LAND COVER CHANGE DETECTION

KASSEL DISTRICT

GERMANY

by

OLUWAGBENGA AREMU

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HOCHSCHULE NACHHALTIGE ENTWICKELUNG,
EBERSWALDE AND SZKOŁA GŁÓWNA GOSPODARSTWA WIEJSKIEGO, WARSZAWIE

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Introduction

Kassel is a city located around the Fulda River in northern Hesse, Germany. It is the administrative seat of the Regierungs bezirk (district) Kassel and the Kreis (circle) of the same name and has 200,507 inhabitants in December 2015

The aim of this research is detecting spatial change in land cover features in the Area Of Interest.

The objectives of the research are:

1. To classify landcover classes in the study area using supervised classification
2. To quantify the area covered by specific landcover classes
3. To map out areas with differential vegetative changes using NDVI
4. To detect area changes in landcover classes using patch analysis

Methodology

- Image download (USGS Glovis Landsat 7 archive)

  landsat 7 30 meters spatial resolution Image capture dates :2014-07-18 and 2016-07-07

- Pre-processing (stacking, subset, Atcor)

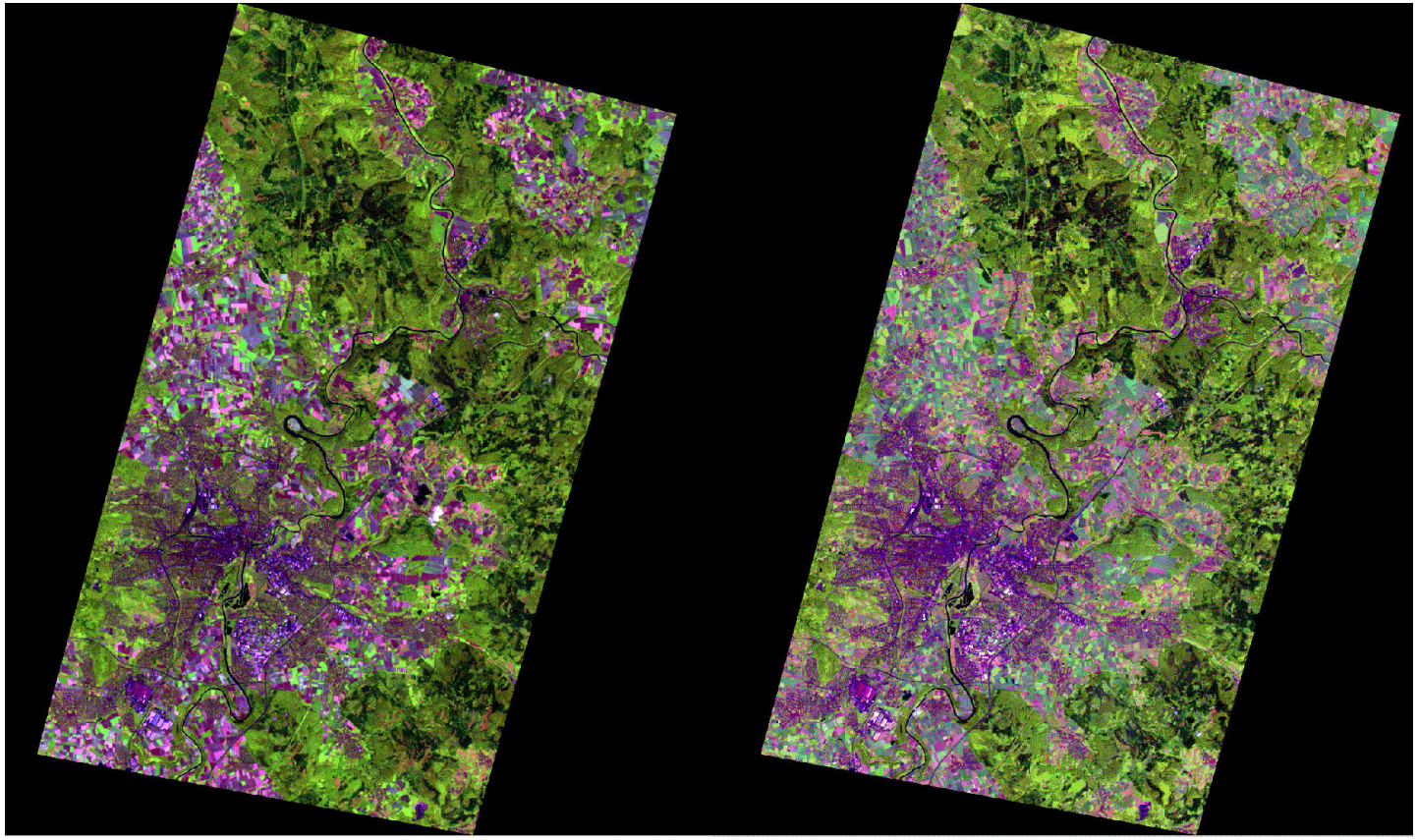
  Bands 1,2,3,4,5,7 and band 8 for pan sharpening

- Image classification (signature file, supervised)
- Analyses (vectorisation, Patch analysis, image difference, NDVI)
- Discussion and Conclusion
- References

