Studying Invasive Plant Distribution by Using GIS: Identification and Impacts of Water Hyacinth (*Eichhornia crassipes*) on Lake Tana, Ethiopia.

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Objective:

This study will examine the extent and possible cause for the distribution of the invasive plant coverage on Lake Tana. The result will provide list of possible causes with weighted percentage contribution to the infestation. The investigation will also proceed into the surrounding area, observing the watershed, population distribution, infrastructure, farms, and other entities nearby. The research is accomplished through ArcGis and satellite imagery(PCI).

Introduction:

Lake Tana is is the largest lake in Ethiopia and the source of the Blue Nile. It is located in the north-western highlands of Amhara region, approximately 84 kilometers long and 66 kilometers wide, with a maximum depth of 15 meters.

The Lake Tana region is highly productive due to its rich soil such that agriculture is the main source of income for 80% of the population, mostly subsistence smallholder farming with crops and livestock. A wide variety of crops are cultivated including sorghum, millet, rice and maize. Coffee is also an important source of income for the local population. Other sectors include tourism, fishing, livestock breeding and small businesses for manufacturing and marketing of products. The area plays an important role in their local communities' culture and religion. The lake and its islands are home to Ethiopian Orthodox churches and monasteries dating back to the 13th century. These monasteries have a unique architectural style and have guarded their magnificent cultural treasures, art and paintings over many centuries. These churches and monasteries are surrounded by patches of natural forest that play a major role in religious practices and are holy places important for spirituality as well as providing a sanctuary for many rare and endemic plant species.

Study Area:

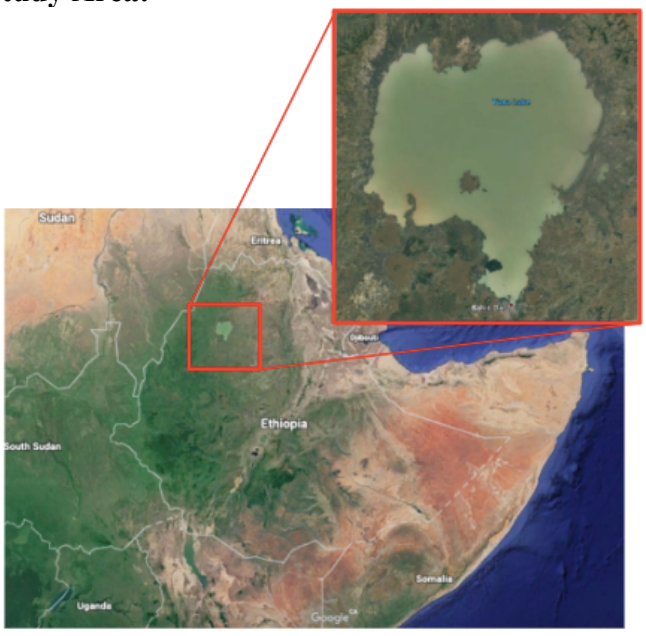

Figure 1: Location of Lake Tana, Source (google earth 2017).

Why Study Lake Tana?

Recent data show that Lake Tana is critically infested with water hyacinth and it is putting the aquatic biodiversity at extreme risk. In 2011, the Regional Environmental Bureau named water hyacinth

as the most dangerous weed affecting Lake Tana. By then, about 20,000 hectares of the north-eastern shore of the lake was infested. In 2014, researchers from Ethiopia found out that about one-third of the lake's shoreline, around 128km, was invaded by water hyacinth.

In 2016, the estimated coverage of the weed doubled from 20,000 to 40,000 hectares. The weed is estimated to cover 50,000 hectares of the lake in year 2017. To make matters worse, inflowing rivers carry heavy loads of soil and suspended sediment into the lake, which affects the water quality and creates favorable conditions for the spread of the weed. Fully developed water hyacinth mats block waterways rendering water transportation and fishing difficult. Water hyacinth also adversely affects freshwater ecology. The mats limit circulation of air and water, thereby diminishing the level of oxygen in the water, which, in turn, threatens the survival of aquatic ecosystems such as fish. The mats also hinder the passage of sunlight beneath the water surface, thus obstructing the photosynthetic activities of underwater plant species and degrading the biological diversity of the lake. Reduction of biological diversity transpires a cascading effect on aquatic animals, which depend on plants for shelter and nesting. In particular, the fish stock, deprived of oxygen and food, could vanish from the lake, thus forcing the fishing industry.

