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Land Distribution, National Greening Program (NGP) Status Using GIS Mapping in Camarines Norte: Basis for LGU Action Plan

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ABSTRACT

Generally, this study determined the Land distribution, National Greening Program (NGP) status using GIS Mapping in Camarines Norte as Basis for LGU action plan preparation. Specifically, this study provided answers to the following questions: 1. What is the status of land distribution of the province of Camarines Norte using GIS Mapping in terms of the following: 1.1Political Boundary; 1.2. Land Classification; 1.3. Land Cover; 2 2. Status of NGP using GIS mapping along with: 2.1 Accomplishment CY 2011-2018; 2.2 Commodity; 2.3 Component 2.4 Zoning; 2.5 Implementation Partner; 2.6. Tenurial instrument 3. What is the level of awareness and understanding of GIS concepts as perceived by the respondents? 4. What is the perceived capability of respondents on the use of GIS mapping? 5. What is the hierarchy of constraints of users, technology, and institution on GIS as perceived by the respondents? 6. Based on the findings of the study, what action plan may be formulated or prepared for LGU to utilize GIS Mapping in their plan preparation?

The study used Descriptive method using a quantitative type of research and uses ArcMap 10.8 GIS software for the manipulation of secondary data, generation, analysis, and presentation of output. The respondents were 36 MPDC staff/ personnel selected through a total enumeration from 12 municipalities within the Municipal Planning, Development, and Coordination Office (MPDC) in the province of Camarines Norte.

The findings of the study are as follows: 1. Status of land distribution in Camarines Norte revealed that the political boundary has a total land area of 232,007 hectares or 2,320.07 square kilometers. The biggest land classification is alienable covering an area of 144,705.14 hectares or 62.37 percent. It has eleven-cover classifications/categories, brushwood-coco is biggest land cover with an of 110,594.01 hectares or 47.67 percent. 2. Status of NGP accomplishments from 2011 to 2018 is 21,400.24 hectares or 9.22 percent. Among the biggest area established are the following: fruit trees commodity with an established of 6,099.00 hectares or 28.50 percent; Agroforestry with an area covered of 12,513.10 hectares or 58.47; protection zone with an area of 10,817.06 hectares or 50.55 percent. Significant results also reveal that, Peoples Organization (POs) are the most engaged as implementation partners with an area covered of 13,679.33 hectares or 63.92. And lastly, the untenured areas/open access or with no tenurial instrument land area the most rehabilitated/reforested area with 10,776.14 hectares or 50.36 percent.

Moreso, 3. the level of awareness and understanding on some GIS concepts are both with an average weighted mean (AWM) of 2.94 and 2.87 which is interpreted as Neutral level of awareness and Fair level of understanding and both indicate an excellent internal consistency within the items of the questionnaire on all the GIS concepts.4. The perceived capability of respondents on the use of GIS mapping revealed as Capable 5. The hierarchal constraints in the utilization of GIS are; understanding of the background of GIS, complexity of the software and limited or no budgetary allotment for GIS projects. 6. The proposed action plan was developed to provide and offer interventions and solutions to the identified key issues, concerns, constraints, and difficulties of the LGUs in the utilization of a GIS

The study concluded that: 1. The land distribution status of Camarines Norte covers 232,007 hectares or 2,320.07 square kilometers. This has important implications for the National Tax Allowance (NTA) or Internal Revenue Allotment (IRA) claimed, as the larger the area and population, the greater the IRA or NTA. Land classified as A&D is the biggest, comprising 62.37% or 144,705.14 hectares indicates land for private (e.i residential commercial or agricultural) use rather than forest use. Land cover with brush wood coco is the biggest with 110,594.01 hectares or 47.67% indicates the economy depends on the agricultural production. And considered as major producers of coconut and pineapple in the Bicol region.

Moreso, 2. Status of NGP from Calendar Year (CY) 2011 to 2018 a total of 21,400.24 hectares or 9.22 percent. Among the biggest area cover were the following; fruit trees' commodity as top commodity with 6,099.00 hectares or 28.50 percent; Agroforestry scheme with 12,513.10 hectares or 58.47 percent; protection zone with 10,817.06 hectares or 50.55%; peoples organizations (POs) with 13,679.33 hectares or 63.92 percent as top implementation partner; and untenured areas with 10,776.14 hectares or 50.36 percent as priority areas. Significantly, all the objectives of NGP was attained but only failed to follow the priority area that it shall be given to community-managed forestlands with appropriate tenure and development of tenured areas and shall be undertaken first before proceeding to open access areas.

Further, 3. Levels of awareness and understanding is Neutral and Fair. Both indicate an excellent internal consistency within the items of the questionnaire. 4.The perceived capability on the use of GIS mapping is Capable, it implies an average understanding on the of GIS mapping. 5. The hierarchal constraints in the utilization of GIS are; understanding of the background of GIS, complexity of the software and limited or no budgetary allotment for GIS projects. Lastly, 6. The proposed action plan was developed to provide and offer interventions and solutions. It supports LGU mainstream GIS in their planning activities, especially in terms of addressing spatial-related issues and concerns.

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Thus, it was recommended that the LGUs, DENR-PENRO CN and other NGAs, may consider the data on land distribution and National Greening Program status in their program evaluation and analysis for possible improvements relative to the implementation. They may also use GIS Mapping in their planning and analysis, decision-making, and policy formulation. This is highly used in the formulation and updating of the comprehensive land-use plan (CLUP) and development plan where land-use allocation of resources is vital for management, development, and conservation effort.

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CHAPTER ONE
THE PROBLEM AND ITS BACKGROUND

- *Background of the Study*

In the 1960s and 1970s, worries about the fast deforestation of the Philippine uplands developed. Since the early 1970s, reforestation initiatives have been implemented throughout the Philippines. Early forestry initiatives offered knowledge that helped with program design. The administration's reforestation strategies were significantly replaced by contracting programs in the late 1980s (Groetschel et al. 2001, p. 61). Despite doing reforestation for a long time, there are still a few technological obstacles that need to be removed. Some actions have been taken in recent years to start addressing some of the worries. However, it is believed that more work should be put into developing and implementing wise, practical, and effective recommendations that will increase success.

The National Greening Program (NGP) was introduced by the Department of Environment and Natural Resources (DENR) in 2011. On February 24, 2011, Executive Order 2 established the NGP. Beyond reforestation, the program's design aims to reduce poverty, provide food security, maintain environmental stability, protect biodiversity, and mitigate the effects of climate change. With such a broad aim, the program includes development in the following areas. A multi-sector approach to reforestation is used to accomplish these goals. Upland and coastal communities, people's organizations, civil society, local government units, national government agencies, state colleges and universities, and the business sector are all involved in this strategy. The NGP is the nation's most comprehensive reforestation initiative to date.

In addition, Executive Order 193, Series 2015 extends its scope from 2016 to 2028. The order stipulates, among other things, that the NGP will be implemented as a national convergence initiative between the three national government agencies: the Department of Agriculture (DA), the Department of Agricultural Reform (DAR), and the Department of Environment and Natural Resources (DENR), the latter being the lead agency. NGP is implemented using this three approaches or strategies:1. Harmonization of all greening efforts by the state, civil society and the private sector. 2. Provide incentives to popular organizations that are major program partners in seedling production, site preparation and planting. 3. We make the most of available science and technology, such as establishing clonal nurseries to produce high-quality planting material, using organic fertilizers and pesticides, and using GIS mapping and geotagging.

Furthermore, according to the DENR (2018), the expected results of the NGP program are: 1. Self-sufficiency in wood and agroforestry products. DENR data indicates that the country's annual timber needs are estimated at 750,000 hectares; 60,000 hectares for coffee; and 30,000 hectares for firewood. 2. Economic security, NGP should provide increased and sustainable supply of forest resources; increased economic activity in the highlands; and optimized use of mountain resources.3. Environmental stability, at the end of the program, the country's forest cover is expected to be increased by 12 percent from the 2003 level of 7.2 million hectares, with a survival rate of 85 percent; an 8 percent increase in carbon sequestration, or from 36 million tons per year to 38.9 million tons per year; increased water retention capacity; less downstream flooding and soil erosion; and better environmental services.

In addition, the 2015 Commission Audit (COA) report, five years after the NGP was implemented, revealed that the Department of Environment and Resources' £7.2 billion National Greening Program (NGP) project natural (DENR) "failed". ", and revealed overwhelming evidence of apparent misuse of billions of pesos in public funds. As a result, DENR identified "non-plantable areas" as locations for tree planting because it did not conduct any mapping and planning. The delay in delivery of seedlings resulted in "premature planting", which occurred at the end of the rainy season, "allowing the planted seedlings a very short period of time to recover and resist the onset of the dry season". In some plantation sites, DENR has no partner organization to help monitor the plantations.

Furthermore, the COA report on the DENR's finances is part of the latest incriminating financial audit of major state agencies that receive the biggest appropriation from the national government and are led by President Aquino's close political allies. The DENR has taken no action to ensure the sustainability of the NGP, which is central to then President Aquino government's efforts to achieve sustainable nutrition and protect the environment from further degradation. "In the overall analysis, the failure of the DENR programme/project delayed the benefits that could have been derived from the completion of the NGP as envisaged by the programme/project" (Ramos, M. 2015).

Unsatisfactory projects waste government financial resources. Therefore, proper assessment and spatial planning are essential to ensure the success of the project. The National Economic Development Authority (NEDA) and DENR recognize the importance of using a Geographic Information System (GIS) to review a spatial assessment of NGP implementation to provide answers to questions regarding performance and scoped to give the knowledge of the NGP and find ways to further improve the policy and mechanisms for implementing and managing a reforestation program in the country from the public, especially local government entities. The use of innovative technologies, information systems and satellite devices and equipment are also very important tools for this type of reforestation program.

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In the past, it is unlikely that the GIS used in the country is undeniably all of its components and applications poorly known to the people. This was confirmed by the GIS literacy study conducted by Ulep (2000). As a result, among the total 1,600 LGUs in the Philippines, approximately 1 percent is in the operational phase, 4 percent are in the development phase, 14 percent are still in the planning phase, and the majority, 82 percent, do not have GIS. Such is an indication that most local government units have not used GIS for the past 15 to 16 years.

Furthermore, prior to the introduction of global positioning systems and geographic information systems, field data were difficult to obtain and, in many cases, inaccurate. Typical examples are plantation boundaries that vary from alienable land (A&D) and forest areas where the implemented afforestation areas differ from the actual ones. This is a result of difficulties measuring and mapping difficult terrain, inaccessible locations, non-plantable areas and overlaps with other development areas or existing projects.

In contrast, the use of GIS has currently flooded almost all fields of engineering, natural sciences, and social sciences. GIS is a spatial management systems tool that allows one to assess past, present and future developments and to make better decisions as more alternatives are considered before committing to action. GIS provides accurate, efficient, and repeatable methods for collecting, displaying, and analyzing spatial data. Make better decisions, improve productivity to save time, money and labor in forest management. GIS has proven to play a crucial role in the following areas; resource management, crop planning, fire management, mapping, GIS for strategic planning and modelling. By using a GIS-based spatial mapping system tool, it can be more efficient and effective in planning, management and development.

With issues such as floods, landslides, earthquakes, and other hazards plaguing the Philippines, a Comprehensive Land Use Plan (CLUP) is very important for LGUs. CLUP is a rational approach to distribute available land resources as equitably as possible among competing user groups and for different functions in accordance with the development plan for the area. This is one of two documents required by the Local Government Code (Republic Act 7160) to be prepared by local government entities, and the other is the Comprehensive Development Plan (CDP), which recommends heavily the use of GIS technology.

The study's location is the province of Camarines Norte, which covers a total area of 2,320.07 square kilometers (895.78 sq mi) occupying the northwest coast of the Bicol Peninsula in the part of southeast Luzon as one of the six provinces of Region V (Bicol). The province is known as an agricultural producer in the Bicol region, coconut has remained the main permanent crop produced in this area, followed by pineapple and rice. It is also known as Fish Capital in Bicol, as reported by the National Statistics Authority (NSA). Camarines Norte has 2 districts: District 1 (Tagalog speaking) consisting of 5 municipality, namely: Capalonga, Jose Panganiban, Labo, Paracale and Sta. Elena. On the other hand, district 2 is composed of 7 municipalities that include Basud, Daet, Mercedes, San Lorenzo Ruiz, San Vincent, Talisay and Vinzons.

The challenge that pushed the researcher in this study is mainly to understand deeper the Land distribution, National Greening Program (NGP) status using GIS Mapping in Camarines Norte as Basis for LGU Plan prepararation. The researcher believed that the study will be highly relevant and significant for the LGUs specially in Camarines Norte.

A. Statement of the Problem

Generally, this study was aimed to determine the Land distribution, National Greening Program (NGP) status using GIS Mapping in Camarines Norte as Basis for LGU plan preparation.

➢ *Specifically, this study provided answers to the following questions:*

- *What is the status of land distribution of the province of Camarines Norte using GIS Mapping along with:*

✓ Political Boundary
✓ Land Classification
✓ Land Cover

- *What is the status of NGP using GIS mapping along with:*

✓ Accomplishment from CY 2011-2018;
✓ Commodity
✓ Component
✓ Zone
✓ Implementation Partner
✓ Tenurial instrument

- *What is the level of awareness and understanding of GIS concepts as perceived by the respondents?*
- *What is the perceived capability of respondents on the use of GIS mapping?*

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- *What is the hierarchy of constraints of users, technology, and institution on GIS as perceived by the respondents?*
- *Based on the findings of the study, what action plan may be formulated or prepared for LGU to utilize GIS Mapping in their plan preparation?*

B. Scope and Limitation of the Study

However, due to the scope, limitation, and time constraints of the study, the researcher chose to focus on what has been mentioned within the conceptual paradigm. The study covered only the following, to wit: land distribution; National Greening Program (NGP) status using GIS Mapping; perceived level of awareness and understanding of GIS concepts; perceived capability of respondents on GIS mapping; hierarchy of the perceived constraints of the users, technology, and institution on GIS, and; a proposed action plan for LGU in the adaption, utilization, and institutionalization of GIS.

The 36 respondents were selected through a total enumeration or census and all are personnel/staff from the Municipal Planning, Development, and Coordination Office (MPDC) of the 12 municipalities within the province of Camarines Norte.

C. Significance of the Study

This study is highly relevant and significant to the following:

➢ *Municipal Local Government Units of Camarines Norte*

They are the main beneficiaries of this study that this will foster a thorough understanding and information on land distribution; National Greening Program (NGP) status using GIS Mapping; perceived level of awareness and understanding on GIS concepts; perceived capability on GIS Mapping; hierarchy of the perceived constraints of the users, technology, and institution on GIS, and; a proposed action plan for LGU for the adaption, utilization, and institutionalization of GIS Mapping. This study will help foster motivation among LGU officials, leaders, and members to contribute efforts in facilitating information dissemination among the locals about the value and significance of GIS. The research will also encourage LGU leaders to conduct and promote other relevant programs that could help support and reinforce the implementation of GIS Utilization.

➢ *Provincial Environment of Natural Resources Office (DENR-PENRO) Camarines Norte*

This study will help foster motivation among its officials and continue to be an essential service provider for their stakeholders or clientele as they use a GIS-based or location-based perspective to better understand their program operations and its needed community service needs for the protection, conservation, and development of environment and natural resources. Understanding and utilizing GIS can easily enable data collection and visualization, spatial analysis, public engagement, and new insights into the communities they serve.

➢ *Provincial Government of Camarines Norte*

The findings of this study serve as the baseline data and information for the implementation of their different project where GIS is used. Through the utilization and understanding of the capability of GIS, this will serve as the information on geospatial data needed in the management, project planning, implementation, monitoring, evaluation, and policy formulation. The research will also encourage its officials to conduct and promote other relevant programs that could help support and reinforce the implementation of GIS Utilization.

➢ *Academe*

The findings of this study provide information and appreciation of the importance, capability, and usability of GIS mapping. The research will also encourage academic officials to conduct and promote programs that could help support and reinforce the implementation of GIS Utilization. The study will likewise promote and recommend the adoption or integration of GIS as an academic subject at Camarines Norte State Colleges for relevant courses wherein GIS is essentially needed.

➢ *Researcher Himself*

Being an employee of the Department of Environment and Natural Resources (DENR) and oftentimes a resource speaker in different forums, workshops and training, the results and findings of this study will essentially help provide relevant information and understanding of the capability of GIS which will be imparted to participants or audience. The research will also encourage him to conduct and promote other relevant programs that could help support and reinforce the implementation of GIS Utilization if given the opportunity. He himself believed that GIS is necessary for the planning, management, and development of projects.

➢ *Future Researchers*

This study could be a source of additional inputs and literature about the implementation of GIS mapping that researchers could integrate with their future studies. Future researchers could gain relevant inputs from this study about the land distribution; National Greening Program (NGP) status using GIS Mapping; perceived level of awareness and understanding on GIS concepts; perceived capability of GIS; hierarchy of the perceived constraints of the users, technology, and institution on GIS, and; proposed action plan for LGUs in adaption, utilization and institutionalization of GIS Mapping.

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CHAPTER TWO
REVIEW OF RELATED LITERATURE AND STUDIES

In order to have a more comprehensive view of the study, several journals, articles, books and manuscripts of other researchers were read and reviewed.

The review of related literature and studies covers both foreign and local. The inadequacy, the research gap and disagreement of conclusions of the sources were synthesized and analyzed. Also, their similarities, and their differences and relationships are presented in this chapter.

➢ *Related Literature*

The following literatures provided perspective and point of view in understanding the research being undertaken.

- *Foreign*

To provide better understanding and comparison for various undertakings, several foreign related literatures were in the succeeding discussions.

The article by Martynova et al. (2021) titled "Forest Management Based on the Principles of Multifunctional Forest Use" asserts that effective forest management is based on the multipurpose use of existing forest resources and their ecological functions that focused on sustainable forest management specifically its environmental, economic, and social factors.

According to the Food and Agriculture Organization (FAO) Global Forest Resources Assessment (FRA) (2015), the area of forests in the Asia-Pacific Economic Cooperation (APEC) region has increased by 15.4 million hectares in the period 2007-2015 to a total of 2.19 billion hectares. As the best estimate, the APEC economies have currently achieved 77 percent of the 20 million hectares APEC 2020 Forest Cover Goal. During the period 2007-2015, forest areas have increased in 11 economies, with the largest increases in forest area achieved in China (12.3 million hectares), United States (3.8 million hectares) and Russian Federation (3.6 million hectares). Conversely, forest areas have declined in nine economies, with the most considerable losses in Indonesia (5.5 million hectares), Peru (1.3 million hectares) and Australia (1.1 million hectares). Most economies have increased their per hectare forest growing stock and total forest growing stocks in 2007-2015 in line with increased forest areas and improved forest management.

Moreso, Environmental Systems Research Institute (ESRI) (2022) defines geographic information systems (GIS) as a system that creates, manages, analyzes and maps all types of data. This provides a basis for the mapping and analysis used in science and almost every industry. GIS helps users understand patterns, relationships, and geographic context. Benefits include improved communication and efficiency, as well as better management and decision-making. GIS has also evolved into a means for data exchange and collaboration, inspiring a vision that is now fast becoming a reality - a continuous, intersecting and interoperable GIS database of the world on virtually everything. GIS will play an increasingly important role in understanding and addressing these issues and provide a means for communicating solutions using the common language of mapping.

Further, the article of Widianingsih et al. (2018) titled "Literature study on the theory of GIS-based multi-evaluation criteria" explained that the multi-criteria evaluation method can be used in making decisions by making complex issues simple. Decision-making by integrating the multi-criteria evaluation with GIS has significant potential for the complexity of making a decision. GIS-based multi-criteria evaluation can be used to make decisions by making complex issues simpler, resulting in precise, fast and effective decisions.

Furthermore, Franch-Pardo et al. (2020) concluded that COVID-19 studies with GIS could be valuable tools in decision-making and, more importantly, social mobilization and community responses. Accordingly, health geography is highly relevant on political decisions that can be accountable to all sectors of society, that minimizing the regularity in marginalized populations that sacrificed or left unprotected. Understanding the spatial-temporal dynamics of COVID-19 is critical to its mitigation.

According to Demsey (2019), the discipline of Geographic Information Systems (GIS) is constantly changing, with technologies now available for usage on mobile devices and in the cloud. GIS is a technology area that uses tabular data and geographical elements to map, analyze, and evaluate actual issues. The actual power of GIS comes from applying spatial and statistical approaches to examine attribute and geographic information. It is utilized as computer cartography for simple map creation. Information that has been interpolated, derived, or prioritized may be the analysis's final output.

The same GIS tool (Optimal) was detailed in Vopenka et al.'s (2015) publication on "GIS tool for optimization of forest harvest-scheduling" for both spatial and temporal optimization of forest harvests. By changing the polygons of the forest stands on the digital map, the forest manager can establish harvest units using Optimal. After the user manually creates the harvest units, an automatic adjacency matrix is generated and sent to a solver module. The solver delivers the spatial distribution of harvest units for each harvest phase after performing optimization using integer programming. The user can configure a variety of parameters,

including the quantity and duration of harvest times, the permissible ranges for harvest unit distances, and more. Forest managers can construct and investigate alternative scenarios using The Optimal, which improves the effectiveness of arranging the harvest of forests.

