Philippine Climate Change and Food Security Analysis

Regional Report on
Zamboanga Peninsula

October 2024

Contributors

Acknowledgements

Table of Contents

List of Tables

List of Figures

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 Zamboanga Peninsula. 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 Zamboanga Peninsula. 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 Zamboanga Peninsula 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, seven (7) were initially identified in Zamboanga Peninsula namely: Aquaculture/Freshwater Fisheries Zone, Aquaculture/Coastal Fisheries Zone, Irrigated Rice Zone, Rainfed Rice Zone, Annual Crops Zone, Perennial Crops Zone, and Built-up Areas Zone. All of these were validated by local experts in the region.

Climate Hazards

- Drought and flood were identified as the top two hazards that significantly affect most of the livelihoods in Zamboanga Peninsula.
- Generally, Zamboanga Peninsula has low susceptibility to drought and flood.

Impacts on Crops

- Future climate scenarios based on RCP 8.5 (years 2030 and 2050) will result to less conducive environments for rice and banana production in major Irrigated and Rainfed Rice LHZs and Perennial Crops LHZs throughout the region.
- Majority of the areas in Zamboanga Peninsula are classified as Annual Crops LHZs. By 2050, 70% of these areas will have less favorable conditions for growing maize.
- 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. All the seven (7) municipalities under the Aquaculture/Coastal Fisheries LHZ are potentially susceptible to these climate-related 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.
- Four (4) livestock and poultry areas in the region 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 Zamboanga Peninsula** which presents the validated livelihood and climate-related profiles of the region. Additionally, this report identifies the specific locations of livelihoods in Zamboanga Peninsula that are most at risk to climate-related 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.

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 be either viewed as maps or be exported as tabular data.

---

[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).

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.

2. Methodology

2.1 Study Site and Population

Zamboanga Peninsula or Region IX is an administrative region in the Philippines found on the western portion of the Mindanao Island group. The region covers three (3) provinces, namely Zamboanga del Norte, Zamboanga del Sur, and Zamboanga Sibugay. It also has 67 municipalities and five (5) cities including one (1) highly urbanized city (Zamboanga City) and the component city of Isabela.

It has a total land area of 15,137.74 square kilometers (km^2) endowed with forest, marine, and freshwater resources (PSA-Zamboanga, n.d.). Recent records show that about 6,769 km^2 Zamboanga Peninsula are alienable and disposable lands while 4,065 km^2 are established forest reserves.
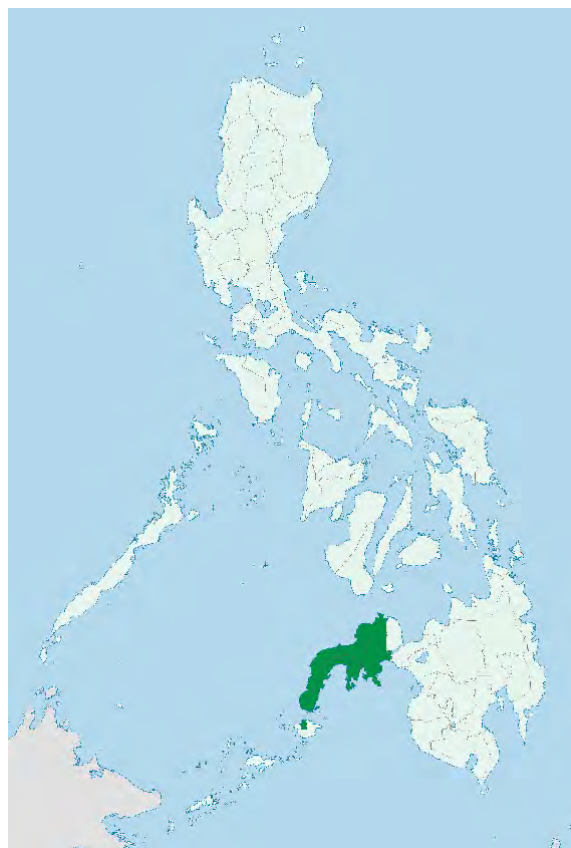
In terms of economy, Zamboanga Peninsula is highly driven by the Agriculture, Fishery, and Forestry (AFF) sectors. The region has access to the five (5) richest fishing grounds in the Philippines, namely the Sulu Sea, Moro Gulf, Sindangan Bay, Pilas Channel, and Celebes Sea. Because of this, it is considered as Mindanao's Coastal Fishery Center and the country's biggest manufacturer of canned and bottled sardines (NEDA Region IX, n.d.). Moreover, Zamboanga Peninsula is also the largest rubber producer in the Philippines and its major agribusiness activities include coconut oil milling, and wood, seaweed, and fish processing.

The Zamboanga Peninsula Region has a total of 3.9 million population based on the 2020 Census of the Population and Housing accounting for 3.55% of the Philippine population (PSA, n.d.). Among its three (3) provinces, Zamboanga del Sur has the biggest population with approximately 1.05 million persons, followed by Zamboanga del Norte with approximately 1.04 million persons, while Zamboanga Sibugay has the smallest population with approximately 670,000 persons. Zamboanga City, with approximately 980,000 persons, is the fifth populous city in the Philippines.

The top three (3) cities/municipalities with the highest population are found in Zamboanga City with approximately 600 thousand persons, Pagadian City (Zamboanga del Sur) with approximately 210 thousand persons, and Dipolog (Zamboanga del Norte) with approximately 138 thousand persons.

On the other hand, the top three (3) municipalities with the least population are La Libertad (Zamboanga del Norte) with approximately 8,000 persons, followed by Mutia (Zamboanga del Norte) with approximately 11,700 persons, and Josefina (Zamboanga del Sur) with approximately 12,200 persons.

Figure 1. Population map of Zamboanga Peninsula (PSA, 2020)
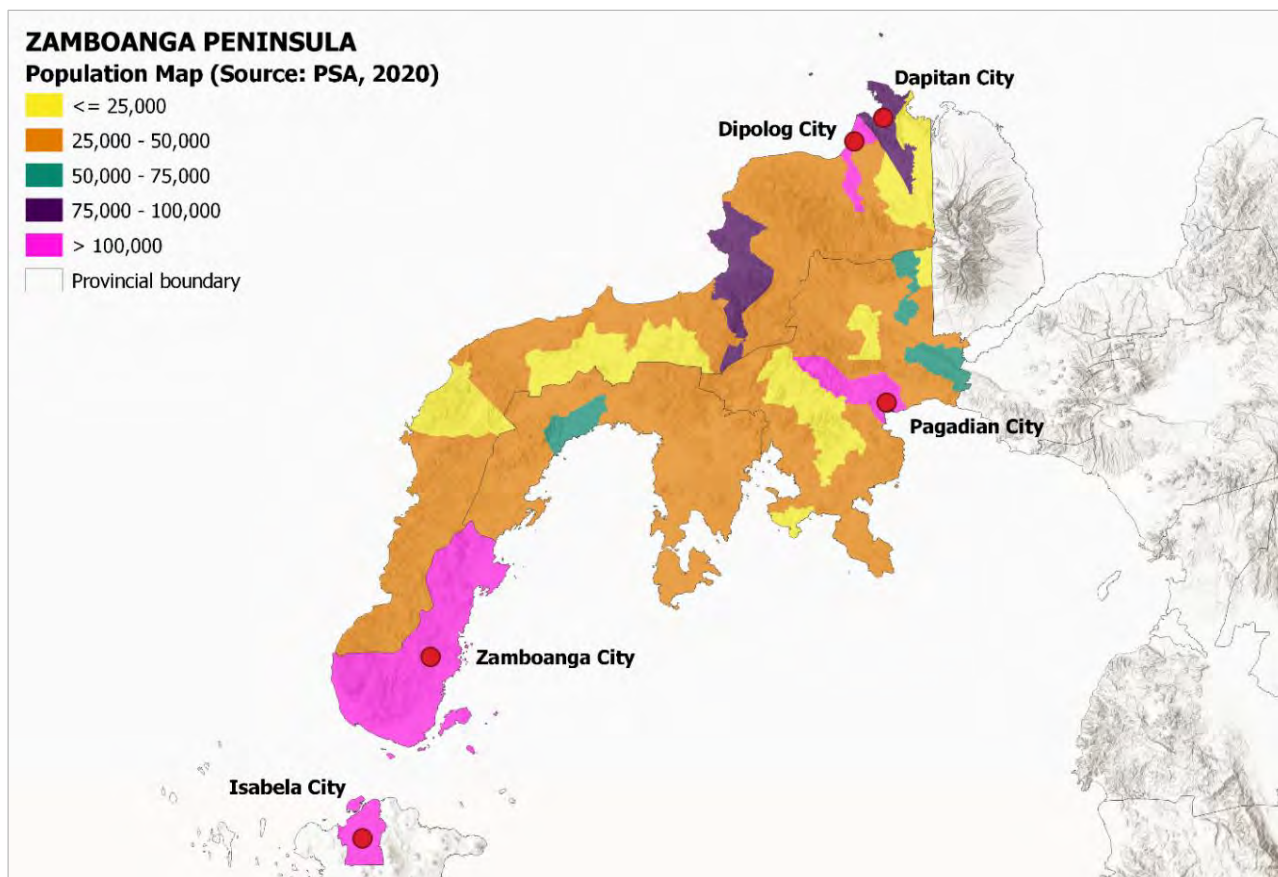
2.2. Livelihood Zones Mapping

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, 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.

---

[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.

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
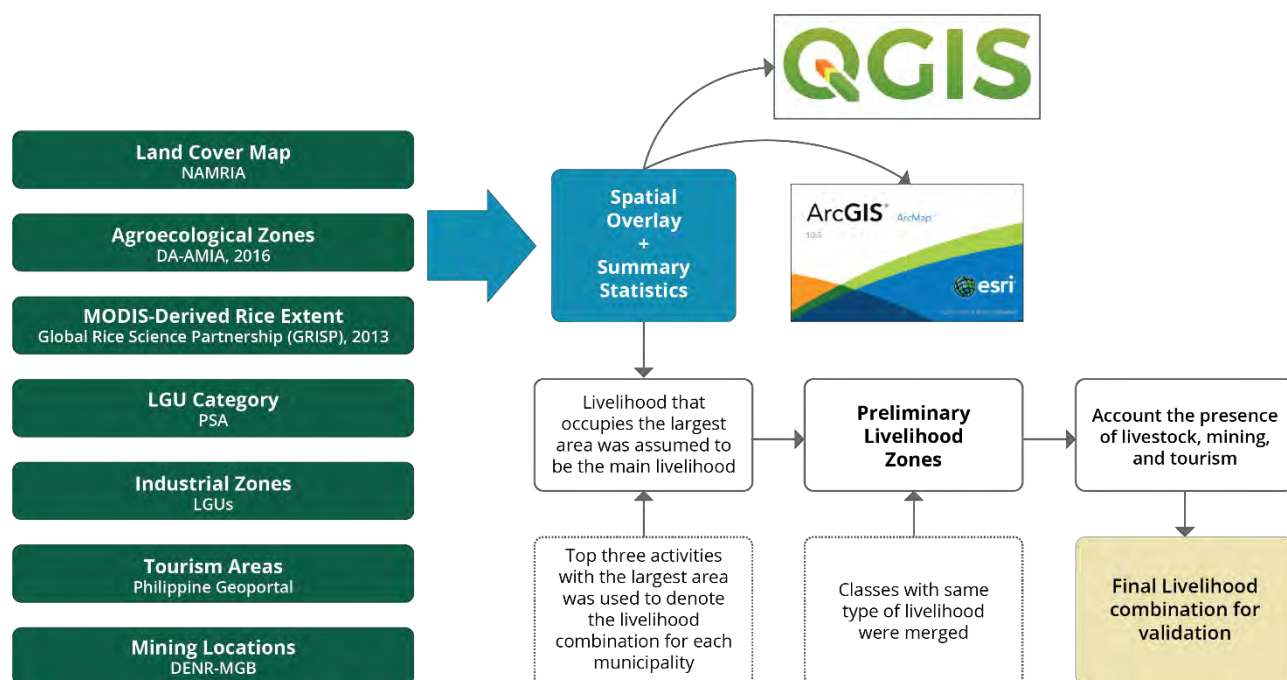
2.3. Assessment of Climate-Related Hazards

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	UNEP/UNISDR (2013) (https://preview.grid.unep.ch/) WFP-PH	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	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.

2.4. Regional Validation Workshop

A virtual validation workshop was conducted on 27-28 September 2020 via Zoom which was participated by several experts from different national agencies who are familiar with the local agricultural systems and livelihoods in Zamboanga Peninsula. 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.