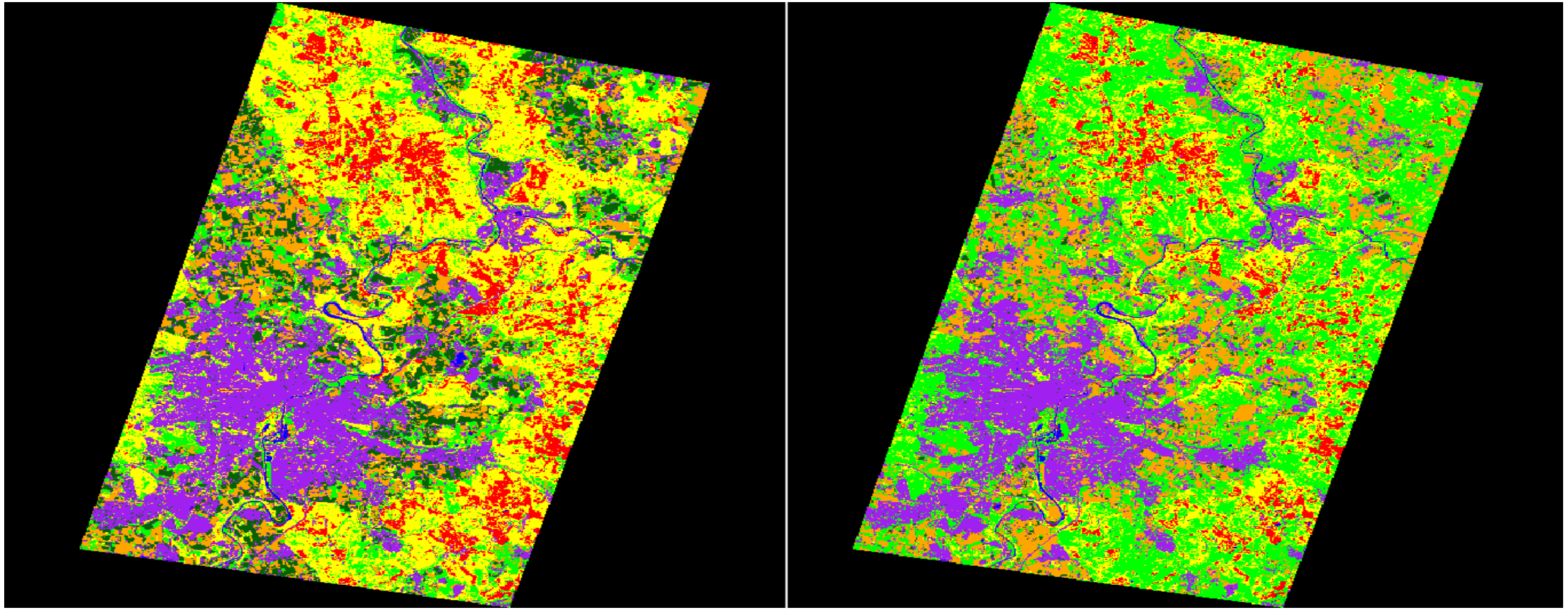
Softwares utilised

Geo-analytical softwares like Esri ArcMap 10.4.1, Erdas imagine 2014, Microsoft word 2013, Microsoft excel 2013 and snipping tools were majorly used during data analysis and visualisation

Atmospherically corrected images of the two years



Supervised Classification



Class #	>	Signature Name	Color
1	▶	Corniferous Forest	
2		Decidous Forest	
3		Schrubs	
4		River	
5		Free Land	
6		Green Pasture Land	
7		Built-up Areas	

7 Landcover classes were used in the supervised classification

Definition of terms used for Patch Analyses

- Class Area (CA): Sum of areas of all patches belonging to a given class
- Number of Patches (NumP): Total number of patches for each individual class because analyses is being carried out by Class.
- Mean Patch Size (MPS): This is the average patch size.

Patch Analyses result for year 2014

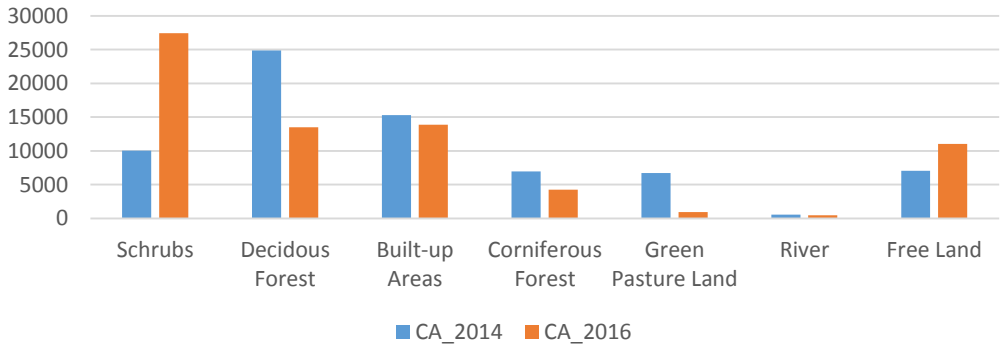
Class	MPS	NumP	CA(ha)
Schrubs	0,43	23397	10041,3
Deciduous Forest	1,57	15843	24871,2
Built-up Areas	0,8	19254	15314,4
Coniferous Forest	1,05	6628	6948,43
Green Pasture Land	0,57	11763	6720,63
River	0,4	1348	539,37
Free Land	0,88	7993	7045,91

