# GEOSPATIAL CHARACTERIZATION OF SCHISTOSOMIASIS AFFECTED AREAS IN MAINIT, SURIGAO DEL NORTE

Joy Mae S. Jadap [1,2*], Meriam M. Santillan[1,2], Jojene R. Santillan[1,2]

[1]Division of Geodetic Engineering, College of Engineering and Information Technology, Caraga State University, Ampayon, Butuan City 8600

*jadapjoymae229@gmail.com*

[2]Caraga Center for Geoinformatics, College of Engineering and Information Technology, Caraga State University, Ampayon, Butuan City 8600

**ABSTRACT:** Schistosomiasis is one of the world's most prevalent tropical disease with an estimated 200 million people infected and 500 million at risk. Based on reports, this disease is widespread in the municipality of Mainit in Surigao del Norte. The Municipality of Mainit is one of the municipalities adjoining Lake Mainit – the fourth largest lake in the Philippines. The objectives of this study are the following: 1) to locate and know the geospatial characteristics of the areas affected by schistosomiasis disease; 2) to map the locations positive of schistosomiasis; and the predicted points that could also be positive due to its similar geospatial characteristics. The main output of this study is a map showing the locations that are positive of schistosomiasis disease and the predicted points that could also be positive due to its similar geospatial characteristics. The geospatial characteristics considered are the landcover type, elevation, slope, soil type, and distance to water bodies. There are 54 sample points that are positive to schistosomiasis which are located in the Barangay Magpayang, Matin-ao, San Isidro and San Francisco that were used in the overlay analysis in the GIS environment. The results of the GIS analysis showed that the snails carrying of schistosomiasis are found in the canal, lake, rice field, creek and irrigation canal. The elevation ranges from 33.72 meters and 43.8 meters with a minimum slope of 0.5% to 66.41%. Soil types are clay loam, sandy clay loam and silt loam. In terms of nearness to water bodies, the nearest positive point has a distance of 20.13 meters away from Lake Mainit and farthest is 1876.5 meters away.

## 1. INTRODUCTION

There are prior studies that use the geospatial modelling to predict schistosomiasis disease prevalence in a certain area. Schistosomiasis should be considered a serious disease to the inhabitants of rural areas, especially farmers, for it causes not only a tremendous reduction in their work efficiency but also suffering and death. An estimated of 12,000 to 200,000 people die from it per year (B.L. Blas, 1989). Since the farmers are the mainstay of the country, this disease adversely affects the agricultural economy. Infected people cannot produce crops in quantities sufficient for their needs because they are sick. In the Philippines, there are 170 towns and cities with a population of 5,102, 524 which are affected of this disease as of 1990 (B.L. Blas, 1989). The disease is intimately connected with conditions of poverty, poor sanitation and lack of clean water and schistosomiasis is emerging in areas undergoing major water resources development and management. Bayesian kriging was used to predict the S. mansoni risk at locations where disease data were not available (Ronaldo G.C. Scholte, 2014).

In this study, the researcher aims to locate and know the geospatial characteristics of the areas affected by schistosomiasis disease in Mainit, Surigao del Norte. These geospatial characteristics of the affected areas will then be used as basis to distinguish points that could also be positive of schistosomiasis disease. The main output that the researcher would like to come up is a map showing the location of schistosomiasis affected areas and the predicted areas that could be positive due to its similar geospatial characteristics. The researcher believes that this study could give awareness not only to the people who are living in other places especially to those tourist and also it could help control programs to plan and prioritize efficient control campaigns to decrease schistosomiasis burden most especially to the predicted areas. The geospatial characteristics that will be considered in the study area are: land-cover type, elevation, slope, soil type and distance to water bodies. The digitized river networks of Lake Mainit and its surrounding water bodies will be the primary factor to be considered.

## 2. MATERIALS AND METHODS

### 2.1 The Methodological Framework of the Study

Figure 1 shows the general activities or flow of activities that the researcher will undergo for this study. First, the gathering of data which are the satellite image and DEM, then these two data will undergo processing to come up

