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Isolation Analysis of Northern Villages in Lagonoy, Camarines Sur, Philippines

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***Abstract* - This study analyzed the present situation of road network in northern villages of the municipality of Lagonoy. Specifically, this described the physical characteristics of the municipality in relation to the location of the isolated villages. This quantified the physical causes of direct road inaccessibility from the identified villages to the municipal proper and illustrated the physical causes of road inaccessibility between the adjoining villages. The data was obtained through site visit, remote sensing, Geographical Information System (GIS) and Digital Elevation Modelling (DEM). A spatial metrics was created to characterize landscape structures in the area. This study found that only small portion of the land area of the municipality is flat to gently sloping while majority are from moderately steep to very steep. The physical causes of direct road inaccessibility are that only small portion of the access road will pass on slope categorized as flat to gentle while major portion are from moderately steep to very steep slope. The physical causes of road inaccessibility are attributed to strongly sloped terrain, obstruction of rivers while others are obstructed with sea water. The situation is in need of harder effort of the municipal government to prioritize in the development plan and to collaborate with the neighboring municipalities, the provincial government or congress since there are situations that connecting with adjoining villages outside their territorial jurisdiction can provide a better and inexpensive approach.**

Keywords: road, inaccessibility, villages, rural, slope, terrain.

I. INTRODUCTION

Following the best-known standards for measuring rurality, isolation captures the trade-off between access to resource-rich, high-population-density areas and the cost of travel that intrinsically low-resource areas may have high access to nearby resources [1]. Road transport, being the most accessible mode of transportation, is vital to the economic development of the nation. Social integration increases due to easy, safe and efficient road transportation. Road transport has gained higher share of both passenger and freight traffic compared to other modes due to easy accessibility and reliability. Development of road infrastructure is imperative for agriculture and overall economic growth for it improves the quality of life [2]. To cater the increasing needs of a growing economy, it is required to expand, develop and improve road networks. However, theoretical and empirical analysis is needed to increase understanding of the role of geography in development and to better design development policy [3] as the task of road development was decided to be done in a planned manner by the government. Various road development plans must be started by keeping in mind the future needs of the area. It is important that locational data be used to train maximum entropy models that identified landscape and anthropogenic features associated with the occurrence of isolated indigenous villages, including elevation, proximity to streams of five different orders, proximity to roads and settlements, proximity to recent deforestation, and vegetation cover type [4]. Improving the overall safety, promote new technology, considering social and environmental factors and to reduce the fuel cost by improving quality of roads are important that the environment should be taken into consideration. Various contractual agreements are formed between a public agency and private sector entity that allows for greater private participation in the delivery of transportation projects. Breaking isolation done by construction of a motorway was found that while connectivity does not break inter linkages completely, it does significantly reduce the exploitative nature [5].

Figure 1: Map of Lagonoy

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The northern villages of the municipality of Lagonoy in the province of Camarines Sur, Philippines are among the areas that are not passable using road transport. These villages are composed of del Carmen, Olas, Bococan, Mapid, Sta. Cruz, Guibahoy, San Isidro, Sipaco, Himanag, Mangogon and Balaton. The area has beaches, rivers, falls, forests and group of islands that are potential for tourist destination. It is rich of minerals like limestone, chromite, etc., sea and marine products. A satellite image shows that these villages are not connected to the municipality proper for the passage is blocked by mountain ranges.

The main objective of this study is to analyze the present situation of the road transport within the northern barangays of the municipality. This paper can advance appropriate improvement strategies and provides policy suggestions for urban planners, public transportation service operation agencies, and policy makers when they seek to create user-friendly public transportation services [6] in the area. Specifically, the objectives are the following: to describe the physical characteristics of the municipality in relation to the location of the isolated villages; to quantify the physical causes of direct road inaccessibility from the identified villages to the municipal proper; and to illustrate the physical causes of road inaccessibility between the adjoining villages.

