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Short Paper

Land Use Policy Area (LUPA): A Stratagem towards Advanced Preparedness in the ArcGIS Platform

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Abstract

Purpose – This paper presents a stratagem designed to reduce disaster risk through a Land Use Policy Area (LUPA) geospatial information model for the Municipality of Lupi, Camarines Sur, Philippines.

Method – ArcGIS was used to organize data to analyze the distribution of the protection, production, settlement, and infrastructure policy areas for the next ten years planning period aiming to achieve the preferred development strategy of the municipality.

Results – The study disclosed that the local government continued protecting 39.37% or 7,988.5 Ha of the land and inland waters of the municipality, properly utilizing the 58.43% or 11,854.6 Ha of land for agricultural uses, using the 1.38% or 279.3 Ha for urban and rural uses, and allocated at least 0.82% or 166.6 Ha of land mostly for transportation use. Focused on the significance of the land-use policies concerning the municipality's plans relative to the need to reduce disaster risk and development constraints, the LUPA geospatial information model for Lupi could fittingly serve as a tool to guide and control its balanced and sustainable growth. As various localities continue to seek answers to the innumerable and diverse challenges posed by climate change, it behooves decision-makers to consider this highly innovative and modern strategy along land-use planning and development to reduce risk and maximize the use of land assets.

Conclusion – As the world experiences environmental change, the traditional disaster risk reduction actions are no longer working to resist the changing climate. This necessitates the application of a stratagem crafted to reduce disaster risk through a Land Use Policy Area (LUPA). Using ArcGIS to organize data, the LUPA Geospatial Information Model systematically analyzed data along with the four important policy areas: protection, production, settlement, and infrastructure which shall become the bases of development planning under the strategic development framework of the Municipality of Lupi, Camarines Sur, Philippines.

Recommendations – The study highly recommends the adoption of the LUPA Geospatial Information Model focused on the aforesaid four important policy areas to reduce risks and other development constraints as the Municipality of Lupi pursues its priorities and charts its future direction.

Practical Implications –As various localities strategize to find solutions to the innumerable challenges posed by climate change, the LUPA for Lupi model can be used to guide land use and local development that strikes physical and environmental balance through continuous monitoring of the municipality’s sustained local development.

Keywords – spatial feature, risk hotspot, development constraints, LUPA

INTRODUCTION

Lupi which is one of the municipalities of Camarines Sur, Philippines, is part of the Libmanan-Polantuna watershed often affected by flooding in Poblacion, Colacling, Bagangay Sr, Bagong Sikat, Bangon, Barerra Jr, Bel Cruz, Buenawerte, Bulawan Sr, Cristorey, Napolidan, Polantuna, San Isidro, San Jose, San Pedro, San Ramon, and Tapi. Floods can damage properties, bring health risks, low productivity, drowning incidents, increase poverty, and so on. All barangays are susceptible to earthquake-induced landslides. Also, Lupi is susceptible to rain-induced landslide specifically in Poblacion, Bangon, Barerra Jr, Barrera Sr, Bel Cruz, Belwang, Cristo Rey, Del Carmen, Haguimit, Hahluban, Lourdes, Polantuna, San Jose, San Rafael Norte, San Ramon, San Vicente, and Tible. It can bring damage to farm-to-market roads interconnecting Lupi to Sipocot, Del Gallego, and Libmanan which can displace students and the working force. Damaged buildings may interrupt academic activities and other socio-economic activities that can increase poverty, illiteracy, and so on. All barangays in Lupi are likely prone to earthquake-induced landslides, ground shaking, and liquefaction although there are no recent and historical reports that can prove it affected Lupi. Bangon is the only barangay prone to storm surge, liquefaction, coastal erosion, sea-level rise, and tsunami.

