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Change Detection, Monitoring and Mapping the Conditions of Rufiji Delta Using Remote Sensed Data

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Abstract

The study focused on change detection, monitoring and mapping of water, forests, grasslands and wetlands resources in Rufiji Delta using remote sensed data. The general objective of the study was to complement the *insitu* methods for change detection with remote sensed data and GIS technique for monitoring and mapping wetlands forest, water and grasslands in Rufiji Delta. Specific objectives were to determine current status of the forests, water and wetland in Rufiji Delta using Land sat Images and develop a map of Rufiji Delta using remote sensed data. The study used LandSat Images of 1997, 2000 and 2007 which were processed using ERDAS computer software. Unsupervised classification approach specifically the Iterative Self-Organizing Data Analysis (ISODATA) algorithm was utilized. The selected AIO were subjected to Matrix Union Analysis which the techniques employed when attempting to reveal the change detection. There was an average of 7% and 12% of forest histograms that changed into grassland histograms and of grassland histogram that changed into forest histogram, respectively between years of 1997 to 2007. There was average loss of 1.73% and 1.86%% of grassland histograms that changed into wetlands histograms and wetland histograms that changed into grasslands histogram, respectively between years of 1997 to 2007. There was 0.8% and 7% average loss of histograms of wetlands which change into forests histograms and average loss of forests histograms into wetland histograms, respectively between years of 1997 to 2007. There was an average percentage loss of 0.12% and 0.26% of histograms of forests histograms that changed into water histograms and water histograms that change into forests histograms, respectively between years of 1997 to 2007. The results shows that there is-declining trend in forests reservoir by 6.2% which changes into wetlands such situation in future will encourage water lodging conditions, soil erosion and secondary salinization during heavy rains.

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The map of Rufiji Delta shows that Kiomboi, Mchinga Msufini and Nyamisati village are very close to the delta and Indian Ocean hence susceptible to on flash and sea level rise floods. Thus planning of site selection of dams and tracking canal to manage the expected floods should well establish in these villages. This study has confirmed that there is opportunity for using remote sensed data for change detection, monitoring and management of natural resources in Rufiji Delta. However the information from unsupervised classification should be used as preliminary findings that need to be supplemented with supervised classification.

Keywords: Change detection in Rufiji Delta; Remote sensing for Monitoring; mapping natural resources.

1. Introduction

The complexity nature of human disturbances coupled with aggressive climate change impacts in Rufiji Basin are necessitating for modern methods of monitoring and management of natural resources in the basin. In particular, the in situ methods used in Rufiji Basin for monitoring and management of natural resources in needs to be supplemented with modern methods remote sensed data and geographic information systems (GIS). In situ methods are time consuming, tedious, fatigues and expensive. The development of digital change detection era and regular acquisition of digital data of the Earth surface in multispectral bands allowed scientists to get relatively consistent data over time and to characterize changes over relatively large area for the first time. Among many approach of change detection vector analysis of spectral changes is based on the spatial representation of change in a spectral space [1] has the advantage to process concurrently any number of spectral bands. Thus, when a pixel undergoes a change between two dates, its position in n-dimensional spectral space is expected to change. This change is represented by a vector which is defined by two factors, the direction which provides information about the nature of change and the magnitude which provides information about the level of change. Change detection through remote sensed data offer quick and reliable means for determining and monitoring land-cover changes in large geographic extents and with high temporal coverage [2]. However, application of remote sensed data and GIS for change detection and monitoring, management natural resources in Rufiji Delta is diminutively reported. Remote sensed data and GIS provide information even inaccessible areas which can't be reached by in situ methods. Incorporating the application of remote sensed data in determining the change detection, monitoring and mapping of resources in Rufiji Delta is very imperative since it's reported that, the mangrove forests are heavily exploited for both the export market and local use [3]. Thus, the overall objective of the research was t complement the in situ methods for change detection with remote sensed data and GIS technique for monitoring and mapping wetlands forest, water and grasslands in Rufiji Delta. The specific objectives were to determine current status and map the forests, water and wetland in Rufiji Delta using Land sat Images of 1997, 2002 and 2007. Time series analysis using LandSat image of 1997 and 2007 have provided the rate of loss of forest, wetland and water in the Rufiji Delta which is also crucial for planning and developing strategic intervention mechanism. In particular, the study has provided the preliminary findings that are vital for future planning of land use/land cover programs in village close to the delta. Moreover, mapping of the Delta has revealed that, villages close to the delta are prone to on flash and sea level rise floods which on other hand is calling for design of dams and tracking canal to manage floods. However, information obtained from unsupervised classification of images should be used as preliminary findings that need to be supplemented by findings from supervised classification approach which involves ground truthing.

2. Methodology

2.1 Description of the study area

The Rufiji Delta is located about 200 km south of Dar es Salaam. Nine major tributaries form the Rufiji River basin, which extends for about 177,000 km^2 and covers roughly 20 percent of Tanzania's area [3]. There are some 43 islands in the Delta though the entire delta area is generally flat. An inventory carried out in 1989 shows that the mangroves of mainland Tanzania cover about 115,500 ha of which the Rufiji Delta alone is about 53,255 ha (40 percent of total).

