Philippine Climate Change and Food Security Analysis

Regional Report on MIMAROPA*

October 2024

*Mindoro (Occidental Mindoro and Oriental Mindoro), Marinduque, Romblon and Palawan

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List of Abbreviations

AEZ	Agro-Ecological Zones
AFF	Agriculture, Forestry, and Fishery Sector
AMIA	Adaptation and Mitigation Initiative in Agriculture
CCAFS	Climate Change, Agriculture and Food Security
CCFSA	Climate Change and Food Security Analysis
CIAT	International Center for Tropical Agriculture
CPH	Census of the Population and Housing
CRVA	Climate Risk and Vulnerability Assessment
DENR	Department of Environment and Natural Resources
DOST	Department of Science and Technology
DSI	Drought Susceptibility Index
DREAM	Disaster Risk and Exposure Assessment for Mitigation
ENGP	Enhanced National Greening Program
FSI	Flood Susceptibility Index
GCM	Global Climate Model
GIS	Geographic Information System
GRDP	Gross Regional Domestic Product
KII	Key Informant Interview
LGU	Local Government Unit
LHZ	Livelihood Zone
MODIS	Moderate Resolution Imaging Spectroradiometer
NAMRIA	National Mapping and Resource Information Authority
NWRB	National Water Resources Board
OCHA	Office for the Coordination of Humanitarian Affairs
OECD	Organisation for Economic Co-operation and Development
PDSI	Palmer Drought Severity Index
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PSA	Philippine Statistics Authority
PRISM	Philippine Rice Information System
RCP	Representative Concentration Pathway
SDM	Species Distribution Modeling
SLR	Sea Level Rise
SS	Storm Surge
UNEP	United Nations Environment Programme
UNISDR	United Nations Office for Disaster Risk Reduction
WFP	World Food Programme

Foreword

Globally, the impacts of weather extremes, environmental degradation, and economic shocks continue to hamper people's access to nutritious and affordable food. Now, more than ever, strengthening the resilience of food systems is crucial, as this is the path where food travels from the farm to the table.

In 2021, the United Nations World Food Programme (WFP) conducted a robust study entitled Climate Change and Food Security Analysis (CCFSA), which assessed the interconnectedness of climate change and food security. To inform key actors of the Government and the private sector, CCFSA highlighted the trends and potential risks of climate change on food and nutrition security, and how they affect livelihoods in rural and urban areas of the Philippines.

Last year, WFP and the International Center for Tropical Agriculture (CIAT) expanded the CCFSA published in 2021. Five regional reports were produced based on quantitative and qualitative research conducted from May 2022 to October 2023. CIAT and WFP prioritized five areas for the sub-national level analysis, as these regions were not able to participate in the initial validation of the key results of the national-level research three years ago.

To that end, WFP presents the CCFSA regional report for MIMAROPA [Mindoro Occidental, Mindoro Oriental, Marinduque, Romblon, and Palawan]. The report interweaves i) climate change, ii) food and nutrition security, and iii) livelihoods and lays out ramifications and mitigation measures. Individual interviews and group consultations with representatives of key regional and national government institutions were also done to supplement the "ground truth" to the CCFSA findings.

To support policy development and resource management, this report provides government and non-government partners with a better understanding of interplay amongst natural hazards, crop suitability, and economy at the local level in MIMAROPA. It also presents base maps of major livelihood zones at the city and municipal levels, illustrating a visual representation of the main economic activities. These aim to i) enhance existing development and action plans and ii) help determine the most effective way to strengthen the adaptive capacity of the different localities to climate change.

The regional report can easily be updated since the CCFSA database can incorporate new datasets (small-area poverty estimates, agricultural production data, nutrition, etc.) from national and international government agencies and non-government organizations. CCFSA can also complement current government initiatives like the national colour-coded agricultural guide map of the Department of Agriculture and provide valuable information for smallholder farmers and fisherfolks.

WFP would like to extend its gratitude for the unwavering support of the national and regional partners and the analytical work of CIAT, which made possible the success of this research project.

WFP hopes that this analysis will support shaping policies, programmes, and investments at the local level to mitigate the effects of climate change and enhance the resilience of many Filipinos. As demonstrated through the past decades, WFP is committed to achieving food and nutrition security in the Philippines.

Regis Chapman
Representative and Country Director
UN World Food Programme, Philippines

Executive Summary

Following the conduct of the Climate Change and Food Security Analysis (CCFSA) and the development of a country-wide Livelihood Zone (LHZ) map in 2021, a follow-up project was conducted to validate the results at the regional level. Using spatial analysis, modelling, and Key Informant Interviews (KII), the exposure and susceptibility of different livelihoods to climate change and climate-related hazards in the MIMAROPA (Oriental Mindoro, Occidental Mindoro, Marinduque, Romblon, Palawan) region were analyzed. Practical applications on the use of the LHZ map for developing strategic adaptation measures on several social issues such as poverty, food security, and undernutrition were also presented in this report.

The following are some of the key findings of the study:

Livelihood Zones

- Of the nine (9) major LHZs nationwide, eight (8) were initially identified in MIMAROPA namely: Aquaculture/Freshwater Fisheries Zone, Aquaculture/Coastal Fisheries Zone, Irrigated Rice Zone, Rainfed Rice Zone, Annual Crops Zone, Cool Environment Zone, Perennial Crops Zone, and Built-up Areas Zone. All of these were validated by local experts in the region.
- Aquaculture/Freshwater Fisheries LHZ was reclassified as Aquaculture/Coastal Fisheries LHZ which covered 17 municipalities.
- From seven areas, Built-up Areas LHZ was reduced to two (2) cities.

Climate Hazards

- Drought and flood were identified as the top two hazards that significantly affect most of the livelihoods in MIMAROPA.
- The region has generally low risk to flooding. Moderate risk is found in the municipality of Balabac in Palawan (Aquaculture/Coastal LHZ) and city of Calapan in Oriental Mindoro (Irrigated Rice LHZ).
- Most of the areas in the region have moderate to high risk to drought. High risk is found in the areas of Cagayancillo in Palawan (Aquaculture/Coastal LHZ), Looc and Lubang in Occidental Mindoro (Annual Crops LHZ and Irrigated Rice LHZ, respectively), and Calapan City and San Teodoro in Oriental Mindoro (Irrigated Rice LHZ and Perennial Crops LHZ, respectively).

Impacts on Crops

- Future climate scenarios based on RCP 8.5 (years 2030 and 2050) will result in less conducive environments for rice production in major Irrigated and Rainfed Rice LHZs throughout the region.
- The impact of climate change on the future suitability of maize in Annual Crops LHZs and banana in Perennial Crops LHZs will result in less favorable conditions but is less dramatic as compared to the effect on rice.
- By 2050, temperature is expected to continue to rise, creating an opportune environment for pests and diseases to spread and proliferate, especially in the areas with temperature greater than 30°C. Rice, maize, and banana are the most likely to be impacted by an increased incidence of pests and diseases.

Impacts on Aquaculture

- The projected increase in temperature and amount of rainfall will have direct and indirect impacts on the abundance and distribution of marine and coastal resources, and on aquaculture production. Fifteen (15) municipalities under the Aquaculture/Coastal Fisheries LHZ are potentially at-risk to these climate change hazards.

Impacts on Livestock

- Increased temperature can negatively affect livestock performance, including stunted growth, more deficient good-quality meat, and by-products, and decreased reproductive capacity, in addition to diminishing the quality and quantity of feed supply.
- Seventeen (17) municipalities in the region with livestock and poultry raising as complementary activities, will be potentially at risk to the projected increase in temperature.

1. Introduction

1.1. Project Background

The World Food Programme (WFP), in collaboration with the Alliance of Bioversity International and the International Center for Tropical Agriculture (CIAT), completed a national-level Climate Change and Food Security Analysis (CCFSA) in May 2021. The project aimed to assist the Philippine government in delivering its priority agenda of 1) Reducing vulnerabilities of food systems and nutrition to long-term shocks and other climate-related hazards; and 2) Improving community resilience by understanding critical impacts of climate change on different aspects of food security.

One of the major accomplishments of the project was the development of a National-level Livelihood Zones (LHZ) Database. This tool can assist planners and policymakers in strategically assessing impacts of climate-related risks to food security and livelihoods through an accurate classification of LHZs at the city/municipal level. This site-specific information is important in crafting tailored recommendations that will support local-level climate change adaptation and promote climate-adaptive food systems.

In July 2022, a follow-up analysis was undertaken by the WFP and Alliance of Bioversity International and CIAT to validate the initial findings in four regions, namely: Region IV-B (MIMAROPA), Region XI (Zamboanga Peninsula), Region XII (SOCCSKSARGEN), and the BARMM. Additionally, the CCFSA in the National Capital Region (NCR) was reviewed to further substantiate its urban analysis.

This report focuses on the **regional-level CCFSA for MIMAROPA** which presents the validated livelihood and climate-related profiles of the region. Additionally, this report identifies the specific locations of livelihoods in MIMAROPA that are most at risk to climate hazards. This information can support the development of strategic adaptation plans at the local level that aim at minimizing the adverse climate-related impacts on livelihoods and food security.

In the long-term, WFP plans to match the results of the national and regional CCFSA with the findings of the Vulnerability and Risk Analysis (VRA) undertaken by the WFP Philippines Country Office and WFP Regional Bureau in Bangkok from 2019 to 2021. The VRA provides an overview of underlying vulnerabilities to climate-related risks to provide geographic priority for shock-responsive social protection interventions in the country. Like the CCFSA, the analysis of the VRA is available at the city and municipal level for the whole country. The complementation of the two studies is expected to provide a better understanding of the interplay of livelihood, natural hazard, and exposure to determine the adaptive capacity of the different cities and municipalities in the Philippines to climate change.

1.2. Initial Livelihood Zones

The initial LHZ database of the Philippines developed during the first phase of the project included a total of nine (9) major categories: **Aquaculture/Freshwater Fisheries Zone**; **Aquaculture/Coastal**

Fisheries Zone; **Irrigated Rice Zone**; **Rainfed Rice Zone**; **Annual Crops Zone**; **Perennial Crops Zone**; **Cool Environment Zone**; **Pasture Zone**; and **Built-up Areas Zone**[1] (**Table 1**).

The database contains 1,646 records of unique cities and municipalities nationwide, following the administrative boundary from the National Mapping and Resource Information Authority (NAMRIA), co-created by the United Nations Office for the Coordination of Humanitarian Affairs (OCHA). All of the datasets were stored in Shapefile format which can either be viewed as maps or be exported as tabular data.

Table 1. Categories of Livelihood Zones developed during the 1st Phase of the CCFSA Project

Major Zones		Descriptions
1	Aquaculture/ Freshwater Zone	Activities related to raising and breeding freshwater aquatic animals and plants for economic purposes with ponds, reservoirs, lakes, rivers, and other inland waterways (brackish water).
2	Aquaculture/ Coastal Zone	Activities related to fisheries and seaweed farming in coastal marine areas.
3	Irrigated Rice Zone	Activities related to rice farming in bunded fields wherein water supply is reliable using irrigation systems. Rice grows once or twice a year and sometimes mixed or intercropped with vegetables.
4	Rainfed Rice Zone	Activities related to growing rice in upland and/or hilly areas wherein water supply is dependent on rainfall. It is usually mixed with maize, cassava, and other vegetables.
5	Annual Crops Zone	Activities related to growing vegetables and root crops that are harvested seasonally and have a life cycle for a year.
6	Perennial Crops Zone	Activities related to growing more permanent plants such as coconut, banana, cacao, coffee, rubber, abaca, calamansi, mango, and other fruit-bearing trees, which requires several growth cycles before its fruit is produced and/or harvested.
7	Cool Environment Zone	Consists of a combination of activities unique in terms of temperature ranges in the area (e.g., highland crops such as broccoli, cauliflower, lettuce, etc., can be grown only in this zone).
8	Pasture Zone	Activities related to raising livestock, swine, poultry, and other domesticated animals, such as goats, cattle, cows, etc., and growing of plants and/or grasses used for feeding animals.
9	Urban Zone	Activities related to commerce, industry, and non-agricultural jobs in urban or built-up areas.

[1] The previously termed "Urban LHZ" was renamed as "Built-up Areas LHZ" to be consistent with the terminology recommended by the Department of Human Settlements and Urban Development (DHSUD) to be used in the development of Comprehensive Land Use Plans (CLUPs) and Zoning Ordinances (ZOs).

2. Methodology

2.1. Study Site and Population

MIMAROPA is an administrative region in the Philippines under the Luzon Island group. It is composed of five (5) provinces (Occidental Mindoro, Oriental Mindoro, Marinduque, Romblon, and Palawan) and one (1) highly urbanized city (Puerto Princesa). It has 71 municipalities and two (2) cities (including Puerto Princesa which is administered independently from any province).

It has a total land area of 30,235.79 square kilometers (km^2) endowed with forest, marine, and freshwater resources (DENR-FMB, 2021). About 10,004.42 km^2 of this land area are designated as national parks or game refuge and bird sanctuaries or wilderness areas. Meanwhile, 9,985.56 km^2 are alienable and disposable lands, 3,692.70 km^2 are timberlands, and 2,688.90 km^2 are established forest reserves.

In terms of economy, MIMAROPA is highly driven by the Agriculture, Fishery, and Forestry (AFF) and ecotourism sectors. The region is one of the top producers of rice, banana, coconut, mango, cashew, papaya, and cassava in the Philippines. It is also the second top producer of fish and seaweed, accounting to 14% and 21%, respectively, of the country's total outputs.

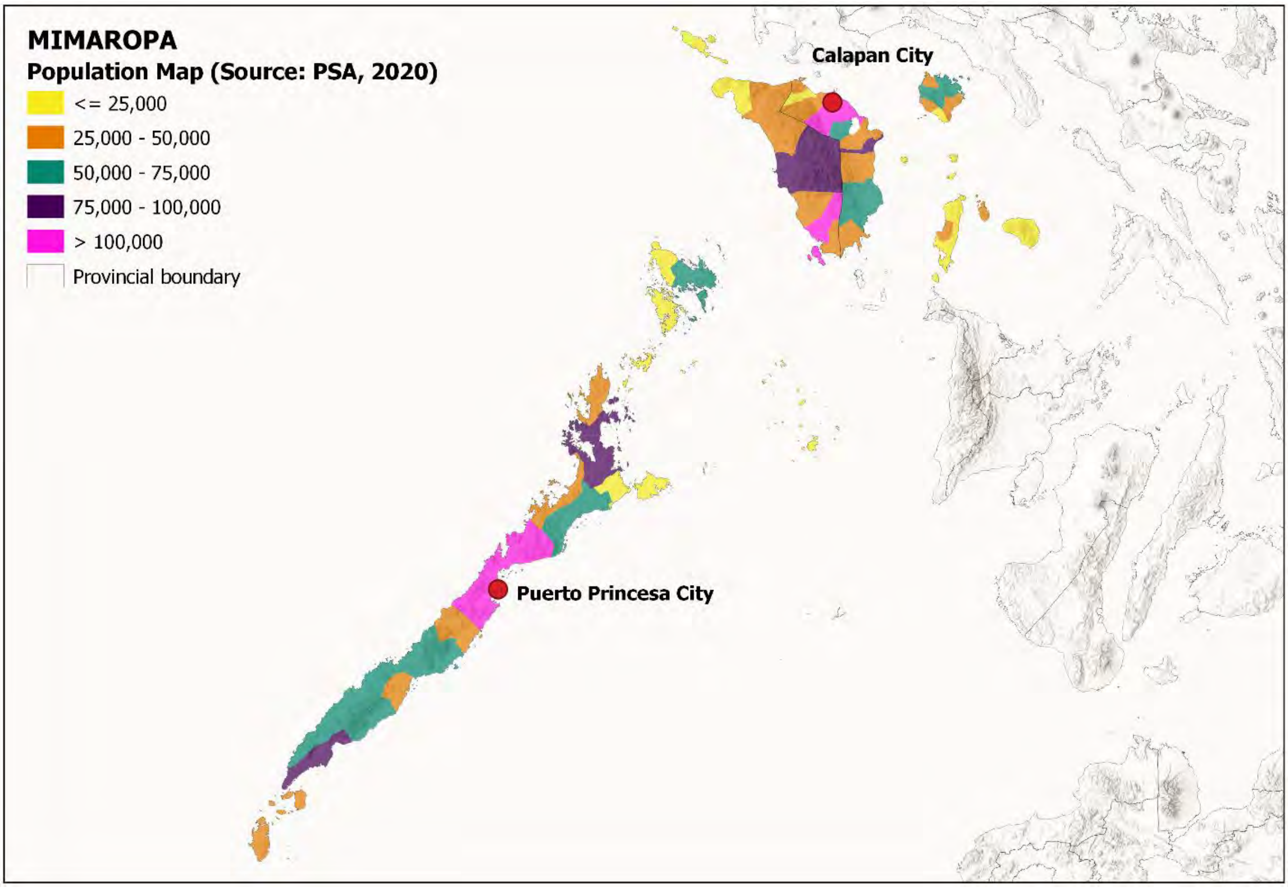
The MIMAROPA Region had a total of 3.2 million population based on the 2020 Census of the Population and Housing (PSA, 2020), accounting for 2.96% of the country's total population.
Among its five (5) provinces, Palawan had the biggest population with approximately 940,000 persons, excluding Puerto Princesa City which had a population of approximately 307,000 persons. On the other hand, Marinduque had the smallest population of 240,000 persons.

The top three (3) municipalities with the highest population were found in San Jose (Occidental Mindoro) with approximately 153,000 persons, and Calapan City and Naujan (Oriental Mindoro) with approximately 146,000 and 110,000 persons, respectively.

