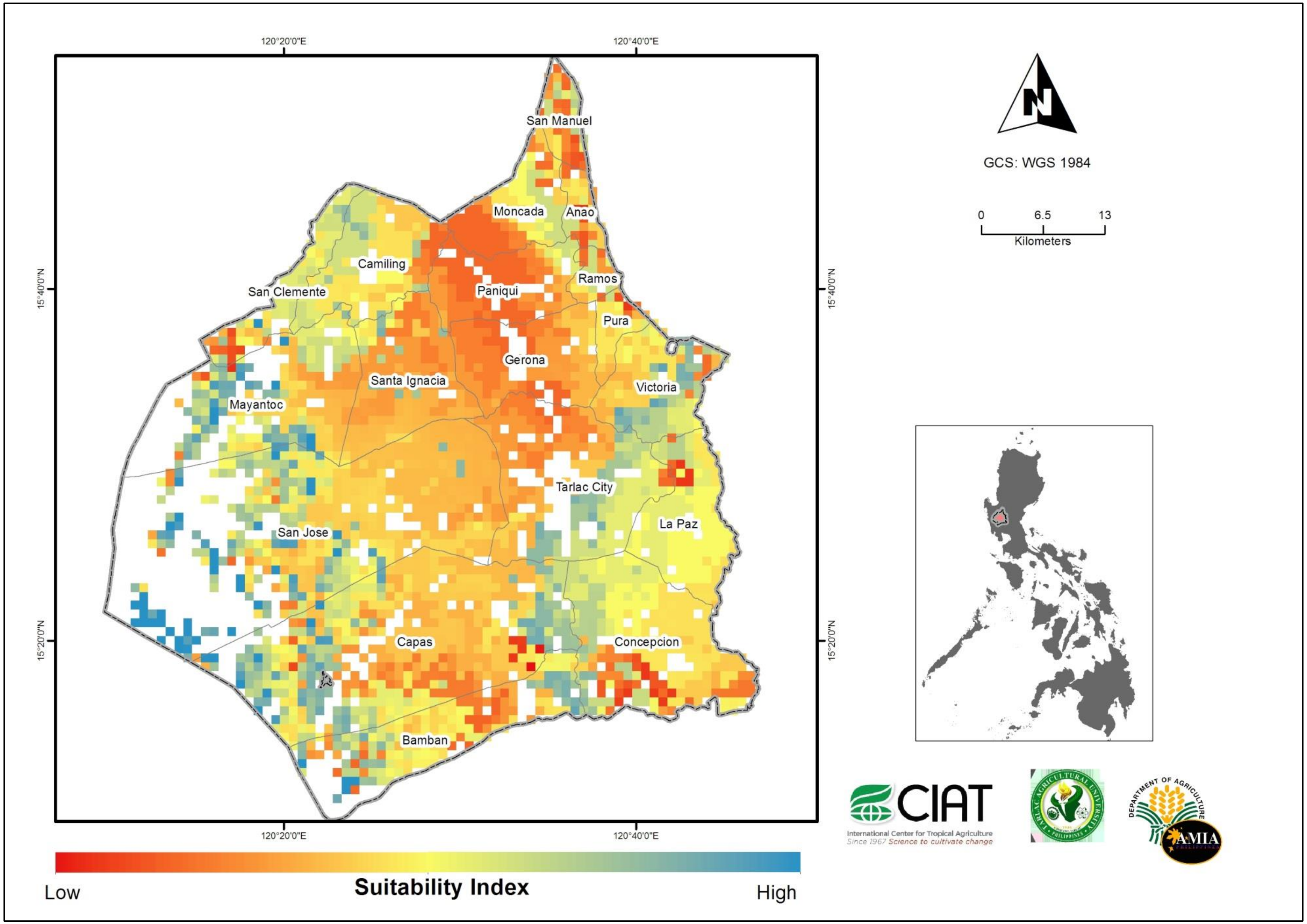


Figure 17. Aggregated Sensitivity for Priority Crops

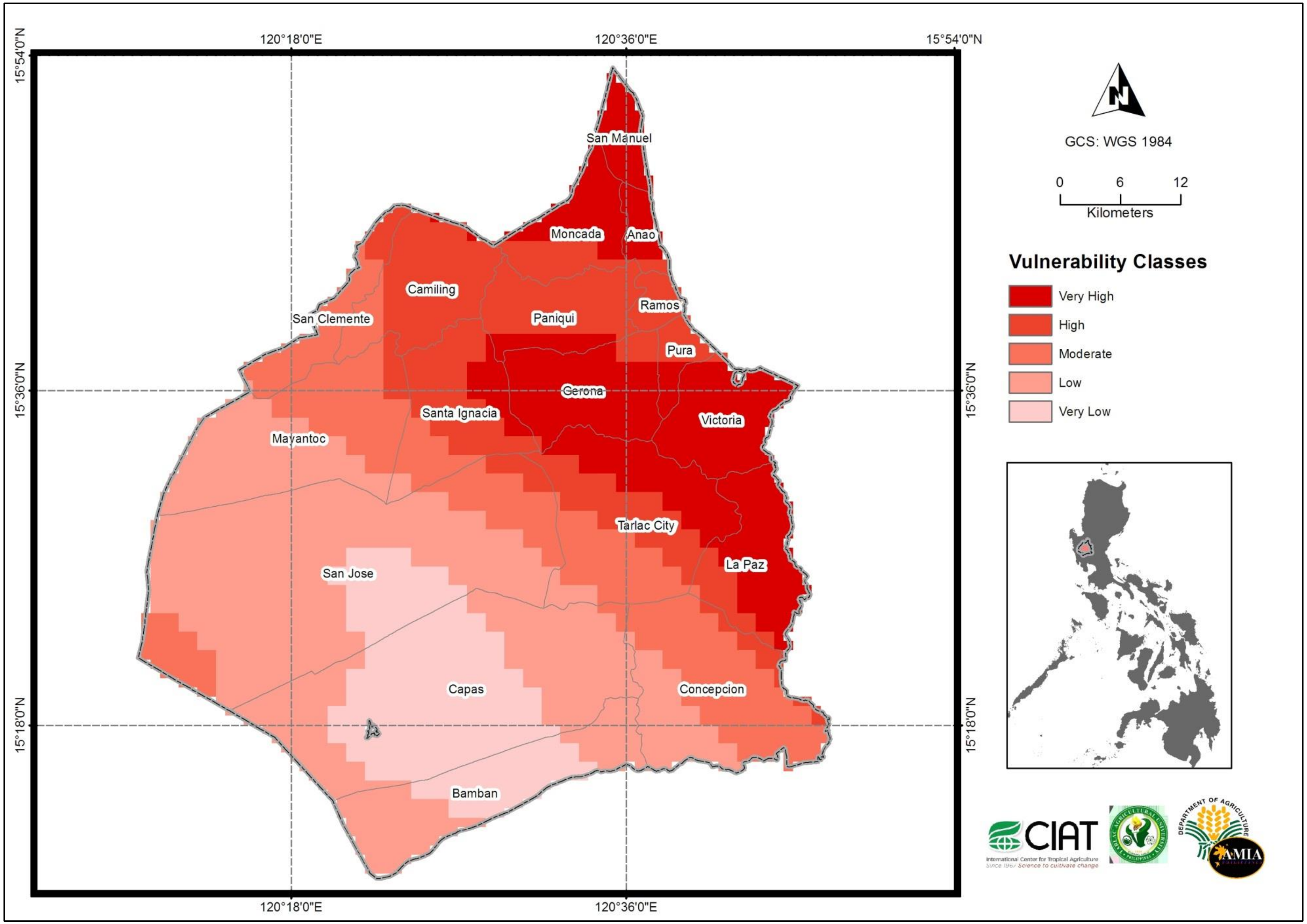


Figure 18. Natural Hazard: Cyclone

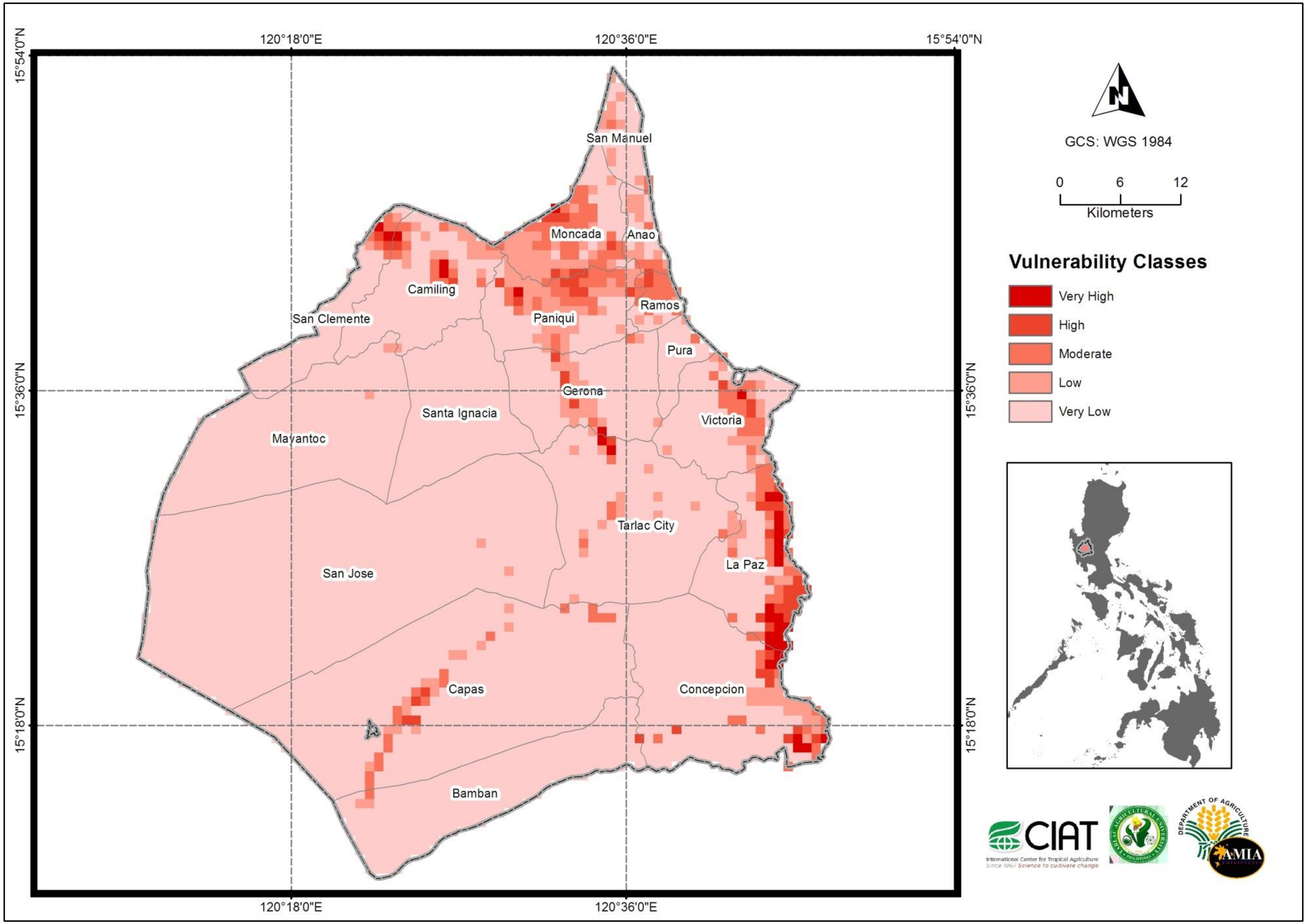