2.2 Materials

- LandSat Image of 1997, 2000 and 2007
- Digital Map of Coastal Region of Tanzania

2.3 Methods

2.3.1 Image preprocessing

Unsupervised approach was utilized in this project, specifically the Iterative Self-Organizing Data Analysis (ISODATA) algorithm. A full scene of Landsat Thematic Mapper (TM) imagery of 1997, 2000 and 2007 was used in the study. The images encompassed seven bands (Blue, Green, Red, Near Infrared, Short-wave Infrared, Thermal Infrared and Mid Infrared). Land Sat Images was imported to ERDAS imagine for converting the file from TIFF format to Imagine (*img) using import module in ERDAS 10 computer software. Images were displayed and layer stacked using interpreter icon that was followed by selecting Utilities- layer stack tool in the ERDAS 10 computer software. The images were reprojected to Grid UTM zone 37 in Arc 1960 to register the output image into the real world coordinates. An Area of Interest (AOI) which is Rufiji Delta was created and stored for further analysis. Classification process which involves sorting pixels into a finite number of individual classes, or categories, of data based on their brightness values was done using unsupervised classification techniques. Unsupervised classification techniques involve assigning the pixels of an image to classes by calculating the distances between specific pixels within feature space, and assigning them to cluster-centers. Iterative Self-Organizing Data Analysis Technique (ISODATA) was used for assigning classes. This algorithm enabled grouping of pixels with similar spectral characteristics by deriving statistics (mean and standard deviation) of groups and assigning a class to each pixel according to its distance from mean [4]. In first step of unsupervised classification 30 classes with 5 iterations was selected and this was reduced to four classes. The classes were reduced to four classes which are water, forests, wetlands and grasslands. For the purpose of this study only the Rufiji Delta were selected as Area of Interest (AOI). **Figure (1-3)** represents the AOI for unsupervised classified images of 1997, 2000 and 2007, respectively. The selected AIO of Rufiji Delta was classified into four classes which are water, wetlands, forests and grasslands. The reduction of the 30 classes to classes were done using recode tool in the ERDAS 10.0 computer software. The selected AIO for image of 1997, 2000 and 2007 were subjected to Matrix Union Analysis. Matrix union analysis is the techniques employed when attempting to reveal the change detection [5]. In this approach, once the data base (layers and attribute data) is assembled, the layers can be analyzed and new information extracted. Some information can be extracted simply by looking at the layers and visually comparing them to other layers [5]. In this study changes detection in class over time, post-classification change detection was employed using the matrix union function in ERDAS Imagine by methods developed by [5, 6] with some modification. In the matrix analysis the image of 1997 and 2000 was used followed by 1997 to 2007 and finally image of year 2000 and 20007.