On the other hand, the top three (3) municipalities with the least population (excluding Kalayaan with only 193 persons) are Concepcion (Romblon) with approximately 3,600 persons, followed by Banton (Romblon) with approximately 5,700 persons, and Cagayancillo (Palawan) with approximately 6,900 persons.

The top four (4) localities with the highest population in the region in 2020 were Cotabato City (Maguindanao) with about 325,079 persons, Marawi City (Lanao del Sur) with approximately 202,000 persons, Jolo (Sulu) with approximately 126,000 persons, and Bongao (Tawi-tawi) with approximately 101,000 persons (Figure 1).

Figure 1. Population Map of MIMAROPA (PSA, 2020)



2.2. Livelihood Zones Mapping

The CCFSA utilized seven (7) different national datasets to build the LHZ database (Table 2). These datasets include Land Cover Map, Agro-Ecological Zones (AEZ), MODIS-derived Rice Extent Map, Tourism Areas, Mining Locations, the Land Classification from the Philippine Local Government Units (LGUs), and areas classified as industrial zones.

The datasets were processed using the Geographic Information System (GIS) software. All datasets were converted into a shapefile format for uniformity. Standardizing data allows better processing of statistical information at a more granular level. Furthermore, the use of data at the city/municipal level enables a more comprehensive and up-to-date analysis that is beneficial for socio-economic planning and development.

Table 2. Data sources for the LHZ database

Layer	Source	Data Type	Resolution	Time Period
Land cover	National Mapping and Resources Information Authority (NAMRIA)	Polygon	1:10,000	2015
Agroecological zones	Department of Agriculture	Polygon	1:10,000	2016
Rice extent	International Rice Research Institute	Raster	250m x 250m	2015
Mining locations	Department of Environment and Natural Resources	Point, Tabular	Municipal scale	2015
Tourism areas	Philippine Geoportal	Point	Municipal scale	2015
Local Government Unit Category	Philippine Statistics Authority	Tabular	Municipal scale	2015
Industrial zones	Local Government Units	Tabular	Municipal scale	2015 up to latest year

The Spatial Overlay operation in GIS was employed to identify the spatial relationships among the different thematic maps in Table 2. All of the datasets and attributes were superimposed and analyzed within a polygon[2] which represents a city/municipality. Using this technique, different combinations of data were formed which allowed to analyze portions of the various layers within polygons. The resulting layer contains new attribute information which formed the LHZ based on the percent area that an activity/livelihood occupied within the polygon. Duplicates and overlaps among the attributes (i.e., land cover, agro-ecological zones, and rice extent) were eliminated using the erase tool to further refine the output.

To determine the extent of each type of livelihood, the area in hectares (ha.) being occupied by a specific activity was calculated using the Summary Statistics Tool. The activity that occupied the largest area in each city/municipality was considered as the Major Livelihood. On the other hand, the succeeding activities that occupy the next largest areas were identified as Secondary, Tertiary, or Quaternary Livelihoods, accordingly.

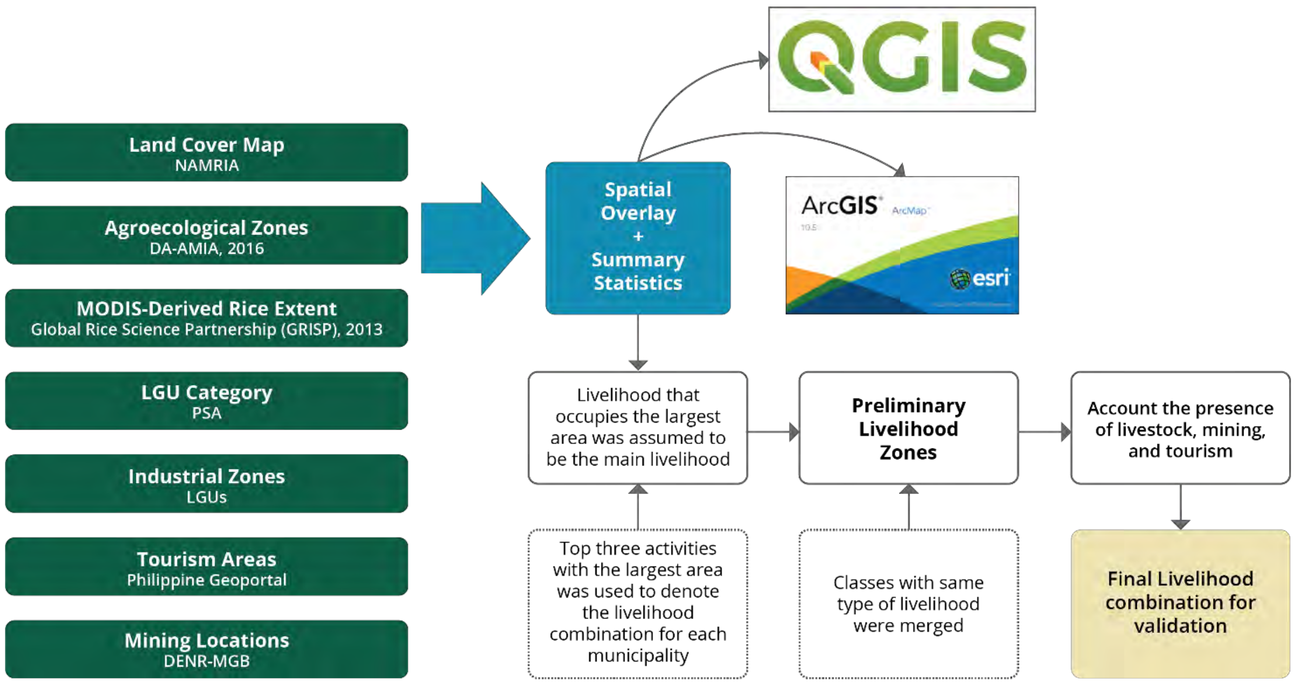
The additional datasets on tourism and mining are all point data[3] which were computed as counts per polygon. Also, livestock activities were just classified as "Yes" (present) or "No" (lacking), and therefore,

[2] Polygon feature is a closed shape defined by a connected sequence of x and y coordinate pairs. It is a geographic representation of an area and location (ESRI).
[3] Point data does not allow for geographical extent or area calculation. In a map, point data is normally shown as point feature representing location or presence of tourism or mining areas.

has no geographical extent. Nevertheless, presence of these activities was still accounted for and included in the analysis whenever identified in a particular city/municipality.

Based on the analytical method shown in Figure 2, a livelihood zone unit can be defined as an area that occupies one position on the map with a resolution at a city/municipal level, which contains similar attributes on livelihood activities based on agroecology, land use characteristics, and dominant economic activities within a production system.

Figure 2. Process flow in GIS for the Livelihood Zones development and mapping



2.3. Assessment of Climate-Related Hazards

2.3.1. Hazard Mapping

To identify and qualify the major climate-related risks prioritized in the initial phase of the project, six (6) datasets on hazards were used to characterize the exposure of the Philippines to climate variability and extreme weather events. These hazards include Typhoon, Flooding, Drought, Storm Surge, Saltwater Intrusion, and Sea Level Rise (Table 3). The selection of these hazards was based on the availability of data at the city/municipal level and the hazard's potential impact on livelihood, food security, and nutrition.

Table 3. Overview of hazard datasets for the Philippines

Parameter	Source	Unit of Measurement, Spatial and Temporal Resolution
Typhoon	United Nations Environment Programme (UNEP)/United Nations Office for Disaster Risk Reduction (UNISDR) (2013) (https://preview.grid.unep.ch/) WFP Philippines	1-km pixel resolution. Estimate of tropical cyclone frequency based on Saffir-Simpson scale category 5. (> 252 km/h) from 1970 to 2013; typhoon tracks
Flooding	Mines and Geosciences Bureau, Department of Environment and Natural Resources (DENR-MGB)	1:10,000 scale. Susceptibility of flood risk for the Philippines, average of 10 years (2008-2017).
Drought	TerraClimate (Abatzoglou et al., 2018); Palmer Drought Severity Index (PDSI) from 1950 to near present	PDSI, Standard Precipitation Index
Storm surge	Adaptation and Mitigation Initiative in Agriculture (AMIA) multi-hazard maps/baseline data from Disaster Risk and Exposure Assessment for Mitigation, Department of Science and Technology (DREAM, DOST)	1:100,000 scale (resampled). Exposure of an area to storm surge
Saltwater intrusion	AMIA multi-hazard map/baseline data from the NWRB	1:100,000 scale (resampled). Risk of saltwater intrusion
Sea level rise	AMIA multi-hazard map	1:100,000 (resampled). 3-meter sea-level rise

2.3.2. Crop Suitability Mapping

For the climate-based suitability assessment of the selected crops, the project employed Species Distribution Modeling (SDM) to estimate which of the current food production regions will turn into no longer viable, less suitable, or suitable for the introduction of a different crop, upon changes in climatic conditions. This analysis was used to identify areas with “high” negative impacts into which shifting to new crops or livelihood source may be feasible and areas with “increased” positive impacts which in turn can be a future investment.

The SDM employed in this project is the EcoCrop model in R, a mechanistic model originally developed by Hijmans (2001) and further developed by Ramirez-Villegas et. al. (2013). EcoCrop was used to predict the baseline and future suitability of the selected crops under different climatic conditions. EcoCrop considers the monthly temperature and rainfall conditions within the crop growing period and assesses crop's suitability based on the crop requirements (Table 4), used to run the model.

Table 4. List of parameters used to run the EcoCrop model

Code	Description
GMN	Minimum length of the growing season (days)
GMX	Maximum length of the growing season (days)
TKILL	Absolute temperature that will kill the plant (◦C)
TMN	Minimum average temperature at which the plant will grow (◦C)
TOPMN	Minimum average temperature at which the plant will grow optimally (◦C)
TOPMX	Maximum average temperature at which the plant will grow optimally (◦C)
TMX	Maximum average temperature at which the plant will cease to grow (◦C)
RMN	Minimum rainfall (mm) during the growing season
ROPMN	Optimal minimum rainfall (mm) during the growing season
ROPMX	Optimal maximum rainfall (mm) during the growing season
RMX	Maximum rainfall (mm) during the growing season

A set of climate layers (gridded data) from WorldClim (https://www.worldclim.org/) with a spatial resolution of about 1 km^2 (or 30 arc-seconds) was used to generate the baseline condition. On the other hand, climate data for future conditions were based on Representative Concentration Pathway (RCP) 8.5 scenario using CMIP5 Global Climate Models (GCMs) downloaded from CCAFS (Climate Change, Agriculture and Food Security – http://www.ccafs-climate.org/data_data_spatial_downscaling/).

The RCP 8.5 scenario represents potentially very high greenhouse gas emission levels in the atmosphere and the subsequent increase in solar energy that would be absorbed (radiative forcing) (IPCC AR5, 2014). Under RCP 8.5, increase in temperature is at +1.4 – 2.6 degree Celsius (ºC) for the mid-century[4] and +2.6 – 4.8ºC for the end of the century[5] (IPCC, 2013). The RCP 8.5 scenario was used in the analysis because climate risks tend to rise in extremely high emission scenario and temperature conditions (Katzfey, 2015).

Compared to other scenarios, for example RCP 6.5 which is more optimistic emission pathways, the RCP 8.5 provides emphasis on risk assessment by providing understanding of the upper limits of potential climate change impacts to inform policy and decision-making. RCP 8.5 scenario is also a valuable tool for assessing vulnerabilities and preparing for potential extreme outcomes which highlights the urgency to address climate change by demonstrating the potential consequences of business-as-usual and inaction. Using this scenario can help motivate actions from policymakers, the public, and other stakeholders through a combined efforts to mitigate climate change.

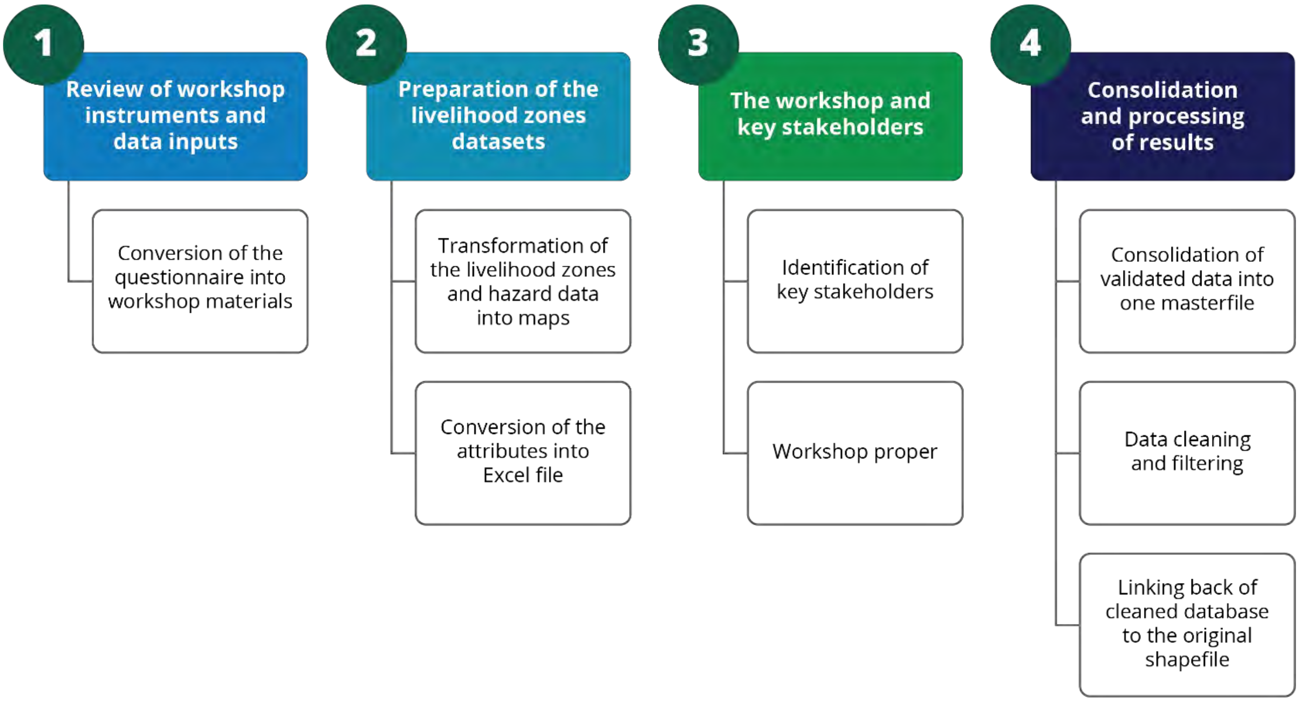
[4] Mid-century represents the 20 years from 2046 to 2065.
[5] End of century represents the 20 years from 2081 to 2100.

2.4. Regional Validation Workshop

A validation workshop was conducted on 16 August 2022 in Quezon City which was attended by several experts from non-government organizations and different regional and national agencies who are familiar with the local agricultural systems and livelihoods in MIMAROPA. The list of experts is attached as Annex 1.

The step-by-step process in conducting the face-to-face validation workshop is shown in Figure 3.

Figure 3. Step-by-step process of the livelihood zones validation



1 **Review of workshop instruments and data inputs**

The team reviewed available datasets and identified relevant materials that are useful for the conduct of a face-to-face workshop such as printed/interactive maps, questionnaires, and other presentation materials. Data inputs such as the LHZ data and the climate-related hazard maps (typhoon, drought, flood, saltwater intrusion, sea level rise, storm surge) were consolidated accordingly.

2 **Preparation of the livelihood zones datasets (shapefile and excel file)**

Considering that not all the participants were familiar with using GIS format (i.e., shapefiles, KML), the team reviewed the data inputs and transformed these into more user-friendly forms. All the LHZ data were presented as image maps while the corresponding spatial attributes were converted into Excel files. This allowed the participants to freely revise the data as needed using an interactive map uploaded on the AMIA-CIAT[6] website.

[6] AMIA (Adaptation and Mitigation Initiative in Agriculture) was a project of CIAT in partnership with the Department of Agriculture.

3 Conduct of the workshop

The workshop was participated by representatives from nine (9) agencies at the national and regional level (Figure 4). These agencies include:

- Department of Agriculture Regional Field Office MIMAROPA
- Department of Tourism MIMAROPA
- Department of Interior and Local Government MIMAROPA
- Department of Trade and Industry MIMAROPA
- Department of Human Settlements and Urban Development MIMAROPA
- Environmental, Land Use and Urban Planning, and Development Bureau
- Manila Observatory - Geomatics for Environment and Development Laboratory
- Climate Change Office-Climate Change Commission
- Global Green Growth Institute Philippines

Figure 4. The participants during the Regional CCFSA Validation Workshop

During the workshop, classification of the identified zones was further refined and validated. As mentioned earlier, a zone was determined based on the extent of the area that it occupies in a city/municipality which was classified as either a major or secondary/tertiary/quaternary livelihood. However, since data on the extent of the area of the identified other zones were lacking, the term **Secondary/Tertiary livelihood** was used to capture activities, aside from the major livelihood, that also exist in the city/municipality. These zones pertain to the activities that provide alternative resources and work opportunities in a city/municipality, following the concept of "alternative livelihood" by Wright et. al. (2015). It is recommended, however, that these "secondary/tertiary livelihoods" be further ranked based on their area, once data is already available.

On the other hand, livestock, mining, and tourism activities were termed as **Complementary Activities** since these are just point data which do not have numerical values, thus, cannot be computed and classified. CCFSA defines the term "complementary activities" as economic activities that provide an added value to a livelihood zone without altering the original use of the land.

Aside from the validation of the LHZs, the workshop participants also validated the occurrence and level or degree of the impact (ranging from "Very Low" to "Very High") of the six (6) climate-related hazards. The validation was based on the hazard maps being used by the Department of Agriculture Regional Field Office MIMAROPA (DA-RFO) and the Comprehensive Land Use Plan (CLUP) developed by the Department of Human Settlements and Urban Development (DHSUD).