Figure 19. Natural Hazard: Flooding

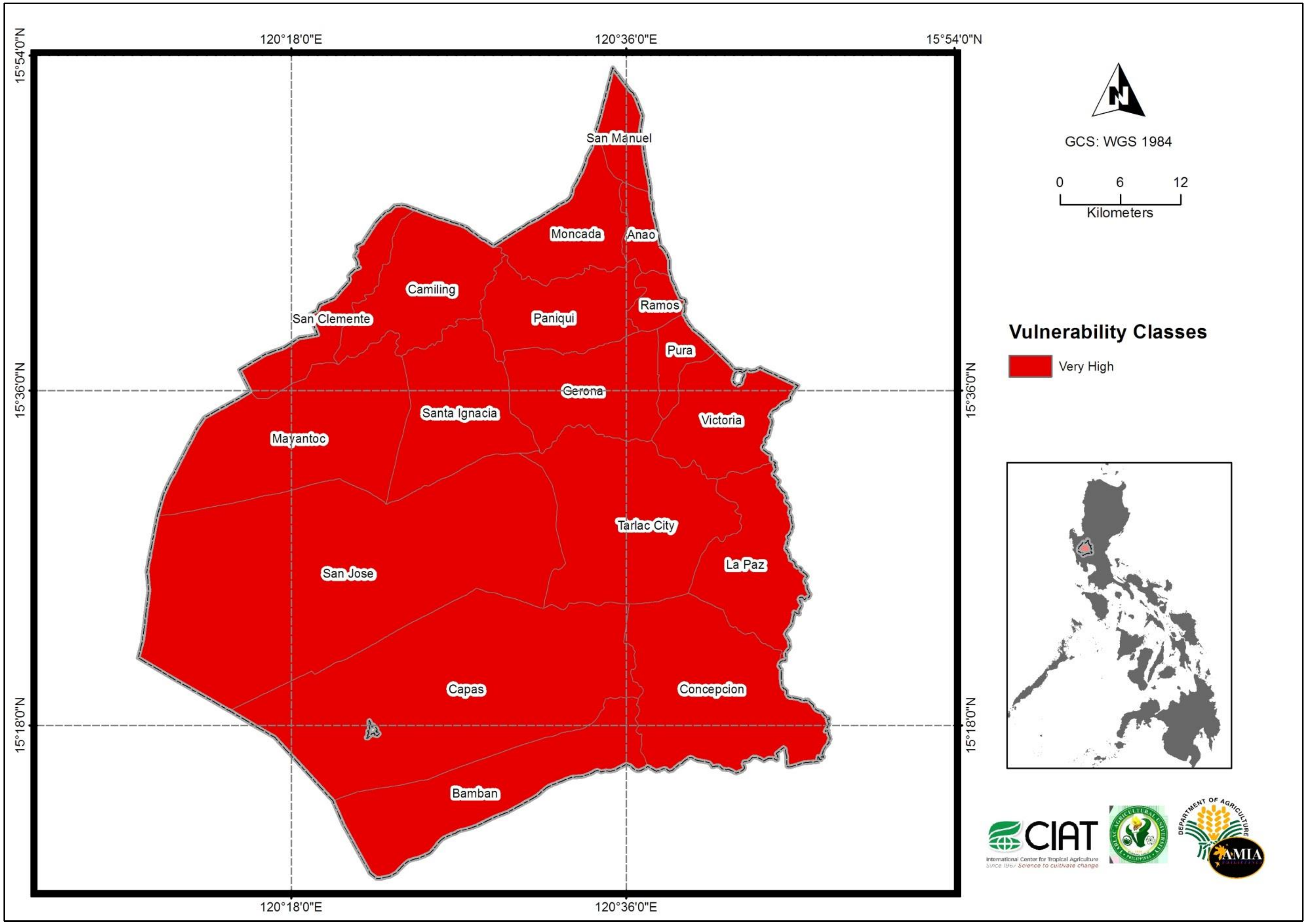


Figure 20. Natural Hazard: Drought

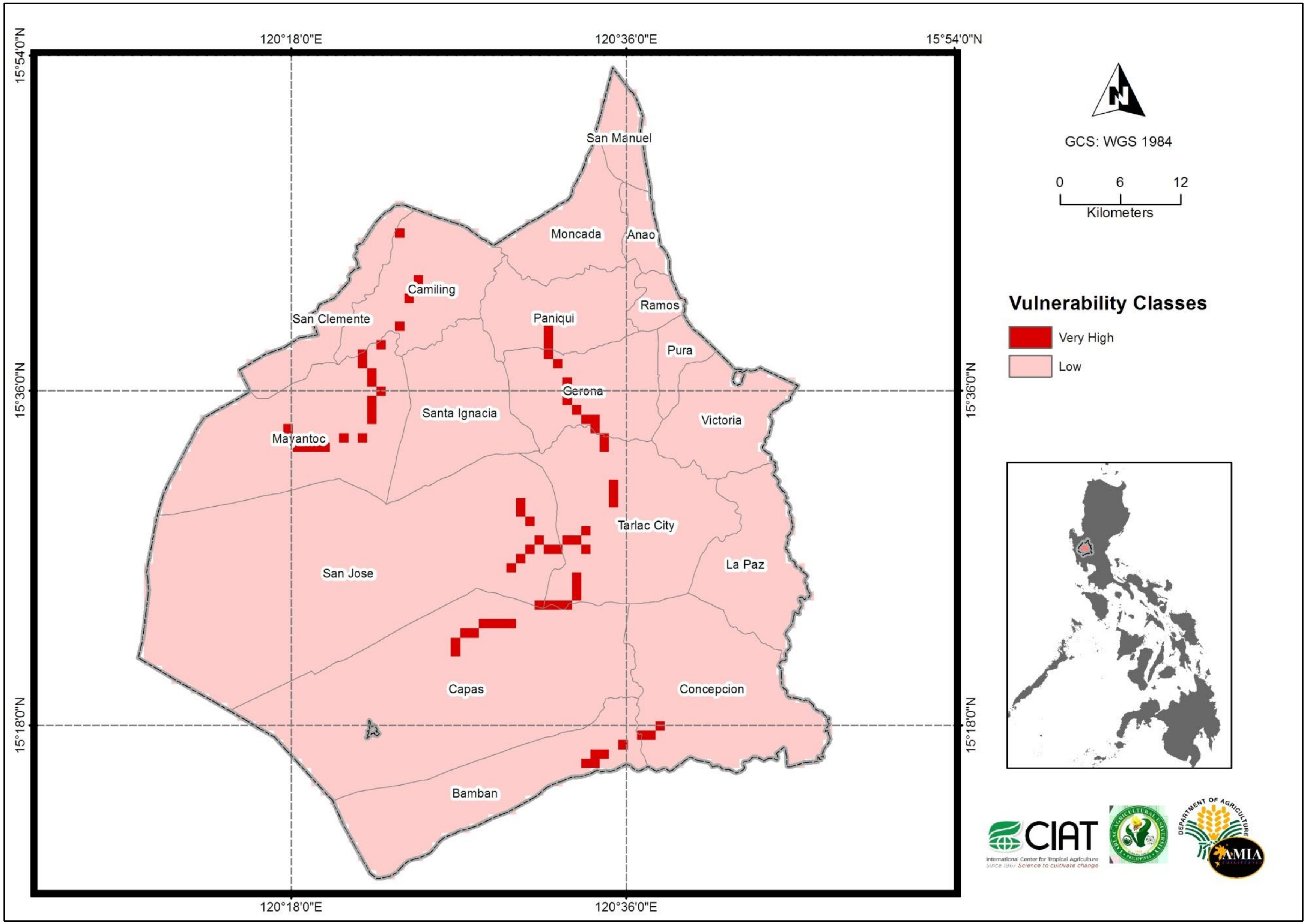


Figure 21. Natural Hazard: Erosion

