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SZKOŁA GŁÓWNA GOSPODARSTWA WIEJSKIEGO W WARSZAWIE

Students Research Colloquium Topic:

Land cover change and landscape fragmentation around a protected forest area in Southwest Ghana

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Introduction

- Changes in forest cover are particularly severe in the tropics and have severe significant impacts on such controversial issues as biodiversity and climate change.
- Malhi *et al*. (2010) points out, “tropical forests have a major influence on global patterns of biodiversity, ecosystem ecology, productivity and biogeochemical cycles, but they remain understudied”.

- Understanding the complexity of landscapes require mapping the landscape through time, incorporating spatial relationships and quantifying its structure (Narumalani et al., 2004).
- The process of forest fragmentation has had three components: an overall loss of forest, a progressive fragmentation of surviving forest stands into smaller blocks, and an increasing spatial isolation of fragments through time (Bennett, 1998, 2003).

- Landscape fragmentation analyses can be used to interpret the impact of land cover changes on a particular habitat, by calculating for each land use/cover class a range of landscape metrics to describe fragmentation and spatial distribution, from satellite-based classifications (Southworth et al., 2004).

- Thus, the application of remote sensing and landscape metrics can be combined to provide more spatially consistent and detailed information on landscape structure, which will facilitate the identification of the social and biophysical processes driving these changes (Brown et al., 2000; Harold et al., 2005).

- Though several researches relating to land cover change in Ghana has been carried out but not much has been done to analyse land cover change and landscape fragmentation of forest reserves.
- In addition, land use/cover studies that aimed at identifying environmental problems such as deforestation focused on land use/cover conversions without considering the actual landscape structural changes.

- Therefore, a study and analysis of land cover change and landscape structure is important to understand the extent and implications of fragmentation within the landscapes.
- The objective of this project is to analyse land cover change and landscape fragmentation in one of Ghana’s ecologically important forest reserves with the Landsat images.

Research Quetions

- How much has the land cover of the Bia Tano forest reserve change within a period of 1989 to 2002?
- To what extent has the landscape become fragmented over the period of 1989 to 2002?