II. METHODOLOGY

The data was obtained through site visit, field survey and by visiting suitable websites to acquire the needed satellite images. It employs the spatial analysis module of geographic information system (GIS) to conduct an in-depth examination of the study area which uses grid cells as the unit analysis to statistically count and summarize morphological variation features [7]. Accurate estimates of household sizes and village areas which are essential to begin assessing the immediate conservation needs of an isolated group that in contrast to over flights and encounters on the ground, remote sensing with satellite imagery offers a safe, inexpensive, non-invasive and systematic approach to provide demographic and land-use information for isolated peoples [8]. In order to get good results, road extraction is combined with multiple methods according to the real applications that road features in an image can be concluded as follows, geometric feature, photometric features, topological features, functional features, and texture features [9]. Knowledge on topographic and field surveying was applied to analyze the relationship between distance, slope, and elevation. The classes of slope gradient were describe based from the description of Food and Agriculture Organization of The United Nations [10] shown in Table 1.

Table 1: Classes of slope gradient by FAO

Class	Description	%
1	Flat	0 - 0.20
2	Level	0.20 - 0.50
3	Nearly level	0.50 - 1.00
4	Very gently sloping	1.00 – 2.00
5	Gently sloping	2.00 – 5.00
6	Sloping	5.00 – 10.00
7	Strongly sloping	10.00 – 15.00
8	Moderately steep	15.00 – 30.00
9	Steep	30.00 – 60.00
10	Very steep	>60

For convenient interpretation of the data, a spatial metrics was created as a valuable instrument to characterize landscape structures in the area [11]. Some descriptions from the table were combined to produce new classification (See Table 2).

Table 2: The modified classification of slope

Description	Code	%	Image pattern
Flat to gentle slope	F2GS	0 - 5.00	
Sloping to strongly sloping	S2SS	5.10 – 15.00	
Moderately steep to very steep	M2VS	15.10– above	

On this study the slope of the soil was classified as flat to gentle slope (F2GS), sloping to strongly sloping (S2SS) and moderate to very steep (M2VS). With the established image patterns, the slope of the soil was classified as shown in the satellite images.

III. RESULTS AND DISCUSSIONS

3.1 Physical characteristics of the municipality

Lagonoy is a second-class municipality. It is composed of thirty-eight (38) villages located at a coordinate of 13°44'N, 123°31'E. It is bounded by the municipalities of Tinambac and Goa in the west, Goa and San Jose in the south, Presentacion and Garchitorena in the east and the Pacific Ocean in thenorthern portion. With a total land area of 377.90 km^2, 40.69 km^2 or 10.74% is considered as flat to gently sloping while 103.87 km^2 or 27.50% are sloping to very strongly sloping and 233.39 km^2 or 61.76% are moderately steep to very steep. Large or very steep sloping area could be attributed to three adjoining mountains of Mt. Tiis, Mt. Putianay and Mt. Suguitan with highest elevation of 710

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meters, 930 meters and 616 meters respectively. Due to rugged terrain, the municipality has eleven (11) villages that are isolated from the main highway. Four isolated villages from the northwestern portion are del Carmen (V-1), Bocogan (V-2); Olas 1 (V-3A) and Olas 2 (V-3B), and Mapid (V-4) while in the northern part are Sta Cruz (V-5), San Isidro (V-6), Quibahoy (V-7), Balaton (V-8), Mangogon (V-9), Sipaco (V-10) and Himanag (V-11). Table 3 shows the isolated villages with the encrypted number and the estimated number of built houses as identified from satellite imagery.

Table 3: The isolated villages and estimated number of built houses as identified from a satellite image

Number	Name of the village	Number of houses
V-1	Del Carmen	100
V-2	Bacocan	330
V-3A	Olas 1	120
V-3B	Olas 2	120
V-4	Mapid	300
V-5	Sta Cruz	190
V-6	San Isidro	150
V-7	Quibahoy	250
V-8	Balaton	300
V-9	Mangogon	150
V-10	Sipaco	450
V-11	Himanag	400
Total		2,860

Satellite imagery was used in several studies to determine the number of houses as it can be used to represent the number of households in the villages. It was used to estimate the population by counting the number of households multiplied with the number of the family based from the survey data [12]. Satellite imagery was able to show the neighborhood information that can be leveraged to achieve the desired spatial smoothing particularly that it was used to predict housing prices in the neighborhood [13] and to understand economic well-being [14].