The study focused on creating the Land Use Police Area (LUPA) for Lupi, Camarines Sur with three sets of objectives to guide the municipal spatial growth to advance preparedness, these are: (i) physical development constraints highlighting the critical slopes relative to waterways and other environmental critical areas, (ii) land use classified into the forest, general agricultural areas comprising both the agricultural and settlements, and water use areas, and (iii) disaster-prone areas where risk hotspots are located which were based on the Abante et. al (2021) LUPA concept model highlighting the intersections of the three elements, namely: (i) intersection of the ecosystem and land use elements; (ii) intersection of the subwatershed and land use elements; and (iii) integrated environmental management.

The challenging work is correlating the 3 three sets of objectives to guide the municipal spatial growth to advance preparedness with the 3 elements of Abante et. al (2021) LUPA model which revealed land use policy areas as seen to influence the municipal growth of the municipality, although LUPA can relatively change as the independent variable "land use" changes which are also seen reliant on the impacts of climate change. Figure 1present the distribution where the LUPA protection, production, settlement, and infrastructure policy areas for the next ten years planning period are taken into consideration. It aimed to achieve the preferred development strategy of the municipality, which combines agriculture, commerce, and tourism development while protecting the waterways, watersheds, forests including the remaining mangroves, easements, tourism sites, and ancestral domain of indigenous people living in Lupi.

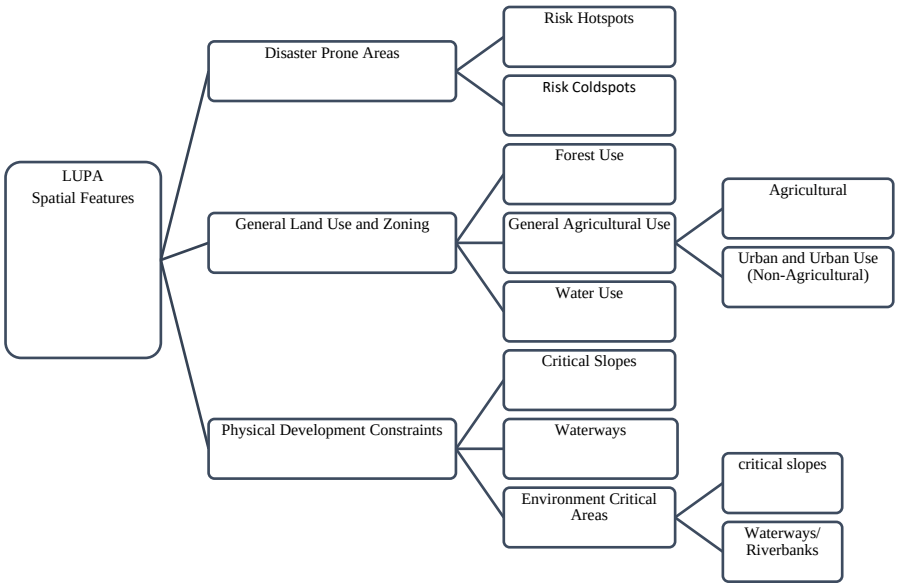

Figure 1. LUPA Spatial Features Model

GENERAL LAND AND WATER USE

The general land use in this paper is regarded as the following: (i) Forest Use includes the protection forest and production forest which are regulated under the relevant provisions of the revised forestry code, revised Public Land Act of 1937, NIPAS Act of 1992 covering a portion of the Bicol Natural Park, and specific proclamations of the forest reservations based on the approved Municipal Forest Land Use Plan; (ii) agricultural use includes all areas intended for the cultivation of the soil, planting of crops, growing of trees, raising of livestock, poultry, fish or aquaculture production, including the harvesting of such farm products, and other farm activities and practices performed in conjunction with such farming operations. The agricultural zones also include the protected agricultural areas as defined by the Agriculture and Fisheries Modernization Act (AFMA) of 1997, Comprehensive Agrarian Reform Law (CARL) of 1988, and related issuances as well as production agricultural areas declared by Lupi. Regulations shall be under AFMA, CARL, Republic Act No. 7160 or the Local Government Code of 1991 (LGC) and related issues; (iii) urban and urban use areas are regarded as non-agricultural use in this paper. Dwelling units are allowed in the general residential zones. Economic activities and business establishments are allowed within a low-density commercial area intended for neighborhood or community scale trade, service, and business activities. Other industrial and economic, tourism development and special uses are also regulated by the comprehensive land-use plan and zoning ordinance; and (iv) Waters Use in Lupi where only municipal fishing, as defined in the Fisheries Code, is allowed. The allowable uses and activities include fishing using fishing vessels of three (3) gross tons or less, and/or fishing may not require the use of fishing vessels within the mandatory navigational lane in Ragay Gulf.