Research Methodology:

The research will be accomplished through the observation of the Lake Tana watershed over 8 years starting in 2009 and ending in 2017. Satellite imagery will be retrieved by using remote sensing techniques, LANDSAT 5 and LANDSAT 8. Data collected from African data information websites (e.g. *Open Africa Data*) with information on the surrounding population, sewage system and types of crop production, will then be analyzed through processing and classification using ArcGIS and PCI software. The processing will be completed through the use of Ordinary Least Squares (OLS) or Geographically Weighted Regression (GWR) tools, to find pollution percentages of the surrounding area to determine if each element has an affect on Lake Tana. Water System, vegetation, population maps and tabular results will be created to properly communicate and display the information.

Analysis:

- Study the inflow and outflow of water from and to the the lake in relation to the drainage system by using DEM.

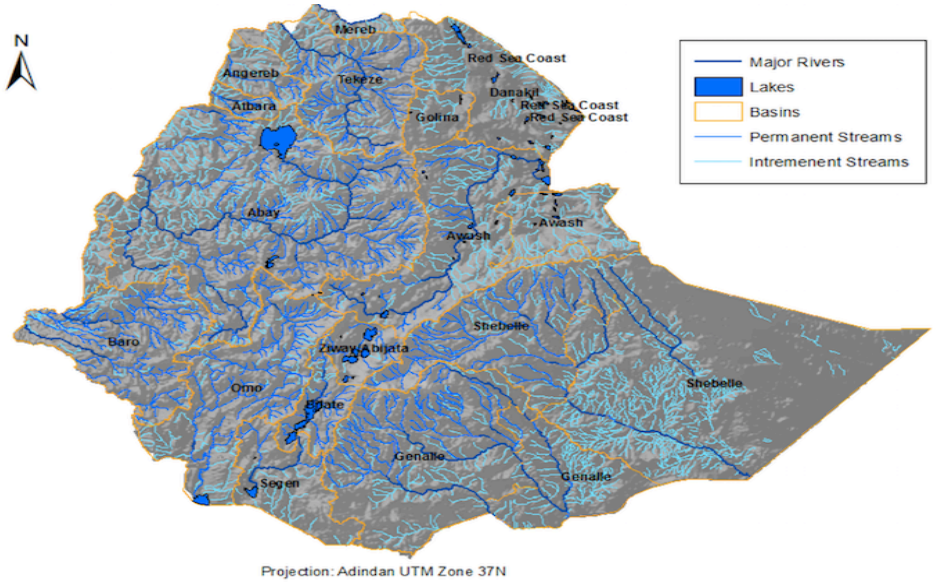

Figure 2: Water flow and drainage system of Ethiopia.

- Study the vegetation and land use near the lake.