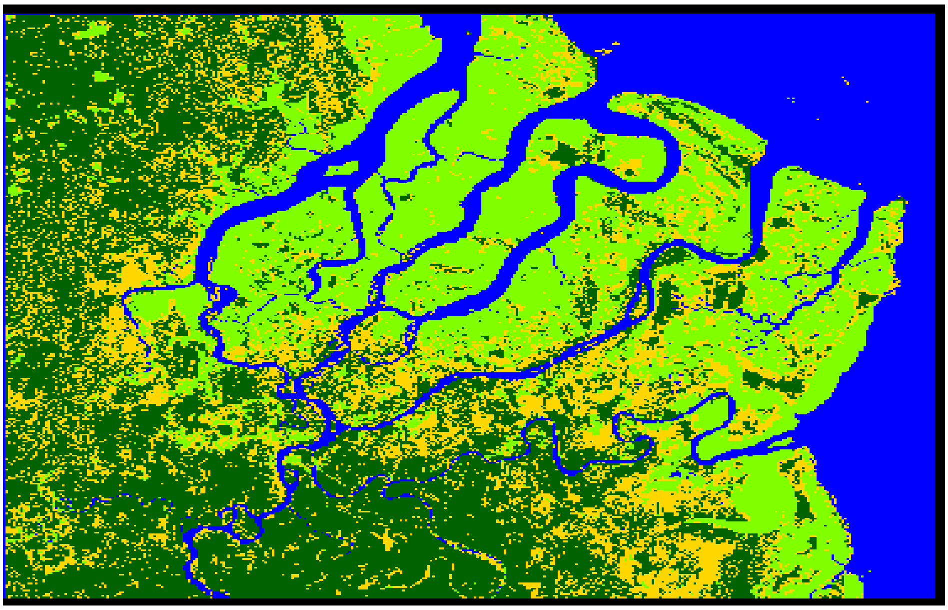

Figure 1: Unsupervised Classification of LandSat Image 1997

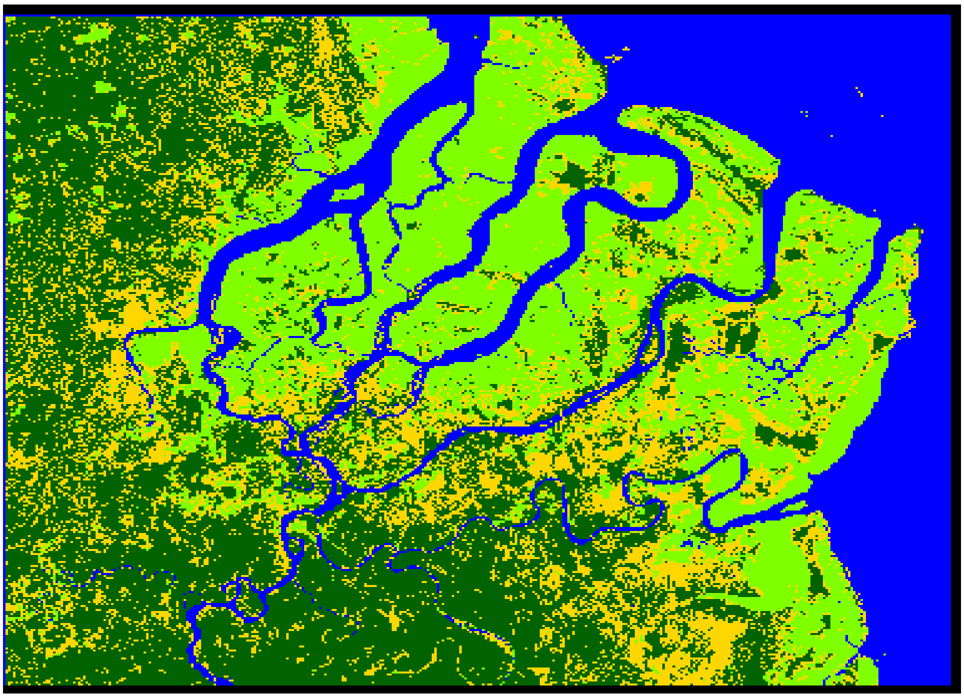

Figure 2: Unsupervised Classification of LandSat Image 2000

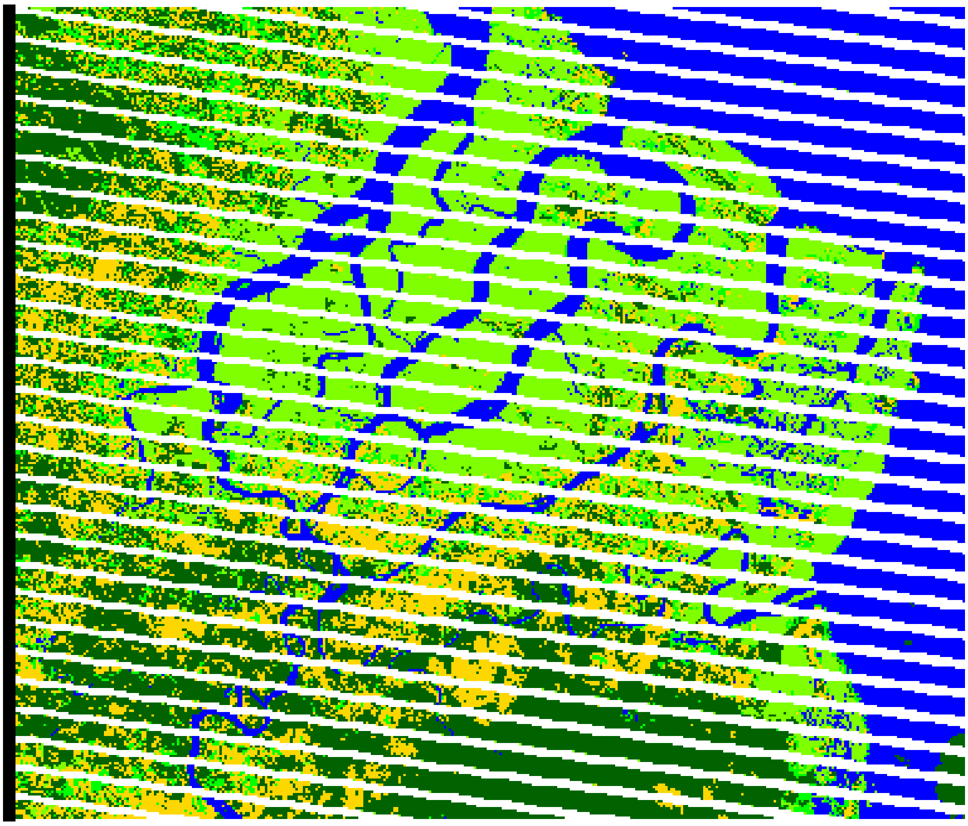

Figure 3: Unsupervised Classification of LandSat Image 2007

3. Results

3.1 Output of Matrix Union Analysis for Change Detection in Rufiji Delta

Figure (4 - 6) are the output image of year 1997 versus 2000, 1997 versus 2007and 2000 versus 2007, respectively. **Table (1 - 3)** narrates the output of Matrix Union Analysis of Image of 1997 versus 2000, 2000 versus 2007 and 1997 versus 2007 of Rufiji Delta while **Table (4 - 16)** summarizes the computed percentage loss of wetlands, forests, water and grasslands histogram between years of 1997 to 2007.

3.2 Percentage Loss of Wetland, Forest, Water and Grasslands between Years of 1997 to 2007

3.2.1 The percentage loss of wetlands histograms into forests histograms and it's versus

Table (4) below summarizes the percentage loss of wetland histograms into forest histograms and percentage loss of wetland histograms into forest histogram. There was average percentage loss of wetlands histograms into forests histograms at the rate of 1.1% between years of 1997 to 2000, at the rate of 0.6% between years of 2000 to 2007, at the rate of 0.6% between years of 1997 to 2007. Thus, there is 0.8% average of histograms of wetlands which change into forests histograms. Besides, **Table (5)** shows that the average percentage loss of forests histograms into wetland histograms per year varies between 8, 6 and 7% for years between 1997 to 2007, 2000 to 2007 and 1997 to 2007, respectively. Thus, there is an average of 7% loss of forests histograms into wetland histograms between years of 1997 to 2007**.** When compared to average percentage loss of wetland histograms into forests histograms the net loss of forest histograms by 6.2% to wetlands histograms between years of 1997 to 2007 is obtained.