---

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

Figure 3. Step-by-step process of the livelihood zones validation
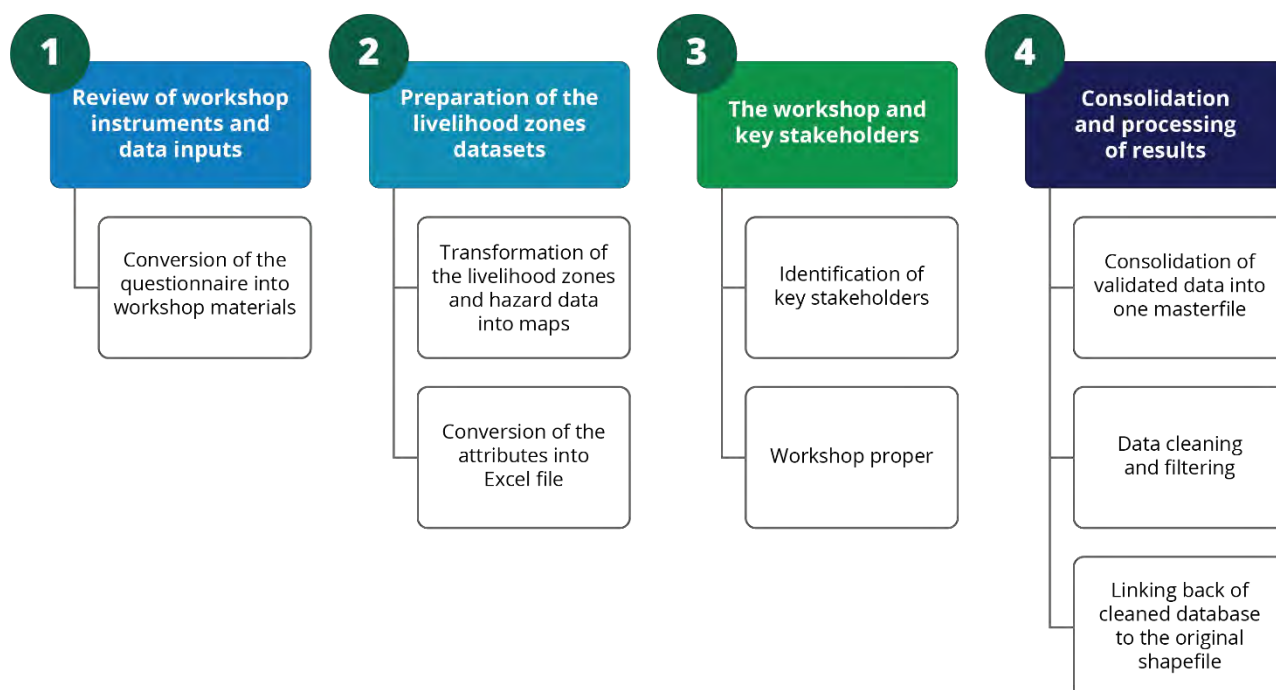
Review of workshop instruments and data inputs

1 The team reviewed available datasets and identified relevant materials that are useful for the conduct of a virtual workshop such as 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.

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

2 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.

Conduct of the workshop

3 The workshop was participated by representatives from six (6) agencies at the national and regional level (Figure 4). These agencies include:

- National Economic and Development Authority – Region IX (2)
- Department of the Interior and Local Government – Region IX (1)
- Department of Labor and Employment – Region IX (4)
- Department of Trade and Industry – Region IX (1)
- Department of Agriculture – Regional Field Office IX (2)
- Department of Tourism – Region IX (1)

---

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

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 Rapid Emergency Action on Disaster Incidence (READi) and the Comprehensive Land Use Plan (CLUP) developed by the Bangsamoro Planning and Development Authority (BPDA).

Figure 4. The participants during the Regional CCFSA Validation Workshop

4 **Consolidation and processing of results**

All 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 Zamboanga Peninsula.

3. Results

3.1. Analysis of the Initial Livelihood Zones

The LHZ database of ZAMBOANGA PENINSULA had a total of 72 records corresponding to four (4) component cities, one (1) independent, chartered, and highly urbanized city and 67 municipalities in the region. ZAMBOANGA PENINSULA initially had seven (7) major LHZs, namely: **Annual Crops Zone**, **Aquaculture/Coastal Fisheries Zone**, **Built-up Areas Zone**, **Irrigated Rice Zone**, **Pasture Zone**, **Perennial Crop Zone**, and **Rainfed Rice Zone.**

3.2. Validation Workshop Findings

3.2.1. Major LHZs in Zamboanga Peninsula

The validated LHZ map of Zamboanga Peninsula is presented in Figure 5 showing the seven (7) major LHZs in the region.

Figure 5. Validated LHZs in Zamboanga Peninsula
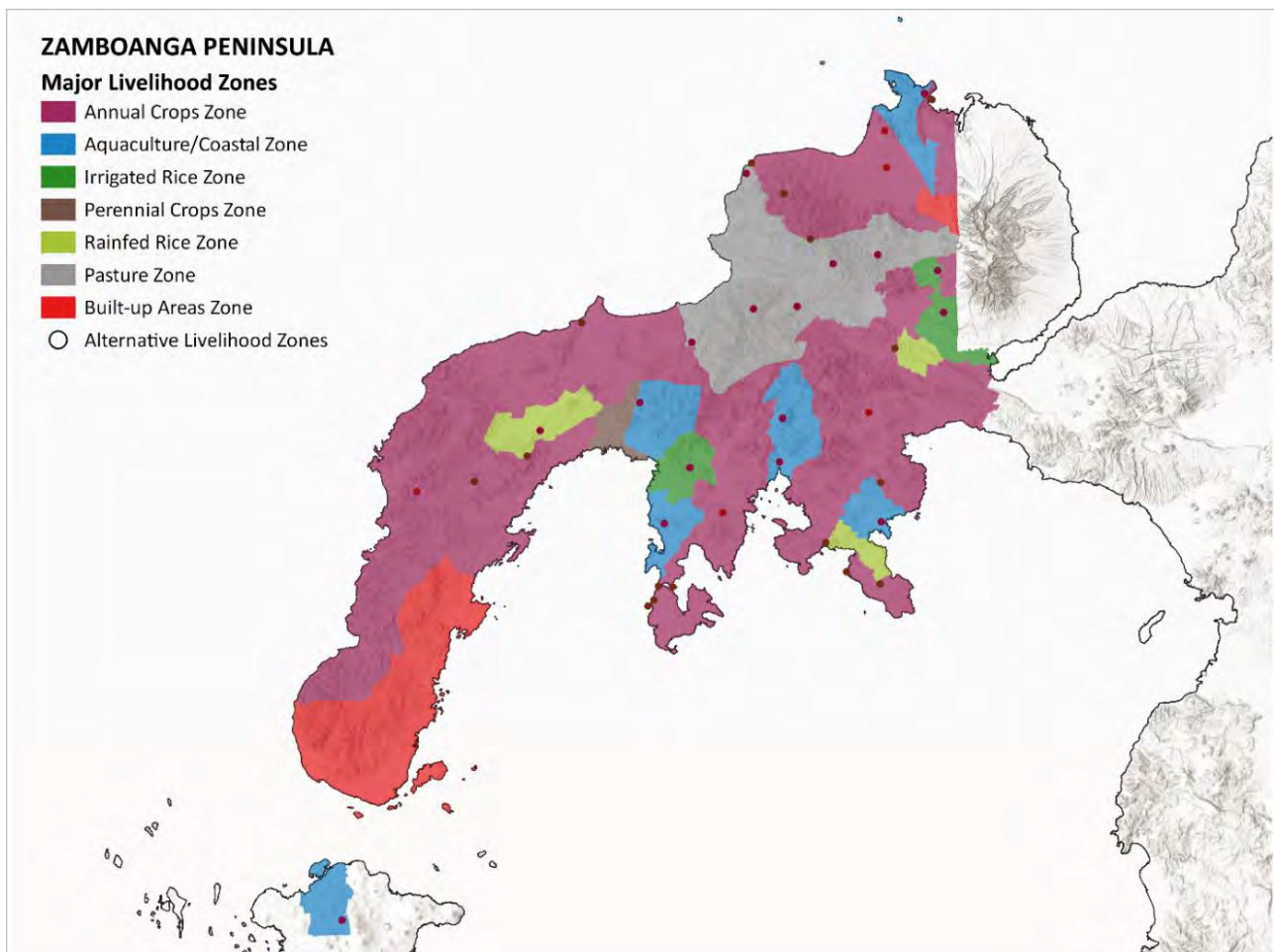
Results of the validation workshop revealed that majority of the livelihoods in Zamboanga Peninsula are still agriculture-based (Figure 6). A total of two (2) cities and 55 municipalities or 79% were found to be highly dependent on agriculture, specifically on annual crops (50), irrigated rice (3), rainfed rice (3), and perennial crops (1).

Figure 6. Major LHZs in Zamboanga Peninsula
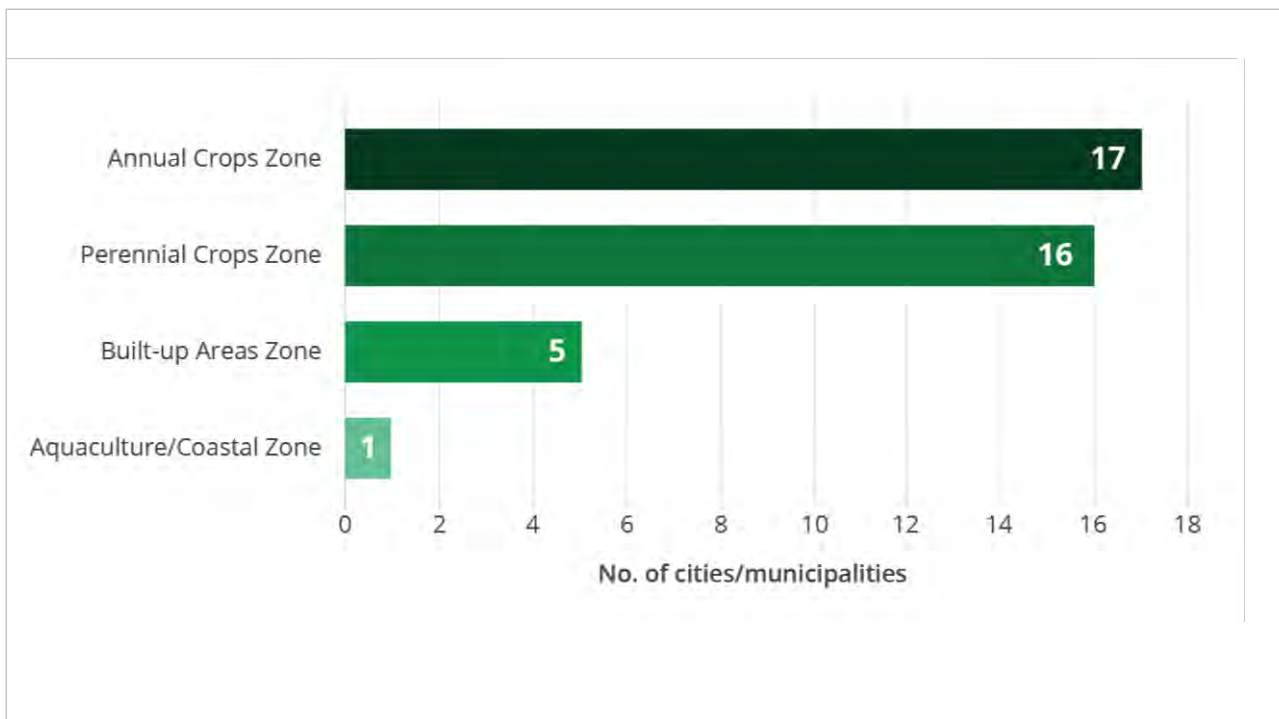
On the other hand, the validated Aquaculture/Coastal Fisheries LHZs in seven (7) municipalities form the second most dominant major LHZ in the region.

Moreover, the first-class, highly urbanized Zamboanga City in Zamboanga del Sur and the municipality of Mutia in Zamboanga del Norte were classified under the Built-up Areas LHZ. Lastly, six (6) municipalities were classified under Pasture LHZ namely: Bacungan, Jose Dalman, Sergio Osmena Sr., Siayan, Sindangan (Zamboanga del Norte), and Dumingag (Zamboanga del Sur).

3.2.2. Secondary/Tertiary LHZs in Zamboanga Peninsula

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 two (2) cities and 15 municipalities. It was followed by perennial crops in 16 municipalities, built-up areas in two (2) cities and three (3) municipalities, and aquaculture/coastal fisheries in one (1) municipality (Figure 7).