with the land-cover map, elevation, slope, and river networks. Soil type of the area was also determined. The sample points positive of schistosomiasis was obtained from a previous study of Dr. Joycelyn C. Jumawan of the Biology department of the Caraga State University. These points were converted into vector shapefile and used in the conduct of overlay analysis and spatial analysis to come up with the main output of this study. The processing done to derive the necessary data are discussed below.
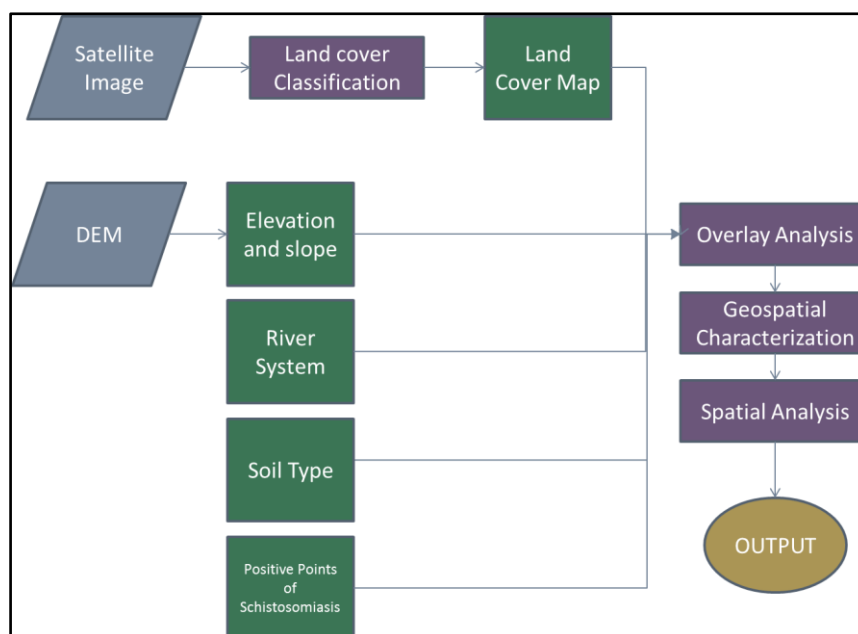


Figure 1. The Methodological Framework of the Study

## 2.2 Study Area

Mainit, Surigao del Norte is the second district of Surigao. As of 2010, it has a population of approximately 26, 000. It is located on the north shore part of Lake Mainit with a coordinates of 9°32′ N and 125°31′ E, elevation of 41 m and an altitude of 35.81 km. in the northeastern part of Mindanao. Municipality of Mainit is subdivided into 21 barangays. In this study, the four barangays which are Magpayang, Matin-ao, San Isidro and San Francisco are considered.
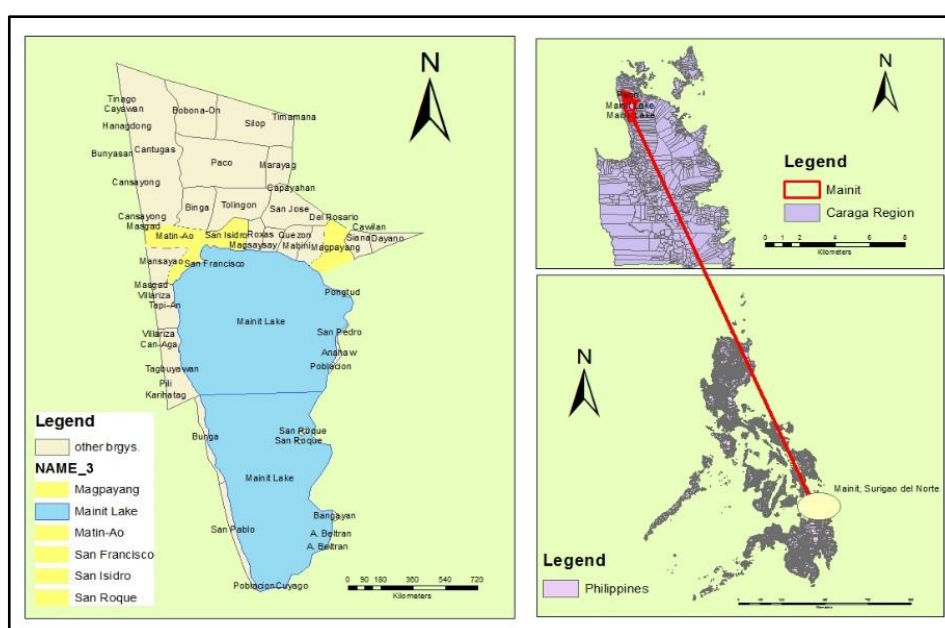


Figure 2. The study area located in Mainit, Surigao del Norte, Mindanao, Philippines

## 2.3 Datasets Used

The satellite image that was used in this study was downloaded from http//:www.earthexplorer.usgs.gov while the DEM used was acquired from the office of CSU Phil-LiDAR 1. The coordinates of the established positive points of schistosomiasis were acquired from the study of Dr. Joycelyn C. Jumawan. The following significant data for the success of this study were generated from ENVI 5.0 and ArcMap 10.1, those data are the following: land-cover map, map of points positive of schistosomiasis with its geospatial characteristics which are its elevation, slope, soil type and distance from water bodies.