Materials and Methods

Study Area

Methodology

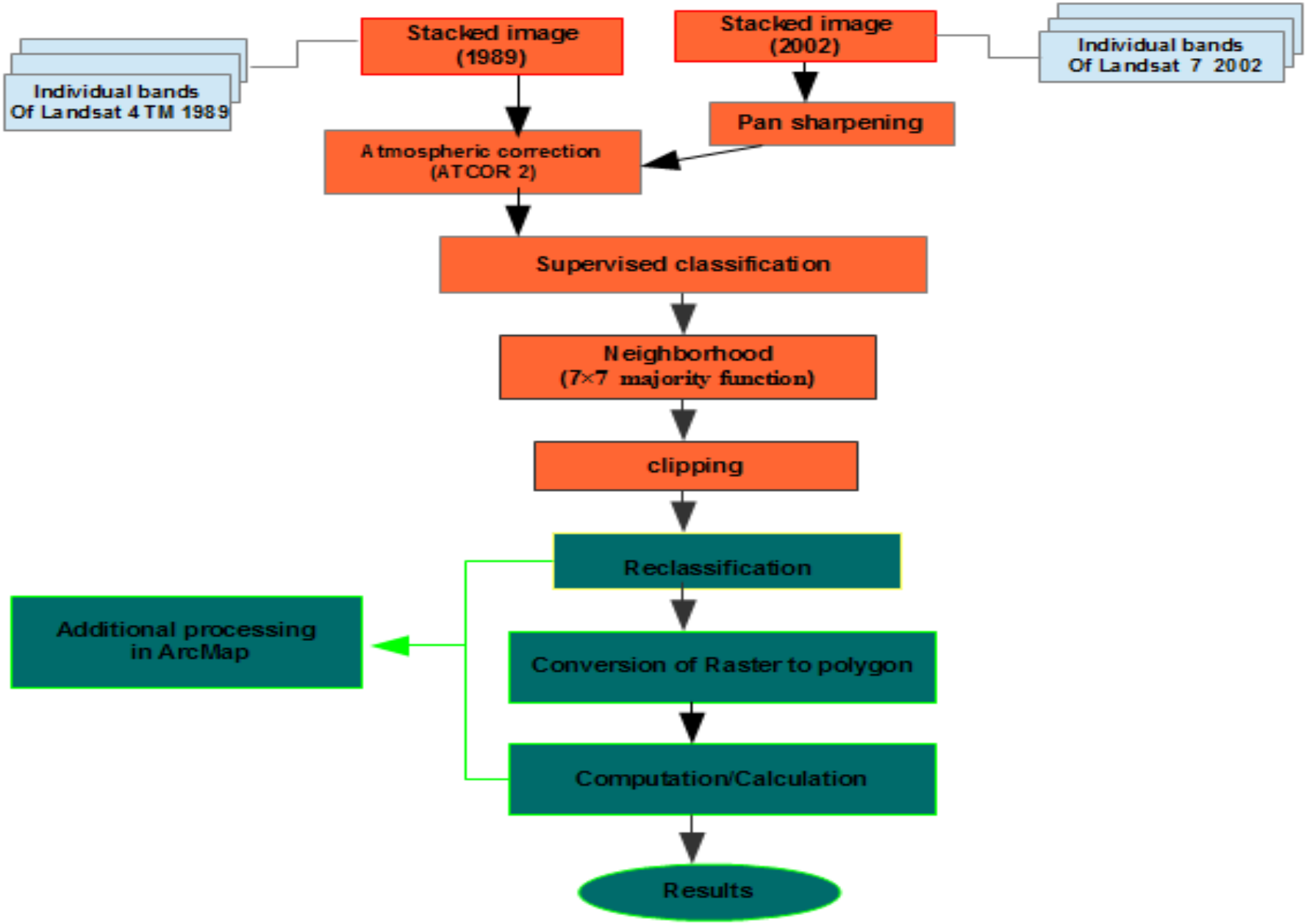
Image download

Landsat images of 1989 (Landsat 4 TM, path 195 and row 055) and 2002(Landsat 7 ETM, path 195 and row 055) were downloaded from USGS database using longitude and latitude of -2.616667 and 7 respectively.

