Digital Urban change mapping for Port Harcourt City

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ABSTRACT

Port Harcourt city was rich in flora and is also a good habitat for fauna but the availability of this quality of land cover tends towards extinction as a result of urban drift from metropolitan areas to coastal landforms for about a century. Prior to wetlands conversion, activities along coastal fringes caused by increased land need of inhabitants, which accounted for the huge loss of 9209.05 hectares over the Niger Delta (Godstime et al., 2005). This study accounts for "Digital Urban change mapping for Port Harcourt City". The methodology of land-use classification and change detection mapping was employed using Landsat datasets for three epochs (Lui and Mason, 2009; Bhatta, 2010). Population growth prior to rapid urbanization was identified as a catalyst for most deforestation. Two land covers were extracted (Vegetation and Water body). These features were converted from raster to polygon, which were later used in creating an index classification map. Therefore, the computed rate of change for the 30 years under review was -3713.18ha between 1999 and 2014 with an annual rate of change -265.227 per year.

INTRODUCTION

Periodic and precise change detection of Earth's surface features is extremely important for understanding relationships and interactions between human and natural phenomena in order to promote better decision making. Remote sensing data are primary sources extensively used for change detection in recent decades. Many change detection techniques have been developed. In this paper the Normalized Difference Vegetation Index (NDVI) which is a simple numerical indicator that can be used to analyze remote sensing measurements, and assess whether the target being observed contains live green vegetation is being used. Land use land cover change study is a diagnostic tool for determining sustainability and hence its precise and proper execution is important for sustainable development of mountainous region (Pradhan, 2002).

CONCEPT

PROBLEM

City growth is a major indicator of industrialization which has a negative impact on the environmental health of a locality. Port Harcourt city is of economic importance to Nigeria with a concentration of multi-national oil industries in it, now being associated with unplanned and nature threatening activities. This had resulted in high amounts of commercial and industrial activities as well as an ever-increasing multi-cultural population and also the most populous Niger Delta city governed by natural land constraints (Specialist Consult, 1975; Pepple, 2014). Pepple (2014) identified population increase while Godstime's (2005) identified different human induced activities for the deforestation in demand for more urban space.

OBJECTIVE

To delineate the land cover changes spatially and quantitatively over period of 30 years.
To identify and class the NDVI extracts for all dates and derive temporal change rate and trend.

AIM

The aim of this study was to produce an effective time lapse map of Port Harcourt working with geo-information tools and relate these delineated areas to vegetation index differences in years employing the tri-stimulus colour theory.

METHODOLOGY

RATIO AND INDEX CHANGE DETECTION APPROACH

PLAN

There are various different types of ratios and indices but this study has chosen the following; Water Ratio (WR), Normalized Difference Vegetation Index (NDVI) and Built up extraction (BUE) as they will be used at every stage of this exercise (Lui and Mason, 2009; Bhatta, 2010). Most vegetation indices are built upon the knowledge that healthy, green vegetation normally reflects 40 – 50% of the incident energy in the near infrared part of the spectrum (0.7– 1.1 µm) while absorbing 80 – 90% of the incident energy in the visible (0.4 – 0.7 µm) portion of the electromagnetic spectrum (Jensen, 1996). These ratios or indices can be expressed mathematically as listed overleaf.

A. Normalized Difference Vegetation Index (NDVI)

A very high positive value for healthy vegetation is obtained from NDVI and on the other hand very low negative value is obtained from features like water cloud etc. and in most case a moderate near zero value for rock and bare earth surface. Normalizing the simple vegetation index could compensate for some of those reflectance issues. Almost all available indices are designed to detect a unique spectral feature known as red edge, hence utilizing enhanced ratio or differencing approach which will highlight the aforesaid red edge.

$$NDVI = \frac{(DN_{NIR} - DN_R)}{(DN_{NIR} + DN_R)}$$

Where DN_{NIR} = Brightness value of pixel in NIR band

DN_R = Brightness value of pixel in Red band

B. Water Ratio (WI) = DN_{SWIR} /DN_G

This is a band ratio technique intended to suppress the similarities of between bands, hence the image histogram will suppress areas of little or no change occurrence by threshold operation; a process of segregating the produced WI image gray values between black and white (0 and 1) separated at a threshold gray value (Lui and Mason, 2009; Bhatta, 2010). Smith's (1997) study utilized a similar approach to distinguish water bodies from other features and obtained an error estimate of less than 5% when compared to aerial photography. For this study it will be used to extract water bodies to create themes for user defined tailored classification approach.

WI = DN_{SWIR} /DN_G

Where

DN_{SWIR} = Brightness value of pixel in SWIR band

C. Built up Extraction (BUE) = (DN_B + DN_{NIR} + DN_{SWIR})

This is a band arithmetic technique intended to suppress the similarities of between bands, hence the image histogram will suppress areas of little or no change occurrence by threshold operation; a process of segregating the produced BUE image having gray values between black and white (0 and 1) separated at a threshold gray value (Lui and Mason, 2009; Bhatta, 2010). This technique can only be performed with the ETM+ 2013 image.

BUE = (DN_B + DN_{NIR} + DN_{SWIR})

Where

DN_B = Brightness value of pixel in Blue band

DN_{NIR} = Brightness value of pixel in NIR band

$DN_{\ldots}$ = Brightness value of pixel

IMPLEMENTATION

DATA AND DATA SOURCES

Data and data sources involves all available relevant acquisition of data; As a prerequisite for studies of this nature the utilization of multi-source dataset is essential part of any functional mapping or inventory project since it requires data description documentation and quality assessment. Therefore, data source is divided in two parts namely; the office and field study.