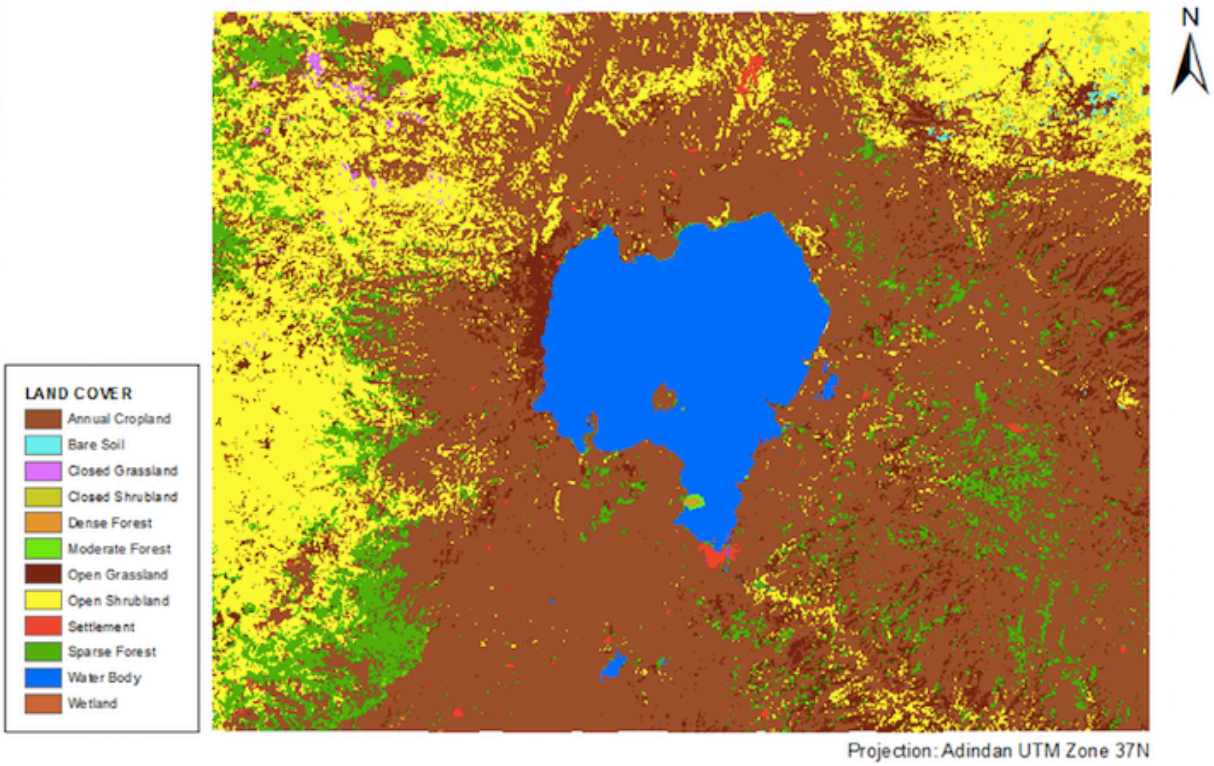

Figure 3: Different types of Land use near Lake Tana.

- Observing infrastructures, farms, and nearby towns that can be possible factors for the infestation.

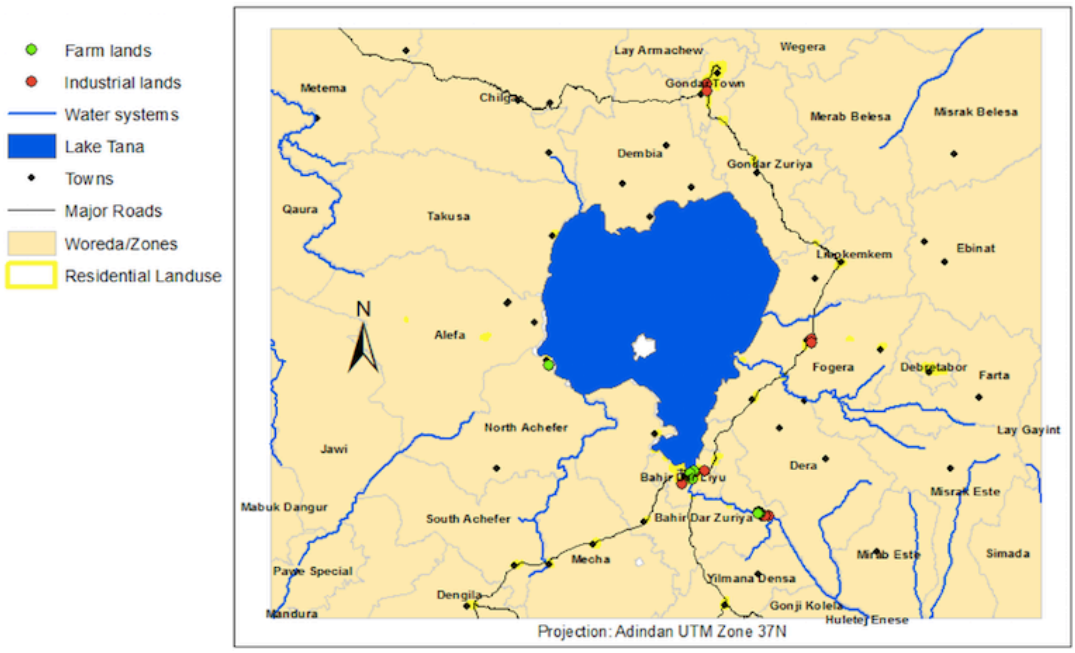

Figure 4: Base Map of Lake Tana.

- Observing changes by using LANDSAT Imagery.