4 Consolidation and processing of results

All of the validated data were consolidated into a Masterfile. These data were further cleaned and filtered to check for consistency and to remove any duplication. After standardizing, the Masterfile was transformed back into a shapefile format. The shapefiles were then used to update the current LHZ geospatial database of MIMAROPA.

3. Results

3.1. Analysis of the Initial Livelihood Zones

The LHZ database of MIMAROPA had a total of 73 records corresponding to the one (1) component city, one (1) highly urbanized city and 71 municipalities in the region. MIMAROPA initially had eight (8) major LHZs, namely: **Annual Crops Zone**, **Aquaculture/Freshwater Fisheries Zone**, **Built-up Areas Zone**, **Cool Environment Zone, Irrigated Rice Zone**, **Perennial Crop Zone**, and **Rainfed Rice Zone.**

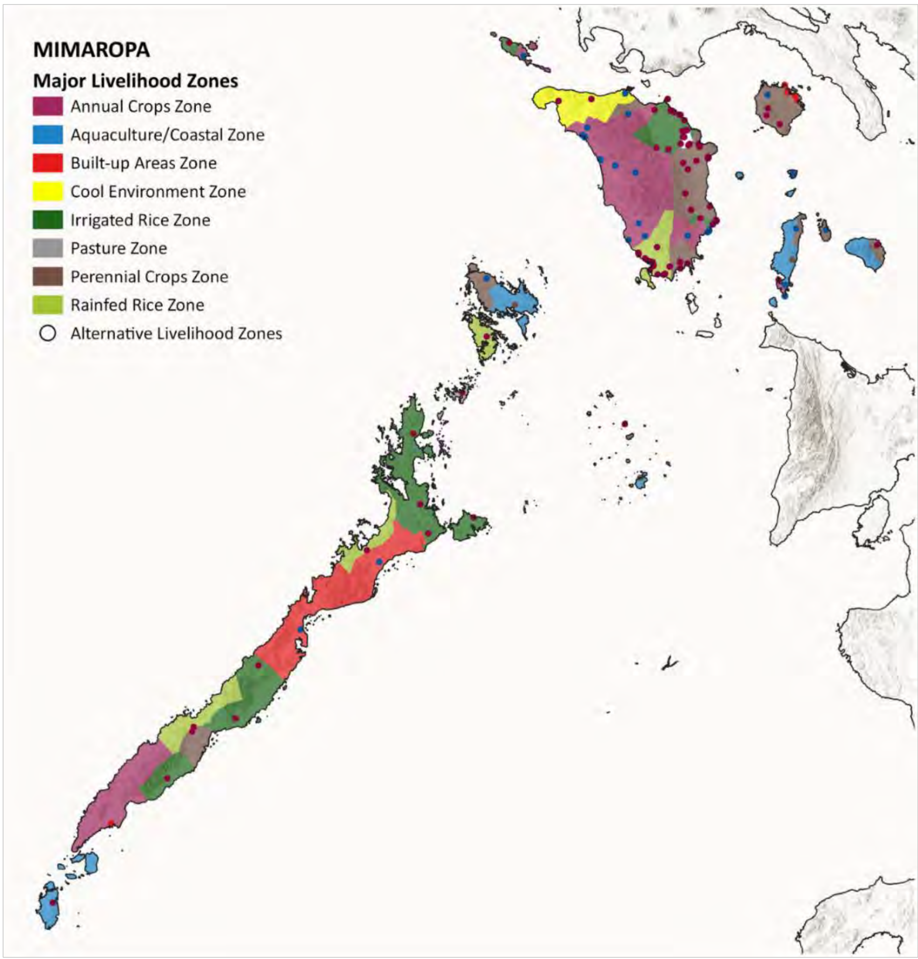
3.2. Validation Workshop Findings

3.2.1. Major LHZs in MIMAROPA

The validated LHZ map of MIMAROPA is presented in Figure 5 showing the eight (8) major LHZs in the region.

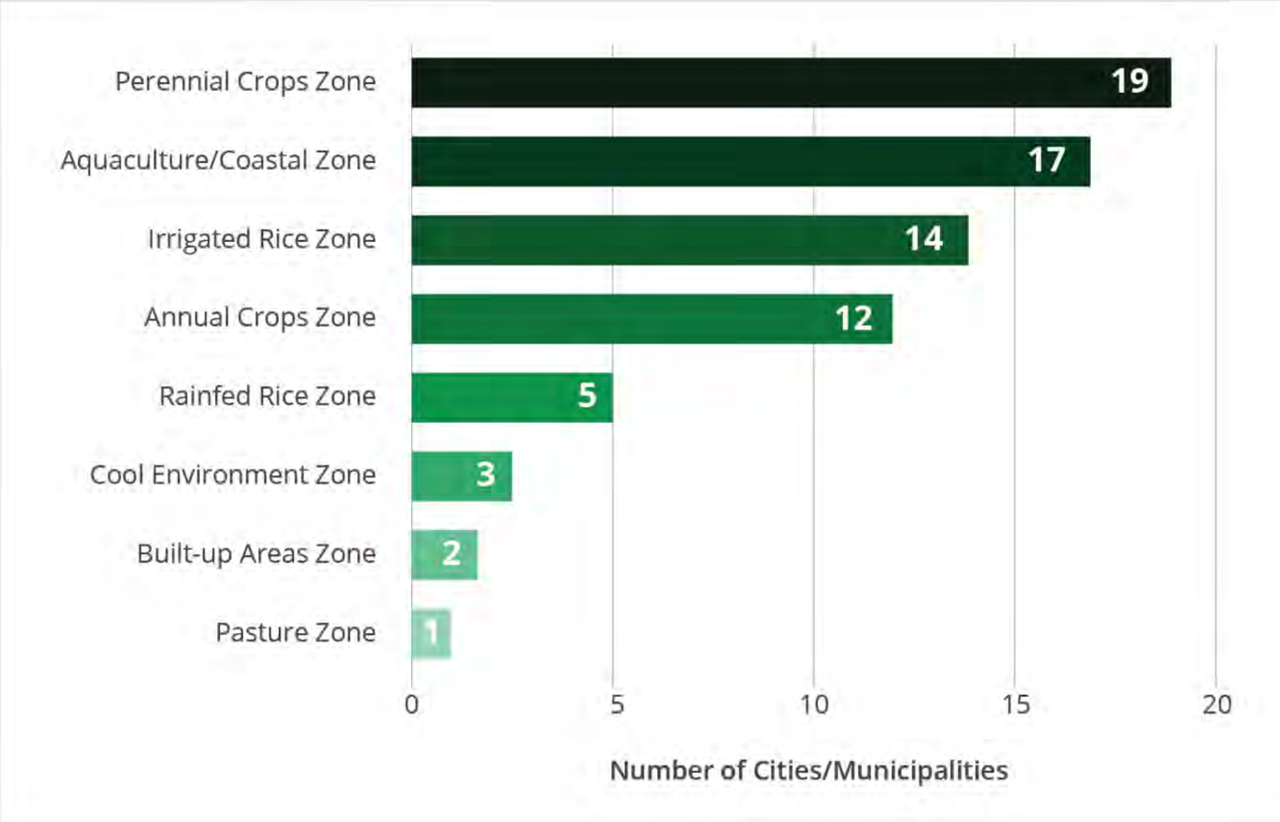
After the validation workshop, the Aquaculture/Freshwater Fisheries LHZ was changed to Aquaculture/Coastal Fisheries Zone which now comprises 17 municipalities. Furthermore, the Built-up Areas LHZ in MIMAROPA was reduced from seven (7) areas to two (2).

Figure 5. Validated LHZs in MIMAROPA



Results of the validation workshop revealed that majority of the livelihoods in MIMAROPA are still agriculture-based (Figure 6). A total of 51 municipalities or 71% were found to be highly dependent on agriculture, specifically on perennial crops (19), irrigated rice (14), annual crops (12), rainfed rice (5), and one (1) under cool environment characterized as annual crops.

Figure 6. Major LHZs in MIMAROPA



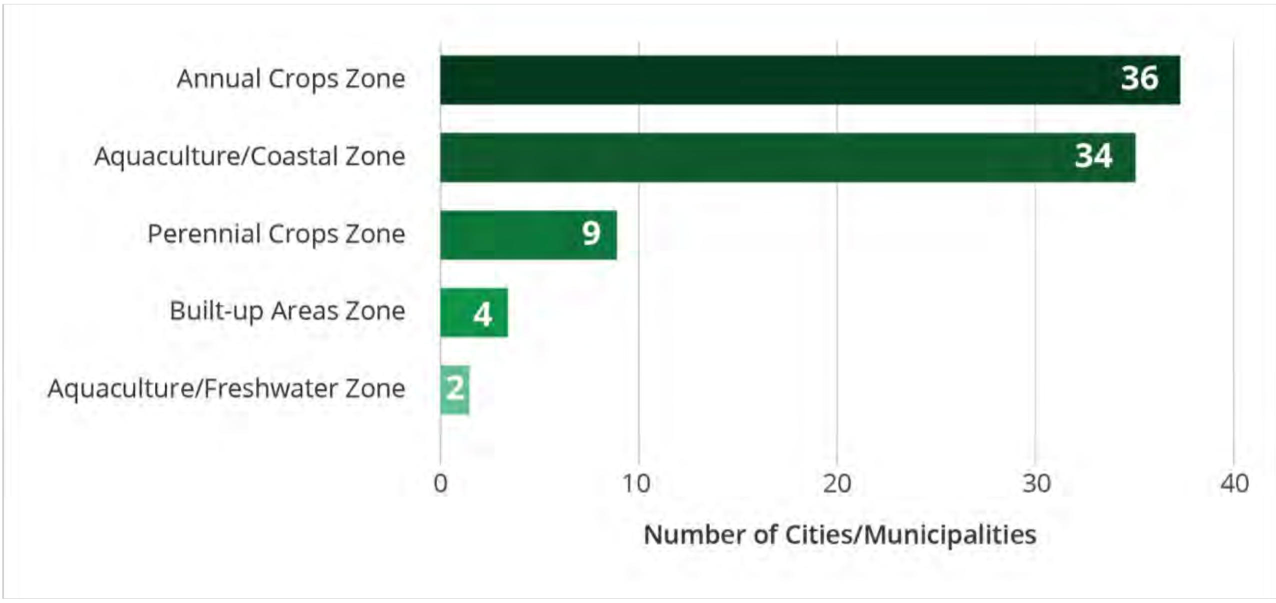
On the other hand, the validated Aquaculture/Coastal Fisheries LHZs in 17 municipalities form the second most dominant major LHZ in the region.

Moreover, the first-class municipality of Roxas and the highly urbanized city of Puerto Princesa in Palawan were classified under the Built-up Areas LHZ. Lastly, one (1) municipality was classified under Pasture LHZ (Linapacan in Palawan).

3.2.2. Secondary/Tertiary LHZs in MIMAROPA

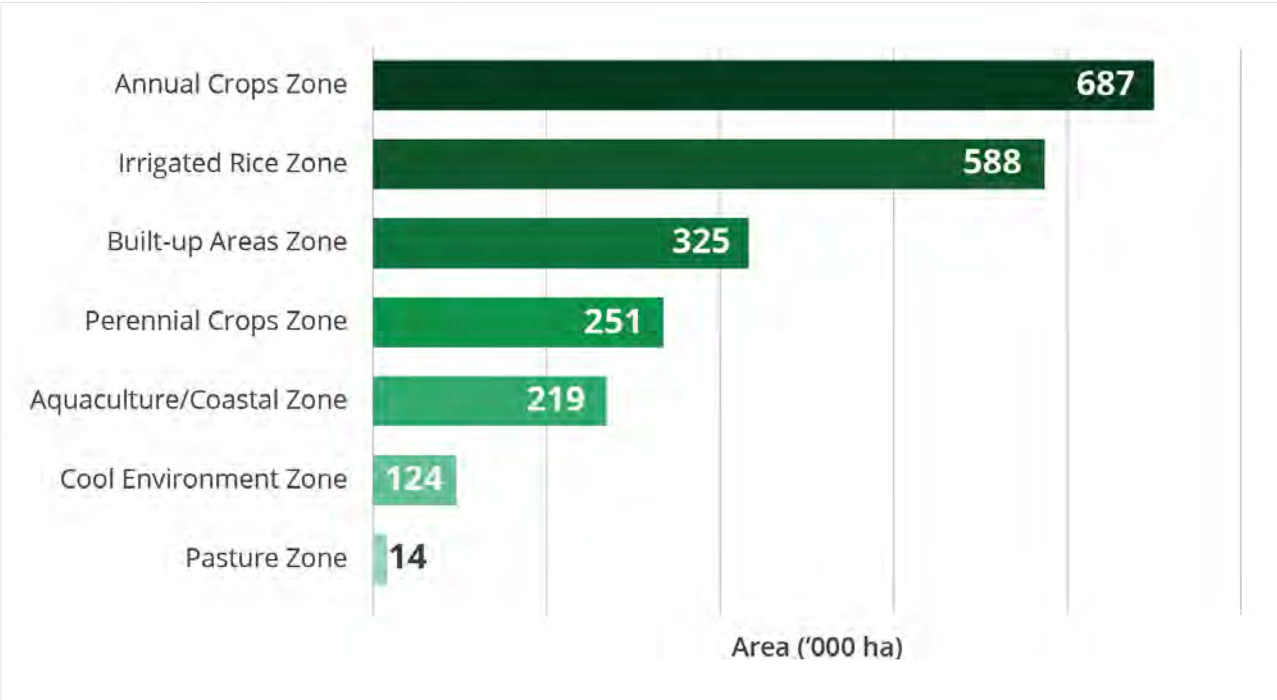
The workshop findings also showed that vegetable farming (annual crops) was the most dominant Secondary/Tertiary Livelihood in the region as it is practiced in one (1) city and 35 municipalities. It was followed by aquaculture/coastal fisheries in 34 municipalities, and perennial crops in nine (9) municipalities (Figure 7).

Figure 7. Type and number of Secondary/Tertiary LHZs in MIMAROPA



In terms of land area, annual crops occupied the largest size with approximately 687,000 ha. which constitutes 29.60% of the total land area of MIMAROPA. It was followed by irrigated rice and annual crops with approximate land areas of 588,000 ha. (27%) and 325,000 ha. (15%), respectively (Figure 8).

Figure 8. Land area occupied by the major LHZs in MIMAROPA



The city of Calapan (Irrigated Rice LHZ), and municipalities of Naujan (Irrigated Rice LHZ) and Pinamalayan (Perennial Crop LHZ) in Oriental Mindoro had the most diverse composition of Secondary/Tertiary livelihoods (Annex 2). The Secondary/Tertiary livelihoods in the city of Calapan includes aquaculture/coastal fisheries, annual crops, and built-up areas zones. On the other hand, Secondary/Tertiary livelihoods in the municipalities of Naujan and Pinamalayan (Oriental Mindoro) include aquaculture/coastal fisheries, aquaculture/freshwater fisheries, and annual crops.

Moreover, the component city of Calapan (Oriental Mindoro), and the three first-class municipalities of Puerto Galera (Oriental Mindoro), Bataraza (Palawan), and Santa Cruz (Marinduque) have identified Built-up Areas LHZ as their secondary/tertiary livelihood.

3.2.3. Complementary Activities in MIMAROPA

Tourism emerged as the most common complementary activity in MIMAROPA with 55 municipalities covered, followed by livestock and poultry in 29 municipalities, and mining in ten municipalities (Annex 2). Conversely, 11 municipalities in the region do not have complementary activities in their livelihoods.

3.3. Susceptibility to Climate-Related Hazards

Several longitudinal studies have identified significant changes in temperature and in rainfall patterns across the country from the 1950s to 1990s. A study from the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) revealed that observed temperature in the Philippines over the past 65 years (1951 – 2015) is warming at an average rate of 0.1 °C/decade. Moreover, evidence showed that the intensity and frequency of rainfall events in most parts in the Philippines are increasing which result to higher rainfall volumes in more recent decades (Thomas et al., 2012; Pajuelas, 2000). Additionally, future projections also indicate that seasonal rainfall volumes will exceed historical averages by approximately 40% across the Philippines, however with some decreases over central sections of Mindanao (CCC, n.d.).

The aforementioned data supports the result of the validation workshop which revealed that flood and drought are the climate hazards which have the greatest impact on the region. To illustrate the impact of these climate hazards, a Flood Susceptibility Index (FSI) and a Drought Susceptibility Index (DSI) were developed using the Spatial Overlay operation in GIS. The FSI and DSI were derived by computing the aggregated areas within the municipality with medium to very high flood and drought risk over the total land area per municipality. FSI value of 0 indicates no flooding, while the value of 1 indicates total submergence of the geographic unit in the event of flooding. On the other hand, DSI value of 0 indicates abnormally dry condition defined as lingering water deficits and short-term dryness slowing plant growth, while the value of 1 indicates extreme drought with no rainfall on the scale of one to three months which may result to crop losses.

The derived FSI and DSI value of 0 to 1 were further categorized into five classes: Very Low (0.0 – 0.2), Low (0.2 – 0.4), Moderate (0.4 – 0.6), High (0.6 – 0.8), and Very High (0.8 – 1.0). The categories were developed to easily compare the degree of hazards experienced by one municipality versus the other municipalities.