Patch Analyses result for year 2016

Class	MPS	NumP	CA(ha)
Schrubs	1,76	15570	27404
Deciduous Forest	0,63	21512	13511,2
Free Land	1,41	7797	11010,2
Built-up Areas	0,96	14527	13881
Green Pasture Land	0,14	6631	943,64
Coniferous Forest	0,72	5934	4278,97
River	0,24	1873	452,58

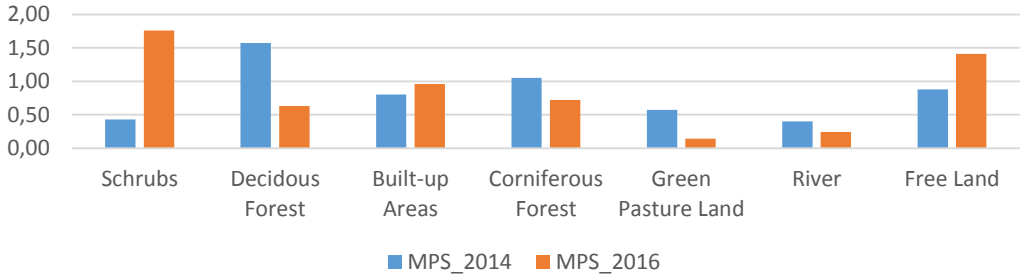
These patch analysis results were used to show the changes in various land cover areas using patches covered in the study area .

Class Area



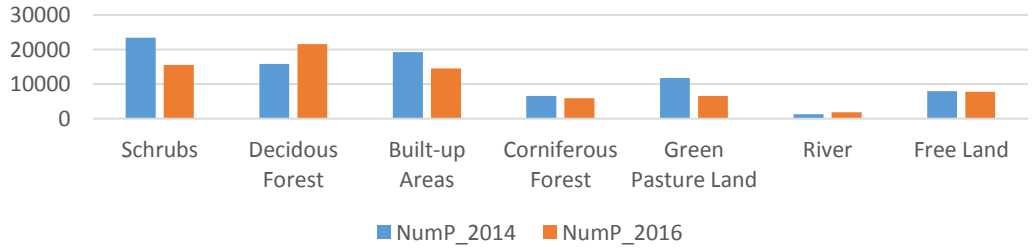
In the chart in this section, the class area,(CA) the sum of areas of all patches belonging to schrubs land cover is seen to be the highest in the year 2016 whereas that of the deciduous forest is seen to be the highest in the year 2014 . The river land cover class has the lowest sum of areas of patches in the study area

Mean Patch Size



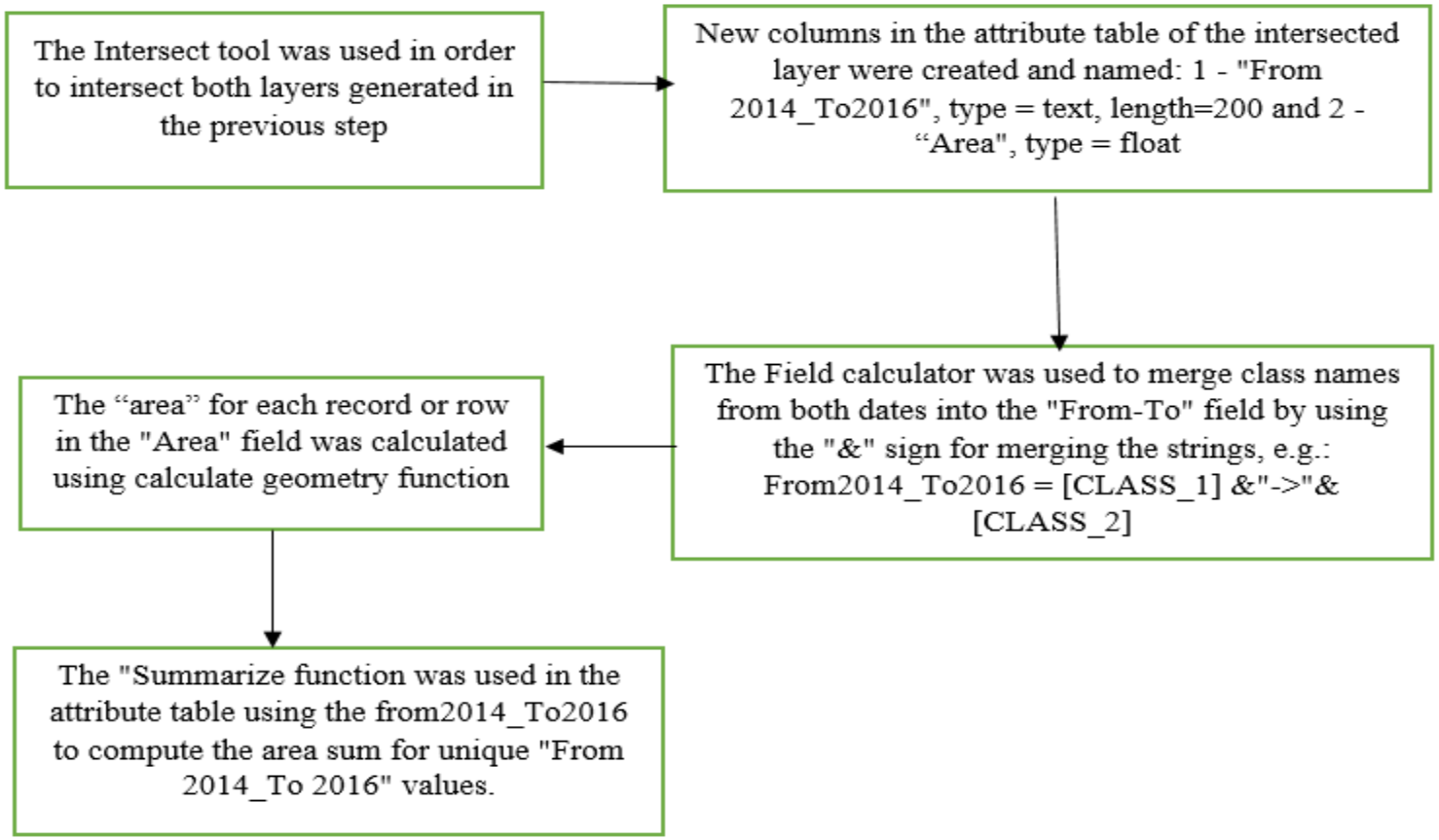
In the chart in this section, the Mean patch size, (MPS) of deciduous forests in 2014 and schrubs in 2016 was higher compared to other land cover classes observed in the area of interest. The lowest observed in green pastures land cover class in 2016