DEVELOPMENT CONSTRAINTS IN LUPI

All barangays in Lupi are generally agricultural lands with ample inland water bodies which serve as natural water sources for farming. The Pulantuna River interconnected with the Solong-Colacling River and Bahi River as well as various streams or creeks is all part of the Libmanan-Pulantuna watershed which drains rainwaters in the Bicol River estuary in Naga City. The increase in temperature relatively influences tropical cyclones which convey damages to crops, livestock, fisheries, and other agriculturally based products of Lupi. Low production gives rise to poverty and crime rates because of low income and food shortages. Damaged trees may trigger soil erosion or landslide in steep and unstable slope areas as well as riverbanks.

As climate changes, the study aims to characterize the land use development constraints and measure the risks to generate knowledge and information to quantify and integrate them into the four land-use policy areas, classified into protection, production, settlement, and infrastructure sets of objectives to influence the municipal growth. The study answers the question "How can a model mimic features where the land use policy areas are mostly needed to significantly reduce disaster risks considering well-managed land resources are fundamental to the growth of cities/municipalities in the ArcGIS platform?

LITERATURE REVIEW

The land is a fundamental material resource and the primary platform for economic and other social activities (Corpuz, 2013), laying emphasis on the assumption that the way land is used and how it is intended to be used are integral components of human development. A land-use policy or a land-use plan defines the ways by which land should be used (Corpuz, 2013). It directly affects the value of land which is related to its productive potential. Land property rights, therefore, reflect the right to extract value from land, based on how the land can be utilized in a socially productive and acceptable manner (Corpuz, 2013). Land-use policies are affecting human development in the Philippines (Corpuz, 2013). The current state of land use policies provides emphasis on the practicality to begin by identifying and describing land-use policies (Corpuz, 2013). The land-use plans and policies should be viewed by planners as well as political leaders as only part of a set of instruments to direct or influence land-based activities and development (Corpuz, 2013).

According to Lurini & Thompson (1992), spatial units as a feature refers to a set of phenomena of different spatial (space) forms which is a basic unit of data storage. It has location-defined coordinates and topological pointers to other features, possibly some non-spatial attributes (table form). The notion of Abante, et al. (2021) on Land Use Policy Area (LUPA) features the ecosystem-based land use, sub-watershed, and integrated environmental management which were paired to analyze the ecological zones, ridge-to-reef watershed delineation, land and water use, and the spatial features to classify the

