

# DEVELOPMENT OF THE LIVELIHOOD ZONES MAP IN THE PHILIPPINES FOR STRATEGIC ASSESSMENT OF CLIMATE CHANGE IMPACTS TO FOOD SECURITY AT THE LIVELIHOOD LEVEL

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## ABSTRACT

Climate change poses critical and complex challenges to global food security. The potential impacts across the various elements of food security are particularly acute in the Philippines, where hundreds of thousands of households depend on natural resource-based livelihoods such as agriculture, fisheries, livestock, etc. While the country has an extremely diverse livelihood, no single map is available that contains a detailed description of the livelihood zones. This in turn carries the need to develop a livelihood zones map which contains spatial data with detailed information on people's economic activity as sources of income, and production system and land use characteristics. In 2021, the National-level Livelihood Zones Map was developed as one of the outputs of the Climate Change and Food Security Analysis (CCFSA) Project in the Philippines, funded by the World Food Programme (WFP), in collaboration with the Alliance of Bioversity International and CIAT.

Using spatial overlay analysis in QGIS, seven national datasets (agroecological zones, industrial zones, land cover, rice extent, tourism areas, and municipal classification into rural and urban), coming from different national agencies, that satisfies all the information on the existing livelihoods in the country were compiled and combined into a new set of spatial data encompassing the livelihood zones and other valuable information. This new set of spatial data is stored in a Geographic Information System (GIS) shapefile which includes the geographic locations of the livelihood zones and their characteristics, providing a location-specific food security analysis and recommendations when combined with climate change projections and analysis of impacts.

Due to mobility restrictions brought by the COVID-19 pandemic in 2021, virtual validation was used as the method in validating the initial livelihood zones map and characterizing each major zones. An interactive livelihood zones map was hosted on the web through the AMIA-CIAT<sup>1</sup> website ([ciatphdemo.firebaseio.com](http://ciatphdemo.firebaseio.com)) to facilitate the visualization of the initial map. Together with the virtual interactive map, an online survey instrument was also developed and deployed using an online survey tool called KOBO Collect that gathers feedback and responses from the national and local experts.

The results of the livelihood zones map, which is the first in the country, can provide a powerful tool that can assist planners and policymakers in strategically assessing impacts of climate-related risks to food security at the livelihood level through accurate and location specific classifications of the livelihood zones in the country.

**Keywords:** Livelihood map, Livelihood activity, Economic activity, Income sources

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<sup>1</sup> This website was created from the previous project of the Department of Agriculture (DA) and the International Center of Tropical Agriculture (CIAT) under the flagship program called Adaptation and Mitigation Initiative in Agriculture also known as AMIA.

## 1. INTRODUCTION

Philippines archipelagic nature and unique topography, livelihoods and sources of income are extremely diverse across the country (Licuanan et. al., 2019). Patterns on how people obtain food and income vary from one geographic area to another. While the country has an extremely diverse livelihood, no single database is available that contains detailed description of the livelihood zones. This in turn carries the need to develop a spatial database of livelihood zones which includes detailed information on people's economic activity as sources of income, and production system and land use characteristics. We compiled different national datasets from different national agencies that satisfies all the information on the existing livelihoods in the country.

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.

## 2. METHODOLOGY

### 2.1 Spatial Data

The CCFSA utilized seven (7) different national datasets to build the LHZ database (**Error! Reference source not found.**). 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 1.** Data sources for the LHZ database

LAYER	SOURCE	DATA TYPE	YEAR
Land cover	National Mapping and Resources Information Authority (NAMRIA)	Polygon	2015
Agroecological zones	Department of Agriculture	Polygon	2016
Rice extent	International Rice Research Institute	Raster	2015
Mining locations	Department of Environment and Natural Resources	Point, Tabular	2015
Tourism areas	Philippine Geoportal	Point	2015
Local Government Unit Category	Philippine Statistics Authority	Tabular	2015
Industrial zones	Local Government Units	Tabular	2015

## 2.2 Livelihood Zones Mapping

The Spatial Overlay operation in GIS (Tiede, 2014) was employed to identify the spatial relationships among the different thematic maps in Error! Reference source not found.. As shown in **Figure 1**, all the datasets and attributes were superimposed and analysed within a polygon which represents a city/municipality. Using this technique, different combinations of data were formed to analyse 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.