Number of Patches



In the chart in this section, the number of patches (NUMP) for each land cover class varied and changed during the 2 year time period. This also is another significant change identifier experienced in this study.

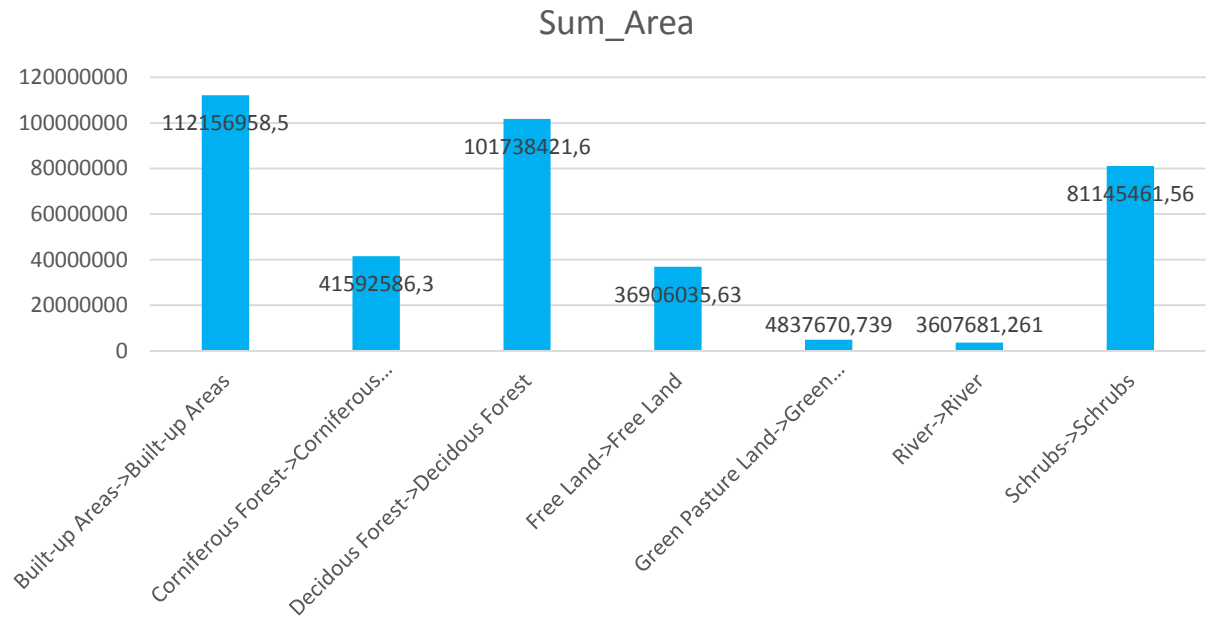
Workflow for Landcover change map from 2014 to 2016 using Esri Arcmap



