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Spatio-temporal dynamic analysis of greenness base on NDVI equation for change detection from 2004 to 2024 at River Nile State, Atbara City, Sudan by using remote sensing and geographical information system

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Abstract

Urban regions' ability to maintain high environmental standards is largely dependent on their vegetation. A decrease in the amount of vegetated area on land has resulted from city expansion and population growth. An examination of land cover change in urban settings is necessary, particularly for urban regional planning that takes green, open space into account. The purpose of this study was to examine changes in urban vegetation cover in two Medan sub-districts from 2004 to 2014. Change analysis and the Normalized Difference Vegetation Index (NDVI) were performed in the study. The range of plant diversity in these locations was Observed. The results showed changes in vegetation cover areas in the mentioned years. In 2004, most of the areas were under a highly dense vegetation class while in 2014, they were under a low-density vegetation class with new sub-class. This indicates a decrease in vegetation cover due to changes to non-vegetation cover or land cover areas with less vegetation.

Keywords: Vegetation; Urban; Ecosystem; Recreation Areas; Enhancing Water; Landsat images

1. Introduction

Vegetation, which is the main element of the terrestrial ecosystem,(1) is essential to the material and energy cycles in the hydrosphere, biosphere, and atmosphere. Moreover, vegetation can serve as a partial indicator of the biological environment and influences the carbon sink in the carbon cycle.(2) At the local, regional, and global levels, plant suppression in biomes, ecosystems, and tropical forests can lead to climate change.(3) Vegetation acts as a feedback mechanism to control the balance of water, carbon, and energy between the land and the atmosphere.(4)

River Nile State, Atbara City, Sudan has less vegetation and very low greenness infrastructure.

Green infrastructure is very important in city for water management, Recreation and health, climate change mitigation, and reducing of Environmental sound. (5).

Low green infrastructure will increase the temperature on that city make island heat , and not be perfect for good life (6)

Green infrastructure strategy on the city spatial planning has been developed by GI task and comprehensive include increasing effectiveness, engaging multiple city department and addressing institutional to funding. (7)

Spatial temporal of dynamic Greenness can be detect and monitor from the Landsat multi-date satellite images acquisition, and can be integrated using geospatial method to analyzing data.

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1.1. Statement of the problem

Atbara is regarded as one of the cities of the River Nile State in Sudan. It is situated in a semi-arid region to the north, where hot spots and a lack of flora (greenness) could have a negative effect on the region's future. Future greenness and high temperatures are greatly impacted by strategic planning for the green infrastructure the following are the research questions for this study based on the aforesaid research problem:

- What is the city's level of greenness
- How is it distributed?

1.2. Research objective

- To obtain for dynamic change for vegetation by analysis of data from satellites
- Discover change detection beyond analysis of data
- Compare and get different between 2004, 2014, 2024

1.3. Benefits of green infrastructure

- Enhancing Water Resource Management. This entails revitalizing the streams in the park's northern region by safeguarding, enhancing, and bringing to light their visual presence.(8)
- health The parklands offer improved chances for physical activity, relaxation, mental wellbeing, and healthy living by reestablishing people's connection to nature. Additionally, the parklands will encourage a significant increase in the amount of frequent, low-impact, informal exercise in the neighborhood, and better connectivity should make walking and cycling the preferred modes of transportation for short trips. Better.(9)
- A feeling of location The river itself, the wetlands inside its floodplain, and the marshes are the Lea Valley's primary natural features. The park's north shows how to create a visually arresting and functional landscape that is also hospitable, alluring, and motivating for people. It has successfully restored a robust and varied population of flora and fauna. Verdant(10)
- Improving Biodiversity The site's species-rich grassland, which is incorporated within the park wherever feasible, makes it remarkable. Together with the fresh planting of thousands of native trees and shrubs, the numerous hedgerows—which serve as important wildlife corridors for the migration of various species—were kept as linear woodland belts. More robust.(11)

1.4. Over view of NDVI

THE NDVI Normalized Difference An indicator of plant greenness or photosynthetic activity is the Vegetation Index (NDVI). It is a widely used and simple to compute proxy for vegetation productivity based on satellite images The NDVI is a straightforward numerical indicator that is related to photo synthetically active radiation and provides a measure of the vegetative cover on the land surface over large areas. It essentially measures the capability of leaves According to Schemed there is a positive link between this indicator and biomass, photosynthetic activity, vegetation cover, and Leaf Area indicator The red reflectance measurements are subtracted from the near-infrared and divided to calculate the NDVI method.(12)