## 2.4 Methods

In this study, there are two major methods done: the overlay analysis and spatial analysis. Each of them has corresponding activities that the researcher undergoes throughout this study.

### 2.4.1 Overlay Analysis

In order to determine the geospatial characteristics of the positive points, an overlay analysis will be done. All the detailed activities that will undergo for the success of this study are thoroughly discussed below:

**Land-cover Map Derivation.** Landsat image of February 2, 2014 of Mainit, Surigao del Norte has undergone pre-processing procedures, radiometric calibration to convert the pixel values in digital number (DN) to top-of-atmosphere (TOA) reflectance and dark subtraction to apply atmospheric scattering corrections to the image data. Cloud and cloud shadows encompassing the study area were masked-out and was then subjected to image classification using Maximum Likelihood classifier using ENVI 5.0. To complete the land-cover in the area, the missing land-cover information due to cloud and cloud shadow contamination was supplemented using land-cover information extracted using different set of image captured in a different date. To determine the accuracy of the land-cover generated, an independent set of ROI's were collected using high resolution images and Google Earth.

**Points positive of Schistosomiasis Acquisition.** The points positive of schistosomiasis disease were obtained from the study of Caraga State University Biology Department headed by Dr. Joycelyn C. Jumawan. A malacological study or survey of the host snail carrying the disease schistosomiasis has been conducted, then through an actual survey using handheld GPS the coordinates of those points where schistosomiasis has been found positive were obtained. Coordinates of those points have been plotted then using ArcMap 10.1.

**Extraction of elevations.** The acquired DEM from the office of CSU Phil-LiDAR 1 has been used in this process. The DEM and the shapefile of positive points of schistosomiasis data has been added to data in the ArcMap 10.1. It was then generated through the "extract values to points" spatial analyst tools in order to get a data for the elevation of the positive points of schistosomiasis. The following information of the elevations of the positive points of schistosomiasis disease affected areas has been automatically added to the attribute table of the shapefile of the elevation.

**Accumulation of Slope.** Extraction of slope will tell how steep the points positive of schistosomiasis is. In this case the ArcMap calculate the maximum rate of change between each raster cell and its neighbors. Through the use of ArcMap 10.1 the researcher can have the calculated slope as either percent slope or degree slope. The researcher just use the percent slope in this study. The function slope of ArcMap 10.1 could be found in the "ArcToolbox" under of the "Surface" tool of the "Spatial Analyst" tool. Then those slopes were categorized into six classes which are the flat (0 to 3%), gently sloping (3 to 6%), sloping (6 to 18%), moderately steep (18 to 32%), steep (32 to 50%) and very steep (>50%) (Santillan, 2015).

**Identification of the Soil types.** This was done through acquisition of the soil data from the Bureau of Soils and Water Management – Department of Agriculture (BSWM-DA). This information was added to the attribute table of the land-cover of the study area. In this study, the land-cover and the points positive of schistosomiasis has been overlaid in order to identify what is the particular soil type of the positive points of schistosomiasis.

**Identification of the distance of sample points from water bodies.** Distances from water bodies, specifically from Lake Mainit and River Networks of the study area were done by the use of ArcMap 10.1 through adding the data of sample points and executing the "near" distance tool. In this study, obtaining the distance from the lake and rivers were performed separately. The values gathered were added to the attribute table of the shapefile of distance from rivers and Lake Mainit.

### 2.4.2   Spatial Analysis

Through the geospatial characteristics result from the overlay analysis of this study, the researcher will use those characteristics to be the basis to produce the predicted points that could also be positive of schistosomiasis disease.

**Reclassification of the geospatial characteristics data.** All the data of geospatial characteristics (land-cover, soil type, distance from lake and rivers, elevation and slopes) were reclassified to obtain new values for each characteristics according to the desired values of the researcher.  Those values of each of the geospatial characteristics has been classified to 5 ranges and then reclassified whether its new values were 1, 2, 3, 4 or 5. 5 is the maximum while 1 is the minimum.

**Weighted overlay analysis.** All reclassified data was combined to the weighted overlay table which is composed of four criteria namely raster, percent influence, field and scale value. The first criterion is composed of the raster data of the reclassified geospatial characteristics. The percent influence is the extent of influence of each raster data to the other data and the over-all percentage should total to100%. Scale value indicates the ranking of each range of the specific raster data ranging from 1 to 5.