Flood risk of municipalities/cities in the region ranges from "Very Low" to "Moderate". Majority of the areas are considered as "Very Low" while the municipalities with "low" to "moderate" FSI are the following:

FLOOD (LOW RISK)		
Province	**City/Municipality**	**Livelihood Zone**
Palawan	Araceli	Irrigated Rice LHZ
Occidental Mindoro	Rizal, San Jose	Annual Crops LHZ
	Magsaysay	Rainfed Rice LHZ
Oriental Mindoro	Naujan	Irrigated Rice LHZ
	Roxas	Built-up Area LHZ

FLOOD (MODERATE RISK)		
Province	**City/Municipality**	**Livelihood Zone**
Palawan	Balabac	Aquaculture/Coastal LHZ
Oriental Mindoro	City of Calapan	Irrigated Rice LHZ

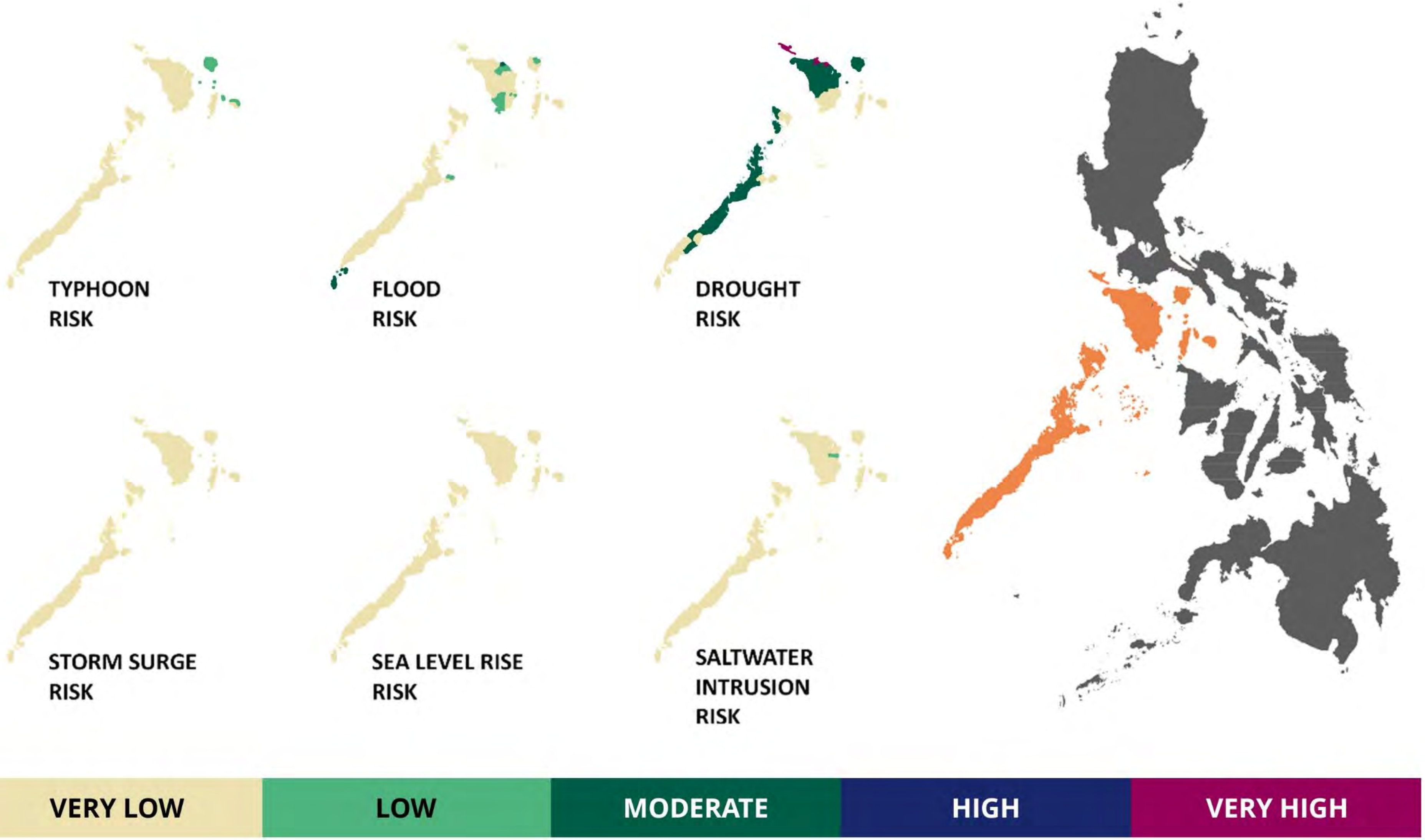
Furthermore, MIMAROPA's risk to drought was revealed to be "Low" to "High". Among the areas with "moderate" to "high" DSI are:

DROUGHT (MODERATE RISK)		
Province	**City/Municipality**	**Livelihood Zone**
Marinduque	Boac, Buenavista, Gesan, Santa Cruz, Torrijos, and Mogpog	Perennial Crops LHZ
Occidental Mindoro	Calintan, Mamburao, Sablayan, Santa Cruz	Annual Crops LHZ
	Abra de Ilog, Paluan	Cool Environment LHZ
Oriental Mindoro	Baco	Annual Crops LHZ
	Naujan, Victoria	Irrigated Rice LHZ
	Bansud, Gloria, Pinamalayan, Pola, and Socorro	Perennial Crops LHZ
Palawan	Quezon, San Vicente, Culion	Rainfed Rice LHZ
	Aborlan, Brooke's Point, El Nido, Narra, Taytay	Irrigated Rice LHZ
	Puerto Princesa City, Toxa	Built-up Areas LHZ
	Busuanga	Perennial Crops LHZ

	Linapacan	Pasture LHZ
Romblon	Concepcion	Aquaculture/Coastal LHZ

DROUGHT (HIGH RISK)		
Province	**City/Municipality**	**Livelihood Zone**
Palawan	Cagayancillo	Aquaculture/Coastal LHZ
Occidental Mindoro	Looc	Annual Crops LHZ
	Lubang	Irrigated Rice LHZ
Oriental Mindoro	Calapan City	Irrigated Rice LHZ
	San Teodoro	Perennial Crops LHZ

Figure 9. Validated climate-related hazard maps of MIMAROPA



3.4. Projected Impacts of Climate-Related Hazards on Livelihoods

Agricultural production in the Philippines is projected to be significantly affected by climate change. Consistent to the projected increase in temperature and annual rainfall (mm) using the RCP 8.5 scenario, results of the future crop suitability showed that majority of the areas in MIMAROPA will be unfavorable for growing crops by the year 2050. Several areas, as shown in Figures 10 and 11, will experience increase[7] in temperature greater than 30ºC, and amount of rainfall (mm) greater than 5% by the years 2030 and 2050.

Exposure to temperature extremes has effects on plant growth and development and has a major impact on vegetative and reproductive stages of crops (Hatfield and Prueger, 2015). Moreover, studies show that proliferation of pests and diseases is highly correlated with hotter temperatures of 26°C or higher.

In terms of increase in the amount of rainfall (mm), PAGASA data shows that an increase of 5% in the annual rainfall by year 2050 is roughly equivalent to 48.9 mm or an additional 10 days or more in the number of rainy days in Mindanao. This has a significant impact on crop production because of its effects on soil structure. Water logging and flooding as caused by heavy rainfall may result to soil erosion which can wash away the topsoil along with important soil nutrients. This affects crop suitability which can potentially decrease crop production and yield.

3.4.1. Projected Impacts on LHZs in MIMAROPA

As seen in Figure 10, most of the LHZs in MIMAROPA will experience the projected increase in rainfall (mm) and temperature by 2050. In terms of the increase in rainfall, all the municipalities are projected to be affected. On the other hand, 42 municipalities or around 58% of MIMAROPA will experience an increase in temperature by 2050 (Table 5).

Table 5. Areas in MIMAROPA with a projected increase in temperature (>5°C) by 2050

Romblon	Banton, Santa Fe	Annual Crops Zone
	Alcantara, Calatrava, Concepcion, Corcuera, Ferrol, Looc, Odiongan, San Andres, San Jose, Santa Maria	Aquaculture/Coastal Zone
	Romblon, San Agustin	Perennial Crops Zone
Palawan	Balabac, Cagayancillo, Coron, Cuyo, Magsaysay	Aquaculture/Coastal Zone
	Agutaya, Araceli, Dumaran, El Nido, Taytay	Irrigated Rice Zone
	Linapacan	Pasture Zone
	Busuanga	Perennial Crops Zone

[7] The increase in temperature and annual rainfall were calculated from the baseline historical climate data downloaded from the WorldClim and future climate data from CMIP5 Global Climate Models (GCMs) downloaded from CCAFS.

	Culion, San Vicente	Rainfed Rice Zone
Oriental Mindoro	City of Calapan, Roxas, Victoria	Irrigated Rice Zone
	Bulalacao, Pola, Socorro	Perennial Crops Zone
Occidental Mindoro	Looc, Rizal	Annual Crops Zone
	Lubang	Irrigated Rice Zone
	Magsaysay	Rainfed Rice Zone
Marinduque	Boac, Gasan, Mogpog, Santa Cruz	Perennial Crops Zone

The most recent data from the Philippine Rice Information System (PRISM) shows the peak of planting rice in MIMAROPA (Figure 12) based on the area planted in 2022-2023. Most areas in the region plant rice from the months of October to March wherein December is the peak of planting during the first semester. No data on the rice cropping calendar during the second semester is available. Understanding the sensitivity of rice to flood and drought stress and knowing when the crop is planted can help in understanding the impacts of these stressors in the expected yield which is crucial in ensuring food security.

Based on PAGASA, MIMAROPA belongs to Type 1 and Type 3 climate type. Type 1 climate dominates Occidental Mindoro and western portion of Palawan wherein it has two pronounced seasons, dry from November to April and wet during the rest of the year. On the other hand, Type 3 climate is present in Oriental Mindoro, Marinduque, and Romblon wherein season is not very pronounced, dry from November to April and wet during the rest of the year. Knowing the current seasonality of rice and the climate type in the region that can trigger flood or drought can help policymakers and local government units in strategizing solutions that can protect the livelihoods that mostly depend on rice.

Among these 42 municipalities, 14 each are from Romblon and Palawan, four (4) each are from Occidental Mindoro and Marinduque, and six (6) are from Oriental Mindoro. In terms of the LHZs, the areas to be affected include: Annual Crops LHZs within four (4) municipalities, Aquaculture/Coastal LHZs in 15 municipalities, Perennial Crops LHZs in 10 municipalities, Irrigated Rice LHZs in eight (8) municipalities and one (1) city, Rainfed Rice LHZs in three municipalities, and one Pasture LHZ in one (1) municipality. Consequently, these areas are exposed to greater climate risks since it will experience both increases in rainfall (mm) and temperature by 2050.

Figure 10. LHZs in MIMAROPA that are affected by the increase in annual rainfall (> 5%) and temperature (> 30ºC) by 2050

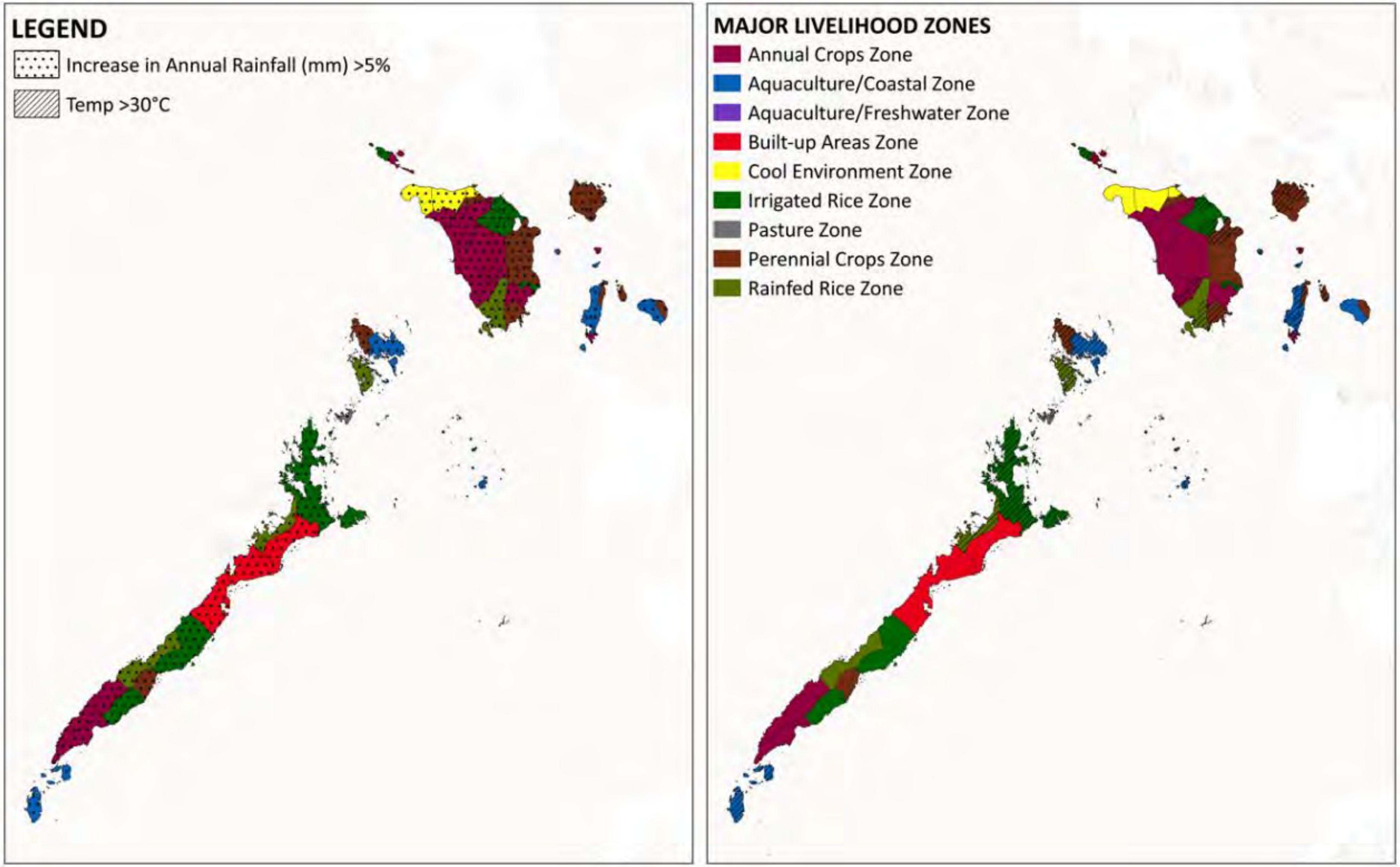


Figure 11. LHZs in MIMAROPA that are affected by both projected increase in temperature and annual rainfall (mm) by 2050