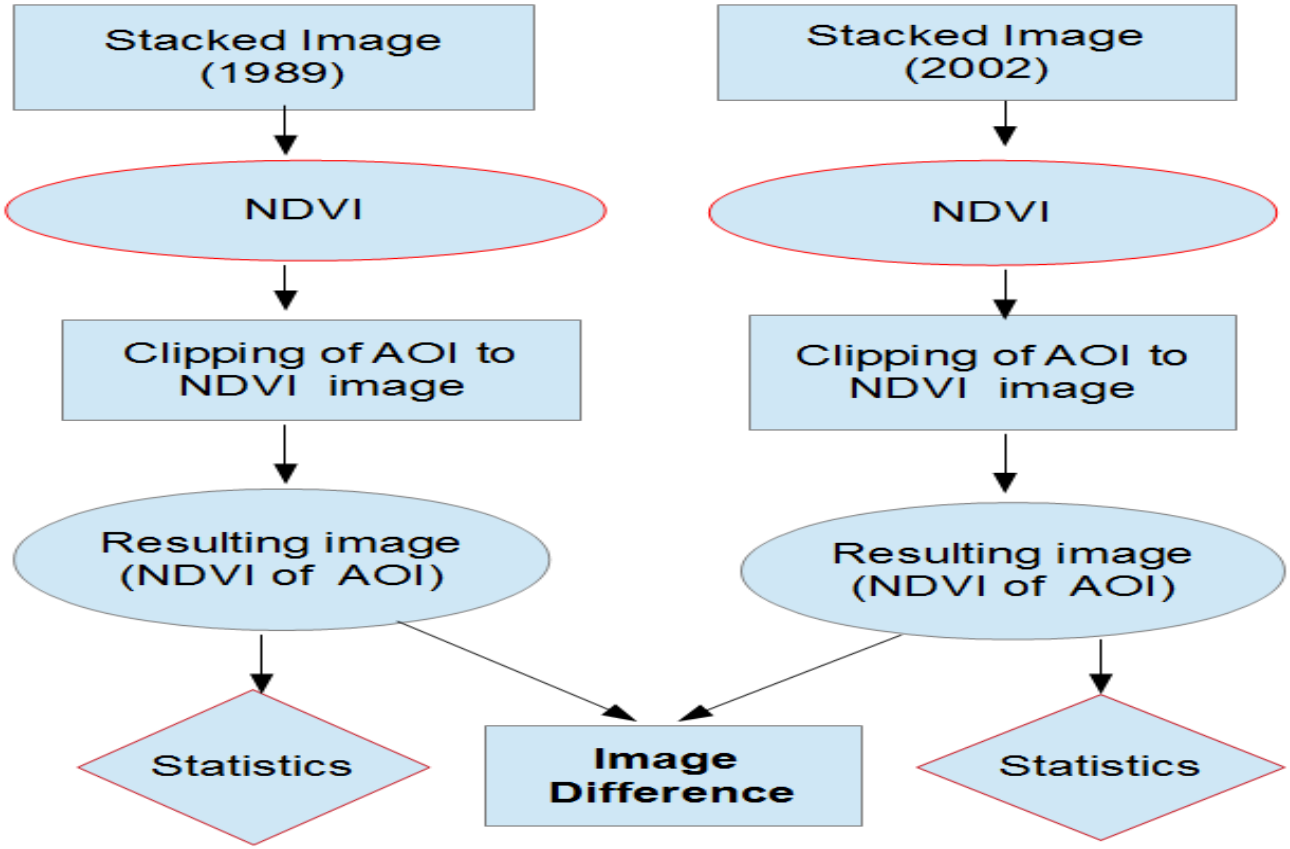
Image processing

To obtain the needed information from the raw images, they were processed with Erdas Imagine 2013, ArcGIS 10.0, and Patch Analyst 5;

Image processing workflow



Normalised Difference Vegetation Index(NDVI)



R codes for statistical Analysis

`> install.packages("foreign")` and `> library(foreign)`. The following codes were then used for the statistical test;

set working directory `> setwd("I:\\Data_Research_project\\ATCOR")`

Read the dbf files of both NDVI values of 1989 and 2002 (i.e. attribute table from ArcGIS) and stores them in data frame of R

```
> dfrm89<-read.dbf("extracted.dbf",as.is=FALSE)
> dfrm02<-read.dbf("extracted3.dbf")
```

#checking for outliers (extreme minimum values)

```
> min(dfrm89$RASTERVALU)
> min(dfrm02$RASTERVALU)
```

#Exclude missing values (coded as -9999)

```
> dfrm89<-subset(dfrm89,dfrm89$RASTERVALU >-2)
> dfrm02<-subset(dfrm02,dfrm02$RASTERVALU >-2)
```

Furthermore, in checking for normality, histograms with curve for the NDVI values (dfrm89$RASTERVALU-1989 NDVI, dfrm02$RASTERVALU-NDVI 2002) of both years were plotted using the found below set of codes;

```
#  >  hist(dfrm89$RASTERVALU,breaks=30,xlab="NDVI",main="Histogram  of  1989 NDVI values",prob=TRUE)
#> curve(dnorm(x, mean(dfrm89$RASTERVALU), sd(dfrm89$RASTERVALU)), add=TRUE
#>  hist(dfrm02$RASTERVALU,breaks=30,xlab="NDVI",main="Histogram  of  2002 NDVI values",prob=TRUE
#>    curve(dnorm(x,    mean(dfrm02$RASTERVALU),    sd(dfrm02$RASTERVALU)), add=TRUE)
```

To be sure of the normality, Kolmogorov test was done for both years NDVI values using the codes;

```
> ks.test(dfrm89$RASTERVALU, "pnorm")
> ks.test(dfrm02$RASTERVALU, "pnorm")
```