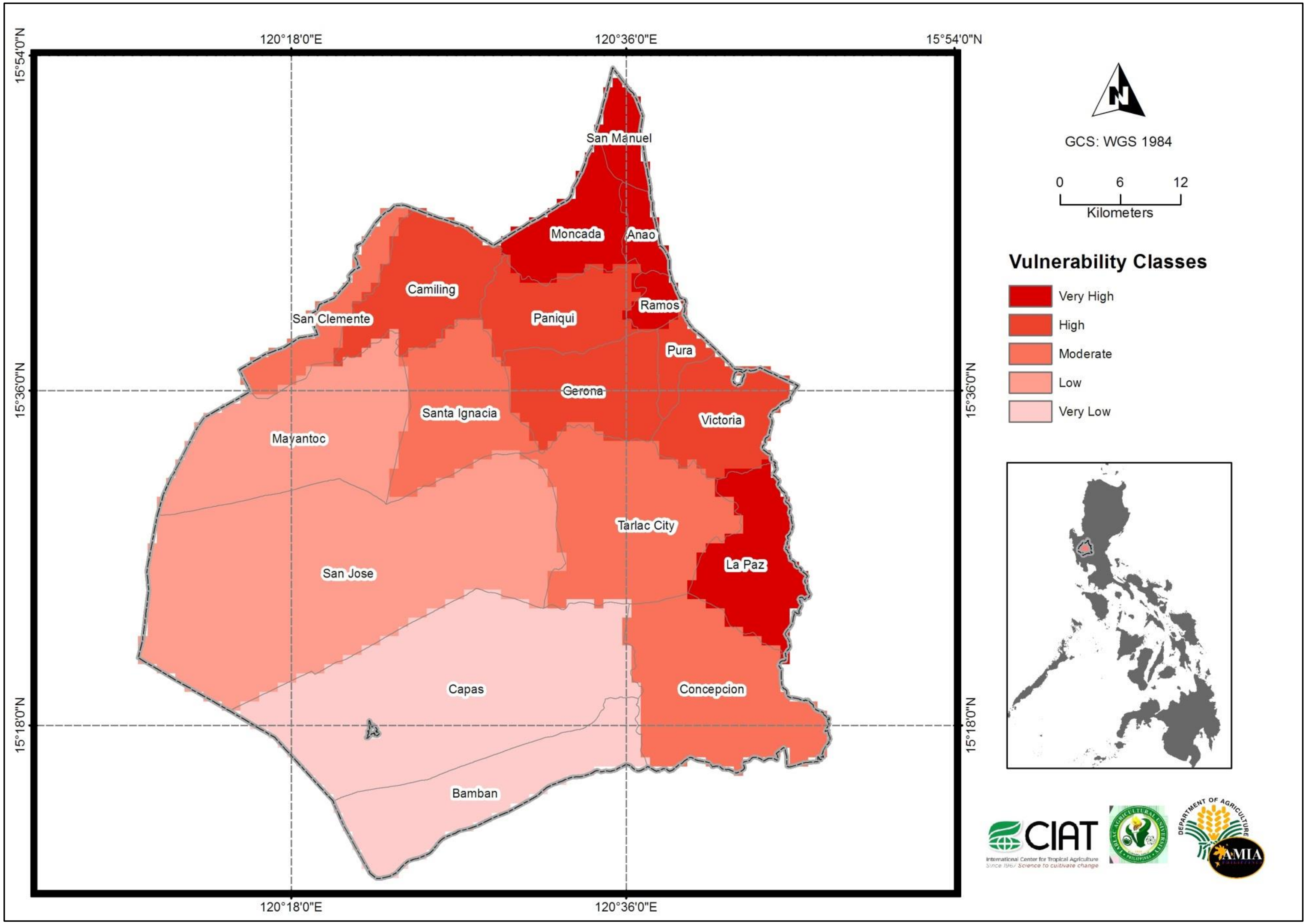


Figure 22. Aggregated Hazards

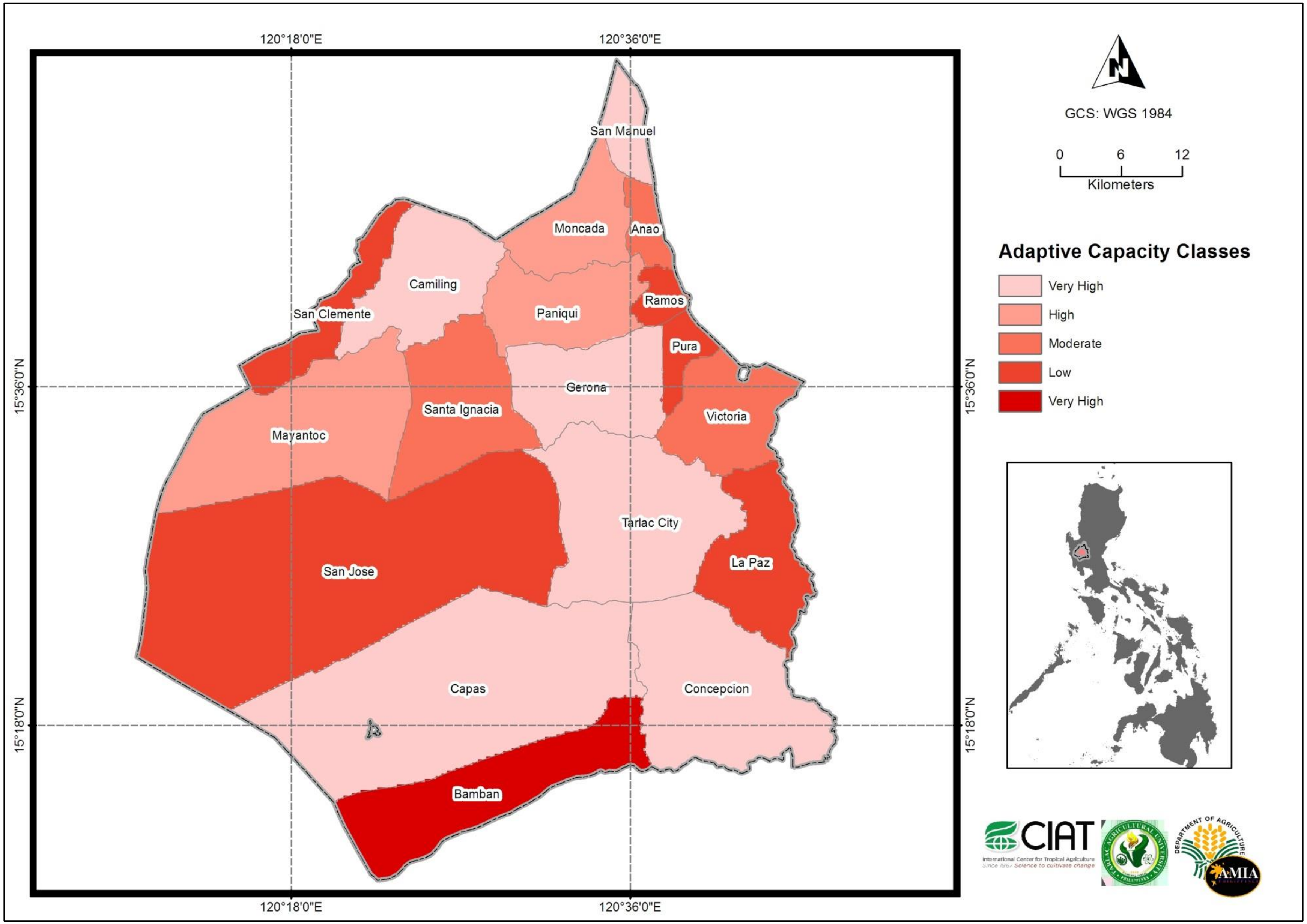


Figure 23. Adaptive Capacity Capitals: Economic

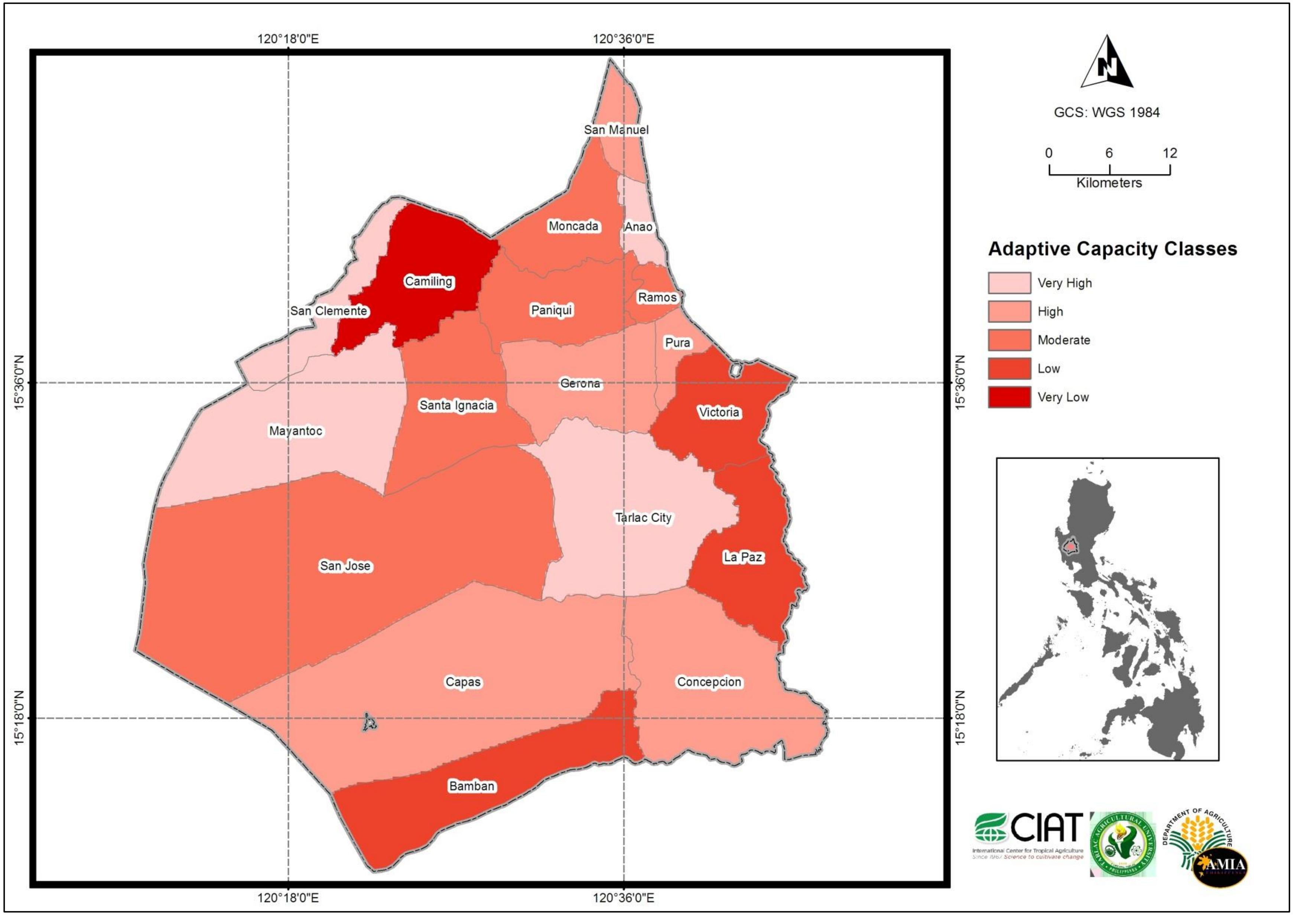