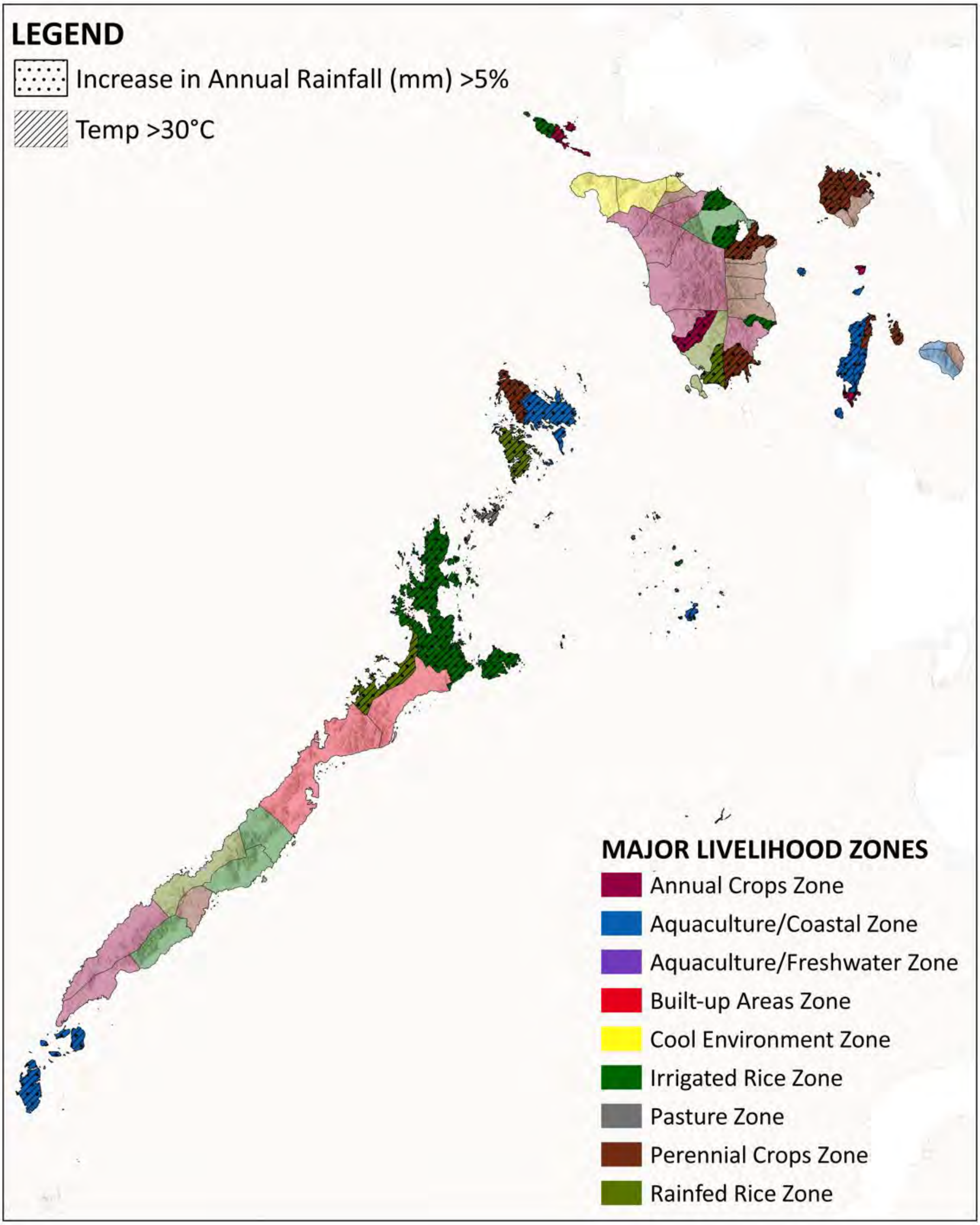
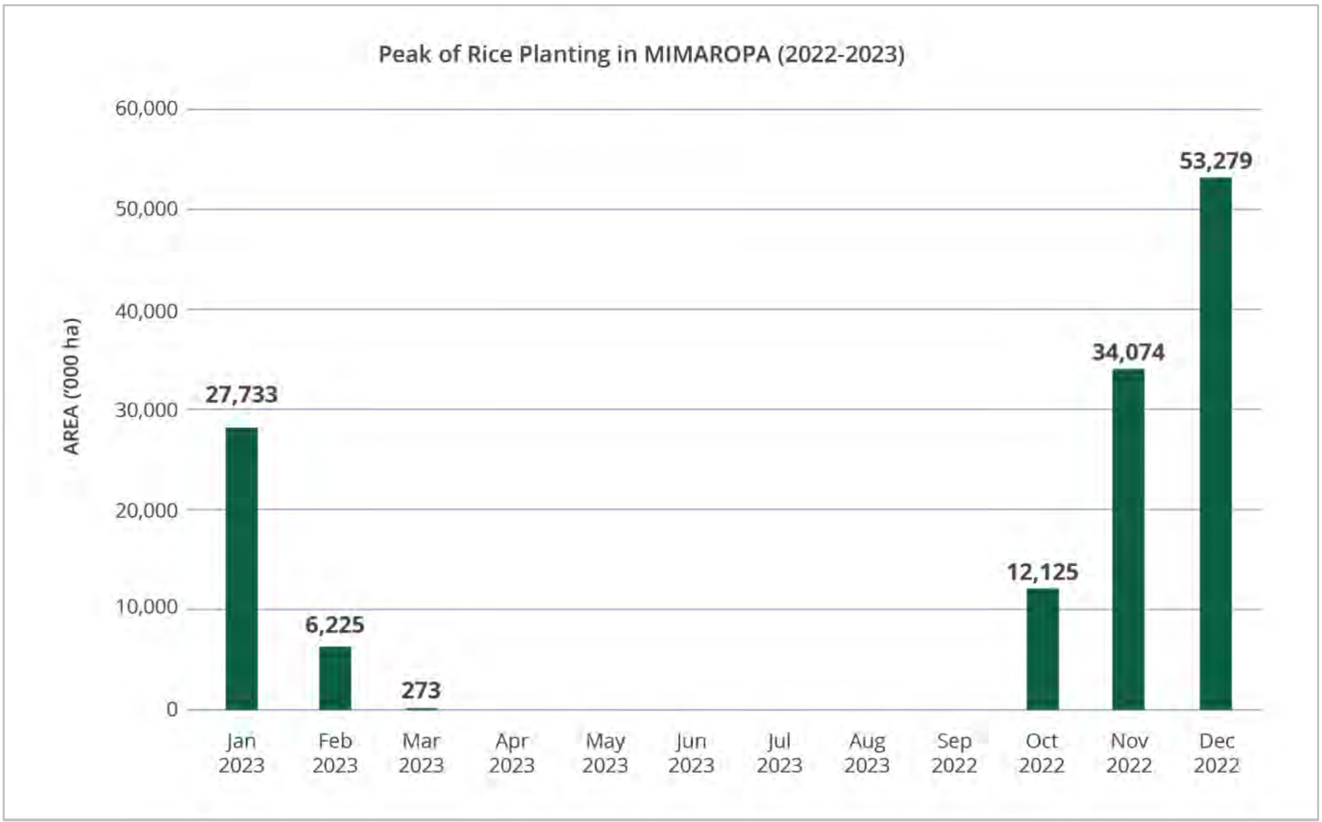


Figure 12. Data from the Philippine Rice Information System (PRISM) showing the peak of planting for rice in MIMAROPA based on the total area planted in 2022-2023



3.4.2. Projected Impacts on Crops

3.4.2.1 Projected Impacts on Crop Suitability

To assess the potential impacts of climate change on the productivity of key crops in MIMAROPA, outputs of the crop suitability modeling were used to understand the geospatial components of crop production, while the results of the validation served as bases to contextualize the analysis through the lens of the LHZs.

For this study, rice, maize, and banana were included in the analysis being the top priority crops in the region and because of availability of data. These crops represent the Irrigated/Rainfed Rice, Annual Crops and Perennial Crops LHZs, respectively.

Using the prioritized crops, models were developed following the RCP 8.5 scenario, which is more closely related to our current trajectory, with inadequate mitigation measures implemented by the years 2030 and 2050. The locations of rice, maize, and banana production areas were mapped over the selected future scenarios to determine how crop suitability will likely be affected by climate change.

For rice, the resulting model (Figure 12) showed that in the years 2030 and 2050, future climate scenarios will provide environments that are generally less conducive for rice growth in the major rice production areas in MIMAROPA. By 2030, Rainfed Rice LHZs within the municipalities of Culion (Palawan); and Magsaysay, and San Jose (Occidental Mindoro), as well as the Irrigated Rice LHZs within the municipalities/city of: Dumara, El Nido, Taytay, and Araceli (Palawan); Calapan City, Roxas, Victoria, and Naujan (Oriental Mindoro); and Lubang (Occidental Mindoro) will have “low decrease” in rice suitability. By 2050, all these areas will remain to have “low decrease” in rice suitability, with the addition of the municipalities of Agutaya, San Vicente, and Quezon in Palawan.

For maize, changes in suitability in Annual Crops LHZ in the region will be less dramatic than rice. There will be no change in maize suitability by 2030 as seen in Figure 13. However, by 2050, “low decrease” will be experienced in the municipalities of Looc, Rizal, and Calintaan (Occidental Mindoro); Bataraza (Palawan); and Banton and Santa Fe (Romblon).

For banana and other perennial crops (Figure 14), the resulting suitability in the years 2030 and 2050 also show less favorable conditions. By 2030, seventeen out of the 19 municipalities under the Perennial Crops LHZs will experience “low decrease” in suitability for growing perennial crops such as banana. Only the municipalities of Bansud and San Teodoro will have “no change”, however, the municipality of Bansud will experience “low decrease” in banana suitability by the year 2050.

Rice farming is one of the major livelihoods in MIMAROPA, making the region one of the top producers of rice in the country. © WFP/Juanito Berja

Figure 13. Sensitivity of major rice production areas in MIMAROPA to climate change impacts based on RCP 8.5 Scenario

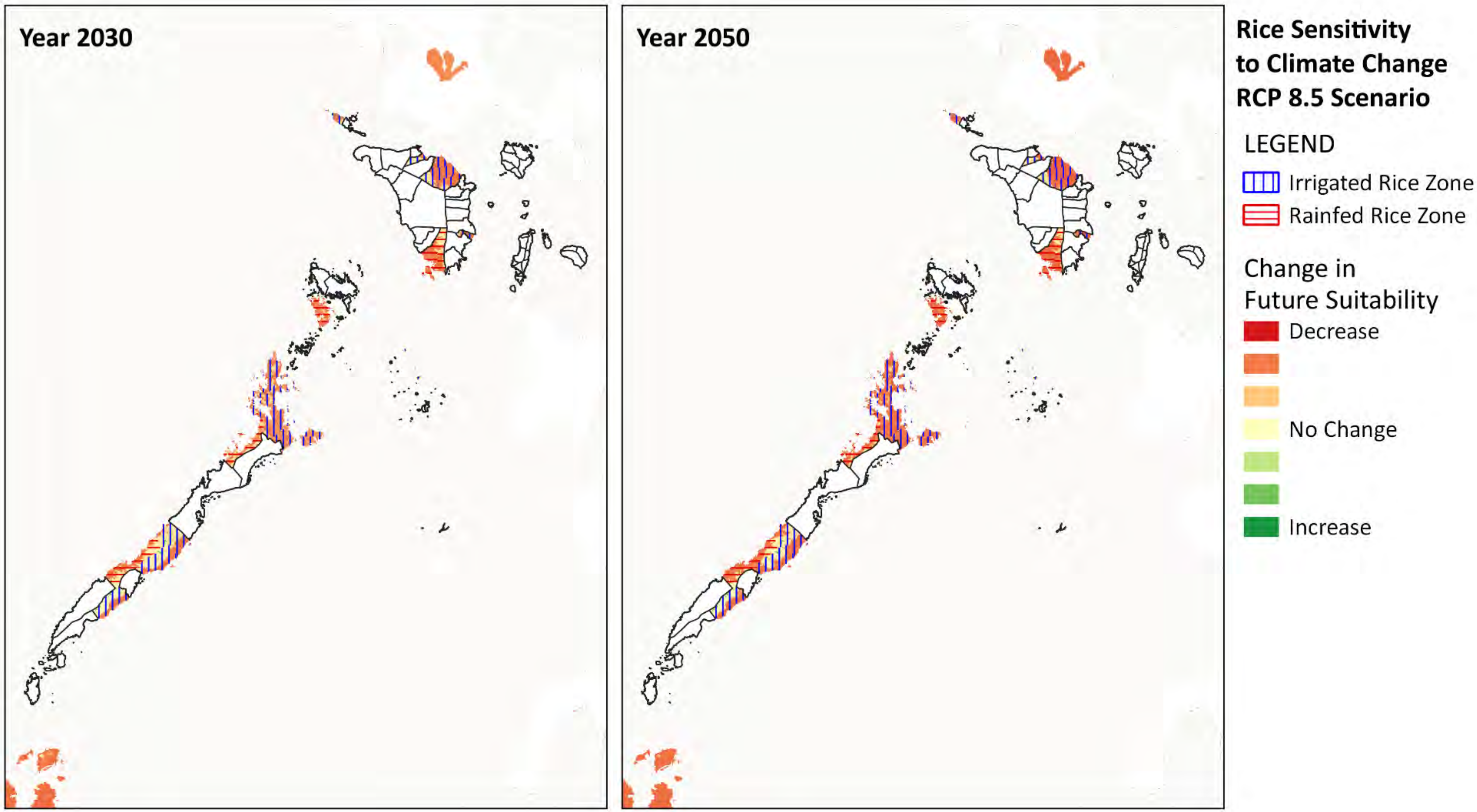


Figure 14. Sensitivity of major maize production areas in MIMAROPA to climate change impacts based on RCP 8.5 Scenario

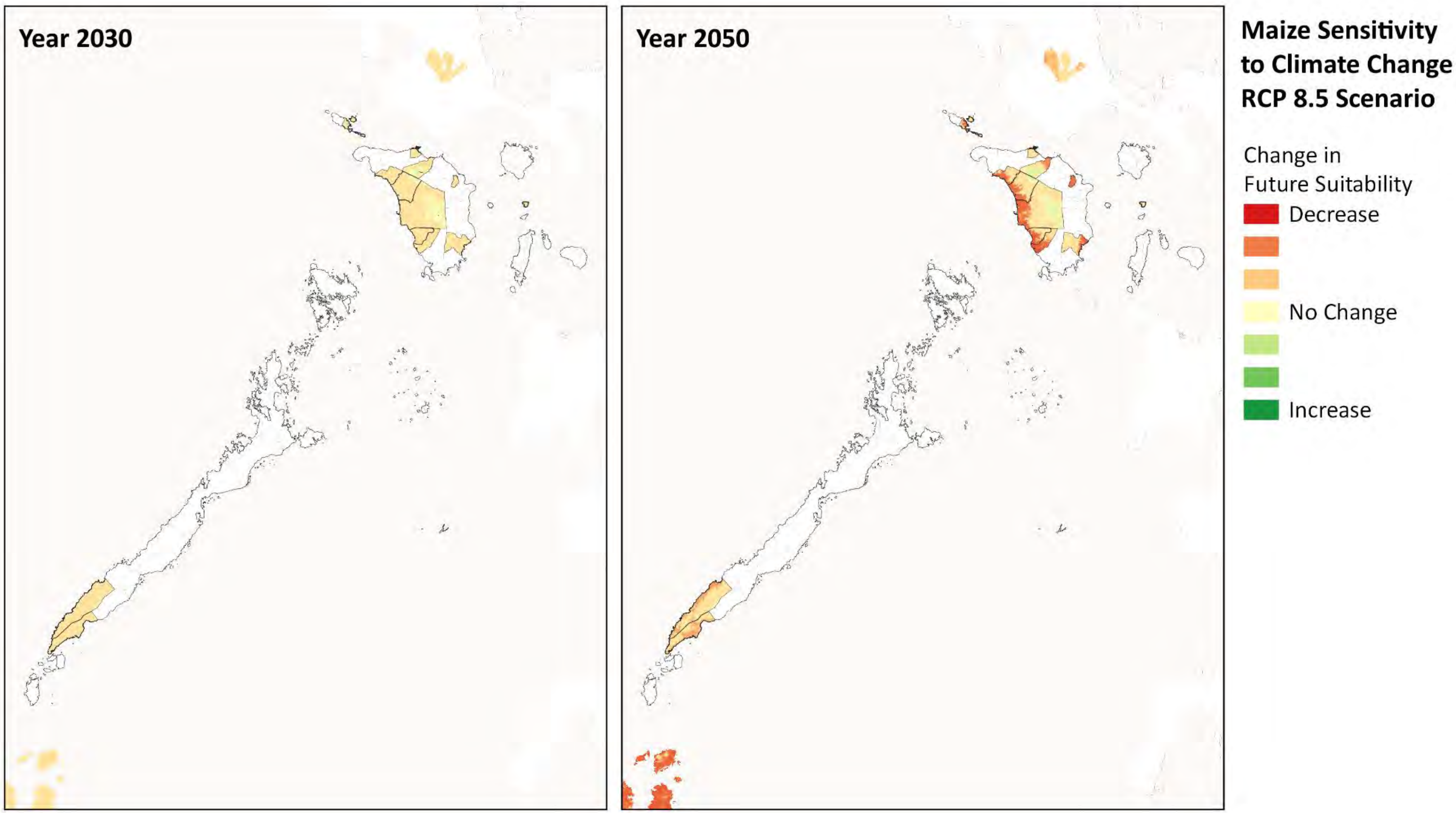
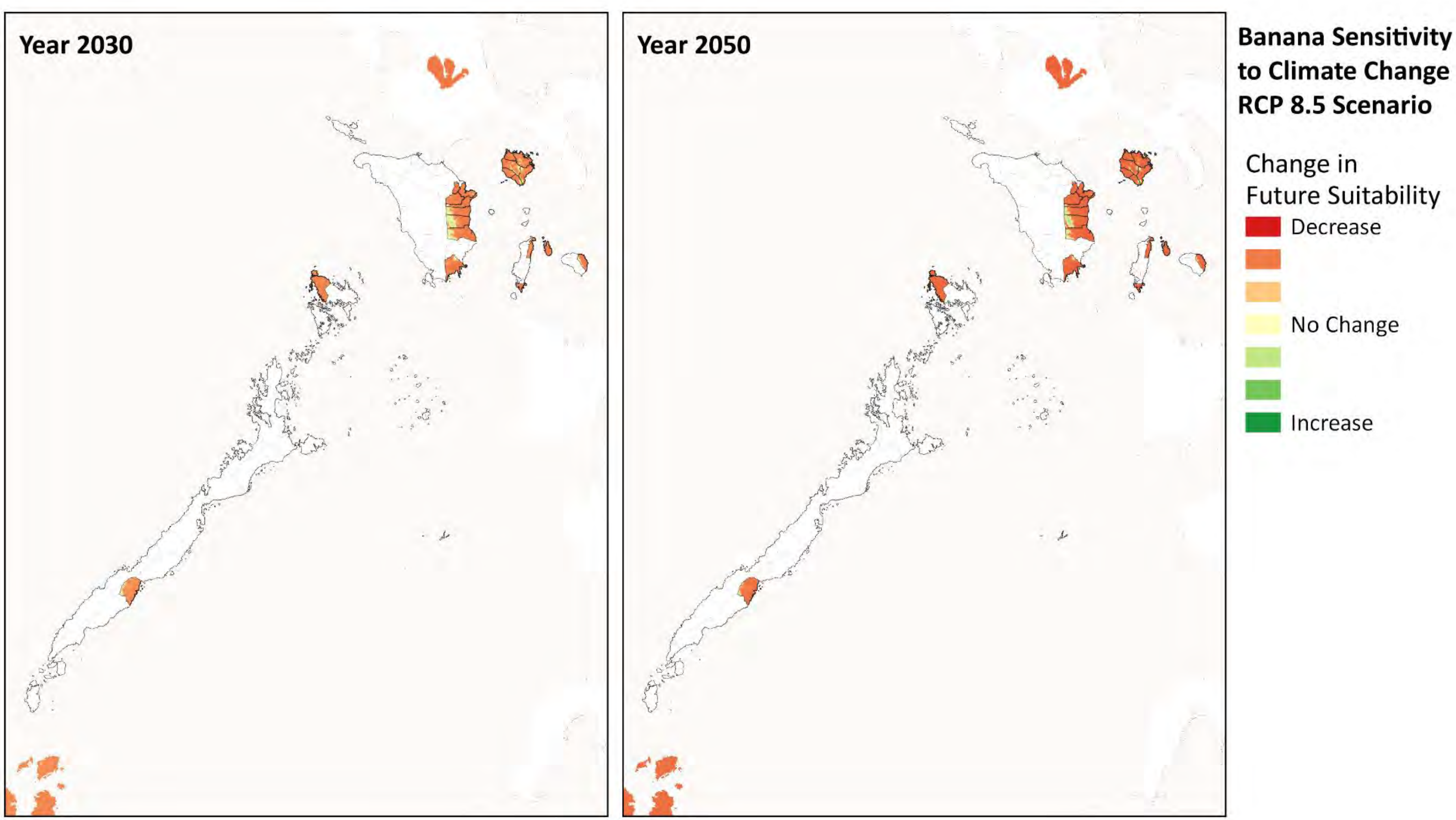


Figure 15. Sensitivity of major banana production areas in MIMAROPA to climate change impacts based on RCP 8.5 Scenario



3.4.2.2. Projected Exposure to Pest and Diseases

Future climate conditions are also expected to lead to an opportune environment for the proliferation of pests and diseases. This is mainly driven by the changing temperature and rainfall patterns caused by climate change (Doody, 2020). According to FAO (2021), the dispersal and intensity of climate change-induced pests and diseases may result in crop failure, decreasing yield and ultimately, threatening food security. Additionally, such conditions increase the demand for pesticides and other pest and disease controls, adding up to the already high cost of agricultural production.