Figure 7. Type and number of Secondary/Tertiary LHZs in Zamboanga Peninsula
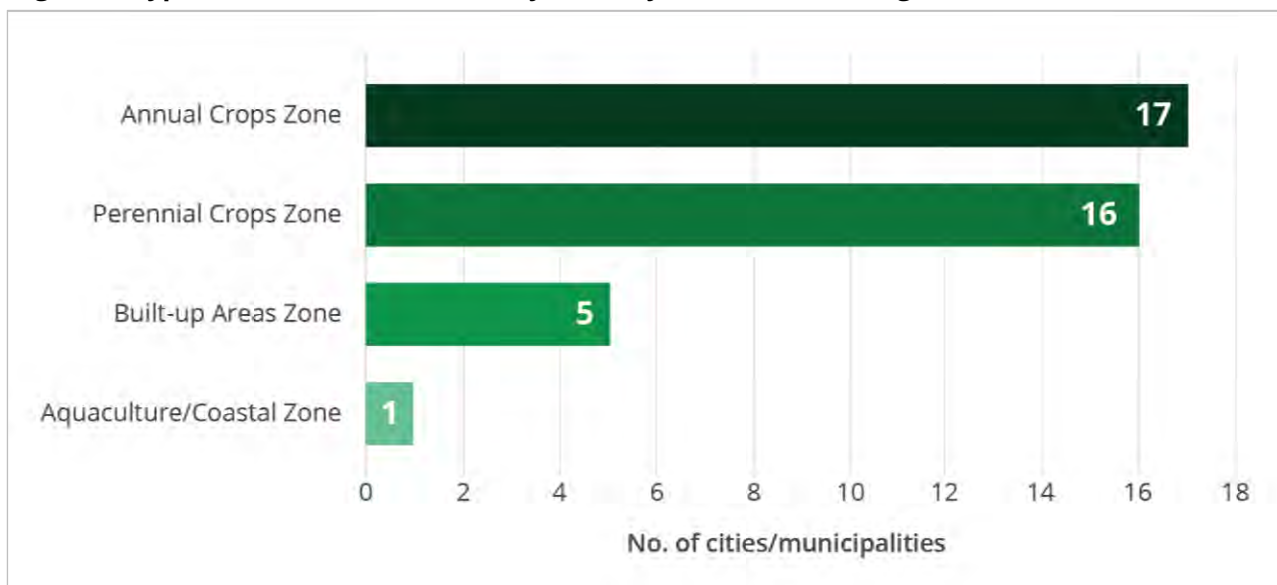
In terms of land area, annual crops occupied the largest size with approximately 843,000 ha. which constitutes 41% of the total land area of ZAMBOANGA PENINSULA. It was followed by rainfed rice and annual crops with approximate land areas of 504,000 ha. (25%) and 199,000 ha. (10%), respectively (Figure 8).

Figure 8. Land area occupied by the major LHZs in Zamboanga Peninsula
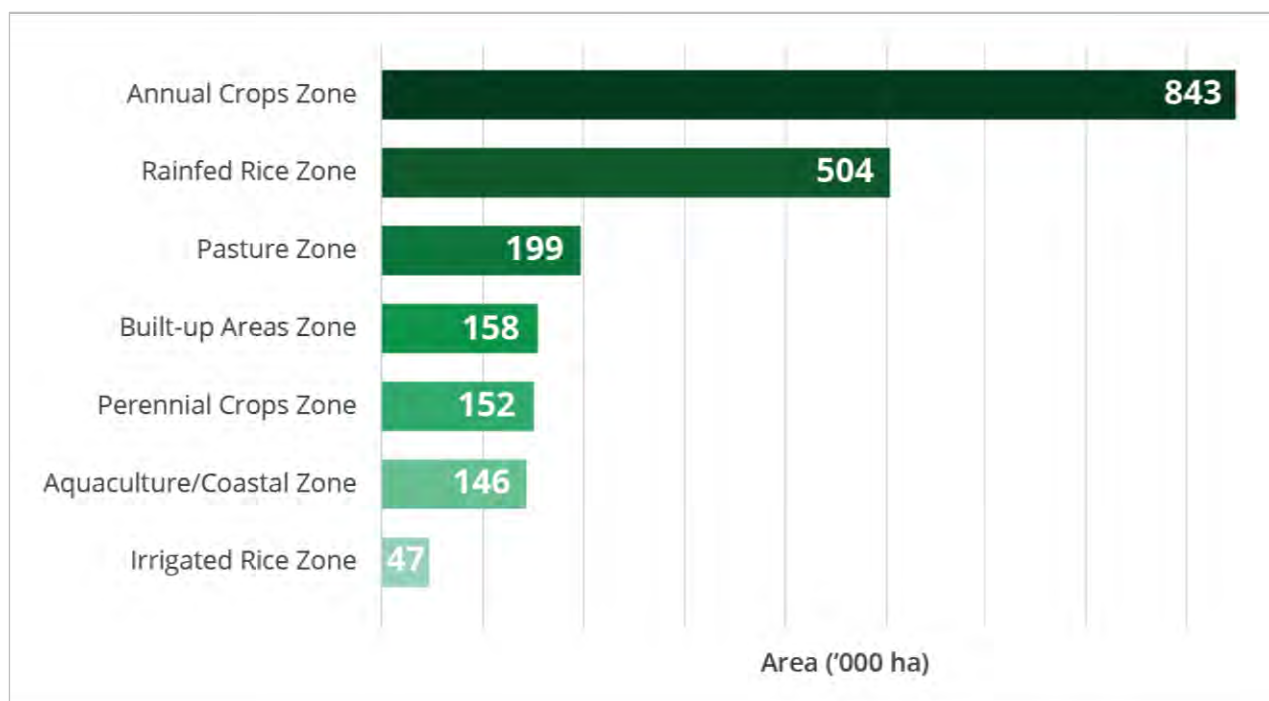
In terms of livelihood diversity, only four (4) cities and 34 municipalities or approximately 53% of Zamboanga Peninsula have Secondary/Tertiay LHZ (Annex 2). While the remaining two (2) cities and 30 municipalities or 47% of the region have no secondary/tertiary LHZ.

3.2.3. Complementary Activities in Zamboanga Peninsula

Tourism emerged as the most common complementary activity in Zamboanga Peninsula with six (6) cities and 30 municipalities covered, followed by livestock and poultry in 20 municipalities, and mining in six (6) municipalities (Annex 2). Conversely, one (1) city and 27 municipalities in the region do not have complementary activities in their livelihoods.

3.3. Climate Risks Zones

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 support the result of the validation workshop which revealed that flood and drought are the climate-related hazards which have the greatest impact on the region. To illustrate the impact of these climate-related 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.

Majority of the areas in Zamboanga Peninsula have "low" risk to drought. However, the city of Zamboanga (Built-up Areas LHZ) in Zamboanga del Sur and the municipality of Sibuco (Annual Crops LHZ) in Zamboanga del Norte have "moderate" DSI.

Similarly, the FSI values of the areas in Zamboanga Peninsula show that majority have low risk to flooding. Some areas, however, have moderate FSI values including the municipalities of Siay (Irrigated Rice LHZ) and Olutanga (Annual Crops LHZ) in the province of Zamboanga Sibugay. The municipality of Tambulig (Irrigated Rice LHZ) in Zamboanga del Sur is the lone area with high risk to flooding.

Figure 9. Validated climate-related hazard maps of Zamboanga Peninsula

Drought Risk

Saltwater Intrusion Risk

Flood Risk

Sea Level Rise Risk

Typhoon Risk

Storm Surge Risk

VERY LOW | LOW | MODERATE | HIGH | VERY HIGH
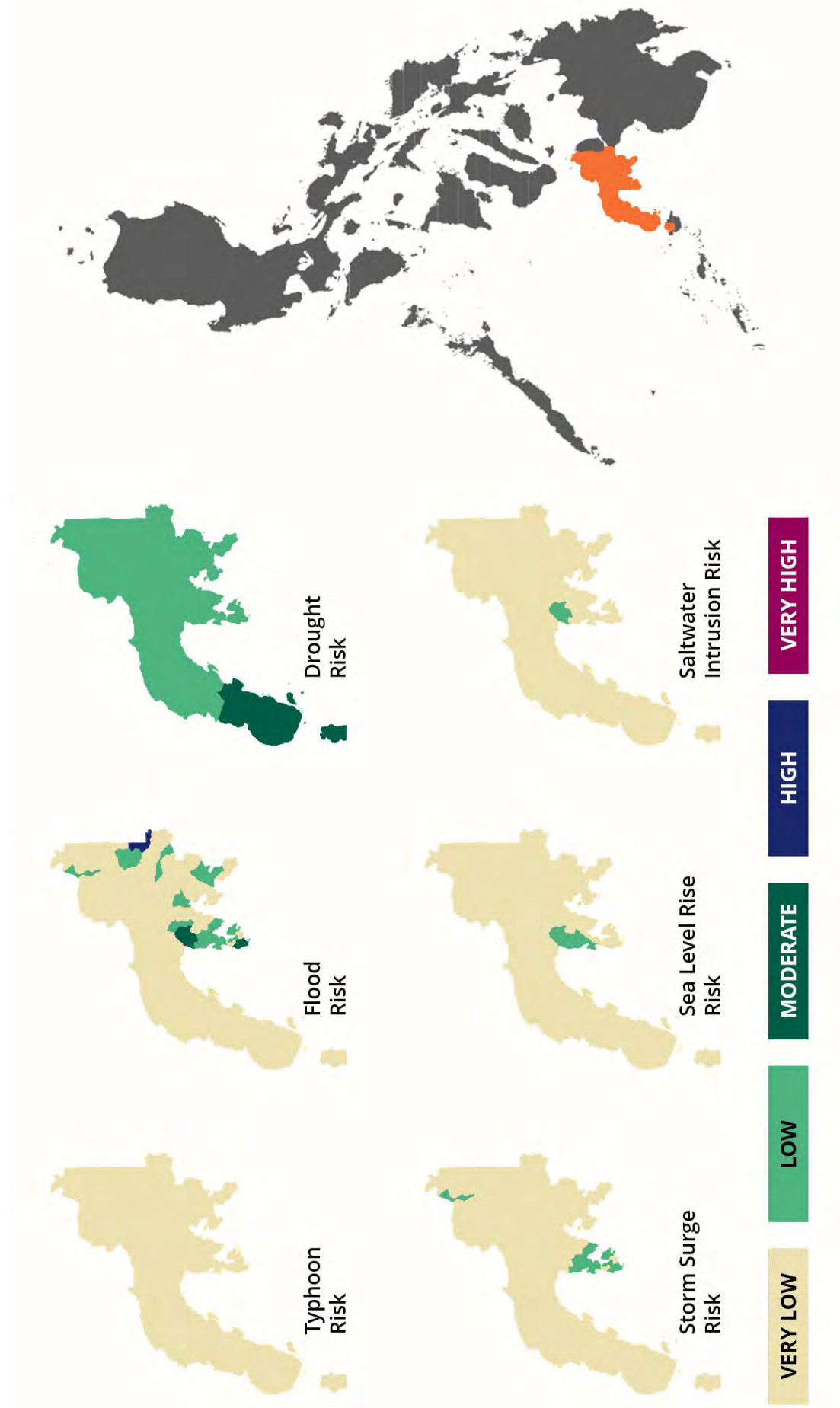
3.4. Projected Impacts of Climate-Related Hazards on Livelihoods

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 Zamboanga Peninsula 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 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 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 Zamboanga Peninsula

As seen in Figure 10, most of the LHZs in Zamboanga Peninsula 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, 64 municipalities or around 89% of Zamboanga Peninsula will experience an increase in temperature by 2050 (Table 5).

Table 5. Areas in Zamboanga Peninsula which will experience increase in temperature (>5ºC) by 2050.

Zamboanga del Norte	Sirawai, Siocon, Gutalac, Katipunan, Sibuco, Labason, Liloy, Salug, Tampilisan, Godod, Kalawit, Dipolog City, Manukan, La Libertad, Rizal, Sibutad, Piñan, Polanco	Annual Crops LHZ
	Dapitan City	Aquaculture/Coastal LHZ
	Siayan, Sindangan, Jose Dalman	Pasture LHZ
Zamboanga del Sur	Margosatubig, Pitogo, Bayog, Lapuyan, San Miguel, Sominot, Guipos, Tigbao, Aurora, Josefina,	Annual Crops LHZ

---

[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.

	Tabina, Vincenzo A., Sagun, Dumalinao, Labangan, Mahayag, San Pablo, Tukuran	
	Dinas, Kumalarang, Lakewood	Aquaculture/Coastal LHZ
	Molave, Tambulig	Irrigated Rice LHZ
	Dumingag	Pasture LHZ
	Dimataling, Ramon Magsaysay	Rainfed Rice LHZ
	Tungawan, Mabuhay, Olutanga, Talusan, Buug, Diplahan, Imelda, Ipil, Roseller Lim, Alicia, Malangas	Annual Crops LHZ
Zamboanga Sibugay	Kabasalan, Payao	Aquaculture/Coastal LHZ
	Siay	Irrigated Rice LHZ
	Naga	Perennial Crops LHZ
	Titay	Rainfed Rice LHZ
City of Isabela		Aquaculture/Coastal LHZ

The most recent data from the Philippine Rice Information System (PRISM) shows the peak of planting rice in Zamboanga Peninsula (Figure 12) based on the area planted in 2022-2023. Most areas in the region plant rice from the months of September to November wherein October is the peak of planting during the first semester of 2022. On the other hand, peak of planting during the second semester starts in December 2022 and starts to decline until March of the succeeding year. 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 Table 6, the impact of inadequate amount of rainfall in 2019 shows that all farming activity was delayed both rainfed and irrigated rice from in December. No farming activity related to planting is possible in April and May for rainfed rice and until June for irrigated rice. It was followed by a minimal amount of rainfall in the month of June and July, which is adequate to start the land preparation and other activities related to planting.

