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Examining Land Use Changes Around Marura Wetlands of Uasin Gishu County from 1985 to 2015

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Abstract

Wetlands are invaluable natural resources that provide essential benefits like water filtration, flood control and habitats for biodiversity however, they are increasingly threatened by human activities. The Marura Wetlands in Uasin Gishu County, Kenya, are no exception, having experienced significant land use changes. These changes are largely driven by population growth and economic activities in the surrounding areas, placing immense pressure on the wetland ecosystem. The Marura Wetlands are now at risk of depletion due to these ongoing pressures. This study seeks to examine the spatial land use changes around the Marura Wetlands over the 30-year period (1985-2015), with the objective of identifying the most rapid changes and determining whether the size of the wetland has increased or decreased during this time. Secondary sources of data were used in mapping the effects of anthropogenic activities through GIS and remote sensing techniques. The results indicate a significant rise in settlement areas in the Marura Wetlands, increasing from 4% in 1995 to 86% in 2015, alongside a 24% expansion in wetland areas. Meanwhile, agricultural land and grasslands declined, particularly from 2006 to 2015. Wetland growth is likely due to nutrient discharge from nearby farms, which promoted the growth of papyrus and other vegetation. The study recommends participatory management plan be developed and implemented to curb exploitation of the wetlands resources and coming up with environmentally friendly land use practices which will sustain the Marura wetlands for posterity.

Keyword: Wetlands, Land Use Change, Marura, GIS and remote sensing

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Introduction

Wetlands are among the most productive ecosystems on the planet, offering several essential benefits to humans (Balwan & Kour, 2021; Nayak & Bhushan, 2022; Mandishona & Knight, 2022). These ecosystems are both sensitive and adaptable. Wetlands regulate climate hydrology, biodiversity and human well-being (Davies et al., 2020; Maithya et al 2020). They provide many unrecognized benefits and services, including food and fibre production, water balance, groundwater recharge, flood mitigation, storm protection, cultural and social functions like sacred and religious significance, recreation and tourism, and soil formation and sediment retention (Onganya, 2023; Kumar & Choudhury, 2021).

Wetlands have faced destruction over the years and if true is not checked most may be completely degraded (Sharma & Singh, 2021). The international community realized this outcry and the effects it would have on humans and, therefore, converged in Iran to come up with Ramsar Convention on wetlands of international importance (Ramsar, 2006). Ramsar Convention highlights major conservation measures to be undertaken to protect wetlands through identifying wetlands of international importance. Despite this treaty there has been continued destruction of the wetlands especially through encroachment by agricultural activities, human settlements and commercial activities. The effects are more in urban areas due to the rapid urbanization that was estimated at an annual growth rate of 1.6 % (UN, 2009). The continued urbanization has increased the ecological footprint of the major world cities far beyond their actual geographical sizes hence complicating their ability to maintain their wetlands. Dougan and Associates (2009) in their study on wetland integrity in the Credit River Watershed of Ontario Canada reported that land use and climate change, nutrient and contaminant loading and introduction of non-native stressors were the main stressors of the wetland integrity.

In several African countries, including Uganda, South Africa, Congo, and Ghana, wetlands have been drained for agricultural purposes because of their fertile soils (Arsene & Nkulu Mwine Fyama, 2021; Adeleke, 2022). In Ghana, increasing evidence indicates that the rate of environmental degradation has increased in recent times with previously rich forests being converted to savanna woodlands and existing savanna woodlands converted into near desert (Adupong, Nortey & Asiedu, 2013). It has been estimated that Ghana's high forest area of 8.2 million hectares at the turn of last century had dwindled to about 1.7 million hectares by the mid-

1980s and about one million hectares by the mid-1990s (Adupong, *et al,* 2013).

Wetlands are among the most important ecosystems in Kenya and are vital for the achievement of Vision 2030 (Nyunja et al., 2012; Onganya, 2023; Mumina & Bourne, 2020). They make up between 3 and 4 % of Kenya's total land area, which increases to 6 % during the rainy season (Maithya et al., 2022; Mwita et al., 2013). The exploitation of wetlands for sustaining livelihoods compounded by climate change has drastically strained wetlands in Kenya. Article 10 (2) (d) of the 2010 Constitution of Kenya as well as the National Land Policy and the Draft Environment Policy of 2013 and the Environmental Management and Coordination Act of 1999 acknowledge the importance of conserving the environment and by extension wetlands. In addition, the National Wetlands Conservation and Management Policy of 2013 fulfills Kenya's obligations under the Ramsar Convention and provides the framework for tackling wetland threats. However, many wetlands in Kenya and by extension Eldoret have continued to experience an array of pressures and threats emanating from both the natural events and the anthropogenic activities as 80% of wetlands occur on lands that are privately or communally owned and without any serious conservation measures (Nyunja *et al*, 2012; Ogechi, 2023; Njagi, 2016).