LUPA into four classes which are protection, production, settlement, and infrastructure. These intersections are mathematically expressed as the sets of {LUPA} ~ {ecosystem-based land use} ∩ {watershed-based land use} ∩ {integrated environmental management} Abante, et al. (2021). According to them, the challenging work was creating the set of instruments in connection with land use policy areas with the following variables: ecosystem, watershed divide or delineation, land use, ecosystem-based land use, watershed-based land use, and integrated environmental management to extract the science-based information which practically highlighted the LUPA classifications, namely: Protection, Production, Settlement, and Infrastructure. The World Bank has identified the Philippines as the third most disaster-prone country in the world and there is low uptake of research and analytic thinking to inform local decision making on disaster risk management. Laureta, et al. (2021) investigated the vulnerability of the agriculture sector and rural agriculture livelihoods in the Bicol River Basin (BRB) of the Philippines to projected changes in climate. They said that the geographical characteristics of the BRB feature eight major sub-basins or watersheds. The Municipality of Lupi is situated in the northwestern section of the Libmanan-Pulantuna watershed. Their study applied the combination of the participatory tools and the Climate Risk Vulnerability Assessment framework to gather information on local climate vulnerabilities and contexts. They disclosed that there is a significant regional difference in terms of vulnerability in the BRB in which Lupi will also experience increased vulnerability. The notion of Abante (2021a) on "an informed local government is prepared" can be applied. Although it will take a long term to realize, the desire to make it real through an information model that can mimic the municipality's risk reality extremes matters to guide and control land and water use should be considered in order to achieve stable and sustainable development. Her article disclosed that the risk hotspots in Lupi were reckoned in the stability line (base) of an ARRIT that was based on Schoen's theory of the golden triangle and Fibonacci's golden ratio as it orbits the golden spiral (Abante, 2021b). The risk-neutral stance represents the balance between receptive and responsive DRRM measured by the resulting z-scores derived from data on hazards, vulnerability, exposure, and capability (Abante, 2021a,b). The Risk Reality Geospatial Information Model for Lupi proved the visualization of land use constraints relative to base zones where restructuring of DRRM actions is needed to attain physical and environmental balance (Abante, 2021a,b).

Based on the Nationwide Operational Assessment of Hazards (NOAH), the steep and unstable slopes, riverbanks, and legal easements are categorized as no dwelling zones (Lagmay, 2017). Development can only be allowed to a somewhat unstable slope area (moderately unsuitable) only if slope protections and interventions, and continued monitoring are in place because such areas are likely to collapse during heavy rainfall or strong earthquakes. According to the NOAH Project, the fan-shaped landforms most likely to experience flood and debris flow are also a no-build zone. Alluvial fans are also considered a natural hazard. The people and infrastructure are likely exposed to danger when their locations x and y coincide with the no-build zones, riverbanks, and legal easements or areas highly susceptible to natural hazards that are hydrological and geological in origin (Lagmay, 2017).

METHODOLOGY

DISASTER RISK ASSESSMENT

The disaster risk was estimated using the six elements of risk which are: multiple hazards, landscape vulnerability, exposure, and capability regarded as preparedness, competency, and coping capacity in terms of the municipality's income class (Abante, 2021a). The multiple hazards were weighted and categorized depending on the natural hazards and their origin. Similarly, the landscape vulnerability in Lupi was expressed in terms of unstable slope, critical elevation, erosion, and river runoffs. The exposure was expressed in terms of the urban use areas including the special use areas. The consequences of combining the multiple hazards, landscape vulnerability, exposure, and overall capability scores were equated to the highest-best possible land use. The non-conforming uses were regarded as the need for prevention and mitigation measures (Abante, 2021a).

The Abante Risk Reality Geospatial Information Model (RRGIM) offers visualization of where restructuring DRRM actions and land development are needed to attain physical and environmental balance (Abante, 2021a). This RRGIM mimicked the risk reality extremes derived from the risk elements: multiple hazards, landscape vulnerability, exposure, and capability measured in terms of base zones that signify the preparedness that hinted at the collective capability of the Local Government of Lupi (Abante, 2021a). The hexagonal binning technique was used to store and sort the information on the elements of risk needed to estimate the risk using the formula R = HVE/C in the ArcGIS platform (Abante, 2021a,b).

LAND USE DEVELOPMENT CONSTRAINT CHARACTERIZATION

The Municipality of Lupi is blessed with forests and vast agricultural areas which hinted at the highest-best-land uses and resilient areas (coldspots) as shown in Figure 2. These coldspot areas are inversely correlated to risk hotspots categorized into seven levels of significance that are dependent on the resulting risk z-scores as shown in Figures 2, 3, and 4. The Development constraint characterization as shown in Table 1 provides information on where to disallow developments through land use plans and zoning ordinances to achieve sustainable development.

