Philippine Climate Change and Food Security Analysis

Regional Report on SOCCSKSARGEN*

October 2024

*South Cotabato, Cotabato, Sultan Kudarat, Sarangani, and General Santos City

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List of Abbreviations

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

Foreword

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

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

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

To that end, WFP presents the CCFSA regional report for SOCCSKSARGEN [South Cotabato, Cotabato, Sultan Kudarat, Sarangani, and General Santos City]. 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 SOCCSKSARGEN. 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 SOCCSKSARGEN (South Cotabato-Cotabato-Sultan Kudarat-Sarangani-General Santos City) region were analyzed. Practical applications on the use of the LHZ map for developing strategic adaptation measures on several social issues such as poverty, food security, and undernutrition were also presented in this report.

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

Livelihood Zones

- Of the nine (9) major LHZs nationwide, eight (8) were initially identified in SOCCSKSARGEN, namely: Aquaculture/Freshwater Fisheries Zone, Aquaculture/Coastal Fisheries Zone, Irrigated Rice Zone, Rainfed Rice Zone, Annual Crops Zone, Cool Environment Zone, Perennial Crops Zone, and Built-up Areas Zone. All of these were validated by local experts in the region.

Climate-Related Hazards

- Drought and flood were identified as the top two hazards that significantly affect the majority of the livelihoods in SOCCSKSARGEN.
- Aquaculture (coastal) and perennial crops production areas in the provinces of Sultan Kudarat and Sarangani are particularly the zones that are highly susceptible to drought.
- Irrigated rice and aquaculture (both freshwater and coastal) production areas across the region have high to very high susceptibility to flooding.

Impacts on Crops

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

Impacts on Aquaculture

- The projected increase in temperature and amount of rainfall will have direct and indirect impacts on the abundance and distribution of marine and coastal resources, and on aquaculture production. Eight (8) municipalities under the Aquaculture/Coastal Fisheries LHZ and two (2) municipalities under the Aquaculture/Freshwater LHZ are potentially susceptible to these climate change hazards.

Impacts on Livestock

- Increased temperature can negatively affect livestock performance, including stunted growth, more deficient good-quality meat, and by-products, and decreased reproductive capacity, in addition to diminishing the quality and quantity of feed supply.
- Two (2) out of the three (3) municipalities in the region with livestock and poultry raising as complementary activities, will be potentially at risk to the projected increase in temperature.

1. Introduction

1.1. Project Background

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

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

In July 2022, a follow-up analysis was undertaken by the WFP and Alliance of Bioversity International and CIAT to validate the initial findings in four regions, namely: Region IV-B (MIMAROPA), Region XI (Zamboanga Peninsula), Region XII (SOCCSKSARGEN), and the Bangsamoro Autonomous Region in Muslim Mindanao. 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 SOCCSKSARGEN** which presents the validated livelihood and climate-related profiles of the region. Additionally, this report identifies the specific locations of livelihoods in SOCCSKSARGEN that are most susceptible 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.

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

1.2. Initial Livelihood Zones

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

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

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

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

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

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

2. Methodology

2.1 Study Site and Population

SOCCSKSARGEN is an administrative region in the Philippines found in the southern-central portion of the Mindanao Island group. It is composed of four (4) provinces (South Cotabato, Cotabato, Sultan Kudarat, and Sarangani) and one (1) highly urbanized city (General Santos). It has 45 municipalities and three (3) component cities namely Kidapawan, Koronadal, and Tacurong.

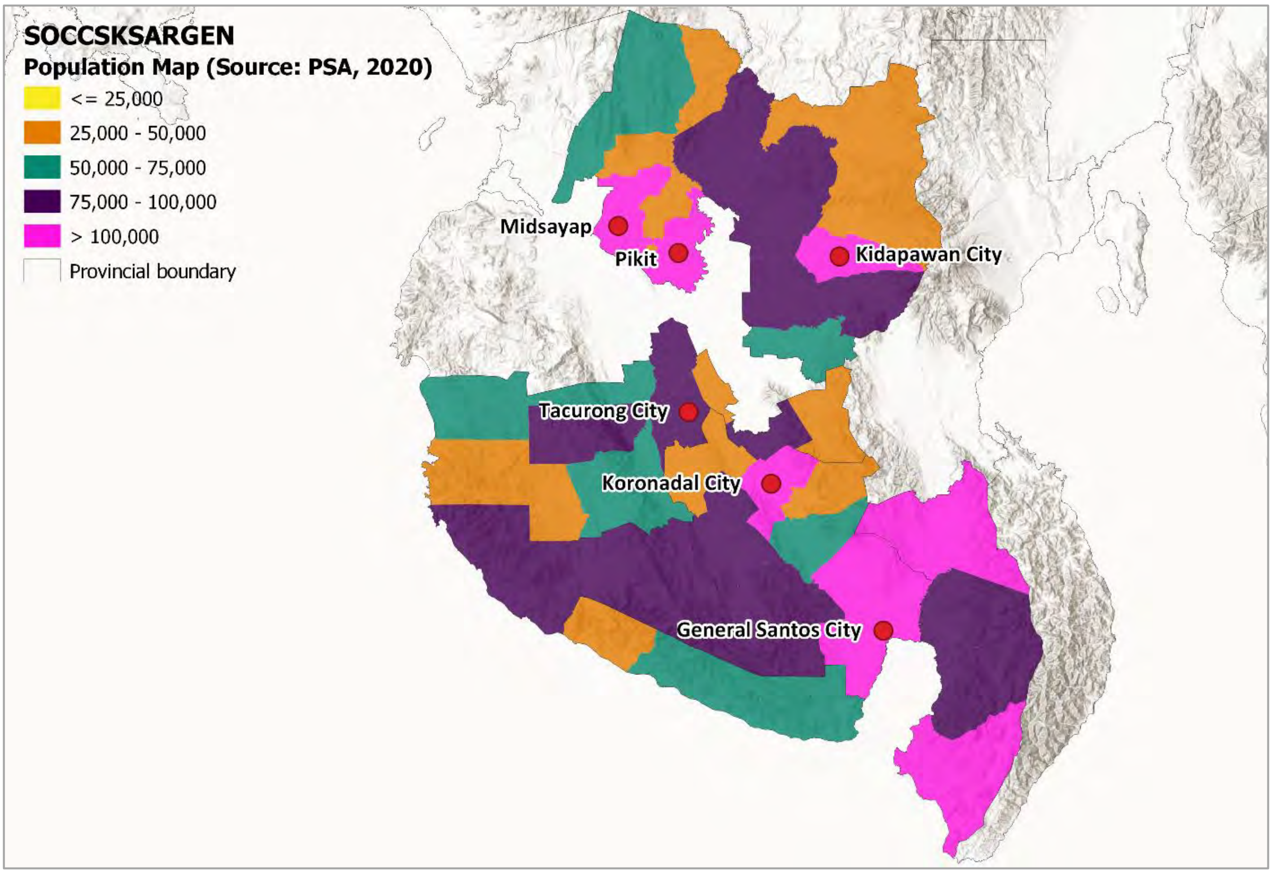
It has a total land area of 19,035.39 square kilometers (km^2) endowed with marine and freshwater resources. About 7,906.38 km^2 of this land area are alienable and disposable lands while 11,129.01 km^2 are forestlands.

In terms of economy, SOCCSKSARGEN is highly driven by the Agriculture, Fishery, and Forestry (AFF) sector which comprises almost 42% of its regional domestic products. The sector contributes largely to the sustained economic growth of the region by posting 6.6% in 2022 from 5.2% growth in 2021 (PSA SOCCSKSARGEN, 2023).

The region has a total of 4.9 million population (Figure 1) based on the 2020 Census of the Population and Housing (PSA, n.d.), accounting for 4.50% of the total Philippine population. Among its four (4) provinces, Cotabato has the biggest population with 1.49 million persons, while Sarangani has the smallest population with only 0.56 million persons.

The top three (3) municipalities with the highest population are found in Koronadal City (South Cotabato) with approximately 195,000 persons, Polomolok (South Cotabato) with approximately 173,000 persons, and Midsayap (Cotabato) with approximately 165,000 persons. On the other hand, the top three (3) municipalities with the least population are Antipas (Cotabato) with approximately 27,000 persons, followed by Columbio (Sultan Kudarat) with approximately 34,000 persons, and Santo Niño (South Cotabato) with approximately 40,000 persons only.

Figure 1. Population map of SOCCSKSARGEN (PSA, 2020)



2.2. Livelihood Zones Mapping

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

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

Table 2. Data sources for the LHZ database

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

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

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

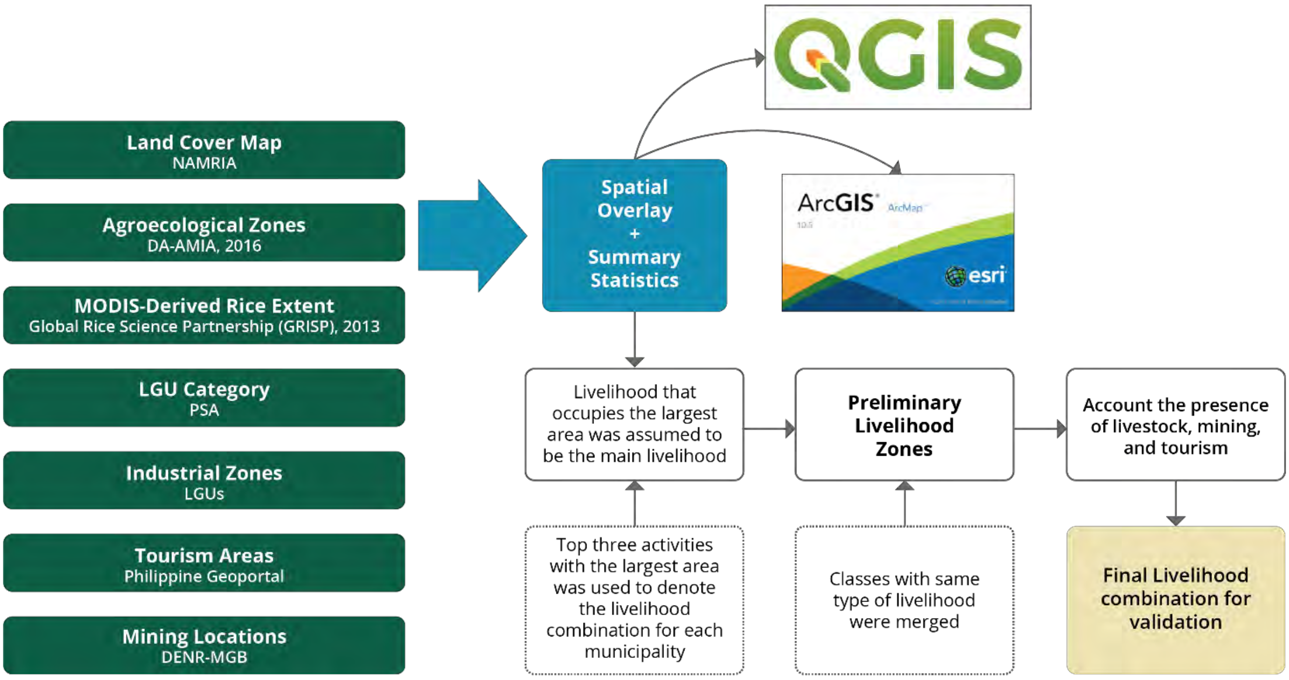
The additional datasets on tourism and mining are all point data[3] which were computed as counts per polygon. Also, livestock activities were just classified as "Yes" (present) or "No" (lacking), and therefore,

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

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

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

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



2.3. Assessment of Climate-Related Hazards

2.3.1. Hazard Mapping

To identify and qualify the major climate-related risks prioritized in the initial phase of the project, six (6) datasets on hazards were used to characterize the exposure of the Philippines to climate variability and extreme weather events. These hazards include typhoon, flooding, drought, storm surge, saltwater intrusion, and sea level rise (

Table 3). The selection of these hazards was based on the availability of data at the city/municipal level and the hazard's potential impact on livelihood, food security, and nutrition.

Table 3. Overview of hazard datasets for the Philippines

Parameter	Source	Unit of Measurement, Spatial and Temporal Resolution
Typhoon	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 (^{o}C) for the mid-century[4] and +2.6 – 4.8^{o}C 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.