Eldoret is experiencing rapid urbanization that does not resonate to infrastructural development and environmental conservation (Odhiambo, 2022; Ngetich, 2019). Anthropogenic activities around Marura wetland have had devastating impacts on its integrity and status leading to its degradation. A number of emerging land uses has penetrated the region adjacent to Marura wetland including housing developments, floriculture, aquaculture, and waste treatment plant and dam constructions. These developments have had diverse effects on previously flourishing ecosystem. Marura wetland has also been shrinking both in size and biodiversity richness (Njagi, 2005). The section of Marura wetland between Marura Bridge on Iten Road and Kaprobu in the North are the stretches facing a serious pull factor from all emerging environmental and planning realms. The stretch is characterized by a large Agricultural farm, uprising and fast growing residential on the West side and University with a growing population along the western banks of the Wetland which has posed varied challenges and pressure to the swamp. Therefore, this study examined the land use changes around Marura wetlands of Uasin Gishu County from 1985 to 2015

Methodology

The study was conducted in Marura wetlands which is situated in Uasin Gishu County, in the North Rift region of Kenya. The County is positioned between 0.52 latitude (0°31' 0N) and longitude 35.28 (35°16'60 E) and covering an area of 3,345.2 Km^2. Altitudes fall gently from 2,700m above sea level at Timboroa in the East to about 1,500m above sea level at Kipkaren in the West. The County shares common borders with Trans Nzoia County to the North, Elgeyo Marakwet County to the East, Baringo County to the South East, Kericho County to the South, Nandi County to the South West and Kakamega County to the North West (County Government of Uasin Gishu, 2018).

Images were obtained from Landsat satellite images Image courtesy of the U.S. Geological Survey covering path 169 row 069.The images were obtained for the Months of January with a span of 10 years apart from 2016 were a span of 11 years and 9 years, this was due to 22% of missing data on Landsat 7.

The second data set was land use types collected for purposes image classification for the current land use and land cover types along Marura wetland. The Google earth image was downloaded and using features with known coordinates, the image was geo-referenced. A combination of visual image interpretation techniques and field work was used to delineate all the major land uses around the wetland. The images were then processed using multivariate analysis unsupervised classification tool, this was to create four land use types that included Wetland, Agricultural Farm, Grasslands and Settlement. The unsupervised classified image was then reclassified using raster re-class to control outliers and unfit land uses. The images were prepared by using ArcGis where the ground was filled of voids and a false colour image created using combination of band 4, 3, 2 on Landsat MSS, TM, TM+ and ETM for ETM+ which were obtained and captured by Landsat 8 the band 5, 4, 3 were used in preparation of a false colour image this is because band 5 in Landsat 8 is the NIR band while Band 1 is ocean coastline sensor. The images were then clipped on an area of study. The clipping was done after creation of colour composite for all the years.

Results and discussion

Geographical description of the research area

The Marura wetland in Eldoret is a major wetland running South - North a few kilometers North of Eldoret. It is a permanent, riverine wetland with a high length to width ratio, about 10 km long and about 700 m wide at the widest point.