3.2 Physical causes of road inaccessibility between the villages and the municipal center

Looking on the satellite imagery have seen the physical causes of road inaccessibility that hamper the direct travel from a village to the main highway, from the center of the municipality and vice versa (See Table 4). The table reveals that construction of direct access of road from any of the villages is difficult since most of the area that the road will pass is categorized as sloping to very steep soil. Although, V-10 has the shortest distance to connect but 72.72% is considered moderately steep to very steep soil and 18.18% is from sloping to strongly sloping soil. Only 9.10% of the distance is considered flat to gently sloping. The village with farthest distance to connect is V-4 in which 58.33% is considered moderately steep to very steep soil and 33.34% is from sloping to strongly sloping soil. Only 8.33% of the distance is considered flat to gently sloping soil. The situation of the other villages is similar with the two villages. The mean of the distance with moderately steep to very steep soil is 69.52%; sloping to strongly sloping, 21.41%; and flat to gently sloping soil, 9.07%.

Table 4: Distance from the village to the town proper

Number	Name of the Village	Distance	Slope description (%)		
			F2GS	S2SS	M2VS
V-1	Del Carmen	18.86	11.11	11.12	77.77
V-2	Bococan	20.80	10.00	20.00	70.00
V-3A	Olas 1	21.74	9.10	27.26	63.64
V-3B	Olas 2	17.83	10.00	30.00	60.00
V-4	Mapid	26.36	8.33	33.34	58.33
V-5	Sta. Cruz	20.70	9.52	19.31	66.67
V-6	San Isidro	20.63	8.69	13.05	78.26
V-7	Quibahoy	18.82	9.52	14.29	76.19
V-8	Balaton	21.68	7.69	30.77	61.54
V-9	Mangogon	20.70	7.41	18.52	74.07
V-10	Sipaco	17.03	9.10	18.18	72.72
V-11	Himanag	17.57	8.33	66.67	75.00
Mean		20.23	9.07	21.41	69.52

This shows that to connect directly any of the villages to the town center is extremely difficult for road construction will result in hill-slope profile modification, removal of vegetation cover, as well as the formation of steep slopes that are prone to severe erosion which needs further study on variety of erosion control measures for controlling road related erosion [15]. Construction associated to land development of this kind of road will promote severe land degradation [16] forest road as the base infrastructure foundation of forestry operation entails a complex engineering effort because they can cause substantial environmental damage to forests and involves high construction cost, however, [17] there are suggestions that in order to reduce the environmental damage on the forest ecosystem, especially in steep terrain, hydraulic excavators should replace bulldozers in forest road construction activities. The most significant advantage offered by mechanical excavators is their potential for achieving high rate of production and advance at reduced excavation cost and time compared to drill and blast method which can be used for underground construction including tunnels [18]. Putting infrastructures underground brings about advantages, from optimization of space to environmental concerns, not forgetting heritage preservation issues [19].

3.3 Physical causes of road inaccessibility between the adjoining villages

A diagram was illustrated to interpret the causes of road inaccessibility between the adjoining villages. Figure 2 shows that the cause's isolation is due to the presence of strongly

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sloped terrain and rivers. The other villages were isolated by the sea water. Among the adjoining villages that are not connected due to strongly sloped terrain are V-1 to V-2, V-2 to V-3A, V-3A to V-3B, V-3B to V-5, V3A to V-4 and vice versa. Other routes are from V-6 to V-7, V-7 to V-10, V-10 to V-11, V-11 to V-9, and vice versa. The shortest distance of these villages is 1.20 km, which covers the distance between V-6 and V-7. The largest distance is 4.83km which covers the distance between V-3A and V-4. The mean distance between these villages which is obstructed by the strongly sloped terrain and the rivers is 3.31km. Several adjoining villages were isolated not only by sloping to strongly sloped terrain and rivers but additionally obstructed with sea water. Among those villages are from V-4 to V-5. However, in order to connect these two villages, have to pass to the other villages with territorial jurisdiction not covered by the municipality. Other villages are obstructed by sloping to strongly sloped terrain, rivers and sea water such as the connection from V-5 to V-6 and however H to V-9 and vice versa. Two adjoining villages are obstructed due to sea water like the connection from V-6 to V-8.

