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A Proposed System for Understanding the Effects of Urbanization on Mangrove Vegetation

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Abstract

Urbanization brings many benefits for human society, but the flora and fauna pays the toll for it. Over the past few years urbanization has occurred at such a rapid pace that it has altered biodiversity drastically. One of the natural elements that have suffered are mangroves, exposing coastline to dangers. In this paper we propose a methodology to understand the correlation between increasing urbanization and its negative effects on mangrove cover. Normalized Difference Vegetation Index (NDVI) and Normalized Difference Built-up Index (NDBI) calculation on Landsat8 OLI images can give a measure to vegetation cover and Urban Heat Index (UHI) which is a measure of urbanization [1]. These measures combined with other parameters like sewage water outlets in mangrove swamps, air quality and carbon emissions will prove the basis for analysis of the relation between growth in urbanization and decrease in mangrove vegetation.

Keywords: *Mangrove, Urbanization, Normalized Difference Vegetation Index (NDVI), Normalized Difference Built-up Index (NDBI), Image Processing, Landsat8.*

1. Introduction

This template, modified in MS Word 2007 and saved as a "Word 97-2003 Document" for the PC, provides authors with most of the formatting specifications needed for preparing electronic versions of their papers. All standard paper components have been specified for three reasons: (1) ease of use when formatting individual papers, (2) automatic compliance to electronic requirements that facilitate the concurrent or later production of electronic products, and (3) conformity of style throughout a conference proceedings. Margins, column widths, line spacing, and type styles are built-in; examples of the type styles are provided throughout this document and are identified in italic type, within parentheses, following the example. Some components, such as multi-leveled equations, graphics, and tables are not prescribed, although the various table text styles are provided. The formatter will need to create these components, incorporating the applicable criteria that follow.Mangroves act as natural protection for shorelines from floods, winds, damaging storms and hurricanes. They also prevent erosion from sedimentation and act as a nursery for marine life.

Mangroves are distributed worldwide in 123 countries spreading about 150,000 sq.km area, with South East Asia contributing about 33% of it. Mangroves spread over 4921 sq.km in India contributing about 3.3% worldwide. Overall vegetation cover has increased from 4046 sq.km in 1987 to 4921 sq.km in 2017, mainly because of the protected sanctuary of Sundarban in West Bengal [1,2].

However, mangrove cover in coastline near urban areas like Thane creek has shrunk over the last few decades. The development in Mumbai Metropolitan Region and sedimentation has encroached vast portions of mangrove vegetation. Since 1973 Thane creek has lost over 36% of its mangrove cover to urban development [3,4] .

We aim to present a statistical study of cause and effect of loss of mangrove forest near urban coastline.

2. Literature Survey

This study [5] by A. W. Sejati examines the urban and forest cover by applying NDBI and NDVI on Landsat 7 ETM and Landsat 8 OLI for metropolitan region of Semarang from 1990 to 2015. The

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Category	Sub-Category	Source

results should that NDBI showed proportional increase with growing urbanization while NDBI dropped along with in. NDBI- NDVI correlation was negative (–0.99

The paper[6] presents the study of the rise in annual temperature in Beijing, China due to Urbanization. The study shows that the meteorological station of Beijing – Guan Xiang Tai and Mi Yun had an increase in annual temperature as the region underwent urban development. They used Land Use and Land Cover data for Beijing from 1990, 1995, 2000, 2005 and 2010 in the form of Landsat/TM images.

The paper[7] proposes a method to identify and track deforestation in India. The system tries to reduce the noise from clouds, mist etc. by applying Haar wavelet transformation. The use of a poly segmentation algorithm with 90% accuracy in identifying the change in forest in India.

The paper[8] explains the use of Image Processing to detect growth in urban settlements. The system uses pre-processed images and passes them through filters to reduce noise, then two images for the same area are compared to detect the change. Canny edge detection is used to find the contours which form the boundaries of buildings and other urban structures.

3.Proposed Methodology

3.1 Methodology

The study requires infrared (RED), near infrared (NIR) and Shortwave infrared (SWIR) reflectance satellite imagery for calculating Normalized Difference Vegetation Index (NDVI) and Normalized Difference Built-up Index (NDBI). United States Geographical Survey (USGS) developed Earth Explorer (EE) which provides Landsat8 OLI images which has RED NIR and SWIR reflectance as panchromatic bands in band 4, band 5 and band 6 respectively [9]. The dataset consists of panchromatic images for 20 countries including 162 regions. Indian State of Forest Report 2017 provides statistical data for state wise mangrove cover in India from 1987 to 2017 [1]. The Ministry of Housing and Urban Affairs contains the data for level of urbanization and urban growth for all states and union territory in India[10].