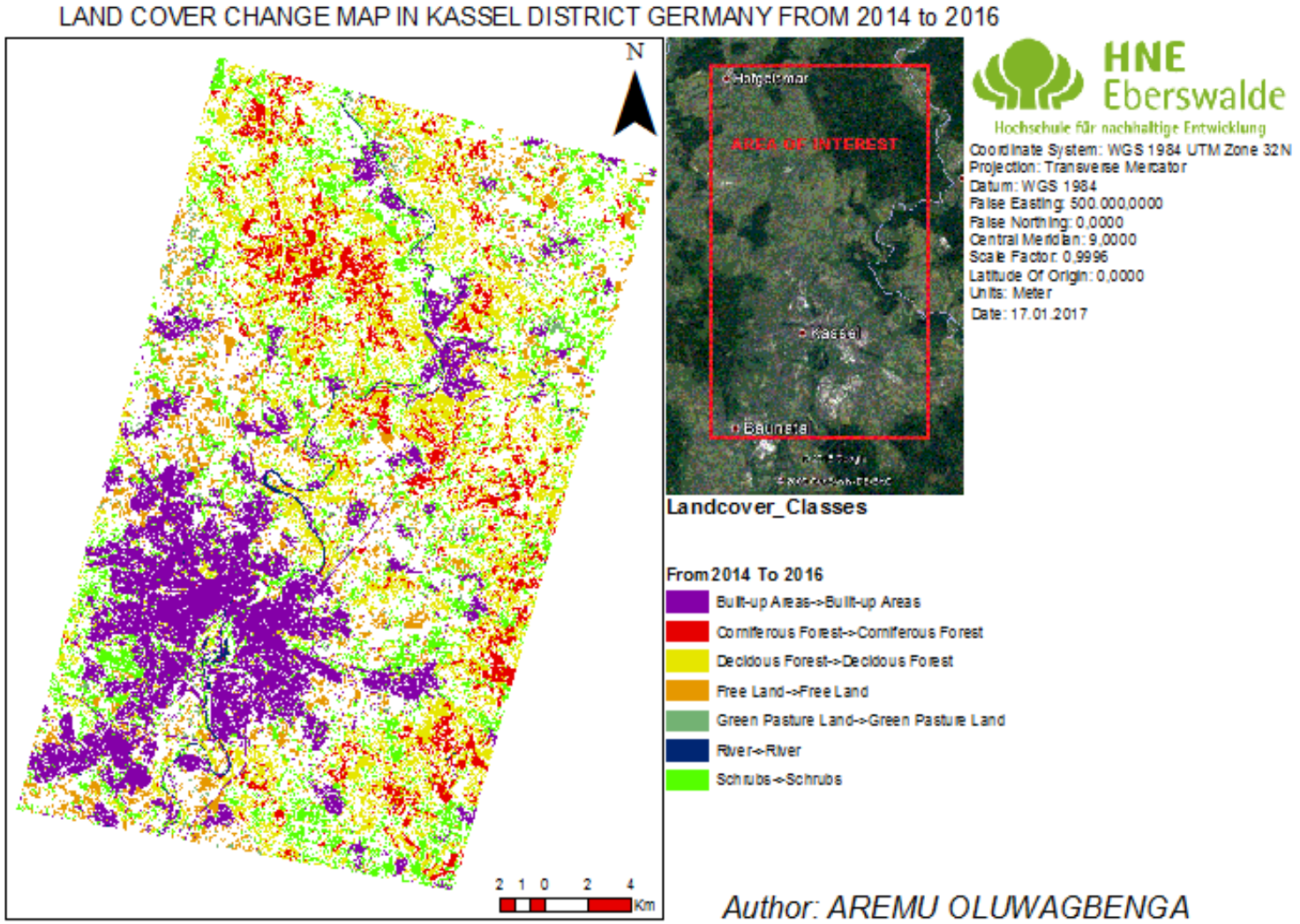
The resultant data from the process above was used to perform statistical functions as a result of multiple varieties of data which was suitable for running Anova of variance. Only needed data was extracted from the resulting data

Landcover change area in square metres from 2014 to 2016

Landcover From2014 _To 2016	Sum_Area (sq m)
Built-up Areas->Built-up Areas	112156958,50
Corniferous Forest->Corniferous Forest	41592586,30
Decidous Forest->Decidous Forest	101738421,60
Free Land->Free Land	36906035,63
Green Pasture Land->Green Pasture Land	4837670,74
River->River	3607681,26
Schrubs->Schrubs	81145461,56