Furthermore, based on the study by Sonti (2015) titled "Application of Geographic Information System (GIS) in Forest Management", it was mentioned that Geographic Information System (GIS) technology may have a general application in forest management. The application of GIS has spread to practically all areas of engineering, the natural sciences, and the social sciences, providing precise, effective, and repeatable methods for gathering, visualizing, and interpreting spatial data. Dynamic locational and descriptive inventory data, rather than geographic data, are needed to make better decisions, increase productivity, and reduce costs associated with time, manpower, and other resources when managing forests. Resource management, harvest planning, fire management, map development, and strategic planning and modeling all benefited greatly from the use of GIS.

Moreso, the article of Ahmad et al. (2018) about “Wild life habitat suitability and conservation hotspot mapping: Remote Sensing and GIS based decision support system” discussed that protected forest areas are fraught with severe threats from mining, agriculture and settlement expansion, and unsustainable use of forest resources. Due to funding and technical challenges, the inadequate monitoring and lack of information limit the conservation efforts in Zambia in general and Solwezi district in particular. Field-based methods in monitoring forest quality and suitability are time-consuming and inefficient especially in inaccessible areas. However, with the advent of technology, Geographical Information System (GIS) and remote sensing, important data for forest quality can easily be accessed.

Furthermore, article of Teixeira et al. (2021) entitled “Indoor Environments and Geographical Information Systems: A Systematic Literature Review “. Briefly compared the various research, highlighting their key findings, points of strength and weakness, and emphasizing what they did well. However, it's possible that the future directions of this field of study are not totally clear. Even while it is well known that GIS tools first seemed to be applied to the external territory, it is clear that they may be used to analyze internal areas, as evidenced by the publications included in the present study. However, he found five key themes (subgroups), some of which were highlighted in the evaluated research and others from this comprehensive literature study.

- *Local*

To have a complete understanding of this research local literature was reviewed and used as part of this study.

Between 1990 and 2013, the Philippines lost 3.8 million hectares of forest due to deforestation, which has an influence on the ecosystem directly or indirectly and may have long-term effects on human health, agricultural output, and possibly climate change. Government initiatives have been put in place in the past, but they haven't done much to meet the country's needs for timber, and more significantly, they can't be repeated locally (Vista et al. 2016). With barely 24 percent of its forests still standing, the Philippines has the second-lowest forest cover in Southeast Asia behind Singapore. According to DENR-FMB Statistics 2016 only about three (3) percent of our primary forests are still standing.

According to DENR (2022), in 2011, an Executive Order 26 was declared by the President of the Philippine Republic implementing the so-called National Greening Program (NGP). This initiative, which invites everyone in the government and even the general public, strives to lessen poverty, advance food security, environmental stability, protect biodiversity, and adapt to and mitigate climate change. In particular, it aims to plant 1.5 billion seedlings in 1.5 million hectares of public lands across the country between 2011 and 2016, including forestlands, mangroves, protected areas, ancestral domains, civil and military reservations, some urban areas, abandoned mining sites, and some suitable public domain sites. Community Based Forest Management, often known as CBFM, is a significant DENR initiative that guarantees the implementation of the National Greening Program will be successful.

In addition, DENR (2022), executive order No. 193, was signed on November 12, 2015, and the Expanded NGP would restore all of the remaining unproductive, denuded, and degraded forestlands, estimated at 7.1 million hectares, from 2016 to 2028. The DENR Administrative Order 2016-20 issued the implementing rules and regulations, which were intended to harmonize all forest development activities that will encourage and enhance the development of forest plantations, including forest parks, with greater participation from the private sector, local government units, and organized upland communities.

Sarmiento and Casas (2014) state that GIS is currently acknowledged as a potent decision-support tool. It entails the collection, management, storage, analysis, and presentation of spatial data for the purpose of locating and mapping areas that meet predetermined criteria, such as those necessary for the production of forest products. Managers can have a glimpse of prospective chances for the growth of current forests on maps created by GIS. The use of GIS technology ensures that forest areas are not damaged and that they should be utilized in a way that will meet the demands of both present-day society and future generations.

Furthermore, Hun (2017) asserted in his article titled "Towards a geospatially-empowered Philippines: Advanced GIS Training on Disaster Preparedness and Response for LGA Selected LGUs" that the training was created to increase the capacity of the LGUs in the utilization of GIS technology as a crucial tool for disaster preparedness, response, and rebuilding, climate change

adaptation, and other applications related to public administration and governance. The use of GIS technology was stressed in their planning and decision-making processes as well as other projects, including the mapping of taxes, the creation of public buildings and infrastructure, and a program for disaster risk reduction and management, among others. The participants were to create a unique map layout covering as their final product on the training's last day.

In order to create contextualized mitigating measures and integrated development plans for urbanizing areas, Bagarinao (2015) contends that spatial analyses of population increase and urbanization are necessary. This analysis and the projection of which spatial unit requires fast execution of interventions could be supported by the quick development of GIS technology.

Furthermore, Garcia's (2014) article entitled Power is Spatial states that power in maps becomes geographical truth. Geographical knowledge is power. The map is the ultimate form of spatial information power. Maps make us aware of our resources and geophysical dynamics: geology, hydrology, land cover, settlements, transportation networks, and other geographic layers. Without cartography there would be no awareness that we have approximately 7,107 islands. Therefore, the power to use our archipelago resources sustainably is derived from the use of maps. A prime example is how mapping and geospatial technologies are enabling Project NOAH to warn people of flooding and storm surges for Disaster Risk Reduction and Management (DRRM). These dynamics encoded in maps are also used to claim territories and resources. Printed, folded, hung, flat, three-dimensional or on-screen maps make geographic knowledge highly usable in any form.

Likewise, an article of Ichimura (2017) entitled "A Filipino Geographer Is Reminding Us How Useful Maps Can Be in a Crisis" stated that the Philippine map has never been this fascinating but that maps are more than just data and color because they are the results of decisions and contexts made by actors who wield power and influence in pursuit of goals and beliefs. It turns data into meaningful visualization by using computational geo-tools and critical geographic ideas, realizing the goal of critical, computational, and imaginative mapping. But altogether, these maps do more than merely plot our environment; in addition to the borders they set, they also seek to rekindle Philippine research, giving our domestic specialists the recognition and credit they merit.

Also, Garcia's (2017) article about "Making Maps Useful for Addressing Disasters and Climate Change" raised the subject of when geographic information starts to be helpful in disaster and climate change response. The question originated from a need to create better maps of the hazards and vulnerabilities associated with climate change and disasters. He noted that leveraging regional information to address such risks and vulnerabilities presented challenges. When using maps from different sources and approaches, there may be problems using this information.

According to Lucena (2018), GIS initiatives in the country are apparently attuned to address impacts of disasters brought about by climate change. The Comprehensive Land Use Plans (CLUP) is the instrument specified in the Local Government Code (RA 7160) as the means to identify the community's needs and translate them into achievable policies and plans, programs and projects. A CLUP prescribes the development pace, direction and strategies in a community as well as its role in provincial, regional and national development. Designing the CLUP to lessen exposure to hazards and manage land and water resources is also a means of disaster risk reduction. The importance of land use planning as a strategic climate change adaptation tool is clearly stated in the Philippines' National Framework Strategy on Climate Change (NFSCC). Under the NFSCC, the integration of climate change and disaster risk reduction into local land use and development plans, based on an integrated ecosystems approach or 'ridge-to-reef' framework, is considered a major pillar of the country's adaptation plan.

- *Related Studies*

The following foreign and local studies consolidated and presented to provide similar situational analysis in the local setting or context and further information in relation to the study.

- *Foreign*

The succeeding studies conducted by previous researchers provided concepts and ideas related to this study.

Based on the study of Hamza and Chmit (2022) entitled "GIS-Based Planning and Web/3D Web GIS Applications for the Analysis and Management of MV/LV Electrical Networks (A Case Study in Tunisia)". It made a case for the use of GIS, the web, and 3D web GIS in the planning of an MV/LV (Medium Voltage/Low Voltage) electrical network in the Medjez El Bab region of northwestern Tunisia in order to create an intelligent electricity network that will serve as a decision-making tool. In order to increase the capacities and productivity of the national company of electricity and gas in Tunisia (STEG), it also covered the contribution of GIS in the field of planning the electric networks. This study, similar to many GIS-based electrical network management studies that have been launched around the world in recent years, demonstrates the importance of GIS as a powerful tool for electrical network management. Power grid planning plays an important role in urban planning and needs to be comprehensively evaluated in order to improve the quality of decision-making and thus the benefit of the investment.

Also, in related study of Jain and Kaur (2021) entitled "Census Mapping in India and Role of GIS: A Look Ahead at Census 2021" it focused on the applications and methods adopted for the census mapping in the 2021 India Census, developed five

mobile apps for data collection and map-related work and utilizes the latest census mapping techniques, namely standardization of GIS geospatial database design, georeferencing of administrative units and the latest mobile mapping application (Arc GIS Quick Capture) for field operations and digitization works for built-up areas. It also discusses the various challenges and their solutions for census mapping in India, most notably a high-quality, updated, comprehensive and georeferenced address register for accurate data collection and mapping, and the use of georeferenced village-level high-resolution satellite imagery to fill in the gaps in rural close border maps.

Moreso, Study of Cetin and Sevik (2020) entitled "Investigation of the relationship between bioclimatic comfort and land use by using GIS and RS techniques in Trabzon" the study aimed to investigate the relationship between bioclimatic comfort and land use in Trabzon through the use of geographic information systems and remote sensing technologies to evaluate the relationship between the bioclimatic conditions of 1985, 1994, 2005 and 2018 with land use in the same years in Trabzon Province in seasonal and annual periods. The Physiological Equivalent Temperature (PET) index, which takes into account human physiological characteristics, was used in determining bioclimatic comfort zones. Using DEM data, altitude-dependent PET values were obtained and bioclimatic comfort maps were created land land use maps were produced using CORINE land cover data.

Further, the study of Lee et al. (2020) entitled "Groundwater Potential Mapping Using Remote Sensing and GIS-Based Machine Learning Techniques" discussed ensemble models using decision tree-based machine learning algorithms were utilized in conjunction with a geographic information system (GIS) to map and assess the potential yield of groundwater. 53 well locations with data on transmissivity (T) and specific capacity (SPC) were chosen and randomly split into two classes for model training (70%) and testing (30%). In places with a dearth of data, the machine learning algorithms used in this study demonstrated successful modeling of groundwater potential. By identifying regions with high groundwater potential, the study's findings may be applied to the sustainable development of groundwater resources.

Furthermore, study of Rahmawaty et al. (2020) about "Integrated GIS and GPS for mapping of land suitability for Multi-Purpose Tree Species (Persea americana) at community agroforestry land in Peria-ria Village". The objective of this study was to map the suitability of land for Persea americana in Peria-ria Village by using survey methods and then the coordinates were marked using the Global Positioning System (GPS). The study used Geographic Information System (GIS) technology to determine land suitability to indicate references and land suitability criteria for Agricultural Plants.

A similar study by Lahoti et al. (2019) entitled "Mapping Methodology of Public Urban Green Spaces Using GIS: An Example of Nagpur City, India" explored a mapping methodology to create a thematic map of public urban green space (UGS). A thematic map of Nagpur City, India, was created using GIS. The goal was to generate precise UGS typologies and spatial data essential for planners and policymakers, as well as to update the city's general distribution and availability of hierarchical recreational green spaces. The study's findings include the following: the thematic map's overall accuracy is 95% and its kappa statistic is 0.93; it provides a realistic depiction of the recreational UGS that are present in the city; the hierarchical distribution of different typologies highlights the lack of provision with regard to sub-city and district green spaces; and the uneven spatial distribution of green spaces.

In addition, related study of Arendt et al. (2019) wherein it analyzes the awareness and perceived relevance of geographic information systems and related technologies by construction industry general contractors via an exploratory survey of individuals in the field.

Moreso, the study of Bugday (2019) on "Landslide Susceptibility Mapping Using Different Modeling Approaches in Forested Areas (Sample of Cankiri-Yaprakli)" stated that the effective management of forest resources is very important for the future of the forest and meets both ecological and economic needs. It aimed to contribute to the applicability of the modeling in practice by identifying landslide-prone regions in forest areas using different modeling approaches. A total of six models were built in this study using four criteria (elevation, slope, aspect and power performance index) and using Fuzzy Inference System (FIS) and Modified-Analytic Hierarchy Process (M-AHP) approaches. The performance of the model was measured using the Receiver Operating Characteristic (ROC) curve and the Area Under Curve (AUC). Based on the results of the study, the most successful model was determined to be FIS model 1 with an AUC value of 82.1 percent and M-AHP model 1 with an AUC value of 80.9 percent. This study is important for the use of the landslide susceptibility mapping map in future studies of forest harvest, road network, and forest management planning.

Further, the study of Baalousha et al. (2018) entitled "Groundwater recharge estimation and its spatial distribution in arid regions using GIS: a case study from Qatar karst aquifer" The method proposed in this study was to estimate rainfall recharge is based on soil–water budget model and utilizing geoprocessing tools in GIS. It uses digital elevation model (DEM), land cover and rainfall distribution to estimate runoff accumulation in low lands. The soil–water budget model is then applied to estimate the groundwater recharge in areas of runoff accumulation. The proposed methodology was applied on Qatar karst aquifer as a case study. The spatial resolution of raster maps was 350 by 350 m and the temporal resolution is one day. Results obtained in this

study for the hydrological year 2013/2014 show the total groundwater recharge is approximately 14 million m3, and concentrated more in the northern part of Qatar. The method can be applied to any arid region.

Likewise, the study of Akay and Erdoğan (2017) entitled "GIS-Based Multi-Criteria Decision Analysis for Forest Fire Risk Mapping" which focused on GIS-based Multi-Criteria Decision Analysis (MCDA) method was used to generate forest fire risk map. In the solution process, "extAhp 2.0" plug-in running Analytic Hierarchy Process (AHP) method in ArcGIS 10.4.1 was used to categorize study area under five fire risk classes: extreme risk, high risk, moderate risk, and low risk. The results indicated that 23.81 percent of the area was of extreme risk, while 25.81 percent was of high risk. The result indicated that the most effective criterion was tree species, followed by tree stages. The aspect had the least effective criterion on forest fire risk. It was revealed that GIS techniques integrated with MCDA methods are effective tools to quickly estimate forest fire risk at low cost. The integration of these factors into GIS can be very useful to determine forested areas with high fire risk and also to plan forestry management after fire.

Lastly, the study of Kiavarz and Jelokhani-Niaraki (2017) entitled "Geothermal prospectivity mapping using GIS-based Ordered Weighted Averaging approach: A case study in Japan's Akita and Iwate provinces" focused on the exploration of geothermal regions as the first step for the use of these resources. This paper incorporated the concept of risk into the GIS-based analysis for generating geothermal prospectivity maps via Ordered Weighted Averaging (OWA) approach. The use of OWA-based approach provides a model that generates geothermal prospectivity maps with different pessimistic or optimistic strategies. The results indicated that the values of wells percentages in high favorite areas for the most pessimistic and optimistic strategies are 85 percent and 100 percent, respectively. Regarding the prediction rate, the results show that the rate for the most pessimistic and optimistic strategies are 18.55 and 1.18, respectively.

- *Local*

The following local studies provided similar concept which guided the researcher in conducting this study.

Based on the study of Belizario et al. (2021) entitled "Use of geographic information system as a tool for schistosomiasis surveillance in an endemic Municipality in Eastern Samar" demonstrated the use of geographic information systems (GIS) to identify factors contributing to schistosomiasis endemic and to identify high-risk areas in a schistosomiasis-endemic community in the Philippines devastated by Typhoon Haiyan in 2013. Data on schistosomiasis determinants obtained through Literature Review, the Philippine Department of Health and affected local government entities were standardized and integrated into a GIS map using ArcGIS. The results showed that most barangays (villages) are characterized by favorable conditions for transmission of schistosomiasis, including location in flood-prone areas, presence of vegetation, low coverage by sanitary toilets, presence of snails as an intermediate host, high Carabao (water buffalo) population density, previously reported prevalence using the Kato-Katz technique, and low MDA coverage. Similarly, barangays are not known to be endemic for schistosomiasis, but are characterized by the same favorable conditions for schistosomiasis as listed above and can therefore be considered potentially endemic, even if they are not high-risk areas. This study demonstrated the importance of GIS technology in characterizing schistosomiasis transmission. Maps created through the application of GIS technology are useful to guide program policies and planning at the local level for effective and sustainable schistosomiasis control and prevention.

Also, Jumawan et al. (2021) study entitled "GIS Weighted Suitability Analysis as Decision Support Tool for Mangrove Rehabilitation in Oriental Mindoro, Philippines" demonstrated the applicability of a geographic information system (GIS) framework as a decision support tool for potential mangrove rehabilitation initiatives. The analysis generated a suitability map that predicted potential rehabilitation areas in Oriental Mindoro, Philippines. The suitable areas were categorized into low, mid, and high suitability areas. It utilized several thematic layers for accuracy in the prediction of mangrove-suitable areas. It integrates with relevant information generated from biodiversity assessments leading to a contextualized approach in rehabilitation actions. The study imparted the applicability of GIS in predicting suitable mangrove areas as a decision-support tool for rehabilitation initiatives.

Likewise, the study of Makinano-Santillan and Santillan (2021) entitled "Mapping land cover change and modelling its impacts on the inundation responses of Agusan Marsh, Mindanao, Philippines" the impacts of land cover change to the hydrologic and hydraulic behaviors of the Agusan River Basin (ARB) was analyzed using an integrated approach involving RS, GIS, and hydrologic and hydraulic models. The land cover maps were used inputs into HEC HMS and HEC RAS models simulate the impacts of the different land cover conditions to total discharge, flood depth and extents. Simulation results showed that there was an increase in discharge, flood depth, and flood extents between 1995 and 2017, implying that that the detected changes in land cover have negative impacts to hydrologic and hydraulic behaviors of the ARB.

Moreover, the study of Encisa-Garcia et al. (2020) entitled "Land Use/Land Cover Changes Assessment and Forest Fragmentation Analysis in the Baroro River Watershed, La Union, Philippines" attempted to assess the land use/land cover changes and forest fragmentation in a Philippine watershed using several landscape metrics at different time periods. From the analysis of Landsat images, land cover maps of the ARB for the year 1995 and 2017 were generated with 93 percent overall classification accuracies. These maps revealed that ARB is 67.7 percent forest in 1995 but have decreased to 62.8 percent in 2017.

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Agricultural areas in the basin were also found to have increased from 12.2 percent to 15.5 percent in the same period. Other notable land cover changes detected include the increase in built-up lands and range lands, and decrease in barren lands. Simulation results showed that there was an increase in discharge, flood depth, and flood extents between 1995 and 2017, implying that that the detected changes in land cover have negative impacts to hydrologic and hydraulic behaviors of the ARB.

Moreso, the study of Santillan et al. (2019) entitled "Analyzing the impact of land cover change to hydraulic behavior of the Philippine Third Largest River Basin" focused on the impacts of land-cover changes to the hydrologic and hydraulic behaviors of the Agusan River Basin (ARB). This was analyzed using an integrated approach involving Remote Sensing (RS), Geographic Information System (GIS), and hydrologic and hydraulic models. The impacts of these changes in land-cover to the basin discharge were then estimated using a calibrated hydrologic model based on the Hydrologic Engineering Center - Hydrologic Modeling System (HEC-HMS) under different extreme rainfall conditions. Land cover classification results revealed that the ARB is 67.7 percent forest in 1995 but have decreased to 62.8 percent in 2017. Agricultural areas in the basin were also found to have increased from 12.2 percent to 15.5 percent in the same period. Other notable land cover changes detected include the increase in built-up lands and range lands, and decrease in barren lands.

Further, Paringit et al. (2019) in his study on "GIS for Better Public Transportation and Transit" highlighted that the Geographic Information System (GIS) applications for transit system modelling include transit service area analysis, data attribution, network representation, transit demand, transit distribution, linking transportation systems, among others. Research studies that utilized GIS to shape their research in terms of public transportation and transit were collated. GIS analysis was a big help in the study. The ability of GIS to combine large amounts of data from different sources makes them a powerful tool. From volume data to population density, level of service and accessibility can be determined. From there route optimization and other transport planning may be further analyzed and developed.

Also, Bato **(**2018) in study on **"**GIS-based Suitability Mapping of Banana in the Philippines" indicated that a banana suitability map shows various areas with different levels of suitability for banana growth: high, moderate, marginal, and not suitable. This research sought to generate a banana suitability map covering the whole Philippines using Geographic Information Systems (GIS) and the most recent sensor-based data. These various spatial data were processed within the GIS using series of recoding, map algebra, and cross-classification procedures. The resulting banana suitability map for the Philippines was published in static PDF or JPEG format and interactively in the World Wide Web.