Table 1. Dataset

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3.2

NDVI-NDBI	Landsat8 panchromatic bands	1. USGS Earth Explorer https://earthexplorer.usgs.gov
Mangroves	Forest Report	Indian state of Forest Report 2017 http://fsi.nic.in/isfr2017/isfr-mangrove-cover-2017.pdf
Urbanization	Level of Urbanization	Ministry of Housing and Urban Affair http://mohua.gov.in/cms/level-of-urbanisation.php

Methodology

First phase is to identify mangrove vegetation and urbanization index in coastal regions. Second phase is to understand the relation between urbanization and mangrove depletion.

1. Identification of mangrove vegetation and urbanization index using Normalized Difference Vegetation Index (NDVI) and Normalized Difference Built-up Index (NDBI):

Normalized Difference Vegetation Index (NDVI) is globally used vegetation index for greenery detection. Healthy vegetation highly reflects Near Infrared (NIR) spectrum and highly absorbs Infrared (RED) spectrum because of the Chlorophyll in them and the internal leaf structure. These two bands form the bases for NDVI calculation. Formula for Normalized Difference Vegetation Index (NDVI) is

$$NDVI = (NIR - RED) / (NIR + RED) \quad (1)$$

For Landsat8

$$NDVI = (Band\ 5 - Band\ 4) / (Band\ 5 + Band\ 4) \quad (2)$$

Normalized Difference Vegetation Index ranges

Table 2. NDVI Ranges

-1 to 0	Water Bodies
-0.1 to 0.1	Rock, soil, snow
0.2 to 0.5	Shrubs, grasslands
0.6 to 1	Dense vegetation

Normalized Difference Built-up Index (NDBI) or Urban Heat Index (UHI) is used to analyze built-up areas. Built-up areas and soil reflects Short Wave (SWIR) Infrared spectrum whereas Near Infrared (NIR) spectrum reflection is less. Water bodies do not reflect on Infrared spectrum (RED). Thus the formula for Normalized Difference Built-up Index (NDBI) is

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NDBI = (SWIR – NIR) / (SWIR + NIR) (3)

For Landsat8

NDBI = (Band 6 – Band 5) / (Band 6 + Band 5) (4)

NDBI ranges from -1 to 1

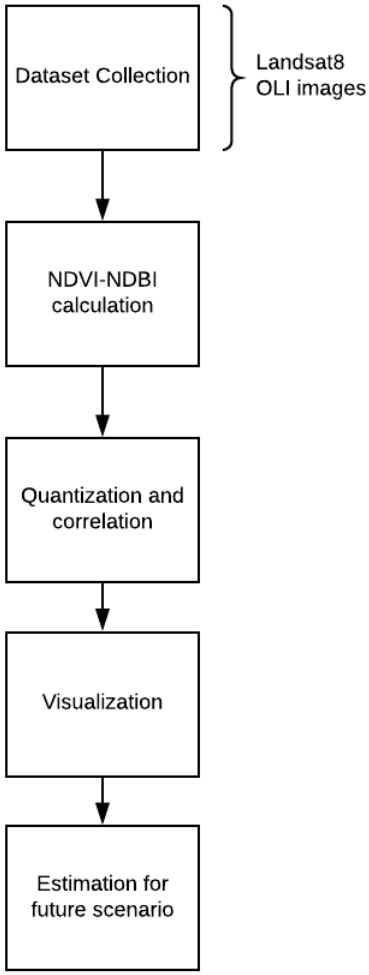

Fig.1 Block Diagram

The NDVI NDBI gives an output for the entire tile. The output can be fine tuned to get better results by thresholding the NDVI and NDBI values to the appropriate range for mangrove vegetation and urban settlement respectively.

2. Correlation of Urbanization and Mangroves Cover

The results from NDVI-NDBI analysis are for a generalized region. The outputs should be quantized for specific regions in terms of the mangrove cover, built-up rate and other depended parameters like air quality, water quality and sewage deposit. The correlation between these parameters will help in visualization of results. The effects of urbanization growth can be clearly

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related to depletion of mangrove vegetation. Correlations can be obtained using Pearson Correlation Coefficient