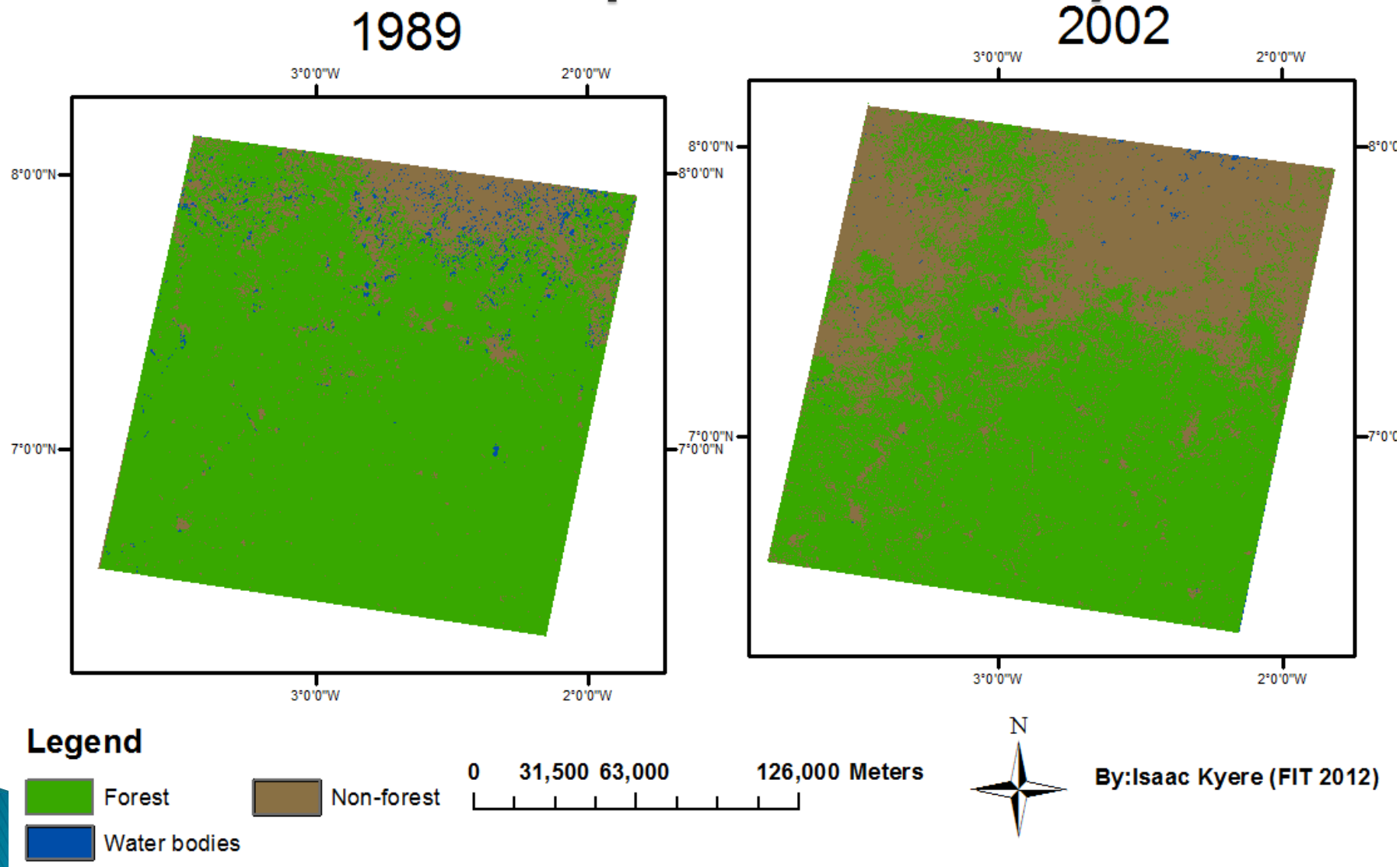
```
> wilcox.test(dfrm89$RASTERVALU, dfrm02$RASTERVALU, paired=TRUE)
```
to reject or accept the null hypothesis.

Landscape metrics analysis(Fragmentation)

- Using patch analyst 5 extensions for ArcGIS, certain landscape metrics or spatial statistics were computed to access the fragmentation of the study area.