Moreover, the investigation made by Rubio et al. (2018) about "Identifying Crime Hotspots in CAMANAVA by Geographic Information System using Spatio-Temporal Analysis", aimed to develop a graphical information system (GIS) identifying the different hotspots of crimes that occurred in the cities of Caloocan, Malabon, Navotas and Valenzuela (CAMANAVA) in 2017 using the Marker Clusterer together with spatial and temporal Summarize analysis of crime cluster occurrence in specific areas and time periods and make recommendation for this hotspot. The development research design was adopted by the proponents to solve the research problem along with the Knowledge Discovery in Database (KDD) during the development of the system. Nine (9) types of crime were observed, namely; Carnapping, drug incidents, manslaughter, murder, assault, rape, robbery, theft and vehicle accidents. The results showed that a total of 12,784 crimes were observed, with traffic accidents being the most common, accounting for 63.97 percent of the total 12,639 crimes in CAMANAVA in 2017.

Furthermore, Valdez (2018) study on **"**Mapping Suitable Areas of Central Luzon, Philippines for Aerobic Rice Production Using GIS-Based Land Suitability Analysis". The study presented suitability maps and spatial data to aerobic rice under different production environments of the Central Luzon Region, Philippines. Simple limitation approach (SLA) was used to derive the overall suitability of aerobic rice production in these areas. Of the seven provinces, Nueva Ecija had the biggest potential area of 547,735.80 hectares with 11.49 percent marked as highly suitable to aerobic rice technology, followed by Bulacan which had a potential area of 255,022.52 hectares with 6.15 percent marked as highly suitable. Pampanga, Tarlac, Zambales, Aurora and Bataan followed with 6.15 percent, 5.88 percent, 2.65 percent, 1.59 percent and 1.56 percent, respectively, of their corresponding potential areas suitable for aerobic rice production. The total land area in Central Luzon which was found to be highly suitable for aerobic rice production was 126,959.91 hectares. On the assumption that ART could give an average yield of 4.5 tons per hectare, Central Luzon can supply an additional 571,319.59 metric tons of aerobic rice annually.

Lastly, Tarife et al. (2017) studied the "Application of Geographic Information System (GIS) in Hydropower Resource Assessment: A Case Study in Misamis Occidental, Philippines" which focused on the application of Geographical Information Systems (GIS) tools in identifying and classifying the theoretical hydropower potential sites. GIS based hydrological modeling is performed on raster cells using topographical and meteorological datasets. Input datasets include Digital Elevation Model (DEM), land use, land cover, soil map, and watershed boundary, weather data (precipitation, humidity and temperature). The study has shown that 62 percent of the potential sites are classified as micro hydropower (5kW-100kW potential capacity) and 38 percent are classified as pico (less than 5kW). The results of this study will help policy makers, public authorities, and investors in the energy sector to optimize the available resources in selecting the suitable sites for small hydropower plants with high power potential.

- *Synthesis of the State-of-the-Art*

This part of the study discusses the similarities and differences among the gathered related studies and the present research. Foreign and local related studies are separately compared with the current research.

In terms of foreign studies, the studies of Hamza, M. H., & Chmit, M. (2022), Jain, A., & Kaur, V. (2021), Lee et al. (2020), Zeren Cetin, I., Sevik, H (2020), Rahmawaty et al (2020), and Lahoti et al. (2019 were similar with the present study as they all used Geographic Information System (GIS) in the analysis, presentation, manipulation, organization and geovisualization or mapping of outputs. They also discussed the importance of GIS as a powerful tool in the planning and decision-making. However, they are different with the present study because the latter focused on the management of electrical networks based on GIS, census mapping, investigate the relationship between bioclimatic comfort and land use using geographical information systems and remote sensing technologies, map and test groundwater yield potential, and map the suitability of land while the present study focused on the land distribution, National Greening Program status using GIS, its level or awareness, understanding and perceived capability of GIS that would be the basis of the LGU in the preparation of Action Plan for the utilization, adaption and institutionalization.

Meanwhile, the studies of Lahoti et al. (2019), Bugday (2019), Baalousha et al. (2018), Akay, A. and Erdoğan,E. (2017), and Majid Kiavarz, H. and Jelokhani-Niaraki, M. (2017) were similar with the present study as they also all used Geographic Information System (GIS). But, they are different in the methodology used and on the focus of the study because the latter delved in landslide Susceptibility Mapping Using Different Modeling Approaches in which the estimate rainfall recharge is based on soil–water budget model and utilizing geoprocessing tools in GIS, GIS techniques integrated with MCDA methods for quick estimate of forest fire risk at low cost, and incorporate the concept of risk into the GIS-based analysis for generating geothermal prospectivity maps via Ordered Weighted Averaging (OWA) approach. While the present study focused on the land distribution, National Greening Program status using GIS, its level or awareness, understanding and perceived capability of GIS that would be the basis of the LGU in the preparation of Action Plan for the utilization, adaption and institutionalization.

On the other hand, the local studies of Belizario et al. (2021), Jumawan et al. (2021), Makinano-Santillan, M. & Santillan, J. (2021), Encisa-Garcia et al. (2020), and Santillan et al. (2019) are connected with the present research as they similarly assessed the status using GIS but differs on the scope and focused of the study. They differ primarily on the following: in identifying factors contributing to schistosomiasis endemicity and identifying high-risk areas, decision support tool for potential mangrove rehabilitation initiatives, land cover change to the hydrologic and hydraulic behaviors, land use/land cover changes and forest fragmentation in a Philippine watershed using several landscape metrics at different time periods, impacts of land-cover changes to the hydrologic and hydraulic behaviors of the Agusan River Basin (ARB), GIS public transportation and transit, and to generate a banana suitability map covering the whole Philippines.

Moreso, the studies of Paringit et al. (2019), Bato **(**2018), Rubio et al. (2018), Valdez, J.A. (2018), and Tarife et al. (2017) were also similar with the present study as they all used Geographic Information System (GIS). However, they are different in the methodology used and focused of the study because the latter centered on public transportation and transit, identifies the different hotspots of crimes, presented suitability maps and spatial data to aerobic rice, and identifying and classifying the theoretical hydropower potential sites. Meanwhile, the present study focused on the land distribution, National Greening Program status using GIS, its level or awareness, understanding and perceived capability of GIS that would be the basis of the LGU in the preparation of Action Plan for the utilization, adaption and institutionalization.

It can be understood that in general most of the gathered foreign and local studies analyzed as they all used Geographic Information System (GIS). Further, the present study is viewed to be broader and profound in scope, it can be deduced from the review of related studies that there was no study conducted regarding land distribution, National Greening Program status using GIS, its level or awareness, understanding and perceived capability of GIS that would be the basis of the LGU in the preparation of Action Plan for the utilization, adaption and institutionalization. Therefore, the study utilized more specific criteria in the used GIS compared to the related studies. This is the research gap that this study aims to bridge.

- *Theoretical Framework*

This study is based on the theoretical principles and concept of Technology Acceptance Model from theory of Reasoned Action. TAM is a revision of the Theory of Reasoned Action (TRA) in the area of Information System (IS).

Theory of Reasoned Action (TRA) is a model that finds its origins in the field of social psychology. This model which was developed by Fishbein and Ajzen (1975) defines the links between beliefs, attitudes, norms, intentions, and behaviors of individuals. According to this model, a person's behavior is determined by its behavioral intention to perform it. Based on the theory of reasoned Action, Davis et. al (1989) developed the Technology Acceptance Model which deals more specifically with the prediction of the acceptability of an information system. The purpose of this model is to predict the acceptability of a tool and to identify the modifications which must be brought to the system in order to make it acceptable to users. This model suggests that the acceptability of an information system is determined by two main factors: perceived usefulness and perceived ease of use.

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Perceived usefulness is defined as being the degree to which a person believes that the use of a system will improve his performance. Perceived ease of use refers to the degree to which a person believes that the use of a system will be effortless. Several factorial analyses demonstrated that perceived usefulness and perceived ease of use can be considered as two different dimensions (Hauser et Shugan, 1980 ; Larcker et Lessig, 1980 ; Swanson, 1987).

The Technology Acceptance Model asserts that use of an information system is determined by behavioral intention, which in turn is determined by the person's attitude toward using the system and his perception of its value, as shown by the theory of reasoned action. According to Davis, a person's attitude is not the only thing that affects how he uses a system; it can also have an effect on how well he does. Therefore, even if an employee does not appreciate an information system, there is a good chance that he will use it if he thinks it would help him perform better at work. With two systems offering the same features, a user will find more useful the one that he finds easier to use (Dillon and Morris, on 1996).

In this study, the applications of this theory are therefore imperative, GIS as Information System technology for resource management for the attainment of the goals and objectives of the projects and mechanism for adaption of the LGUs as driving forces for good governance and public service. The variables of the theory were linked to the variables of the study. The arrows show represents the link between connection of the variables regarding land distribution, National Greening Program status using GIS, its level or awareness, understanding and perceived capability of GIS that would be the basis of the LGU in the preparation of Action Plan for the utilization, adaption and institutionalization.

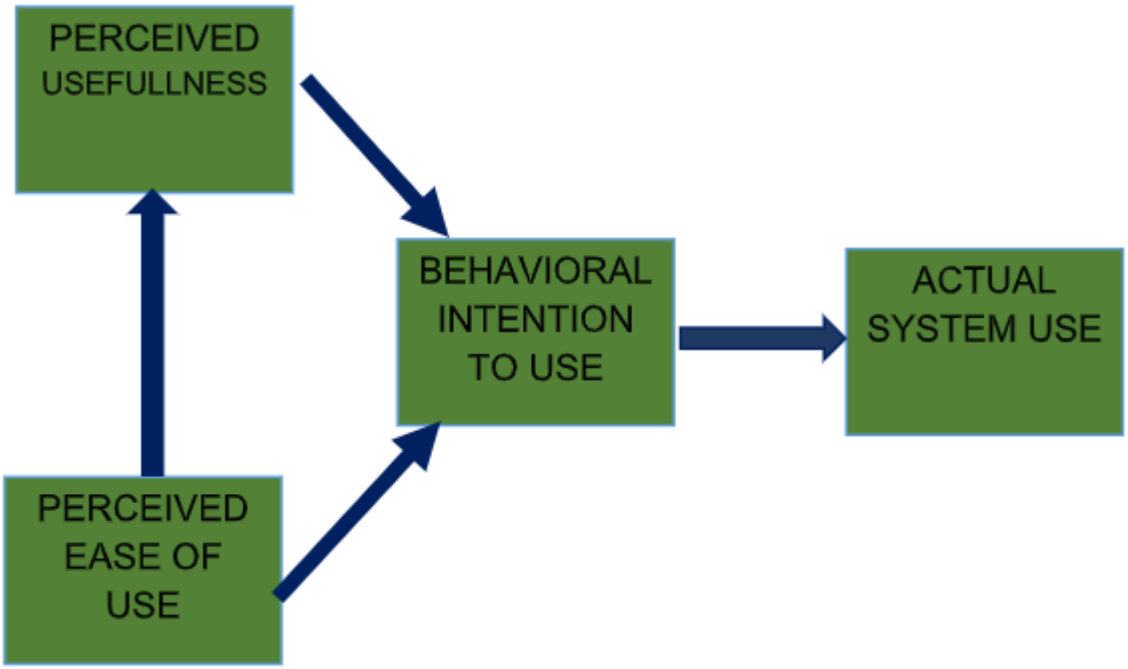

Fig 1 Theoretical Paradigm of the Study

➢ *Conceptual Framework*

The conceptual framework of the study is anchored on Proposed Original Model (POM) research framework. Figure 2 shows the conceptual framework of this research undertaking. This conceptual framework of this study uses boxes, arrows and circle to illustrates and to show relationships among these ideas and how they relate to the research study.

The first box shows and indicates the predictor variable in which the first two objectives of the study is being presented. It includes the status of the Land distribution along with political boundary, land classification, and land cover, and National Greening Program (NGP) along with accomplishments from CY 2011-2018, commodities, component, zone, Implementation Partner, and tenurial instrument.

The second box indicates the criterion variables, it includes the level of awareness and understanding of GIS concepts, perceived capability of respondents on the use of GIS mapping, and hierarchy of constraints of users, technology, and institution on GIS. Box 1 and box have no significant relationships with each other.

From this, there will be an individual arrow pointing on the third box. it indicates the next step. The third box or box 3 is the process and method used For this study, a descriptive method using a quantitative type of research such as frequency counts, means, percentages and rankings was used to analyze the results. In addition, ArcMap 10.8 GIS software was used to process, present, and generate GIS Maps. Likert Scale was also used in determining the corresponding statistical range and descriptive

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equivalent of variables that utilized rating scales. Furthermore, the Reliability test using Cronbach's alpha was utilized, to tell how closely related a set of test items are as a group.

The methods, processes, results, and findings generated as indicated in the third box will be used to propose action plan for LGUs in the utilization, adaption and institutionalization of GIS. The proposed action plan will provide and offer interventions and solutions to the identified issues, concerns, constraints, and difficulties of the LGUs in the utilization of a GIS.

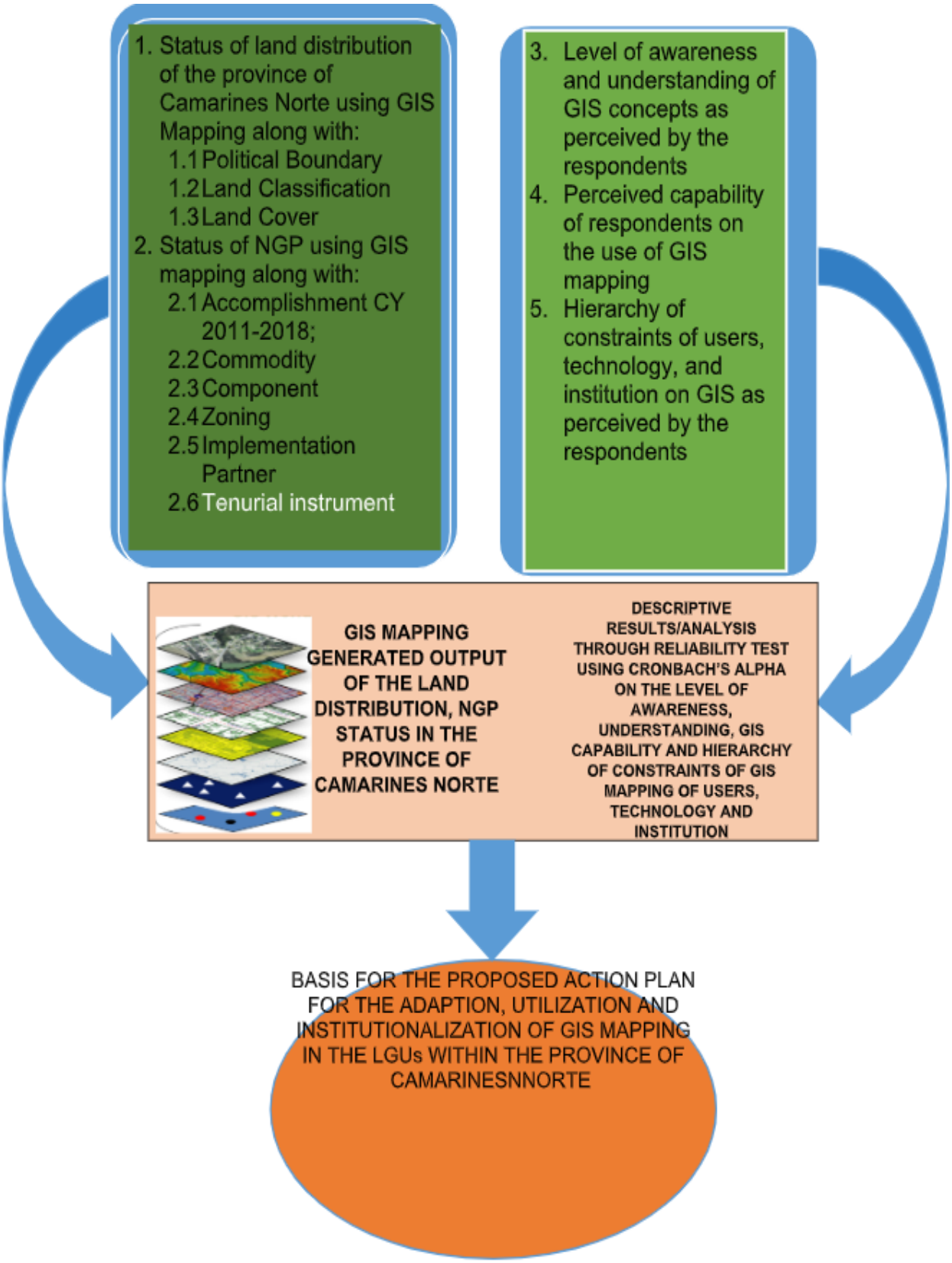

Fig 2 Conceptual Paradigm of the Study

➢ *Definition of Terms*

The researcher used various terms in the conduct of the study which were conceptually and operationally defined to facilitate the continuous flow of the thoughts in the discussion of the study.

- *Agroforestry*

Refers to the sustainable management of land, which raises their productivity via the implementation of management strategies that are consistent with the local temperature, topography, and slope. This can be done by correctly integrating agricultural crops with forest crops at the same time or in succession through time.

- *Arcmap 10.8*

It introduces new features and capabilities in using maps, compiling geographic data, analyzing map information, sharing and discovering geographic information, using maps and geographic information in a range of applications, and managing geographic information in a database. The GIS software used in this study is GIS software developed by the Environmental Systems Research Institute, Inc. (ESRI).

- *Attribute Table*

According to ESRI, it is non-spatial data that is linked to a geographic feature in a GIS by a special identifier and is often recorded in a table. A few examples of qualities are the name of the barangay, the municipality, the species, the product, the tenure, and the categorization. It is the data found in the shapefile used in this research.

- *Calculate Geometry*

As defined by ESRI as the ArcGIS geoprocessing tool that adds information to a feature's attribute fields representing the spatial or geometric characteristics and location of each line, point or polygon. It calculates area and length of a line, point or polygon.

- *Community-Based Forest Management Agreement (Cbfma)*

This was developed as part of a national policy to promote the sustainable development of the Philippines' forest resources under Executive Order No. 263 that President Ramos issued in July 1995. The approach refers to the government's concerted efforts to collaborate with local communities in and around public forests in order to safeguard, restore, manage, conserve, and make use of the resources. It is one of the tenurial areas where NGP was developed in this study. It is a sort of tenurial instrument provided by the state with a contract validity of 25 years.

- *DENR PENRO*

Department of Environment and Natural Resources (DENR) is responsible for the conservation, management, and development of the country's environment and natural resources. It ensures the proper use of these resources and the protection of the environment within the framework of sustainable development (https://www.denr.gov.ph/). It is the DENR Provincial field office in the province of Camarines Norte that implements the National Greening Program.

- *Desktop*

A whole computer, placed on a desk or table or PC, usually consists of a display, either color or monochrome; a system box containing the processor, memory, drives, power supply and communication interfaces; a keyboard; a pointing device, often a mouse (https://www.encyclopedia.com computers-and-computing desktop). The researcher installs the ArcMap 10.8.1 software on this computer, on which data is stored, analyzed and his research presented.

- *Forest Land Tenurial Instruments*

These are legal instrument liked ISF, CBFMA and among others used by the government to allocate public forests and forest lands to interested individuals, organization or entities and put these areas into effective and responsible on-site management.

- *Geographic Information System (GIS)*

As defined by ESRI, it is a framework for collecting, managing, and analyzing data. GIS has its roots in the science of geography and integrates many types of data, analyzes spatial location, and organizes layers of information into visualizations using maps and 3D scenes. With this unique ability, GIS reveals deeper insights into data, such as patterns, relationships, and situations that help users make smarter decisions. It is the system used in this study where the GIS mapping of land distribution and the national greening program was determined.

- *Integrated Social Forestry (Isf)*

The national program provided for by Letter of Instructions (LOI) No. aims to maximize land productivity, improve ecological stability, and improve the socioeconomic conditions of forest dwellers and communities. It is a type of government-granted temporary instrument with a 25-year contract and is one of the temporary areas where NGP was established in this study.

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- *Land Classification*

The 1987 Constitution's Section 3 of Article XII on National Economy and Patrimony defines as a method for classifying public domain land into forest land, mineral land, national parks, and agricultural land. It is one of the problem objectives to be determine using GIS Mapping in this study relative to status of Land classification in the province of Camarines Norte.

- *Land Cover*

It is described as the ground's visible surface cover, such as flora, urban infrastructure, water, bare soil, etc. Land cover identification creates the baseline data for tasks like thematic mapping and change detection analyses. It is the actual surface covering material of the earth. It is one of the problem objectives to be determined using GIS Mapping in this study relative to status of Land cover in the province of Camarines Norte.

- *Mangroves*

This applies to specific trees and shrubs that are primarily members of the families Rhizophoraceae, Acanthaceae, Lythraceae, Combretaceae, and Arecaceae, grow in thickets or forests along tidal estuaries, in salt marshes, and on muddy coasts, and have prop roots, or exposed supporting roots, as their defining characteristic. A variety of ecosystem services are offered by mangroves. In this study, it is the area in the coastal zone where NGP planting is targeting to rehabilitate.