4. Results

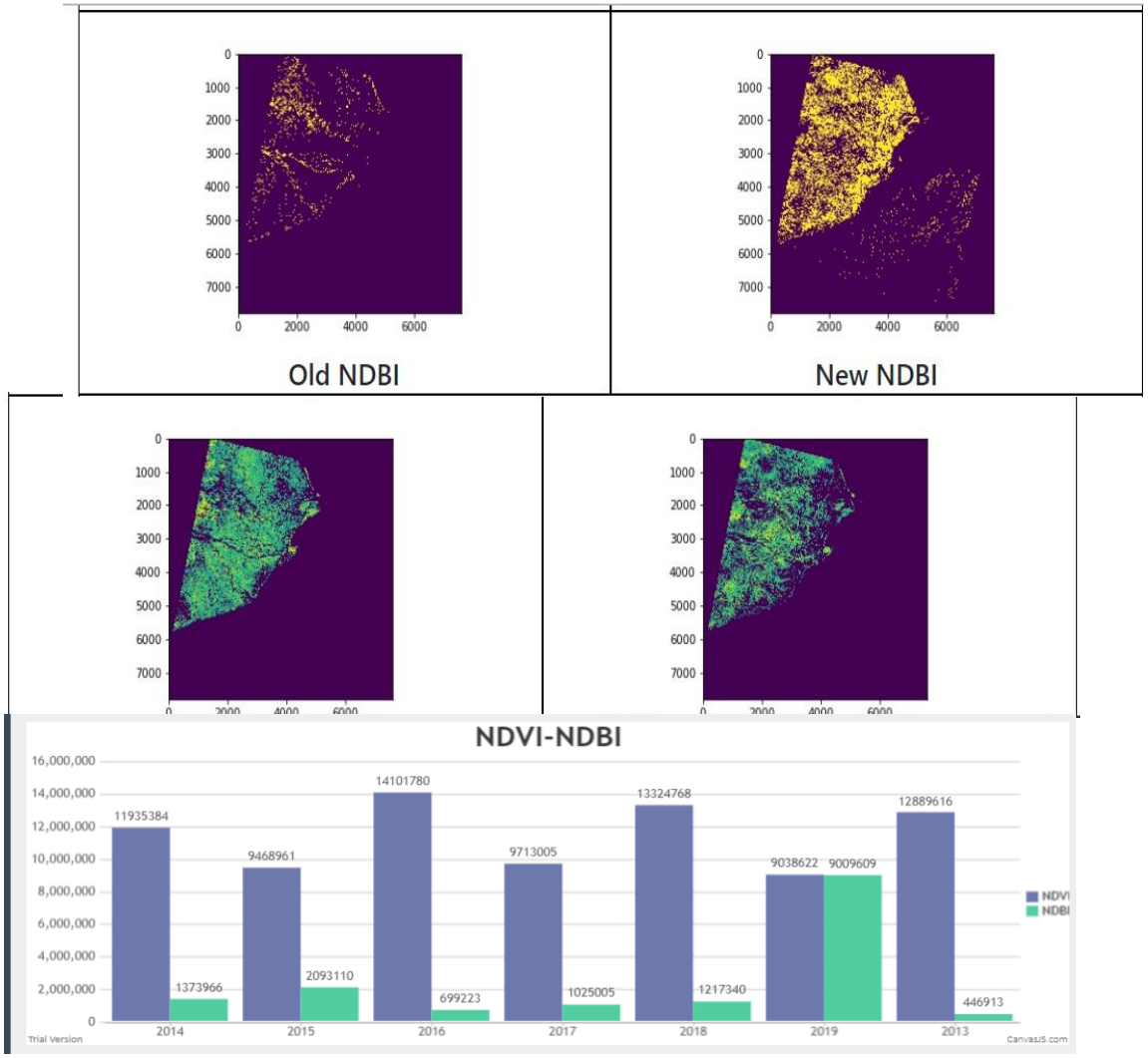

Figure 2. Results

As the NDVI- NDBI calculation shows a general trend in in mangroves and settlements. Mangroves have reduced overtime and settlements have increased, however recent years shows growth of mangroves due to increase in awareness. There are occasional spikes and offshoots in NDVI

NDBI values, these are due to the cloud cover that reflects Infrared lights spectrum. Selecting better panchromatic images can help increasing accuracy. The results can be further be improved by limiting the calculations to coastline.

5. Goals

1. To Provide a Measure for analysis

The projects provides a quantitative measure to understand the relation between Mangroves and Urbanization. The NDVI and NDBI values can be converted to measure of area in square kilometers,

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by using the number of pixels that the shows NDVI NDBI values in a certain range. The intensity can also be calculated.

2. Help Authorities to make informed decisions

With visual representation the trends and effects are easy to understand. The project provides a regional and global view, the respective authorities responsible for safeguarding and protection of Mangroves can make informed decisions for reducing the negative effects of urbanization. This statistics can also help the authorities make better planning for new cities and settlement near Mangrove vegetation.

6. Future Scope and Conclusion

The study will provide a method to understand the relation between the growth in built-up rate and mangrove depletion. This will create an awareness for protection of natural treasure in order to safeguard our coastline. The study can further be generalized to all types of vegetation and help understand causes of deforestation on a wider scope. This study will be helpful for authorities responsible for the protection and development of coastal regions.

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