Results

Land cover map of the study area



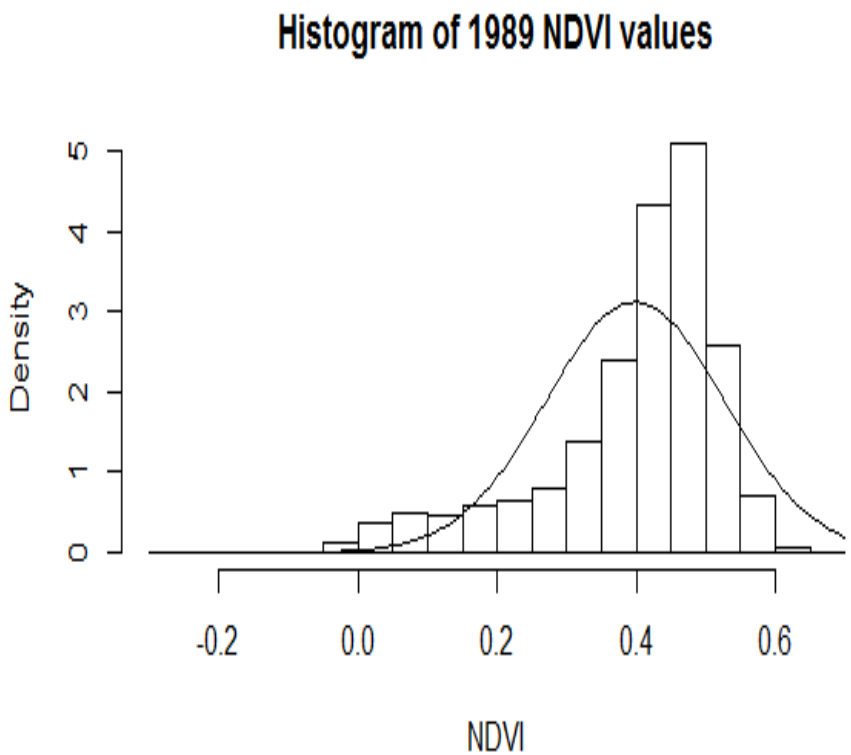
Share of Land cover classes

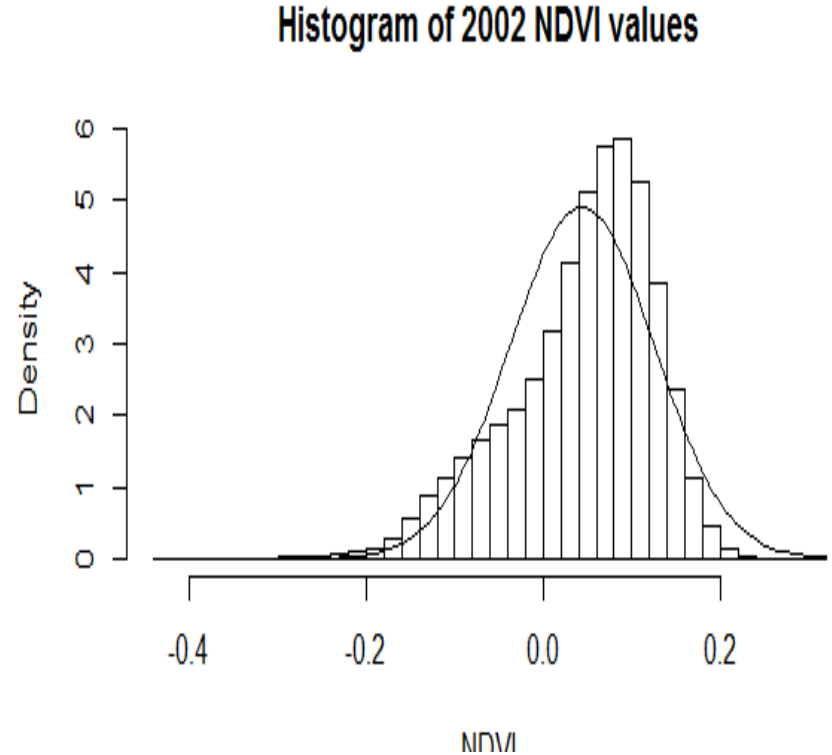
Year	Land cover		Area (ha)	%Area	Total Area (ha)
1989	Land	Forest	2814379.0	85.85%	3278217.01
		Non-forest	415042.29	12.66%	
		Total	3229421.31	98.51%	
	Water bodies		48795.70	1.49%	
2002	land	Forest	1987662.91	60.63%	3278216.47
		Non-forest	1282568.94	39.12%	
		Total	3270231.85	99.76%	
	Water bodies		7984.62	0.24%	