- *Map Lay-Out*

According to ESRI, it is a group of map components arranged on a virtual page intended for printing maps. One or more map frames (each having an ordered group of map layers), a scale bar, a north arrow, a map title, illustrative text, and a legend are typical map components. It is in this study presents the output of the GIS map derived in the ArcGIS 10.8.

- *National Greening Program (NGP)*

It is the program created by DENR through Executive Order 26 to plant 1.5 billion trees in 1.5 million hectares for a period of six (6) years from 2011 to 2016. It refers to the reforestation or tree planting program being implemented by the DENR PENRO Camarines Norte and one of the subject of this research.

- *People's Organization (PO)*

It describes a legitimate group of individuals with a proven ability to advance the common good and with definable goals. leadership, participation, and organization (www.congress.gov.ph › legisdocs › basic_17). It generally refers to the organization within the province of Camarines Norte who are partner of the DENR in the NGP implementation.

- *Perceived Constraints*

These is factors perceived by individuals to inhibit or prohibit participation and enjoyment in leisure" (Jackson 1991, p. 279). It is the information gathered from the respondents regarding their constraints on the GIS like for users, technology and institution.

- *Political Boundary*

The boundaries created and imposed on or around a geographic territory to make distinctions between different political control types or spheres of governance. They serve two purposes: managing a group of people and reducing conflict and setting up effective political units. It is one of the problem objectives to be determined using GIS Mapping in this study relative to the status of political boundary in the province of Camarines Norte.

- *Production Zone*

Reforestation areas identified for rehabilitation through planting trees intended for utilization of timber and other derived products for food security and economic stability.

- *Protected Areas (PA)*

As defined in Republic Act No. 7586, these are areas of land and water maintained to promote biodiversity and protected from harmful human exploitation. They are part of the National Integrated Protected Areas System (NIPAS). Nature or resource reserves, natural parks, monuments, or biotic zones; wildlife sanctuaries; protected lands or seascapes; or those designated by legislation, conventions, or international agreements are some of the different types of PAs. It is the project site of NGP and the problem objectives are to be determined using GIS Mapping in this study relative to the status of NGP along the type tenurial coverage in the province of Camarines Norte.

- *Protection Zone.*

Reforestation areas identified for rehabilitation through planting trees intended protection for the improvement of the ecosystem and biodiversity enhancement.

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- *Proposed Original Model (Pom)*

It is paradigm model used in research studies that propose a program or any intervention measure and it also used when the researcher presents as original paradigm. It is conceptual paradigm used in this study, wherein a graphical presentation of the concepts or ideas on the basic structure or components of this research correlates or influenced each other in order to proposed strategies or plans.

- *Reforestation*

This is the management strategy to rehabilitation and reforestation of unproductive, denuded, and degraded areas using perennial trees or crops to contribute for self-sufficiency in wood and agroforestry products, economic stability, climate mitigation, and biodiversity enhancement. It is one of the scheme of NGP to rehabilitate denuded areas using perennial trees.

- *Shapefile*

ESRI defines shapefile as a simple, nontopological format for storing the geometric location and attribute information of geographic features. Geographic features in a shapefile can be represented by points, lines, or polygons (areas). The workspace containing shapefiles may also contain dBASE tables, which can store additional attributes that can be joined to a shapefile's features. It is the digital information/data like point, polyline and polygon used in mapping in this study.

- *Technology Acceptance Model (Tam)*

It was developed by Davis (1986) from the theory of Reasoned Action (TRA) which deals more specifically with the prediction of the acceptability of an information system. The purpose of this model is to predict the acceptability of a tool and to identify the modifications which must be brought to the system in order to make it acceptable to the users. This model suggests that the acceptability of an information system is determined by two main factors: perceived usefulness and perceived ease of use. It is in this theory where the researcher anchors his theoretical framework of his study.

- *Unclassified Land*

These public forests are not allocated or not subject to present tenurial rights which is legally under the classification of public or timber lands, in consonance with the Regalian Doctrine that all lands of the public domain belong to the State, and that the State is the source of any asserted right to ownership in land and charged with the conservation of such patrimony. Under the Regalian Doctrine, all lands not otherwise appearing to be clearly within private ownership are presumed to belong to the State. For this study, NGP policy guidelines states that priority areas must first fully develop the tenured areas or shall be undertaken first before proceeding to open access areas or untenured areas.

- *Urban Scheme*

Is the care and management of single trees and tree populations in urban settings for the purpose of improving the urban environment. It serve as the backbone of the green infrastructure, bridging rural and urban areas and ameliorating a city's environmental footprint to contribute in mitigating climate change, and environmental loss and improve urban green architecture and aesthetics. It is also a component scheme of NGP where the study is determining the status of.

- *Utilization*

The amount of something available, produced, etc. compared with the total amount that exists or that could be produced(https://dictionary.cambridge.org/us/dictionary/english/utilization). Operationally, it is the level and extent of GIS usage of the LGUs and DENR as implement agency of the system tools.

- *Untenured*

It is a land classified as public/timberland with no tenurial rights given by the government or DENR at present.

- *Zoning*

As indicated in the NGP guidelines, rehabilitation and tree plantation development effort the watershed areas identified are for protection, production, urban greening, and mangroves for the NGP establishment. For this study, the type zones of NGP are the protection, production and combination protection and production or commonly called as multiple used zones.

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CHAPTER THREE
RESEARCH METHODOLOGY

This chapter covers the presentation of the research design, research locale, population sample size and sampling technique, data gathering instruments, data gathering procedures and statistical treatment used and data analysis techniques to answer the research question discussed previously.

- *Methods of Research*

This study employed a descriptive method of research, which focused on the observation and description of the characteristics of a population or phenomenon being studied. In this research, the descriptive method using quantitative type of research was applied in the analysis of the following integral concepts of the study. In addition, GIS using ArcMap 10.8 software was also used in the generation, manipulation and presentation of the data. Further, secondary data were used as input and manipulated using ArcMap 10.8 software to describe and present the GIS Map output particularly on: 1. The status of land distribution of the province of Camarines Norte using GIS Mapping in terms of the following: 1.1Political Boundary; 1.2. Land Classification; 1.3. Land Cover; 2 2. Status of NGP using GIS mapping along with: 2.1 Accomplishment CY 2011-2018; 2.2 Commodity; 2.3 Component 2.4 Zoning; 2.5 Implementation Partner; 2.6. Tenurial instrument

Moreso, descriptive method using quantitative type of research was applied for the level of awareness, understanding, capability and GIS constraints such as users, technological and institutional as perceived by the respondents as the basis for LGU for plan preparation.

- *Population, Sample Size, and Sampling Technique*

The population of this study is 36 respondents, selected through a total enumeration from 12 municipalities within the Municipal Planning, Development and Coordination Office (MPDC) in the province of Camarines Norte. The main criteria in the selection of the respondents depend on the main users of GIS Mapping and office functions and responsible for the formulation of plans, policies, and development projects/programs within the LGUs.

Further, total enumeration or census was applied in this study because the population is small, nevertheless, the researcher has the resources to reach out to all of them. This is the best-case scenario and making sure that everybody is represented accurately.

- *Description of Respondents*

The 36 respondents selected are all personnel/staff of the Municipal Planning, Development, and Coordination Office (MPDC). Out of the 36 respondents, 24 are male and 12 are female. The composition of the respondent's job position/designation is: twelve (12) are Municipal Planning and Development Officers (MPDO), eight (8) are Planning Officers (PO), five (5) are Draftsman, three (3) are Zoning Inspectors, four (4) are Administrate Assistance and four (4) are MPDO staff. For the length of service, ten (10)are within the range of 1-5years, thirteen (13) are within the range of 6-10years, six (6) are within the range of 11-15years and seven (7) are 16years and above in the service. As to the status of appointments, the majority of them are permanent and some are casual and job orders.

- *Research Instrument*

The significant data and information in this study were gathered using a researcher-made survey questionnaire. This survey questionnaire was subjected to four integral research processes: the construction of the survey form, validation, reliability testing, and dry run. Construction involves the alignment of the contents of the survey questionnaires based on the research objectives. The questionnaire consists of close-ended and open-ended questions. The questionnaire was devised in English language and translated orally into vernacular during the conduct of the interview. In addition, focus group discussions (FGD) were held among the personnel of the Municipal Planning Development and Coordinating Office.

In the validation phase, the developed survey questionnaires were subjected to the evaluation of the research committee of the Graduate School and a research instructor or expert in the field. The contents of the research tool were validated based on its accuracy and alignment with the research objectives. Moreover, the contents of the tool were also subjected to reliability testing using the Chronbach Alpha test of reliability. Finally, the survey questionnaires were subjected to dry run or pilot test wherein technical staff and officers from DENR-PENRO Camarines Norte not covered by the study were tasked to answer the survey form. This is to test the accessibility of the data and the feasibility of data gathering.

In addition, GIS software using ArcMap 10.8 software was also used in the generation, manipulation, and presentation of data. Further, secondary data from DENR-PENRO Camarines Norte, NAMRIA and Google Earth was used as input and manipulated using ArcMap 10.8 software to describe and to present the GIS Map output of the status of the following: 1. What is the status of land distribution of the province of Camarines Norte using GIS Mapping in terms of the following: 1.1Political Boundary; 1.2. Land Classification; 1.3. Land Cover; 2 2. Status of NGP using GIS mapping along with: 2.1 Accomplishment CY 2011-2018; 2.2 Commodity; 2.3 Component 2.4 Zoning; 2.5 Implementation Partner; 2.6. Tenurial instrument.

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- *Data Gathering Procedure*

Prior to the conduct of the study, the researcher attended to the significant ethical considerations of the research. This included sending communication letters seeking the approval of the Municipal Mayors in the province of Camarines Norte. Most importantly, all the respondents were assured that the study will highly comply with the mandates of Data Privacy Act by keeping their identities as respondents private and confidential.

After meeting all these ethical considerations, the researcher gathered data through interviews and administration of survey questionnaires to the respondents. Informal interviews were administered among the respondents. In addition, focus group discussion (FGD) was done. Likewise, the survey questionnaires were personally distributed to the respondents by the researcher with accompanying explanations of the indicators and contents for better comprehension of the participants.

Further, secondary data was gathered from different sources like DENR-PENRO Camarines Norte office, NAMRIA, and Google Earth and used as input in ArcMap 10.8 software to manipulate, organize, describe and present the GIS Mapping of the status of Land distribution and National Greening Program (NGP) in the province of Camarines Norte.

- *Statistical Treatment of Data*

In this research, the statical treatment of data used descriptive statistics using frequency counts, means, percentages and rankings. The Likert Scale was also used in determining the corresponding statistical range and descriptive equivalents of variables that utilized rating scales.

In addition, GIS software using ArcMap 10.8 software was also used in the generation, manipulation, and presentation of the data. Further, secondary data were used as input and manipulated using ArcMap 10.8 software to describe and to present the objectives: 1. What is the status of land distribution of the province of Camarines Norte using GIS Mapping in terms of the following: 1.1Political Boundary; 1.2. Land Classification; 1.3. Land Cover; 2 2. Status of NGP using GIS mapping along with: 2.1 Accomplishment CY 2011-2018; 2.2 Commodity; 2.3 Component 2.4 Zoning; 2.5 Implementation Partner; 2.6. Tenurial instrument. Moreso, the quantitative data were statistically treated through frequency counts, means, percentages, and rankings. The Likert Scale was also used in determining the corresponding statistical range and descriptive equivalents of variables that utilized rating scales for objectives 3. What is the level of awareness and understanding of GIS concepts as perceived by the respondents? 4. What is the perceived capability of respondents on the use of GIS mapping? 5. What is the hierarchy of constraints of users, technology, and institution on GIS as perceived by the respondents?

Furthermore, the Reliability Test using Cronbach's alpha, α (or coefficient alpha), developed by Lee Cronbach in 1951, measures reliability, or internal consistency. Reliability is another name for consistency. Cronbach's alpha tests to see if multiple-question Likert scale surveys are reliable. These questions measure latent variables—hidden or unobservable variables like a person's conscientiousness, neurosis or openness. These are very difficult to measure in real life, using Cronbach's alpha this will tell how closely related a set of test items are as a group.

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CHAPTER FOUR
ANALYSIS AND INTERPRETATION OF DATA

This chapter presents the results, analyses and interpretation of the data gathered on the status of Land distribution, National Greening Program using GIS Mapping in Camarines Norte as Basis for LGU action plan.

➢ *Status of Land Distribution*

Land distribution is an important measure to advance land rights and land use policies. Results, discussions, and analysis of the status of land distribution along with Political Boundary, Land Classification, and Land Cover using GIS Mapping of the province of Camarines Norte were presented.

Political boundaries are defined as boundaries established and imposed on or around a geographic area to distinguish between areas of government or types (strategies) of political control. They act both as a tool for managing a group of people and as a means of minimizing conflict and organizing efficient political entities. Accordingly, political borders can divide not only territories but also cultures, languages, ethnic groups and natural resources. As a result, they can give people a sense of security and belonging, or alternatively, a sense of exclusion.

- *Political Boundary*

Table 1 shows the data about the Status of Political Boundary, particullarly the covered municipalities, land area (hectare), percentage of the area covered from the total provincial area, total number of barangays per municipality and its ranking.

Table 1 Political Boundary

Municipality	Land Area (Hectare)	No. of Barangay	Percentage	Rank	
				District	Municipality
Camarines Norte	232,007	282	100		
First District	**149,105**	**147**	**64.27**	**1**	
Capalonga	29,000	22	12.5		2
Jose Panganiban	21,444	27	9.24		4
Labo	58,936	52	25.4		1
Paracale	19,790	27	8.53		6
Sta. Elena	19,935	19	8.59		5
Second District	**82,902**	**135**	**35.73**	**2**	
Basud	26,028	29	11.22		3
Daet	4,600	25	1.98		11
Mercedes	17,369	26	7.49		7
San Lorenzo Ruiz	11,937	12	5.14		9
San Vicente	5,749	9	2.48		10
Talisay	3,076	15	1.33		12
Vinzons	14,143	19	6.1		8

Note: Hierarchy of ranking is that first is the biggest last is the lowest in terms of area cover.

It can be gleaned from the table that the status of political boundary of the province of Camarines Norte has a total land area of 232,007 hectares or 2,320.07 square kilometers. It manifests 13 percent of the total land area of region 5 (Bicol) and 0.077 percent of the total land area of the Philippines. It has two (2) congressional districts, District 1 or Tagalog Speaking has the biggest area covered of 64.27 percent or 149,105 hectares while District 2 (Bicol Speaking) has an area covered of 35.73 percent or 82,902 hectares. Furthermore, the municipality with the biggest political boundary cover is the Municipality of Labo with 25.4 percent or 58,936 hectares while, the smallest political boundary area cover is Municipality of Talisay with 1.33 percent or 3,076 hectares. In addition, Labo has a greater number of barangay cover with 52 barangays while San Vicente has the least number of barangay cover with 9 barangays. The generated GIS maps for political boundary is shown in Appendix G.

The Internal Revenue Allotment (IRA) is the main intergovernmental fiscal transfer in the Philippines. It is the biggest source of operating revenues of local government units (LGUs) to provide basic goods and services and finance other development activities. The Supreme Court Ruling Under Section 284 of Republic Act (RA) No. 7160 or the Local Government Code (LGC) of 1991, LGUs are entitled to a 40 percent share of the national internal revenue taxes (Manasan 2020). Following the Mandanas-Garcia ruling, the IRA is renamed as the National Tax Allocation (NTA). According Department of Budget and Management (DBM), the distribution of shares of individual provinces, cities and municipalities is made on the basis of the following formula, 50 percent for the population, 25 percent for land area and 25 percent for equal sharing which affirms the significance results of political boundary using GIS regarding IRA or NTA.

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It can be inferred from the results that political boundary has a significant impact to the Internal Revenue Allotment (IRA) of the LGUs because the bigger the population and area the larger the IRA.It implies that municipality of Labo has the highest allocation of IRA because it has the biggest boundary area from other municipalities which also affirms from the DBM reports on IRA or NTA releases.

Land classification based on Section 3 of Article XII on National Economy and Patrimony of the 1987 Constitution is defined as a system for determining public domain land into forest land, mineral land, national parks, and agriculture. Agricultural lands of the public domain may be further classified by law according to the uses in which they may be devoted. Accordingly, alienable lands of the public domain shall be limited to agricultural lands.

Moreso, land classification refers to both the process and the product of the process. Under the 1987 Constitution, all lands are divided into lands of the public domain and private lands (which include ancestral lands). Private lands are either in private ownership or held by the State in its capacity as a private individual. Privately-owned lands are subject to eminent domain; that is, they can be taken back by the State provided that the taking is for public purposes and the requirements of due process and just compensation is satisfied. Lands in the public domain, on the other hand, are further subdivided into (1) non-disposable lands and therefore not available for alienation (i.e., natural parks, mineral lands, and forest lands); and (2) disposable lands and hence available for alienation (i.e., agricultural lands).

- *Land Classification*

The tabulated results are presented in Table 2, which shows the provinces' three-land classification status, such as A&D lands, Forestlands, and Unclassified lands. It also shows the distribution by districts, municipalities, area (hectare,) and percentage cover per specific land classification type.

Table 2 Land Classification

Municipalities	A & D Lands		Forestland		Unclassified lands		Total
	Area (ha)	Percent	Area (ha)	Percent	Area (ha)	Percent	
First District	90,543.70	60.72%	57,971.49	38.88%	589.81	0.40%	149,105.00
Capalonga	16,364.62	56.43%	12,610.78	43.49%	24.6	0.08%	29,000
Jose Panganiban	15,592.17	72.71%	5,691.14	26.54%	160.69	0.75%	21,444
Labo	33,402.65	56.68%	25,533.35	43.32%	-	-	58,936
Paracale	10,173.56	51.41%	9,211.92	46.55%	404.52	2.04%	19,790
Sta. Elena	15,010.70	75.30%	4,924.30	24.70%	-	-	19,935
Second District	54,161.44	65.33%	25,615.84	30.90%	3,124.72	3.77%	82,902.00
Basud	15,288.18	58.74%	10739.82	41.26%	-	-	26,028
Daet	4,436.62	96.45%	163.38	3.55%	-	-	4,600
Mercedes	7,965.38	45.86%	8,576.37	49.38%	827.25	4.76%	17,369
San Lorenzo Ruiz	8,850.55	74.14%	3,086.45	25.86%	-	-	11,937
San Vicente	4,516.81	78.57%	1,232.19	21.43%	-	-	5,749
Talisay	3,076.00	100.00%	-		-	-	3,076
Vinzons	10,027.90	70.90%	1,817.63	12.85%	2,297.47	16.24%	14,143
TOTAL	144,705.14	62.37%	83,587.33	36.03%	3,714.53	1.60%	232,007
Percentage (%)	62.37		36.03		1.6	1.60%	100
Rank	1st		2nd			3rd	

Note: The hierarchy of ranking is that first is the biggest last is the lowest in terms of area cover/established

The result shows that about 144,705.14 hectares or 62.37 percent of the total area of the province Camarines Norte is alienable and disposable lands (A&D),which make it the biggest or ranked first in terms of area coverage. It implies that it has more available land for alienation. This also indicates that this land has been subjected to the present system of classification and declared as not needed for forest purposes but for private ownership. Regarding area cover of A&D lands by district, Bicol Speaking or District II is bigger by about 4.61 percent compared to District 1. In addition, the municipality of Talisay has 100 percent of its land area is classified as A&D covering about 3,076 hectares. It implies that all the areas or land of the public domain of Talisay have been subjected to the present system of classification and declared as not needed for forest purposes but rather for agricultural, commercial, and other uses subject to the ownership of the individual or group.

Further, results show that land classified as Forestlands placed second with an area cover of 83,587.33 hectares or 36.03 percent of the province Camarines Norte. It also shows that forest lands in district 1 are much bigger compared to district 2; district 1 has 2,297.47 hectares or 38.88 percent, while district 2 has only 32,355.65 hectares or 30.90 percent indicating a 7.98 percent difference in terms of area cover. It implies that land in this area has been subjected to the present system of classification and declared as needed for forest or public purposes. It also revealed that the municipality of Labo has the largest forestlands of about 25,533.35 hectares in the province.

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Lastly, land classified as Unclassified lands or belonging under the category classification of public or timber lands has the least area covered, it consists only of about 3,714.53 hectares or 1.60 percent of the total area coverage of the province. Unclassified lands in district 2 are much bigger compared to district 1, district 2 has 2,297.47 hectares or 16.24 percent while district 1 has only 589.81 hectares or 0.40 percent with 15.84 percent difference in terms of area coverage. It also revealed that the municipality of Vinzons has the largest Unclassified lands about 25,533.35 hectares. The generated GIS maps for land classification are shown in Appendix H.

The significance of the study on land classification was also supported by the policy matrix of the senate that Land classification is significant because the land is a fundamental material resource and the primary platform for economic and other social activities. How land is used and intended to be used are integral components of human development. Knowing the significance of land classification, it can quickly formulate policy that provides for the rational allocation, utilization, development and management of the country's land to ensure the use is consistent with the principle of sustainable development.