Rice

The increase in temperature and rainfall induces the proliferation of several rice diseases such as rice sheath blight and bacterial sheath blight. Studies analyzing the correlation among meteorological parameters and disease incidence find that sheath blight incidence and severity are highly governed by temperature, with disease establishment and spread favoring air temperatures in the range of 26°C to 34 °C (Kaur et al., 2015). Based on the results presented in section 3.4.1, Irrigated Rice LHZs within the municipalities/city of: Agutaya, Araceli, Dumaran, El Nido, and Taytay (Palawan); City of Calapan, Roxas, and Victoria (Oriental Mindoro); and Lubang (Occidental Mindoro), as well as Rainfed Rice LHZs within the municipalities of: Culion, and San Vicente (Palawan), and Magsaysay (Occidental Mindoro), which will experience increase in temperature, are also likely to have high incidence of the disease by 2050.

Maize

On the other hand, mycotoxins, northern corn leaf blight, and southern corn leaf blight were considered as the most threatening diseases for maize.

According to the study of Salvacion et.al. (2015), there were changes associated with climate change noted on the mycotoxin risk of maize production areas in the Philippines. Warm and humid conditions (25°C to 42°C) are particularly favorable to the growth of Fusarium mycotoxins and southern corn leaf blight in maize. Given the increase in temperature by 2050 (RCP 8.5), maize-growing areas in the Philippines would potentially be at high risk of this disease, including the Annual Crops LHZs within the municipalities of: Banton, and Santa Fe (Romblon); and Looc, and Rizal (Occidental Mindoro) as shown in Figure 10.

Consequently, the proliferation of pests and diseases may also result to appreciable yield losses, lowering income among farmers who cultivate maize as their main or complementary crop. Furthermore, studies have shown that mycotoxins can also affect the health of humans and animals that consume maize and maize-based feeds through acute toxicosis, immune suppression, and several other effects.

Both northern and southern corn leaf blight are fungal infections that initially cause leaves to turn a grayish green to tan color and later produce dark gray or black fungus, which can decrease yield by at least 30%. Under highly humid conditions, the fungus will produce new spores at the leaf surface, which are then spread by rain or wind to create secondary infections. Northern corn leaf blight can be found in regions that are relatively wetter and cooler throughout the year. In the context of LHZs, since all the 12 municipalities under the Annual Crops LHZ are projected to have more than 5% increase in the annual rainfall (mm) by 2050, these areas may also experience widespread of the said diseases in the future.

Banana

Among the key diseases that are expected to challenge banana cultivation in Perennial Crop LHZs in MIMAROPA under changing climate scenarios, are Fusarium Wilt and Black Sigatoka.

In the Philippines, increased precipitation during the warmest season is predicted to increase fungal activity, including Fusarium wilt, in the coming decades (Salvacion et al., 2019). Moreover, another pathogen that may become increasingly threatening to banana production in the Philippines is black sigatoka, a foliar fungal disease caused by *Pseudocercospora fijiensis* (Busogoro et al., 2004). The climatic characteristics that favor the occurrence of black sigatoka are high relative humidity greater than 90%, significant precipitation, and temperatures from 25°C to 28°C. (Bebber, 2019).

Considering the LHZ map, around 53% of 10 out of the 19 areas in MIMAROPA considered as Perennial Crops LHZs are at-risk of Fusarium Wilt and Black Sigatoka infestation, given the increase in temperature at these areas by 2050. These are the municipalities of: Romblon, and San Agustin (Romblon); Busuanga (Palawan); Bulalacao, Pola, and Socorro (Oriental Mindoro); and Boac, Gasan, Mogpog, and Santa Cruz (Marinduque).

3.4.3. Projected Impacts on Aquaculture

Aquaculture was also identified as a major LHZ in several areas in MIMAROPA. In the LHZ database, aquaculture is classified as either freshwater or coastal. As described in Table 1, the Aquaculture/Freshwater LHZ includes areas with aquaculture sites found in inland water bodies including brackish water, while the Aquaculture/Coastal LHZ refers to the areas practicing marine aquaculture. Same with the other commodity systems, livelihoods related to aquaculture are also expected to be adversely impacted by the projected increase in temperature and annual rainfall (mm). As mentioned previously, climate change, along with the changes in temperature and amount of rainfall, may affect the oceanic systems resulting in induced sea-based hazards. These hazards may directly or indirectly affect the abundance and distribution of fisheries resources and the suitability of some areas dedicated to aquaculture production. The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR 5) provides evidence on the certainty of global


MIMAROPA is composed of island provinces endowed with vast forest and marine resources. © WFP/Juanito Berja

warming leading to climate change and its effects on the oceans, coastal areas, and inland waterbodies (FAO, 2016). The IPCC AR 5 also highlights that evidence exists on the modification and change in distribution of marine and freshwater species. Many marine species are found to migrate to deeper waters which have ideal oxygen levels for their survival, causing a migratory shift and resulting in changes in interaction dynamics among species, trophic linkages, and food web. On the other hand, many freshwater species are likely to experience a change in size, reproductive cycles, and survival rates.

The impacts of climate change to fishery and aquaculture systems may bring both positive and negative effects depending on the location. These impacts can directly affect the livelihood and income of fisherfolk and at the same time, threaten food security since coastal and marine areas are critical sources of fish and fishery products.

Air temperature greater than 30ºC is within the border of the temperature ranges that are optimal for the growth and survival of both marine and freshwater species. As mentioned above, when water temperature gets warmer than usual, marine species tends to migrate to deeper waters which can affect catch rate. On the other hand, negative impacts on freshwater species are mainly felt in the reduction of yield due to the reduction in fish size and lower survival rates.

In terms of rainfall, it was discussed in section 3.3.2 that an approximate increase of 5% in the annual rainfall by year 2050 is roughly equivalent to 48.9 mm or an additional 10 days or more in the number of rainy days in the Philippines. Increase in the number of rainy days may result to flooding which can wash away fish stocks and reduce production in aquaculture sites. Water quality can also be negatively affected due to the pollutants, sediments, and excess nutrients carried by excess rainfall which may lead to oxygen depletion and increased algal blooms.

In MIMAROPA, the aquaculture livelihoods that are projected to experience an increase in temperature and amount of rainfall (mm) by 2050 are the coastal areas in the region (Figure 11). These include 15 municipalities classified under Aquaculture/Coastal Fisheries LHZ located along the coastline provinces, namely: Alcantara, Calatrava, Concepcion, Corcuera, Ferrol, Looc, Odiongan, San Andres, San Jose, and Santa Maria (Romblon); and Balabac, Cagayancillo, Coron, Cuyo, and Magsaysay (Palawan).

3.4.4. Projected Impacts on Livestock

The Department of Agriculture (DA) defines livestock as domesticated animals raised in an agricultural setting to produce labor and commodities such as meat, eggs, milk, fur, leather, and wool. Poultry, on the other hand, refers to the domesticated birds kept by humans for their eggs, meat, or feathers.

During the validation workshop, the experts identified livestock production as the second complementary activity in 29 municipalities or 40% of MIMAROPA. The latest inventory of PSA-MIMAROPA from January – December 2021 shows an estimated total of 5,123,000 heads/birds of livestock and poultry in the region, of which 82% is from poultry and 18% is from livestock. However, in terms of volume of production in metric tons, swine/hog has the highest production with a total of 91,711 MT (Table 6). Records also show that Palawan is consistently among the top three producers per commodity.

Table 6. Livestock and Poultry Statistics in MIMAROPA – PSA 2021

Commodity	Volume of Production in MT	Number of heads/birds	Top Three Provinces
Carabao	5,703	112,000	Palawan Oriental Mindoro Occidental Mindoro
Cattle	10,682	120,000	Palawan Occidental Mindoro Oriental Mindoro
Swine/Hog	91,711	505,000	Palawan Marinduque Oriental Mindoro
Goat	2,097	187,000	Palawan Oriental Mindoro Romblon
Chicken	11,468	3,834,000	Palawan Oriental Mindoro Romblon
Duck	404	365,000	Occidental Mindoro Palawan Oriental Mindoro

Changing climatic conditions such as increases in temperature pose challenges to the livestock and poultry sector, both in terms of animal health and the viability of pasturelands and fodder crops that are used as feeds. The ongoing climatic changes, in temperature and moisture, can have detrimental impacts on livestock's growth and weight, reproductive performance, and susceptibility to pests and diseases.

Direct effects of the changes in microclimatic factors on swine and poultry behavior include increased panting, reduction in voluntary feed intake, and increased water consumption, which could in turn result in depressed growth, lower meat quality, lower immune functions, and lower reproductive performance of both male and female breeders (Lara and Rostagno, 2013).

For example, laying hens' productivity is moderately affected by temperatures that exceed 27°C, while temperatures surpassing 32°C can have a severe impact on both laying capacity and quality, such as shell thickness and breaking strength (Mahmoud et al., 1996; Lin et al., 2006; Kim et al., 2020). With regards to hogs, the thermoneutral zone for rearing and finishing[8] pigs is at a temperature from 21°C to 24°C provided that the relative humidity is 70% or lower (Lass, 2019). For sows (adult female hogs), a temperature not more than 22°C should be maintained (Hörtenhuber et al., 2020) to not negatively affect conception rate. Overall, all animals in a hot environment tend to diminish feed intake to decrease metabolic heat production, resulting in inferior growth performance (Rauw et al., 2020; Secor, 2009).

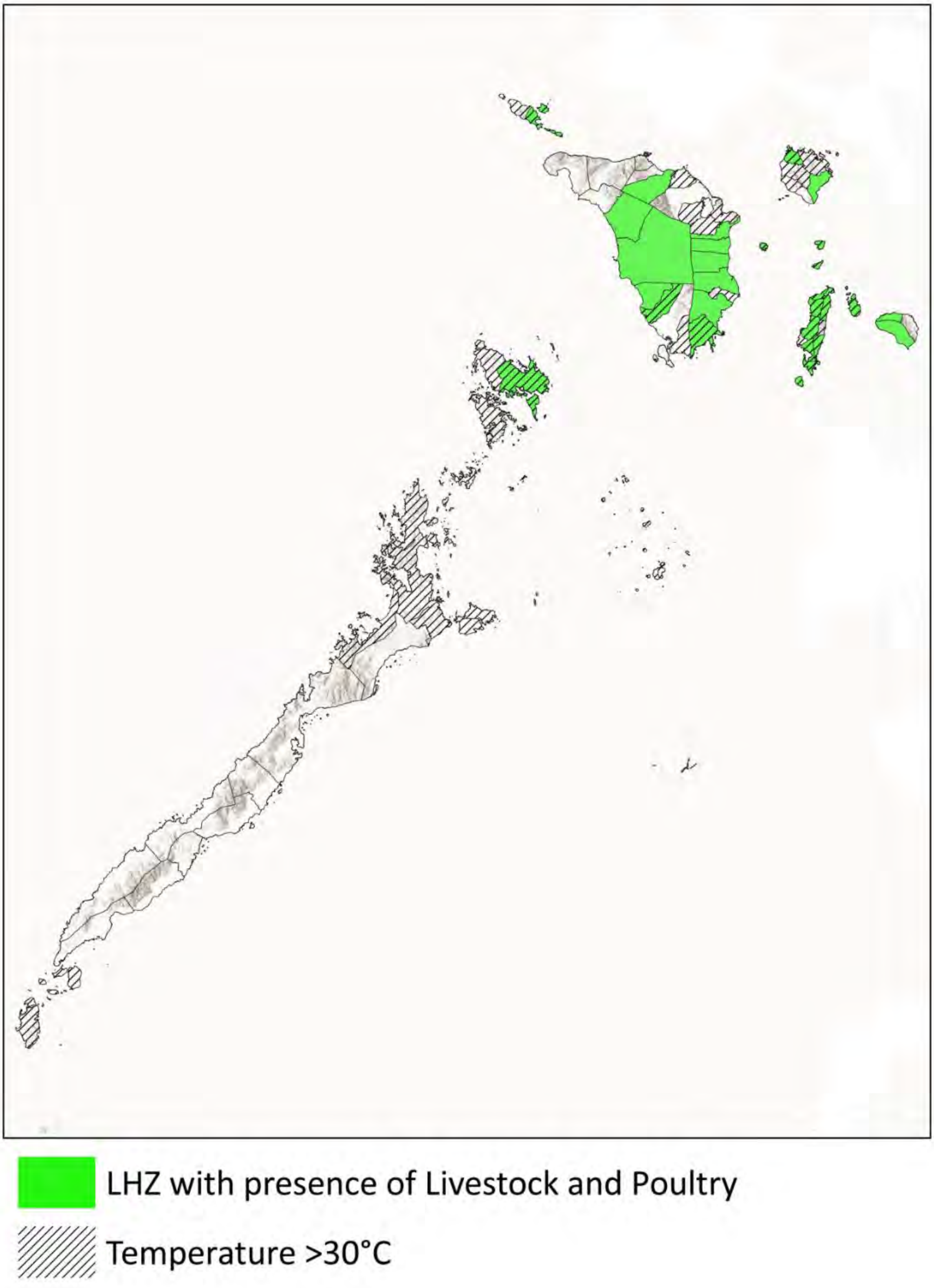
Based on the projected change in temperature by year 2050, among the livestock and poultry areas at-risk are 17 municipalities in the MIMAROPA namely: Coron (Palawan), Looc, Rizal (Occidental Mindoro), Bulalacao (Oriental Mindoro), Mogpog (Marinduque), Banton, Concepcion, Corcuera, Calatrava, San Andres, San Agustin, Odiongan, Looc, Alcantara, Santa Fe, San Jose, and Romblon (Romblon) (Figure 15).

In addition, livestock production in the Philippines is susceptible to extreme weather events, which are expected to increase in frequency and intensity as a result of climate change. For the past decade (2000 to 2010), one study placed the total value of agricultural damage to crops, fisheries, and livestock due to typhoons, floods, and droughts in the Philippines at approximately US$219 billion (Israel and Briones, 2012). In December 2021, Super Typhoon Rai (Odette) caused a total damage to agriculture of P10.8 billion, which includes livestock and poultry. According to the DA, damage to the livestock sector reached P486.2 million in the affected areas of MIMAROPA, CALABARZON, and selected provinces in Visayas and Mindanao (Rivera, 2022).

Finally, since intensive swine and poultry production rely heavily on cereal grains, the implications of climate change on the production and distribution of staple grains used in animal feed across the Philippines can likewise affect the health and nutrition of livestock and poultry. As discussed in the preceding sections, climate change may contribute to higher temperatures and variable rainfall that may weaken or expose crops to pests and diseases, thus decreasing the quantity and quality of important feed crops. In terms of natural fodder and pasture for grazing, climatic changes can contribute to resource competition among plants and weeds and a biodiversity loss that further exacerbates the problem.

[8] Finishing is the phase of pig production where pigs are fed to reach market weight.

Figure 16. The map represents LHZ with livestock as complementary activity affected by the projected temperature greater than 30°C by the year 2050 in MIMAROPA.



4. Practical Applications of the LHZ Tool

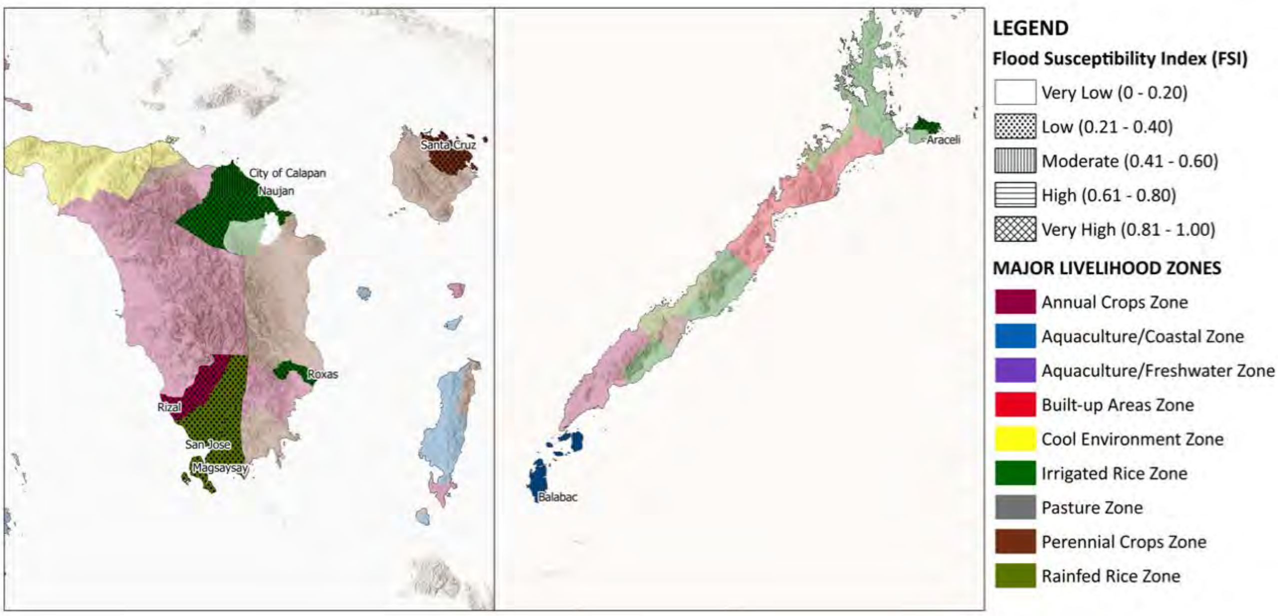
The LHZ map can serve as a guide for planners and decision makers by providing them with geographically disaggregated information that is relevant for food security monitoring, analysis, and decision support (Grillo, 2009). This tool offers a practical, yet strategic process in targeting and prioritizing areas that are most susceptible to potential climate-related hazards. Moreover, the LHZ map can provide more accurate answers about where food security is likely to deteriorate and what alternatives are available at the local level.