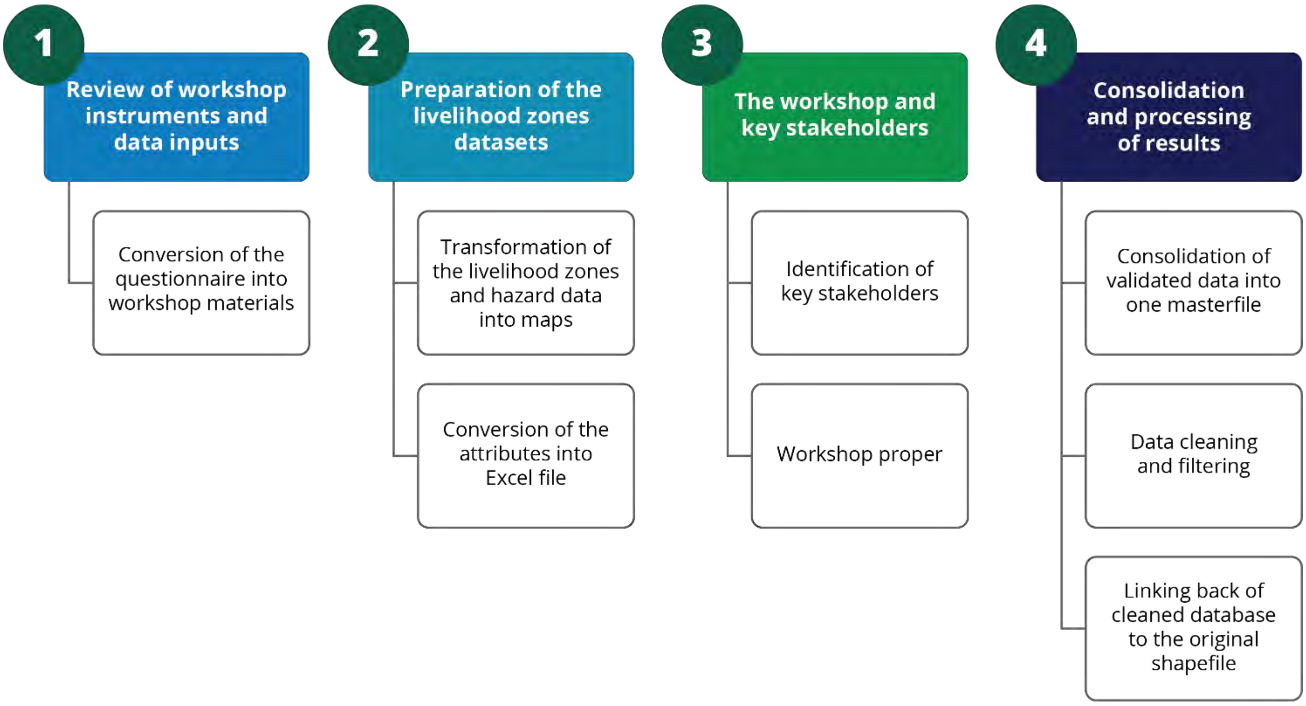
2.4. Regional Validation Workshop

A validation workshop was conducted on 06-08 September 2022 in General Santos City which was attended by several experts from different agencies who are familiar with the local agricultural systems and livelihoods in SOCCSKSARGEN. The list of experts is attached as Annex 1.

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

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

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



1

Review of workshop instruments and data inputs

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

2

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

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

3

Conduct of the workshop

A total of nine (9) representatives from six (6) different government agencies in SOCCSKSARGEN participated in the workshop (Figure 4). They were composed of experts who are knowledgeable with the local agricultural systems and livelihoods in the region. Of the total number of participants, 33% are male and 66% are female (see Annex 1 for more details).

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

Figure 4. The participants during the Regional CCFSA Validation Workshop

During the workshop, classification of the identified zones was further refined and validated. As mentioned earlier, a zone was determined based on the extent of the area that it occupies in a city/municipality which was classified as either a major or secondary/tertiary/quaternary livelihood. However, since data on the extent of the area of the identified other zones were lacking, the term **Secondary/Tertiary livelihood** was used to capture activities, aside from the major livelihood, that also exist in the city/municipality. These zones pertain to the activities that provide alternative resources and work opportunities in a city/municipality, following the concept of "alternative livelihood" by

Wright et. al. (2015). It is recommended, however, that these "secondary/tertiary livelihoods" be further ranked based on their area, once data is already available.

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

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

4

Consolidation and processing of results

All 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 SOCCSKSARGEN.

3. Results

3.1. Initial Analysis of the Livelihood Zones

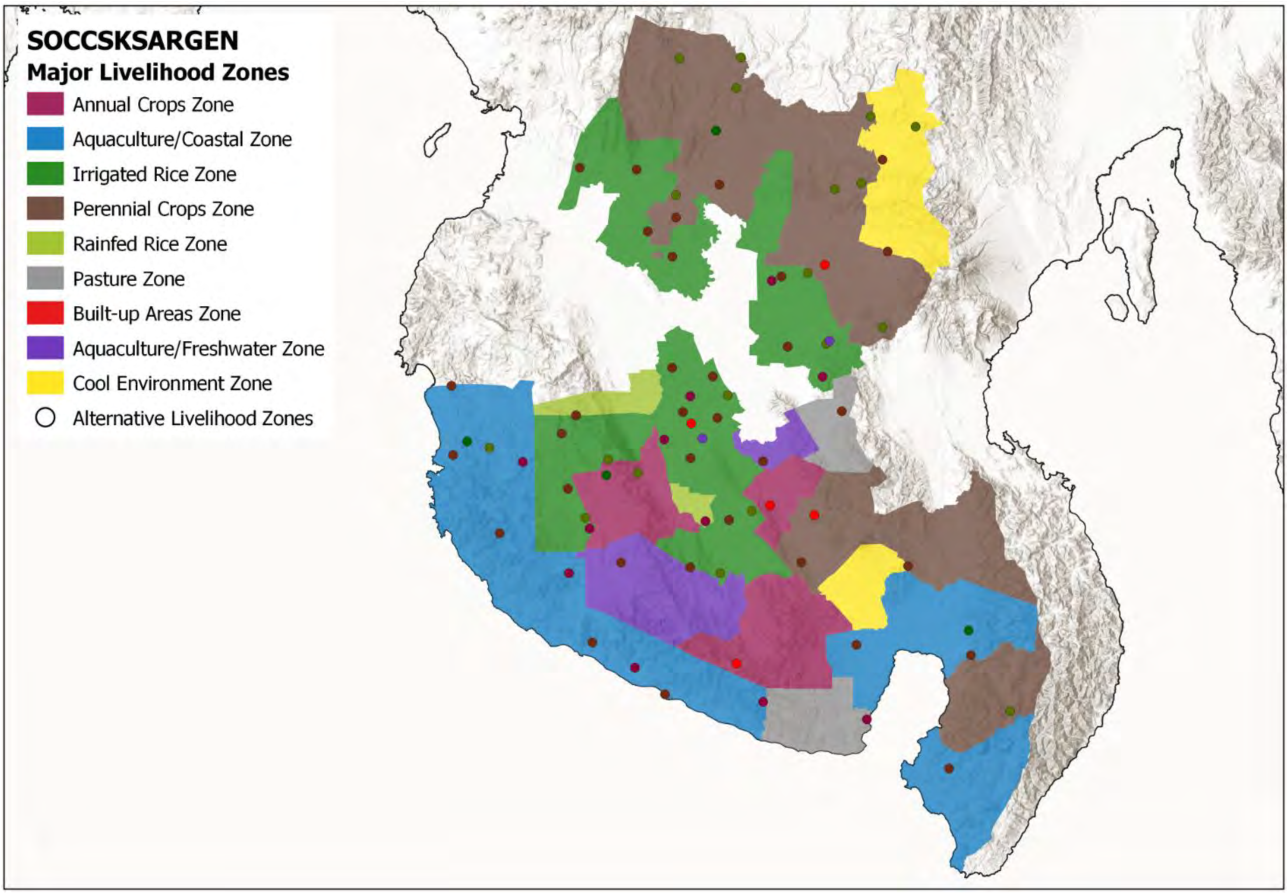
The LHZ database of SOCCSKSARGEN had a total of 49 records corresponding to four (4) cities, and 45 municipalities in the region. Initially, the identified LHZs in SOCCSKSARGEN has nine (9) major LHZs, namely: **Annual Crops Zone**, **Aquaculture/Coastal Fisheries Zone**, **Aquaculture/Freshwater Fisheries Zone**, **Built-up Areas Zone**, **Cool Environment Zone**, **Irrigated Rice Zone**, **Pasture Zone**, **Perennial Crop Zone**, and **Rainfed Rice Zone**.

3.2. Validation Workshop Findings

3.2.1. Major LHZs in SOCCSKSARGEN

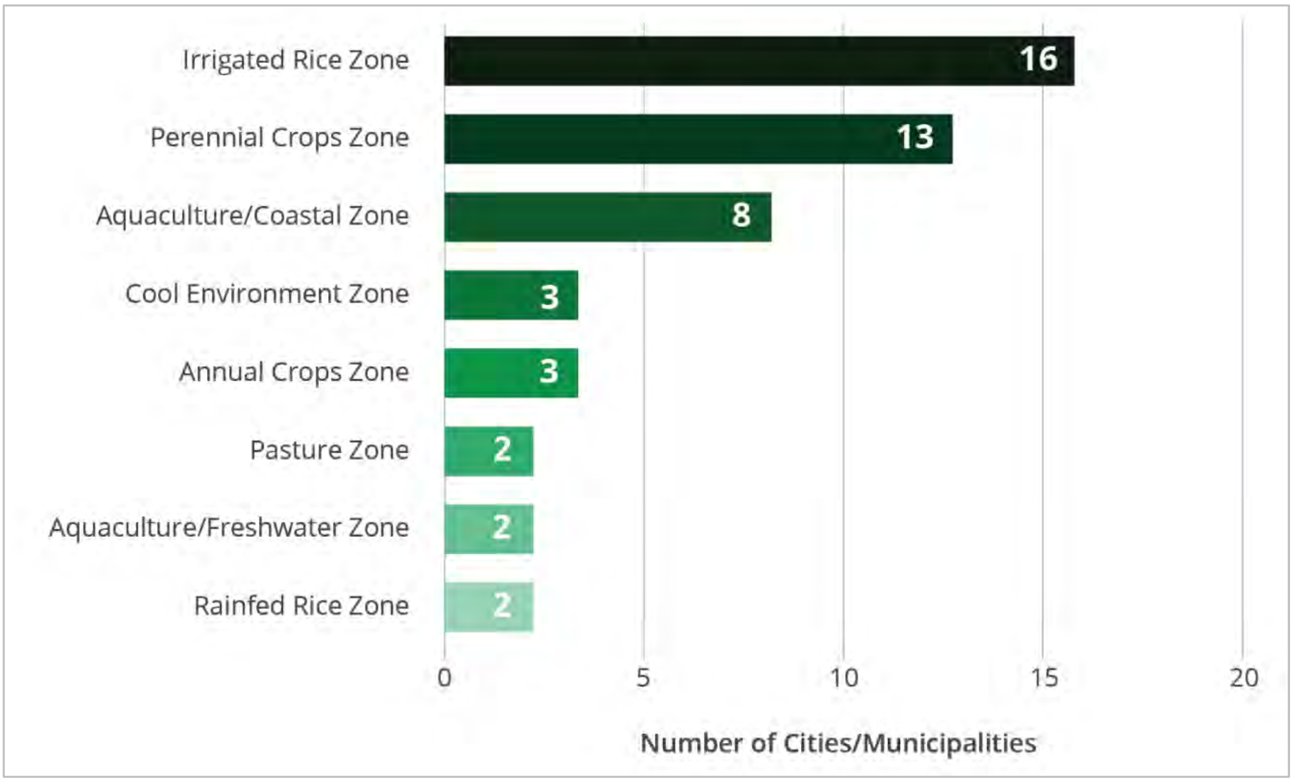
The validated LHZ map of SOCCSKSARGEN is presented in Figure 5 showing the nine (9) major LHZs in the region.

Figure 5. Validated LHZs in SOCCSKSARGEN



Results of the validation workshop revealed that all the livelihoods in SOCCSKSARGEN are still agricultural-based (Figure 6). A total of three (3) component cities and 36 municipalities were found to be highly dependent on agriculture, specifically on irrigated rice (16), perennial crops (13), annual crops (3), pasture (2), rainfed rice (2), and cool environment (3) wherein two (2) municipalities belong to perennial crops and one (1) municipality belongs to annual crops.

Figure 6. Major LHZs in SOCCSKSARGEN

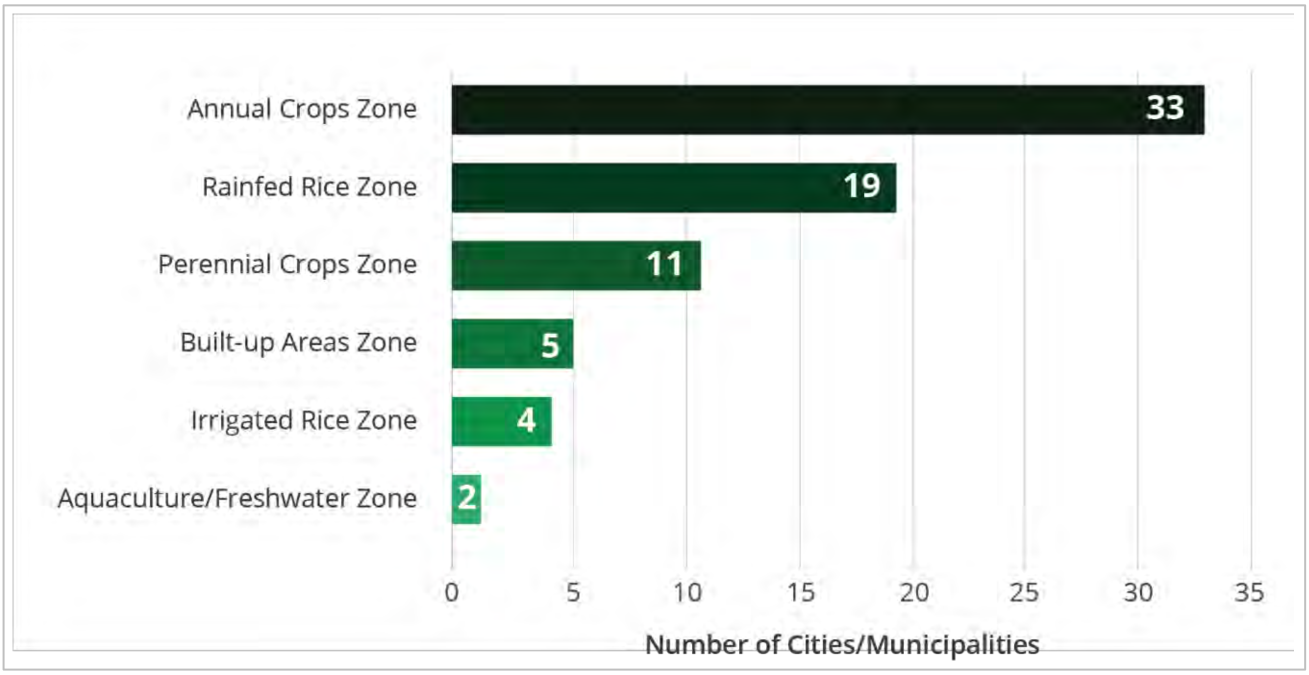


On the other hand, one (1) highly urbanized city and 10 municipalities were found dependent on aquaculture-based livelihood, specifically "Aquaculture/Freshwater LHZ" (2) and "Aquaculture/Coastal Fisheries LHZ" (9).