## 3. Results and Discussion

### 3.1 Geospatial characterization

The geospatial characteristics of the points positive of schistosomiasis disease affected areas are located in the four barangays of the Municipality of Mainit which are in Magpayang, San Isidro, Matin-ao and San Francisco and the habitat of the snail carrying host are in the lake, creek, canal, irrigation, and ricefields as shown in the Table 1. As shown on the Figure 3, the positive points of schistosomiasis affected areas were found to have land-cover types of barren, built-up areas, cropland, rivers, grassland, palm areas and water and there were no points found to be in forest areas.

Table 1. List of Barangay, Landcover types, and the habitat of those schistosomiasis positive points

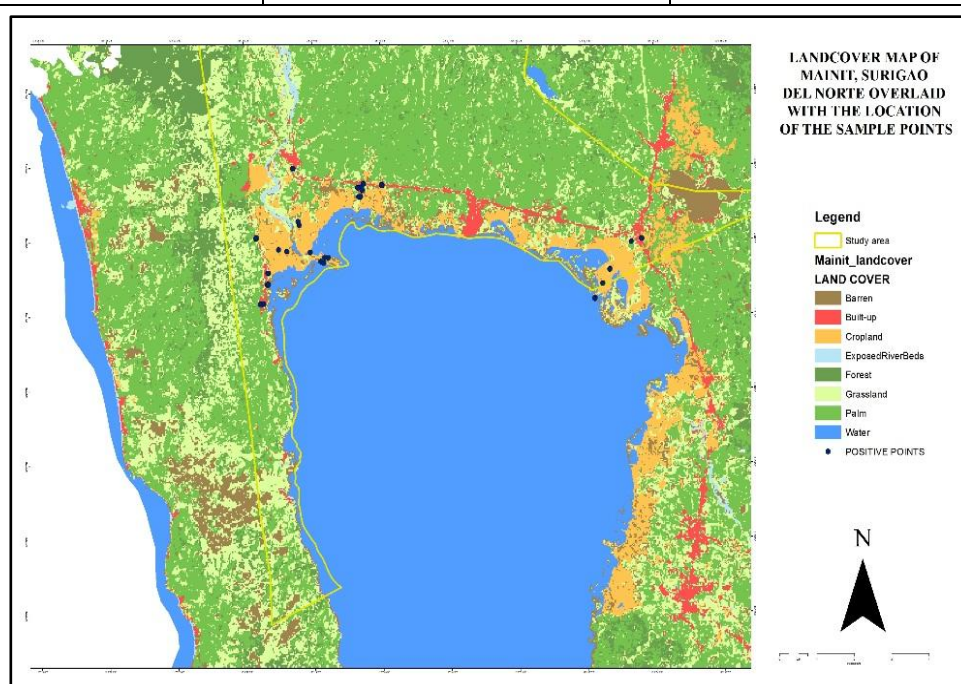| Barangay | Landcover Types | Habitats of the snail carrying host of schistosomiasis |
|---|---|---|
| Magpayang | | Canal, Lake, Ricefield |
| Matin-Ao | Barren, Built-Up, Cropland, Rivers, Forest, Grassland, Palm and Water | Canal, Lake, Ricefield |
| San Francisco | | Canal, Creek, Lake, Ricefield |
| San Isidro | | Canal, Creek, Irrigation, Lake, Ricefield |



Figure 3. Landcover Map of Mainit, Surigaodel Norte overlaid with the location of sample points

The locations have a minimum elevation of 33.72 meters and a maximum of 43.8 meters as shown in the Table 2 and Figure 4. The slope of each point has the following percentage of 12.05% (average), minimum of 0.5% and maximum of 66.41% as shown in Figure 5. Most of the positive points have soil types of clay loam, sandy clay loam and silt loam as shown in the Figure 6. The points have a distance minimum of 7.74 meters and maximum of 1620.92 meters from the river networks and 20.13 meters minimum and 1876.5 meters from the Lake Mainit as shown in Figure 7 and Figure 8, respectively.

Table 2. List of the dataset with its corresponding average, maximum and minimum values.