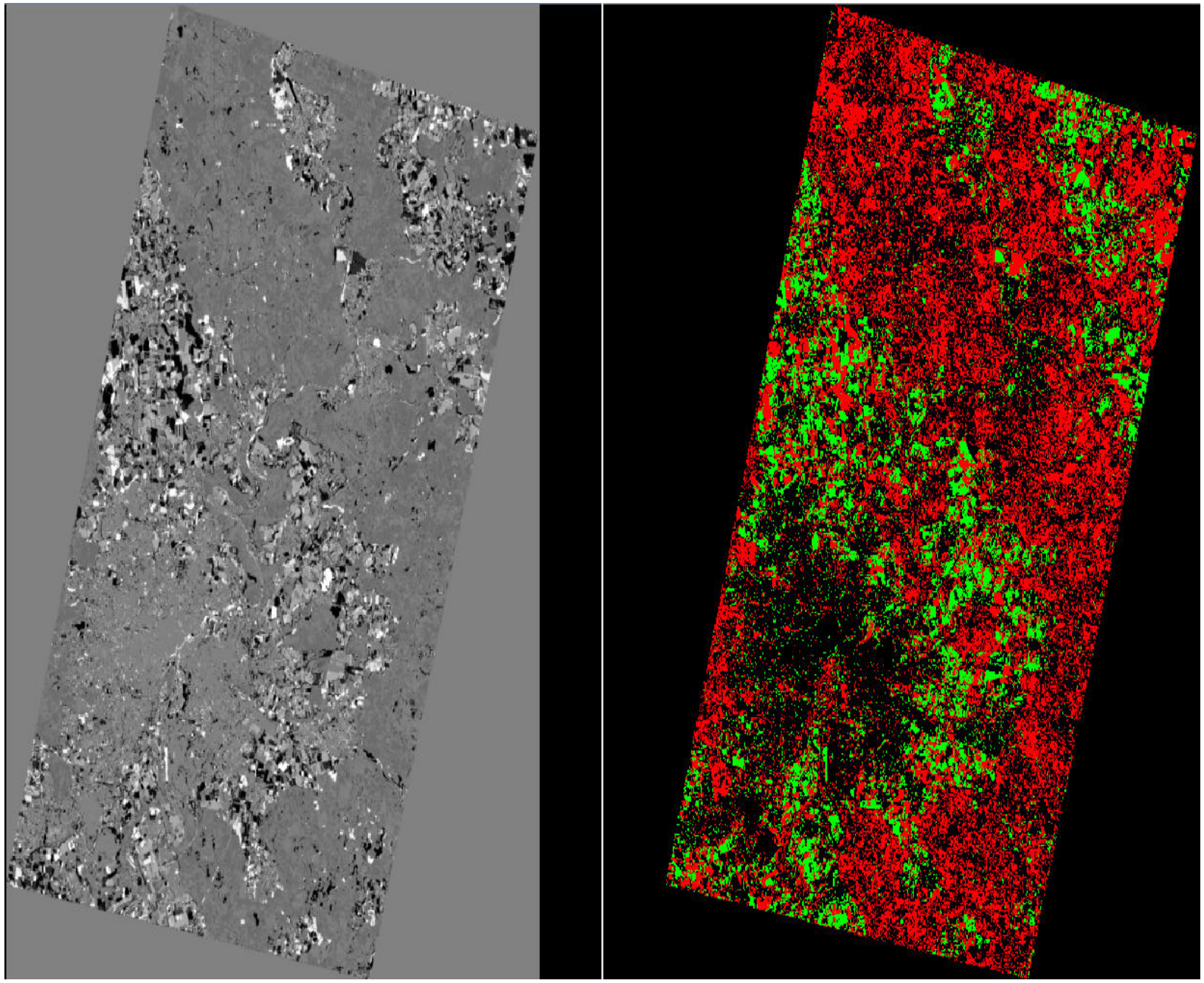


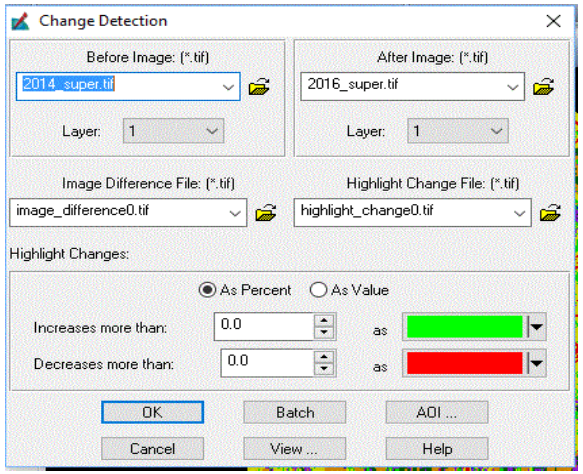
Land Cover Change Map In Kassel District Germany From 2014 to 2016



The image above shows the areas in each land cover class that experienced spatial change. This was done by subtracting coverage area of 2016 from 2014 to derive the difference; used to represent land cover change of each class. Here, the boundaries of each land cover classes was removed (outline width 0.0) in Esri ArcMap to show the exact area cover of the differential change in land cover classes.