It was affirmed by the related study of Lee et al (2020), wherein the study used GIS to assess land use and land cover (LULC) conversion of Mt. Pulag National Park (MPNP), Benguet Province, Philippines, from 1990–2020 to provide valuable information for land resource management strategies while this study used GIS mapping to determine the status land classification in the province of Camarines Norte.

Land use and land cover are often used interchangeably, but each term has its unique meaning. Land cover refers to the surface cover on the ground like vegetation, urban infrastructure, water, bare soil, etc. Identification of land cover establishes the baseline information for activities like thematic mapping and change detection analysis. It is the physical material at the surface of the earth.

- *Land Cover*

Table 3 shows the result of the status of the land cover using GIS mapping . Results show that brushwood-coco has the biggest or rank first in terms of area covered at about 110,594.01 hectares or 47.67 percent while barren/sand is the least area covered at 1,227.52 hectares or 0.53 percent. It also revealed that brushwood coconut is dominant in the municipality of Labo with 34,803.48 hectares and coconut area in the municipality of Basud and Labo with 7,555.91 and 7,534.22 hectares respectively. The biggest built-up area is in the municipality of Daet with about 919.11 hectares. Moreso, it concludes that the land cover in the Camarines Norte province was dominantly covered by brushwood and coconut trees. The generated GIS maps for land cover is shown in Appendix I.

This was affirmed by the report of the Provincial Government of Camarines Norte that the status on socio-economic of the province revealed that Camarines Norte’s economy largely depends on agriculture, with grain crops, vegetables, coconuts, root crops and fruits as its primary products. Furthermore, this is considerd as the top producer of coconut in Bicol region.

Moreso, the related study of Lahoti et al (2019) supported the importance and capability of GIS mapping wherein it uses and explored a mapping methodology using GIS to create a thematic map of public urban green space (UGS) to analyze and present the study outputs where both of this study affirmed the use and importance of GIS mapping.

The significant implication of knowing the land cover is that, a society’s growth totally depends on its social and economic development. It plays a significant and prime role in planning, management, and monitoring programs at local, regional, and national levels. This requires the present and past land cover information of the area. It also helps us understand the changes happening in our ecosystem and environment.

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Table 3 Land Cover

District & Municipality	Rice Lands	Barren/ Sand	Brushwood-coco	Built-up	Coconut	Fishpond	Grass	Mangrove	Second Growth Forest	Residual Forest	Water	Total
First District	2,490.5	649.22	87,254.04	942.53	17,932.53	2,337.12	2,954.24	2,364.86	3,856.50	27,760.30	652.13	149,104
Capalonga	458.4	103.74	16,238.66	78.25	2,782.94	396.73	146.28	949.53	-	7,693.90	151.56	29,000
Jose Panganiban	76.01	122.64	15,663.41	335.14	1,400.23	273.62	878.37	393.18	-	2,281.72	19.68	21,444
Labo	1,194.93	95.18	34,803.48	203.77	7,534.22	0.05	192.65	-	3,088.13	11,531.02	292.57	58,936
Paracale	671.15	144.1	10,445.45	134.32	2,890.98	162.45	767.45	602.48	-	3,910.93	60.68	19,790
Sta. Elena	91.01	183.56	10,103.04	191.05	3,324.16	1,504.27	969.49	419.67	768.37	2,252.73	127.64	19,935
Second District	*9,508.71*	*578.28*	*23,339.97*	*1,444.16*	*23,300.02*	*521.66*	*1,289.40*	*1,536.57*	*10,071.43*	*10,353.25*	*958.57*	*82,902*
Basud	989.34	22.14	8,436.16	100.82	7,555.91	9.53	163.99	23.00	5,703.74	3,002.50	20.87	26,028
Daet	1,823.24	58.39	27.24	919.11	1,394.73	76.93	164.73	64.68	-	-	70.94	4,600
Mercedes	414.32	260.10	5,408.58	82.77	3,056.46	297.43	486.86	417.57	2,147.74	4,602.67	194.51	17,369
San Lorenzo Ruiz	10.33	3.36	6,506.31	92.02	2,262.70	-	9.04	-	1,516.92	1,512.50	23.84	11,937
San Vicente	65.94	5.05	1,966.58	65.91	1,688.01	1.04	4.25	-	703.03	1,235.58	13.61	5,749
Talisay	1,573.87	20.19	30.92	58.98	1,276.78	21.46	67.88	24.04	-	-	1.88	3,076
Vinzons	4,631.67	209.05	964.18	124.55	6,065.43	115.27	392.95	1,007.28	-	-	632.92	14,143
TOTAL	12,000.21	1,227.52	110,594.01	2,386.69	41,232.55	2,858.78	4,243.65	3,901.44	13,927.94	38,023.54	1,610.69	232,007
Percentage	5.17	0.53	47.67	1.03	17.77	1.23	1.83	1.68	6.00	16.39	0.69	100.00
Rank	5th	11th	1st	9th	2nd	8th	6th	7th	4th	3rd	10th	

Note: The hierarchy of ranking is that first is the biggest last is the lowest in terms of area cover/established

➢ *Status of National Greening Program*

In 2011, President Benigno Aquino III executed the National Greening Program (NGP) through Executive Order 26 as the reforestation initiative of the government. Through the NGP, the government did hope to address other related problems on poverty, food security, environmental stability and biodiversity conservation, and climate change. NGP is the largest and widest reforestation effort in the country, fully funded by the Philippine government. Compared to past reforestation efforts under Master Plan for Forestry Development (MPFD), the NGP has a large target of 1.5 million hectares reforested in only six years (2011-2016), almost twice shorter than the usual period of the reforestation program in the country.

- *Accomplishments from CY 2011-2018*

Table 4 shows the NGP accomplishments from the Calendar Year 2011 to 2018, the number of cover municipalities, area established/planted, number of sites developed per year, percentage, and hierarchal ranking was presented.

Table 4 Accomplishments from Calendar Year 2011 to 2018

Year	Cover Municipality	Area (Hectares)	No. of Site	Percentage	Ranking
NGP 2011	8	645.11	97	3.01%	8th
NGP 2012	11	2,686.13	109	12.55%	5th
NGP 2013	8	2,542.00	19	11.88%	7th
NGP 2014	6	3,505.00	28	16.38%	2nd
NGP 2015	6	3,798.00	17	17.75%	1st
NGP 2016	6	2,697.00	12	12.60%	4th
NGP 2017	5	2,668.00	12	12.47%	6th
NGP 2018	8	2,859.00	28	13.36%	3rd
TOTAL		21,400.24	322	100.00%	

Note: The hierarchy ranking was interpreted that, rank 1 or first is considered the biggest and rank last is considered the least in terms of area

Results show that the total area of accomplishment in the province from Calendar Year (CY) 2011 to 2018 has a total area of 21,400.24 hectares or 9.22 percent of the entire area of Camarines Norte covering 322 sites within the 12 municipalities. Data revealed that in CY 2011 or in its first year, it is the slightest accomplishment or rank 8th with only 645.10 hectares or 3.01 percent. It implies that NGP as still new implementer, which is the DENR PENRO Camarines Norte encountered various problems and challenges in implementing the program. Meanwhile, the calendar year with the highest area of accomplishment is on fifth year or CY 2015, with a total area of 3,853 hectares or 17.75 percent. It implies that the implementers can manage issues and problems, the lesson learned was considered and solution recommendations identified were implemented. The results of the NGP accomplishments from CY 2011 to 2018 generated from the GIS Map output of this study were affirmed in the DENR-PENRO Camarines Norte Briefing Kit and were shown in Appendix P wherein both information are similar on the area accomplishment from CY 2011 to 2018. The generated GIS maps for Accomplishments from Calendar Year 2011 to 2018 is shown in Appendix J.

Furthermore, it was revealed in the findings of the Commission of Audit (COA, 2015) that ccordingly, program implementers, including people's organizations (POs), identified various problems in implementing the program, such as the distance of the areas, calamities, and insufficiency of contract payments. It was also found that the most crucial issue was DENR's strategy of fast-tracking the program. Fast-tracking led the DENR to 1) impose targets on its field officials beyond their absorptive capacities; 2) proceed with the program without conducting the survey, mapping, and planning; 3) include far untenured areas, which will be abandoned after the term of the maintenance and protection contract; and 4) cause the POs to miss financial opportunities, such as profits from seedling production. According to the field officials, the targets were too ambitious. Instead of increasing forest cover, fast-tracking reforestation activities only increased the incidences of wastage.

Based on the NGP implementing rules and regulations there should be a commodity roadmap that must be followed which includes timber, fuelwood, hedgerows, bamboo, rattan, mangrove, beach forest species, high-value crops, agroforestry species, and other commodities in consonance with the thrust of the government for food security, environmental stability and biodiversity conservation, and climate change.

Moreso, fruit-bearing trees are allowed to be planted in the program such as mango, coffee, cacao, cashew and guyabano; these are recommended commodities aside from forest tree species. Forest tree species identified for planting in the uplands include dipterocarps, narra, and other premium and indigenous species, as well as fast-growing species such as mahogany, gmelina, bagras, acacia, and rubber. Bamboo and mangrove species are also tapped as reforestation crops, particularly in river banks and coastal areas, to control soil erosion and as buffers against wave action.

- *Commodity*

Table 5 shows the results of the NGP status by commodity, an area established/planted, the number of sites, percentage, and hierarchy ranking was presented. Strategies and intervention in the implementation of NGP adopted schemes such agroforestry,

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timber plantation, fuelwood plantation, fruit trees plantation, orchard plantation, ornamental growing, urban landscaping, and among others. The commodity used varies on the scheme suitability of the area; these can be a combination of a commodity or pure plantation development but treated in a per-site base approach or simply a polygon area scheme of approaches.

Table 5 Commodity

Commodity Scheme	Area (Hectares)	No. of Site	Percent	Rank
Fruit trees, Ornamental plants, and Timber	2.08	1	0.01%	15
Ornamental plants and Timber	18.53	18	0.09%	14
Betel nut	30	1	0.14%	13
Ornamental plants	40.54	25	0.19%	12
Rattan	355	2	1.66%	11
Cacao, Coffee	366	2	1.71%	10
Bamboo	642	6	3.00%	9
Fuelwood	811	4	3.79%	8
Mangrove	983.46	49	4.60%	7
Cacao	1,416.00	16	6.62%	6
Indigenous	1789	8	8.36%	5
Coffee	1,936.00	20	9.05%	4
Fruit trees and Timber	2703.1	67	12.63%	3
Timber	4208.54	72	19.67%	2
Fruit trees	6,099.00	29	28.50%	1
	21,400.25	320	100.00%	

Note: The hierarchy ranking was interpreted that, rank 1 or first is considered the biggest and rank last is considered the lowest in terms of area

It can be deduced from the results that Fruit trees commodity follows the scheme of plantation development which include species like Cacao, Coffee, Guyabano, Lipote, Pili, Rambutan, Santol, Cashew, Duhat, Guyabano, Jackfruit, Sampaloc) has the biggest area established of about 6,099.00 hectares or 28.50 percent while combination commodity of Fruit trees, Ornamental plants and Timber is the lowest in terms of the area established of about 2.08 hectares or 0.01 percent. It manifests that the priority commodity within the province aligns with the thrust of the government to help communities in livelihood activities, for food security, pursue the country's economic development, productivity and as well as the suitability of species relative survival rate, climate change mitigation, endemism, and biodiversity enhancement. It implies that the implementer is compliant with NGP policy guidelines. The generated GIS maps from commodity is shown in Appendix K.

On uses of GIS Mapping, this was affirmed related study of Encisa-Garcia et al (2020) wherein both studies used GIS to assess the land use/land cover changes and forest fragmentation in a Philippine watershed using several landscape metrics at different time periods. While this study uses GIS to determine the NGP commodity. The results of NGP commodity using GIS Mapping were also affirmed in the DENR-PENRO Camarines Norte Briefing Kit and were shown in Appendix P, wherein both the results data on area generated for the status of NGP by commodity are the same.

While the NGP is primarily a reforestation program that seeks to bring back the vegetative cover of the country's upland areas and designed to achieve more and beyond just a reforestation project. With such an encompassing mission, the following areas are included as a priority development under the program, this includes; open, degraded and denuded Forestlands; Protected areas and mangroves; Ancestral domains; Civil and military reservations; Urban areas under the greening plan of; Local Government Units; Inactive and abandoned mine sites and; Other suitable areas.

- *Component*

Table 6 shows the results of the NGP status in the province of Camarines Norte by type component implemented, area (hectares) established/planted, number of sites, percentage, and hierarchy ranking. The type of Components of Established Plantation implemented for CY 2011-2018 were Mangrove, Urban, reforestation, and Agroforestry component is presented.

The Agroforestry scheme is referring to the sustainable management of land, which increases productivity by properly combining agricultural crops with forest crops simultaneously or sequentially over time through the application of management practices, which are compatible with the local climate, topography, and slope. Urban Scheme is a care and management practice of single trees and tree populations in urban settings for the primary purpose to improve the urban environment. It is the backbone of the green infrastructure, bridging rural and urban areas and ameliorating a city's environmental footprint to mitigate climate change, and environmental loss and improve urban green architecture and aesthetics. It is also a component scheme of NGP where the study determined the status of NGP. Reforestation is the management strategy to rehabilitation and reforestation of unproductive, denuded and degraded areas using perennial trees or crops to contribute for self-sufficiency in wood and agroforestry products, economic stability, climate mitigation, and biodiversity enhancement. It is one of the schemes of NGP to rehabilitate denuded areas using perennial trees.

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Table 6 Component

Component	Area (Hectares)	No. of Site	Percentage	Rank
Mangrove	3.44	3	0.02%	4
Urban	103.67	78	0.48%	3
Reforestation	8,780.02	106	41.03%	2
Agroforestry	12,513.10	133	58.47%	1
	21,400.24	320	100.00%	

Note: The hierarchy ranking was interpreted that, rank 1 or first is considered the biggest and rank last is considered the lowest in terms of area

It can be deduced from the result that the Agroforestry component has the biggest area established, with a total area of 12,513.10 hectares or 58.47 percent of the total planted of NGP implementation. It implies that the province has prioritized rehabilitation purposedly for Agroforestry that will contribute to food security, self-sufficiency in wood and agroforestry products, environmental stability profitability, and economic security. Meanwhile mangrove component got the least area established with 3.44 hectares or 0.002 percent. It implies that Agroforestry components area top priority for the rehabilitation of denuded areas that help contribute to food security, self-sufficiency in wood and agroforestry products, environmental stability, profitability, and economic security as far as the province of Camarines Norte is concerned. The results of the NGP component using GIS Map were similar to the DENR-PENRO Camarines Norte Briefing Kit and were shown in Appendix P, data relative to the area of NGP in terms of the NGP component. The generated GIS maps for the component is shown in Appendix L.

Based on DENR NGP guidelines, rehabilitation and tree plantation development effort uses the watershed as the primary planning unit, which is commonly called the watershed management approach. By taking this approach, the hydrological and ecological functions of a watershed are maximized. Accordingly, it will have the greatest impact in mitigating soil erosion and geohazards (landslides, floods, rockfall, streambank erosion, etc.) that especially affect the downstream areas. The River Basin Control Office (RBCO) of the DENR has identified 18 major river basins and 421 principal river basins. Further, 140 watersheds have been considered to support the national irrigation system. NGP Planting sites are prioritized within these watersheds as well as those covered by the 609 poor municipalities identified by the National Anti-Poverty Commission (NAPC) and the National Convergence Initiative (NCI) areas for development.

Further, watershed planning involves several activities such as zoning, site selection, determining species and design for planting, Information, Education and Communication/Advocacy Communication and Social Mobilization (IEC/ACSM) activities, and coordination meetings. In zoning, areas for protection, production, urban greening, and mangroves within the identified watershed shall be determined.

- *Zone*

Table 7 shows the results of the status of NGP by the type zone where established plantation was implemented corresponding to its area (hectares) established/planted, a number of sites, percentage, and hierarchy ranking. The type of zones where NGP established is protection and production and its combination. Protection zone is a reforestation area identified for rehabilitation through planting trees intended for protection for the improvement of the ecosystem and biodiversity enhancement. Production zone. Reforestation areas identified for rehabilitation through planting trees intended to utilize timber and other derived products for food security and economic stability. A combination (production and protection) identified areas intended for utilization and protection.

Table 7 Zone

Zone	**Area (Hectares)**	**No. of Site**	**Percentage**	**Rank**
Production and Protection	2,705.18	68	12.64%	3
Production	7,878.00	57	36.81%	2
Protection	10,817.06	195	50.55%	1
	21,400.24	320	100.00%	

Note: The hierarchy ranking was interpreted that, rank 1 or first is considered the biggest and rank last is considered the lowest in terms of area.

It can inferred from the result that the allocation of the area using the watershed management approach was devoted to production and protection zone as identified by the implementers. The results show that the area allocated to Protection zone is rank 1 or first, it is the biggest in terms of area covered of around 10,817.06 hectares or 50.55 percent of the total area covered. It implies that this area is a top priority that will give the greatest impact in mitigating soil erosion and geohazards (landslides, floods, rockfall, streambank erosion, etc.) that especially affect the downstream areas. The generated GIS maps for the zone is shown in Appendix M.

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Moreso, the production zone with an area covered of 7,878 hectares or 36.81 percent was placed second, it indicates that these areas were intended for self-sufficiency in wood and agroforestry products, economic security and environmental stability. Meanwhile, the combination of Production and Protection or commonly called as multiple Use Zone is the least or place third in terms established area of about 2,705.18 hectares or 12.64 percent. It implies based on definition that this is a portion of the protected areas where settlement, traditional or sustainable land use, including agriculture, agroforestry, extraction activities and other income generating or livelihood activities may be allowed as prescribed in the management plan. The results of the NGP zone generated from the GIS Map output of this study was affirmed in the DENR-PENRO Camarines Norte Briefing Kit and were shown in Appendix P.

As stipulated in the policy guidelines of NGP, qualified participants are any persons, natural or juridical, may actively participate either through the Memorandum of Agreement (MOA) or a formed of Contract represented by DENR. Qualified participants or partners are the following; any holder of a tenure or management agreement and in good standing with the DENR, LGU, Indigenous Cultural Communities (ICCs), and any person/community group.

DENR prioritized POs with existing tenurial instruments because they are already organized and they are the actual occupants and tillers of the forestlands. Especially in the early years of the program, most—if not all—NGP partners are tenure holders. However, the number of POs with existing tenurial instruments is insufficient to cover all denuded forestlands: hence, they had to allow POs without any tenure instruments to join. They will be the ones who will occupy the untenured areas (areas with no tenurial contracts). For areas with no POs, DENR partners with LGUs. LGUs are allowed to participate in the Program, provided that the area they will develop is within their administrative jurisdiction and consistent with their adopted Forest Land Use Plan (FLUP). The DENR Field Offices identified areas to be established through the following modes of implementation: Contracting of Communities/POs including tribal communities, Family Approach Rehabilitation (FAR), Partnership with Local Government Units and other National Agencies and by administration.

- *Implementation Partner*

Table 8 shows the partners/implementer involved in the establishment of plantation such as people's organizations, non-government organizations, cooperatives, individual/family, academe, Philippine Army and LGU relative to its area (hectares) established/planted, number of sites, percentage, and hierarchy ranking.

Table 8 Implementation Partner

Implementing Partners	Area (Hectares)	No. of Site	Percentage	Rank
Philippine Army	0.58	1	0.00%	11
LGU, Academe	1.53	1	0.01%	10
Religious Organizations	5.24	4	0.02%	9
Gawad Kalinga in Laniton	12.34	1	0.06%	8
Provincial Government	12.55	1	0.06%	7
Academe	35.9	44	0.17%	6
Local Government Units (LGUs)	62.41	19	0.29%	5
Family Approach Rehabilitation (FAR)	688.41	66	3.22%	4
Cooperative	2,862.95	34	13.38%	3
Non-Government Organizations (NGO)	4,039.00	27	18.87%	2
Peoples Organization (PO)	13,679.33	122	63.92%	1
	21,400.24	320	100.00%	

Note: The hierarchy ranking was interpreted that, rank 1 or first is considered the biggest and rank last is considered the lowest in terms of area.

It can be deduced from the result that the Peoples Organization (POs) has the biggest and most engage partners in the implementation of NGP with a total area covered of 13,679.33 hectares or 63.92 percent and with 122 total sites. It implies that the DENR field office which the PENRO Camarines Norte is compliant with NGP policy guidelines that DENR must prioritized POs with existing tenurial instruments because they are already organized and they are the actual occupants and tillers of the forestlands. On the contrary, the Philippine Army is ranked last or with the least engagement in the implementation of NGP with only area developed of 1.53 hectares 0.00 percent. It implies that they have little involvement in the NGP. The results of the NGP Implementation partner generated from the GIS Map output were affirmed in the DENR-PENRO Camarines Norte Briefing Kit and were shown in Appendix P where data revealed similar. The generated GIS maps for implementing partners is shown in Appendix N.

Accordingly, the priority of NGP implementation shall be given to community-managed forestlands with appropriate tenure (Community-based Forest Management Agreement (CBFMA), Integrated Social Forestry (ISF), Protected Areas (PA) IPs/CADT, Forest Land Management Agreement (FLMAs) and among others), based on the following criteria: Full development of tenured areas shall be undertaken first before proceeding to open access areas.