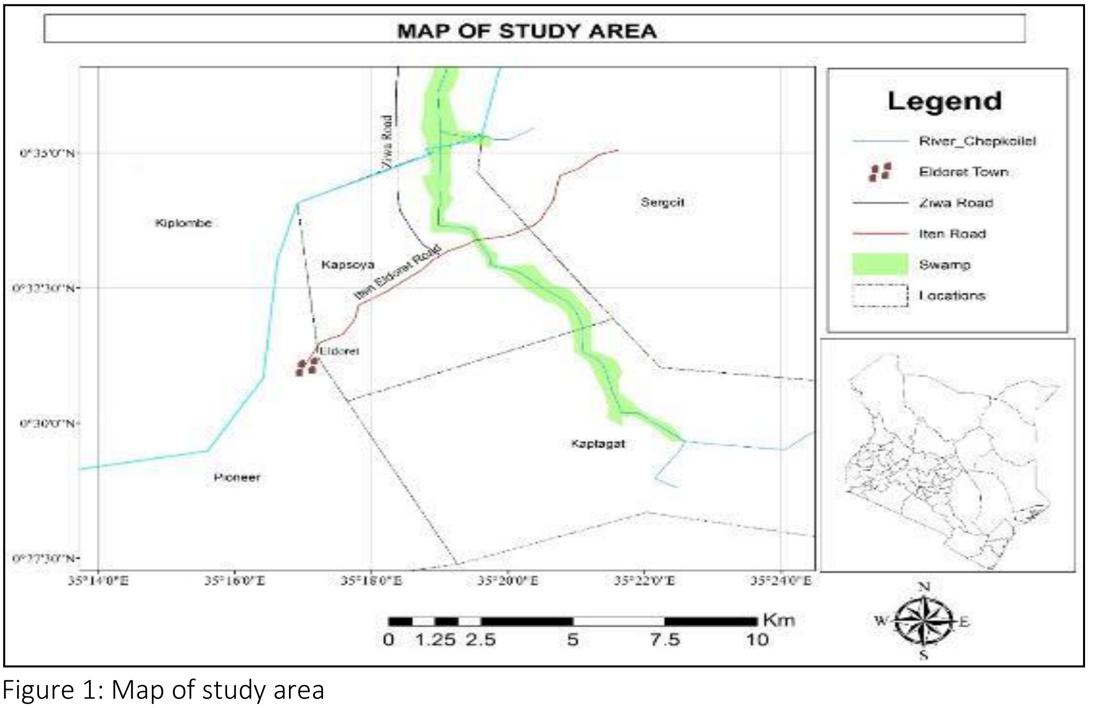


Figure 1: Map of study area

Source: Google Maps (2018)

The wetland sits in a shallow trough-like valley that lies at an elevation between 2110m and 2140m above sea level. Marura wetland covers a total area of 18 km in length rising from 2340 m above mean sea level at Kaptagat forest on GPS location $35^0 45"8'$ E $0^0 52"$ 8' N to South East to 1408 m Above Mean Sea Level at the end of the swamp North at GPS location $35^0 05"9$ 'E and $0^0 63"$ 2' N (figure1).

Uses of Marura Wetland between 1985 and 2015

It was observed that from 1985 to 1995 there was varied rate of anthropogenic activities in the study areas respectively. Figure 2 shows the trend of anthropogenic activities in the wetland from 1985 to 2015. It is observed that settlement has increased from 4% in 1995 to a high of 86% in 2015, on all the land use activities the most increased land use was wetland area with a change of 24%.