3.2.2. Secondary/Tertiary LHZs in SOCCSKSARGEN

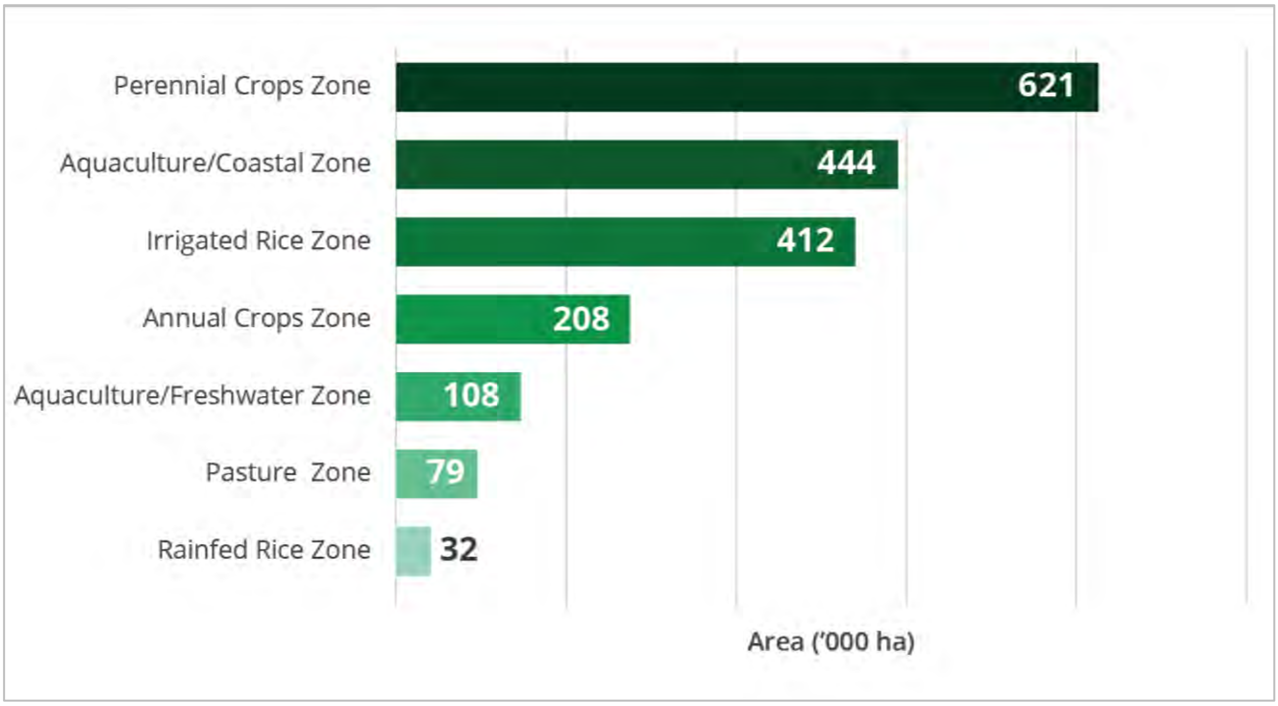
The workshop findings also showed that vegetable farming (annual crops) was the most dominant Secondary/Tertiary Livelihood in the region being practiced in two (2) cities and 52 municipalities. It was followed by rainfed rice farming within 19 municipalities, and perennial crops within 11 municipalities (Figure 7).

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



In terms of land area, perennial crops occupied the largest size with approximately 621,000 ha. which constitutes 33% of the total land area of SOCCSKSARGEN. It was followed by aquaculture/coastal and irrigated rice farming with approximate land areas of 444,000 ha. (23%) and 412,000 ha. (22%), respectively (Figure 8).

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



The City of Tacurong in Sultan Kudarat and municipality of Tulunan in Cotabato (both "Irrigated Rice LHZ") have the most diverse composition of secondary/tertiary livelihoods with a total of four (4). The City of Tacurong includes aquaculture/freshwater fisheries, perennial crops, annual crops, and built-up areas. Meanwhile, Tulunan includes aquaculture/freshwater fisheries, rainfed rice, perennial crops, and annual crops.

Moreover, three (3) component cities and two (2) municipalities have identified the "Built-up Areas Zone" as their secondary/tertiary livelihood. The City of Kidapawan in Cotabato ("Perennial Crops LHZ") and City of Tacurong in Sultan Kudarat ("Irrigated Rice LHZ") were classified as "urban centre" while City of Koronal, Tampakan, and T'Boli in South Cotabato were not classified into any other type of built-up areas.

3.2.3. Complementary Activities in SOCCSKSARGEN

Tourism emerged as the most common complementary activity in SOCCSKSARGEN with 23 municipalities covered followed by MINING in four (4) municipalities, and livestock in three (3) municipalities (Annex 2). Four (4) of these municipalities have a total of two (2) complementary activities particularly focused on tourism and mining. Conversely, there are 23 municipalities without any complementary activities.

3.3. Susceptibility to Climate-Related Hazards

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

The aforementioned data supports the result of the validation workshop which revealed that flood and drought are the climate-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 susceptibility over the total land area per municipality. FSI value of 0 indicates no flooding, while the value of 1 indicates total submergence of the geographic unit in the event of flooding. On the other hand, DSI value of 0 indicates abnormally dry condition defined as lingering water deficits and short-term dryness slowing plant growth, while the value of 1 indicates extreme drought with no rainfall on the scale of one to three months which may result to crop losses.

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

Flood susceptibility of municipalities/cities in the region ranges from "High" to "Very High":

MODERATE SUSCEPTIBILITY		
Province	**City/Municipality**	**Livelihood Zone**
South Cotabato	City of Koronadal	Annual Crops Zone
Sultan Kudarat	City of Tacurong	Irrigated Rice Zone

HIGH SUSCEPTIBILITY		
Province	**City/Municipality**	**Livelihood Zone**
Cotabato	Kabacan, Libungan, Midsayap, M'Lang, Pigkawayan, Pikit, Tulunan	Irrigated Rice Zone
South Cotabato	Banga, Norala, Tantangan	Irrigated Rice Zone
Sultan Kudarat	Isulan, President Quirino	Irrigated Rice Zone
	Lebak	Aquaculture/Coastal Zone
	Lutayan	Aquaculture/Freshwater Zone
	Alabel	Aquaculture/Coastal Zone

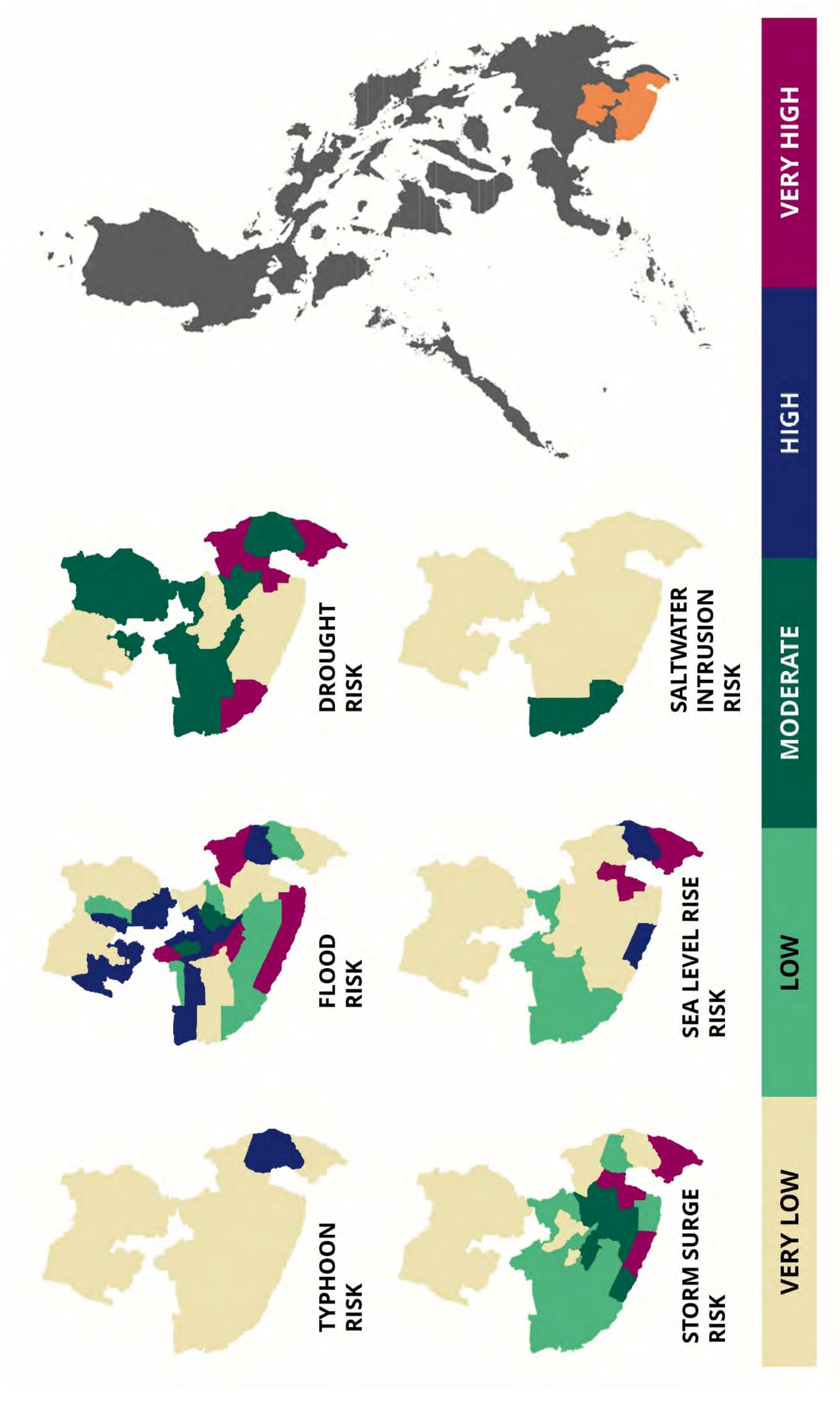
VERY HIGH SUSCEPTIBILITY		
Province	**City/Municipality**	**Livelihood Zone**
Sarangani	Kiamba	Aquaculture/Coastal Zone
	Maasim	Pasture Zone
	Maitum	Aquaculture/Coastal Zone
	Malungon	Perennial Crops Zone
South Cotabato	Suralla	Rainfed Rice Zone
	Santo Niño	Irrigated Rice Zone
Sultan Kudarat	Lambayong	Irrigated Rice Zone

Furthermore, SOCCSKSARGEN's susceptibility to drought was revealed to be "Moderate" to "Very High". Among the areas are:

MODERATE SUSCEPTIBILITY		
Province	**City/Municipality**	**Livelihood Zone**
Sarangani	Alabel	Aquaculture/Coastal Zone
	Malapatan	Perennial Crops Zone
South Cotabato	Polomolok	Cool Environment Zone
	Surallah	Irrigated Rice Zone
	Tupi	Perennial Crops Zone
Sultan Kudarat	Bagumbayan	Annual Crops Zone
	Kalamansig, Lebak, Lutayan	Aquaculture/Coastal Zone
	Isulan, Lambayong, President Quirino, City of Tacurong, Sen. Ninoy Aquino	Irrigated Rice Zone
	Columbio	Pasture Zone
	Esperanza	Rainfed Rice Zone
Cotabato	Magpet, Arakan	Cool Environment Zone
	Kabacan, M'Lang, Pikit, Tulunan	Irrigated Rice Zone
	City of Kidapawan, Makilala, Matalam, President Roxas, Antipas	Perennial Crops Zone

HIGH TO VERY HIGH SUSCEPTIBILITY		
Province	**City/Municipality**	**Livelihood Zone**
General Santos City	General Santos City	Aquaculture/Coastal Zone
Sultan Kudarat	Palimbang	Aquaculture/Coastal Zone
Sarangani	Glan	Aquaculture/Coastal Zone
	Malungon	Perennial Crops Zone

Figure 9. Validated climate-related hazard maps of SOCCSKSARGEN



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 SOCCSKSARGEN 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 30°C, and amount of rainfall (mm) greater than 5% by the years 2030 and 2050.