Changes in Land cover classes

	Land cover		Area (ha)	%Area	Relative (%)
Changes (Δ_{Area})	Land	Forest	-826716.11	-25.22%	-29.37%
		Non-forest	+867526.65	+26.46%	+30.53%
		Total	+40810.54	+1.24%	+1.26%
	Water bodies		-40811.08	-1.25%	-83.63%

Normality Test for NDVI values






```
>          ks.test(dfrm89$RASTERVALU,
"pnorm")

        One-sample        Kolmogorov-
Smirnov test

data:  dfrm89$RASTERVALU
D = 0.4974, p-value < 2.2e-16
alternative hypothesis: two-sided
```

```
ks.test(dfrm02$RASTERVALU, "pnorm")

        One-sample        Kolmogorov-
Smirnov test

data:  dfrm02$RASTERVALU
D = 0.4224, p-value < 2.2e-16
alternative hypothesis: two-sided
```

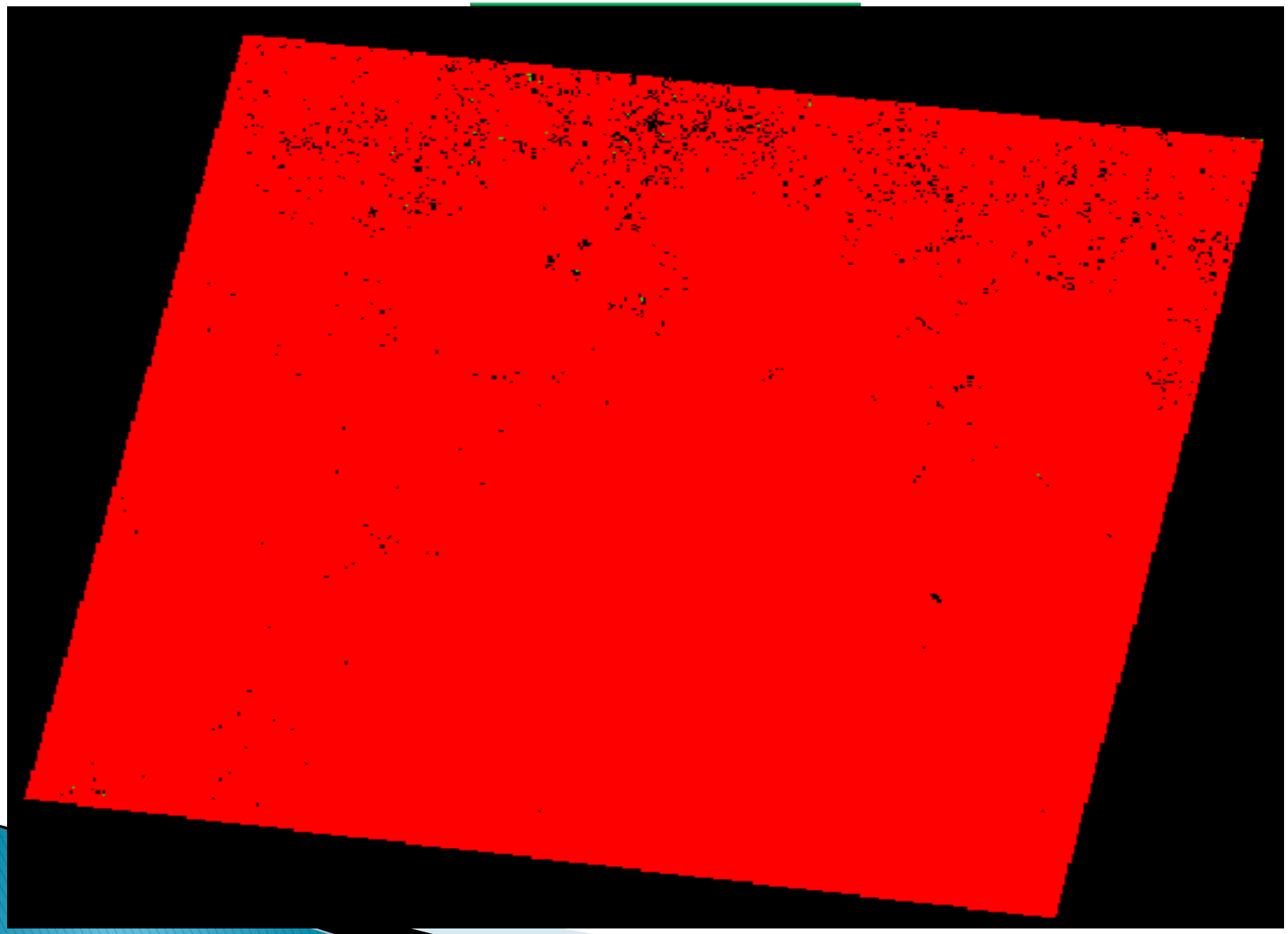
Hypothesis Test

```
> wilcox.test(dfrm89$RASTERVALU, dfrm02$RASTERVALU, paired=TRUE)

        Wilcoxon signed rank test with continuity correction

data:  dfrm89$RASTERVALU and dfrm02$RASTERVALU
V = 8132987742, p-value < 2.2e-16
alternative hypothesis: true location shift is not equal to 0
```