Figure 24. Adaptive Capacity Capitals: Natural

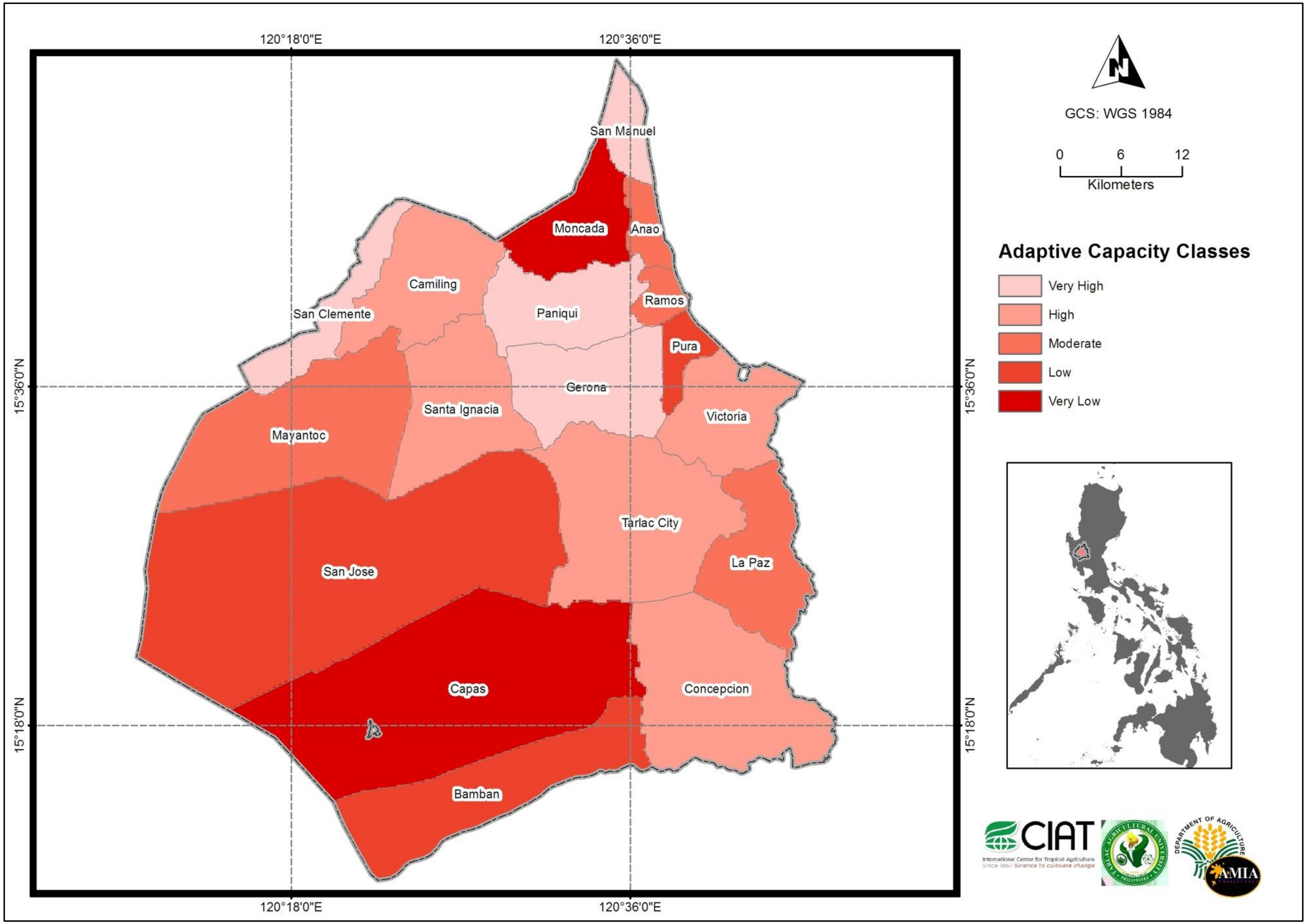


Figure 25. Adaptive Capacity Capitals: Social

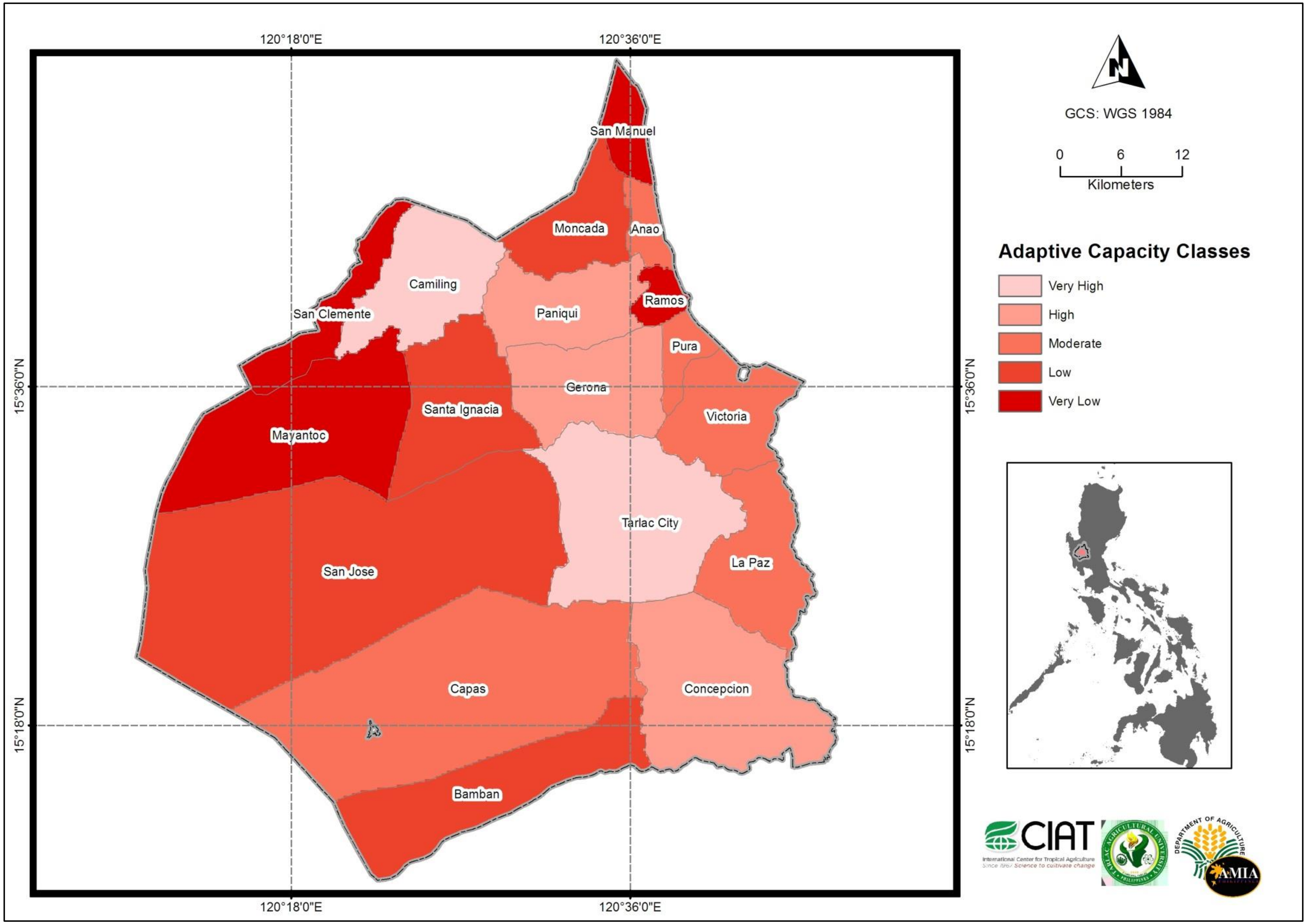


Figure 26. Adaptive Capacity Capitals: Human