Based on PAGASA, majority of Zamboanga Peninsula belongs to Type 4 Corona System climatic classification wherein rainfall is evenly distributed throughout the year. Some provinces of the region belong to Type 3 climate wherein season is not very pronounced, dry from November to April, and wet during the rest of the year. And a very small portion with Type 2 climate wherein no dry season with a very pronounced rainfall from November to January. 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 64 areas (including City of Isabela), 22 municipalities are from Zamboanga del Norte, 25 are from Zamboanga del Sur, and 16 are from Zamboanga Sibugay. In terms of the LHZs, the areas to

be affected include: Annual Crops LHZs within 46 municipalities, Aquaculture/Coastal LHZs in city of Isabela and six (6) municipalities, Perennial Crops LHZs in one (1) municipality, Irrigated Rice LHZs in three (3) municipalities, Rainfed Rice LHZs in three (3) municipalities, and Pasture LHZs in four (4) municipalities. 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 Zamboanga Peninsula that are affected by the increase in annual rainfall (>5%) and temperature (>30ºC) by 2050.
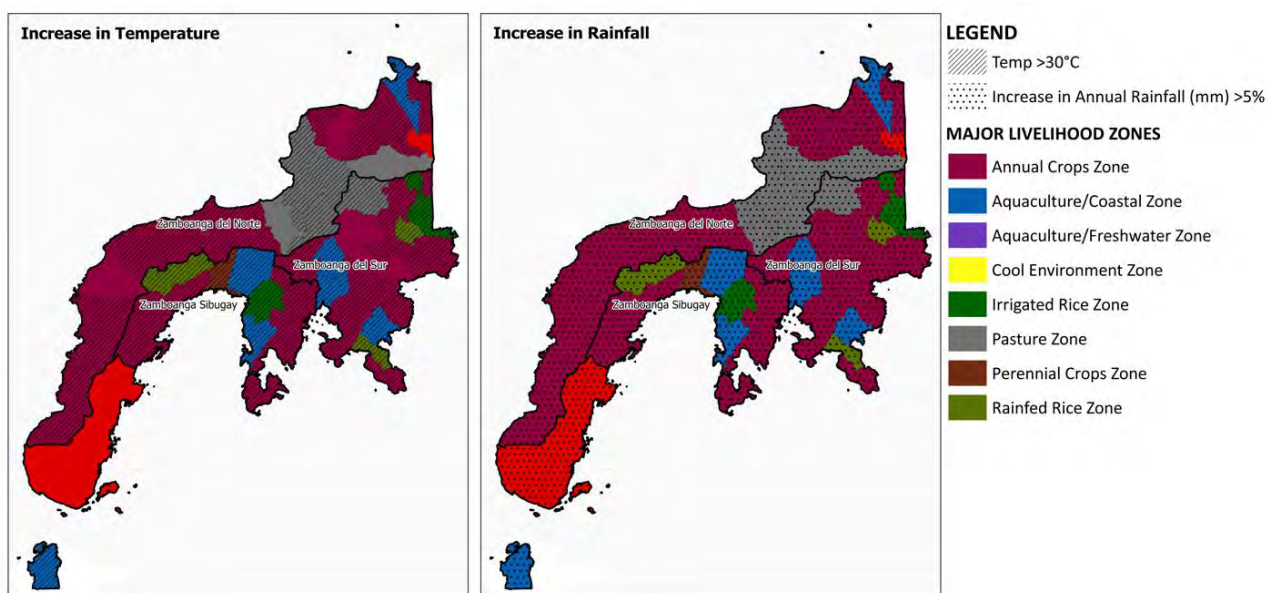
Figure 11. LHZs in Zamboanga Peninsula affected by both projected increase in temperature and annual rainfall (mm) by 2050.
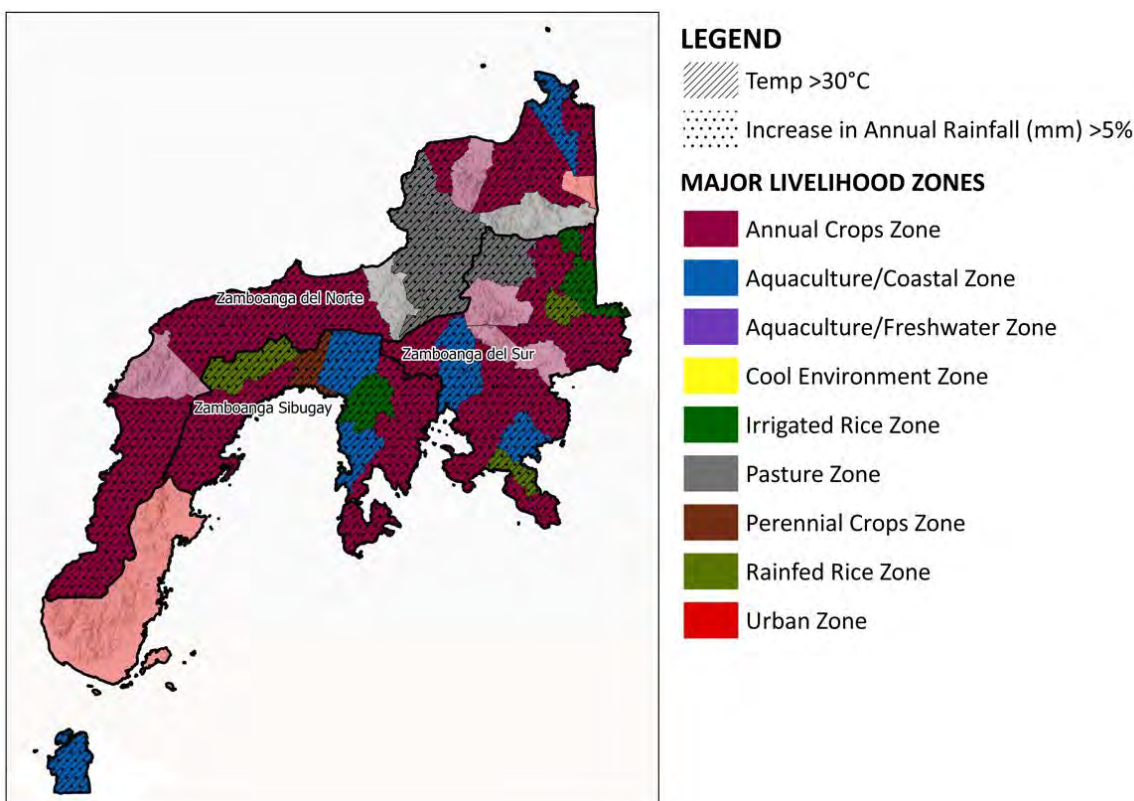
Figure 12. Data from the Philippine Rice Information System (PRISM) showing the peak of planting for rice in Zamboanga Peninsula based on the total area planted in 2022-2023
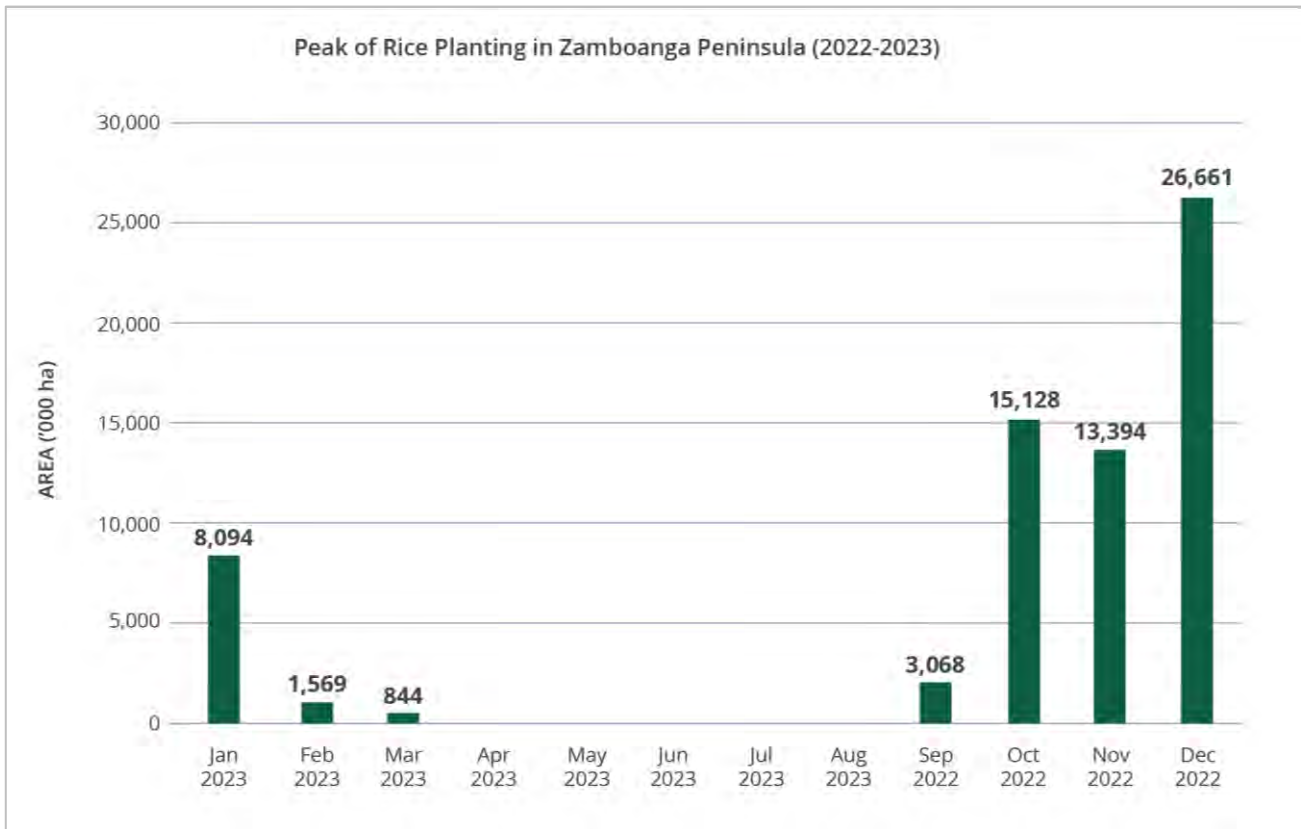
Table 6. Cropping calendar of rice and maize in Zamboanga Peninsula showing how rainfall affects the planting date of the crops. (Data from PAGASA Agroclimatic Assessment in 2019).

ZAMBOANGA PENINSULA CROPPING CALENDAR FOR RICE AND MAIZE IN 2019

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rains	Very low rainfall, insufficient moisture during the month					Sufficient moisture in Zamboanga del Norte / Minimal moisture in Zamboanga del Sur	Sufficient moistures are available during the month	Sufficient moisture during the month in Zamboanga del Norte / Minimal rainfall in Zamboanga del Sur	Insufficient moisture available during the month in Zamboanga del Norte / Sufficient moisture available during the month in Zamboanga del Sur		Way-below normal rainfall received during the month	Ample amount of rainfall received (northern part of the region) / Very minimal rainfall received (southern part of the region)
Rainfed Rice												
Irrigated Rice												
Maize												

LEGEND

- No farming activity related to planting (rice and maize) is possible.
- Delay in land preparation, planting, and transplanting activities has started across the region.
- The newly planted and late planted crops across the region experienced moisture stress.
- Harvesting and post-harvest activities (sun drying, stocking, etc.) has started across the region.

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 Zamboanga Peninsula, 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 13) 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 Zamboanga Peninsula. By 2030, four (4) out of the six (6) major rice production areas in the region will have "low decrease" in rice suitability. These include the Rainfed Rice LHZs within the municipalities of Titay (Zambonga Sibugay), and Dimataling (Zambonga del Sur), and the Irrigated Rice LHZs within the municipalities of Tambulig (Zamboanga del Sur), and Siay (Zamboanga Sibugay). By 2050, all of the six (6) major rice production areas will have low decrease in rice suitability, with the addition of the Irrigated Rice LHZ within the municipality of Molave, and Rainfed Rice LHZ within the municipality of Ramon Magsaysay, both in the province of Zamboanga del Sur.

Irrigated Rice Zone and Rainfed Rice Zone are two of the major livelihood zones in Zamboanga Peninsula.
© WFP/Earvin Perias

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 in most of the areas in the region except for some which will have "low decrease" as seen in Figure 14. These areas include the municipalities of: Rizal, Polanco, Sibutad, and Piñan (Zamboanga del Norte); and Tukuran, Mahayag, Aurora, and Labangan (Zamboanga del Sur). However, by 2050, many of the areas in the region will experience "low" to "high" decrease in maize suitability. These areas include:

Table 7. Changes in suitability of major maize production areas in Zamboanga Peninsula by 2050

Level of Decrease	Province	Municipality/City
High Decrease	Zamboanga del Norte	Rizal, Polanco, Dipolog City
	Zambonga del Sur	Tukuran, Mahayag
Moderate Decrease	Zamboanga del Norte	Sibutad, Piñan, La Libertad, Liloy
	Zamboanga del Sur	Aurora, Labangan, Pitogo, Vincenzo A. Sagun, San Pablo
	Zamboanga Sibugay	Mabuhay, Olutanga, Talusan, Alicia, Ipil
Low Decrease	Zamboanga del Norte	Katipunan, Labason, Manukan, Salug, Pres. Manuel A. Roxas
	Zamboanga del Sur	Tabina, Dumalinao, Lapuyan, Pagadian City, Sominot, Guipos, Margosatubig
	Zamboanga Sibugay	Diplahan, Malangas, Imelda, Tungawan

For banana and other perennial crops (Figure 15), the lone major production area in the region – municipality of Naga in Zamboanga Sibugay, will have "low decrease" in suitability by 2030 and 2050.