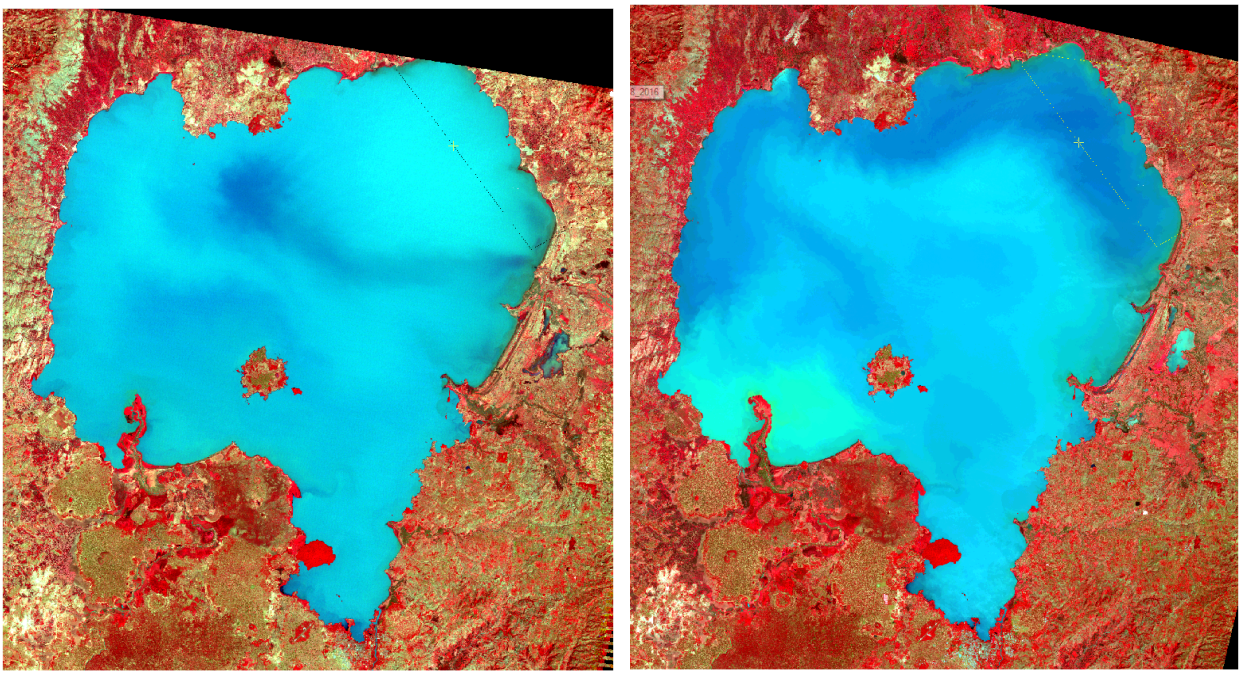

Figure 5: (Left) Landsat 5, 2009, false color composite. (Right) Landsat 8, 2017, false color composite.

- Perform cropping and Unsupervised classification to see the change over 8year period of time.