Change detection using image difference in Erdas Imagine

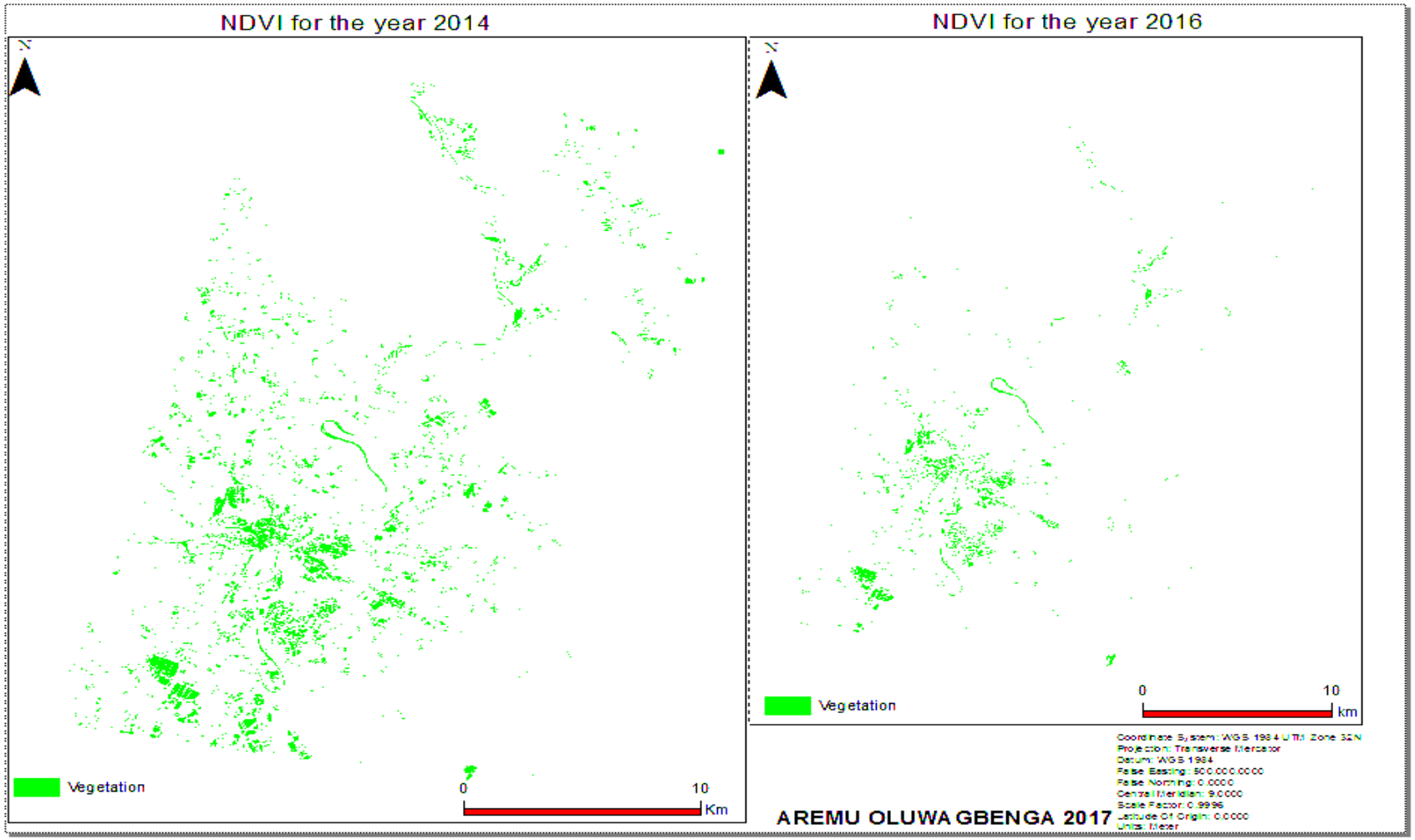




Images from supervised classification were used because this form of image reflectance difference could only be performed on 1band. Green indicates change above 0 threshold and red is change below 0 threshold.Areas in black are considered to have no change and also a possibility of a waterbody being present there.

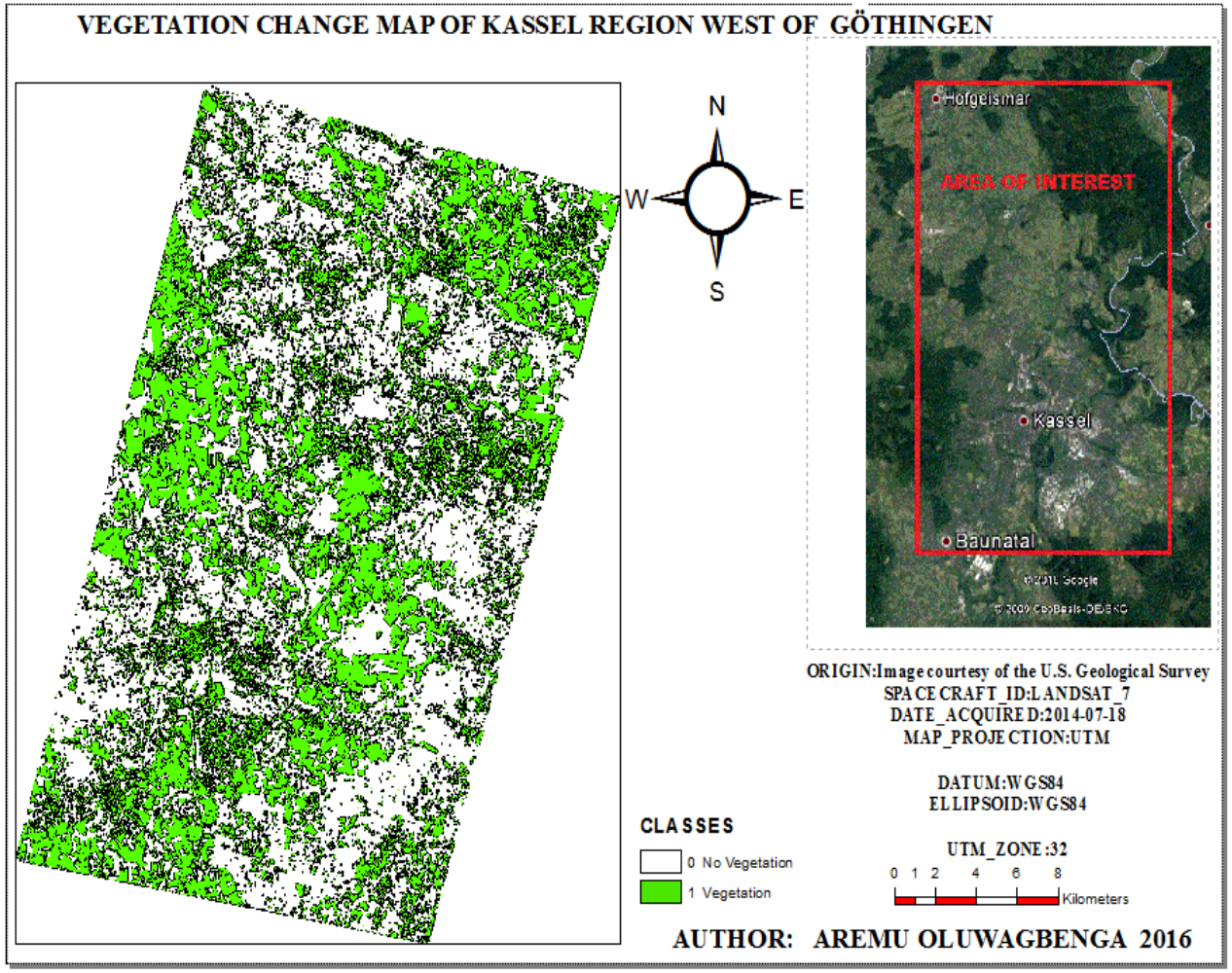
Normalised Differential Vegetation Index