Like in other regions in the Philippines, maize farming is part of the annual crop zone in Zamboanga Peninsula.
© Alliance of Bioversity International and CIAT

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

Rice Sensitivity to Climate Change RCP 8.5 Scenario

LEGEND

Irrigated Rice Zone
Rainfed Rice Zone

Change in Future Suitability

Decrease

No Change

Increase

Year 2050

Year 2030

Maize Sensitivity to Climate Change RCP 8.5 Scenario

Change in Future Suitability

Decrease

No Change

Increase

Year 2050

Zamboanga del Sur

Zamboanga del Norte

Zamboanga Sibugay

Year 2030

Zamboanga del Sur

Zamboanga del Norte

Zamboanga Sibugay

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

Banana Sensitivity to Climate Change RCP 8.5 Scenario

Change in Future Suitability

Decrease

No Change

Increase

Year 2050

Zamboanga del Norte
Zamboanga del Sur
Zamboanga Sibugay

Year 2030

Zamboanga del Norte
Zamboanga del Sur
Zamboanga Sibugay
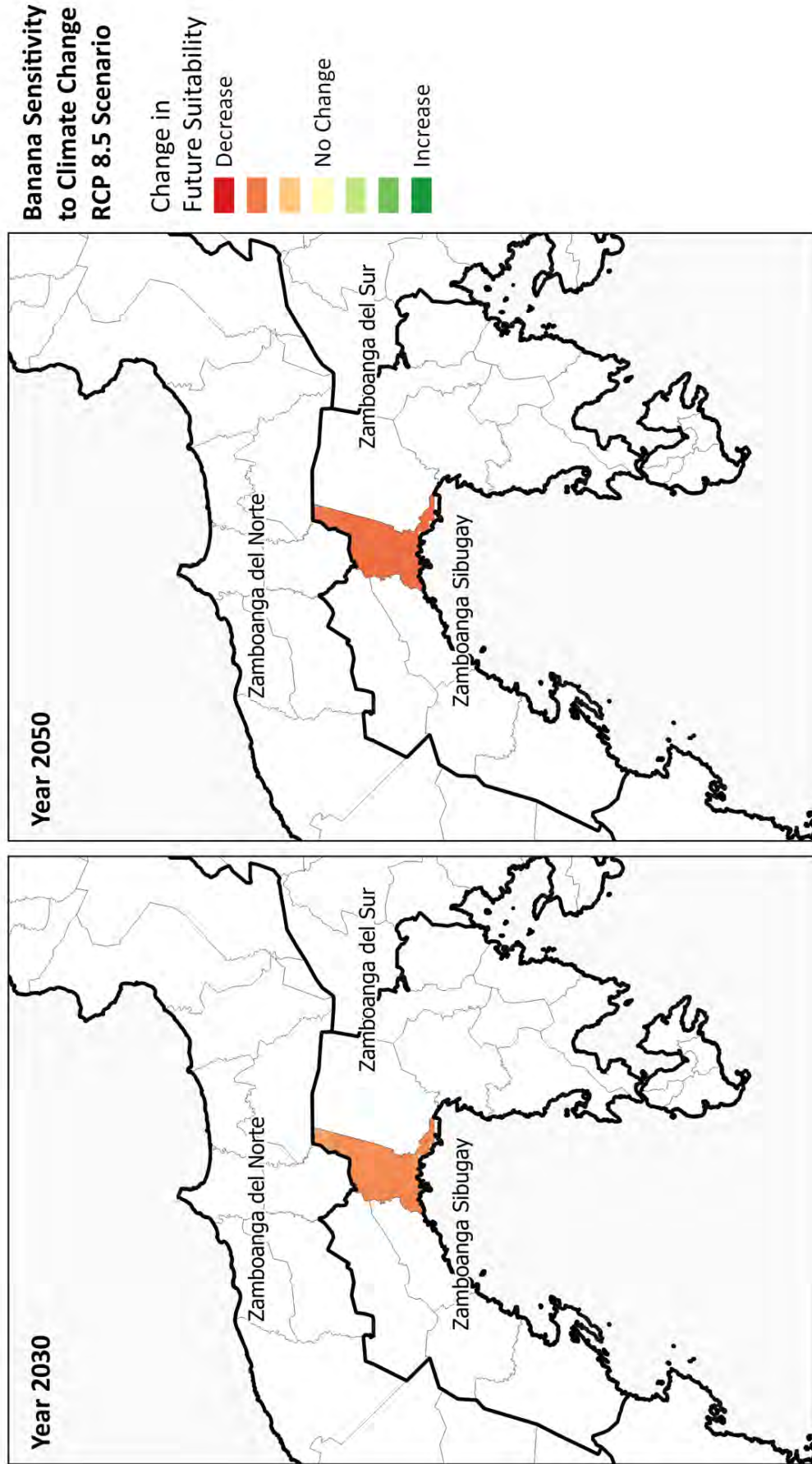
3.4.2.2. Projected Exposure to Pest and Diseases

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 the climate change-induced pests and diseases may result to crop failure, decreasing yield and ultimately, threatening food security. Additionally, such condition increases 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 the 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, all of the Irrigated Rice LHZs (municipalities of: Molave and Tambulig in Zamboanga del Sur, and Siay in Zamboanga Sibugay) and Rainfed Rice LHZs (Dimataling and Ramon Magsaysay in Zamboanga del Sur, and Titay in Zamboanga Sibugay) in the region, 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 following (Figure 10):

Table 8. Annual Crops LHZs that may be affected with Fusarium mycotoxins and southern corn leaf blight by 2050

Province	Municipality/City
Zamboanga del Norte	Sirawai, Siocon, Gutalac, Katipunan, Sibuco, Labason, Liloy, Salug, Tampilisan, Godod, Kalawit, Dipolog City, Manukan, La Libertad, Rizal, Sibutad, Piñan, Polanco

Zamboanga del Sur	Margosatubig, Pitogo, Bayog, Lapuyan, San Miguel, Sominot, Guipos, Tigbao, Aurora, Josefina, Tabina, Vincenzo A., Sagun, Dumalinao, Labangan, Mahayag, San Pablo, Tukuran
Zamboanga Sibugay	Tungawan, Mabuhay, Olutanga, Talusan, Buug, Diplahan, Imelda, Ipil, Roseller Lim, Alicia, Malangas

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 50 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 Zamboanga Peninsula 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, the municipality of Naga in Zamboanga Sibugay, considered as the only Perennial Crops LHZ in the region, is at-risk of Fusarium Wilt and Black Sigatoka infestation, given the increase in temperature at this area by 2050.

3.4.3. Projected Impacts on Aquaculture

Aquaculture was also identified as a major LHZ in seven (7) areas in Zamboanga Peninsula. 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 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 30°C 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 Zamboanga Peninsula, 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 the seven (7) municipalities/cities classified under Aquaculture/Coastal Fisheries LHZ located along the coastline provinces, namely: Dapitan City (Zamboanga del Norte); Dinas, Kumalarang, Lakewood (Zamboanga del Sur); Kabasalan, Payao (Zamboanga Sibugay); and city of Isabela.

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.

Livestock production is considered as a complementary economic activity in Zamboanga Peninsula.
© Alliance of Bioversity International and CIAT

During the validation workshop, the experts identified livestock production as the complementary activity in six (6) out of the 72 municipalities or only 8% in Zamboanga Peninsula. These municipalities are classified as Pasture LHZs. Based on the latest available data from PSA - Zamboanga Peninsula in January – March 2022, there is an estimated total of 8,112,388 heads/birds of livestock and poultry in the region - 13% is from livestock and 87% is from poultry. Conversely, in terms of production in metric tons, swine/hog has the highest volume with a total of 19,542.79 MT (Table 9). There is no available data of livestock and poultry disaggregated by province based on the latest record from PSA.

Table 9. Livestock and Poultry Statistics in Zamboanga Peninsula – PSA 2022

| Commodity	Volume of Production in MT	Number of Heads/Birds
Carabao	2,292.43	139,755
Cattle	1,472.88	107,471
Swine/Hog	19,543.79	724,471
Goat	548.00	118,485
Chicken	9,812.84	6,592,560
Duck	83.37	429,646

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).

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 Zamboanga Peninsula.

LHZ with presence of Livestock and Poultry
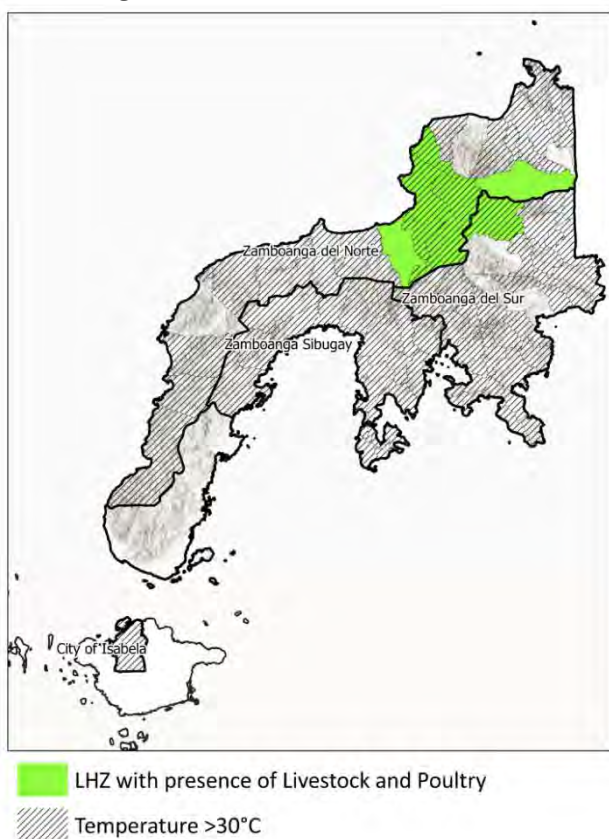
Temperature >30°C

Based on the projected change in temperature by the year 2050, there are four (4) livestock and poultry areas at-risk in Zamboanga Peninsula. These are the municipalities of Jose Dalman, Siayan, Sindangan (Zamboanga del Norte), and Dumingag (Zamboanga del Sur) (Figure 16).

In addition, livestock production in the Philippines is vulnerable 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 a report last September 2023, Typhoons Egay (Doksuri) and Falcon (Khanun) enhanced the Southwest Monsoon (Habagat) causing a total

---

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

damage to agriculture of PHP 12 billion, which includes livestock and poultry (Patinio, 2023). The most affected area in Mindanao includes SOCCSKSARGEN, CARAGA, and Zamboanga Peninsula.

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.

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 at-risk 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 Zamboanga Peninsula and the specific LHZs that are at-risk. As discussed in section 3.3, the municipality of Tambulig (Zamboanga del Sur) which is classified as an Irrigated Rice LHZ, is the most exposed to flooding in Zamboanga Peninsula. Meanwhile, the municipalities of Siay (Irrigated Rice LHZ) and Olutanga (Annual Crops LHZ) in the province of Zamboanga Sibugay are moderately at-risk to flooding.

Figure 17. Flood Susceptibility Index of municipalities and cities in Zamboanga Peninsula
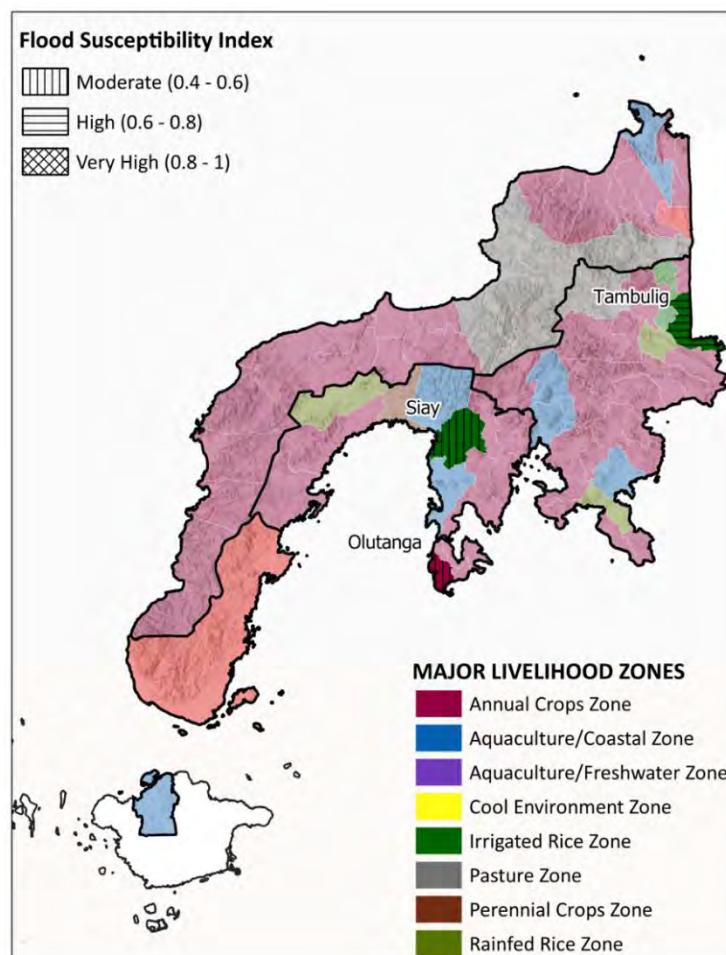
Generally, the map shows that Zamboanga Peninsula is not a flood-prone region. However, recent extreme weather events have caused severe damages in the region, particularly to the agriculture and fisheries sector. Severe Tropical Storm Paeng[9] that hit the region in 2022, particularly in Zamboanga City, left estimated damages amounting to PHP 44.8 million and PHP 22.4 million on the fishery and agricultural sector, respectively. Given that all the areas in the region will experience an increase in the amount of annual rainfall by 2050, this may further exacerbate the risk to flooding, particularly of the LHZs presented in Figure 17. Rice production areas in the municipalities of Siay and Tambulig in Zamboanga Sibugay are the LHZs that are most at-risk since these areas have the highest FSIs which may worsen following the increase in the amount of annual rainfall by 2050, if no interventions are made.