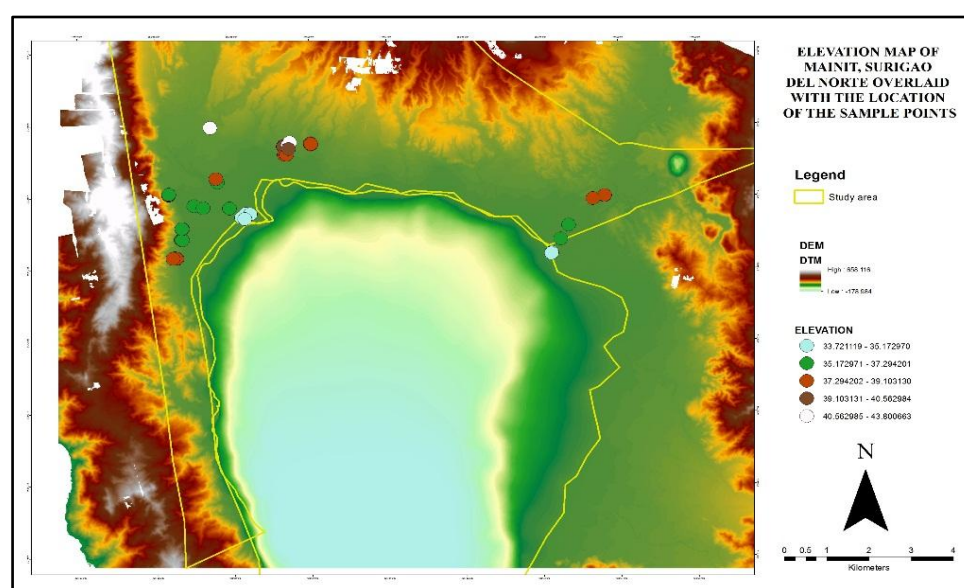| Dataset | Average | Maximum | Minimum |
|---|---|---|---|
| ELEVATION (m) | 38.15 | 43.80 | 33.72 |
| SLOPE (%) | 12.05 | 66.41 | 0.5 |
| DISTANCE Of Points From Water Bodies (m) | | | |
| LAKE MAINIT | 885.23 | 1876.5 | 1620.9 |
| RIVER NETWORKS | 558.81 | 20.13 | 7.7416 |



Figure 4. Shows the overlay map of DEM, Schistosomiasis positive points and elevation of Mainit, Surigao del Norte
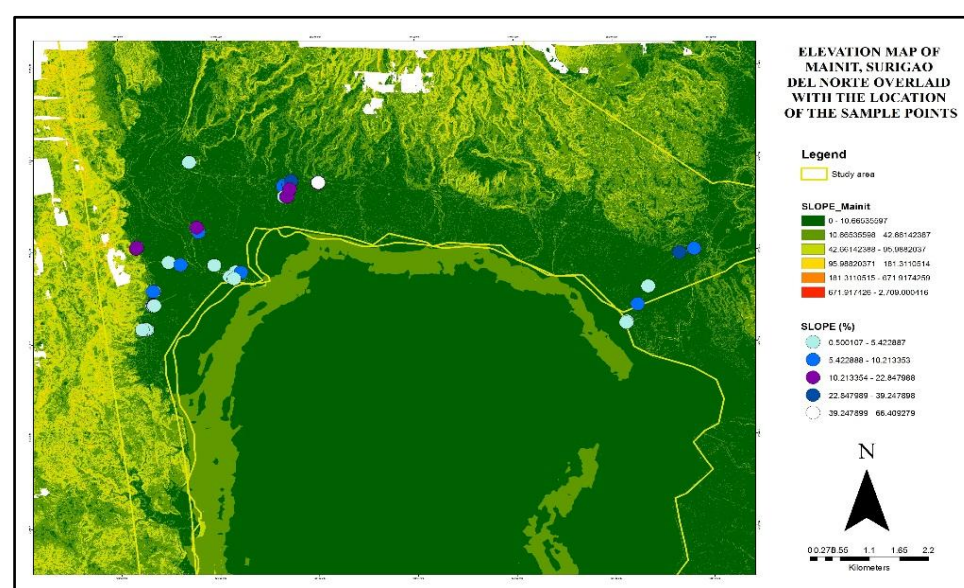