In this section, we have sampled areas in the region based on the level of susceptibility to climate change, to demonstrate how LHZ maps can be integrated with different datasets such as climate-related hazards, poverty, and nutrition, to develop context-specific analyses.

Using the LHZ tool to develop adaptation strategies in addressing the impacts of climate-related hazards: The increase in temperature and amount of rainfall affects both the intensity and frequency (including timing) of flood and drought events. Consequently, this will intensify the magnitude of impacts in areas that are most at-risk. Therefore, understanding such potential climate-related extremes is critical to guide policy decisions and ensure adequate adaptation measures are implemented at the local level.

For instance, Figure 17 shows the susceptibility to flooding of municipalities in MIMAROPA and the specific LHZs that are more exposed. Irrigated Rice LHZs in the municipality of Balabac (Palawan) and city of Calapan (Oriental Mindoro) have the highest FSI (moderate flood susceptibility) among all the areas in MIMAROPA.

Figure 17. FSI of municipalities and cities in MIMAROPA

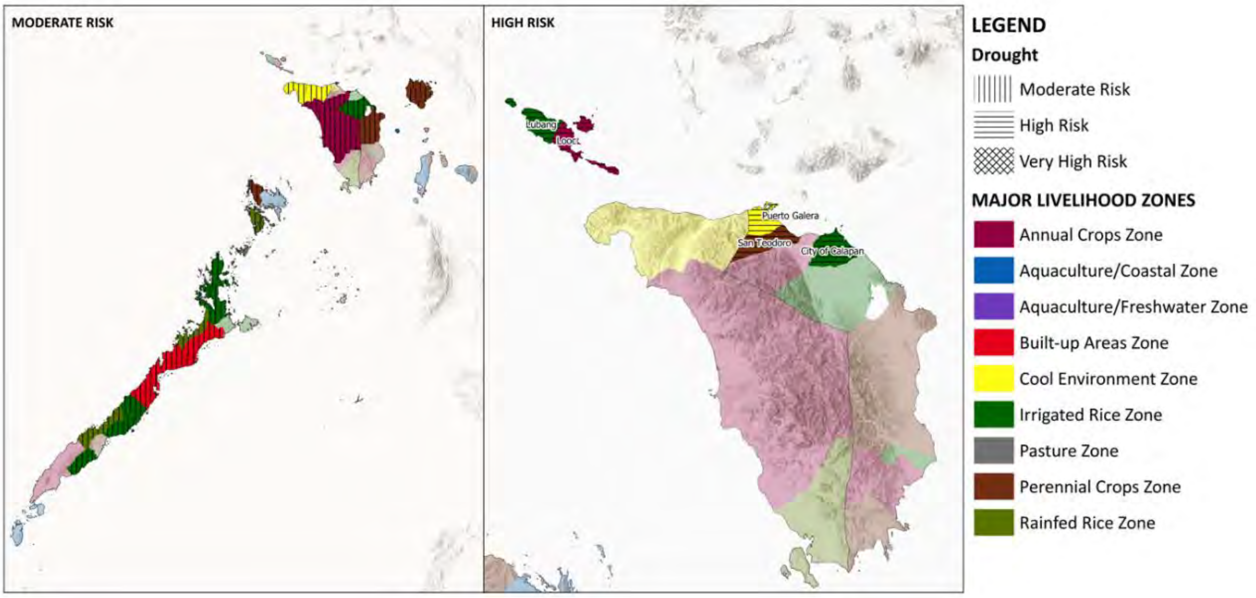


Generally, the map shows that MIMAROPA is not a flood-prone region. However, recent reports show that flooding in the region is becoming more frequent as a result of heavy rainfall caused by typhoons. In 2021, Super Typhoon Odette hit the Philippines, heavily devastating large portions of Visayas and Mindanao, including the province of Palawan in MIMAROPA. State of calamity due to heavy flooding and typhoon damages was raised in Palawan, particularly to the municipalities/city of Arceli, Dumaran, Roxas, San Vicente, Taytay, and Puerto Princesa City (WFP, 2022). Early this year, several areas in Oriental Mindoro were also reported to experience flooding due to heavy rains. Several towns in the municipality of Naujan in Oriental Mindoro were affected by continuous flooding, with total damages amounting to P10,825,736.00 in the rice and fishery sectors from January 4-6, 2023, according to the Naujan Municipal Agriculture Office[9]. Aside from geographical and environmental considerations, uncontrolled kaingin, deforestation, and land use conversion were seen as major factors which may increase flooding susceptibility according to the Mines and Geosciences Bureau (MGB MIMAROPA, 2023). Moreover, given that the projected increase in amount of rainfall (mm) will affect the whole MIMAROPA region by 2050, this may further exacerbate the risk of flooding, particularly of the LHZs presented in Figure 17. Rice production areas in the municipalities/city of: Naujan, Calapan City, Roxas, San Jose, and Magsaysay (Oriental Mindoro); and Araceli (Palawan) are the LHZs that are most susceptible since these areas have the highest FSIs which may worsen following the increase in the amount of annual rainfall by 2050, if now interventions are made.

In terms of adaptation strategies, rice production areas susceptible to flooding will require the use of flood-tolerant varieties and development of flood forecasting and early warning systems (Vidallo et. al., 2019). Other short-term interventions that may be prioritized for rice production areas, particularly those under “moderate” flood susceptibility, are improvements on drainage system, temporary flood barriers, and early planting or shifting of crop calendars.

Meanwhile, Figure 18 shows the susceptibility of MIMAROPA to drought. As seen in the map, several areas in Palawan are moderately susceptible while some areas in Oriental Mindoro are highly susceptible.

Figure 18. DSI of municipalities and cities in MIMAROPA



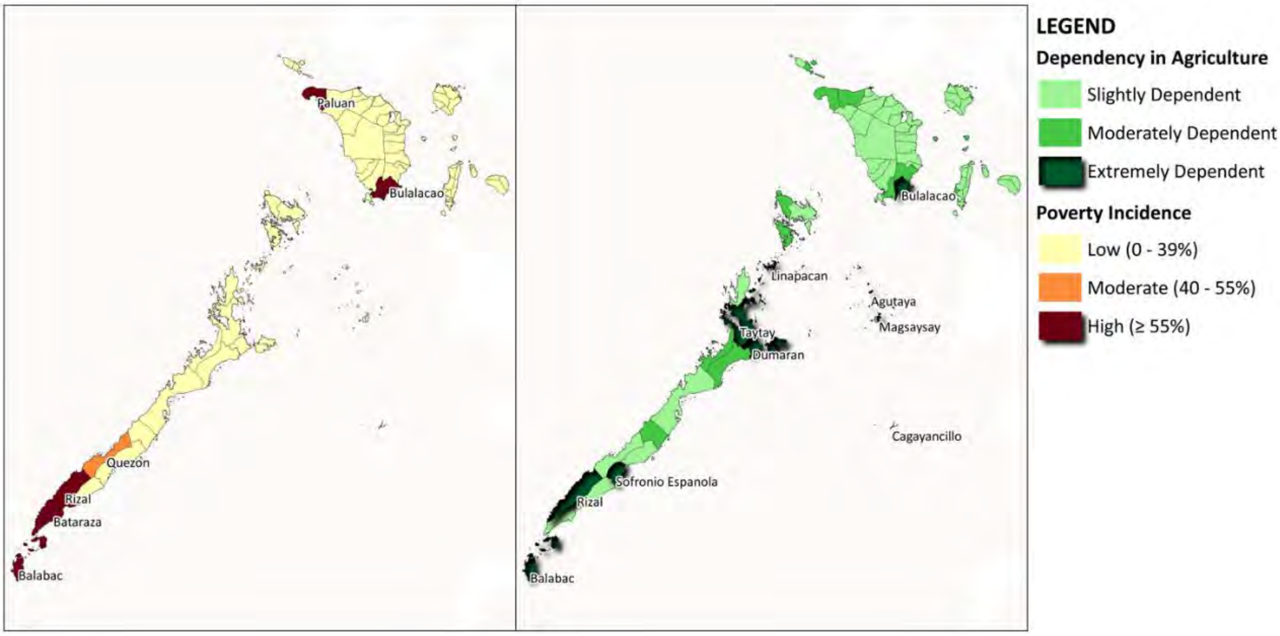
[9] https://news.abs-cbn.com/news/01/18/23/floods-hit-several-barangays-in-naujan-oriental-mindoro

The Irrigated Rice LHZs within the municipalities/city of: El Nido and Taytay (Palawan); and Calapan City (Oriental Mindoro), as well as the Rainfed Rice LHZs in the municipalities of Culion and San Vicente in Palawan are the areas susceptible to drought and at the same time, are likely to experience an increase in temperature to greater than 5ºC by 2050 (Table 5). In 2019, Palawan, Oriental Mindoro, and Occidental Mindoro were among the provinces that were affected by drought during the El Niño phenomenon. In Palawan, Puerto Princesa City was placed in a state of calamity as it suffered a total agricultural loss of P5,768,088.00 from the months of January to April due to dry spell[10]. Meanwhile, Occidental Mindoro recorded the highest average heat index of 39ºC in the month of April, from 36ºC in 2016[11]. The intense heat affected more than 6,000 farmers and an estimated 9,000 ha. of farms according to the Disaster Risk Reduction and Management Council (DRRMC) of MIMAROPA. Among the adaptation options identified by the DA-AMIA program for drought-prone areas are establishment of rainwater harvesting system for irrigation, use of drought-tolerant crop varieties, and diversified farming and intercropping to control pest infestation.

Using the LHZ tool to support the development of plans for poverty alleviation:

The LHZ map can also be utilized to identify specific livelihoods of the poorest areas in the region. This information is beneficial in developing tailor-fitted interventions to alleviate poverty, including improvements in livelihood and income. For instance, Figure 19, shows that most of the areas in MIMAROPA have low incidences of poverty in 2015. However, some areas in Palawan including the municipalities of Rizal, Bataraza, and Balabac, and few municipalities in Occidental and Oriental Mindoro (Paluan and Bulalacao, respectively) have high poverty incidences.

Figure 19. Poverty incidences of municipalities/cities in MIMAROPA in 2015 (PSA, 2017)



[10] https://palawan-news.com/puerto-princesa-declares-state-of-calamity-due-to-drought/

[11] https://newsinfo.inquirer.net/1101721/39c-heat-in-occidental-mindoro-takes-deadly-toll-on-farms

Figure 19 also shows that the aforementioned areas are moderately to extremely dependent[12] on agriculture. These areas are mainly agriculture (Annual Crops and Rainfed Rice LHZs) and fisheries (Aquaculture/Coastal LHZ) areas, hence, prioritizing programs that will boost crop and fisheries productivity are of prime importance. A study by OECD (2011) showed that increasing agricultural productivity and income of farmers results to sustainable progress that reduces extreme poverty, particularly in developing countries such as the Philippines. However, the adverse impacts of climate change pose greater risks particularly to the poorest areas that heavily rely on farming. To address these problems, the local government needs to ensure that farmers have access to sustainable sources of irrigation, low-cost farm inputs, more efficient crop insurance system, and climate-resilient technologies, machineries, and equipment.

Aside from farmers, fisherfolks had the highest poverty incidence (34%) among the basic sectors in the Philippines in 2015 (PSA, 2017). At present, they remain to be the poorest of the poor having the highest poverty incidence at 30.6% (PSA, 2023). This data calls for the local government to support the development of fishery industries in the said municipalities. Given the persistent threats of climate change and the susceptibility of these poorest areas to climate risks, it is necessary to invest in programs that will help increase the adaptive capacity of fisherfolks. According to FAO (n.d.), adaptation measures to sustain aquaculture production include change in aquaculture feed management – fishmeal and fish oil replacement, improvement on water-use efficiency and sharing efficacy (e.g., with rice paddy irrigators), and aquaculture infrastructure investments (e.g., nylon netting and raised dykes in flood-prone pond systems).

Using the LHZ tool to support the development of plans for improving health and nutrition: Stunting[13] is considered as one of the leading problems related to undernutrition, particularly among children in the Philippines. The latest Operation Timbang Plus (OPT) report in 2022 from the National Nutrition Council indicated that in general, MIMAROPA has a low prevalence of malnutrition of only 10.59 % for the whole region. However, Abra de Ilog in Occidental has notably serious cases of stunting among children less than 5 years old as shown in Figure 20. Abra de Ilog is the home of Iraya Mangyan, a known indigenous tribe in Mindoro.

Indigenous people such as the Mangyans are prone to undernutrition because of their geographical location which limits them to access diverse and nutritious food, health and nutrition services, and water and sanitation facilities (Development Academy of the Philippines, 2021). In 2021, the National Nutrition Council MIMAROPA and the Local Government Unit (LGU) of Abra de Ilog established an Early Warning System on Food and Nutrition Security (EWS-FNS) project. The EWS-FNS aims to collect primary data needed for decision-making of the LGU in addressing the problems that affect the ability of the community and households to obtain sufficient and nutritious food (Blanco, 2021).

The present livelihood zones classification of Abra de Ilog shows that aside from its major livelihood of annual crops production, aquaculture/coastal fisheries, vegetable farming, and tourism are also available as its Secondary/Tertiary livelihood. Given that most of Abra de Ilog's livelihoods are agriculture and aquaculture-based, the local government is encouraged to strengthen food

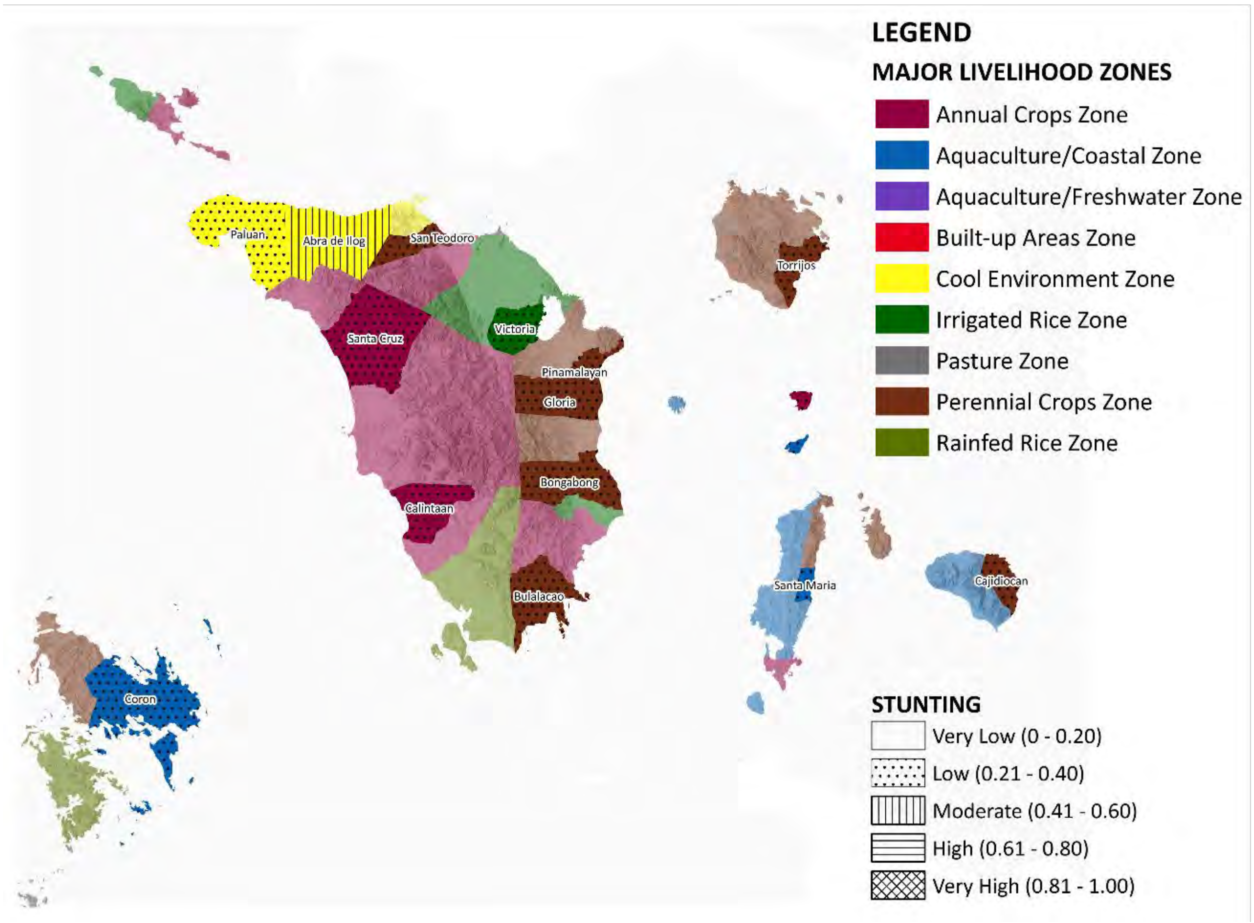
[12] Dependency in agriculture was computed by getting the ratio of the agricultural workers over the total population of the municipality, based on the available data of gainful workers with ages 15 years old above from PSA (2017).
[13] Stunting is "the impaired growth and development that children experience from poor nutrition, repeated infection, and inadequate psychosocial stimulation" (World Health Organization, 2015).

production and diversification of sources of quality produce to address the problem of limited access to diverse and nutritious food or diet.