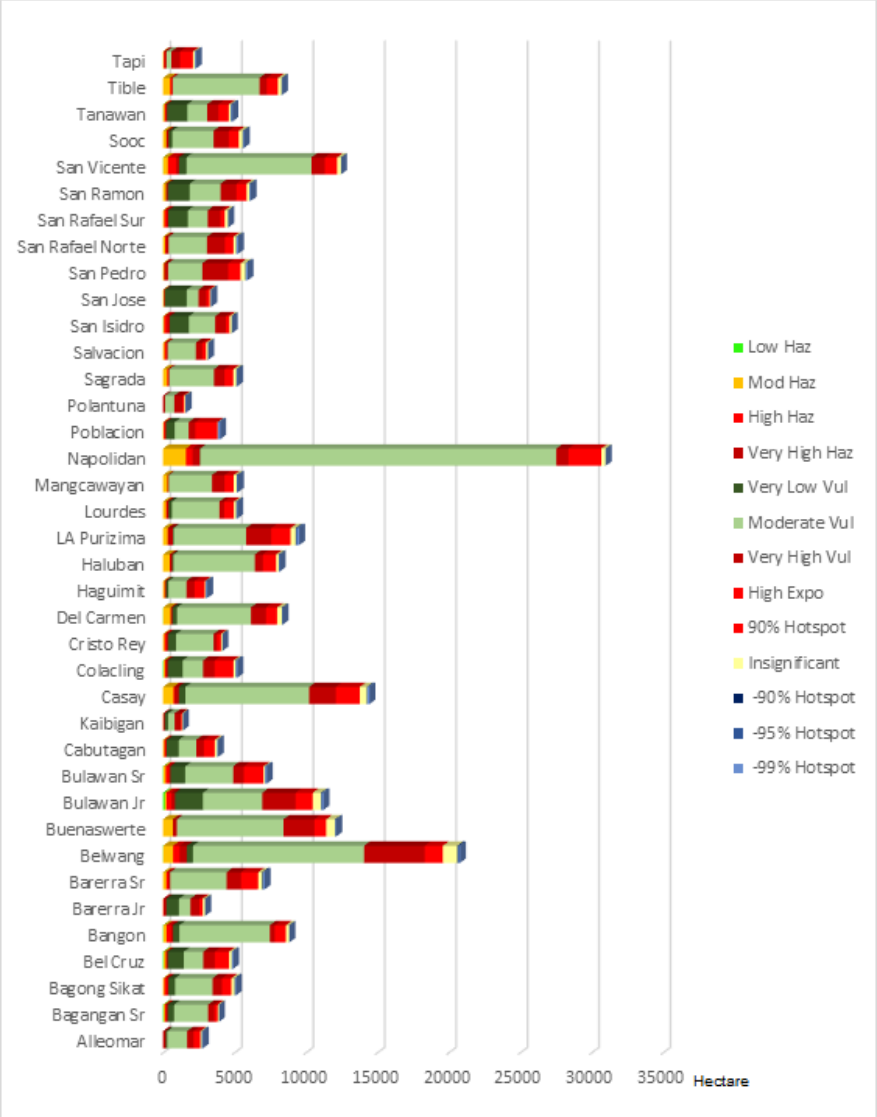

Figure 2. Development Constraints and Risk and Risk Element Distribution By Barangay

The municipality is classified into forest lands with 27.21 sq. km. or 10.86 percent and alienable and disposable lands with 223.43 sq. km. or 89.14 percent. Prioritization of areas should be consistent with the LUPA categorization: protection, production, settlement, and infrastructure to avoid land degradation or habitat losses with the greatest effect on biota and ecosystems and to balance the utilization of the land resources with the greatest sustainable benefits.

Figure 3 presents risk information distribution in hectares. It disclosed the multiple hazards, landscape vulnerability, exposure, as well as risk reality in terms of hotspots and coldspots. The spatial feature information on risk and its elements are vital in risk reduction. When mainstreamed into land use and zoning ordinance, it creates new knowledge needed to verbalize land-use policies as shown in the figure below.