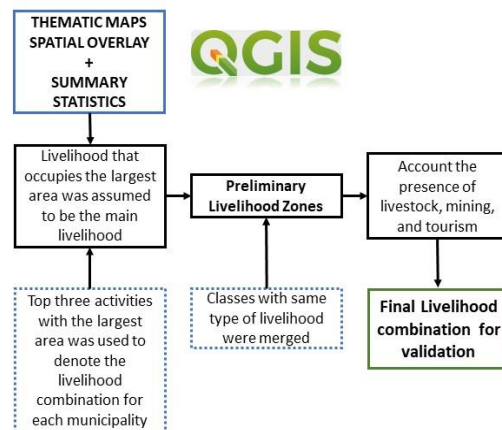
To determine the extent of each type of livelihood, the area in hectares (ha.) being occupied by a specific activity was calculated using the Summary Statistics Tool. The activity that occupied the largest area in each city/municipality was considered as the Major Livelihood. On the other hand, the succeeding 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 which were computed as counts per polygon.

Livestock activities were also simply classified as “Yes”

(present) or “No” (lacking) so they had 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 1**, 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 1.** Process flow in QGIS for the Livelihood Zones development and mapping

## 2.3 Climate Risk Mapping

To identify and qualify the major climate change-related risks that were prioritized for this project, six datasets on hazards were used to characterize the Philippines’ exposure to climate variability and extreme weather events. The prioritized climate risks are flood, drought, typhoons, saltwater intrusion, storm surge, and sea-level rise (**Table 2**).

The selection of hazards was based on their potential impact on livelihood, food security and nutrition, and data availability. The hazard maps represent the current risk and exposure of crops, people, and institutions. Flooding is then used in this paper to demonstrate the exposure level and better understand the impact of hazards on livelihoods.

**Table 2.** Overview of hazard datasets.

PARAMETERS	SOURCE
Flooding	Mines and Geosciences Bureau, Department of Environment and Natural Resources (DENR-MGB)
Drought	TerraClimate (Abatzoglou et al., 2018). Palmer Drought Severity Index (PDSI) from 1950 to near present
Typhoon	UNEP/UNISDR (2013) ( <a href="https://preview.grid.unep.ch/">https://preview.grid.unep.ch/</a> ) WFP-PH
Storm Surge	AMIA multi-hazard maps/baseline data from Disaster Risk and Exposure Assessment for Mitigation, Department of Science and Technology (DREAM, DOST)
Saltwater Intrusion	AMIA multi-hazard map/baseline data from the NWRB
Sea-level Rise	AMIA multi-hazard map

### 3. RESULTS

#### 3.1 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 (**Table 3**).

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 the datasets were stored in Shapefile format which can either be viewed as maps or be exported as tabular data.

**Table 3.** Categories of the LZs in the Philippines

MAJOR ZONES	DESCRIPTIONS
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).
Aquaculture/ Coastal Zone	Activities related to fisheries and seaweed farming in coastal marine areas.
Irrigated Rice Zone	Activities related to rice farming in banded fields wherein water supply is reliable using irrigation systems. Rice grows once or twice a year, and sometimes mixed or intercropped with vegetables.
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.
Annual Crops Zone	Activities related to growing vegetables and root crops that are harvested seasonally and have an annual life cycle.
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 require several growth cycles before their fruits are produced and/or harvested.
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, and lettuce can be grown only in this zone).
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.
Built-up Areas Zone	Activities related to commerce, industry, and non-agricultural jobs in urban or built-up areas.

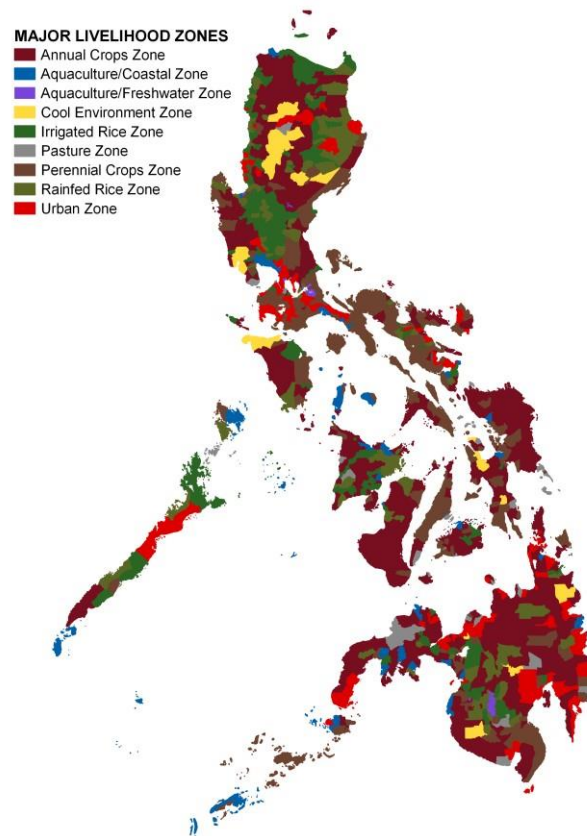
### 3.2 Virtual Validation

After the initial Livelihood Zones Map was developed, it was presented to different experts. Because of the COVID-19 pandemic and mobility restrictions, the project created a methodology to virtually validate the map and characterize each major livelihood zone and sub-zone. The initial Livelihood Zones Map (**Figure 2**) was hosted on the AMIA-CIAT website ([ciatphdemo.firebaseio.com](http://ciatphdemo.firebaseio.com)), and an online survey questionnaire was developed and deployed using an online survey tool (Kobo). The AMIA-CIAT website was created from the previous project of the Department of Agriculture (DA) and the International Center of Tropical Agriculture (CIAT) under the flagship program called Adaptation and Mitigation Initiative in Agriculture also known as AMIA.