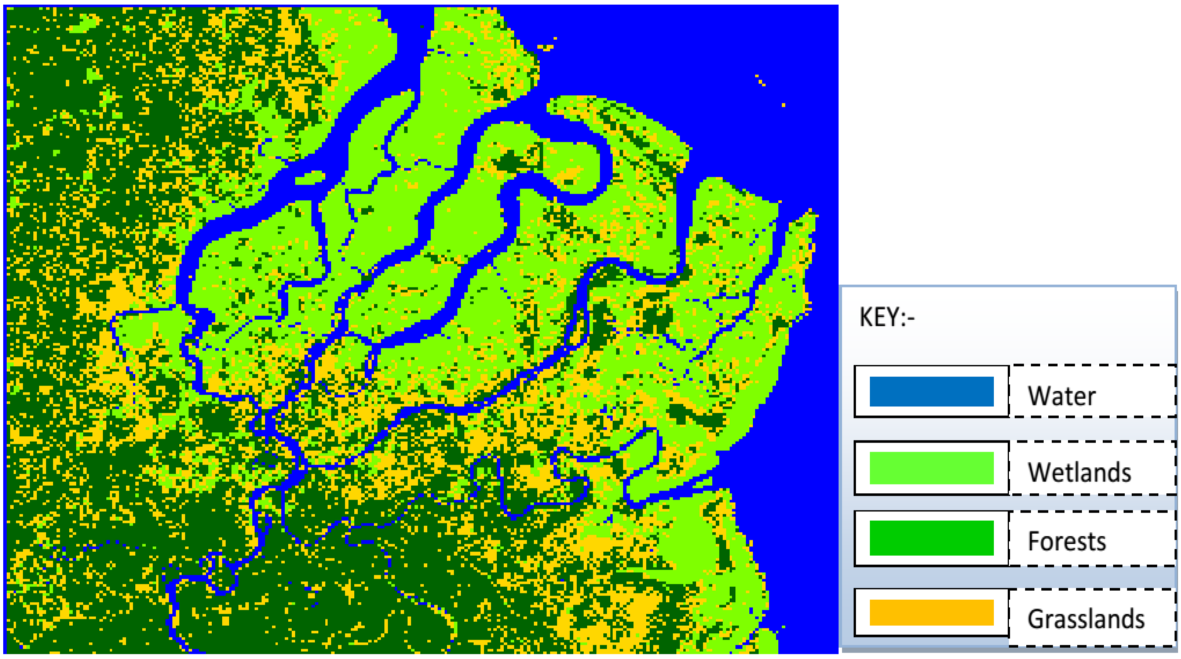

Figure 4: Output of matrix union analysis of image 1997 versus 2000

Table 1: Output matrix union analysis of image of 1997 versus 2000

Rows	Histogram	Recode_1997	Recode_2000	Description
1	799946	1	1	Water (stable)
2	9205	1	2	Loss of water to forests
3	34444	1	3	Loss of water to wetlands
4	86109	1	4	Loss of water to grasslands
5	7102	2	1	Loss forests to water
6	917778	2	2	Forests (stable)
7	314964	2	3	Loss of forests to grassland
8	17724	2	4	Loss of forests to wetland
9	5007	3	1	Loss of grassland to water
10	264928	3	2	Loss of grassland to forest
11	221671	3	3	Grassland (stable)
12	40686	3	4	Loss of grassland to wetland
13	4016	4	1	Loss of wetland to water
14	30945	4	2	Loss of wetland to forests
15	85041	4	3	Loss of wetland to grassland
16	777558	4	4	Wetland (stable)

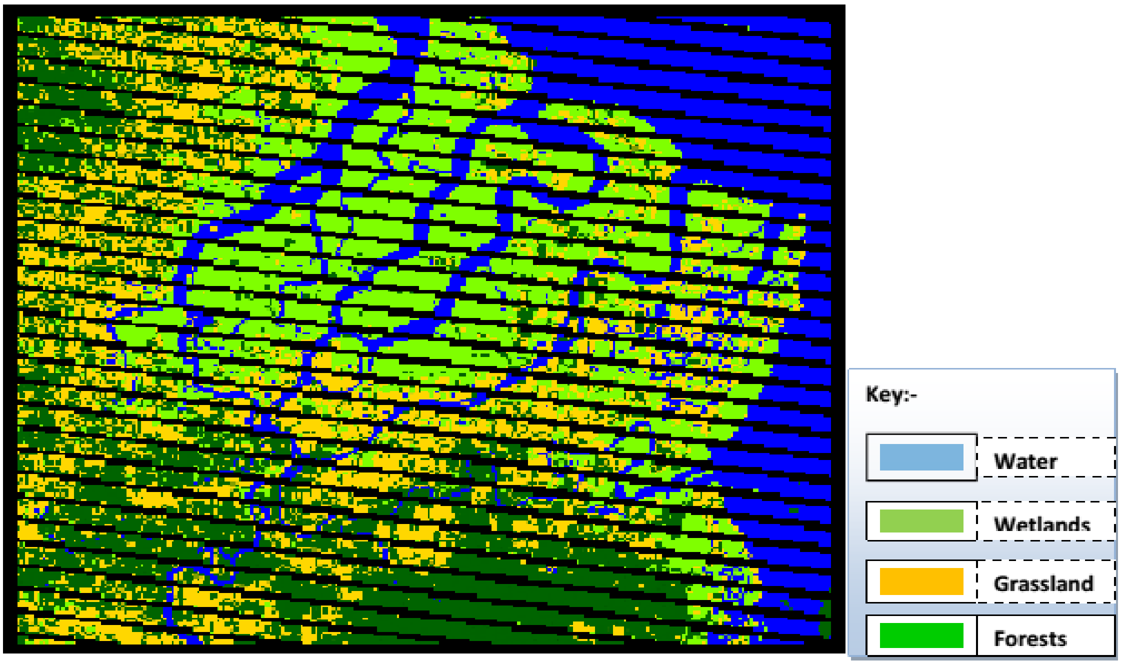

Figure 5: Output of matrix union analysis of image of 1997 versus 2007

Table 2: Output of matrix union of 1997 versus 2007

Rows	Histogram	Recode_1997	Recode_2007	Description
1	567359	1	1	Water (stable)
2	17338	1	2	Loss of water to forests
3	42351	1	3	Loss of water to wetlands
4	26096	1	4	Loss of water to grasslands
5	8895	2	1	Loss forests to water
6	489081	2	2	Forests (stable)
7	403734	2	3	Loss of forests to grassland
8	14169	2	4	Loss of forests to wetland
9	9823	3	1	Loss of grassland to water
10	171856	3	2	Loss of grassland
11	153605	3	3	Grassland (stable)
12	47492	3	4	Loss of grassland to wetland
13	20036	4	1	Loss of wetland to water
14	40996	4	2	Loss of wetland to forests
15	77179	4	3	Loss of wetland to grassland
16	512033	4	4	Wetland (stable)