On the other hand, low prevalence of stunting was found in the municipalities of: Paluan, Santa Cruz, Calintaan (Occidental Mindoro), Bongabong, Bulalacao, Gloria, Pinamalayan, San Teodoro, Victoria (Oriental Mindoro), Torrijos (Marinduque), Cajidiocan, Santa Maria (Romblon), and Coron (Palawan). As discussed in the previous sections, most of the production areas across MIMAROPA will be less suitable for growing rice, annual crops such as maize, and perennial crops including banana.

While the aforementioned areas have relatively low percentage of stunting, future climatic conditions particularly to the municipalities under Perennial Crops LHZ (Bulalacao), Irrigated Rice LHZ (Victoria), and Aquaculture/Coastal Fisheries LHZ (Santa Maria, Coron) may increase the prevalence of stunting if no interventions are made. Diversification of livelihood and food sources, as well as promotion of climate-resilient practices and technologies among fisherfolk and perennial crops and rice farmers in the region may help in improving health and nutrition in the said municipalities.

Figure 20. Prevalence of stunting in municipalities/cities in MIMAROPA in 2015 (PSA, 2017)



5. Summary and Conclusion

This report highlights the research findings of the CCFSA in MIMAROPA. Temporal and spatial risks and impacts of climate change on food security and nutrition were assessed through a modeling approach and spatial analysis using GIS. Specific areas and population that are most susceptible to climate change, particularly the types of livelihoods that will be most affected, were characterized in the report.

The LHZ map and its corresponding datasets were validated and refined as necessary. Secondary/Tertiary LHZ, as well as complementary activities, of all the municipalities in MIMAROPA were well-defined and characterized in this report. The identification of these zones provides a more holistic view of the livelihood profile of the region and the various opportunities available in the region aside from its major LHZs.

The livelihood profile of MIMAROPA shows that it remains to be an agriculture-based region relying largely on farming and fishing livelihoods. However, the analysis showed that climate hazards, particularly drought and flood, will continue to adversely impact these agriculture and aquaculture LHZs. Specifically, the municipalities under the Rainfed and Irrigated Rice LHZs, Perennial Crops LHZs and Aquaculture/Coastal LHZs are the most susceptible to drought and flooding.

Using crop models, future suitability of rice, maize, and banana were mapped under high GHG emissions scenarios. Results show that by the year 2050 existing major production areas will be generally less conducive for growing these crops, particularly rice, in MIMAROPA due to the projected increase in temperature and changes in the amount of rainfall (mm). The variability and changes in temperature and rainfall patterns can also drive the spread and proliferation of pests and diseases, which may result in production losses and lower income among farmers.

These projected changes in temperature and amount of rainfall are also expected to directly affect oceanic systems resulting in induced sea-based hazards. These may have direct and indirect impacts on the abundance and distribution of fishery resources and the suitability of some areas dedicated to aquacultural production. Such phenomenon may affect many areas in MIMAROPA given that aquaculture-based activities were among the region’s major livelihoods.

For the livestock and poultry sector, climate change poses risk to animal health and the viability of pasturelands and fodder crops that are used as animal feed. This will have effects on the animal’s growth and weight, reproductive performance, and susceptibility to pests and diseases.

By integrating these climate risk datasets with the LHZ map, planners and decision makers can target specific locations of the livelihoods that are most at-risk to potential climate-related hazards. This will also give insights for food security monitoring and analysis, implementation of strategies leading to food and nutrition improvement, and development of plans and programs for poverty alleviation.

The findings also show that agriculture and fisheries production play a significant role in the economy of MIMAROPA. While recent data shows improvement on the region’s poverty and health statistics, many individuals including members of indigenous groups still remain below the poverty line. Moreover, analysis of climate-related hazards reveal that climate change impacts will potentially disrupt

Fishing, a major industry in MIMAROPA, contributes significantly to the region's economy. © WFP/Dale Rivera

crop productivity, and in turn affect domestic agricultural production, consumption, and food security in the region. Given its high dependence in agriculture, developing climate change adaptation strategies to safeguard the sector from potential risks is of utmost importance not only to sustain production, but also to promote resilience and structural transformation among the most vulnerable areas in the region.

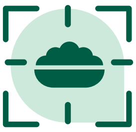
As agriculture faces several threats in the future, there is also a need to diversify livelihoods and integrate climate-resilient interventions into local policies, based on the prevailing susceptibility to climate risks. The LHZ map, together with other relevant databases, can serve as a tool to conduct a highly localized analysis of the impacts of climate change on specific livelihood groups which can support the development of appropriate adaptation strategies.

6. Recommendations

The report aimed at understanding the potential impacts of climate change on the livelihoods in the context of MIMAROPA, demonstrating the role of livelihoods on food security of the population in this region. Using this report, further studies can be built that can further help in addressing vital issues related to climate change, food security, nutrition, and gender and development.

Integration of Climate Risk and Vulnerability Assessment (CRVA): This assessment encompasses the identification and analysis of key climate risks, as well as the adaptive capacity or ability of the population to cope with or adapt to climate change impacts. This integration can provide a more holistic view on the vulnerabilities of an area and its corresponding livelihoods which has a significant implication to food security and nutrition. For MIMAROPA, some of the notable CRVAs that can be used for the integration with the CCFSA are the VRA prepared by WFP and the Climate Vulnerability and Risk Information System (CVRIS) developed by the Global Green Growth Institute (GGGI) for Oriental Mindoro.

Inclusion of Data on Yield for Key Crops: Using data on current yield and historical trends on food production can facilitate a more comprehensive analysis of the projected impacts of future climate scenarios on the performance of a crop. Ultimately, such data is useful to identify factors that can directly and indirectly affect food production and security.



Use of Granular Data on Nutrition: A comprehensive understanding of the nutritional status of the region will help policy makers enable a more targeted policy to enhance and prioritize the production of more diverse food sources. It is crucial to assess availability and accessibility of food, especially if both are affected by crop suitability in the area. Hence, the use of higher resolution and more defined data on nutrition at the local level is crucial to further promote food security.

Inclusion of Gender in Agriculture: Understanding the nexus between gender, climate change, and agriculture, and incorporating it to the development of agricultural plans and programs ensures social inclusivity, equality, and equity. While climate change impacts affect everyone, several studies have shown that women farmers are more exposed to climate risks due to unequal gender relations within households and communities particularly in developing countries such as the Philippines. Hence, integrating gender considerations in the analysis will provide a more holistic approach in developing gender-responsive and climate-resilient livelihoods and communities.

It is also recommended that the findings of the study be shared to as many communities as possible to provide more information about climate change and its impact on food security and help individuals and groups at the local level to make guided decision about their livelihood activities. While doing these dissemination activities, it would also be advisable to undertake dialogues with local people using both quantitative and qualitative methods to generate more up-to-date information that can further reinforce the current analysis. The information that will be gathered can then help the study elaborate more on other issues like overgrazing and soil erosion and degradation and come up with more appropriate knowledge products like a seasonal calendar simulating the impact of climate change at present and in the near future.

Given that MIMAROPA is highly dependent on agriculture, there is a need to develop climate change adaptation strategies to mitigate risks on crop production, livelihoods, and food security in the region. © WFP/Angelo Mendoza

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ANNEX 1: List of livelihood zones in MIMAROPA Region

Province	City/ Municipality	Major LHZ	Secondary/Tertiary LHZ	Complementary Activity
Marinduque	Santa Cruz	Perennial Crops Zone	built-up areas and tourism	tourism
Marinduque	Boac	Perennial Crops Zone	vegetables and tourism	tourism
Marinduque	Buenavista	Perennial Crops Zone	vegetables and tourism	tourism
Marinduque	Gasan	Perennial Crops Zone	vegetables and tourism	tourism
Marinduque	Mogpog	Perennial Crops Zone	aquaculture/coastal fisheries, livestock/pasture, mining, and tourism	livestock/pasture, mining, and tourism
Marinduque	Santa Cruz	Perennial Crops Zone	built-up areas and tourism	tourism
Marinduque	Torrijos	Perennial Crops Zone	livestock/pasture and livestock	livestock/pasture and tourism
Occidental Mindoro	Calintaan	Annual Crops Zone	aquaculture/coastal fisheries and livestock/pasture	livestock/pasture
Occidental Mindoro	Looc	Annual Crops Zone	aquaculture/coastal fisheries, livestock/pasture, and tourism	livestock/pasture and tourism
Occidental Mindoro	Rizal	Annual Crops Zone	aquaculture/coastal fisheries and livestock/pasture	livestock/pasture
Occidental Mindoro	Sablayan	Annual Crops Zone	aquaculture/coastal fisheries, perennial crops, livestock/pasture, mining, and tourism	livestock/pasture, mining, and tourism
Occidental Mindoro	Abra de Ilog	Cool Environment Zone	aquaculture/coastal fisheries, vegetable farming, and tourism	tourism
Occidental Mindoro	Paluan	Cool Environment Zone	aquaculture/coastal fisheries, vegetable farming, and tourism	tourism
Occidental Mindoro	Lubang	Irrigated Rice Zone	aquaculture/coastal fisheries, vegetable farming, and tourism	tourism
Occidental Mindoro	Magsaysay	Rainfed Rice Zone	aquaculture/coastal fisheries, vegetable farming, and tourism	tourism

Province	City/ Municipality	Major LHZ	Secondary/Tertiary LHZ	Complementary Activity
Occidental Mindoro	Mamburao	Annual Crops Zone	aquaculture/coastal fisheries, perennial crops, livestock/pasture, mining, and tourism	tourism
Occidental Mindoro	Santa Cruz	Annual Crops Zone	aquaculture/coastal fisheries and livestock/pasture	livestock/pasture
Occidental Mindoro	San Jose	Rainfed Rice Zone	aquaculture/coastal fisheries, vegetable farming, and tourism	tourism
Oriental Mindoro	Baco	Annual Crops Zone	aquaculture/coastal fisheries, perennial crops, livestock/pasture, and tourism	livestock/pasture and tourism
Oriental Mindoro	Puerto Galera	Cool Environment Zone	aquaculture/coastal fisheries, built-up areas, and tourism	tourism
Oriental Mindoro	City of Calapan	Irrigated Rice Zone	aquaculture/coastal fisheries, built-up areas, vegetable farming, and tourism	tourism
Oriental Mindoro	Victoria	Irrigated Rice Zone	aquaculture/freshwater fisheries, vegetable farming, mining, and tourism	mining and tourism
Oriental Mindoro	Bansud	Perennial Crops Zone	aquaculture/coastal fisheries, vegetable farming, livestock/pasture, and tourism	livestock/pasture and tourism
Oriental Mindoro	Bongabong	Perennial Crops Zone	aquaculture/coastal fisheries, vegetable farming, livestock/pasture, and tourism	livestock/pasture and tourism
Oriental Mindoro	Bulalacao	Perennial Crops Zone	aquaculture/coastal fisheries, vegetable farming, livestock/pasture, and tourism	livestock/pasture and tourism
Oriental Mindoro	Gloria	Perennial Crops Zone	aquaculture/coastal fisheries, vegetable farming, livestock/pasture, and tourism	livestock/pasture and tourism
Oriental Mindoro	Pinamalayan	Perennial Crops Zone	aquaculture/coastal fisheries, vegetable farming, livestock/pasture, and tourism	livestock/pasture and tourism
Oriental Mindoro	Pola	Perennial Crops Zone	aquaculture/coastal fisheries, aquaculture/freshwater fisheries, vegetable farming, and tourism	tourism
Oriental Mindoro	San Teodoro	Perennial Crops Zone	vegetables	
Oriental Mindoro	Socorro	Perennial Crops Zone	aquaculture/freshwater fisheries, vegetable farming, and tourism	tourism

Province	City/ Municipality	Major LHZ	Secondary/Tertiary LHZ	Complementary Activity
Oriental Mindoro	Naujan	Irrigated Rice Zone	aquaculture/coastal fisheries, aquaculture/freshwater fisheries, vegetable farming, and tourism	tourism
Oriental Mindoro	Mansalay	Annual Crops Zone	aquaculture/coastal fisheries, perennial crops, livestock/pasture, and tourism	livestock/pasture and tourism
Oriental Mindoro	Roxas	Irrigated Rice Zone	aquaculture/coastal fisheries, vegetable farming, and tourism	tourism
Palawan	Bataraza	Annual Crops Zone	built-up areas, mining, and tourism	mining and tourism
Palawan	Rizal	Annual Crops Zone		
Palawan	Dumaran	Irrigated Rice Zone	vegetable farming	
Palawan	El Nido	Irrigated Rice Zone	vegetable farming and tourism	tourism
Palawan	Balabac	Aquaculture/Coastal Zone	vegetable farming and tourism	tourism
Palawan	Aborlan	Irrigated Rice Zone	vegetable farming	
Palawan	Narra	Irrigated Rice Zone	vegetable farming, mining, and tourism	mining and tourism
Palawan	Agutaya	Irrigated Rice Zone	vegetable farming	
Palawan	Araceli	Irrigated Rice Zone	vegetable farming	
Palawan	Taytay	Irrigated Rice Zone	vegetable farming and tourism	tourism
Palawan	Brooke's Point	Irrigated Rice Zone	vegetable farming, mining, and tourism	mining and tourism
Palawan	Linapacan	Pasture Zone	vegetable farming and tourism	tourism
Palawan	Magsaysay	Aquaculture/Coastal Zone	perennial crops	
Palawan	Puerto Princesa City	Built-up Areas Zone	aquaculture/coastal fisheries and tourism	tourism

Province	City/ Municipality	Major LHZ	Secondary/Tertiary LHZ	Complementary Activity
Palawan	Sofronio Espanola	Perennial Crops Zone	vegetable farming, mining, and tourism	mining and tourism
Palawan	San Vicente	Rainfed Rice Zone	vegetable farming and tourism	tourism
Palawan	Culion	Rainfed Rice Zone	vegetable farming and tourism	tourism
Palawan	Quezon	Rainfed Rice Zone	vegetable farming, mining, and tourism	mining and tourism
Palawan	Cagayancillo	Aquaculture/Coastal Zone	tourism	tourism
Palawan	Busuanga	Perennial Crops Zone	aquaculture/coastal fisheries and tourism	tourism
Palawan	Coron	Aquaculture/Coastal Zone	perennial crops, livestock/pasture, and tourism	livestock/pasture and tourism
Palawan	Cuyo	Aquaculture/Coastal Zone		
Palawan	Roxas	Built-up Areas Zone	aquaculture/coastal fisheries and perennial crops	
Romblon	San Jose	Aquaculture/Coastal Zone	livestock/pasture and tourism	livestock/pasture and tourism
Romblon	Santa Fe	Annual Crops Zone	aquaculture/coastal fisheries, perennial crops, livestock/pasture, and tourism	livestock/pasture and tourism
Romblon	Banton	Annual Crops Zone	aquaculture/coastal fisheries, livestock/pasture, and tourism	livestock/pasture and tourism
Romblon	Alcantara	Aquaculture/Coastal Zone	perennial crops and livestock/pasture	livestock/pasture
Romblon	Cajidiocan	Perennial Crops Zone	aquaculture/coastal fisheries, vegetable farming, and tourism	tourism
Romblon	Calatrava	Aquaculture/Coastal Zone	livestock/pasture	livestock/pasture
Romblon	Romblon	Perennial Crops Zone	aquaculture/coastal fisheries, livestock/pasture, and mining	livestock/pasture and tourism

Province	City/ Municipality	Major LHZ	Secondary/Tertiary LHZ	Complementary Activity
Romblon	San Agustin	Perennial Crops Zone	aquaculture/coastal fisheries and livestock/pasture	livestock/pasture
Romblon	Ferrol	Aquaculture/Coastal Zone		
Romblon	Santa Maria	Aquaculture/Coastal Zone		
Romblon	Concepcion	Aquaculture/Coastal Zone	livestock/pasture	livestock/pasture
Romblon	Looc	Aquaculture/Coastal Zone	vegetable farming, livestock/pasture, and tourism	livestock/pasture and tourism
Romblon	Magdiwang	Aquaculture/Coastal Zone	livestock/pasture, mining, and tourism	livestock/pasture, mining, and tourism
Romblon	Odiongan	Aquaculture/Coastal Zone	livestock/pasture and tourism	livestock/pasture and tourism
Romblon	San Andres	Aquaculture/Coastal Zone	livestock/pasture and tourism	livestock/pasture and tourism
Romblon	San Fernando	Aquaculture/Coastal Zone	livestock/pasture, mining, and tourism	livestock/pasture, mining, and tourism
Romblon	Corcuera	Aquaculture/Coastal Zone	livestock/pasture and tourism	livestock/pasture and tourism

ANNEX 2: Photo Documentation

Juanito Berja, program policy officer of WFP, leads the small group discussion on additional climate-related data from the participants' respective organizations to be included in the project database.

Participants answer a four-page questionnaire to assess and characterize the liveliho zones map of MIMAROPA.

Participants answer a four-page questionnaire to assess and characterize the livelihood zones map of MIMAROPA.

Research Associate Jane Girly Balanza, from The Alliance of Bioversity International and CIAT, discusses the core of the project that developed the comprehensive livelihood zones map for the Philippines.

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