In terms of adaptation strategies, rice production areas at-risk 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 risk, are improvements on drainage system, temporary flood barriers, and early planting or shifting of crop calendars.

Figure 18. Drought Susceptibility Index of municipalities and cities in Zamboanga Peninsula
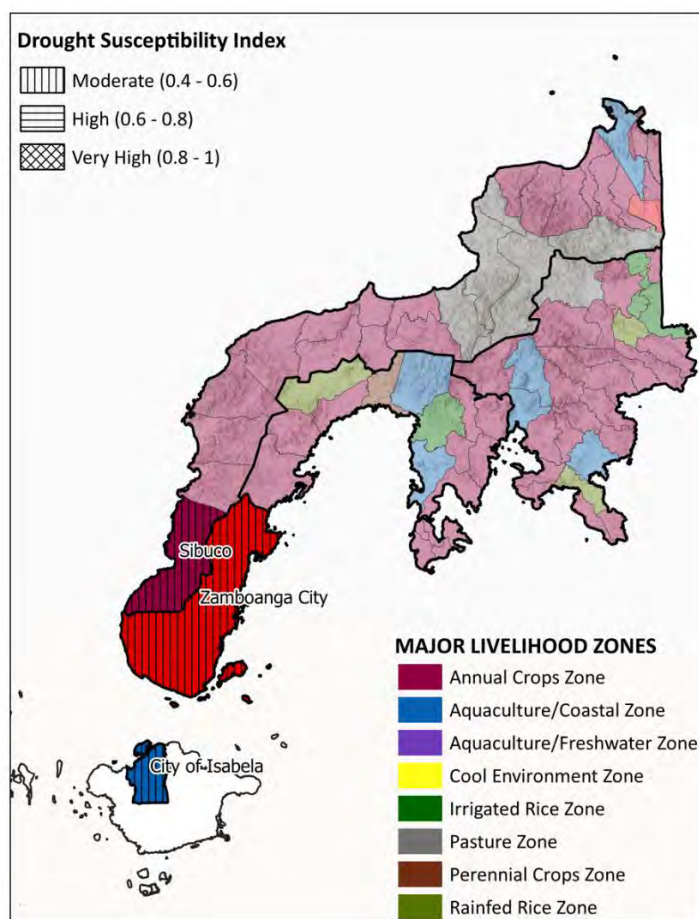
Meanwhile, Figure 18 shows the susceptibility of Zamboanga Peninsula to drought. As seen in the map, the city of Zamboanga (Built-up Areas LHZ) and the municipality of Sibuco (Annual Crops LHZ), both in the province of Zamboanga del Norte, have "moderate" DSI.

The risk to drought, especially for the municipality of Sibuco, may worsen since this area is also projected to experience an increase in temperature of greater than 5°C by 2050. Significant rainfall deficits may impact annual crops, such as maize, by inducing stress at the late vegetative and reproductive growth phases which may reduce yields (USDA, 2016). 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.

---

[9] https://www.pna.gov.ph/articles/1188119

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 several areas in Zamboanga Peninsula have "moderate" to "high" incidences of poverty in 2015.

Figure 19. Poverty incidences of municipalities and cities in Zamboanga Peninsula in 2015 (PSA, 2017)
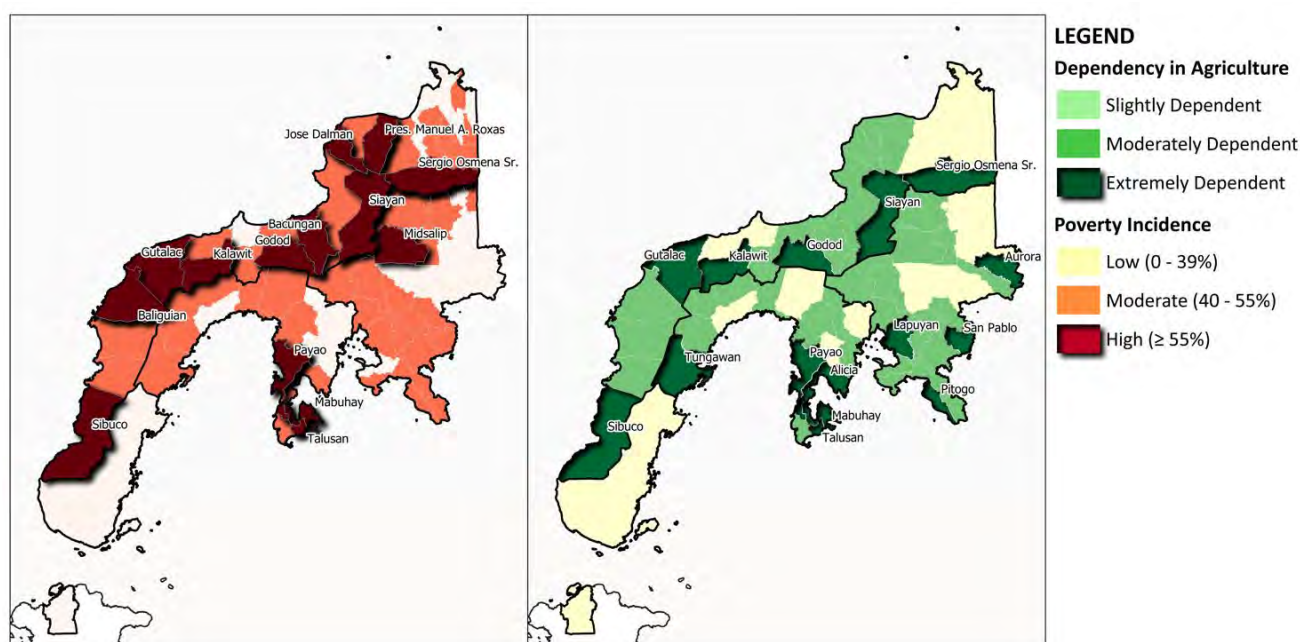
Figure 19 also shows that the poorest areas in the region are also extremely dependent[10] on agriculture. These areas are mainly agriculture and fisheries zones (Annual Crops LHZs and Aquaculture/Coastal Fisheries LHZs), hence, prioritizing programs that will boost crop and fisheries productivity are 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. As previously discussed, the municipality of Sibuco, which had the highest poverty incidence among all the municipalities in Zamboanga Peninsula, also has high risk to drought. Moreover, the municipality is projected to experience increase in both temperature and rainfall by 2050 which can likely exacerbate the climate risks in the municipality. This can potentially affect livelihood and income of farmers which may also increase poverty in the area. 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

---

[10] 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).

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 on 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[11] is considered as one of the leading problems related to undernutrition, particularly among children in the Philippines. As shown in Figure 20, Zamboanga Peninsula has generally low prevalence of the condition. However, moderate cases of stunting were recorded in the municipalities of Labangan (Annual Crops LHZ), Tigbao (Annual Crops LHZ), and Kumalarang (Aquaculture/Coastal LHZ) in Zamboanga del Sur, and Talusan (Annual Crops LHZ) in Zamboanga Sibugay.

Figure 20. Prevalence of stunting in Zamboanga Peninsula

---
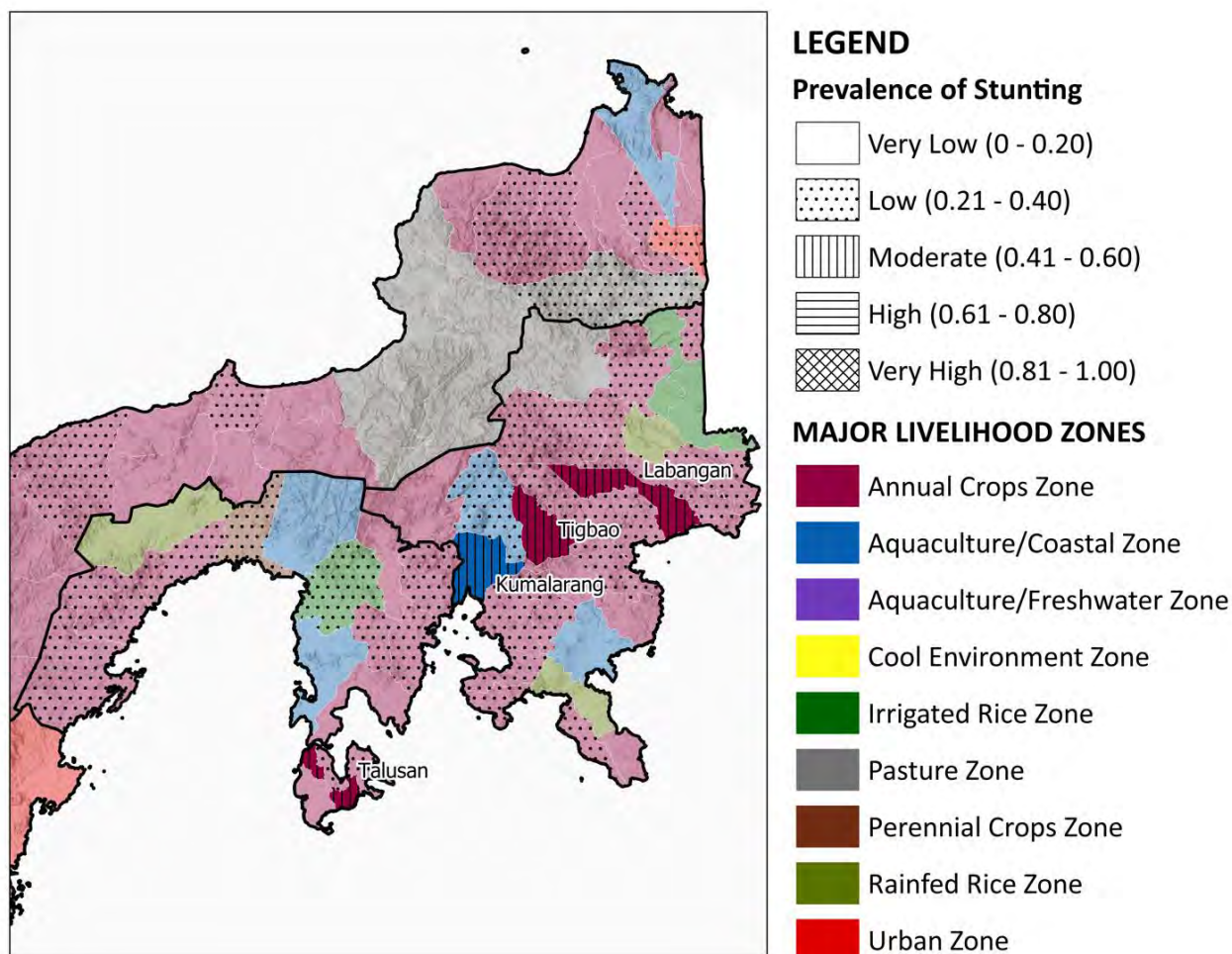
[11] Stunting is "the impaired growth and development that children experience from poor nutrition, repeated infection, and inadequate psychosocial stimulation" (World Health Organization, 2015).

According to the World Health Organization (WHO, 2015), a child becomes stunted due to inadequate nutrition which limits intake of growth-promoting nutrients. Poor nutrition is often associated with lack of access to diversified food and ineffective healthcare system for both the children and their mothers.

In relation to the LHZs, data show that the municipalities of Talusan (Zamboanga Sibugay); and Tigbao, and Labangan (Zamboanga del Norte), which are classified as Annual Crops LHZs, have limited sources of livelihood. The municipalities of Talusan and Tigbao only have perennial crops farming and tourism as their Secondary/Tertiary livelihood, respectively. Meanwhile, the municipality of Labangan relies greatly to annual crops production as it does not have an identified Secondary/Tertiary livelihood. This data reveals that these three (3) municipalities, which were also identified as among the areas in the region with highest cases of stunting, have limited sources of livelihood and consequently, may have low dietary diversity.

According to a study by Dwivedi et. al. (2017), the lack of diversified diet threatens food security and human health. The authors emphasized that diversifying farm production and facilitating access to market are important to improve dietary diversity on subsistence farms. Therefore, interventions to diversify livelihood sources and to improve access to healthy and nutritious food in the aforementioned municipalities should be taken to prevent any further increase on the cases of stunting among infants and young children.