In total, 26 experts from different Regional Field Offices of the Department of Agriculture (DA-RFOs), national government agencies (NGAs), and state universities and colleges (SUCs) participated in the online survey, providing validation and enhancement of the original Livelihood Zones Map. The breakdown of expert participants included:

- Six experts from four different NGAs
- Three experts from three different SUCs
- Seventeen experts from 11 different DA-RFOs

Out of the 81 provinces in the Philippines, 32 were validated by the survey, providing a sample group that covers approximately 39% of the nationwide total.



**Figure 2.** Initial Livelihood Zones Map of the Philippines

### 3.3 Impact of Climate Change to LHZ

Results of flood risk and livelihood mapping corroborate the findings from the prevailing literature on the projected impacts of climate change on precipitation in the Philippines. To illustrate the impact of flooding on livelihoods, an overlay analysis of flood susceptibility mapping and livelihoods mapping was conducted. The Flood Susceptibility Index (FSI) was derived by computing the aggregated areas within the municipality with medium to very high flood risk over the total land area per municipality.

The FSI map was created using the existing flood map of the Philippines and NAMRIA's municipal administrative map. The resultant index is useful for approximating the extent of land area affected by flooding per city or municipality, although it does not indicate specific flooding locations within a given city or municipality. As a measure of the geographic extent of flooding per city or municipality, the FSI value of 0 indicates no flooding, while the value of 1 indicates total submergence of the geographic unit in the event of flooding.

The FSI makes it apparent that flooding is a burgeoning problem that will likely increase in frequency and severity in many parts of the Philippines from 2020 to 2050. This increased susceptibility to floods will strongly affect agricultural livelihoods, particularly farming and fishing, which will have knock-on effects on the national food supply. **Figure 3** depicts how the areas across the three island groups of Luzon, Visayas, and Mindanao that are largely devoted to agricultural production are the same areas that are expected to experience significant climatic variability and a heightened susceptibility to flooding.

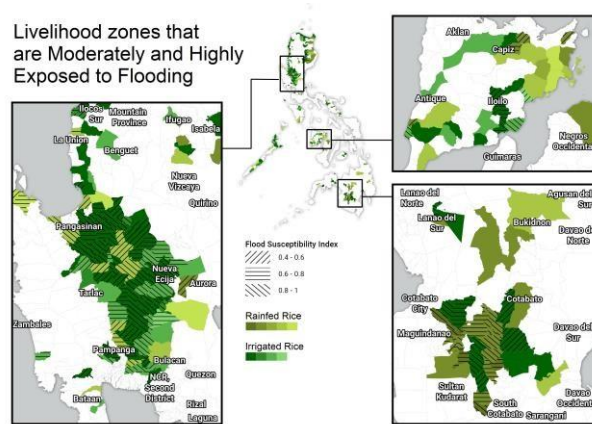


Figure 3. Livelihood zones that are moderately and highly exposed to flood

#### 4. CONCLUSION

Among the achievements of the project is the development of the first ever livelihood zones map in the Philippines and that majority of the livelihood zones were validated by different experts. The livelihood zones map can be used as a tool to understand the potential implications of climate change for the food security in the context of the Philippines. Climate-related hazards are projected to continue having major implications for agricultural, livestock, and fishery livelihoods. Analysis through both geospatial and livelihood lenses can provide a highly localized decision-making in climate change mitigation and adaptation across specific livelihood groups. This study hopes to support the local planning and targeting components and other types of adaptation strategies.

#### References:

- Licuanan, W., Cabreira, R. & Alino, P. 2019. *World Seas: an Environmental Evaluation*. Second Edition, Vol. 2, pp. 515-537.
- “OCHA” United Nations Office for the Coordination of Humanitarian Affairs. 2019. Available at: [www.unocha.org/](http://www.unocha.org/)
- Tiede, Dirk. (2014). A new geospatial overlay method for the analysis and visualization of spatial change patterns using object-oriented data modeling concepts. *Cartography and Geographic Information Science*. 41. 227-234. 10.1080/15230406.2014.901900.
- WFP (World Food Programme). 2010. Emergency Food Security Assessment: Philippines Luzon Typhoon and Floods. Available at: <https://bit.ly/3xmITw2>