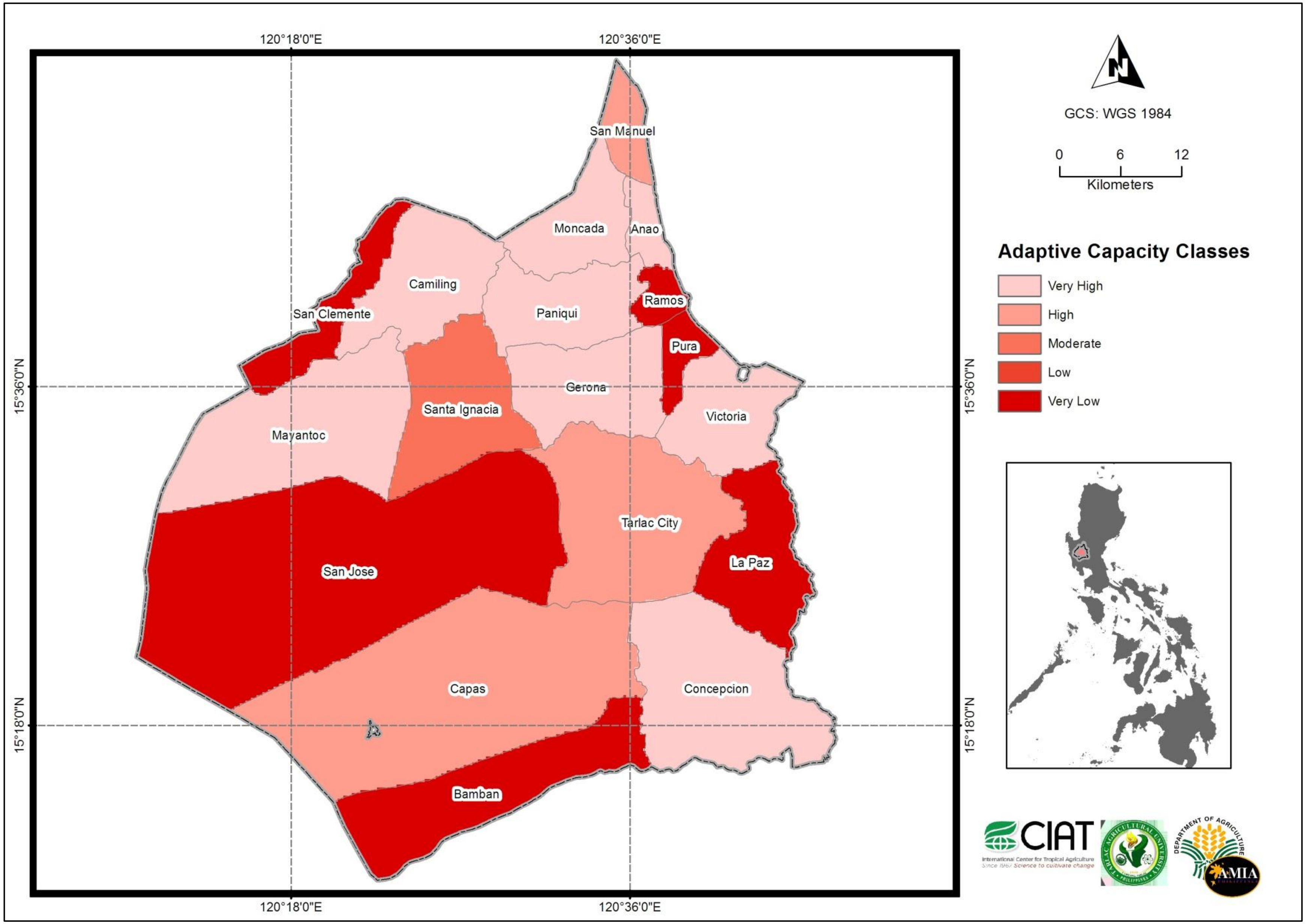


Figure 27. Adaptive Capacity Capitals: Physical

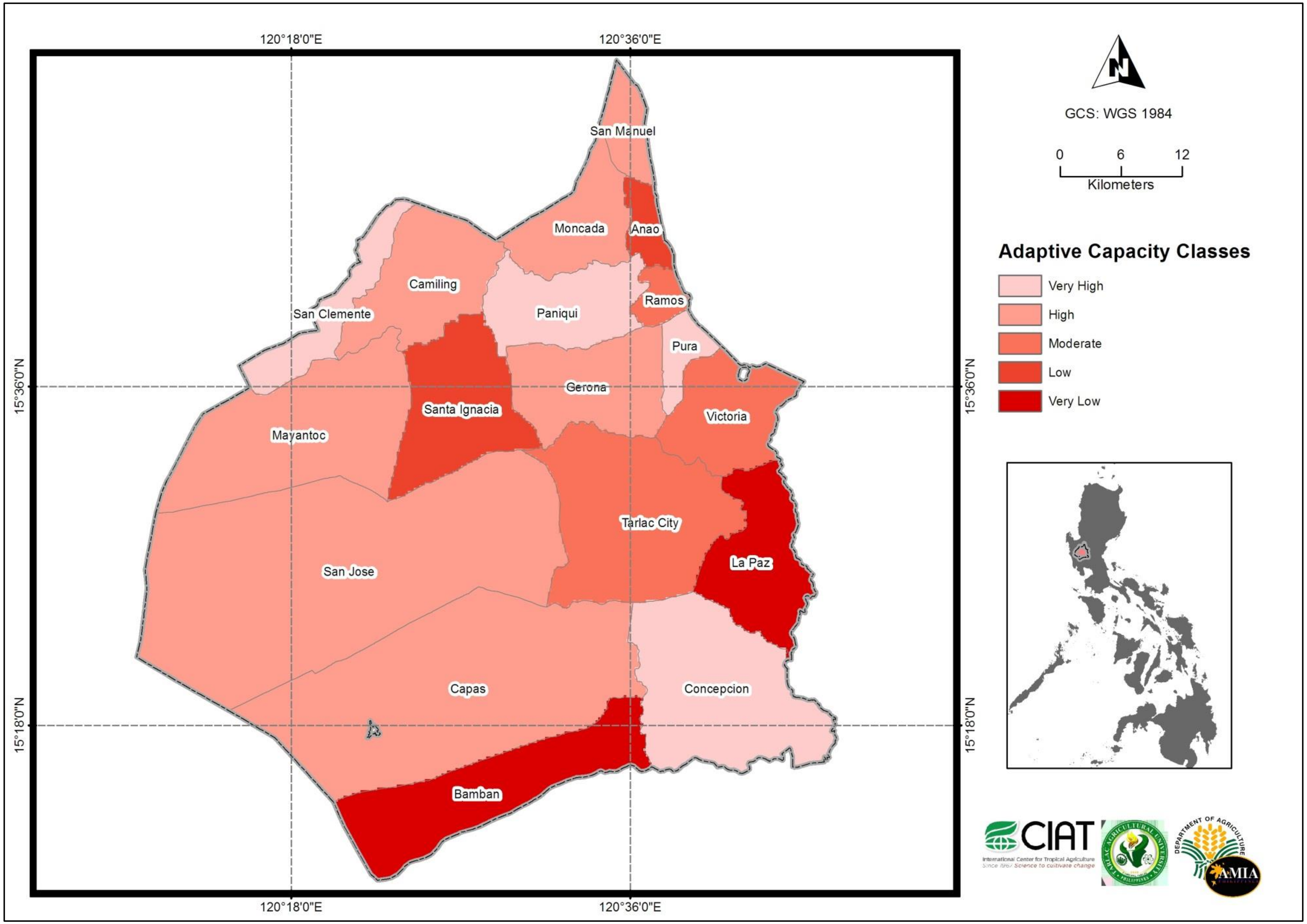


Figure 28. Adaptive Capacity Capitals: Anticipatory