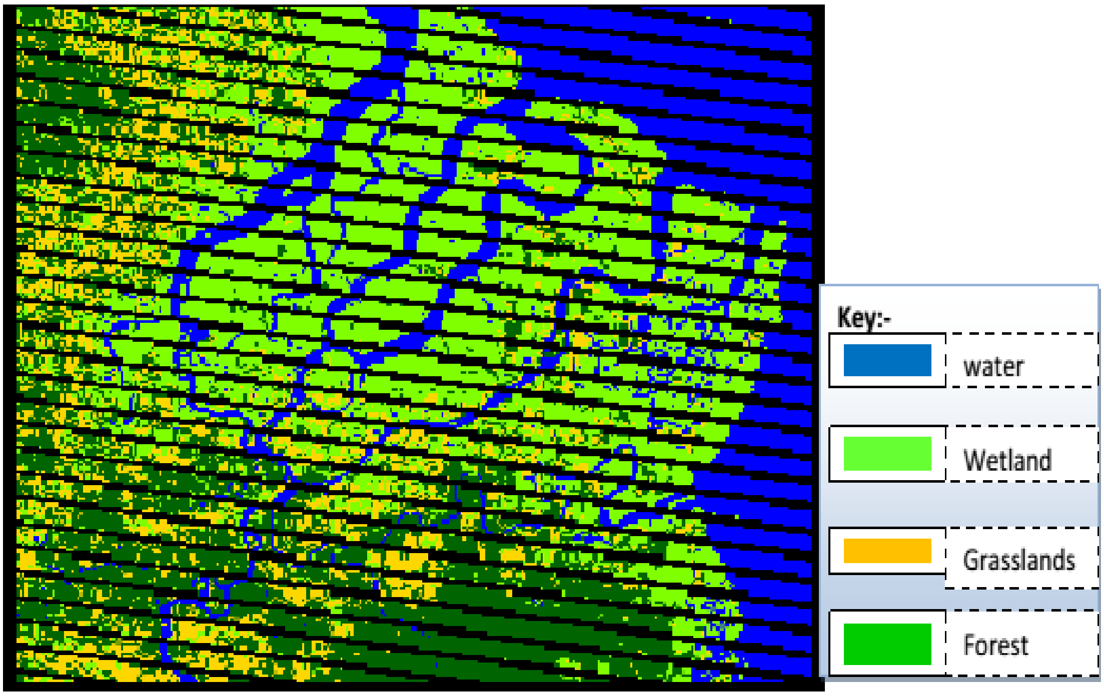

Figure 6: Output of matrix union analysis of image 2000 versus 2007

Table 3: Output of Matrix Union Analysis of Image of 2000 versus 2007

Rows	Histogram	Recode_2000	Recode_2007	Description
1	546375	1	1	Water (stable)
2	8192	1	2	Loss of water to forests
3	9834	1	3	Loss of water to wetlands
4	4380	1	4	Loss of water to grasslands
5	6491	2	1	Loss forests to water
6	500865	2	2	Forests (stable)
7	359623	2	3	Loss of forests to grassland
8	23584	2	4	Loss of forests to wetland
9	21903	3	1	Loss of grassland to water
10	182170	3	2	Loss of grassland
11	224019	3	3	Grassland (stable)
12	46904	3	4	Loss of grassland to wetland
13	30458	4	1	Loss of wetland to water
14	26972	4	2	Loss of wetland to forests
15	82741	4	3	Loss of wetland to grassland
16	524652	4	4	Wetland (stable)

3.2.2 The percentage loss of forests histograms into water histograms it's versus

From the Table (4.6) above there was average percentage loss of forests histograms into water histograms at the rate of 0.17% between years of 1997 to 2000, at the rate of 0.10% between years of 2000 to 2007, at the rate of 0.097% between years of 1997 to 2007. Thus, there is 0.12% average of histograms of forests histograms that changed into water histograms.

Table 4: The Percentage Loss of wetland histograms into forest histograms for years between 1997 to 2000, 2000 to 2007 and 1997 to 2007

Year	**Percentage loss of wetlands histograms into forests histograms (%)**	**Average Percentage loss per year ((%)**
1997 – 2000	3.3	1.1
2000 – 2007	4.1	0.6
1997 – 2007	6.3	0.6
Total	13.7	2.3
Average	4.56	0.8

Table 5: The Percentage Loss of forests histograms into wetland histograms for years between 1997 to 2000, 2000 to 2007 and 1997 to 2007

Year	**Percentage loss of forests histograms into wetland histograms (%)**	**Average Percentage loss per year (%)**
1997 – 2000	25	8
2000 – 2007	40	6
1997 – 2007	73	7
Total	138	21
Average	46	7

Table 6: The Percentage Loss of forests histograms into water histograms for years between 1997 to 2000, 2000 to 2007 and 1997 to 2007.