- *Tenurial Instrument*

Table 9 shows the status of tenurial instrument coverage used in the implementation of the project such as ISF, PA, CBFM and untenured relative to its area (hectares) established/planted, number of sites, percentage, and hierarchy ranking.

Integrated Social Forestry (ISF) is the national program provided for by Letter of Instructions (LOI) No. 1260 designated to maximize land productivity and enhance ecological stability and to improve the socio-economic conditions of forest occupants and communities. It is a type of tenurial instrument granted by the state with a contract validity of 25 years and it is one of the tenurial area where NGP was established in this study. Protected areas (PA) is defined in Republic Act No. 7586 or the National Integrated Protected Areas System (NIPAS), are portions of land and water with unique physical and biological significance, managed to enhance biodiversity and protected against destructive human exploitation. PAs are categorized as nature or resource reserves; natural parks, monuments, or biotic areas; wildlife sanctuaries; protected land or seascapes; or as established by law, conventions or international agreements. For this study, PA is one the project site of were the NGP was established, using GIS Mapping it determined the status of NGP along the type tenurial coverage in the province of Camarines Norte.

Moreso, the Community-Based Forest Management Agreement (CBFMA) was established under Executive Order No. 263 promulgated by President Ramos in July 1995, as a national strategy to ensure the sustainable development of the Philippines' Forest resources. The strategy is the organized efforts of the government to work with communities in and near public forests to protect, rehabilitate, manage, conserve and utilize the resources. It is a type of tenurial instrument granted by the state with a contract validity of 25 years and it is one of the tenurial areas where NGP was established in this study. Untenured areas is defined as land classified as public/timberland with no tenurial rights given by the government or DENR at present.

Table 9 Type of Tenurial Instrument

Tenurial Instruments	Area (Hectares)	No. of Site	Percentage	Rank
ISF	702	54	3.28%	4
PA	2,402.00	16	11.22%	3
CBFMA	7,520.10	65	35.14%	2
Untenured	10,776.14	185	50.36%	1
	21,400.24	**320**	**100.00%**	

Note: Hierarchy ranking was interpreted that, rank 1 or first is considered the biggest and rank last is considered the lowest in terms of area.

Results show that untenured areas or open access areas have the most or highest areas covered with 10,776.14 hectares or 50.36 percent. It implies that this area was prioritized by the implementer because of its availability for the project during that time, but failed to follow the priority of NGP implementation policy guidelines that community-managed forestlands with appropriate tenure and development of tenured areas shall be undertaken first before proceeding to open access areas. It also shows that the project established in tenurial instruments of CBFMA has revealed second with an area covered of 7,520.10 hectares or 34.14 percent. The third and fourth/last rank are areas established in Protected Areas (PA) and Integrated Social Forestry (ISF) Areas with an area developed of 2,402.00 hectares or 11.22 percent and 702.00 hectares or 3.28 percent, respectively. The results of the NGP tenurial instruments generated from the GIS Map output of this study was affirmed in the DENR-PENRO Camarines Norte Briefing Kit and were shown in Appendix P.

➢ *Level of Awareness and Understanding of GIS*

In this study, the awareness and understanding of respondents on selected GIS concepts were assessed with the aim of partly describing the knowledge of GIS users about GIS in the LGUs.

Level of awareness is defined as the extent of the state of being conscious of something. More specifically, it is the ability to directly know and perceive, to feel, or to be cognizant of events. The concept is often synonymous with consciousness and is also understood as being consciousness itself. While the level of understanding is defined as the extent or measures of a psychological process related to an abstract or physical object, such as a person, situation, or message whereby one is able to use concepts to model that object. Understanding is a relation between the knower and an object of understanding. Understanding implies abilities and dispositions with respect to an object of knowledge that is sufficient to support intelligent behavior.

- *Levels of Awareness and Understanding of GIS*

Table 10 shows the results of the level of awareness and understanding on Selected GIS Concepts as perceived by the respondents like; GIS definition, elements, and data; GIS-related sciences; and thematic mapping and spatial analyses but a relatively high awareness on map projections, coordinate and positioning systems, and georeferencing relative to indicators used, its weighted wean, numerical equivalent, and its interpretation. Likert Scale was used in determining the corresponding statistical range and descriptive equivalents of variables that utilized rating scales.

Table 10 Levels of Awareness and Understanding of GIS

Indicators	Awareness		Understanding	
	WM	Interpretation	WM	Interpretation
GIS Definition, Elements and Data Structures and Types	2.94	Neutral	2.89	Fair
GIS-related sciences (Geography, Cartography, Geodesy/Geodetics and Remote Sensing	3	Neutral	2.83	Fair
Map projections, Coordinate and Positioning Systems and Georeferencing	2.89	Neutral	2.86	Fair
Thematic mapping and spatial analyses	2.94	Neutral	2.89	Fair
Average Weighted Mean	**2.94**	**Neutral**	**2.87**	**Fair**

Legend

Likert Scale for Understanding	
4.20 - 5.00	Aware
3.40 - 4.19	Moderately Aware
2.60 - 3.39	Neutral
1.80 - 2.59	Moderately Unaware
1.00 - 1.79	Unaware

Legend

Likert Scale for Understanding	
4.20 - 5.00	Very Good
3.40 - 4.19	Good
2.60 - 3.39	Fair
1.80 - 2.59	Poor
1.00 - 1.79	Very poor

It can be inferred from the results that the level of awareness of the respondents on selected GIS concepts have an average weighted mean (AWM) of 2.94 interpreted as **Neutral** level of awareness. Further, these results imply that the knowledge about some GIS concepts by the respondents is average or limited, indicating a reduction in the maximization of the technology/system. This further means that respondents need to broaden their understanding of some of the GIS concepts. Knowing awareness of LGUs regarding the GIS is essential in accomplishing the GIS-related plans of the LGUs. It implies that GIS helps users understand patterns, relationships, and geographic context. The benefits include improved communication and efficiency as well as better management and decision-making. This is affirmed in the related study of Arendt et al (2019) wherein it analyzes the awareness and perceived relevance of geographic information systems and related technologies by construction industry general contractors via an exploratory survey of individuals in the field.

It can be inferred from the results that the level of understanding of the respondents on selected GIS concepts have an average weighted mean (AWM) of 2.87 interpreted as **Fair** level of understanding. Consistently, there is a fair understanding of respondents on all the GIS concepts evaluated. As such, it can be assumed that the LGUs averagely understand GIS and integrates the above mentioned activities in their future or present plans or activities as they understand the applications and need for GIS. GIS helps users understand patterns, relationships, and geographic context. The benefits include improved communication and efficiency as well as better management and decision making.

This finding is supported in the article of Shaw and McGuire (2017) about understanding geographical information systems (GISs) and how they can be applied to public health informatics, medical informatics and epidemiology. The authors concluded that gains in health informatics can be made when GISs are applied through research, however, improvements need to occur in the quantity and quality of data input for these systems to ensure better geographical health maps are used, so that proper conclusions between public health and environmental factors may be made.

Furthermore, using Cronbach's alpha coefficient that the level of awareness is 0.991 and 0.993 for the level of understanding which both indicates an excellent internal consistency within the items of the questionnaire as perceived by the respondents on some GIS concepts.

- *Perceived Level of Capability on the use of GIS*

The perceived capability is defined as the ability to execute a specified course of action or to achieve certain outcomes as perceived by the individual. A geographic information system (GIS) is a computer-based tool for mapping and analyzing things that exist and events that happen on Earth. GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps.

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- *Perceived Level of Capability on the use of GIS*

Table 11 shows the level of capability on the use of GIS as perceived by the respondents relative to indicators used such as Comprehensive Land-Use Planning (CLUP); Forest Land-Use Planning (FLUP); Tax Mapping; Demographic data collection/analysis; Demographic data collection/analysis; and Disaster preparedness and response. Shows also are the Weighted Mean numerical equivalent and interpretation. Likert Scale was used in determining the corresponding statistical range and descriptive equivalents of variables that utilized rating scales.

Table 11 Perceived Level of Capability on the use of GIS

INDICATORS	WM	INTERPRETATION
Comprehensive Land-Use Planning (CLUP)	3.31	Capable
Forest Land-Use Planning (FLUP)	3.31	Capable
Tax Mapping	3.22	Capable
Demographic data collection/analysis	3.36	Capable
Comprehensive Development Planning	3.39	Capable
Disaster preparedness and response	3.39	Capable
Development of Project planning and management	3.44	Much Capable
Map production	3.44	Much Capable
Average Weighted Mean	**3.36**	**Capable**

Legend: DE – Descriptive Equivalent: Highly Capable 4.20 – 5.00; Much Capable 3.40 – 4.19; Capable 2.60 – 3.39; Moderately Not capable 1.80 – 2.59; Not Capable 1.00 – 1.79

It can be gleaned that the perceived capability of respondents on the use of GIS Mapping has revealed an average mean result of 3.36 interpreted as Capable for the majority of indicators but only differs for two (2(indicators which are the development of project planning and management, and map production which revealed as Much capable with the average mean result of 3.44. This implies that GIS and its potential are averagely utilized in the LGUs.

These are affirmed by the study of Lucena (2018), which determined the Geographic Information System (GIS) capabilities of the Local Government Units (LGUs) of La Union province in the Philippines wherein their level of expertise in GIS is average; thus, the results to not fully utilize the system affected mainly the LGU limited budgetary allotment.

➢ *Perceived Constraints in the Utilization of GIS*

Constraints are important elements of every modeling process and the hierarchy of constraints is defined as something that controls what you do by keeping you within particular limits.

- *Perceived Constraints in the Utilization of GIS*

Table 12 shows the three (3) Perceived Constraints in the Utilization Constraints by the respondents indicating its hierarchy ranking, these are; users, technological and institutional.

Table 12 Perceived Constraints in the Utilization of GIS

Constraints	Sum of Ranks	Rank
Users		
Background about GIS	62	1
Support for GIS trainings	73	2
Time to work on GIS-based projects	124	3
No GIS consultants/ expert	136	4
Interest to learn GIS	145	5
Technological Constraints		
Complexity of software	54	1
High cost of hardware and software	69	2
Computers are outdated and not capable of handling GIS	115	3
Availability of GIS data	141	4
New to the GIS technology	161	5
Institutional Constraints		
Budgetary allotment for GIS projects	61	1
Priority given to GIS projects	90	2
Collaboration with other agencies/institutions	124	3
Full time GIS specialist/s (not included in the manpower complement/ positions)	126	4
No GIS unit in the Office	139	5

Note: The hierarchy ranking was interpreted that, rank 1 or first is considered the topmost and rank last is considered the least in terms of perceived constraints.

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It can be inferred from the results that the hierarchal constraint for users in the utilization of GIS is the understanding the background of GIS with generated sum of ranks of 62 indicates as rank 1 or the top most pressing constraints while the least constraint is Interest to learn GIS . It manifests that, most of the respondents have little background on GIS. This may be attributed to the fact that most of the respondents have basic background in GIS therefore, it is expected that some would note such constraints. It can be supported by the statement of Bato, et al. (2011) that most LGUs do not currently have the technical capability to perform remote sensing and GIS. Therefore, concerned national agencies should conduct regular trainings to LGU staff and should develop an easy-to-follow technical manual utilizing free and open-source remote sensing and GIS software.

More so, the hierarchal constraint for technology as perceived by respondents with the generated sum of ranks of 54 indicates as rank 1 or the top most pressing constraint is the complexity of the software while least constraints is the New to the GIS technology The acquisition of commercially offered GIS software can be a difficult problem to LGUs as they are limited to financial resources and majority of local executive which are the municipal Mayors are not interested in GIS as a tool in planning, thus this is not part of their priority development projects for implementation, hindering the maximum use of GIS. It may be attributed to the level of awareness and understanding of respondents to certain GIS concepts as they only have neutral awareness and fair understanding therefore, some of them would not fully understand the actual applications of a GIS software.

Further, the hierarchal institutional constraint as perceived by the respondents with generated sum of ranks of 61 indicates as rank 1 or the top most pressing is the limited or no budgetary allotment for GIS projects, while the least constraints is No GIS unit in the Office. Based on interviews, GIS is not quite a priority for most of the LGUs they are focused on many imperative priorities in their localities such as; public health and safety, infrastructure projects, agricultural projects, and among others. It may also be associated with the lack of collaboration between the LGUs and other institutions as noted by some of the respondents which imply difficulty technologically.

This is supported by the article of Hohnle et al. (2013) entitled " What are the constraints to GIS usage? Selected results of a teacher survey about constraints in the school context". In this paper selected results of a survey about constraints to Geographic Information Systems (GIS) usage including 410 participating teachers in Germany are presented. The results show that especially the lack of regular teacher practice in handling the software, the lack of classroom time and the lack of simple and copyable lessons including GIS are considered the biggest constraints. As regards potential factors of influence, the teacher's private usage of a desktop GIS software combined with his general computer literacy proves to be the decisive predictor for school usage of GIS.

This is also supported in the study of Bernhäuserová et al (2022) accordingly, despite the extensive discussion on the educational potential of GIS and the changes made in the curricula in many countries, the implementation of GIS in classrooms has still been relatively slow. This is because of variables limiting the process of GIS implementation in lessons. Although research into the limits of GIS implementation has been carried out quite extensively, there is a need for knowledge systematization in the field.

- *Preparation of Proposed Action Plan*

The concrete product of this study is the preparation of the proposed plan of action to address prevailing issues, constraints, and difficulties of the LGUs in the utilization of a GIS and provide a plan of action to define solutions and strategies that are timely, relevant and implementable as shown in Table 13. It will help LGU to mainstream GIS in their planning activities, especially in terms of addressing spatial-related problems or issues.

Moreso, the lack of capability training on GIS is one of the issues identified in this study, the solutions and strategies to counter this gap is to introduce and designed capability enhancement training for the personnel or users of GIS. Training improves employees' efficiency and productivity it ensures the use of GIS to its optimum capability. Lack of proper training leads to employees taking extended amounts of time to fix something, more trial and error to find solutions, and more time needed for tasks to be completed. It improves the efficiency of the personnel/ employees and will enable them to complete a variety of tasks, finish their work faster, and simplify the entire process. Improvement of staff knowledge of GIS will add to their collective skill set.

Further, the proposed trainings identified were as follow; Introduction to GIS and Global Navigation Systems; Georeferencing; Thematic Mapping; Spatial Analysis, and; Topology. This is to increase the understanding of LGU staff on the concepts and develop awareness, skills, and information on basic capabilities and functionalities of GIS as well as to enable LGU personnel to apply georeferencing techniques and to increase their understanding on how coordinating systems work. Also to provide knowledge on basic and common map editing tasks and spatial analysis tools. The participants are expected to explain the components and functionality of global navigation systems, be able to operate the GPS hardware, understand the concept and application of georeferencing techniques, and produce reliable and basic maps.

Furthermore, a benchmarking activity for GIS utilization is also proposed so that LGUs with a low extent of utilization can have actual learning experiences. It will enable LGUs to adopt best practices LGUs in terms of GIS utilization. The participants

may be able to assess LGUs and benchmark GIS best practices. Likewise, GIS data collaboration was also proposed to enable data sharing and possible collaboration of GIS projects between LGUs, NGAs and other stakeholders. The expected outcome is a networking and sharing between collaborators.

Along with the availability of usable hardware, software and networking are among identified key area of concerns. Allocation of fund for the procurement of hardware, software and network installation are proposed solutions/ strategies. The choice of suitable hardware, software and network are needed in order to have an efficient GIS that is capable of running of intended digital data information and output.

Accordingly, a successful GIS implementation requires more than just technology. Whether or not a GIS is successful, largely depends upon motivated people that are committed to managing change, and effectively applying the technology in a sustainable manner, while following best practices. On the other hand, even though GIS is largely unknown by LGU personnel resistance to change is expected and the level of interest of LGU officials in this new technology will be a problem. Also, skills acquired during GIS training could easily stagnate or be forgotten if not used regularly. Non allocation of budgetary funding by the chief executive for GIS will discourage the GIS users.

Furthermore, the last key issues identified were uninstitutionalized GIS within the LGU, almost all the LGUs do not have a legislated GIS unit or office. The identified solutions/ strategies for the institutionalization of GIS Unit and it must be legislated by the Sanggunihan Bayan upon the recommendation of the Chief Executive. In addition, the creation of organizational staffing patterns and provision of funding allocation for the operational functions.

As part of extending the results of the study, the outputs of the research were disseminated to the MPDC regarding proposed action plan for the adaption, utilization and institutionalization of GIS Mapping. This will also be presented to the concerned LGUs in the province of Camarines Norte for their comments and recommendation. At present, the researcher initially integrates the concept of adoption of GIS in their formulation of Coastal Resources Management Plan, Forest Land Use Plan and the initial updating of their CLUPs during the coordination, leveling off and consultative meeting initiated though the provision of technical assistance to LGUs of the DENR PENRO Camarines Norte where the researcher is employed.

Table 13 Preparation of Proposed Action Plan

Key issues/ constraints	Project/Activity	Objectives	Expected Outcomes	Milestone or Success Indicator	Time Frame	Person Responsible
Lack of training Support for GIS	1. Capability Training Capacitation					
	A. Introduction to GIS and Global Navigation Systems	To increase the understanding of LGUs on the concepts and develop awareness, skills and information on basic capabilities and functionalities of GIS	• Participants should be able to explain the components and functionality of global navigation systems Participants should be able to operate a GPS hardware	Training Conducted and personnel are skilled equipped	CY 2023 2nd Quarter	LGU MPDC
	B. Georeferencing	To enable LGU personnel to apply georeferencing techniques and to increase their understanding on how coordinating systems work	• Participants should be able to understand the concept and application of georeferencing • Participants should be able to employ and implement several types of georeferencing techniques	Training Conducted and personnel are skilled equipped	CY 2023 3rd Quarter	LGU MPDC
	C. Thematic Mapping, Spatial Analysis and Topology	To provide knowledge on basic and common map editing tasks and spatial analysis	• Participants should be able to produce reliable and basic maps	Training Conducted and personnel are skilled	CY 2023 3rd Quarter	LGU MPDC

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		tools.		equipped		
Lack Benchmarking on GIS utilization of LGUs	2. Benchmarking on GIS utilization of LGUs	•To enable LGUs adopt best practices LGUs in terms of GIS utilization	Participants should be able to assess LGUs and benchmark GIS best practices	Adopted GIS Best Practices and lessons learned	CY 2024 2nd Quarter	LGU MPDC
Lack GIS Data Collaboration	3. GIS Data Collaboration	•To enable data sharing and collaboration between LGUs	A networking and sharing of GIS data between the LGU	Availability of Network and database sharing mechanism	CY 2024 2nd Quarter	LGU MPDC
No Budgetary allotment for GIS projects	PROCUREMENT AND INSTALLATION OF GIS RESOURCES (HARDWARE, SOFTWARE, NETWORK AND MANPOWER COMPLIMENT)					
	Hardware Component	To procure necessary GIS equipment/gadget with required specification such as desktop computers, laptop, mobile/geotagging device, printer, scanner and global position system (GPS)	Hardware component procured • Personal Computer/ Desktop • Laptop/Notebook • Mobile Device • Printer • Scanner	Computer and GIS hardware peripheral procured and installed	CY 2024 2nd Quarter	LGU MPDC & MBO
A.	Software Component	To procure and install ArcGIS or manifold software or download online free GIS Software like Quantum GIS.	Software component procured • ArcGIS • Manifold Quantum GIS	GIS software procured and installed	CY 2024 3nd Quarter	LGU MPDC & MBO
B.	MANPOWER	To hire manpower/personnel to handle GIS activities	Manpower hired • GIS User • GIS Developer • GIS Analyst GIS Manager	GIS Manpower and personnel emplaced	CY 2024 3nd Quarter	LGU MPDC & MBO
C.	NETWORK	To procure and install network/internet for linkages/networking	Network/internet procured and installed	GIS internet network procured and installed	• CY 2024 3nd Quarter	LGU MPDC & MBO
	INSTITUTIONALIZATION					
Non-Initialization of GIS	CREATION OF GIS UNIT	To create GIS Unit through legislative process to institutionalize and to strengthen the capability and sustainability	Institutionalized/created GIS unit within LGU	SB Legislated and created functioning GIS unit with appropriation	CY 2024 3nd Quarter	LGU MPDC & SB

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CHAPTER FIVE
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter presents the summary, conclusions, and recommendations of the study.

➢ *Summary*

Generally, this study determined the Land distribution, National Greening Program (NGP) status using GIS Mapping in Camarines Norte as Basis for LGU action plan preparation. Specifically, this study provided answers to the following: 1. What is the status of land distribution of the province of Camarines Norte using GIS Mapping in terms of the following: 1.1Political Boundary; 1.2. Land Classification; 1.3. Land Cover; 2 2. Status of NGP using GIS mapping along with: 2.1 Accomplishment CY 2011-2018; 2.2 Commodity; 2.3 Component 2.4 Zoning; 2.5 Implementation Partner; 2.6. Tenurial instrument 3. What is the level of awareness and understanding of GIS concepts as perceived by the respondents? 4. What is the perceived capability of respondents on the use of GIS mapping? 5. What is the hierarchy of constraints of users, technology, and institution on GIS as perceived by the respondents? 6. Based on the findings of the study, what action plan may be formulated or prepared for LGU to utilize GIS Mapping in their plan preparation?