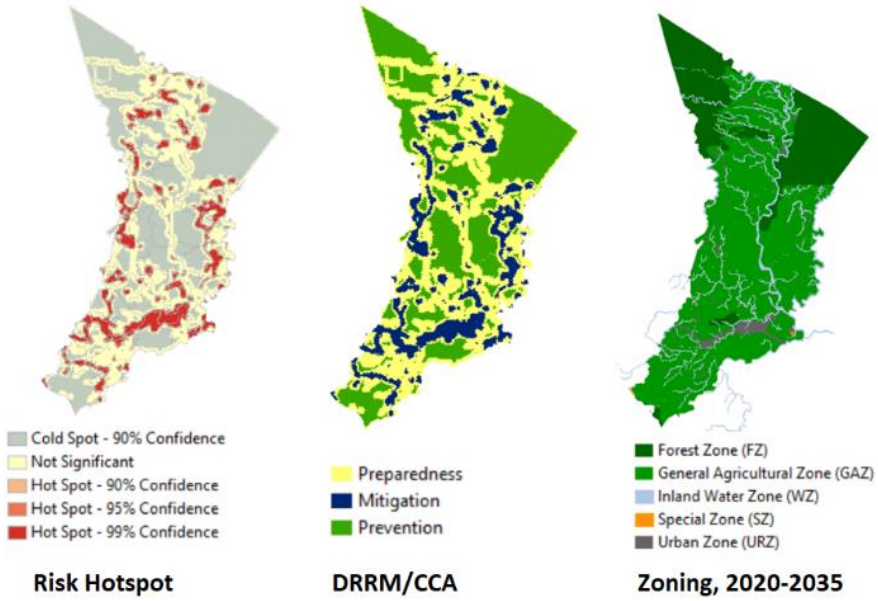

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Figure 3. Integrating Risk and Risk Reduction Information into Land Use and Zoning in ArcGIS Platform

RESULTS & DISCUSSIONS

Like any municipality with a wide agricultural base, conversion of agricultural lands to residential or any urban use is somewhat unrestrained in Lupi. In fact, some agricultural landowners circumvent the law by leaving their lands idle even though soil suitability for agriculture is high and even if the property is beside an irrigation canal. This improper land utilization affects food production. Some areas are idle lands wherein the soil is generally good for agriculture and could be made more productive by taking proper measures to condition the soil.

The LUPA is a stratagem that can guide the physical and environmental development in the Municipality of Lupi in the Province of Camarines Sur as it hints at providing information on where to tweak proper land and water utilization to stabilize and sustain food production while protecting the sensitive environment of the municipality (Abante et al., 2021).

Table 1 shows the hectarage of land development constraints classified into forest use, agricultural use, non-agricultural, and water use at the same time characterized as follows: i) in terms of 90% level of Significance Coldspot (Resilient), ii) Insignificant or random values, iii) 90% level of Significance Risk Hotspot, (iv) 95% level of Significance Risk Hotspot, and v) 99% level of Significance Risk Hotspot.

Table 1. Land Use Development Constraint and Risk Characteristics of Lupi

Land Use		Land Use Development Constraint and Risk Characterization (in Hectares)				
		90% level of Significance Coldspot (Resilient)	Insignificant	90% level of Significance Risk Hotspot	95% level of Significance Risk Hotspot	99% level of Significance Risk Hotspot
1. Forest Use		4,023	1,335	14	17	64
2. General Agricultural Use		3,741	7,128	363	517	1,611
3. Non-Agricultural Use	Parks and Open Spaces Use					5
	Special Use		1		1	8
	Urban and Urban Uses		68	13	32	480
4. Inland Water Use			488	56	45	132

Figure 4 and Figure 5 disclose the following: (i) the municipality continued to protect 39.37% or 7,988.5 Ha of the land and inland waters of the municipality, (ii) it envelops 58.43% or 11,854.6 Ha of land for agricultural uses, (iii) 1.38% or 279.3 Ha of the settlements are distributed to urban and rural barangays, and (iv) there are at least 0.82% or 166.6 Ha of land allocated mostly for the transportation sector.