5. Summary and Conclusion

This report highlights the research findings of the CCFSA in Zamboanga Peninsula. Temporal and spatial risks and impacts of climate change to 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 Zamboanga Peninsula were well-defined and characterized in this report. 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 Zamboanga Peninsula shows that it remains to be an agriculture-based region relying largely on annual crops farming and fishing livelihoods. However, the analysis showed that climate-related hazards, particularly drought and flood, will continue to adversely impact these agriculture and aquaculture LHZs. Specifically, the municipalities under the Annual Crops LHZs, Rainfed and Irrigated Rice 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 and annual crops, in Zamboanga Peninsula 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 Zamboanga Peninsula given that aquaculture-based activities were among the region's major livelihood.

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.

Integrating these climate risk datasets with the LHZ map, planners and decision makers can target specific locations of the livelihoods that are most susceptible 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 Zamboanga Peninsula. While recent data shows improvement on the region's poverty and health statistics, many individuals remain below the poverty line. Moreover, analysis of climate risks and hazards reveal that climate change impacts will potentially disrupt 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 susceptible 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.

There is a need to develop climate change adaptation strategies to mitigate risks on crop production, livelihoods, and food security in Zamboanga Peninsula.

Left: © WFP/Jacob Maentz
Bottom: © WFP/Chase Lim

6. Recommendations

The report aimed at understanding the potential impacts of climate change on the livelihoods in the context of Zamboanga Peninsula, 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, and nutrition.

Integration of Climate Risk and Vulnerability Assessment: 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 solid foundation in the identification of the most vulnerable livelihoods which has a significant implication to food security and nutrition.

Inclusion of Data on Yield for Key Crops: Comprehensive data on current yield and historical trends can help in the analysis of the impacts of future climate on the performance of the crop and how it can directly affect food security.

Granular Data on Nutrition: Nutrition is one of the critical components of food security since the availability of diverse and nutritious food largely depends on the type of crops suitable in the specific livelihoods. 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 a more diverse food.

Inclusion of Gender and Women in Agriculture: This is important to ensure inclusivity and equity by identifying the roles of women in agriculture and in other livelihoods. Knowing the perspective of women in the specific challenges and opportunities related to climate will contribute to a more holistic approach.

7. References

Asian Development Bank. 2014. Urban Climate Change Resilience: A Synopsis. Available at:
https://www.adb.org/publications/

Asadi, J.A. 2018. "Potability of ground water supply in Sulu, Philippines", International Journal of
Development and Sustainability, Vol. 7 No. 10, pp. 240-246

Bangayan, H. (2023). *DOH-9 launch project to Combat Child Malnutrition*. Philippine Information Agency
(PIA). https://pia.gov.ph/news/2023/07/12/doh-9-launch-project-to-combat-child-malnutrition

Bebber, D.P. 2019. Climate change effects on black sigatoka disease of banana. Philosophical
Transactions of the Royal Society for Biological Sciences 374(1775):20180269.

Busogoro, J.P., Etameo, J.J., Lognay, G., Messiaen, J., van Cutsem, P., & Lepoivre, P. 2004. Analysis of the
mechanisms of action of Mycosphaerella fijiensis toxins during the development of Black leaf
streak disease. In: Jain MS, Swennen R (eds.) Banana improvement: Cellular, molecular biology,
and induced mutations. Enfield, NH: Science Publishers.Climate Change Commission. n.d.
Available at: https://bit.ly/3rRcjkI

CIAT; DA-AMIA. 2017. Climate-Resilient Agriculture in Philippines. CSA Country Profiles for Asia Series.
International Center for Tropical Agriculture (CIAT); Department of Agriculture - Adaptation and
Mitigation Initiatives in Agriculture, Government of the Philippines. Manila, Philippines. 24 p.

Davis, A. 2023. Perennial Grains could be the Future of Sustainable Agriculture. Environmental and
Energy Study Institute. Retrieved from: https://www.eesi.org

Davis, B. & Caprazli, K. 2019. The role of agriculture and rural development in achieving SDG 1. UN
Economic Commission for Africa (ECA) Conference Centre, Addis Ababa, Ethiopia. Retrieved from:
https://www.un.org/development/desa/dspd/wp-content/uploads/sites/22/2019/03/EGM-on-ERP-
FAO-Presentation-in-AA-on-27-FEB-2019.pdf

Doody, A. 2020. Pests and diseases and climate change: Is there a connection. Retrieved from:
https://www.cimmyt.org/news/pests-and-diseases-and-climate-change-is-there-a-
connection/FAO. 2016. Climate change implications for fisheries and aquaculture: Summary of
the findings of the Intergovernmental Panel on Climate Change Fifth Assessment Report. FAO
Fisheries and Aquaculture Circular No. C1122. Rome.

FAO. 2021. Climate change fans spread of pests and threatens plants and crops, new FAO Study.
Retrieved from: https://www.fao.org/news/story/en/item/1402920/icode/

GOVPH. 2015. El Niño Advisory no. 3: Drought assessment as of May 6, 2015: Official Gazette of the
Republic of the Philippines. Retrieved from: https://www.officialgazette.gov.ph/2015/05/06/el-
nino-advisory-no-3-drought-assessment-as-of-may-6-2015/

Grillo, J. (2009). Application of the Livelihood Zone Maps and Profiles for Food Security Analysis and Early Warning. United States Agency for International Development Famine Early Warning Systems Network (FEWS NET). Hörtenhuber SJ et al. 2020. The effect of climate changeinduced temperature increase on performance and environmental impact of intensive pig production systems. Sustainability 12(22):9442. Available at: https://doi.org/10.3390/su12229442

Gowda, P., et al. 2018. Ch. 10: Agriculture and rural communities. In: *Impacts, risks, and adaptation in the United States: Fourth national climate assessment, volume II*. U.S. Global Change Research Program, Washington, DC, p. 401.

IFRC (International Federation of Red Cross). 2016. In Pictures - El-Niño and Food Security in the Philippines. Available at: https://bit.ly/37kI7oA

IPCC: Climate Change 2014: Synthesis Report, Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. 2014. Available at: https://www.ipcc.ch/assessment-report/ar5/

Israel, D. & Briones, RM. 2012. Impacts of Natural Disasters on Agriculture, Food Security, and Natural Resources and Environment in the Philippines. Philippine Institute for Development Studies (PIDS). Discussion Paper Series,

Katzfey, J.J. 2015. Climate Scenarios for the Philippine Climate Change Adaptation Project (PhilCCAP). CSIRO, Australia.

Kaur, A., Dhaliwal, L.K., & Panny, P.P.S. 2015. Role of meteorological parameters on sheath blight of rice under different planting methods. International Journal of Bio-research and Stress Management 6(2):214−219IRRI Rice Knowledge Bank. 2020. Rice Knowledge Bank, Philippines. International Rice Research Institute. Retrieved from: https://bit.ly/3Ccycjh

Lapidez, J. P., Tablazon, J., Dasallas, L., Gonzalo, L. A., Cabacaba, K. M., Ramos, M. M., Suarez, J. K., Santiago, J., Lagmay, A. M., & Malano, V. 2015. Identification of storm surge vulnerable areas in the Philippines through the simulation of Typhoon Haiyan-induced storm surge levels over historical storm tracks. Natural Hazards and Earth System Sciences, 15(7), 1473–1481. Available at: https://doi.org/10.5194/nhess-15-1473-2015

Lara LJ; Rostagno MH. 2013. Impact of heat stress on poultry production. Animals 2013, 3, 356-369. Available at: https://doi.org/10.3390/ani3020356

Lass A. 2019. Avoid production losses in swine due to heat stress. Available at https://bit.ly/37jbN5O

Mahmoud K.Z., et al. 1996. Acute high environmental temperature and calcium-estrogen relationship in the hen. Poultry Science 75:1555−1562. Available at: https://doi.org/10.3382/ps.0751555

NEDA (National Economic and Development Authority) (2018). Climate Adaptation and Mitigation Plan for the Agriculture Sector. Retrieved from https://www.neda.gov.ph/wp-content/uploads/2018/08/Climate-Adaptation-and-Mitigation-Plan-for-the-Agriculture-Sector.pdf

"OCHA" United Nations Office for the Coordination of Humanitarian Affairs. 2019. Available at: www.unocha.org/

Omar, K., Noori, Z., Ali & Cimellaro, G. & Mahin, S. 2019. Resilience Assessment of Urban Communities. Collection of Technical Papers - AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference. 5. 04019002. 10.1061/AJRUA6.0001004.

Oulaytham L. 2014. The study on smallholder aquaculture in flood and drought areas in Phiengand Paklai District, Xayabuly Province, and Outhoumphone and Champhone District, Savannakhet Provinces. 2nd Mekong Climate Change Forum: Adaptation to Climate Change in the Transboundary Context. Retrieved from: https://www.mrcmekong.org/assets/Publications/Events/2nd-CCAI-Forum/7-2-3-The-study-on-smallholder-aquaculture-in-flood-and-drought-areas-Laos.pdf.

PAGASA. 2019. El Niño Advisory No.2. Philippines Atmospheric, Geophysical and Astronomical Services Administration. Quezon City, Philippines. Available at: https://www.pagasa.dost.gov.ph/

PAGASA. 2018. Observed and projected Climate Change in the Philippines. Philippines Atmospheric, Geophysical and Astronomical Services Administration. Quezon City, Philippines.

Pajuelas, B. G. 2000. "A study of rainfall variations in the Philippines: 1950-1996," Science Diliman, vol. 12, no. 1, pp. 1–28.

Pang SHE, De Alban JDT & Webb EL. 2021. Effects of climate change and land cover on the distributions of a critical tree family in the Philippines. Science Report 11:27. Available at: https://doi.org/10.1038/s41598-020-79491-9

Patinio, F. (n.d.). Da: Damage to agri due to "Habagat," 2 typhoons reaches P12-B. https://www.pna.gov.ph/articles/1209920

Philippine Statistics Authority (PSA). Philippine Standard Geographic Code. 2021. Available at: https://psa.gov.ph/classification/psgc/

Philippine Statistics Authority. Census of the Population (CPH). 2020

Philippine Statistics Authority (PSA). 2022. *Livestock and Poultry Statistics*. Philippine Statistics Authority Zamboanga Peninsula. https://rsso09.psa.gov.ph/content/livestock-and-poultry-statistics-2nd-quarter-2022

Preventionweb. 2021. Climate change drives disaster risk. Climate change as a disaster risk driver. Retrieved from: https://www.preventionweb.net/understanding-disaster-risk/risk-drivers/climate-change

Rauw W et al. 2020. Impact of environmental temperature on production traits in pigs. Science Report 10(1):2106. Available at: https://doi.org/10.1038/s41598-020-58981-w

Rivera D. 2022. Paeng agriculture damage breaches P3 billion. Philstarcom. Retrieved from:
https://www.philstar.com/nation/2022/11/06/2221816/paeng-agriculture-damage-breaches-p3-billion#:~:text=Damage%20to%20livestock%20and%20poultry.

Salvacion, A.R., Pangga, I.B., & Cumagun, C.J. 2015. Assessment of mycotoxin risk on corn in the
Philippines under current and future climate change conditions. Rev Environ Health. 30(3):135-42.
Available at: doi: 10.1515/reveh-2015-0019.

Salvacion, A.R., Cumagun, C.J., Pangga, I.B., Magcale-Macandog, D.B., Sta Cruz, P.C., Saludes, R.B.,
Solpot, T.C., & Aguilar, E.A. 2019. Banana suitability and Fusarium wilt distribution in the
Philippines under climate change. Spatial Information Research 27:339–349.