The study used descriptive methods using a quantitative type of research and used ArcMap 10.8 GIS software for the manipulation of secondary data, generation, analysis, and presentation of output. The respondents were 36 selected through a total enumeration from 12 municipalities within the Municipal Planning, Development, and Coordination Office (MPDC) in the province of Camarines Norte.

➢ *Findings*

The following are the significant findings of the study:

- As to the status of land distribution, the political boundary has a total land area of 232,007 hectares or 2,320.07 square kilometers. District 1(Tagalog Speaking) has the biggest land area cover with a total area of 149,105 hectares or 64.27%. Labo is the biggest municipality covering 58,936 hectares or 25.4 percent. For land classification status, A&D lands is the biggest covering of 144,705.14 hectares or 62.37 percent, while Unclassified is the least lands covered of about 3,714.53 hectares or 1.60 percent. For land cover status it has of the eleven-cover classification or category, brushwood-coco has the most or biggest in the area covered of about 110,594.01 hectares or 47.67 percent while barren/sand has the least of the area covered of 1,227.52 hectares or 0.53 percent.
- As to the status of NGP accomplishment in 2011 to 2018 there is total of 21,400.24 hectares or 9.22 percent of the total area of Camarines Norte, wherein in CY 2015 has the biggest or rank 1 on area accomplished of 3,798.00 hectares or 17.75 percent while 2011 is the least of the area established with 645.11 hectares or 3.01 percent. In terms of commodity, the fruit trees commodity is the biggest area established of about 6,099.00 hectares or 28.50 percent while the fruit trees, ornamental plants, timber commodity is the lowest of about 2.08 hectares or 0.01 percent. In terms of components, Agroforestry has the biggest with a total area of 12,513.10 hectares or 58.47 percent while mangrove only covers an area of 3.44 hectares or 0.02%. In terms of zone, the protection zone is ranked 1 or the biggest area covered of around 10,817.06 hectares or 50.55 percent while the combination of production and protection or commonly called as multiple Use Zone is the least area covered of about 2,705.18 hectares or 12.64 percent. In terms of implementation partners involved, Peoples Organization (POs) are the most engaged as partners in the implementation with a total area covered of 13,679.33 hectares or 63.92 percent while Philippine Army is the least area established with only established of 0.58 hectares or 0.00 percent. In terms of the tenurial instrument , untenured areas/ open access or no tenurial instruments areas are the biggest with covered of10,776.14 hectares or 50.36 percent while the least is the area covered by Integrated Social Forestry (ISF) with only 702.00 hectares or 3.28 percent.
- The level of awareness and understanding of some GIS concepts are both with an average weighted mean (AWM) of 2.94 and 2.87 which is interpreted as **Neutral** level of awareness and **Fair** level of understanding. In addition, consistently, there is a fair understanding evaluated. The results on reliability test using Cronbach's alpha coefficient revealed that the level of awareness is 0.991 and 0.993 level of understanding which both indicate an excellent internal consistency within the items of the questionnaire on all the GIS concepts.
- The perceived capability of respondents on the use GIS mapping revealed an average weighted mean result of 3.36 interpreted as Capable for the majority of indicators but only differs for two (2) indicators which are the development of project planning and management and map production which revealed as Much capable with average mean result of 3.44.
- The hierarchal constraint for users in the utilization of GIS is the understanding of the background of GIS which, indicates as rank 1 or the top most while the least constraint is Interest to learn GIS. For the hierarchal technological constraints of GIS, which indicates rank 1 or the top most pressing is the complexity of the software while the least constraint is new to the GIS technology. For hierarchal institutional constraint as perceived by respondents with a generated sum of ranks of 61 indicates as rank 1 or the top most pressing is the limited or no budgetary allotment for GIS projects while the least constraint is No GIS unit in the office
- The proposed action plan was developed to provide and offer interventions and solutions to the identified key issues, concerns, constraints, and difficulties of the LGUs in the utilization of a GIS such as lack of training support for GIS, lack of

benchmarking on GIS utilization, lack of GIS data collaboration, no budgetary allotment for the procurement of hardware, software and network and; GIS is not institutionalized in which proposed intervention derived from as such are as follows; capability training support, benchmarking on GIS utilization, data collaborations to the other agencies like NAMRIA, DENR, DOST, ICT and Academe; fund allocations for the procurement of software, hardware, and networking equipment, and; GIS institutionalization.

➢ *Conclusion*

Based from the findings, the following conclusions were drawn:

- The status of land distribution in the province of Camarines Norte using GIS mapping reveals that the political boundary covers 232,007 hectares or 2,320.07 square kilometers, 13 percent of the total Bicol Area and 0.077 percent of the total Philippine area. This has a significant implication on Income Revenue Allotment or NTA claimed where the bigger the area and population has the biggest allocation of IRA or NTA. Most of the land classification of the province of Camarines Norte is alienable and disposal lands (A&D) comprising 62.37% or 144,705.14 hectares. In this province the majority of the area is available for alienation (i.e., agricultural lands) and declared as not needed for forest purposes but for private ownership. For land cover, out of the eleven-cover classification brushwood-coco biggest or dominant land cover area of 110,594.01 hectares or 47.67%, implying that Camarines Norte economy' relies on agricultural production of grain crops, vegetables, coconuts, root crops, and fruits. And considered as the top producer of coconut and pineapple in Bicol region, accordingly. The National Greening Program (NGP) in the province had accomplished or reforested 21,400.24 hectares or 9.22 percent from Calendar Year (CY) 2011 to 2018 covering 322 sites within the 12 municipalities. It had established the biggest area using fruit trees' commodity of an area of 6,099.00 hectares or 28.50 percent and the biggest area using Agroforestry scheme of 12,513.10 hectares or 58.47 percent to contribute in the attainment of food security, to pursue the country's economic development, and productivity. Also, this contributes to the restoration and rehabilitation of the protection zone of 10,817.06 hectares or 50.55% to mitigate soil erosion and geohazards (landslides, floods, rockfall, streambank erosion, etc.) that especially affect the downstream areas. Mostly, collaborating and engaging with implementation partners are the Peoples Organizations (POs) with 13,679.33 hectares or 63.92 percent. But the failure to follow the implementation policy guidelines on the priority area be given to community-managed forestlands with appropriate tenure and development of tenured areas and shall be undertaken first before proceeding to open access areas wherein untenured areas or open access areas have been prioritized 10,776.14 hectares or 50.36 percent.
- The levels of awareness and understanding of the respondents on selected GIS concepts both have an average weighted mean (AWM) of 2.94 and 2.87 interpreted as Neutral level of awareness and Fair level of understanding. Consistently, there is a fair understanding of respondents on all the GIS concepts evaluated. Both indicates an excellent internal consistency within the items of the questionnaire as perceived by the respondents on some GIS concepts in terms of awareness and understanding. This further means that respondents need to broaden their understanding of some of the GIS concepts. Knowing awareness and understanding on the use GIS mapping is essential in the identification of the interventions and capacity development to help improve GIS understanding. It is also vital in accomplishing GIS-related plans and projects wherein success in the implementation and use of GIS is dependent on the extent of understanding on the use of GIS. It is also significant in the choice or purchase of GIS software and hardware, types of training to avail, the type of workforce to hire, and others. Knowing or understanding the capability of GIS is very vital in analysis, decision-making, and policy formulation.
- The respondents are capable on the use of GIS mapping for the majority of indicators but only differs for two (2) indicators which are the development of project planning and management and map production which were revealed as Much capable. It implies that it has an average understanding with regard to GIS capability, usability and functionality., thus, optimization of the use of GIS cannot be fully attained. Knowing the capability of GIS is very vital in analysis, decision-making, and policy formulation.
- The topmost pressing constraints in the utilization of GIS are the following: users' constraint, which is the little/no background on GIS; the technological constraint is the complexity of the software and; the institutional constraint is the limited or no budgetary allotment for GIS projects. It implies that there will be implications if this constraint is not given immediate solutions. Solutions, strategies, and recommendations are dependent on prevailing issues and constraints, thus, propose action plans or interventions must be anchored in the prevailing constraints.
- The proposed action plan was developed to provide and offer interventions and solutions to the identified issues, concerns, constraints, and difficulties of the LGUs in the utilization of a GIS such as lack of training support for GIS, lack of benchmarking on GIS utilization, lack of GIS data collaboration, no budgetary allotment for the procurement of hardware, software and network and; GIS is not institutionalized. In addition, this may help the LGUs to mainstream GIS in their planning activities, especially in terms of addressing spatial-related problems or issues.

➢ *Recommendations*

In light of the findings and conclusions of the study, the following recommendations are hereby proposed:

- The Local Government Units (LGUs) and National Government Agencies (NGAs) within the Camarines Norte may consider the adoption and use of GIS Mapping in their planning, assessment, analysis, monitoring, and decision-making. The generated data (shapefile format) and information status on land distribution along political boundary, land classification, and land cover

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are, these are the based thematic maps needed for overlaying other maps with crucial information for land resource allocation, advancing land rights and land use policies.

- The Provincial of Environment and Natural Resources (DENR-PENRO Camarines Norte) and also the LGUs may use the maps generated using GIS on status of land distribution and National Greening Program (NGP) to distinguished possible improvements relative to the implementation of NGP. Example of this is the significant findings on noncompliance on priority area will correct and ensure compliance on NGP policy guidelines.
- LGU may consider conducting regular capability enhancement training on GIS for their technical personnel. The training is necessary to ensure that the personnel have the skills and expertise to take full advantage of this new technology. Training improves employees' efficiency and productivity; it ensures the use of GIS to its optimum capability.
- The LGU may consider adopting and using GIS Mapping in the formulation of plans and the execution of decisions. This is crucial to public administration because GIS makes it easier to obtain, analyze, and turn data into information that can be used for the creation, planning, and management of resource policies. It is also crucial to public safety because it can be mission-critical to be able to quickly access, process, and deploy resources where they are needed. It is heavily utilized in the updating of their comprehensive land-use plan and development plan since it is essential for resource management, development, and conservation efforts to allocate resources according to their intended purpose.
- It is strongly advised that LGU use ESRI products like ArcMap 10.8 or its most recent version when deciding whether to invest in the purchase of licensed GIS software.
- The LGU may consider the purchase of a computer for GIS. The Ideal windows computer for running GIS software would be windows 10 (64 bit), multi-core, hyper-threaded, core i5 or better processor, 6 plus processing cores, 16+ GB of RAM (32+ GB recommended, 8 GB minimum) 6 plus GB graphics card with (8+ GM 8+ GM recommended, 2 GB minimum and dedicated graphics cards are typically better), 512+ GB SSD (Solid State Drive) - or bigger depending upon your needs. Basically, something similar to a high-end gaming computer and a large (and/or multiple) monitor(s).
- The LGU may consider implementing the proposed action plan which will offer interventions and solutions to the key issues and concerns identified, such as capability training, benchmarking activity for GIS utilization, GIS data collaboration, prioritization of GIS through the allocation of funds for the procurement of hardware, software, and network, and institutionalization of GIS Unit.
- Top officials of the Academe may support, encourage and introduce the use of GIS in State Colleges and Universities' academic programs.

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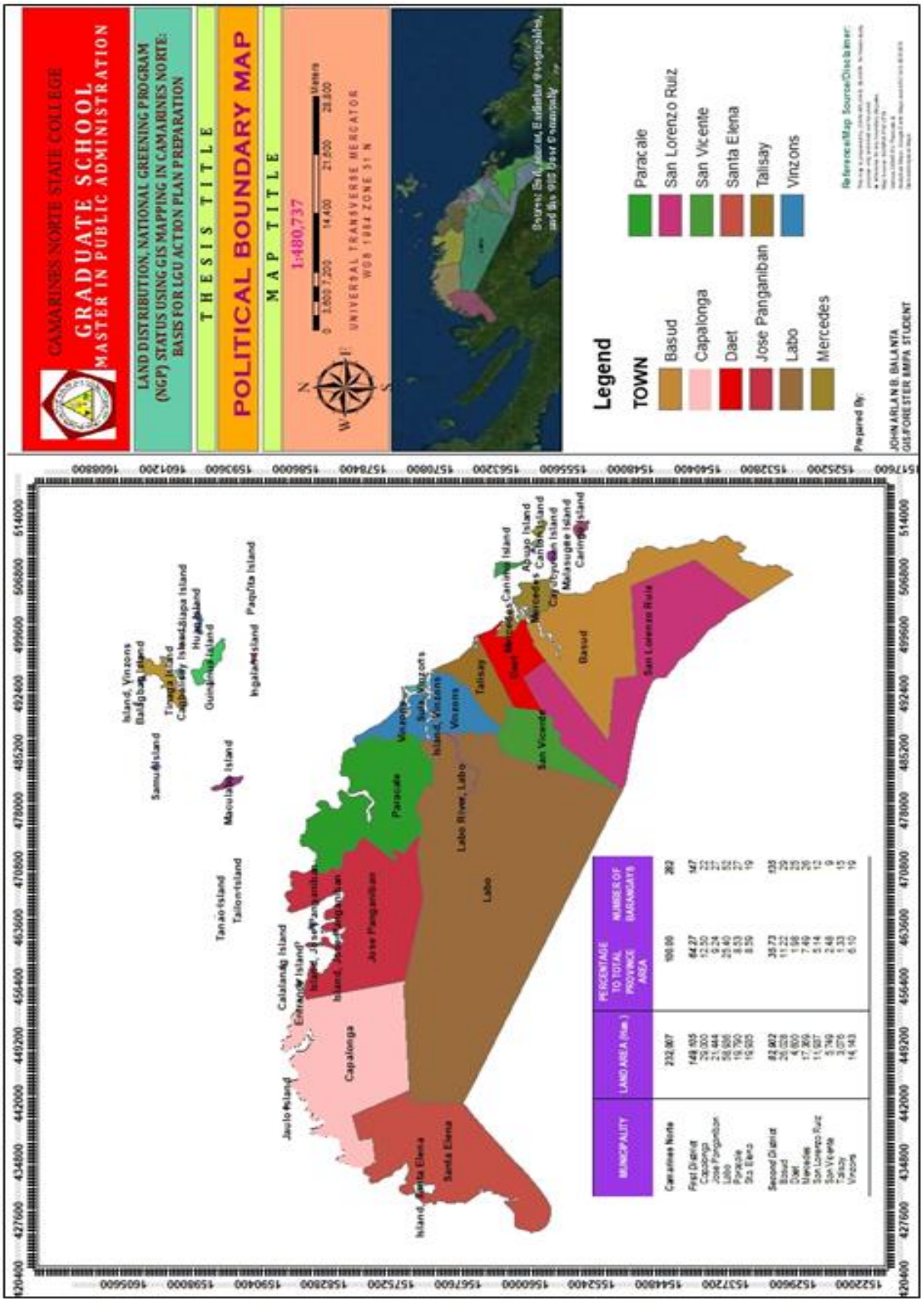
APPENDIX G
POLITICAL BOUNDARY MAP



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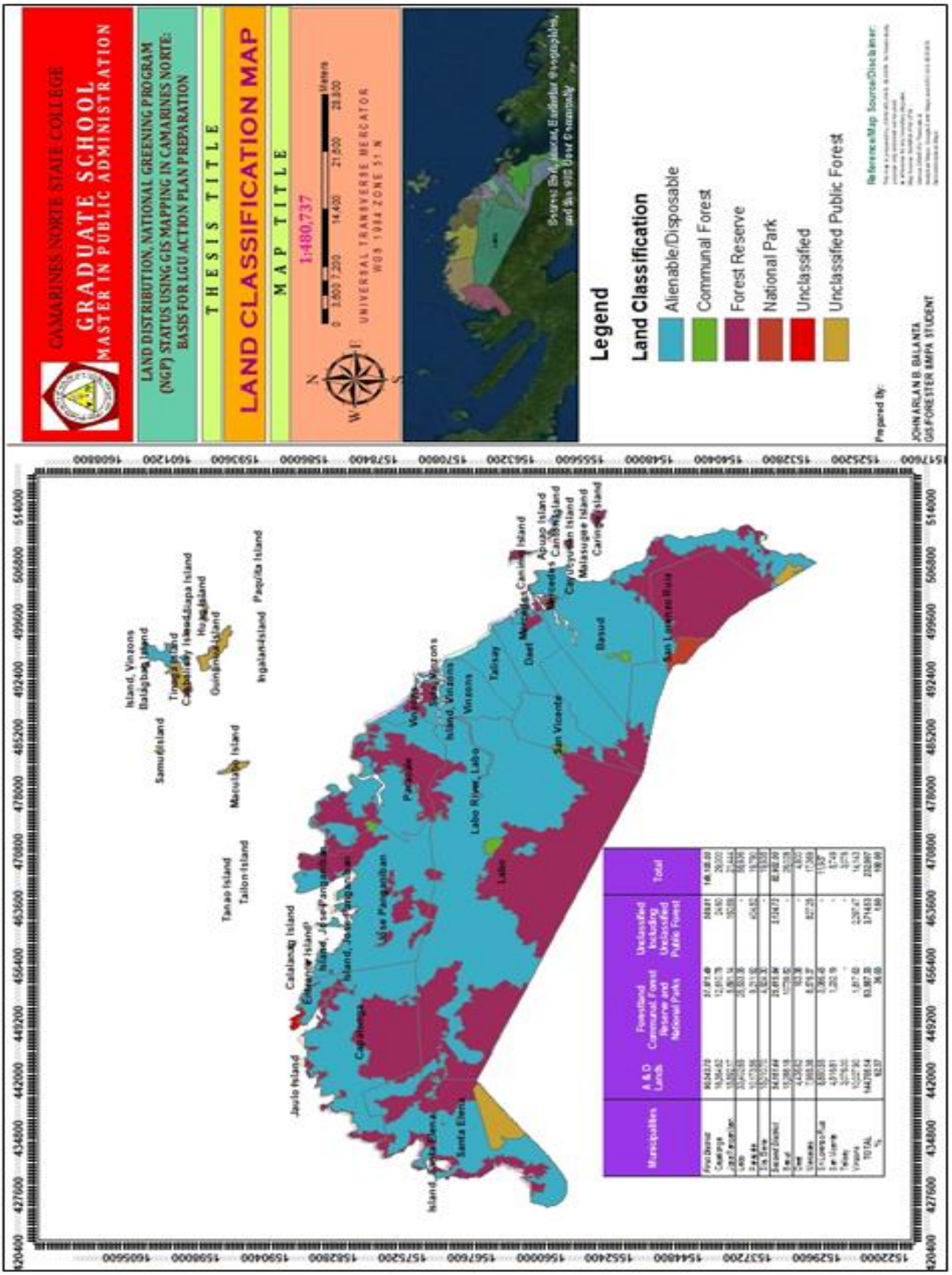
APPENDIX H
LAND CLASSIFICATION MAP



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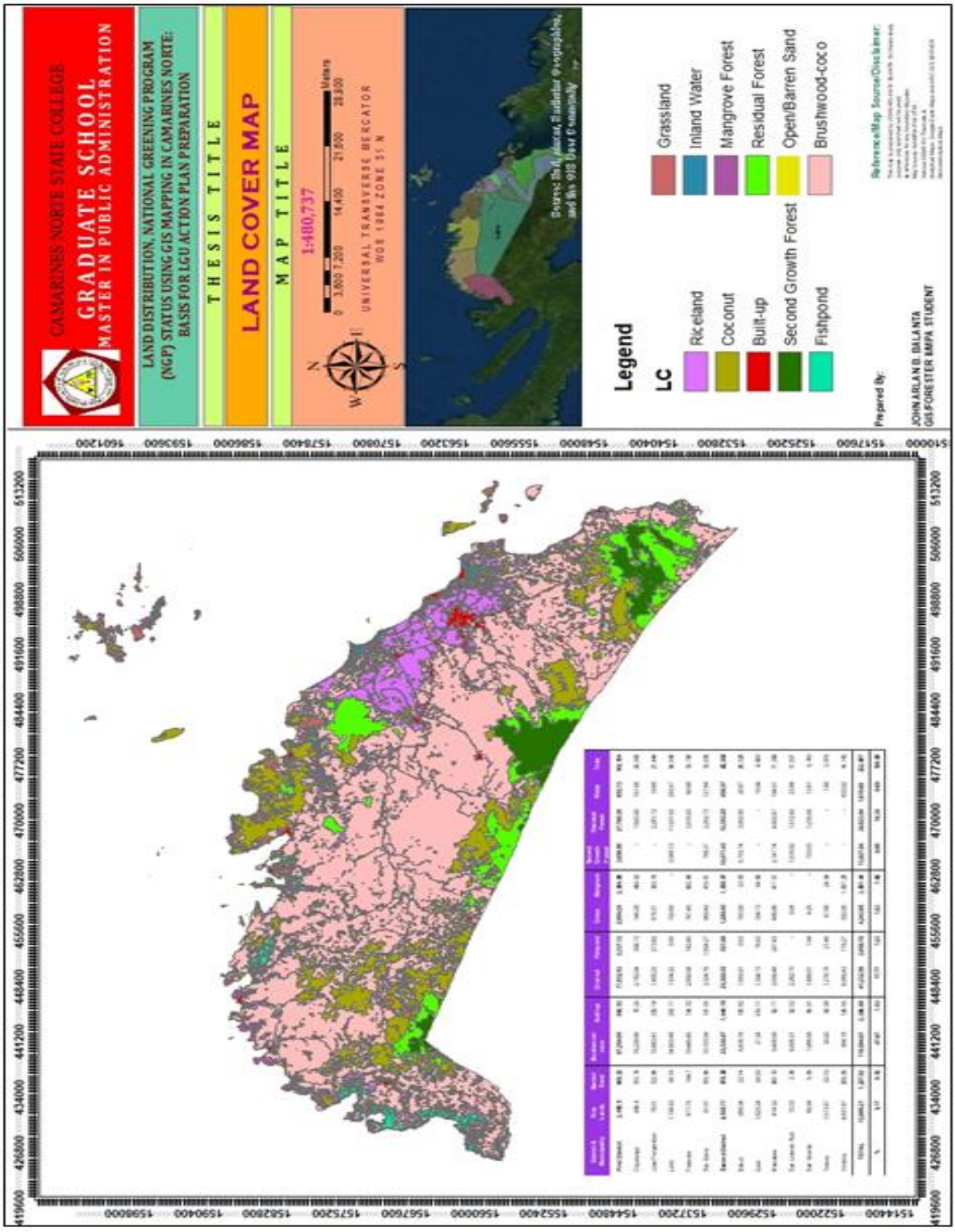
APPENDIX I
LAND COVER MAP