Highlight of change from Image Difference



Statistics of the NDVI Values

Date of image / Parameter	1989	2002
Mini	-0.48	-0.46
Max	0.73	0.36
Mean	0.12	-0.05
Standard deviation	0.35	0.24

Landscape Metrics for the classes

Indices	1989 Land cover classes			2002 Land cover classes		
	Forest	Non-forest	water	Forest	Non-forest	Water
MSI	1.31	1.33	1.33	1.31	1.27	1.35
MPFD	1.32	1.32	1.33	1.36	1.35	1.37
NumP	3639	9509	5119	27284	54834	1716
CA	2814379.02	415042.29	48795.70	1987662.91	1282568.94	7984.62
AWMSI	24.78	17.66	1.90	66.96	40.46	2.69

Landscape Metrics

Year Indicies	1989	2002	Change
SDI*	0.46	0.69	0.23
SEI*	0.41	0.62	0.21
MSI	1.33	1.28	-0.05
MPFD	1.33	1.35	0.02
NumP	18267	83834	65567
MPS	179.46	39.10	-140.36
AWMSI	23.54	56.44	32.9

conclusion

- Forests in Africa are believed to have been cleared 29 times faster than they were being planted in the early 1980s compared to 10.5 in Tropical America and 4.5 in Tropical Asia (Holmberg, Bass and Timberlake, 1991).
- In relation to above, the study has revealed the extent of land cover change and landscape fragmentation in the Bia Tano Forest Tano (which is one of Ghana's protected areas) within a 13 year period.

- The area saw an intensive forest cover loss and a reduction in the water bodies within the reserve with an increase in non-forest areas.
- Logging is one of the main reasons for forest fragmentation, and although it may change the landscape structure at a small spatial scale and not alter the structure of the entire forest mosaic (Leimgruber et al., 2002), it can be associated with

- dramatic changes in the structure and composition of the forests(Echeverrıa et al., 2007), and the Bia forest reserve is an not exception to this assertion.

Limitation of the Research

No accuracy assessment using ground control points was done to ensure the reliability of the classified map obtained from the satellite images and neither were the results compared with any empirical data.

References

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Thank You

Source: http://www.saforestrymag.co.za/articles/detail/important_role_of_forestry_in_ghana