The Equation below show the

- NDVI method for analysis
- NIR minus R / NIR plus R is the NDVI equation.
- NDVI = (Band 4 – Band 3) / (Band 4 + Band 3) for Landsat 4-7
- NDVI = (Band 5 – Band 4) / (Band 5 + Band 4) for Landsat 8–9. (13)

The range of NDVI values is -1 to 1. A very low NDVI value is indicative of desolate regions made of rock, sand, snow, clouds, etc. Tropical and temperate rainforests are shown by high values, whereas shrub and grassland are represented by moderate values. and water bodies are represented by NDVI values that are negative while bare soil is represented by values that are closest to 0. The objects with varying NDVI values.

Table 1 NDVI range and concern objective

Range of NDVI value	Name of the objective
-1	Water body
0	Bare soile,Rock,sand and snow, cloud
0.2-0.3	Shrub and grassland
0.3-0.5	Sparse and unhealthy forest
> 0.5	Density and healthy forest

Classification of NDVI range

Table 2 NDVI band in different bands

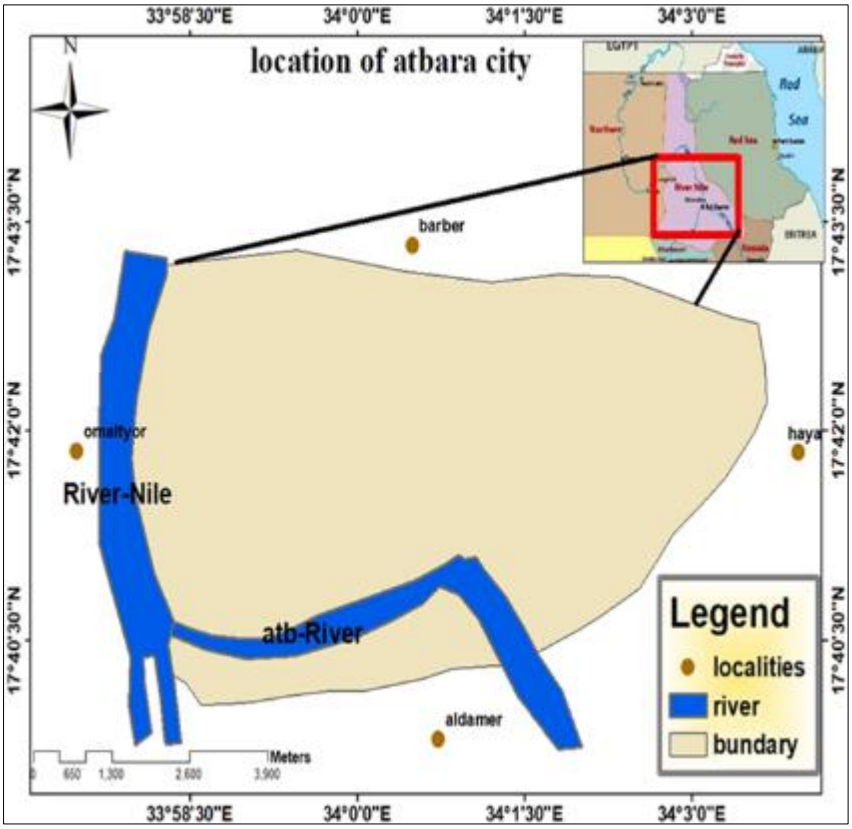
Lansat5 TM	Landsat ETM 7	Landsat 8 LOI
Band 3and 4	Band 3and 4	Band 4 and 5

NDVI in Landsat 5, 7, and 8

1.5. location of the study area

This study was conducted in the Sudanese city of Atbara in the River Nile state.

As a result, it is situated in a semi-arid area at longitudes 33°58' 30" and 34°3' 0" E and latitudes 17°40' 30" and 17°43' 30" N.