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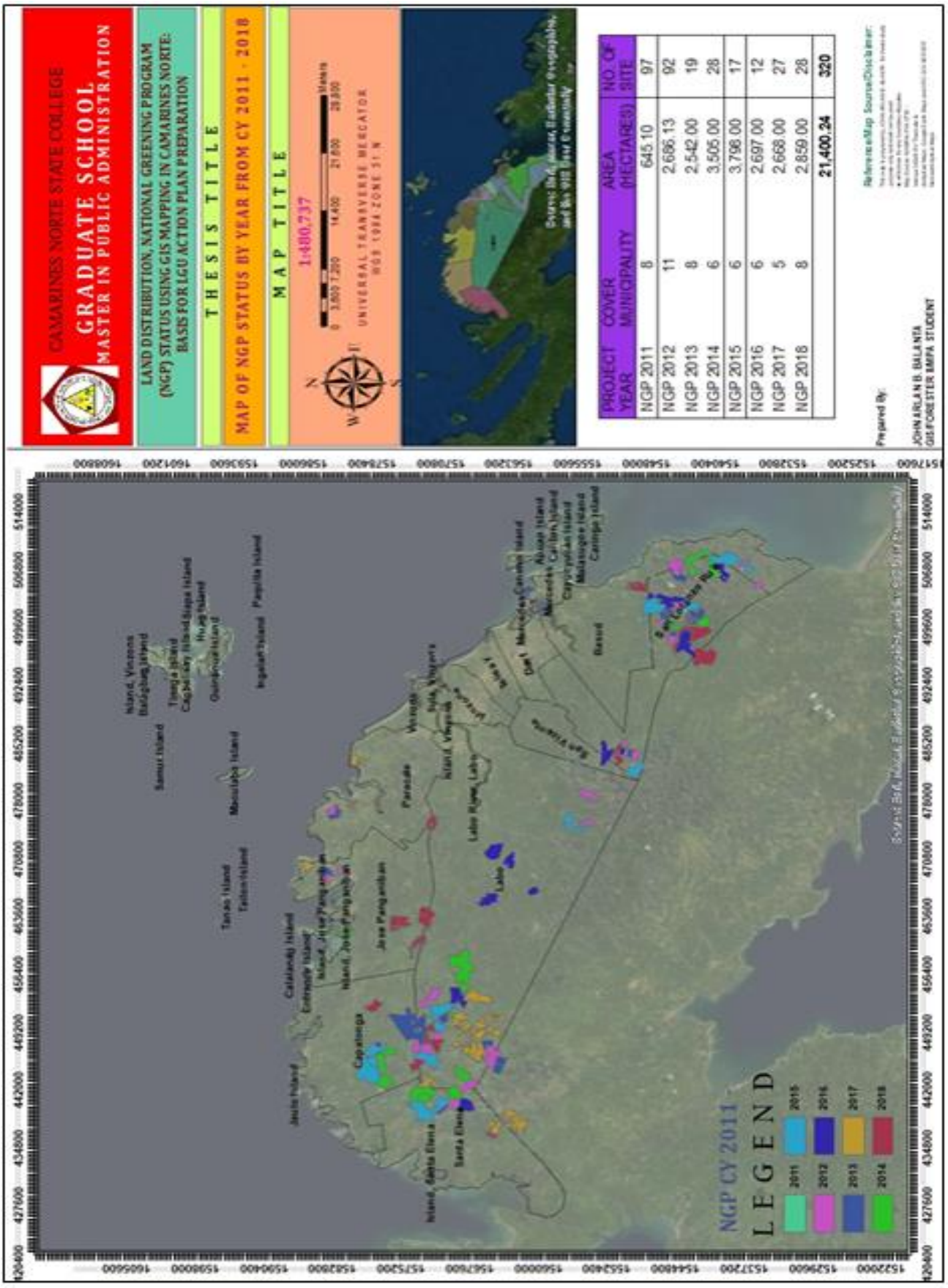
APPENDIX J
NGP ACCOMPLISHMENT FROM CY 2011-2018 Map



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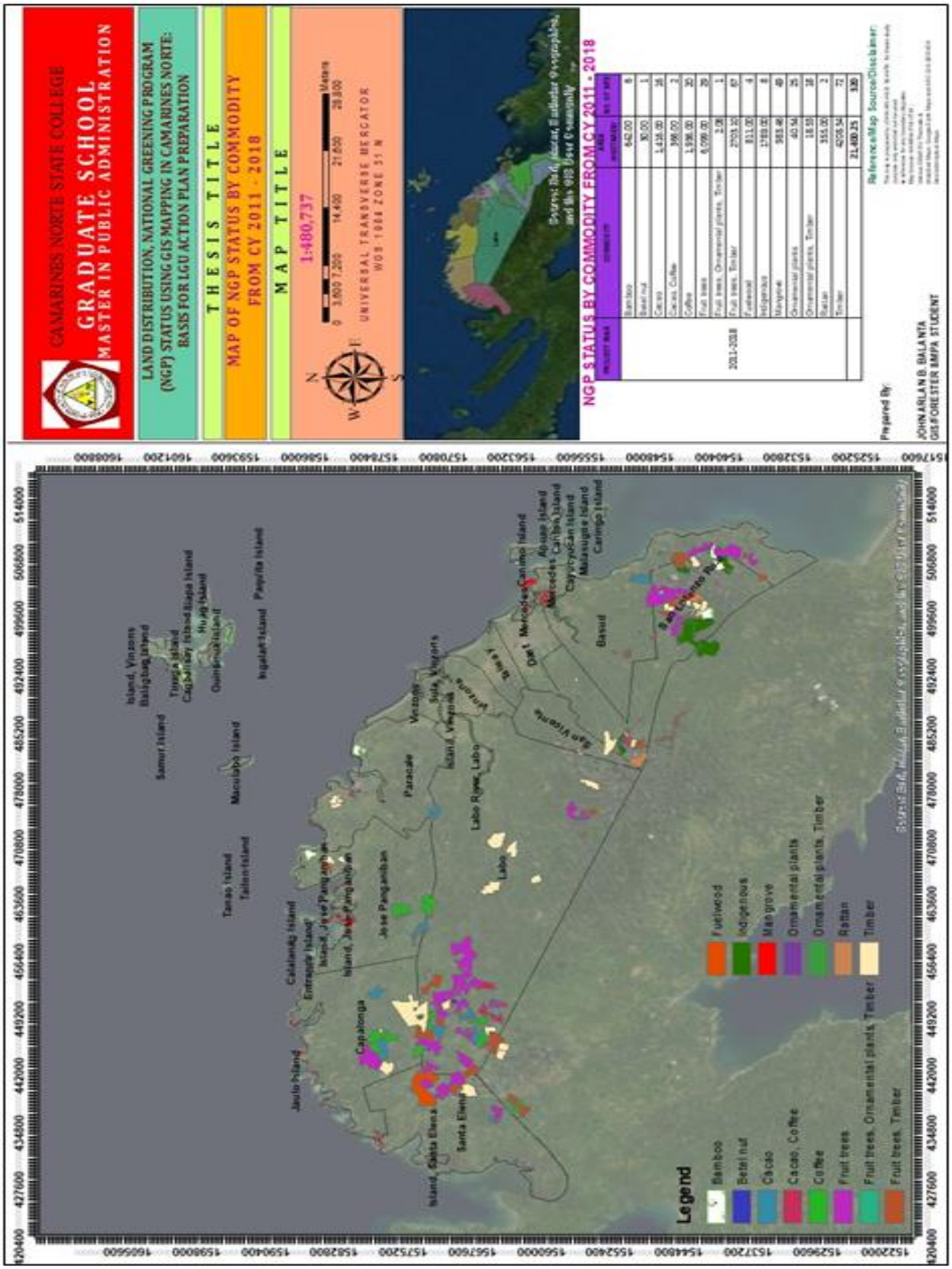
APPENDIX K
NGP COMMODITY MAP



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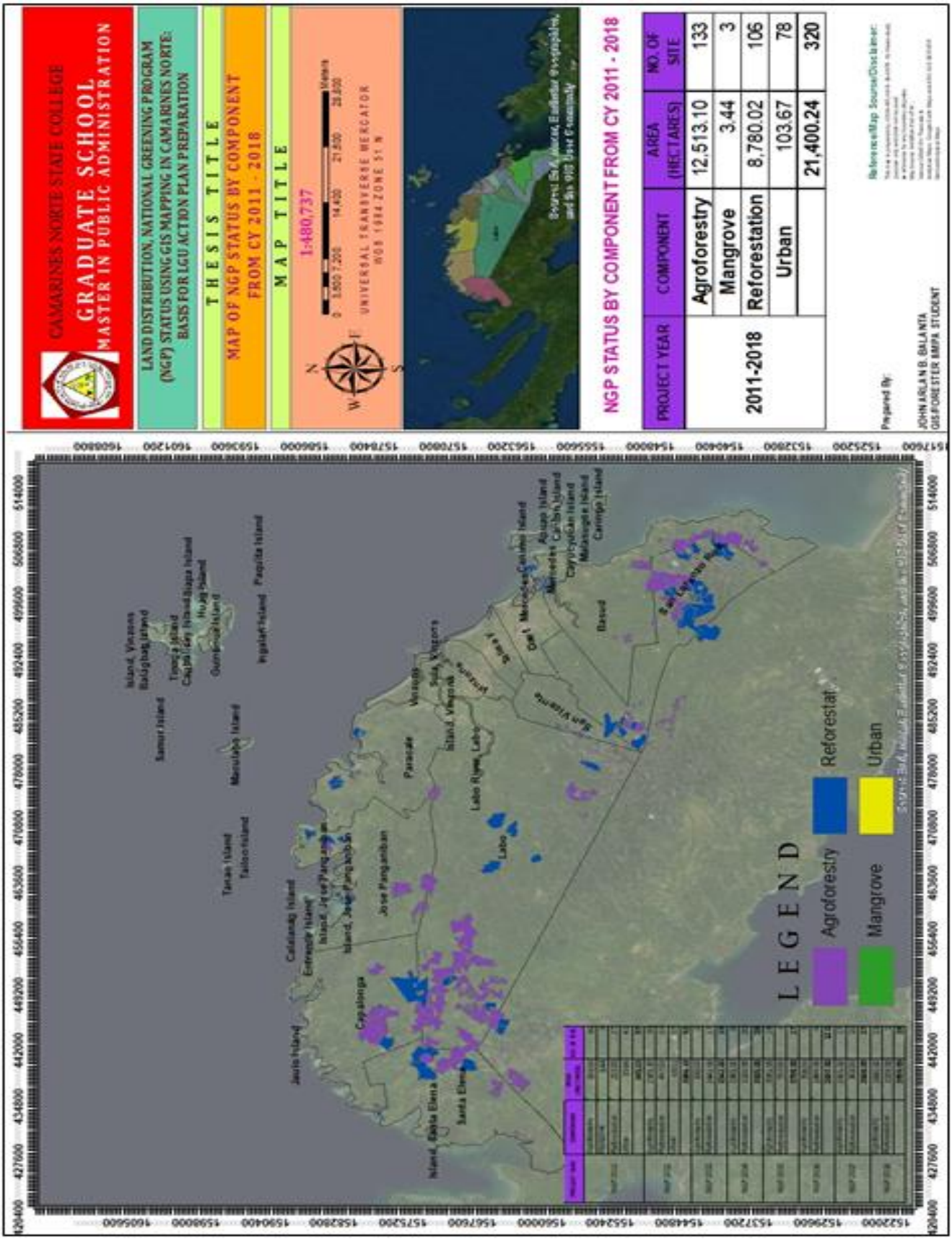
APPENDIX L
NGP COMPONENT MAP



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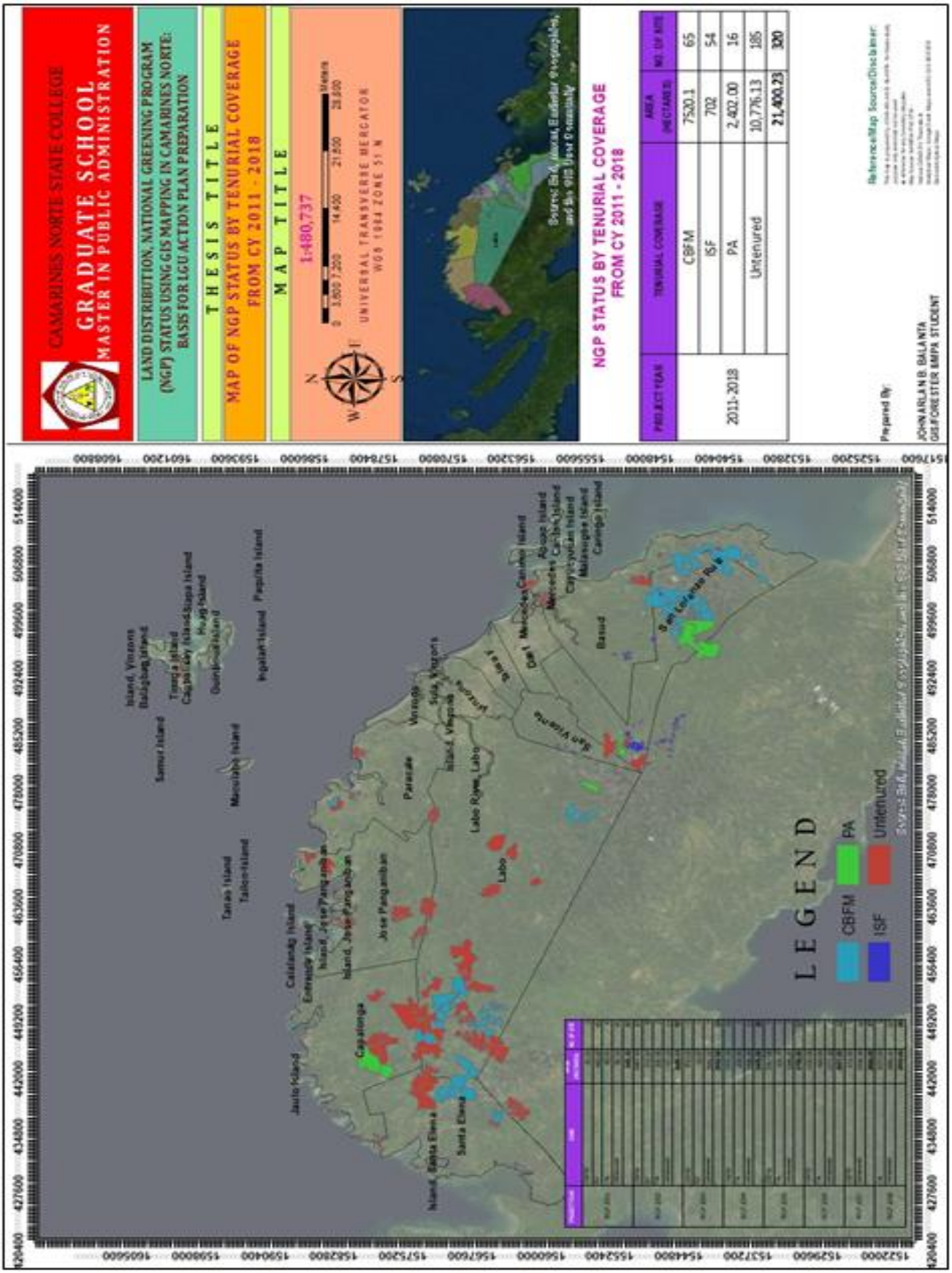
APPENDIX O
NGP TENURIAL INSTRUMENT MAP



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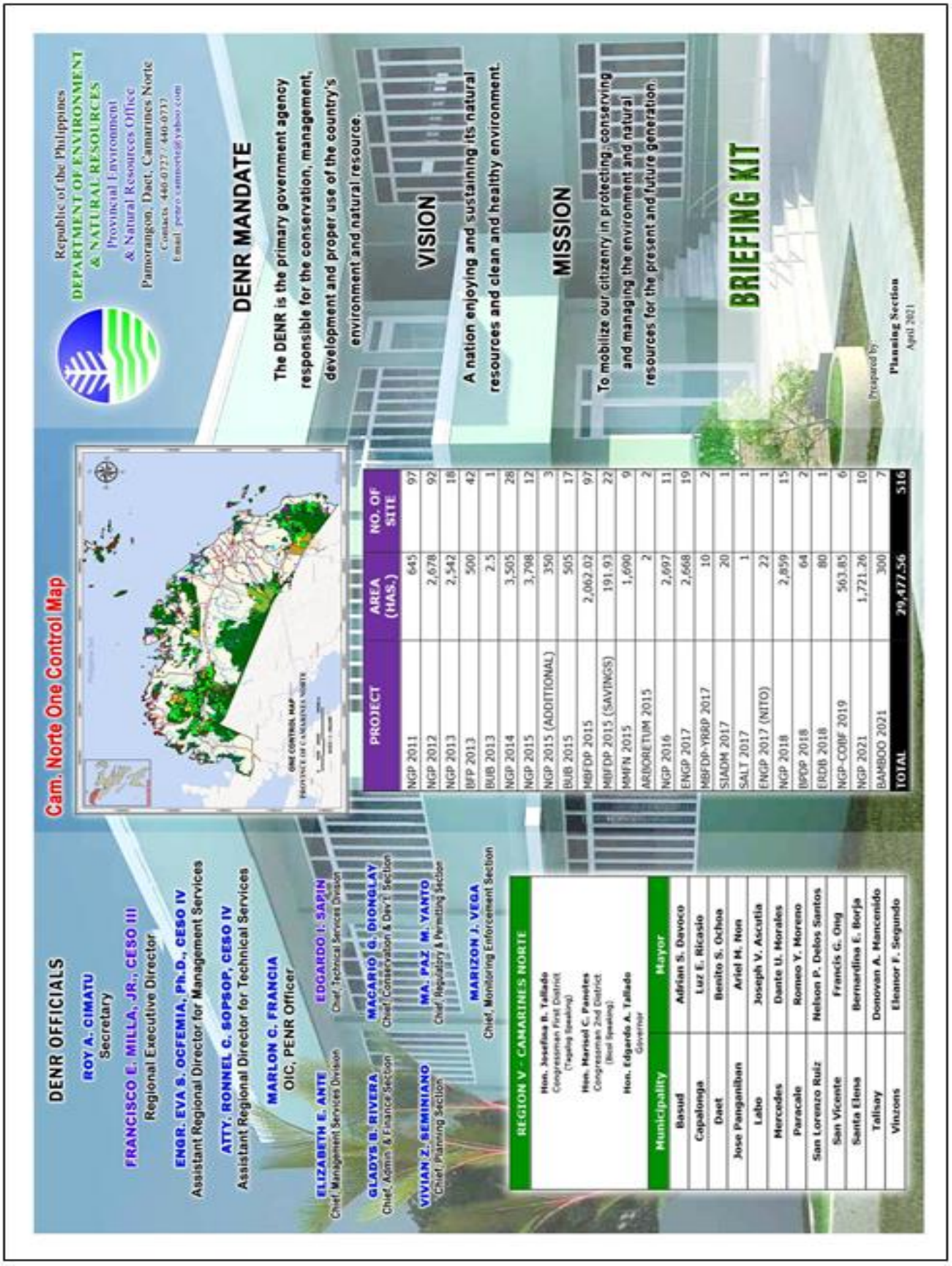
APPENDIX P
DENR – PENRO CAMARINES NORTE BRIEFING KIT



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APPENDIX P
DENR – PENRO CAMARINES NORTE BRIEFING KIT