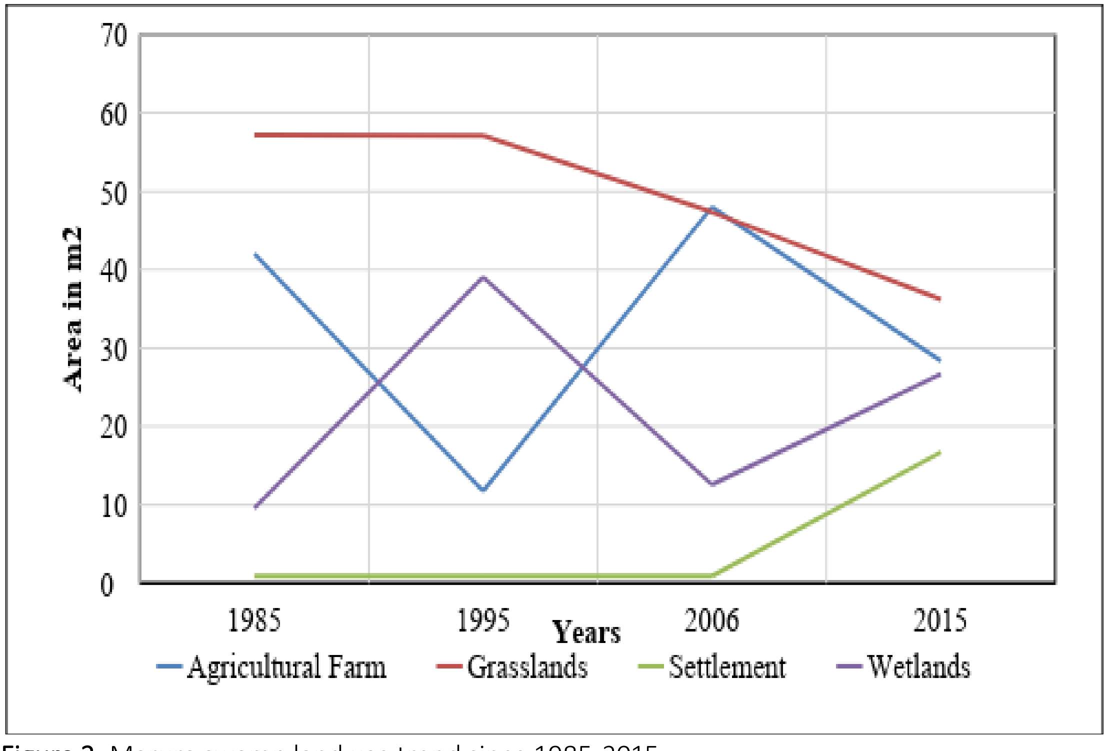


Figure 2: Marura swamp land use trend since 1985-2015
Source: *Author's Data, (2018)*

Land Use/cover Area in m^2 between 1985 and 2015

Table 1 illustrates the changes in land use and cover area (in m²) over a 30-year period from 1985 to 2015. The table highlights four main categories: Agricultural Farm, Grasslands, Settlements, and Wetlands, providing a clear picture of how these land use types have evolved during this period.

In 1985, the largest area was devoted to settlements (480,084.55 m²), followed closely by agricultural farms (420,245.75 m²) and wetlands (283,634.17 m²). Grasslands occupied the smallest area at 117,605.37 m². Over the years, significant changes occurred. By 1995, there was an increase in agricultural land, expanding to 571,757.99 m², while grasslands also surged to 571,140.88 m², overtaking other land uses. Wetlands and settlements experienced moderate increases during this period.

However, between 2006 and 2015, a notable decline in certain land uses was observed. Agricultural land drastically decreased to just 8,677.91 m² in 2006 but later recovered slightly to 95,978.02 m² by

2015. Grasslands also saw a similar trend, dropping to the same value in 2006 before expanding to 390,557.61 m² in 2015. Wetlands also experienced a decline, falling from 283,634.17 m² in 1985 to 166,837.84 m² in 2006, though they showed some recovery in 2015, reaching 266,617.72 m².

Increasing human population, urbanization and agricultural activities are one of the major threats now facing Wetland globally (Xu et al., 2019; Gupta et al., 2020; Mengesha, 2017) and in Kenya (Kemunto, 2018; Githiora-Murimi et al., 2022; Maua et al., 20220)

Table 1: Land Use/cover Area in m^2 between 1985 and 2015

Land use	1985	1995	2006	2015
Agricultural Farm	420245.746	571757.9971	8677.906665	95978.02232
Grasslands	117605.3671	571140.8796	8677.906665	390557.6121
Settlement	480084.5454	473406.3967	8807.868984	125682.9543
Wetlands	283634.1672	362214.1404	166837.8352	266617.7159
TOTAL Area m^2	1301569.826	1978519.414	193001.5175	878836.3046

Source*: Author's Data, (2018)*

Land use change in Km^2

Figure 1 presents the changes in land use over time, measured in km², from 1985 to 2015. Land use change in Km^2 showed no much change between 1985 and 2006 while an increased change was noted between 2006 and 2015; this was due to increased green surface in the areas in 2015. This increase suggests a growth in vegetation cover, possibly as a result of reforestation efforts or shifts in land management practices aimed at enhancing the green infrastructure during this time