Figure 5. The slope map of the positive points of schistosomiasis derived from the DEM of Mainit, Surigao del Norte
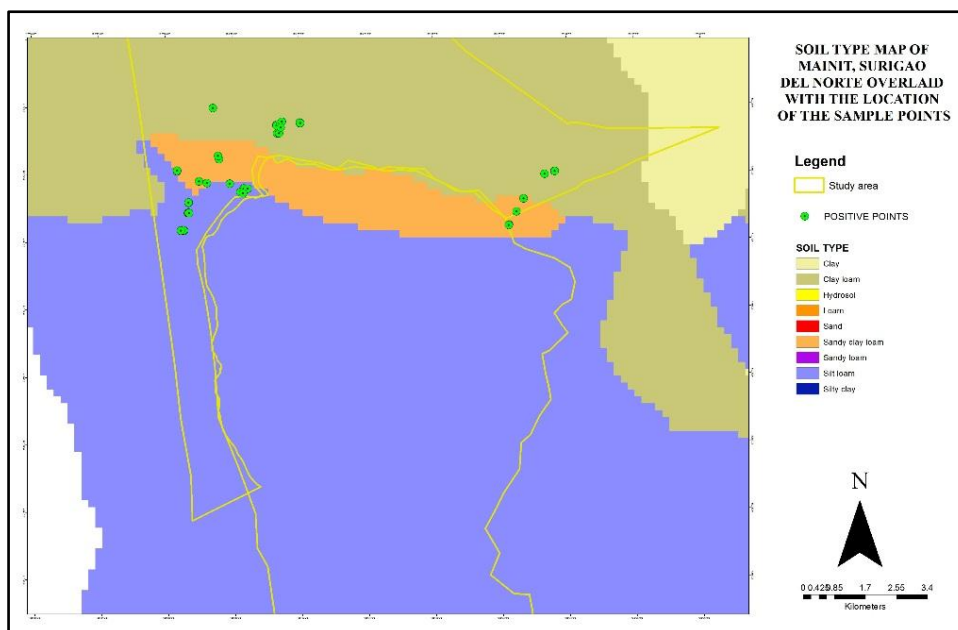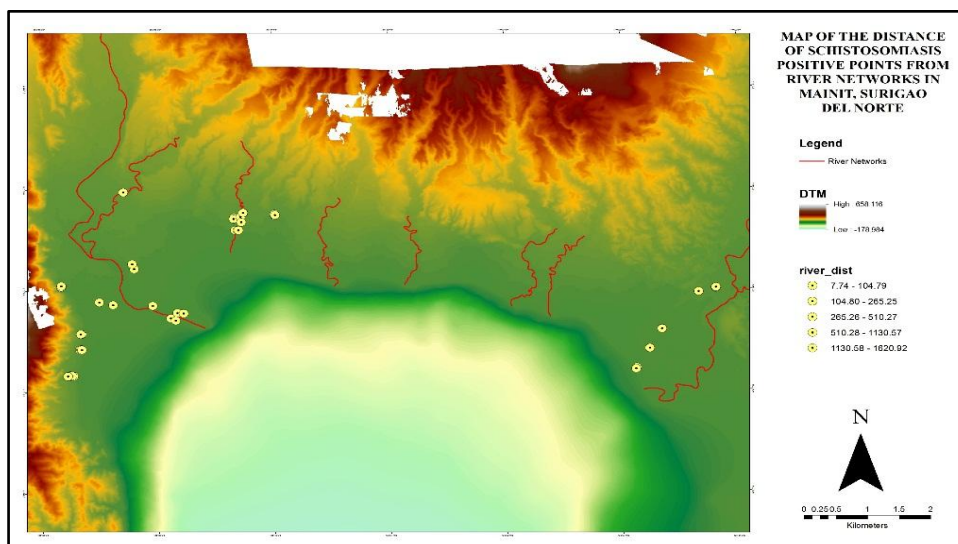
Figure 6. The Soil type Map in Mainit, Surigao del Norte



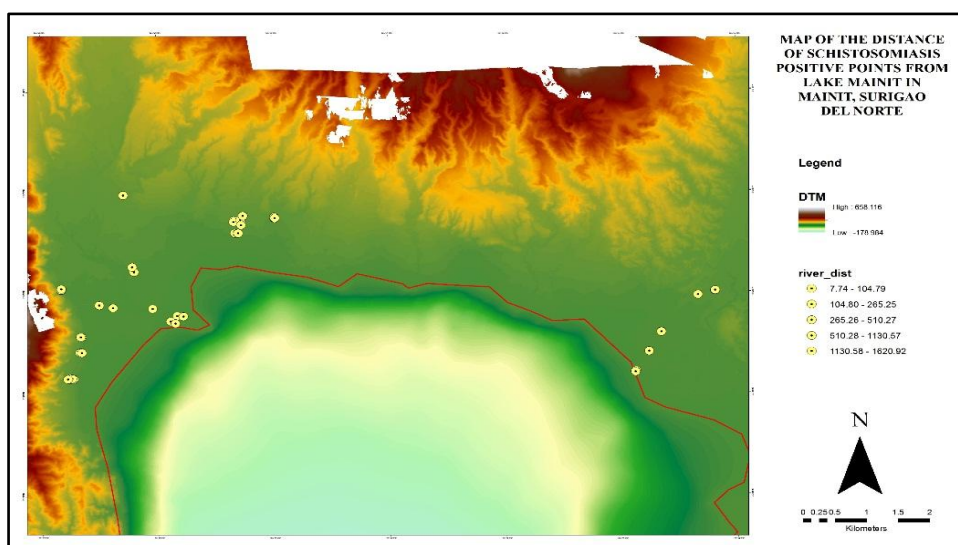Figure 7. The distance of the positive points from the rivers