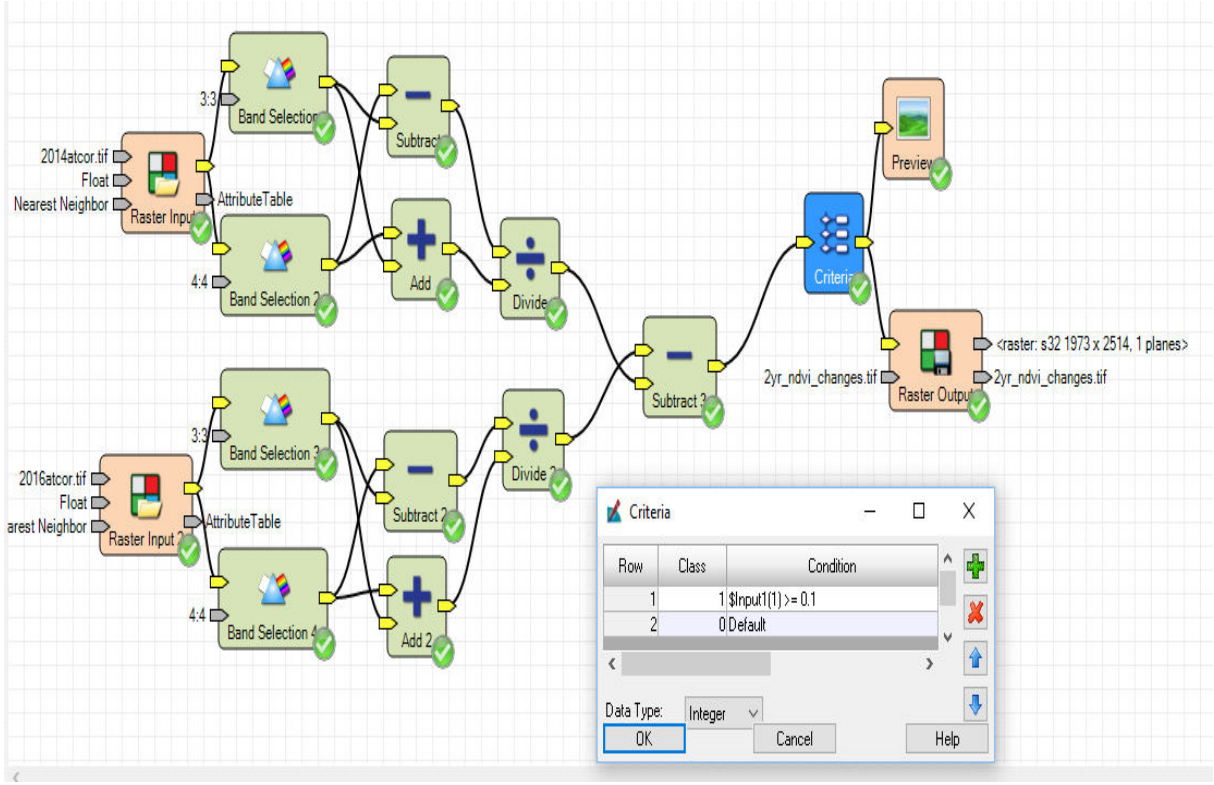
$$NDVI = \frac{Near\ IR\ band\ (Band4) - Red\ band\ (Band3)}{Near\ IR\ Band\ (Band4) + Red\ Band\ (Band3)}$$



The picture displayed was derived by reclassifying the NDVI results for the two years into areas with vegetation and areas without vegetation. In the image displayed,only areas with vegetation were shown in green

Differential NDVI analysis Map and model Format for the year 2014 and the year 2016





The green shows areas that have experienced some vegetative change from the year 2014 to the year 2016 in the area of study. The white parts shows areas with no vegetative classes

Discussion

Observing various results derived from this research, changes were observed right from the level of data pre-processing. From all 7 land cover classes observed, the most observed change according to patch analysis, was with the **built-up areas** followed by the **deciduous forest regions**. Considering it was a 2 year time interval from 2014 to 2016 but changes were still nevertheless observed considering the time of capture of time series imageries being in the same month and the same seasonal conditions.

Conclusion

Remote sensing has further proved to be a very futuristic tool for sustainable forest management practices. Although these processes can be made more effective and accurate with the presence of ground truthed data and also the Digital Elevation models of area of interests around exact dates of image capture. Also combining the use of Erdas Imagine and Esri ArcMap softwares enabled various ways of analysing the data.

It was discovered after the analysis that there was relative increase in the areas occupied by built-up areas land cover class and this led to the conclussion that there was an increase in the demand for building facilities and also an increase in the population of people living in the study area during the time frame analysed.

Unfortunately accuracy analyses was not performed due to unawareness of data like the Corine landcover data as at the time of analysis.

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