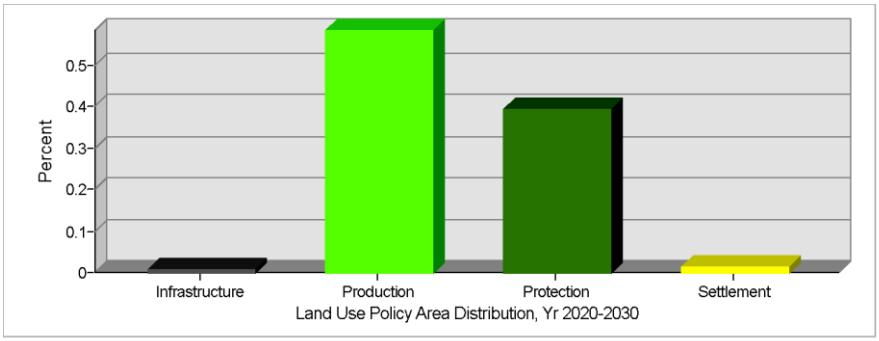

Figure 4. LUPA Distribution, Year 2020-2030

LUPI PROTECTION (SPATIAL) AREAS

Protection of land and water use as shown in Figure 5 refers to the use of land primarily for rehabilitation, conservation, and protection purposes and the promotion of the country's ecological and life-support systems (Abante et al., 2021). In the case of the Municipality of Lupi, a portion of the Bicol Natural Park in Barangay Napolidan is a protected area set aside by reason of its unique physical and biological significance. The DENR also manages other forest areas in Barangay San Vicente, Tible, Buenasuerte, Halu, San Rafael Sur, Lourdes, and the remaining mangrove areas in Bangon to enhance the biological diversity and protect it against destructive human exploitation. Barangay San Vicente covers the southeast lower portion of the Abasig Matogdon Mananap Natural Biotic Area (AMMNBA) that is a legislated Protected Area in Mount Labo as a Watershed Forest Reserve under Proclamation No. 836, November 18, 1991. The protection policy

areas also cover all the waterways and water zones defined by the Water Code of the Philippines. Furthermore, the Protection Forest covers the ancestral domain where the 33 households of the Indigenous People of Lupi live in Barangay Sooc or Neapolitan. Moreover, the easement is part of the protection zones, these are (i) 40-meter buffer for the natural caves and/or geographic forms, waterfalls, escarpments, and riverbanks or creek and stream edges within the forest zones (ii) 20-meter buffer for the protected and productive agricultural areas, and (iii) 3-meter buffer from the highest edge of the rivers or creeks in non-agricultural areas of urban use areas. In most cases, ecotourism and/or special zones are classified as part of the protected areas.

LUPI PRODUCTION (SPATIAL) AREAS

The production areas within Lupi are areas as shown in Figure 6 directly and indirectly utilized for agricultural uses or strategic crop and integrated livestock development to generate food, watershed recharge areas (ridge), and remaining unprotected mangrove (including fishing ground within the municipal waters and reefs of Lupi) areas, and other local economic activities in the municipality. In some cases, the protected water zone is also part of the production areas in Lupi specifically near the estuary near Barangay Bangon as well as inland water or along the Pulantuna River that traverses the municipality.

LUPI SETTLEMENT (SPATIAL) AREAS

The human settlement/resettlement areas in Lupi as shown in Figure 6 refer to the non-agricultural use areas covering the existing residential areas, socialized housing, and other urban uses such as commercial, industrial areas within the urban setting.

LUPI INFRASTRUCTURE (SPATIAL) AREAS

The infrastructure areas which refer to the major infrastructure and utility systems in Lupi as shown in Figure 6, also form part of the non-agricultural use areas comprising the transportation network and power, water, and communication facilities and utilities.