Year	**Percentage loss of forests histograms into water histograms (%)**	**Average Percentage loss per year (%)**
1997 – 2000	0.52	0.17
2000 – 2007	0.72	0.10
1997 – 2007	0.97	0.09
Total	2.21	0.36
Average	3.00	0.12

On contrary, the average percentage loss of water histograms into forests histograms was at the rate of 0.33%

between years of 1997 to 2000, at the rate of 0.20% between years of 2000 to 2007, at the rate of 0.26% between years of 1997 to 2007 **(Table 7).** Thus, there is 0.26% average of histograms of water histograms that change into forests histograms. There is net gain in forest histograms by 0.14% from wetlands histograms between years of 1997 to 2007.

Table 7: The Percentage Loss of water histograms into forest histograms between years 1997 to 2000, 2000 to 2007 and 1997 to 2007.

Year	**Percentage loss of water histograms into forests histograms (%)**	**Average Percentage loss per year (%)**
1997 – 2000	0.99	0.33
2000 – 2007	1.4	0.20
1997 – 2007	2.6	0.26
Total	4.99	0.79
Average	1.66	0.26

3.2.3 Percentage loss of water histograms into grasslands histograms and it's versus

From the Table (8) above there was average percentage loss of water histograms into grasslands histograms at the rate of 3.09% between years of 1997 to 2000, at the rate of 0.10% between of years 2000 to 2007, at the rate of 0.39% between years of 1997 to 2007. Thus, there is 1.19% average of histograms of water histograms that changed into grasslands histograms.

Table 8: The Percentage Loss of Water histograms into Grasslands histogram between years of 1997 to 2000, 2000 to 2007 and 1997 to 2007.

Year	**Percentage loss of water histograms into grasslands histograms**	**Average Percentage loss per year**
1997 – 2000	9.26	3.09
2000 – 2007	0.77	0.10
1997 – 2007	3.99	0.39
Total	14.02	3.58
Average	4.67	1.19

On contrary, the average percentage loss of grasslands histograms into water histograms was at the rate of 0.31% between years of 1997 to 2000, at the rate of 0.66% between years of 2000 to 2007, at the rate of 0.26% between years of 1997 to 2007 **(Table 9).** Thus, there is an average of 0.52% histograms of water histograms that changed into grasslands histograms. Therefore, there, is net gain of grassland histograms by 0.67% from water histograms between years of 1997 to 2007.

Table 9: The Percentage Loss of Loss of grasslands histograms into water histograms between years of 1997 to 2000, 2000 to 2007 and 1997 to 2007

Year	Percentage loss of grasslands histograms into water histograms (%)	Average Percentage loss per year (%)
1997 – 2000	0.94	0.31
2000 – 2007	4.60	0.66
1997 – 2007	2.57	0.26
Total	8.11	1.57
Average	2.7	0.52

3.2.4 The percentage loss of wetlands histograms into water histograms and it's versus

From the **Table (10*)*** below there was average percentage loss of wetlands histograms into water histograms at the rate of 0.15% between years of 1997 to 2000, at the rate of 0.66% between years of 2000 to 2007, at the rate of 0.31% between years of 1997 to 2007. Thus, there is 0.37% average of histograms of wetlands histograms that changed into water histograms between years of 1997 to 2007. On contrary, the average percentage loss of loss of water histograms into wetlands histograms was at the rate of 5.30% between years of 1997 to 2000, at the rate of 0.25% between years of 2000 to 2007, at the rate of 0.65% between years of 1997 to 2007 **(Table 11).** Thus, there is 2.07% average of histograms of loss of water histograms into wetlands histograms. Therefore, there, is net gain of wetland histograms by 2% from water histograms between years of 1997 to 2007.

Table 10: The Percentage Loss of wetland histograms into water histograms between years of 1997 to 2000, 2000 to 2007 and 1997 to 2007.

Year	Percentage loss of wetlands histograms into water histograms (%)	Average Percentage loss per year (%)
1997 – 2000	0.45	0.15
2000 – 2007	4.58	0.66
1997 – 2007	3.08	0.31
Total	8.11	1.12
Average	2.70	0.37

3.2.5 The percentage loss of grasslands histograms into water histograms and it's versus

From the Table (12) below there was average percentage loss of grasslands histograms into water histograms at the rate of 0.22% between years of 1997 to 2000, at the rate of 0.66% between years of 2000 to 2007, at the rate of 0.45% between years of 1997 to 2007. Thus, there is 0.44% average of grasslands histograms that changed into water histograms between years of 1997 to 2007. On contrary, the average percentage loss of water histograms into grasslands histograms was at the rate of 3.09% between years of 1997 to 2000, at the rate of

0.11% between years of 2000 to 2007, at the rate of 0.40% between years of 1997 to 2007 (Table 13). Thus, there is 1.20% average of histograms of water histograms that change into grassland histograms. Therefore, there, is net gain of grassland histograms by 1.2% from water histograms between years of 1997 to 2007.

Table 11: The Percentage Loss of water histograms into wetlands histograms between years of 1997 to 2000, 2000 to 2007 and 1997 to 2007.

Year	**Percentage loss of histograms of water into wetland histograms (%)**	**Average Percentage loss per year (%)**
1997 – 2000	15.89	5.30
2000 – 2007	1.72	0.25
1997 – 2007	6.48	0.65
Total	24.09	6.20
Average	8.03	2.07

Table 12: The Percentage Loss of grasslands histograms into water histograms between years of 1997 to 2000, 2000 to 2007 and 1997 to 2007.