Santiago, S. (2020). *Stunted, underweight kids "prevalent" in 10 Zambo villages*. Philippine News Agency.
https://www.pna.gov.ph/articles/1110220

Secor SM. 2009. Specific dynamic action: a review of the postprandial metabolic response. Journal of
Comparative Physiology B 179:1–56. Available at: https://doi.org/10.1007/s00360-008-0283-7

Thomas V., Albert J.R., & Perez R. 2012. Examination of Intense Climate-related Disasters in Asia-Pacific.
Discussion Paper 2012–16. Philippine Institute for Development Studies. Available at:
https://bit.ly/3Ac2alN

Thomas, V., & LLpez, R. 2015. Global increase in climate-related disasters. SSRN Electronic Journal.
Available at: https://doi.org/10.2139/ssrn.2709331

Villado, R., Bayot, R., Rosimo, M.,Monville-Oro, E., Gonsalves, J., Ilaga, A., Sebastian, L., Manalo, U., &
Baltazar, P. 2019. The AMIA Experience: Supporting local actions for Climate Resilient Agriculture.
Integrating Agriculture in National Adaptation Plans (NAP-Ag) Programme – led by the United
Nations Development Programme (UNDP) and the Food and Agriculture Organization of the
United Nations (FAO)

Wright, J. H., Hill, N. A., Roe, D., Rowcliffe, J. M., Kümpel, N. F., Day, M., Booker, F., & Milner-Gulland, E. J.
2015. Reframing the concept of alternative livelihoods. Conservation Biology, 30(1), 7–13.
Available at: https://doi.org/10.1111/cobi.12607

ANNEX 1: List of livelihood zones in Zamboanga Peninsula

Province	City/Municipality	Major LHZ	Secondary/Tertiary LHZ	Complementary Activity
Zamboanga del Norte	Baliguian	Annual Crops Zone		
Zamboanga del Norte	Dipolog City	Annual Crops Zone	built-up areas and tourism	tourism
Zamboanga del Norte	Godod	Annual Crops Zone		
Zamboanga del Norte	Gutalac	Annual Crops Zone		tourism
Zamboanga del Norte	Kalawit	Annual Crops Zone		mining
Zamboanga del Norte	Katipunan	Annual Crops Zone	perennial crops and tourism	tourism
Zamboanga del Norte	La Libertad	Annual Crops Zone		
Zamboanga del Norte	Labason	Annual Crops Zone		
Zamboanga del Norte	Liloy	Annual Crops Zone	perennial crops and tourism	tourism
Zamboanga del Norte	Manukan	Annual Crops Zone	perennial crops	
Zamboanga del Norte	Piñan	Annual Crops Zone		
Zamboanga del Norte	Polanco	Annual Crops Zone	built-up areas, mining, and tourism	mining and tourism
Zamboanga del Norte	Pres. Manuel A. Roxas	Annual Crops Zone	perennial crops	
Zamboanga del Norte	Rizal	Annual Crops Zone		mining
Zamboanga del Norte	Salug	Annual Crops Zone		
Zamboanga del Norte	Sibuco	Annual Crops Zone		mining and tourism
Zamboanga del Norte	Sibutad	Annual Crops Zone	perennial crops	
Zamboanga del Norte	Siocon	Annual Crops Zone	built-up areas, mining, and tourism	mining and tourism
Zamboanga del Norte	Sirawai	Annual Crops Zone		
Zamboanga del Norte	Tampilisan	Annual Crops Zone		tourism

Province	City/Municipality	Major LHZ	Secondary/Tertiary LHZ	Complementary Activity
Zamboanga del Sur	Aurora	Annual Crops Zone		tourism
Zamboanga del Sur	Bayog	Annual Crops Zone		mining and tourism
Zamboanga del Sur	Dumalinao	Annual Crops Zone		tourism
Zamboanga del Sur	Guipos	Annual Crops Zone		mining
Zamboanga del Sur	Josefina	Annual Crops Zone		tourism
Zamboanga del Sur	Labangan	Annual Crops Zone		
Zamboanga del Sur	Lapuyan	Annual Crops Zone		tourism
Zamboanga del Sur	Mahayag	Annual Crops Zone		tourism
Zamboanga del Sur	Margosatubig	Annual Crops Zone		tourism
Zamboanga del Sur	Midsalip	Annual Crops Zone		mining
Zamboanga del Sur	Pagadian City	Annual Crops Zone	built-up areas and tourism	tourism
Zamboanga del Sur	Pitogo	Annual Crops Zone	perennial crops	
Zamboanga del Sur	San Miguel	Annual Crops Zone		mining
Zamboanga del Sur	San Pablo	Annual Crops Zone	perennial crops and tourism	tourism
Zamboanga del Sur	Sominot	Annual Crops Zone		
Zamboanga del Sur	Tabina	Annual Crops Zone	perennial crops and tourism	tourism
Zamboanga del Sur	Tigbao	Annual Crops Zone		tourism
Zamboanga del Sur	Tukuran	Annual Crops Zone		tourism
Zamboanga del Sur	Vincenzo A. Sagun	Annual Crops Zone		
Zamboanga Sibugay	Alicia	Annual Crops Zone	perennial crops and tourism	tourism
Zamboanga Sibugay	Buug	Annual Crops Zone		
Zamboanga Sibugay	Diplahan	Annual Crops Zone		mining

Province	City/Municipality	Major LHZ	Secondary/Tertiary LHZ	Complementary Activity
Zamboanga Sibugay	Imelda	Annual Crops Zone		
Zamboanga Sibugay	Ipil	Annual Crops Zone	perennial crops, mining, and tourism	mining and tourism
Zamboanga Sibugay	Mabuhay	Annual Crops Zone	perennial crops	
Zamboanga Sibugay	Malangas	Annual Crops Zone	built-up areas and tourism	tourism
Zamboanga Sibugay	Olutanga	Annual Crops Zone	perennial crops	
Zamboanga Sibugay	Roseller Lim	Annual Crops Zone	perennial crops and tourism	tourism
Zamboanga Sibugay	Talusan	Annual Crops Zone	perennial crops	
Zamboanga Sibugay	Tungawan	Annual Crops Zone		
City of Isabela	City of Isabela	Aquaculture/Coastal Zone	vegetable farming and tourism	tourism
Zamboanga del Sur	Dinas	Aquaculture/Coastal Zone	vegetable farming	
Zamboanga del Sur	Kumalarang	Aquaculture/Coastal Zone	vegetable farming, mining, and/or tourism	mining and tourism
Zamboanga del Sur	Lakewood	Aquaculture/Coastal Zone	vegetable farming	
Zamboanga Sibugay	Kabasalan	Aquaculture/Coastal Zone	vegetable farming and tourism	tourism
Zamboanga Sibugay	Payao	Aquaculture/Coastal Zone	vegetable farming	
Zamboanga del Norte	Dapitan City	Aquaculture/Coastal Zone	vegetable farming, mining, and/or tourism	mining and tourism
Zamboanga del Sur	Molave	Irrigated Rice Zone	vegetables	
Zamboanga del Sur	Tambulig	Irrigated Rice Zone	vegetables	

Philippine Climate Change and Food Security Analysis: Regional Report on Zamboanga Peninsula

Province	City/Municipality	Major LHZ	Secondary/Tertiary LHZ	Complementary Activity
Zamboanga del Norte	Bacungan	Pasture Zone	vegetable farming, livestock/pasture, and tourism	tourism
Zamboanga del Sur	Dumingag	Pasture Zone	vegetable farming, livestock/pasture, and mining	livestock/pasture and mining
Zamboanga Sibugay	Siay	Irrigated Rice Zone	vegetables and tourism	tourism
Zamboanga del Norte	Sergio Osmena Sr.	Pasture Zone	vegetable farming, livestock/pasture, mining, and tourism	livestock/pasture, mining, and tourism
Zamboanga del Norte	Siayan	Pasture Zone	vegetable farming, livestock/pasture, mining, and tourism	livestock/pasture, mining, and tourism
Zamboanga del Norte	Sindangan	Pasture Zone	vegetable farming, livestock/pasture, mining, and tourism	livestock/pasture, mining, and tourism
Zamboanga del Norte	Jose Dalman	Pasture Zone	vegetable farming, livestock/pasture, and mining	livestock/pasture and mining
Zamboanga Sibugay	Naga	Perennial Crops Zone	aquaculture/coastal fisheries	
Zamboanga Sibugay	Titay	Rainfed Rice Zone	vegetables, mining, and tourism	mining and tourism
Zamboanga del Sur	Dimataling	Rainfed Rice Zone	vegetables	
Zamboanga del Sur	Ramon Magsaysay	Rainfed Rice Zone	vegetables	
Zamboanga del Norte	Mutia	Built-up Areas Zone		
Zamboanga del Sur	Zamboanga City	Built-up Areas Zone	mining and tourism	mining and tourism

ANNEX 2: Sample Validation Form

Screenshot of Excel file: ZamboPen_LivelihoodZones_Validation_dlig — sheet tab: ZamboPen_LivelihoodZones_Valida

#	ADM1_EN	ADM2_EN	Zone	Legend	Dominant_Livelihood?	Complimentary_Activity1?	Complimentary_Activity2?	Complimentary_Activity3?	Livestock/Pasture?	Mining?	Tourism?
2	Region IX	Zamboanga del Norte	Annual Crops Zone	5 Vegetable farming	Vegetable farming						
3	Region IX	Zamboanga del Norte	Annual Crops Zone	5 Vegetable farming mixed with built-up areas, minin…	Vegetable farming	Urban				yes	yes
4	Region IX	Zamboanga del Norte	Annual Crops Zone	5 Vegetable farming	Vegetable farming		Ecotourism (Birdwatching)	Cultural Tourism			
5	Region IX	Zamboanga del Norte	Annual Crops Zone	5 Vegetable farming	Vegetable farming						
6	Region IX	Zamboanga del Norte	Annual Crops Zone	5 Vegetable farming mixed with perennial crops	Vegetable farming	Perenial Crops	Heritage Tourism (Rizal Farm)	Nature Tourism			
7	Region IX	Zamboanga del Norte	Annual Crops Zone	5 Vegetable farming mixed with perennial crops	Vegetable farming	Perenial Crops					
8	Region IX	Zamboanga del Norte	Annual Crops Zone	5 Vegetable farming mixed with mining	Vegetable farming		Sun and Beach Tourism	Cultural Tourism		yes	
9	Region IX	Zamboanga del Norte	Annual Crops Zone	5 Vegetable farming	Vegetable farming	Perenial Crops					
10	Region IX	Zamboanga del Norte	Annual Crops Zone	5 Vegetable farming mixed with perennial crops	Vegetable farming	Perenial Crops	Sun and Beach Tourism				
11	Region IX	Zamboanga del Norte	Annual Crops Zone	5 Vegetable farming	Vegetable farming						
12	Region IX	Zamboanga del Norte	Annual Crops Zone	5 Vegetable farming	Vegetable farming		Nature Tourism (Waterfalls)				
13	Region IX	Zamboanga del Norte	Annual Crops Zone	5 Vegetable farming	Vegetable farming						
14	Region IX	Zamboanga del Norte	Annual Crops Zone	5 Vegetable farming mixed with mining	Vegetable farming	Urban	Ecotourism and Adventure Tourism			yes	
15	Region IX	Zamboanga del Norte	Annual Crops Zone	5 Vegetable farming mixed with built-up areas and to…	Vegetable farming	Perenial Crops				yes	
16	Region IX	Zamboanga del Norte	Annual Crops Zone	5 Vegetable farming mixed with perennial crops	Vegetable farming						
17	Region IX	Zamboanga del Norte	Annual Crops Zone	5 Vegetable farming	Vegetable farming						
18	Region IX	Zamboanga del Norte	Annual Crops Zone	5 Vegetable farming mixed with mining	Vegetable farming	Perenial Crops				yes	
19	Region IX	Zamboanga del Norte	Annual Crops Zone	5 Vegetable farming mixed with perennial crops	Vegetable farming						
20	Region IX	Zamboanga del Norte	Annual Crops Zone	5 Vegetable farming	Vegetable farming	Perenial Crops					
21	Region IX	Zamboanga del Norte	Annual Crops Zone	5 Vegetable farming mixed with built-up areas, minin…	Vegetable farming	Urban	Farm Tourism (Cacao Plantation)			yes	yes
22	Region IX	Zamboanga del Sur	Annual Crops Zone	5 Vegetable farming	Vegetable farming		Sun and Beach Tourism	Marine Sports Tourism			
23	Region IX	Zamboanga del Sur	Annual Crops Zone	5 Vegetable farming mixed with perennial crops	Vegetable farming	Perenial Crops					
24	Region IX	Zamboanga del Sur	Annual Crops Zone	5 Vegetable farming mixed with mining	Vegetable farming		Nature Tourism	Heritage Tourism		yes	
25	Region IX	Zamboanga del Sur	Annual Crops Zone	5 Vegetable farming	Vegetable farming		Cultural Tourism	Nature Tourism			
26	Region IX	Zamboanga del Sur	Annual Crops Zone	5 Vegetable farming mixed with mining	Vegetable farming					yes	
27	Region IX	Zamboanga del Sur	Annual Crops Zone	5 Vegetable farming mixed with mining	Vegetable farming					yes	
28	Region IX	Zamboanga del Sur	Annual Crops Zone	5 Vegetable farming	Vegetable farming						
29	Region IX	Zamboanga del Sur	Annual Crops Zone	5 Vegetable farming mixed with mining	Vegetable farming					yes	
30	Region IX	Zamboanga del Sur	Annual Crops Zone	5 Vegetable farming	Vegetable farming		Ecotourism	Marine Sports Tourism			yes
31	Region IX	Zamboanga del Sur	Annual Crops Zone	5 Vegetable farming	Vegetable farming						yes
32	Region IX	Zamboanga del Sur	Annual Crops Zone	5 Vegetable farming	Vegetable farming						yes
33	Region IX	Zamboanga del Sur	Annual Crops Zone	5 Vegetable farming mixed with perennial crops	Vegetable farming	Perenial Crops	Ecotourism	Marine Sports Tourism			yes
34	Region IX	Zamboanga del Sur	Annual Crops Zone	5 Vegetable farming	Vegetable farming						
35	Region IX	Zamboanga del Sur	Annual Crops Zone	5 Vegetable farming	Vegetable farming						
36	Region IX	Zamboanga del Sur	Annual Crops Zone	5 Vegetable farming	Vegetable farming						
37	Region IX	Zamboanga del Sur	Annual Crops Zone	5 Vegetable farming	Vegetable farming						
38	Region IX	Zamboanga del Sur	Annual Crops Zone	5 Vegetable farming mixed with built-up areas and to…	Vegetable farming	Urban	Culinary Tourism				yes
39	Region IX	Zamboanga del Sur	Annual Crops Zone	5 Vegetable farming mixed with perennial crops	Vegetable farming	Perenial Crops	Nature Tourism				yes
40	Region IX	Zamboanga del Sur	Annual Crops Zone	5 Vegetable farming	Vegetable farming		Sun and Beach Tourism				