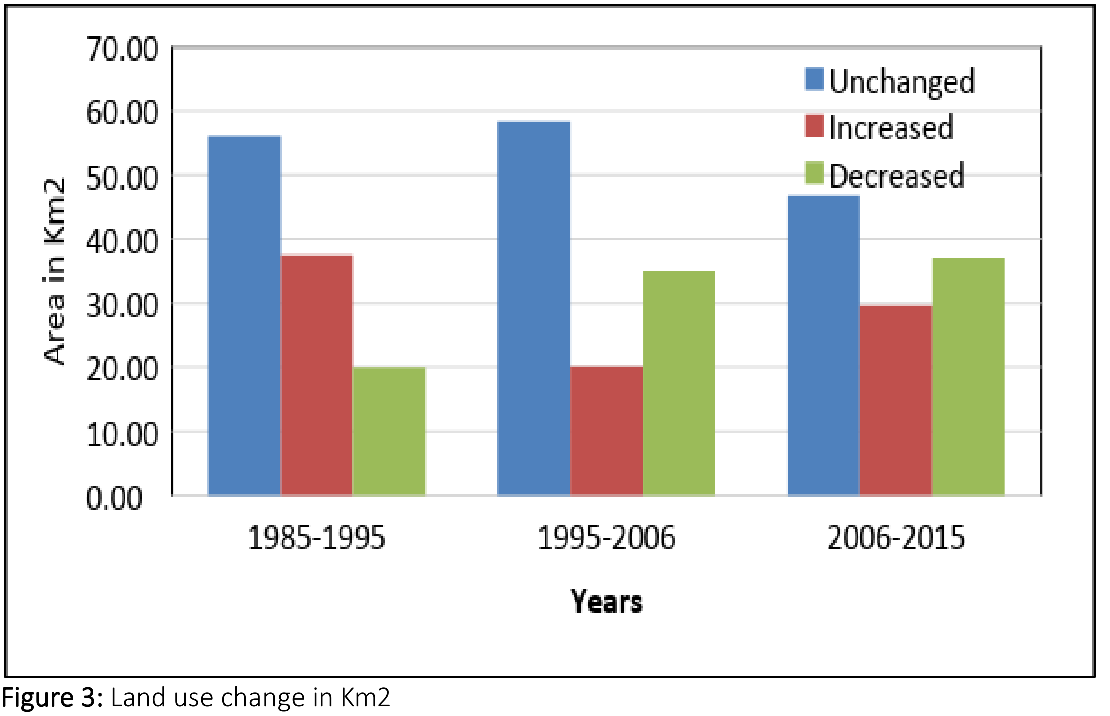


Figure 3: Land use change in Km2
Source*: Author's Data, (2018)*

In Kenya, studies on land use change reflect similar patterns. Mutie et al. (2006) highlight that the lack of significant change in earlier years was attributed to relatively stable agricultural and settlement practices. However, post-2006, increased efforts in reforestation, conservation, and green infrastructure projects—especially in areas like the Mau Forest and other key water towers—contributed to the rise in green surface. Similarly, research by Mwangi et al. (2018) points out that community-driven afforestation and environmental policies under the Kenyan Vision 2030 strategy encouraged greener landscapes, aligning with the broader global shift towards sustainable land management during this period.

Land cover changes per year

The land use changes based on the intervals were provided in the flowing serie of images depicting a change in land cover with a steady growth in urban areas and reduction in grassland and farmlands. The land use change in Marura for the past 30 years were depicted by the following change in images from 1985 to 2015.

Vegetation appears in different shades of red depending on the types and conditions of the vegetation, since it has a high reflectance in the NIR band while Clear water appears dark-bluish (higher green band reflectance), while turbid water appears cyan (higher red reflectance due to sediments) compared to clear water. Bare soils, roads and buildings may appear in various shades of blue, yellow or grey, depending on their composition.

The above images show a false colour image of the study area for a period of 30 years from 1985 to 2015 March. From the image it can be observed that there is an increase in swamp size from 1985 to 2015 and an increased settlement in the year 2015 (depicted by the cyan colour). From the images the vegetation increased North East and North West. Equator flowers and other farms cover these arears. It can be noted that the increased swamp size towards equator flowers could be due to nutrients discharge rich in phosphorous from the flower farms. Gilliam (1994) notes that wetland systems also play an important role in retaining nutrients because of their position in the landscape and this retaining of nutrients can cause them to bloom and grow robustly.

Land cover changes per year (1985 – 2015)

The land use changes based on the intervals were provided in the flowing series of images depicting a change in land cover with a steady growth in urban areas and reduction in grassland and land cover.

There was increased wetlands area from 2006 to 2016 and this could be attributed to increased siltation downstream at sections of Kaprobu with soils full of fertilizers from the farms favoring the growth of papyrus, the increased papyrus has also been favored by increased riparian plantations from exotic trees by resident within the swampy areas.