Year	**Percentage loss of grasslands histograms into water histograms (%)**	**Average Percentage loss per year (%)**
1997 – 2000	0.66	0.22
2000 – 2007	4.61	0.66
1997 – 2007	4.52	0.45
Total	3.26	1.33
Average	1.09	0.44

Table 13: The Percentage Loss of water histograms into grasslands histograms between years of 1997 to 2000, 2000 to 2007 and 1997 to 2007.

Year	**Percentage loss of water histograms into grasslands histograms (%)**	**Average Percentage loss per year (%)**
1997 to 2000	9.26	3.09
2000 to 2007	0.77	0.11
1997 to 2007	3.99	0.40
Total	14.01	3.6
Average	4.67	1.2

3.2.6 The Percentage Loss of grassland histograms into wetlands histograms and it's versus

From the **Table (14)** there was average percentage loss of grassland histograms that changed into wetlands histograms at the rate of 2.55% between years of 1997 to 2000, at the rate of 1.41% between years of 2000 to 2007, at the rate of 1.24% between years of 1997 to 2007. Thus, there is 1.73% average of grassland histograms that changed into wetlands histograms between years of 1997 to 2007. On contrary, the average percentage loss of wetland histograms into grasslands histograms was at the rate of 3.16% between years of 1997 to 2000, at the rate of 1.25% between years of 2000 to 2007, at the rate of 1.17% between years of 1997 to 2007 **(Table 15).** Thus, there is 1.86%% average of histograms of wetland histograms that changed into grasslands. Therefore, there, is net gain of grassland histograms by 0.13% from wetland histograms between years of 1997 to 2007.

Table 14: The Percentage Loss of grassland histograms into wetlands histograms between years of 1997 to 2000, 2000 to 2007 and 1997 to 2007.

Year	Percentage loss of grasslands histograms into wetland histograms (%)	Average Percentage loss per year (%)
1997 – 2000	7.64	2.55
2000 – 2007	9.88	1.41
1997 – 2007	12.41	1.24
Total	29.93	5.20
Average	9.98	1.73

Table 15: The Percentage Loss of wetland histograms into grasslands histograms between years of 1997 to 2000, 2000 to 2007 and 1997 to 2007.

Year	Percentage loss of wetland histograms into grasslands histograms (%)	Average Percentage loss per year (%)
1997 to 2000	9.48	3.16
2000 to 2007	8.81	1.25
1997 to 2007	11.72	1.17
Total	30.01	5.58
Average	10.00	1.86

3.2.7 The Percentage Loss of grassland histograms into forest histograms and it's versus

From the **Table (16)** there was average percentage loss of forest histograms into grasslands at the rate of 8% between years of 1997 to 2000, at the rate of 6% between years of 2000 to 2007, at the rate of 8% between years of 1997 to 2007. Thus, there is an average of 7% of forest histograms that changed into grassland histograms between years of 1997 to 2007. On contrary **Table (17)** presents the average percentage loss of grassland histograms into forest histograms which was at the rate of 15% between years of 1997 to 2000, at the rate of 5% between years of 2000 to 2007, at the rate of 17% between years of 1997 to 2007. Thus, there is an average of 12% of grassland histograms that changed into forest histograms between years of 1997 to 2007.

Table 16: The percentage loss of forest histograms into grassland histograms between years of 1997 to 2000, 2000 to 2007 and 1997 to 2007.

Year	**Percentage loss of forest histograms into grassland histograms (%)**	**Average Percentage loss per year (%)**
1997 to 2000	25	8
2000 to 2007	40	6
1997 to 2007	73	8
Total	138	22
Average	46	7

Table 17: The percentage loss of grassland histograms into forest histograms between years of 1997 to 2000, 2000 to 2007 and 1997 to 2007.

Year	**Percentage loss of grassland histograms into forest histograms (%)**	**Average Percentage loss per year (%)**
1997 to 2000	45	15
2000 to 2007	38	5
1997 to 2007	50	17
Total	133	37
Average	44	12

4. Discussion and Conclusion

4.1 Loss of water histograms to wetlands grassland and forest histograms between years of 1997 to 2007

There is average of 0.37% and 2.07% of wetlands histograms that changed into water histograms and water histograms into wetlands histograms between years of 1997 to 2007, respectively. There, is net gain of wetland histograms by 2% from water histograms between years of 1997 to 2007. This imply that water reservoir are getting drier at average of 2%, thus the areas that were covered by water are currently drying with ability of supporting life of some plant species. There is an average 0.52% and 1.19% histograms of water histograms that changed into grasslands histograms and water histograms that changed into grasslands histograms, respectively. Thus, there is net gain of grassland histograms by 0.67% from water histograms between years of 1997 to 2007.

This entail that the area that were formerly covered by water have changed into grassland by 0.67% between years of 1997 to 2007. There is an average of 0.12% and 0.26% histograms of forests histograms that changed into water histograms and water histograms that change into forests histograms, respectively. There is net gain in forest histograms by 0.14% of water histograms between years of 1997 to 2007. These also imply that the water resources reservoirs are declining at the rate of 0.14% between years of 1997 to 2007. This trends shows that areas covered by water in the Rufiji Delta is decreasing which is in line with early research findings reported by [7].