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

In terms of increase in the amount of rainfall (mm), PAGASA data shows that an increase of 5% in the annual rainfall by year 2050 is roughly equivalent to 48.9 mm or an additional 10 days or more in the number of rainy days in Mindanao. This has a significant impact on crop production because of its effects on soil structure. Water logging and flooding as caused by heavy rainfall may result in 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 SOCCSKSARGEN

As seen in Figure 10, most of the LHZs will experience projected increase in rainfall (mm) and temperature by 2050. In terms of the increase in rainfall, the Irrigated Rice LHZ and Aquaculture/Coastal LHZ have the greatest number of municipalities to be affected. These areas under the Irrigated LHZ include the municipality/city of: Banga, Noralla, Surallah, and Tantangan (South Cotabato); Midsayap, Pigkawayan (Cotabato); and Isulan, Lambayong, Tacurong City, Sen. Ninoy Aquino (Sultan Kudarat). For the Aquaculture/Coastal LHZ, areas to be affected include the municipality/city of: General Santos City (South Cotabato); Kalamansig, Lebak, and Palimbang (Sultan Kudarat); and Alabel, Glan, Kiamba, and Maitum (Sarangani).

Several areas under the Irrigated Rice LHZ and Perennial Crops LHZ were projected to experience an increase in temperature (>5%) by 2050. For the Irrigated Rice LHZ, these areas include the municipality/city of: Kabakan, Libungan, Midsayap, M'Lang, Pigkawayan, Pikit, and Tulunan (Cotabato); Banga, Norala, Surallah, and Tantangan (South Cotabato); and Lambayong, President Quirino, and Tacurong City (Sultan Kudarat). Meanwhile, the areas under the Perennial Crops LHZ include the municipalities Carmen, Matalam, President Roxas, Antipas, Banisilan, and Aleosan (Cotabato).

On the other hand, Figure 11 shows the areas which will experience both increase in rainfall (mm) and temperature by 2050. These areas include the Irrigated Rice LHZ and Aquaculture/Coastal LHZ, with few municipalities under the Annual Crops LHZ and Rainfed Rice LHZ. For the Irrigated Rice LHZ, the municipalities/cities to be affected include: Pigkawayan and Midsayap (Cotabato); Tacurong City and Lambayong (Sultan Kudarat); and Banga, Surallah, Tantangan, and Norala (South Cotabato). The

Aquaculture/Coastal LHZ includes the municipalities/city of: Lebak (Sultan Kudarat); Maitum (Sarangani); and General Santos City (South Cotabato). Additionally, Koronadal City and Santo Niño (South Cotabato) under the Annual Crops LHZ and Rainfed Rice LHZ, respectively, will also experience the projected increase in temperature by 2050.

The most recent data from the Philippine Rice Information System (PRISM) shows the peak of planting rice in SOCCSKSARGEN (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 is hampered both rainfed and irrigated rice from November and December. No farming activity related to planting is possible in January of the succeeding year until April which covers the second semester of rice in SOCCSKSARGEN. It was followed by a minimal amount of rainfall in the month of July, which is adequate to start the land preparation and other activities related to planting.

Based on PAGASA, majority of SOCCSKSARGEN belongs to Type 4 Corona System climatic classification wherein rainfall is evenly distributed throughout the year. Moreover, northern portion of the region belongs to Type 3 climate wherein season is not very pronounced, dry from November to April, and wet during the rest of the year. Knowing the current seasonality of rice and the climate type in the region that can trigger flood or drought can help policymakers and local government units in strategizing solutions that can protect the livelihoods that mostly depend on rice.

In summary, around 27% of the total number of municipalities/cities in SOCCSKSARGEN (11 municipalities and 2 cities) will be affected by simultaneous increase in temperature and amount of rainfall (mm) by the year 2050.

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

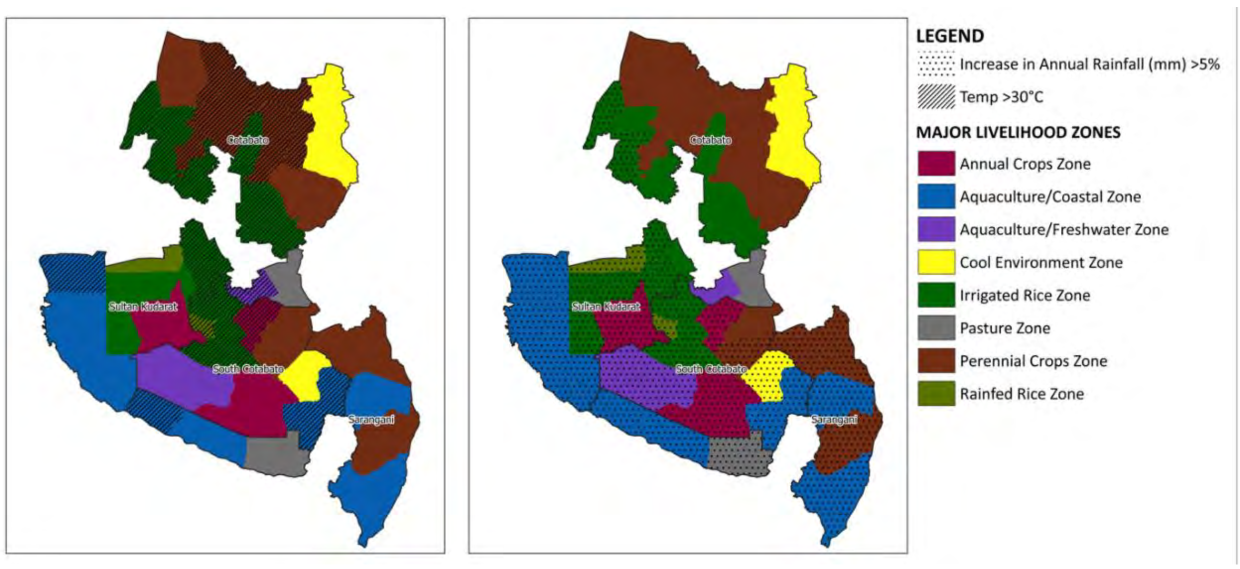


Figure 11. LHZs in SOCCSKSARGEN affected by both projected increase in temperature and annual rainfall (mm) by 2050

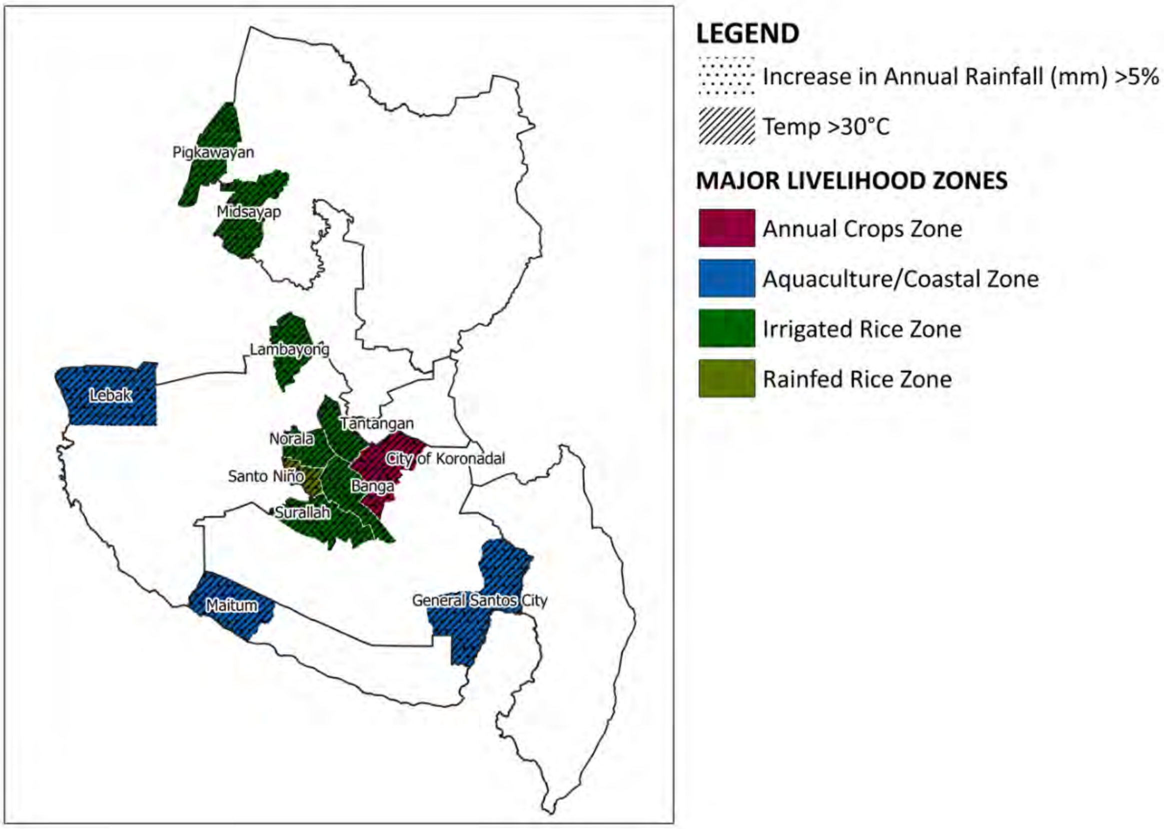


Figure 12. Data from the Philippine Rice Information System (PRISM) showing the peak of planting for rice in SOCCSKSARGEN based on the total area planted in 2022-2023

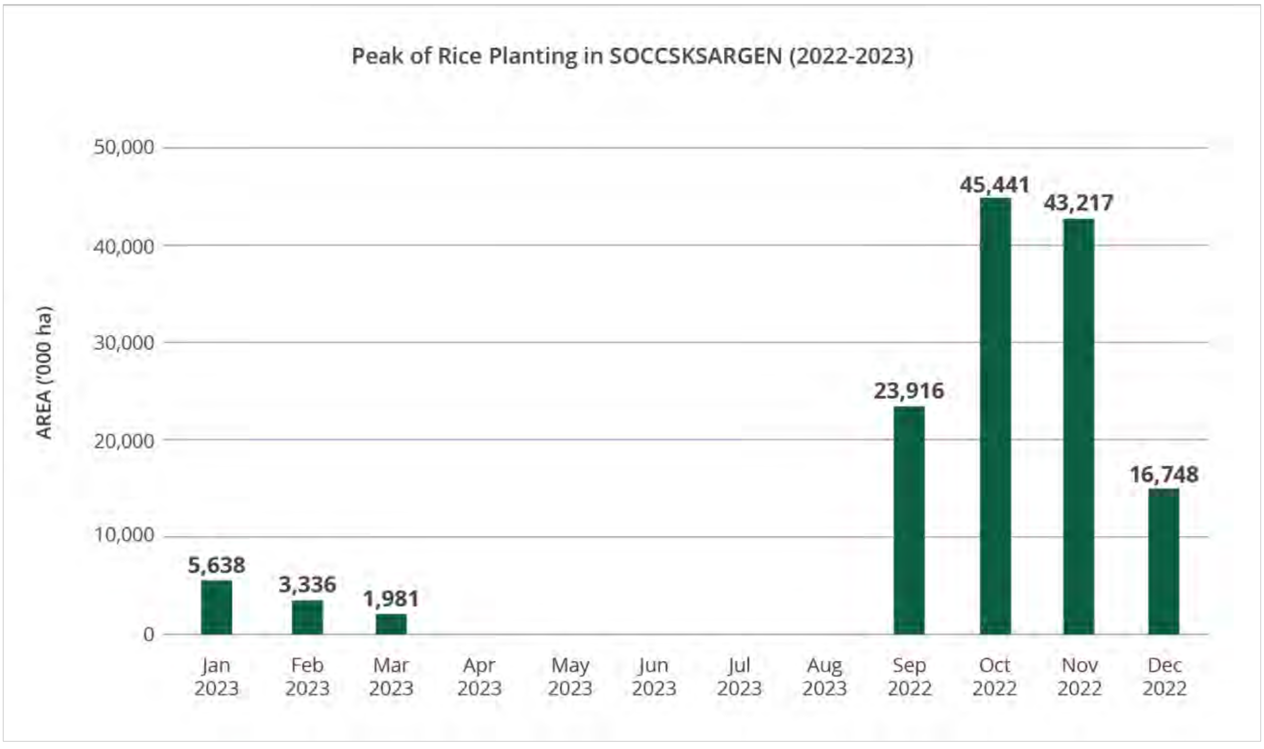


Table 5. Areas in SOCCSKSARGEN which will experience increase in temperature (>5ºC) by 2050

	SOCCSKSARGEN CROPPING CALENDAR FOR RICE AND MAIZE IN 2019											
Months	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Rains	Rainfall amount is still minimal, and moisture available during the month remains inadequate						Adequate amount of moisture available during the month	Insufficient amount of moisture available during the month			Inadequate rainfall received during the month	
Agriculture												
Rainfed Rice												
Irrigated Rice												
Maize												
LEGEND												
	No farming activity related to planting (rice and maize) is possible.											
	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.											
	Any farming activities related to planting (rice and maize) were hampered due to insufficient amount of rainfall.											

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 SOCCSKSARGEN, 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.

Aside from rice, the participants of the validation workshop also identified maize, banana, cacao, coffee, coconut, rubber, and fruit bearing trees as other important crops in the region. 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.