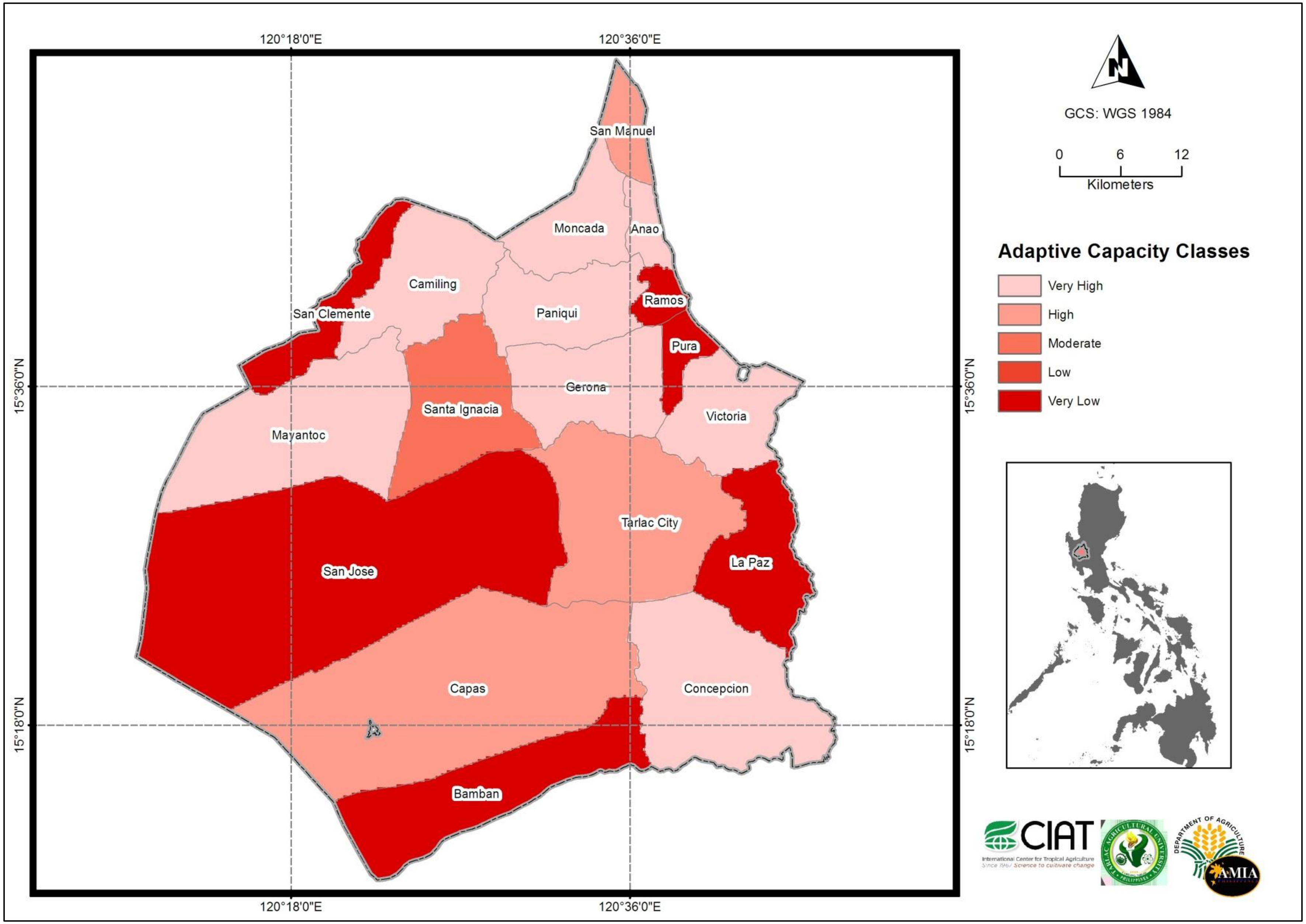


Figure 29. Adaptive Capacity Capitals: Institutional

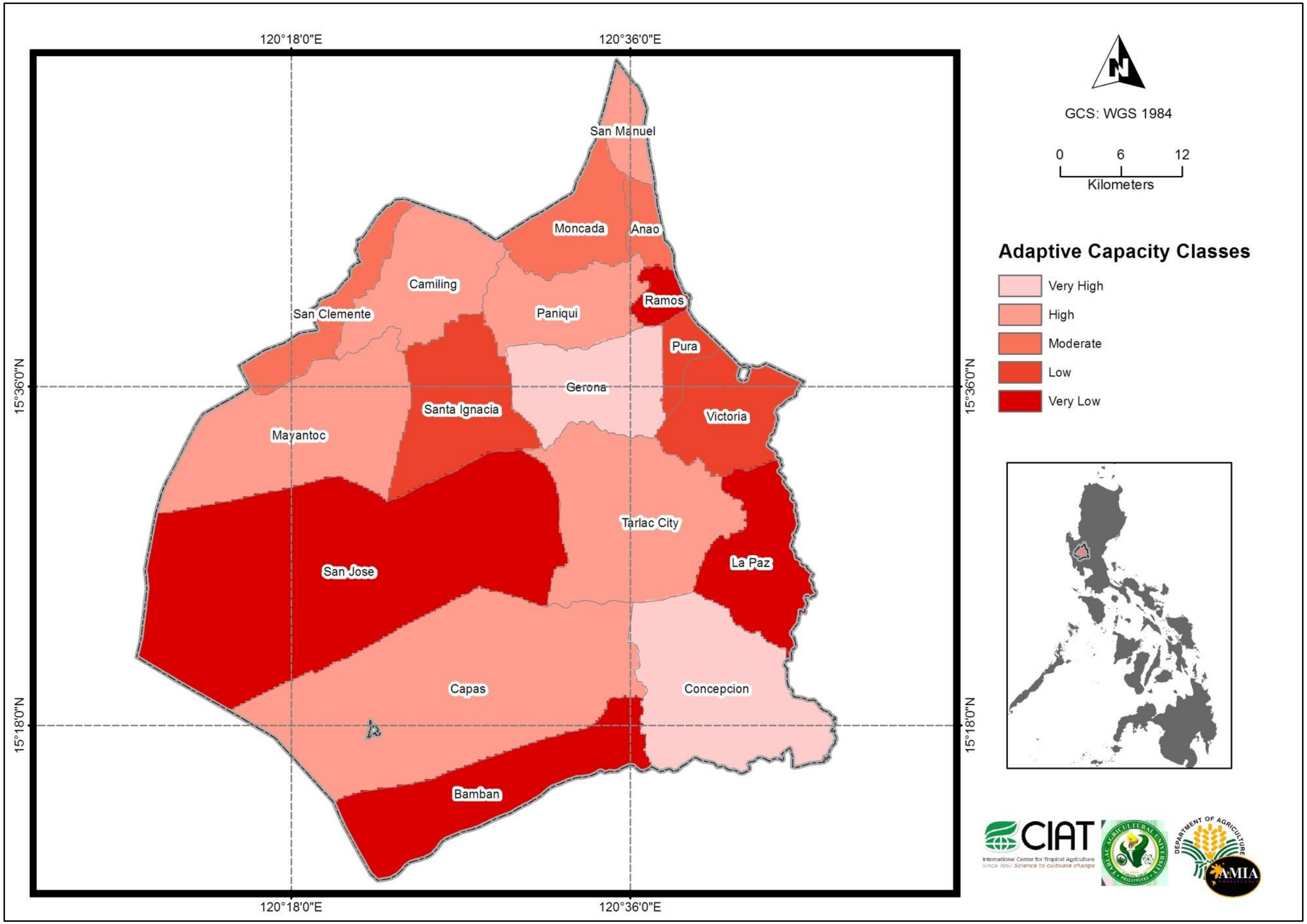


Figure 30. Aggregated Adaptive Capacity

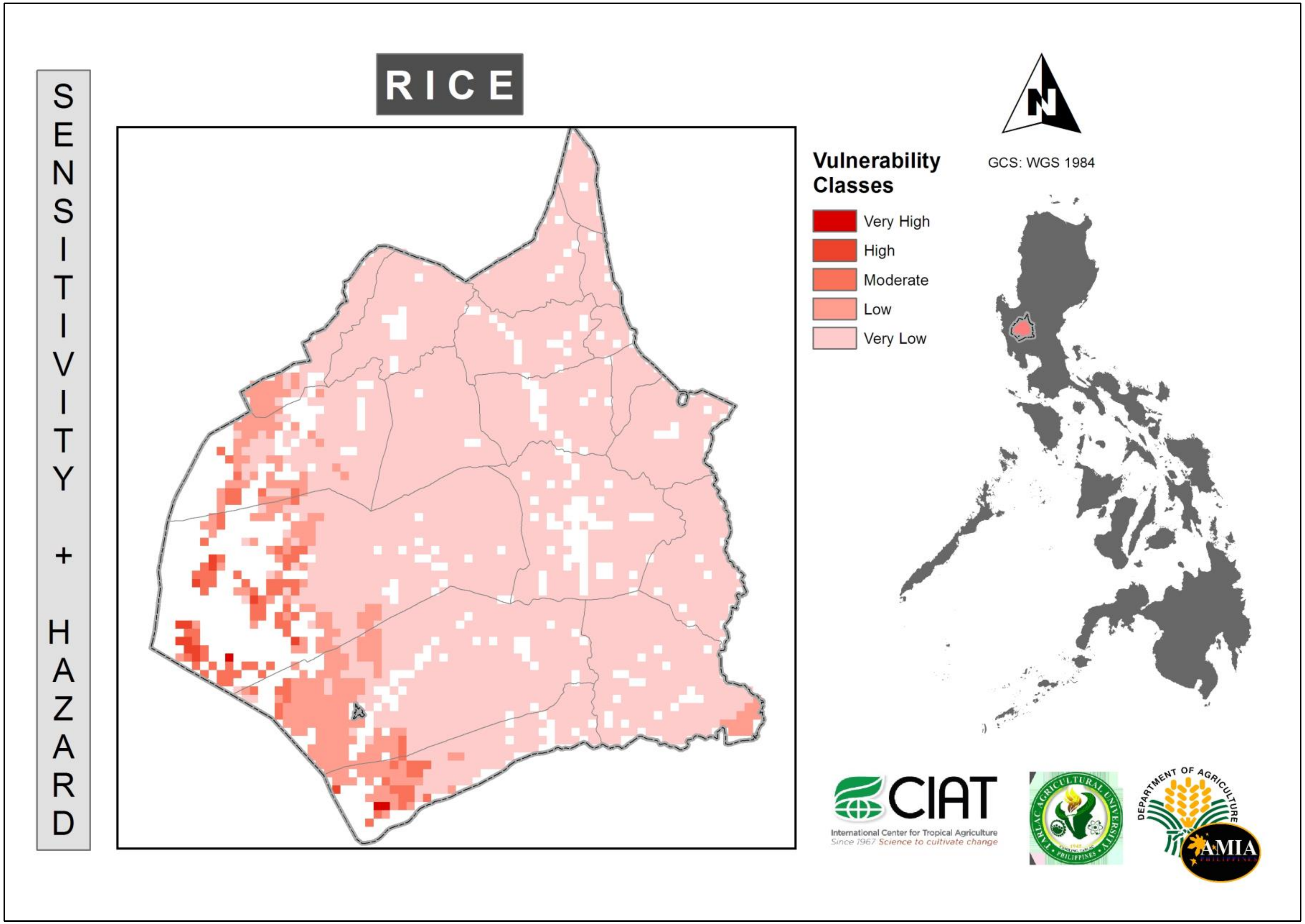