Source: integration and Google Earth Zone 36N in the GIS coordinate system WGS 1984

Figure 1 Three time series of NDVI analysis in study area

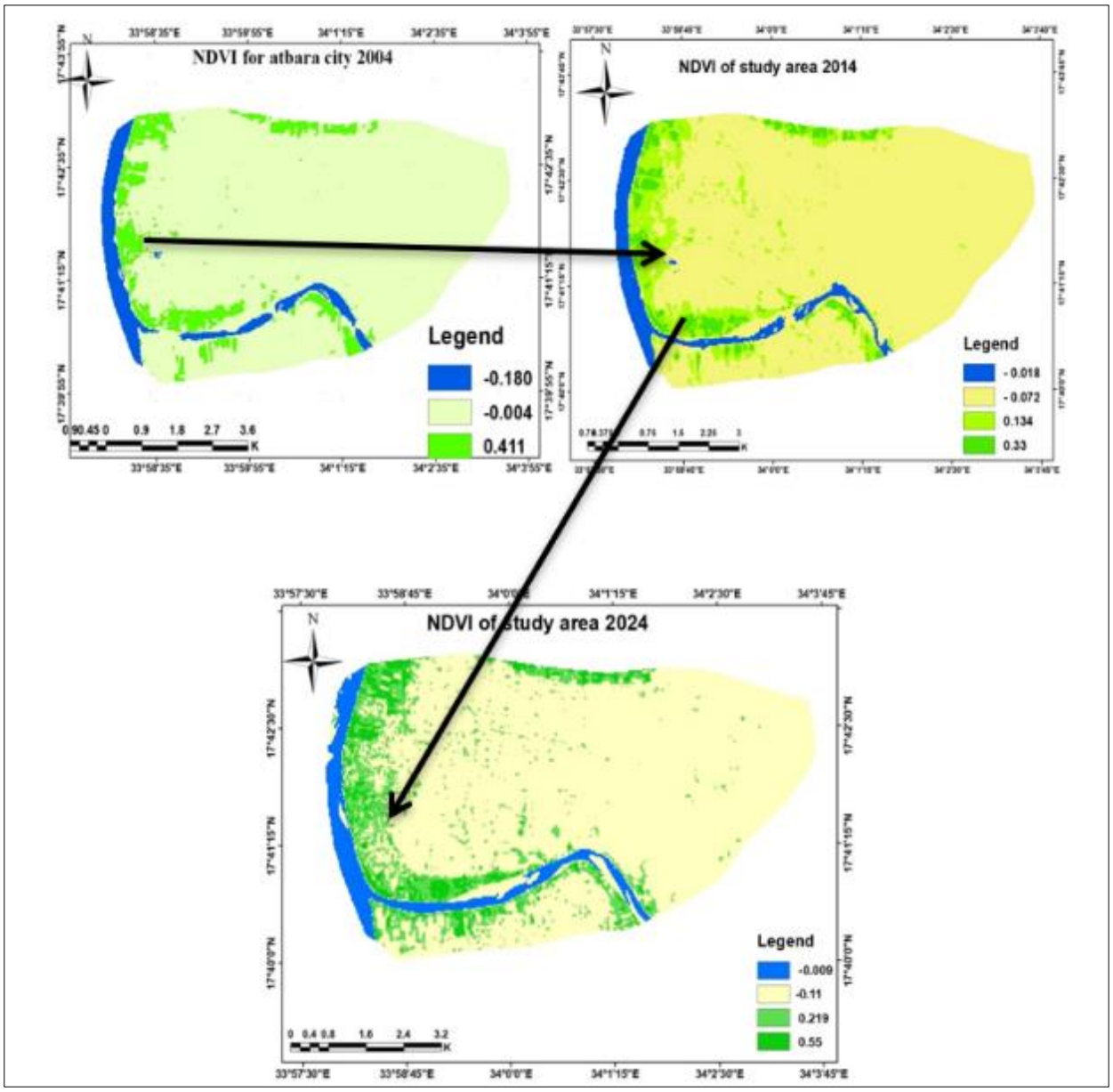


Figure 2 NDVI map of study area 2004 ,2014, and 2024

2. Conclusion

Overall, the NDVI analysis of the study area revealed for 2004 one class the NDVI is 0.4 its low vegetation and include water bodies and residential areas for 2014 there are two class number of NDVI is 0.1 for low vegetation and 0.3 low vegetation although there are new class but there decreases from first class 2004 and include of water and population area and 2024there are four class with different vegetation classes: class 1 and tow included open spaces, non-vegetated areas, and water bodies;

The results indicate that between 2004 and 2014, the high greenness index decreased and then grew again sub-plant in new areas. The area of which had a high greenness index located near the River Nile state , increased between 2014 up to 2024 classified as having a high greenness index is 0.5and concentrate in western direction of the area because from the river Nile and another direction poor with vegetation need for developing from city government.

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