Rice farming is one of the major livelihoods in SOCCSKSARGEN. Future climate scenarios show generally less conducive environment for rice growth in the region. © Alliance of Bioversity International and CIAT

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 major rice production areas in SOCCSKSARGEN. Of the 16 areas identified as Irrigated Rice LHZs, six (6) municipalities in Cotabato, three (3) in South Cotabato, and four (4) in Sultan Kudarat will have a moderate decrease in rice suitability by 2030, as well as the two (2) Rainfed Rice LHZs in the region. Furthermore, Figure 13 shows that all of these areas will still experience a decrease in rice suitability by 2050 but is more prominent and will be less conducive for rice production as compared to 2030. However, it was also noted that positive gains or increase in rice suitability may be achieved in the municipalities of Isulan (Sultan Kudarat) and Surallah (South Cotabato), both classified as Irrigated Rice LHZs. By 2050, only the municipality of Isulan (Sultan Kudarat) will experience positive gains while the municipality of Surallah (South Cotabato) will be negatively affected. The results of the analysis were consistent with the study of Gowda et. al., (2018) which concludes that impacts of climate change can be less favorable or more conducive for growing different types of crops in different regions (Gowda, P., et al. (2018).

Corn or maize farming is part of the Annual Crops LHZ in SOCCSKSARGEN. Future climate scenarios show no change in crop suitability for corn by 2030 and moderate decrease by 2050. © Alliance of Bioversity International and CIAT

For maize, changes in suitability in Annual Crops LHZ in the region will be less dramatic than rice. There will be no change in maize suitability by 2030 as seen in Figure 14. However, by 2050, “moderate decrease” will be experienced in the municipality of Bagumbayan (Sultan Kudarat) and city of Koronadal (South Cotabato) while “low decrease” will be evident in the municipalities of T’Boli and Polomolok in South Cotabato.

For banana and other perennial crops (Figure 15), the resulting suitability in the years 2030 and 2050 also show less favorable conditions. Perennial Crops LHZs in the municipalities/city of: Antipas, Alamada, Aleosan, Carmen, Kidapawan City, Makilala, President Roxas, Banisilan, and Matalam (Cotabato); Malapatan and Malungon (Sarangani); and Tupi, and Tampakan (Sultan Kudarat) will have a "low decrease" in suitability for growing perennial crops such as banana. By 2050, the decrease in suitability in all these areas will be more pronounced ("high decrease") as shown in Figure 15.

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

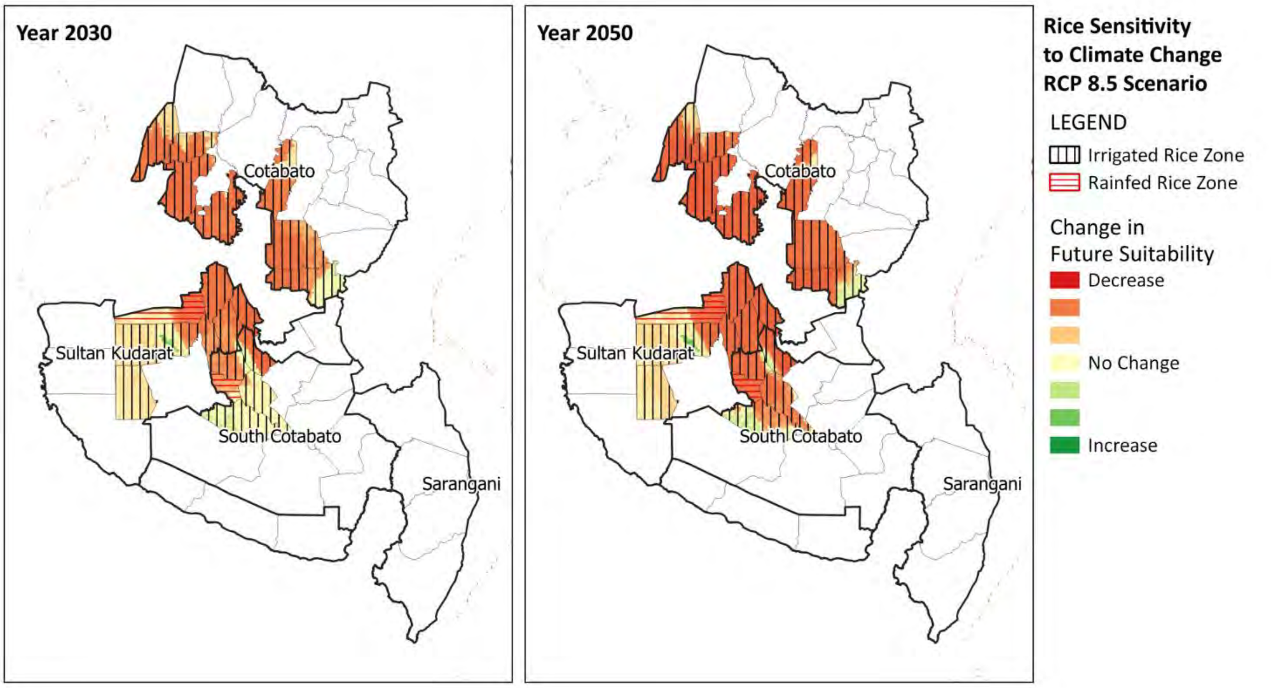


Figure 14. Sensitivity of major maize production areas in SOCCSKSARGEN to climate change impacts based on RCP 8.5 Scenario

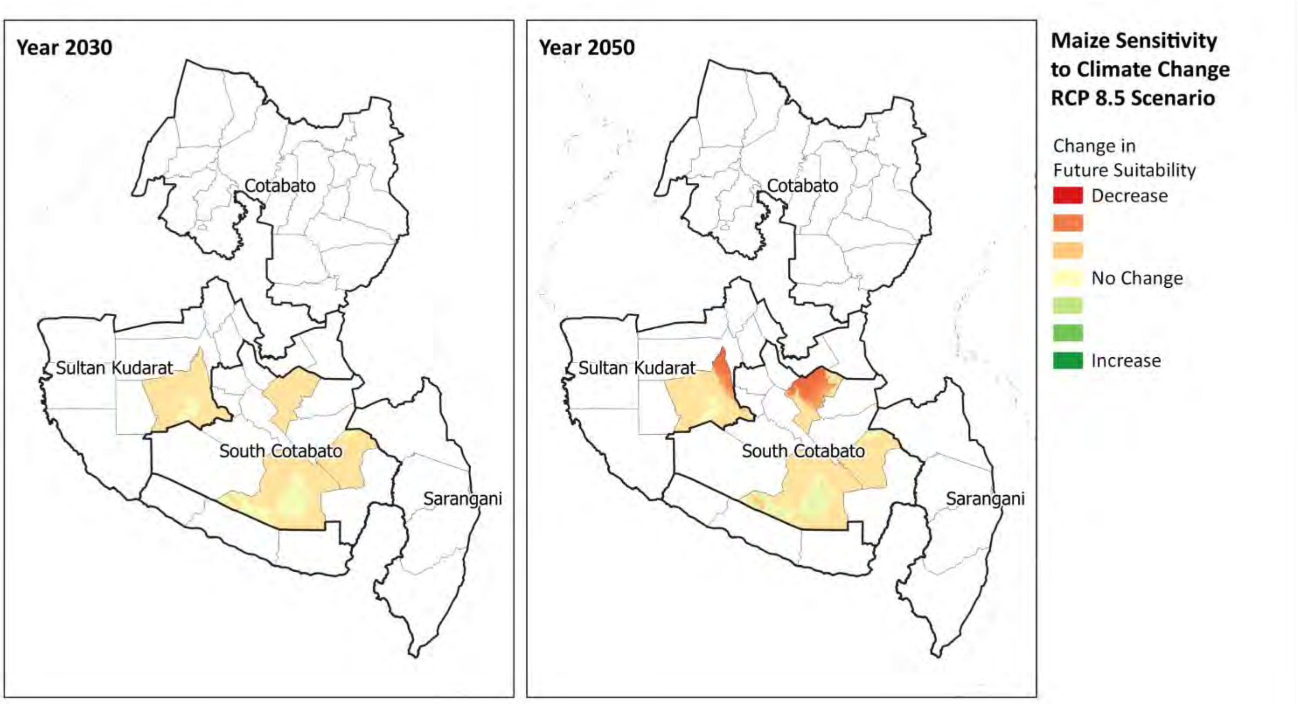
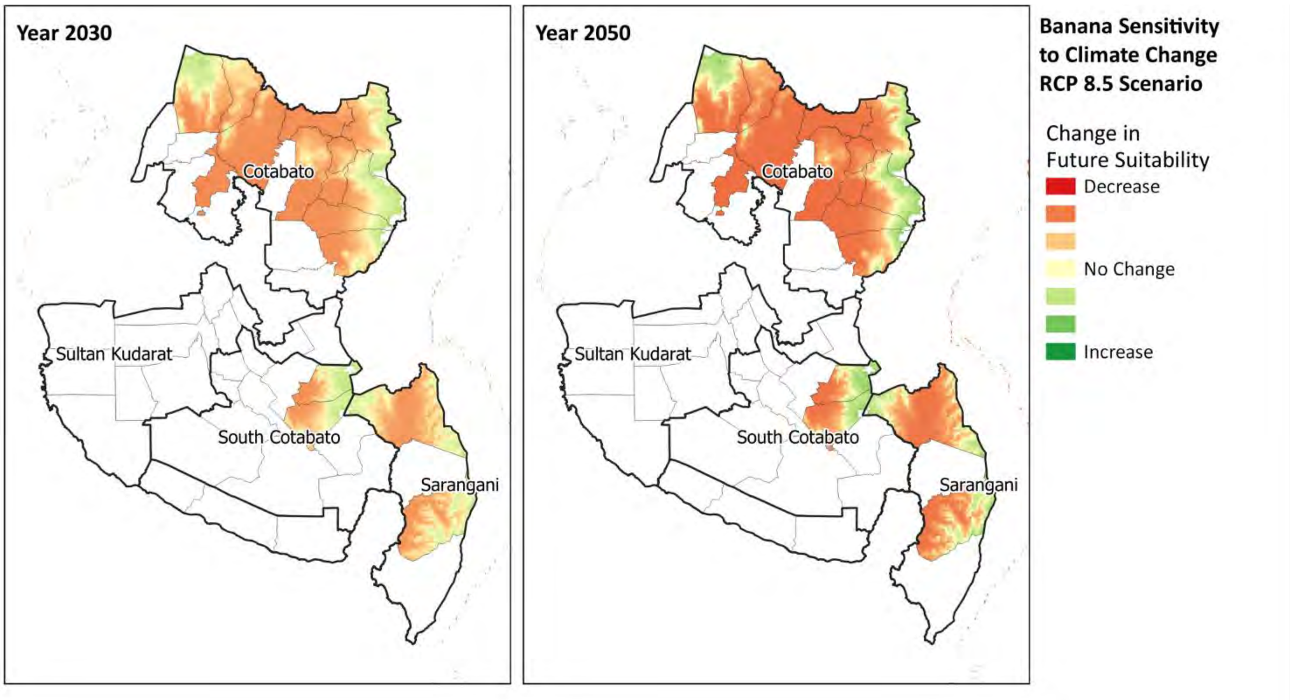


Figure 15. Sensitivity of major banana production areas in SOCCSKSARGEN to climate change impacts based on RCP 8.5 Scenario



3.4.2.2. Projected Exposure to Pest and Diseases

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

Rice

The increase in temperature and rainfall induces the proliferation of several rice diseases such as rice sheath blight and bacterial sheath blight. Studies analyzing the correlation among meteorological parameters and disease incidence find that sheath blight incidence and severity are highly governed by temperature, with disease establishment and spread favoring air temperatures in the range of 26°C to 34°C (Kaur et al., 2015). Based on the results presented in section 3.4.1, the municipalities/city of: Kabakan, Libungan, Midsayap, M'Lang, Pigkawayan, Pikit, and Tulunan (Cotabato); Banga, Norala, Surallah, and Tantangan (South Cotabato); and Lambayong, President Quirino, and Tacurong City (Sultan Kudarat) 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, particularly in the city of Koronadal in the province of South Cotabato for SOCCSKSARGEN as shown in Figure 11.

Consequently, the proliferation of pests and diseases may also result in 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, all of the municipalities under the Annual Crops LHZ which are projected to have more than 5% increase in the annual rainfall (mm) by 2050, may experience widespread of these diseases in the future. These areas include the municipalities of T'boli (South Cotabato) and Bagumbayan (Sultan Kudarat), and Koronadal City (South Cotabato).

Banana

Among the key diseases that are expected to challenge banana cultivation in Perennial Crop LHZs in SOCCSKSARGEN, 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, six (6) municipalities in the province of Cotabato may experience Fusarium wilt and black sigatoka infestations following the increase in temperature to greater than 30°C by 2050. These are the municipalities of Carmen, Matalam, President Roxas, Antipas, Banisilan, and Aleosan.

3.4.3. Projected Impacts on Aquaculture

Aquaculture was also identified as a major LHZ in some areas in SOCCSKSARGEN. 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 Mindanao. 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 in 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 SOCCSKSARGEN, the aquaculture livelihoods that are projected to experience an increase in temperature and amount of rainfall (mm) in the future are the coastal areas in the region (Figure 11). These include eight (8) municipalities classified under Aquaculture/Coastal Fisheries LHZ located along the coastline provinces, namely: Kiamba, Glan, Alabel, and Maitum (Sarangani); Kalamansig, Lebak, and Palimbang (Sultan Kudarat); and General Santos City (South Cotabato).

On the other hand, two (2) municipalities classified under Aquaculture/Freshwater Fisheries LHZ which will be adversely affected by climate change impacts are found in Lake Sebu (South Cotabato) and Lutayan (Sultan Kudarat).