Figure 8. The distance of the positive points from the Lake Mainit

## 3.2 Weighted overlay analysis

Based on the result of the weighted overlay analysis, the areas with the presence and absence of schistosomiasis were identified. The area where the presence was detected was categorized into four classification: dominant, slightly dominant, minimal and weak. It was observed that areas with the presence of schistosomiasis was located on the barangays surrounding Lake Mainit namely, Tagbuyawan, San Francisco, Mabini, Mansayao, Tapi-an, Magpayang and Matin-ao.
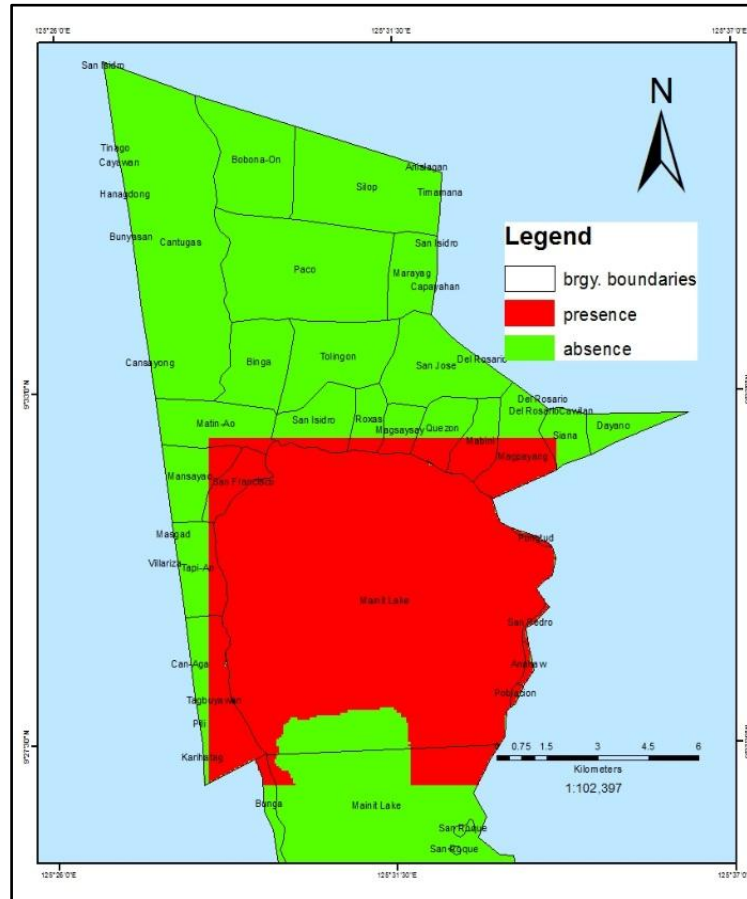