Figure 31. Sensitivity and Hazards for Rice

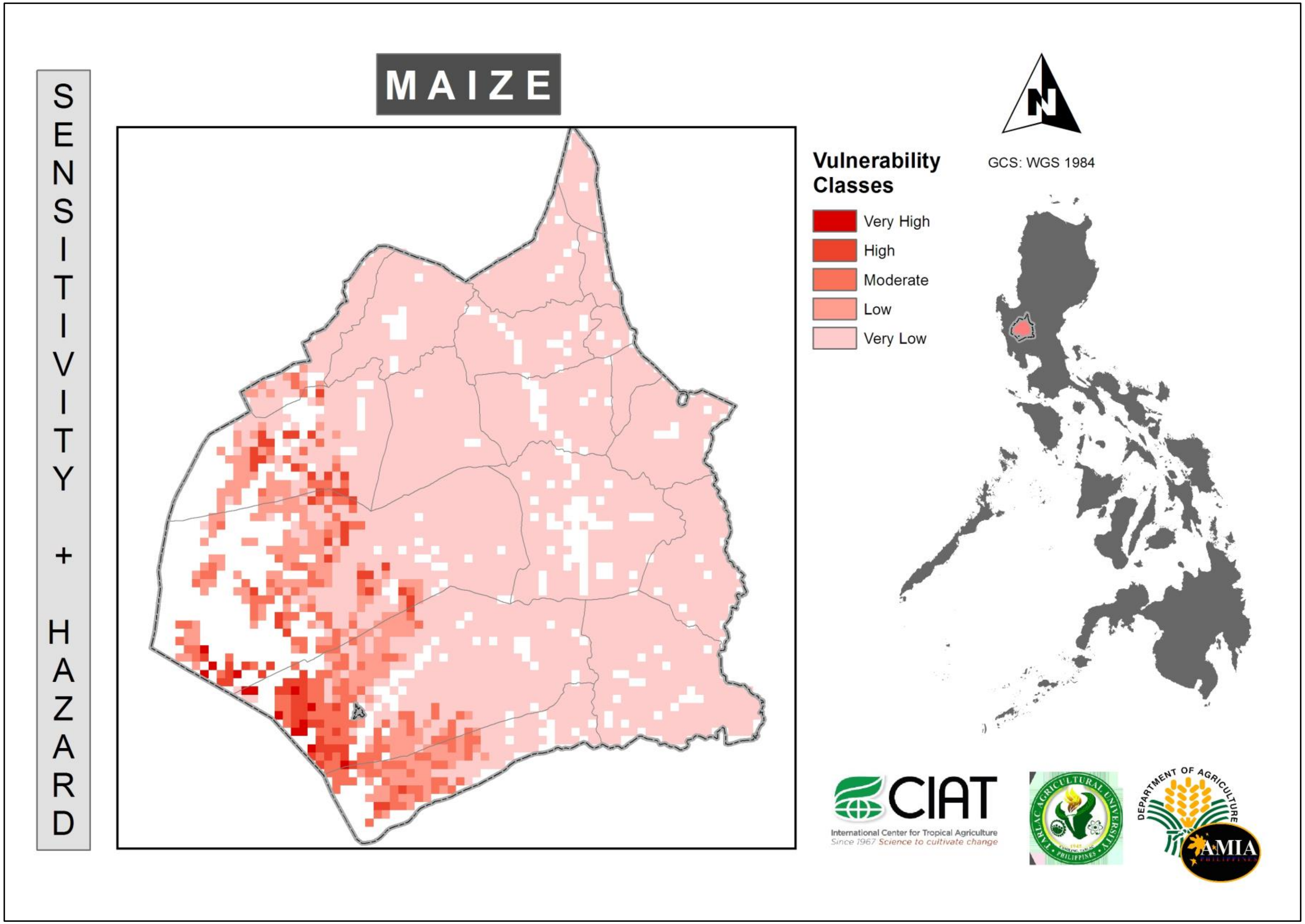


Figure 32. Sensitivity and Hazards for Maize

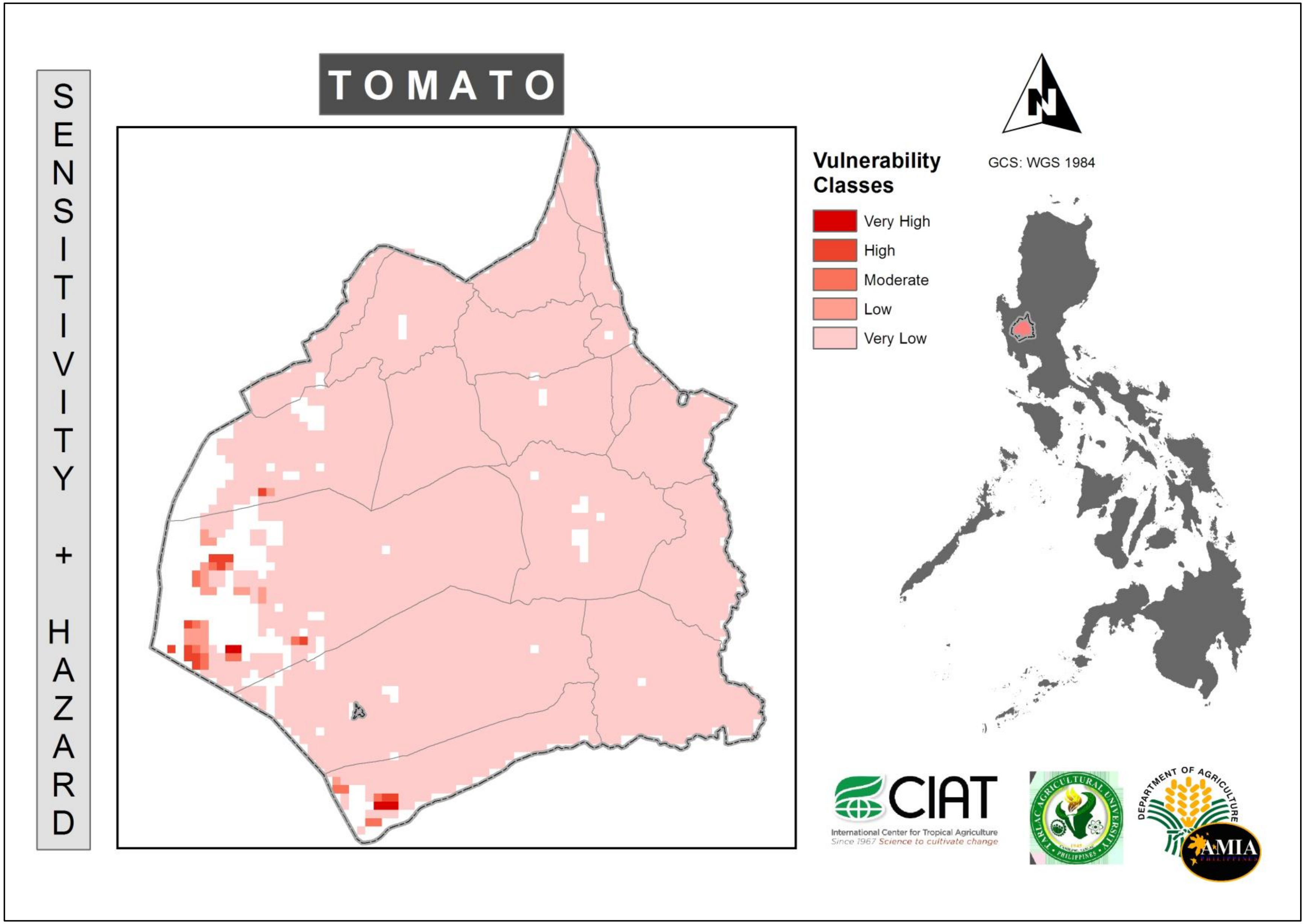


Figure 33. Sensitivity and Hazards for Tomato