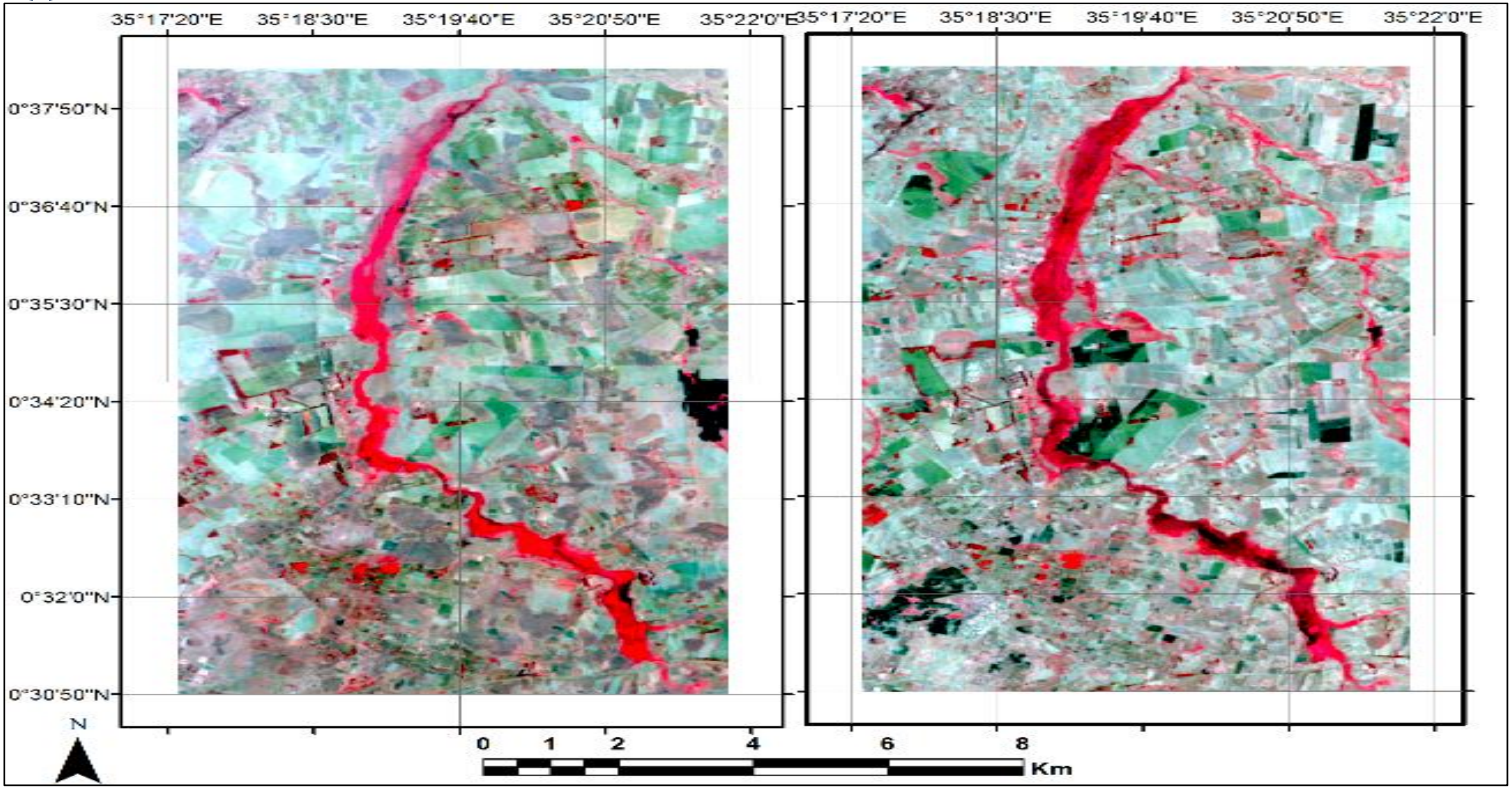


Figure 4a: Left: False Colour Image of March 1985 left and March 1995
Source*: GIS, (1995)*