3.4.4. Projected Impacts on Livestock

The Department of Agriculture (DA) defines livestock as domesticated animals raised in an agricultural setting to produce labor and commodities such as meat, eggs, milk, fur, leather, and wool. Poultry, on the other hand, refers to the domesticated birds kept by humans for their eggs, meat, or feathers. During the validation workshop, three (3) municipalities or only 6% were identified by the experts having livestock production as a complementary activity in SOCCSKSARGEN. These municipalities are Aleosan and Magpet (Cotabato), and Banga (South Cotabato) (Figure 16). The latest inventory from PSA-SOCCSKSARGEN as of January 2023 shows that the region has an estimated total of 1,249,752 heads of livestock and poultry, of which 81.3% come from backyard farms and 18.7% are produced commercially.

Changing climatic conditions pose challenges to the livestock and poultry sector, impacting their growth and weight, reproductive performance, and susceptibility to pests and diseases. © Alliance of Bioversity International and CIAT

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, in swine/hogs, the thermoneutral zone for rearing and finishing[7] pigs is at a temperature from 21°C to 24°C provided that the relative humidity is 70% or lower (Lass, 2019). For sows (adult female hogs), a temperature not more than 22°C should be maintained (Hörtenhuber et al., 2020) to not negatively affect conception rate. Overall, all animals in a hot environment tend to diminish feed intake to decrease metabolic heat production, resulting in inferior growth performance (Rauw et al., 2020; Secor, 2009).

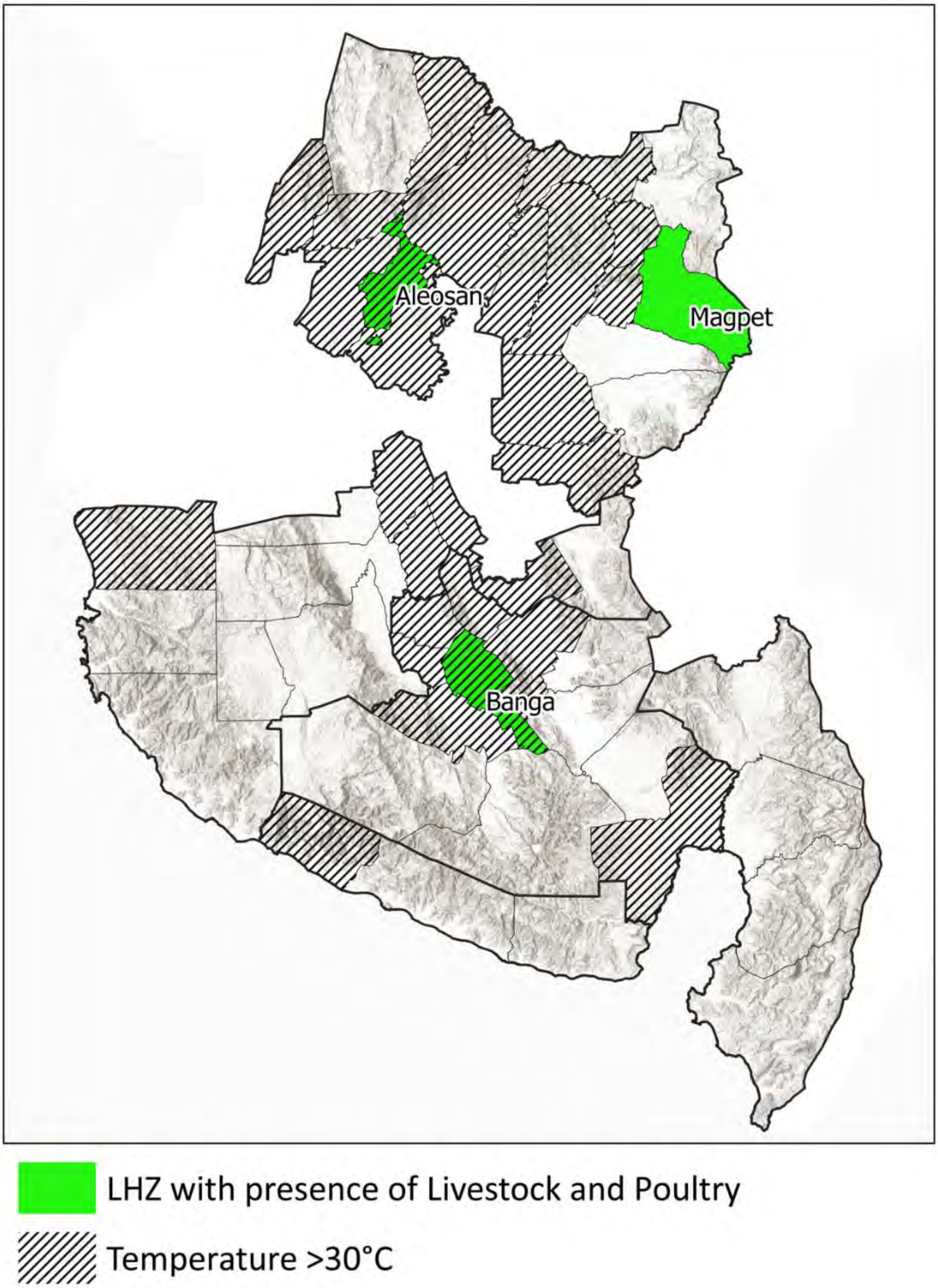
Based on the projected increase in temperature by the year 2050, only two (2) out of the three (3) municipalities mentioned are most likely to be affected by this change. These are the municipalities of Aleosan (Cotabato) and Banga (South Cotabato).

Livestock production in the Philippines is also vulnerable to extreme weather events which are expected to increase in frequency and intensity because of climate change. A study placed the total value of agricultural damage to crops, fisheries, and livestock due to typhoons, floods, and droughts in the Philippines over the last decade (2000-2010) at approximately US$219 billion (Israel and Briones, 2012). In October 2022, Severe Tropical Storm Paeng caused severe damage to livestock and poultry areas in the region. Data from DA showed that damage to the sector reached PHP 40.04 million which represents 129,596 heads of chicken, swine, cattle, carabao, goat, sheep, duck, and horse perished.

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.

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

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



4. Practical Applications of the LHZ Tool

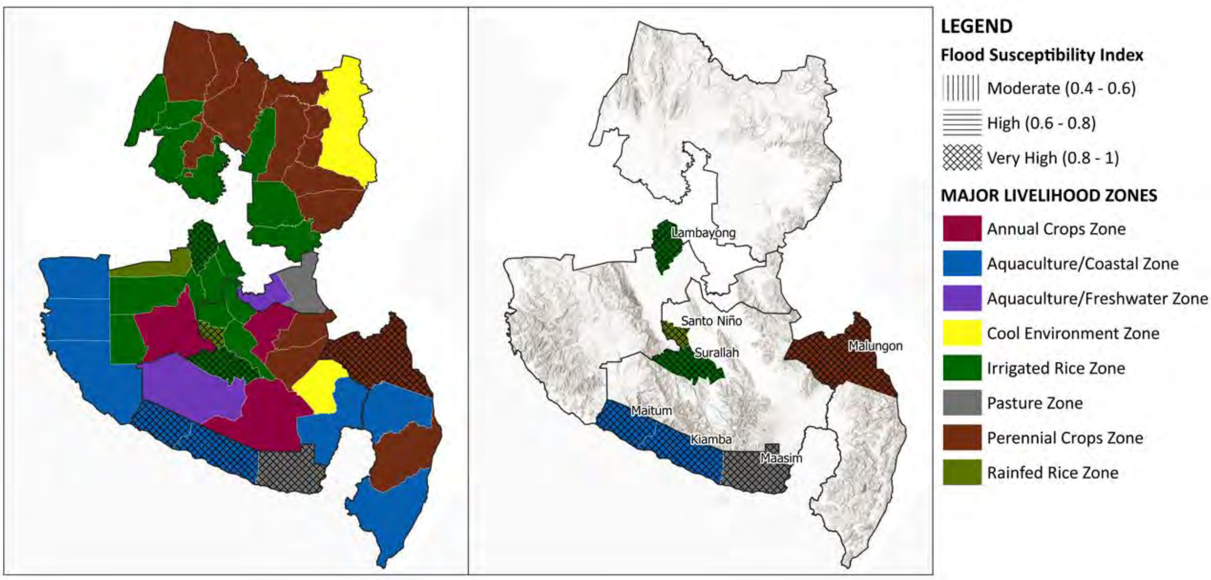
The LHZ map can serve as a guide for planners and decision makers by providing them with geographically disaggregated information that is relevant for food security monitoring, analysis, and decision support (Grillo, 2009). This tool offers a practical, yet strategic process in targeting and prioritizing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

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

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

For instance, Figure 17 shows the susceptibility to flooding of municipalities in SOCCSKSARGEN and the specific LHZs that will be affected. The municipalities of Lambayong (Sultan Kudarat) and Surallah (South Cotabato) under Irrigated Rice LHZ, the municipality of Santo Niño (South Cotabato) under Rainfed Rice LHZ, and municipalities in the province of Sarangani namely Maitum and Kiamba under the Aquaculture/Coastal LHZ, Maasim classified as Pasture LHZ, and Malungon identified as Perennial Crops LHZ have "very high susceptibility" to flooding based on their FSI.

Figure 17. FSI of municipalities in the province of Maguindanao



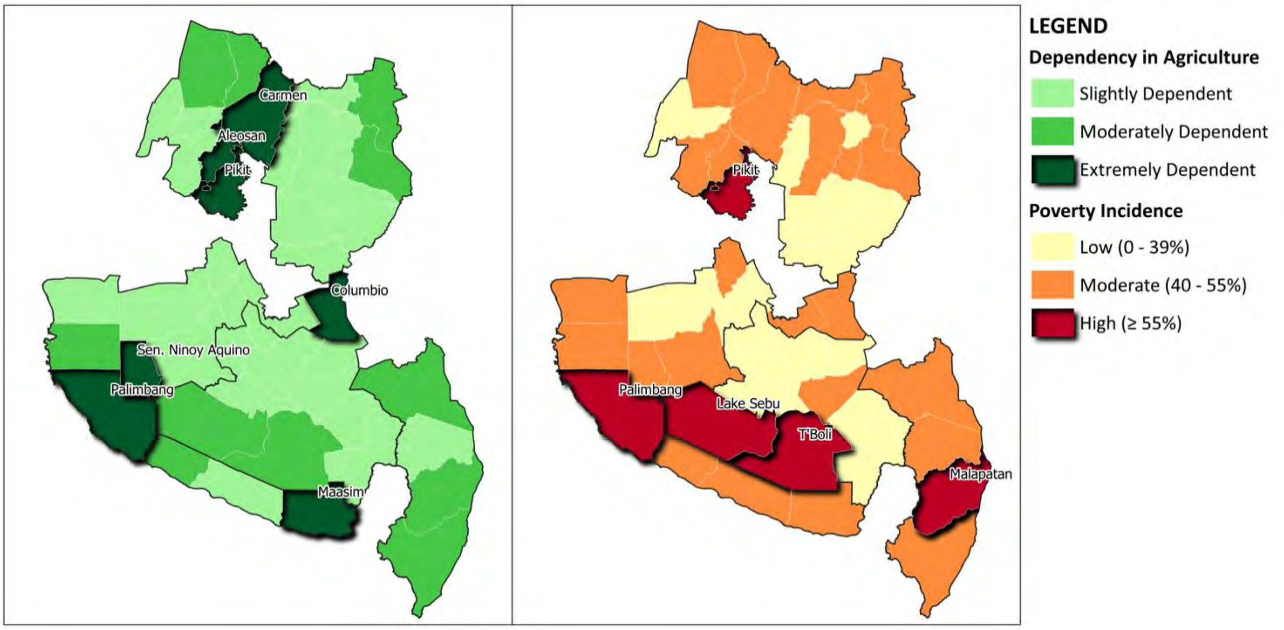
In 2022, several incidences of extreme events of flooding were reported in the region. In particular, the municipalities of Surallah in South Cotabato[8] (Rebollido, 2022) and Maitum in Sarangani[9] (Rebollido, 2022) were placed under the state of calamity due to recurring floods caused by heavy rains. The floodwaters devastated several infrastructures including 2,000 houses in many farming and fishing villages, with estimated damage amounting to PHP 200 million. In terms of adaptation strategies, rice production areas under "high" to "very high" susceptibility to flooding will require the use of flood-tolerant varieties and development of flood forecasting and early warning systems (Vidallo et. al., 2019). On the other hand, short-term interventions that may be prioritized for rice production areas under "moderate" flood susceptibility are improvements on drainage system, temporary flood barriers, and early planting or shifting of crop calendars. For aquaculture areas such as in the municipalities of Maitum and Kiamba in Sarangani, some of the adaptation strategies which may be promoted in response to the risk of flooding are cage management using deeper and thicker nets, transfer of aquaculture farms to inland areas, and establishment of reliable warning systems (Abu Samah et. al., 2021).

Additionally, diversification of livelihood is seen to be beneficial particularly to rice production areas that are highly susceptible to climate risks. During the validation workshop, the participants identified cacao, abaca, rubber, and sugarcane as other emerging important crops in SOCCSKSARGEN. Based on the data from the DA-National Color-Coded Agricultural Guide Map (NCCAG), several areas in the region are also suitable for growing of these perennial crops. Results shown in section 3.2 revealed that Perennial Crops LHZ is next to Irrigated Rice LHZ as the major LHZ and is also among the most common Secondary/Tertiary livelihood in the region. The production of perennial crops is a promising livelihood because these crops are considered as more permanent, do not require replanting to produce yield annually, and can grow with fewer soil-intensive practices and less water requirements (Davis, 2023). These crops are also characterized by a deep rooting system which can hold the soil persistently, making the crops survive a long duration of flood. These characteristics make perennial crops more resilient to climate change impacts as compared to rice and other annual crops, hence, can be considered as alternative planting materials in high-risk areas to diversify sources of income.