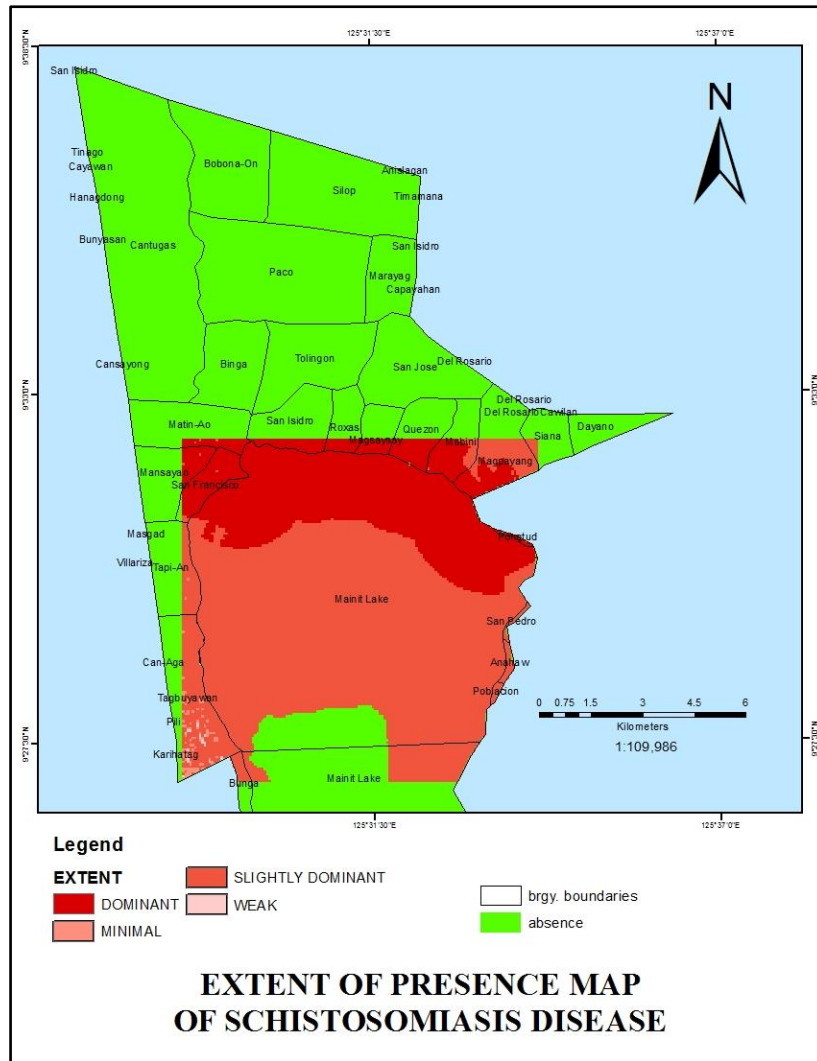Figure 9. Prediction map of Schistosomiasis disease

Figure 10. Extent of the Presence of Schistosomiasis Disease

Table 3. Relationship of the area of each extent to the total area

|  | Pixel Count | EXTENT | RELATIONSHIP |
|---|---|---|---|
|  | 20 | WEAK | 0.114292245 |
|  | 94 | MINIMAL | 0.537173553 |
|  | 11648 | SLIGHTLY DOMINANT | 66.56380365 |
|  | 5737 | DOMINANT | 32.78473056 |
| SUM | 17499 |  | 100 |

Table 3 shows that majority of the areas with the presence of schistosomiasis is slightly dominant with schistosomiasis comprising 66.56% of the entire area present of schistosomiasis. This is then followed by the dominant areas covering 32.78%. The table also reveals that areas that are weak and minimal extent of schistosomiasis are insignificant compared to the preceding extents.

## 4. CONCLUSION

Schistosomiasis is a serious disease that burdens a lot of people. Predicting and mapping the areas that could be positive of schistosomiasis is an important thing for the community and it could help control programs to plan and prioritize efficient control campaigns to decrease schistosomiasis burden.

The geospatial characterization of the areas positive of schistosomiasis revealed that this disease are found in areas with elevation not exceeding 43.8 meters and its slope is 66.41%. They are also found in barren areas, built-up areas, cropland, palm areas, grassland, rivers and any other water bodies. Minimum distance from the river is 7.74 up to 1620.92 meters and minimum distance from Lake Mainit is 20.13 meters and can go up to 1876.50 meters. Clay loam, sandy loam and silt loam are the soil types of the schistosomiasis habitat.

## ACKNOWLEDGEMENTS

## REFERENCES

**B.L. Blas P.F. Velasco, O.B. Alialy, E.S. Erce, J.C. Basas, And E.S. Bautista** Epidemiology And Control Of Schistosomiasis In The Philippines: progress report as of 1987" [Journal]. - [s.l.] : Mem Inst Oswaldo Cruz, 1989. - Vols. 84:105-16.

**Cesar C. Cassion 1 Erwin T. Pingal,1 Richard B. Maniago,1 John Robert C. Medina2 and Vicente Y. Belizario, Jr.2,3** Schistosomiasis and Soil-Transmitted Helminth Infections in School Children [Journal]. - [s.l.] : ACTA MEDICA PHILIPPINA, 2013. - NO. 3 : Vol. 47.

**Ronaldo G.C. Scholte Laura Gosoniu, John B. Malone , Frédérique Chammartin** Predictive risk mapping of schistosomiasis in Brazil using Bayesian geostatistical models [Journal]. - [s.l.] : Elsevier B.V., 2014.

**Santillan Meriam Makinano-Santillan and Jojene R.** Suitable Areas for Mass Propagation of Sago Palms in the Philippines [Journal].