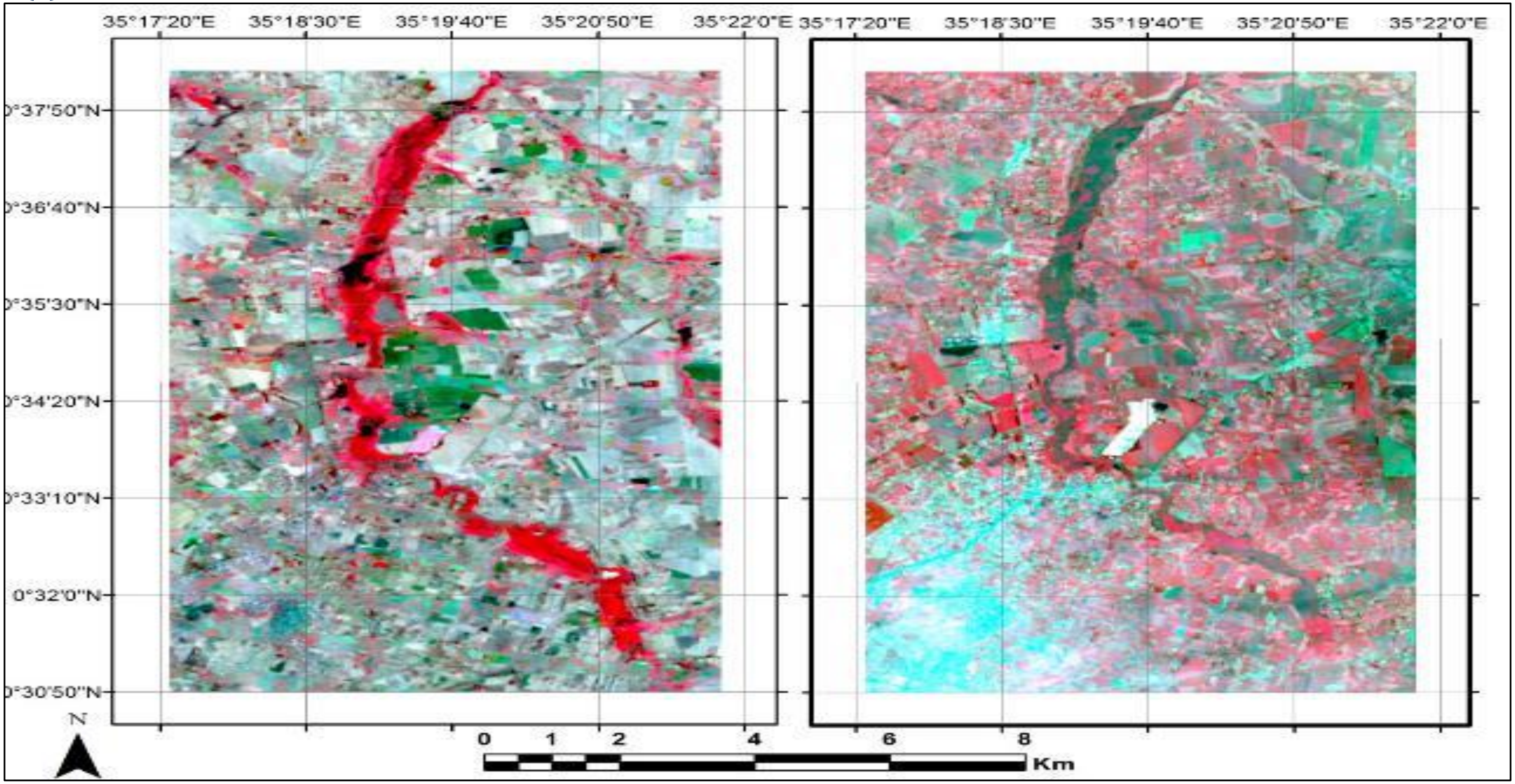
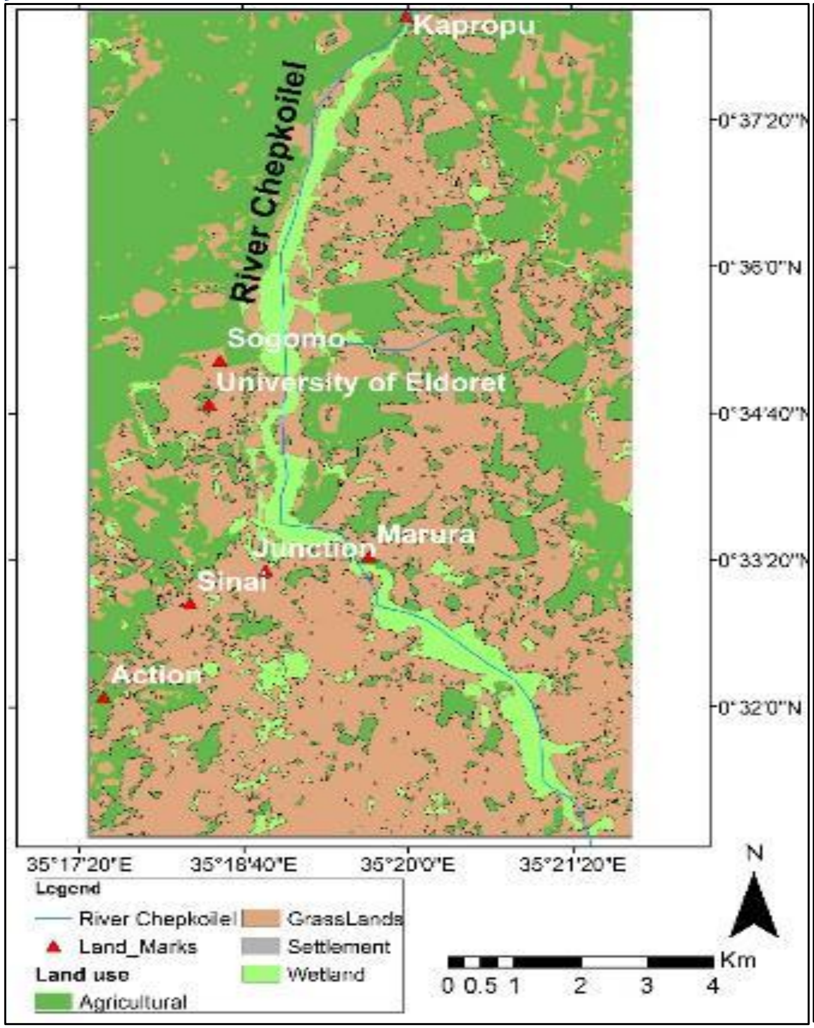