Using the LHZ tool to support the development of plans for poverty alleviation: SOCCSKSARGEN had a poverty incidence of 22.3% in 2018 (PSA-SOCCSKSARGEN, 2020). As shown in Figure 18, most of the areas in the region have moderate to high poverty incidences. The municipalities of Pikit (Cotabato); Palimbang (Sultan Kudarat); Lake Sebu and T'Boli (South Cotabato); and Malapatan (Sarangani), in particular, have high poverty incidences. Notably, the province of Sarangani had the highest poverty incidence of 36% according to PSA data in 2018.

[8] https://www.pna.gov.ph/articles/1182983
[9] https://www.rappler.com/nation/maitum-sarangani-state-calamity-rivers-overflow-cause-devastation-march-2022/

Figure 18. Poverty incidences of municipalities and cities in Lanao del Sur and Maguindanao in 2015 (PSA, 2017)



Using this data and the LHZ map, strategic plans to alleviate poverty can be drawn. Figure 18 also shows that the aforementioned areas are moderately to extremely dependent[10] on agriculture. These areas are mainly agriculture and fisheries areas, hence, prioritizing programs that will boost rice and fisheries productivity are of prime importance. A study by OECD (2011) showed that increasing agricultural productivity and income of farmers results to sustainable progress that reduces extreme poverty, particularly in developing countries such as the Philippines. However, the adverse impacts of climate change pose greater risks particularly to the poorest areas that heavily rely on farming. To address these problems, the local government needs to ensure that farmers have access to sustainable sources of irrigation, low-cost farm inputs, more efficient crop insurance system, and climate-resilient technologies, machineries, and equipment.

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

[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).

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. In SOCCSKSARGEN, Cabrido (2018) said that data from the National Nutrition Council showed that four out of every ten (10) children aged five years old were suffering from stunting. Notably, a high case of stunting was recorded in the municipality of T'boli (South Cotabato) (Figure 19) where the indigenous group, T'boli, inhabits highland areas of the municipality.

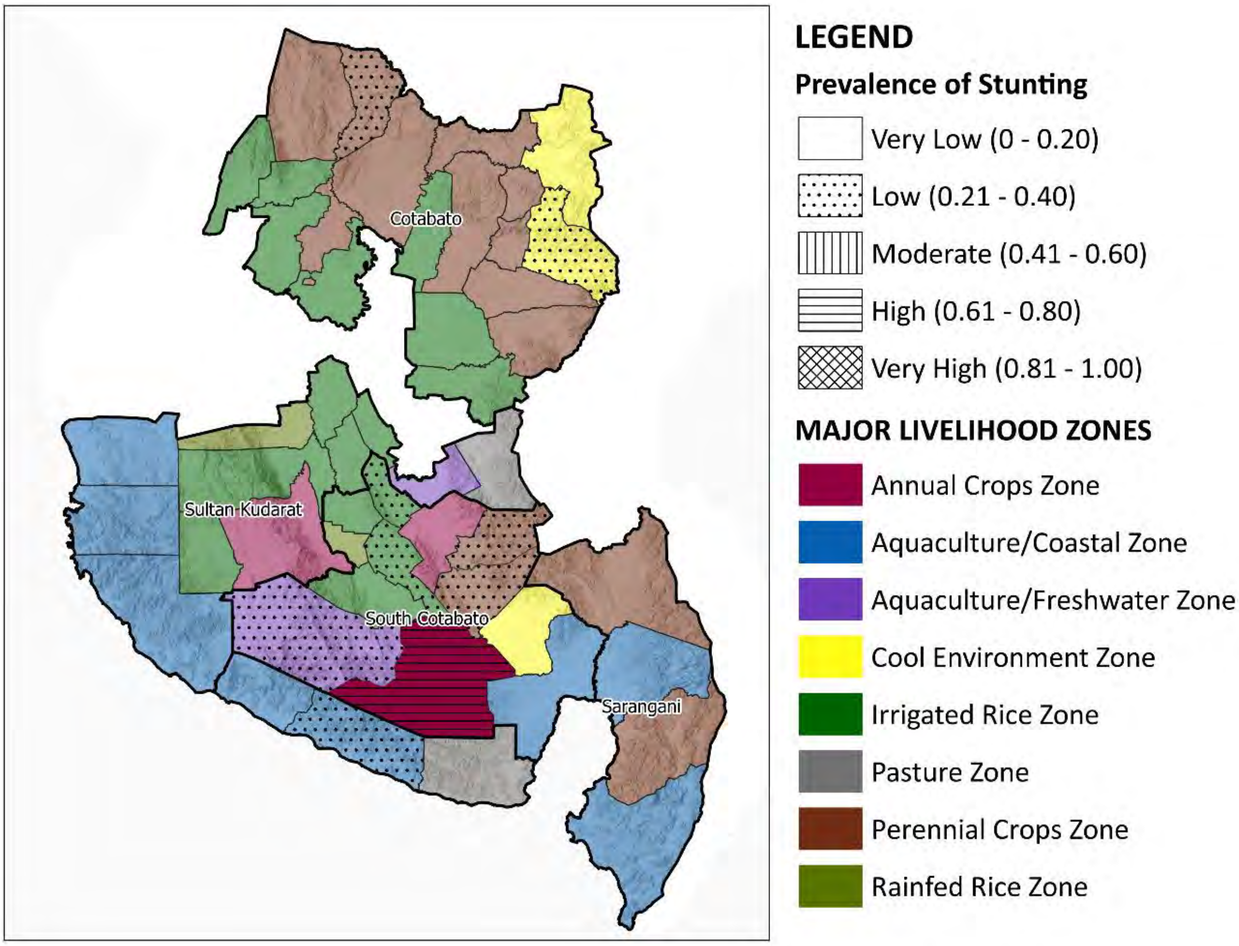
Indigenous people such as the T'Boli are prone to undernutrition because of their geographical location which limits them to access diverse and nutritious food, health and nutrition services, and water and sanitation facilities (Development Academy of the Philippines, 2021). In 2015, the National Nutrition Council and the Local Government Unit (LGU) of T'Boli established an Early Warning System on Food and Nutrition Security (EWS-FNS) project. The EWS-FNS aims to collect primary data needed for decision-making of the LGU in addressing the problems that affect the ability of the community and households to obtain sufficient and nutritious food (Flores, 2015).

Based on the LHZ database, the municipality of T'Boli is classified under Annual Crops LHZ, with limited number of secondary/tertiary livelihood under built-up areas that primarily caters to tourism. Aside from few sources of food, the limited number of livelihoods also affects income and ultimately, people's purchasing capacity. Hence, the local government is encouraged to develop and target additional livelihoods in the municipality that will support its people, especially the indigenous ones, in having better access to more sustainable food sources.

On the other hand, low prevalence of stunting was found in the municipalities of: Magpet and Banisilan (Cotabato); Kiamba (Sarangani); and Tampakan, Banga, Tantangan, Lake Sebu, and Tupi (South Cotabato). As discussed in the previous sections, most of the production areas across SOCCSKSARGEN will be less suitable for growing rice, annual crops such as maize, and perennial crops including banana. While the aforementioned areas have relatively low percentage of stunting, future conditions particularly to the municipalities under Perennial Crops LHZ (Magpet, Banisilan, and Tampakan) and Irrigated Rice LHZ (Banga and Tantangan) may increase the prevalence of stunting if no interventions are made. Diversification of livelihood and food sources, as well as promotion of climate-resilient practices and technologies among perennial crops and rice farmers in the region may help in improving health and nutrition in the said municipalities.

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

Figure 19. Prevalence of stunting in SOCCSKSARGEN and the corresponding LHZs



5. Summary and Conclusion

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

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

The livelihood profile of SOCCSKSARGEN shows that it remains to be an agriculture-based region relying largely on 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 Rainfed and Irrigated Rice LHZs, Perennial Crops LHZs and Aquaculture/Coastal LHZs are the most susceptible to drought and flooding.

Using crop models, future suitability of rice, maize, and banana were mapped under high GHG emissions scenarios. Results show that by the year 2050 existing major production areas will be generally less conducive for growing these crops in SOCCSKSARGEN 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 SOCCSKSARGEN 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 SOCCSKSARGEN. While recent data shows improvement on the region's poverty and health statistics,

many individuals including members of indigenous groups 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.

Given that SOCCSKSARGEN is mainly an agricultural region, there is a need to develop climate change adaptation strategies to mitigate risks on its crop production, livelihoods, and food security. © WFP/Ivan Sarenas

6. Recommendations

The report aimed at understanding the potential impacts of climate change on the livelihoods in the context of SOCCSKSARGEN, 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 of 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.

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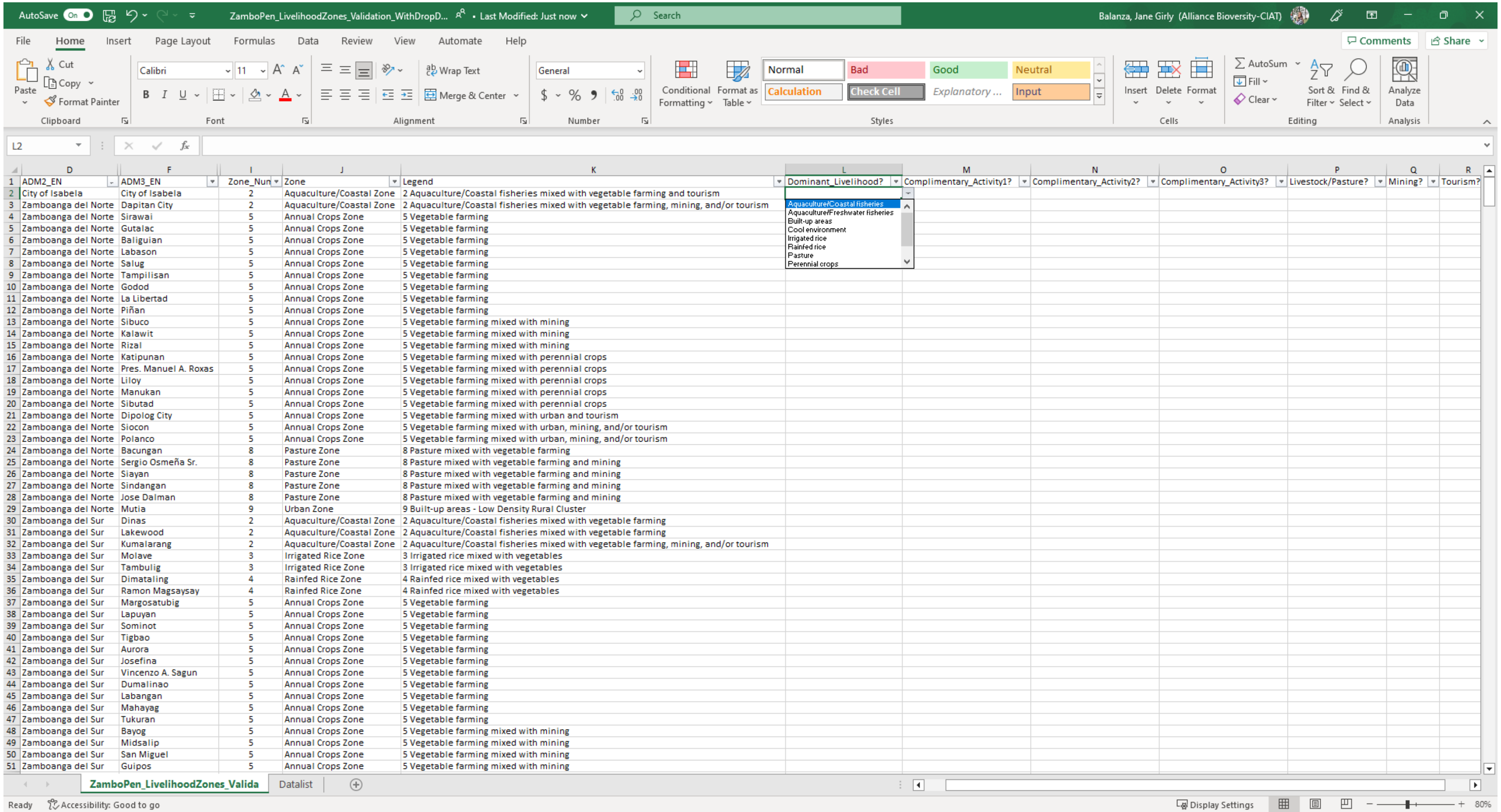
ANNEX 1: List of livelihood zones in SOCCSKSARGEN