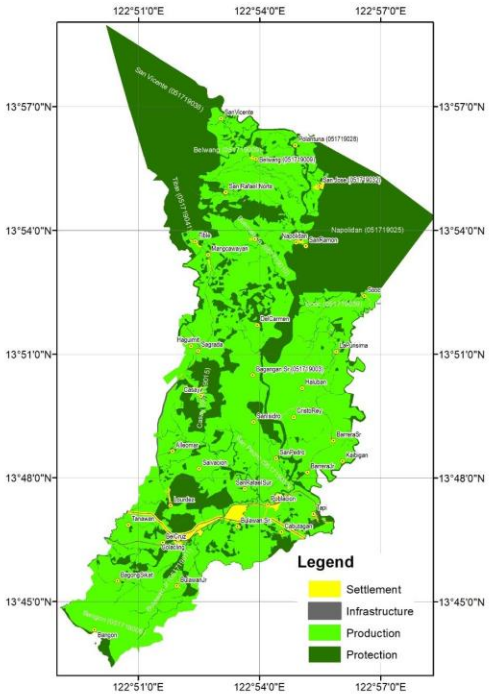

Figure 5. LUPA Spatial Model for Lupi, 2020-2030

CONCLUSIONS AND RECOMMENDATIONS

As the world experiences environmental change, the traditional disaster risk reduction actions are no longer working to resist the changing climate. This necessitates the application of a stratagem crafted to reduce disaster risk through a Land Use Policy Area (LUPA). Using ArcGIS to organize data, the LUPA Geospatial Information Model systematically analyzed data along with the four important policy areas: protection, production, settlement, and infrastructure which shall become the bases of development planning in accordance with the strategic development framework of the Municipality of Lupi, Camarines Sur, Philippines. The study highly recommends the adoption of the LUPA Geospatial Information Model focused on the aforesaid four important policy areas to reduce risks and other development constraints as the Municipality of Lupi pursues its priorities and charts its future direction.

IMPLICATIONS

Considered the most basic of all economic resources, land and other associated assets are fundamental to how society operates. If properly managed, they contribute significantly to the promotion of inclusive growth and make a considerable impact on the local economy. As various localities the world over continue to positively respond to the innumerable and diverse challenges related to climate change, it is high time that they should consider innovative strategies along with land use planning and development to

reduce risk and maximize the use of land assets. The LUPA model in this study is a Geospatial Information Model in the ArcGIS platform focused on protection, production, settlement, and infrastructure sets of objectives to guide municipal growth which will serve as one of the modernistic and innovative strategies to achieve the aspirations of municipalities and cities of having well-managed land assets to their constituents.

ACKNOWLEDGEMENT

The researchers acknowledge the BU's commitment to providing dynamic and responsive research, development, and extension service towards the improvement of the quality of life of the Bicolanos. In line with that commitment, BU has come up with research, development, and extension services with the title "Rewriting the CLUP and Zoning Ordinance of the Municipality of Lupi, Camarines Sur. BU commits to authorize faculty to practice their profession to carry-out environmental planning by duly registered and licensed Environmental Planners and duly registered, licensed Geodetic Engineers, Environment Managers, and allied professionals to organize spatial data on the surface of the earth with the use of precision instruments, scientific and methodical processing of data, presenting them on graphs, plans, maps, charts, and other documents. The LGU-Lupi (LUPI) recognized the importance of having tie-ups in the form of research, development, and extension services to rewrite the Comprehensive Land Use Plan (CLUP Volume 1) and Zoning Ordinance (CLUP Volume 2) as well as generating DRRM Maps, overlay zone maps and zoning maps to comply with the latest HLURB Guidelines published in years 2013-2014. This paper recognizes the researchers' commitments to providing dynamic and responsive research, development, and extension services towards the improvement of the quality of life of the general public of the Municipality of Lupi, Camarines Sur.

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