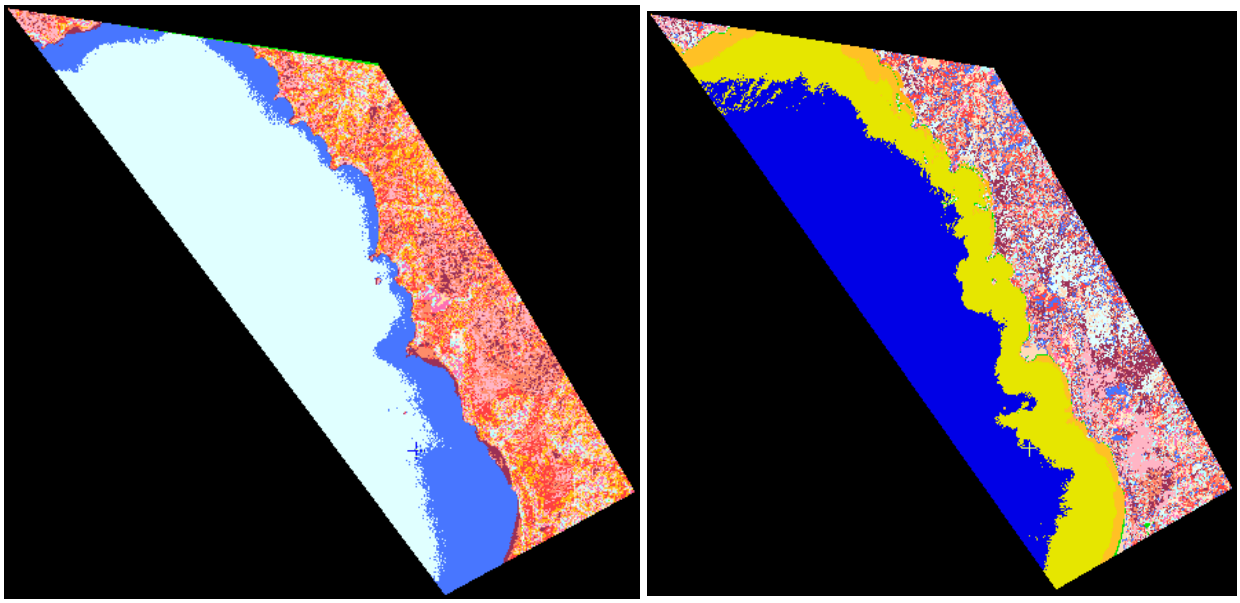

Figure 6: (Left) Unsupervised classification, Landsat 5, 2009. (Right) Unsupervised classification, Landsat 8, 2017.

- Classify to 3 classes (Water, Land, and Hyacinth) and perform Post Classification by editing the result.

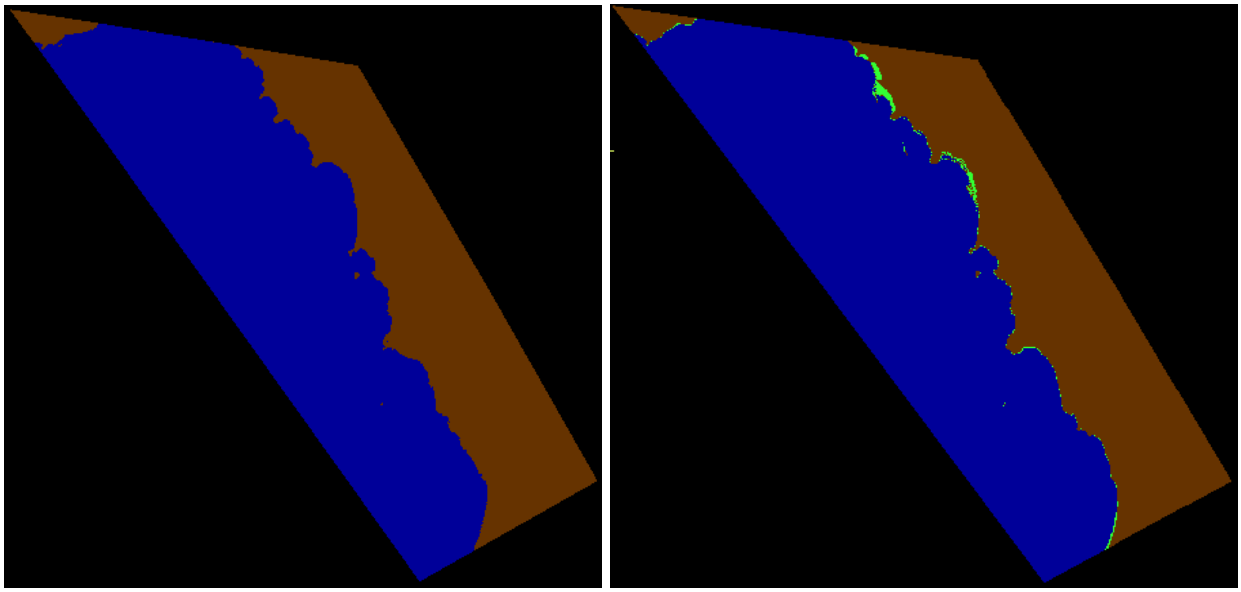

Figure 7: (Left) Classification of Land and Water, Landsat 5, 2009. (Right) Classification of Land, Water and Hyacinth, Landsat 8, 2017.

What is Next?

- The Next step is to convert the Raster data set we got from the Landsat imageries (Figure 7) to vector by bringing it to Arc GIS and then use Ordinary Least Squares (OLS) and Geographically Weighted Regression (GWR) tools to find percentage pollution of the surrounding area which helps us to determine if the possible factors has correlation to the infestation of lake.
- The final result will show list of possible factors and their percentage contribution for the infestation of Lake Tana by Water Hyacinth.

References:

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