4.2 Change of forest histogram to wetland, water and grassland histogram from 1997 to 2007

There are 0.8% and 7% average loss of histograms of wetlands which change into forests histograms and average loss of forests histograms into wetland histograms between years of 1997 to 2007, respectively. By comparing the above average percentage loss a net loss of forest histograms by 6.2% to wetlands histograms between years of 1997 to 2007 is obtained. This imply that, there is declining trend in forests reservoir by 6.2% which changes into wetlands such situation in future will encourage water lodging conditions, soil erosion and secondary salinization during heavy rains. These finds conforms that there is decline of forested areas in the Rufiji Delta as reported in previous research findings by [7] which reported the decrease in the area coverage of mangroves by mentioning the considerable decrease in the density, height and canopy cover of the mangroves within the forests. More less similar, findings were reported by [7]) which reported that, mangrove ecosystems are being altered by uncontrolled human activities, mainly through overexploitation of mangrove wood for construction and fuel, and from cutting of substantial areas of mangroves for solar saltpans, agriculture and aquaculture (e.g. rice and shrimp ponds), industries, and urban and hotel developments. Moreover, [8] reported that, data on the extent of harvesting of mangrove forest products in the deltas is scanty and inconsistent, but project officials believe legal harvesting is high, and illegal harvesting is even higher. Besides [5] the increase in the market of hardwood from Tanzania, especially to China, has been a lucrative business to everyone who was involved in the business, from felling trees in the forest to transportation. The sitution has prolonging for some time since [8] reported the harvesting trends are likely to continue or even increase as long as new alternatives and opportunities are not found, and as far as ineffective management regimes are still in place [8] However, the future scenario may change for the better if sustainable approaches are adopted. Besides, there is an average percentage loss of 0.12% and 0.26% of histograms of forests histograms that changed into water histograms and water histograms that change into forests histograms, respectively. By comparing the two percentage loss a net gain in forest histograms by 0.14% from water histograms between years of 1997 to 2007 is obtained. This imply that, water reservoir areas that were covered by water are getting drier hence has the areas has encouraged plant regeneration and growth of shrubs and other small trees that tolerate water lodged conditions. In other words the areas which formerly were not supporting growth and development of plants due water lodging are currently getting off from water lodged conditions and supporting plant growth and development. There is an average of 7% and 12% of forest histograms that changed into grassland histograms and of grassland histogram that changed into forest histogram between years of 1997 to 2007. By comparing the two percentage loss a net gain in grasslands histogram by 5% from forest histograms between years of 1997 to 2007 is obtained. This implies that areas which were under gone deforestation recently its plants are regenerating and sprouting especially during the rainy season.

4.3 Change of wetlands histogram into grassland and water histogram between years of 1997 to 2007

There are average loss of 1.73% and 1.86%% of grassland histograms that changed into wetlands histograms and wetland histograms that changed into grasslands histogram between years of 1997 to 2007. By comparing the two average losses above, a net loss of wetlands by 0.13% to grassland is obtained between years of 1997 to 2007. This also implies that areas which were formerly covered by wetlands reservoirs in Rufiji Delta are currently changing to grasslands between years of 1997 to 2007. The decline of wetlands in Tanzania areas was early reported in 1990s by [9] and has both socio economic and ecological implication. [7] reported several reasons accounts for this decline in wetlands including the overexploitation of high-value species, the introduction of invasive non-native species, pollution and climate change. Although many diverse activities cause these direct threats, the specific proximate causes appear to be rooted in a smaller number of deeper root causes, or drivers which are lack of an integrated framework for natural resources management (NRM) and land use planning, conflicting and contradictory laws and policies, weak national capacity for environmental impact assessment, corruption, rapid population growth and lack of sustainable livelihood opportunities for poor, rural, small farmers and fishers [7]. Besides, there is an average of 0.37% 2.07% of histograms of wetlands histograms that changed into water histograms and water histograms that changed into wetlands histograms between years of 1997 to 2007. By comparing the two average losses, a net loss of 2% of histogram from water to wetland histogram between years of 1997 to 2007 is obtained. These imply that, the areas that were formerly covered by water have been changing into wetlands at rate of 2%. In other word there is declining in areas covered by water which is been converted into wetlands at rate of 2% per year between years of 1997 to 2007. There are 0.8% and 7% average loss of histograms of wetlands which change into forests histograms and average loss of forests histograms into wetland histograms between years of 1997 to 2007, respectively. By comparing the above average percentage loss a net gain of wetland by 6.2% from forest histograms between years of 1997 to 2007 is obtained. This also shows that forest reservoirs in the Rufiji Delta are declining at rate of 6.7% changing into wetlands which have been contributed by the overexploitation of forest in Rufiji Delta.

5. Recommendation and Conclusion

5.1 Recommendations

- Further studies using supervised classification of satellite images for change detection on different land cover and land use (LCLU) units should be designed and implemented in the Rufiji Basin.
- The change detection, monitoring and mapping programs of natural resources using remote sensed data should developed and implemented by RUBADA and other stakeholders in Rufiji Basin.
- High average loss of forest histogram which implies that there are decline trends of forest areas in the Rufiji Delta is calling inventory and physical verification of important forests species as initiatives stages prior the conservation programs.
- Dam and tracking canal for management of on flash and sea level rise floods should designed and installed in Nyamisati, Kiomboi and Mchinga village which prone to on flash and Sea level rise floods.
- The human population and settlement rate in Nyamisati, Kiomboi and Mchinga village should be checked in order not to exceed the carrying capacity of the environments.

5.2 Conclusion

Change detection for motoring and mapping conditions of Rufiji Delta has shown that forest, wetlands and water are declining at different rates. Thus, the change detection using remote sensed data should be encouraged and incorporated in programs for monitoring and mapping the natural resources in Rufiji Basin. Besides, the study has confirmed that there is an opportunity of complementing the remote sensed data and in situ methods for change detection, monitoring and mapping natural resources of Rufiji Delta. However this information from unsupervised classification should be used as preliminary findings that need to be verified with supervised classification of the image which encompass the ground truthing. Moreover, the use of remote sensed data should be encouraged in change detection and classifications of agriculture lands, reserves, parks and animal ranges for analysis of soil and water degradation in relation to climate change and human induced effects.

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