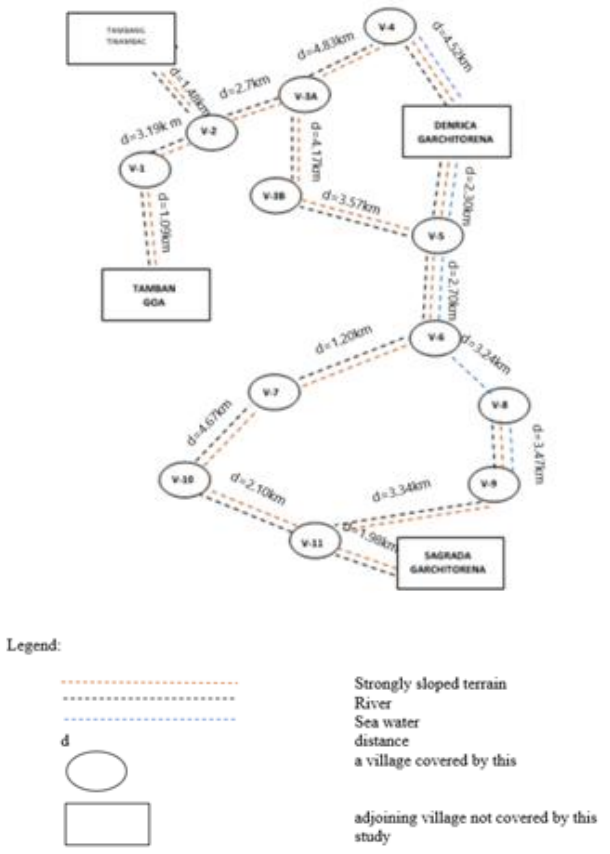

Figure 3: Illustrated obstructions and possible shortest distance of connectivity between the villages

Some villages are more accessible to be connected due to short distances but the territorial jurisdiction belongs to other municipalities. These adjoining villages are Tamban. Goa to V-1, Tambang, Tinambac to V-2, and Sagrada, Garchitorena to V-11 and vice versa with distances of 1.09km, 1.48km and 1.98km respectively. Their mean distance is 1.52km. The villages if interconnected will be a gateway to the main road. However, they belong to other municipalities. As far as the resources are concerned, the lowest level of political administration which is the local government unit, are severely handicapped to have funds for infrastructure development and do not have a steady income to affect their planning capability [20]. The village's isolation is illustrated by lengthy travel times, limited access to news and information, limited local job opportunities and limited information about opportunities but [21] it was argued that both mobility and isolation are experienced in off-road villages by pointing out that off-road villages are often less isolated and their populations are more mobile than one would assume.

Rural dwellers state isolation and remoteness is a major contributor to the state of poverty that has led to inequalities with regards to access and mobility [22]. Interconnecting of villages through constructed road could create rural development that generally refers to the process of improving the quality of life and economic well-being of people living in relatively isolated and sparsely populated areas [23]. The connection between neighborhoods with effective road networks and efficient arterial links to centers of economic power holds true today specifically that neighborhoods enjoy relatively higher socio-economic development if they are closer to a center of power [24]. It must be understood that if there is greater transport mobility and connectivity with surrounding communities, there is increased access to the various economic opportunities and amenities of life [25].

IV. CONCLUSION

Only small portion of the land area of the municipality of Lagonoy is considered as flat to gently sloping while majority are from moderately steep to very steep. Similarly, the physical causes of direct road inaccessibility from the villages to the municipal proper is that only small portion of the access road will pass on slope categorized as flat to gentle while majority are from moderately steep to very steep slope. The physical causes of road inaccessibility between the adjoining villages are attributed to strongly sloped terrain, rivers and obstruction of sea water. Although, it was seen that to connect the villages directly to the town proper is a difficult option, a possibility of interconnection is highly recommended for interconnectivity between the villages will improve the socio-economic status of the villagers. The isolated inhabitants may not be deprived of the economic opportunities and amenities that other communities are enjoying. Hence, it is necessary that interconnection of the villages be prioritized in the development plan of the municipality. For faster and

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simplified implementation, the local government unit is in need of agreement with the neighboring municipalities as well as the collaboration with the higher government unit such as the provincial government or congress to promote cooperation and interconnection of the neighboring villages.

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