DATA

Desk Study

This conceptual stage of the project solely involves the observation of existing secondary information of the Port Harcourt Local Government Area. Existing dataset were prepared for visual image interpretation; essential to the proposed mapping and field planning exercise.

Table 1: Showing available datasets, their description, dates of acquisition and sources.

S/N	DATA DESCRIPTION	DATE	SOURCE
1.	LANDSAT MSS (image data)	1984	http://edcsns17.cr.usgs.gov/NewEarthExplorer
2.	LANDSAT TM (image data)	1999	http://edcsns17.cr.usgs.gov/NewEarthExplorer
3.	LANDSAT ETM+ (image data)	2014	http://edcsns17.cr.usgs.gov/NewEarthExplorer

Field Study

This could also be called a field study since it actually deals with the data obtained by the researcher from the study area. For this study field reconnaissance was conducted to obtain photographs and ground control coordinates of vantage point of photographic data capture.

ANALYSIS

EVALUATION & RESULTS

CHANGE ANALYSIS

Change detection ability does not terminate at identifying land cover changes but the analytic capability of measurements utilizing geo-information application tool. Therefore, the difference between images and maps is very important in change detection analysis, utilizing statistical testing can show significant difference the type of index or classifier used.

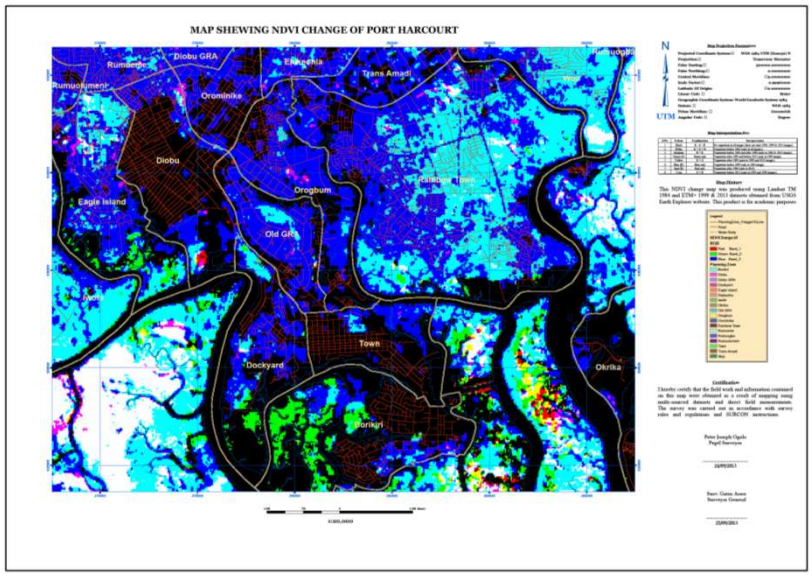
Table 2: Shows area and change calculation from NDVI statistics for all dates.

Interval	Before Impact Area (ha)	After Impact Area (ha)	Change Area (ha)	Annual change Rate Area (ha/yr)	Inference	Spacing in years
1984 - 1999	5060.44	5347.09	286.65	19.110	Gain	15
1999 - 2014	5347.09	1633.91	-3713.18	-265.227	Loss	14

Table 3: Shows the interpretation for the binary image of 3 dates in RGB composite.

S/No	Colour	Combination	Interpretation
1	Black	R - G - B	No vegetation in all images (not in 1984, 1999 & 2014 images).
2	White	R + G + B	Vegetation before 1984 (exist in all images).
3	Magenta	B + R	Vegetation before 1984 and after 1999 (exist in 1984 & 2014 images).
4	Green (G)	Green only	Vegetation after 1984 and before 2014 (only in 1999 image).
5	Yellow	R + G	Vegetation after 1984 (exist in 1999 and 2014 images).
6	Blue (B)	Blue only	Vegetation before 1999 (only in 1984 image).
7	Red (R)	Red only	Vegetation after 1999 (only in 2014).
8	Cyan	G + B	Vegetation before 2014 (exist in 1984 and 1999 images).

RESULTS



CONCLUSION

URBANISATION & THE FUTURE

S/N	Human Activities	Effects
1.	Deforestation	Decrease in green vegetation; decrease in transpiration; decrease in rainfall; land deterioration; increase in pollution in water bodies.
2.	Agriculture	Increase in sedimentation and storm water runoff; land deterioration; increase in pollutants in water bodies.
3.	Mining and Construction	Lowering of water table; increase in sediments and pollutants; leaching.
4.	Domestic and municipal	Increase in pollutants in water bodies; loss of aquatic life; inferior water quality sanitary and health hazards.
5.	Industrial	Increase in pollutants, toxic and hazardous chemicals; health hazards; increase in temperature of water bodies, loss of aquatic life.

CONCLUSION

It is important to restate the overall objectives of this study are as follows; firstly "to delineate the land cover changes spatially and quantitatively over period of 30 years". Secondly, "to identify and class the NDVI extracts for all dates and derive temporal change rate and trend".

RECOMMENDATION

Further work is recommended to improve the results obtained from water ratio and NDVI.

THANK YOU

FOR YOUR APT

ATTENTION

QUESTION: HOW CAN YOUNG SURVEYORS HELP IN MANAGING THE AFORESAID HUMAN ACTIVITIES?

Human Activities
1. Deforestation
2. Agriculture
3. Mining and Construction
4. Domestic and municipal
5. Industrial