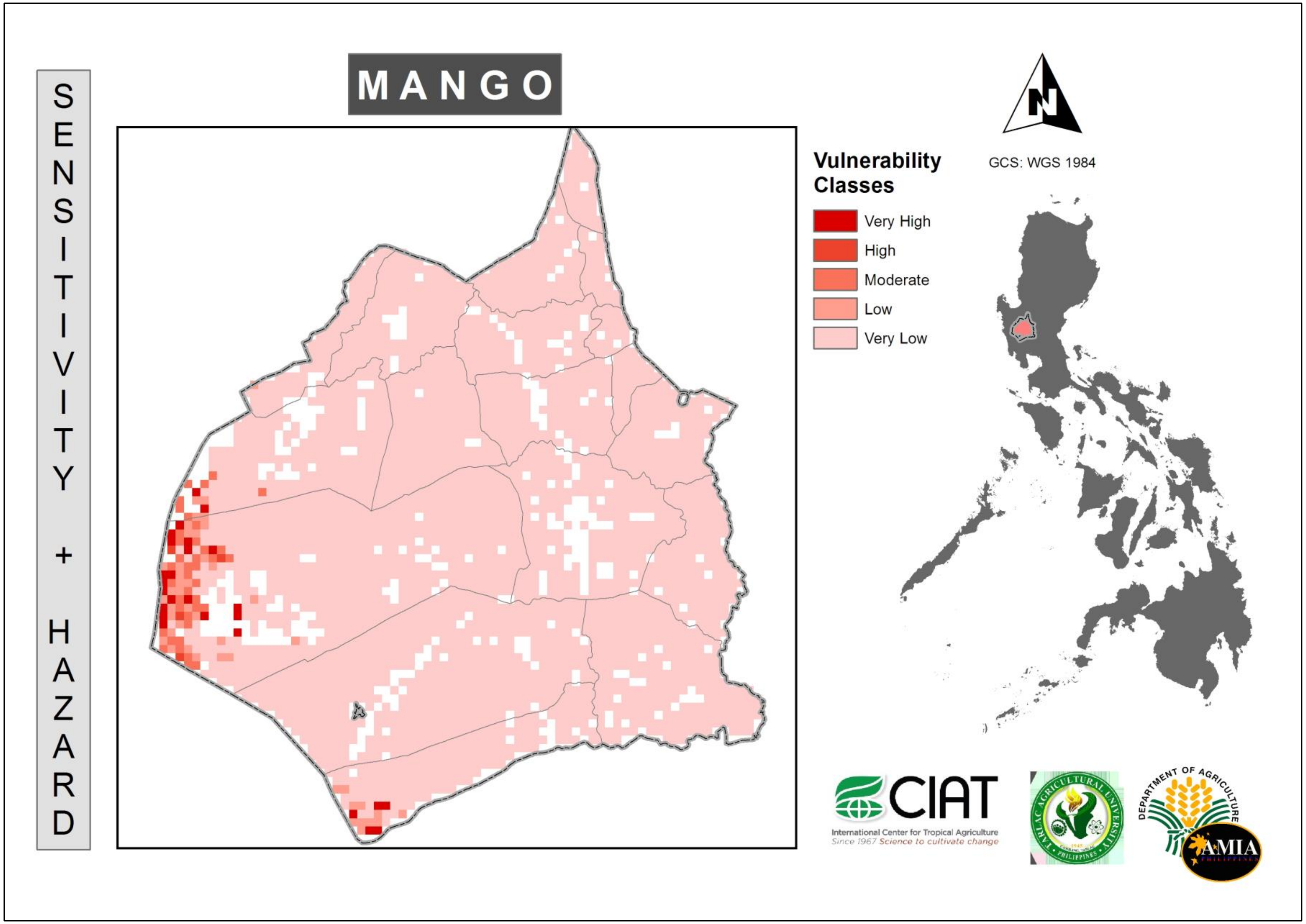


Figure 34. Sensitivity and Hazards for Mango

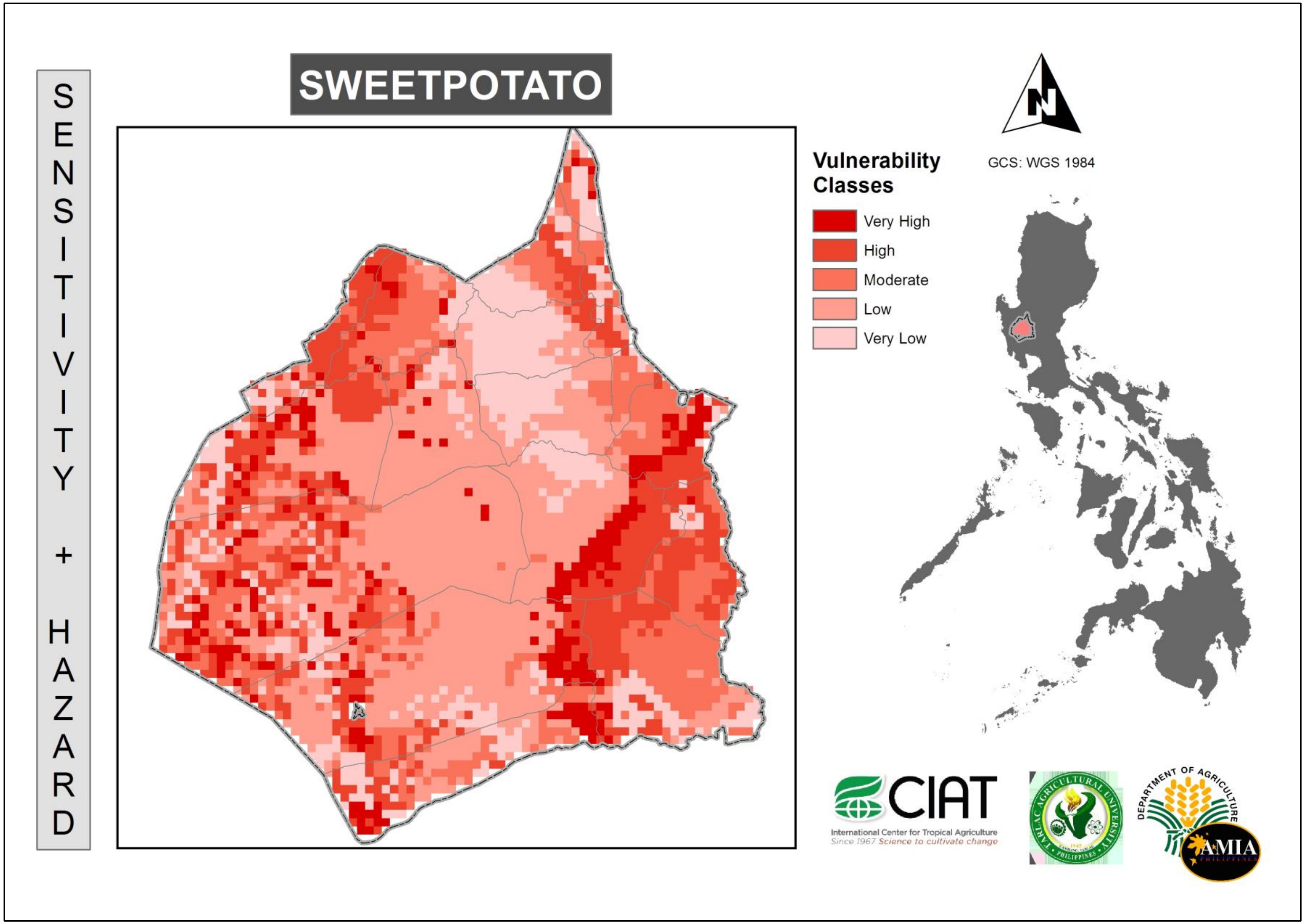


Figure 35. Sensitivity and Hazards for Sweetpotato

Investment Brief