Province	City/Municipality	Major LHZ	Secondary/Tertiary LHZ	Complementary Activity
Cotabato	Alamada	Perennial Crops Zone	rainfed rice	
Cotabato	Carmen	Perennial Crops Zone	irrigated rice, rainfed rice, and vegetable farming	
Cotabato	Kabacan	Irrigated Rice Zone	vegetable farming	
Cotabato	City of Kidapawan	Perennial Crops Zone	built-up areas (urban centre) and tourism	tourism
Cotabato	Libungan	Irrigated Rice Zone	vegetable farming	
Cotabato	Magpet	Cool Environment Zone - Perennial Crops	vegetable farming and livestock/pasture	livestock/pasture
Cotabato	Makilala	Perennial Crops Zone	rainfed rice and tourism	tourism
Cotabato	Matalam	Perennial Crops Zone	rainfed rice	
Cotabato	Midsayap	Irrigated Rice Zone	vegetable farming	
Cotabato	M'Lang	Irrigated Rice Zone	perennial crops, rainfed rice, and vegetable farming	
Cotabato	Pigcawayan	Irrigated Rice Zone	vegetable farming	
Cotabato	Pikit	Irrigated Rice Zone	Irrigated rice with mixed vegetable farming	
Cotabato	President Roxas	Perennial Crops Zone	rainfed rice	
Cotabato	Tulunan	Irrigated Rice Zone	perennial crops, rainfed rice, and vegetable farming	
Cotabato	Antipas	Perennial Crops Zone	rainfed rice and tourism	tourism
Cotabato	Banisilan	Perennial Crops Zone	rainfed rice	
Cotabato	Aleosan	Perennial Crops Zone	rainfed rice, vegetable farming, and livestock/pasture	livestock/pasture

Province	City/Municipality	Major LHZ	Secondary/Tertiary LHZ	Complementary Activity
Cotabato	Arakan	Cool Environment Zone - Perennial Crops	rainfed rice and vegetable farming	
South Cotabato	Banga	Irrigated Rice Zone	rainfed rice, vegetable farming, livestock/pasture, and tourism	livestock/pasture and tourism
South Cotabato	General Santos City	Aquaculture/Coastal Zone	vegetable farming and tourism	tourism
South Cotabato	City of Koronadal	Annual Crops Zone	built-up areas and tourism	tourism
South Cotabato	Norala	Irrigated Rice Zone	Irrigated rice with mixed vegetable farming	
South Cotabato	Polomolok	Cool Environment Zone - Annual Crops		tourism
South Cotabato	Surallah	Irrigated Rice Zone	rainfed rice, vegetable farming, and tourism	tourism
South Cotabato	Tampakan	Perennial Crops Zone	built-up areas, mining, and tourism	mining and tourism
South Cotabato	Tantangan	Irrigated Rice Zone	vegetable farming	
South Cotabato	T'Boli	Annual Crops Zone	built-up areas, mining, and tourism	mining and tourism
South Cotabato	Tupi	Perennial Crops Zone	vegetable farming and tourism	tourism
South Cotabato	Santo Nino	Rainfed Rice Zone	perennial crops	
South Cotabato	Lake Sebu	Aquaculture/Freshwater Zone	vegetable farming and tourism	tourism
Sultan Kudarat	Bagumbayan	Annual Crops Zone	irrigated rice and rainfed rice	
Sultan Kudarat	Columbio	Pasture Zone	vegetable farming and mining	mining
Sultan Kudarat	Esperanza	Rainfed Rice Zone	vegetable farming	
Sultan Kudarat	Isulan	Irrigated Rice Zone	perennial crops, rainfed rice, and vegetable farming	
Sultan Kudarat	Kalamansig	Aquaculture/Coastal Zone	perennial crops, vegetable farming, and tourism	tourism

Province	City/Municipality	Major LHZ	Secondary/Tertiary LHZ	Complementary Activity
Sultan Kudarat	Lebak	Aquaculture/Coastal Zone	irrigated rice, rainfed rice, vegetable farming and tourism	tourism
Sultan Kudarat	Lutayan	Aquaculture/Freshwater Zone	vegetable farming and tourism	tourism
Sultan Kudarat	Lambayong	Irrigated Rice Zone	vegetable farming	
Sultan Kudarat	Palimbang	Aquaculture/Coastal Zone	perennial crops, vegetable farming, and tourism	tourism
Sultan Kudarat	President Quirino	Irrigated Rice Zone	Irrigated rice with mixed rainfed rice and vegetable farming	
Sultan Kudarat	City of Tacurong	Irrigated Rice Zone	built-up areas (urban centre), aquaculture/freshwater fisheries, perennial crops, vegetable farming, and tourism	tourism
Sultan Kudarat	Sen. Ninoy Aquino	Irrigated Rice Zone	perennial crops, rainfed rice, and vegetable farming	
Sarangani	Alabel	Aquaculture/Coastal Zone	irrigated rice, vegetable farming, and tourism	tourism
Sarangani	Glan	Aquaculture/Coastal Zone	vegetable farming and tourism	tourism
Sarangani	Kiamba	Aquaculture/Coastal Zone	perennial crops, vegetable farming, and tourism	tourism
Sarangani	Maasim	Pasture Zone	perennial crops and tourism	tourism
Sarangani	Maitum	Aquaculture/Coastal Zone	perennial crops, vegetable farming, mining, and tourism	mining and tourism
Sarangani	Malapatan	Perennial Crops Zone	rainfed rice	
Sarangani	Malungon	Perennial Crops Zone	vegetable farming and tourism	tourism

ANNEX 2: Sample validation form



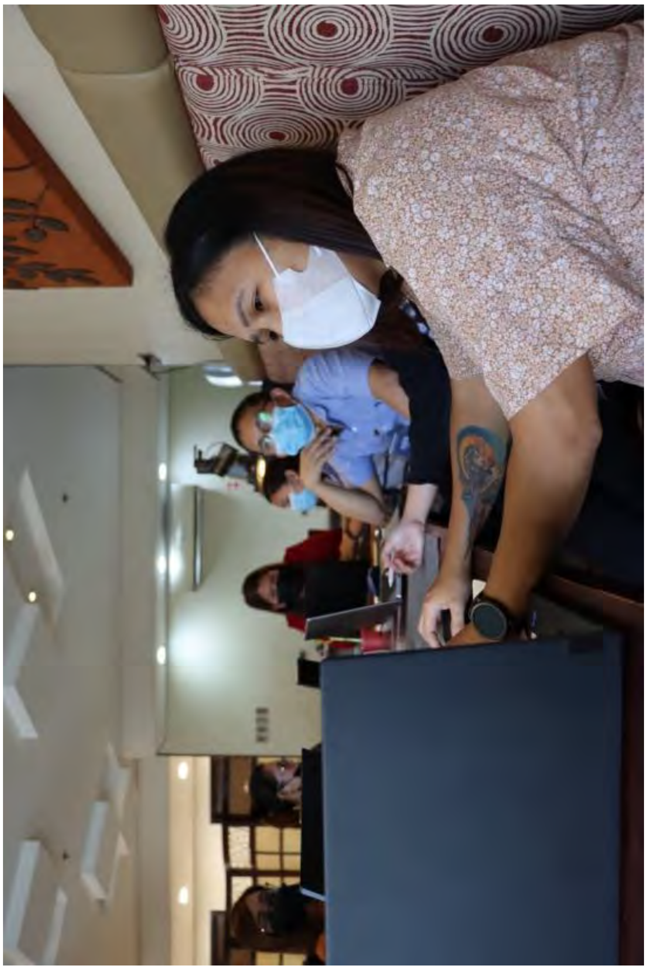
ADM2_EN	ADM3_EN	Zone_Num	Zone	Legend	Dominant_Livelihood?	Complimentary_Activity1?	Complimentary_Activity2?	Complimentary_Activity3?	Livestock/Pasture?	Mining?	Tourism?
City of Isabela	City of Isabela	2	Aquaculture/Coastal Zone	2 Aquaculture/Coastal fisheries mixed with vegetable farming and tourism							
Zamboanga del Norte	Dapitan City	2	Aquaculture/Coastal Zone	2 Aquaculture/Coastal fisheries mixed with vegetable farming, mining, and/or tourism							
Zamboanga del Norte	Sirawai	5	Annual Crops Zone	5 Vegetable farming							
Zamboanga del Norte	Gutalac	5	Annual Crops Zone	5 Vegetable farming							
Zamboanga del Norte	Baliguian	5	Annual Crops Zone	5 Vegetable farming							
Zamboanga del Norte	Labason	5	Annual Crops Zone	5 Vegetable farming							
Zamboanga del Norte	Salug	5	Annual Crops Zone	5 Vegetable farming							
Zamboanga del Norte	Tampilisan	5	Annual Crops Zone	5 Vegetable farming							
Zamboanga del Norte	Godod	5	Annual Crops Zone	5 Vegetable farming							
Zamboanga del Norte	La Libertad	5	Annual Crops Zone	5 Vegetable farming							
Zamboanga del Norte	Piñan	5	Annual Crops Zone	5 Vegetable farming							
Zamboanga del Norte	Sibuco	5	Annual Crops Zone	5 Vegetable farming mixed with mining							
Zamboanga del Norte	Kalawit	5	Annual Crops Zone	5 Vegetable farming mixed with mining							
Zamboanga del Norte	Rizal	5	Annual Crops Zone	5 Vegetable farming mixed with mining							
Zamboanga del Norte	Katipunan	5	Annual Crops Zone	5 Vegetable farming mixed with perennial crops							
Zamboanga del Norte	Pres. Manuel A. Roxas	5	Annual Crops Zone	5 Vegetable farming mixed with perennial crops							
Zamboanga del Norte	Liloy	5	Annual Crops Zone	5 Vegetable farming mixed with perennial crops							
Zamboanga del Norte	Manukan	5	Annual Crops Zone	5 Vegetable farming mixed with perennial crops							
Zamboanga del Norte	Sibutad	5	Annual Crops Zone	5 Vegetable farming mixed with perennial crops							
Zamboanga del Norte	Dipolog City	5	Annual Crops Zone	5 Vegetable farming mixed with urban and tourism							
Zamboanga del Norte	Siocon	5	Annual Crops Zone	5 Vegetable farming mixed with urban, mining, and/or tourism							
Zamboanga del Norte	Polanco	5	Annual Crops Zone	5 Vegetable farming mixed with urban, mining, and/or tourism							
Zamboanga del Norte	Bacungan	8	Pasture Zone	8 Pasture mixed with vegetable farming							
Zamboanga del Norte	Sergio Osmeña Sr.	8	Pasture Zone	8 Pasture mixed with vegetable farming and mining							
Zamboanga del Norte	Siayan	8	Pasture Zone	8 Pasture mixed with vegetable farming and mining							
Zamboanga del Norte	Sindangan	8	Pasture Zone	8 Pasture mixed with vegetable farming and mining							
Zamboanga del Norte	Jose Dalman	8	Pasture Zone	8 Pasture mixed with vegetable farming and mining							
Zamboanga del Norte	Mutia	9	Urban Zone	9 Built-up areas - Low Density Rural Cluster							
Zamboanga del Sur	Dinas	2	Aquaculture/Coastal Zone	2 Aquaculture/Coastal fisheries mixed with vegetable farming							
Zamboanga del Sur	Lakewood	2	Aquaculture/Coastal Zone	2 Aquaculture/Coastal fisheries mixed with vegetable farming							
Zamboanga del Sur	Kumalarang	2	Aquaculture/Coastal Zone	2 Aquaculture/Coastal fisheries mixed with vegetable farming, mining, and/or tourism							
Zamboanga del Sur	Molave	3	Irrigated Rice Zone	3 Irrigated rice mixed with vegetables							
Zamboanga del Sur	Tambulig	3	Irrigated Rice Zone	3 Irrigated rice mixed with vegetables							
Zamboanga del Sur	Dimataling	4	Rainfed Rice Zone	4 Rainfed rice mixed with vegetables							
Zamboanga del Sur	Ramon Magsaysay	4	Rainfed Rice Zone	4 Rainfed rice mixed with vegetables							
Zamboanga del Sur	Margosatubig	5	Annual Crops Zone	5 Vegetable farming							
Zamboanga del Sur	Lapuyan	5	Annual Crops Zone	5 Vegetable farming							
Zamboanga del Sur	Sominot	5	Annual Crops Zone	5 Vegetable farming							
Zamboanga del Sur	Tigbao	5	Annual Crops Zone	5 Vegetable farming							
Zamboanga del Sur	Aurora	5	Annual Crops Zone	5 Vegetable farming							
Zamboanga del Sur	Josefina	5	Annual Crops Zone	5 Vegetable farming							
Zamboanga del Sur	Vincenzo A. Sagun	5	Annual Crops Zone	5 Vegetable farming							
Zamboanga del Sur	Dumalinao	5	Annual Crops Zone	5 Vegetable farming							
Zamboanga del Sur	Labangan	5	Annual Crops Zone	5 Vegetable farming							
Zamboanga del Sur	Mahayag	5	Annual Crops Zone	5 Vegetable farming							
Zamboanga del Sur	Tukuran	5	Annual Crops Zone	5 Vegetable farming							
Zamboanga del Sur	Bayog	5	Annual Crops Zone	5 Vegetable farming mixed with mining							
Zamboanga del Sur	Midsalip	5	Annual Crops Zone	5 Vegetable farming mixed with mining							
Zamboanga del Sur	San Miguel	5	Annual Crops Zone	5 Vegetable farming mixed with mining							
Zamboanga del Sur	Guipos	5	Annual Crops Zone	5 Vegetable farming mixed with mining							

ANNEX 3: Photo documentation

SOCCSKSARGEN small group 1 discusses plans on how to approach the preliminary assessment of livelihood zones and climate risks for each municipality/city/ province in Region XII.

SOCCSKSARGEN small group 2 gathers to finalize their inputs and assessment of dominant livelihood zones in region XII.

Angelito Villar, Senior Trade & Industry Specialist of DTI-XII, talks about his group's findings and also urges the review of key terms used in the livelihood zones map.



Senior Research Associate, Jane Girly Balanza, from The Alliance of Bioversity International and CIAT, facilitates the small group discussion for characterization of climate risks in Region XII.

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