Figure 4b: Right: False Colour Image of March 2006 left and March 2015
Source*: GIS, (2015)*



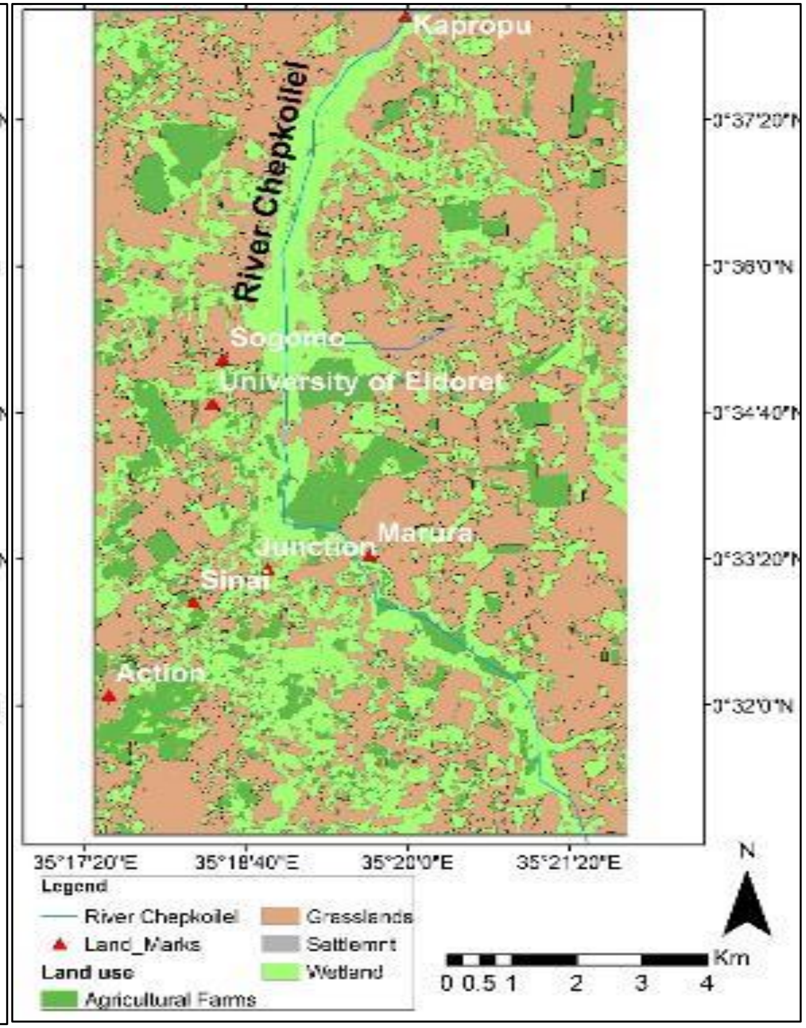


Figure 5a: Left 1985 and Right 1995 Land use change
Source*: GIS, (1995)*

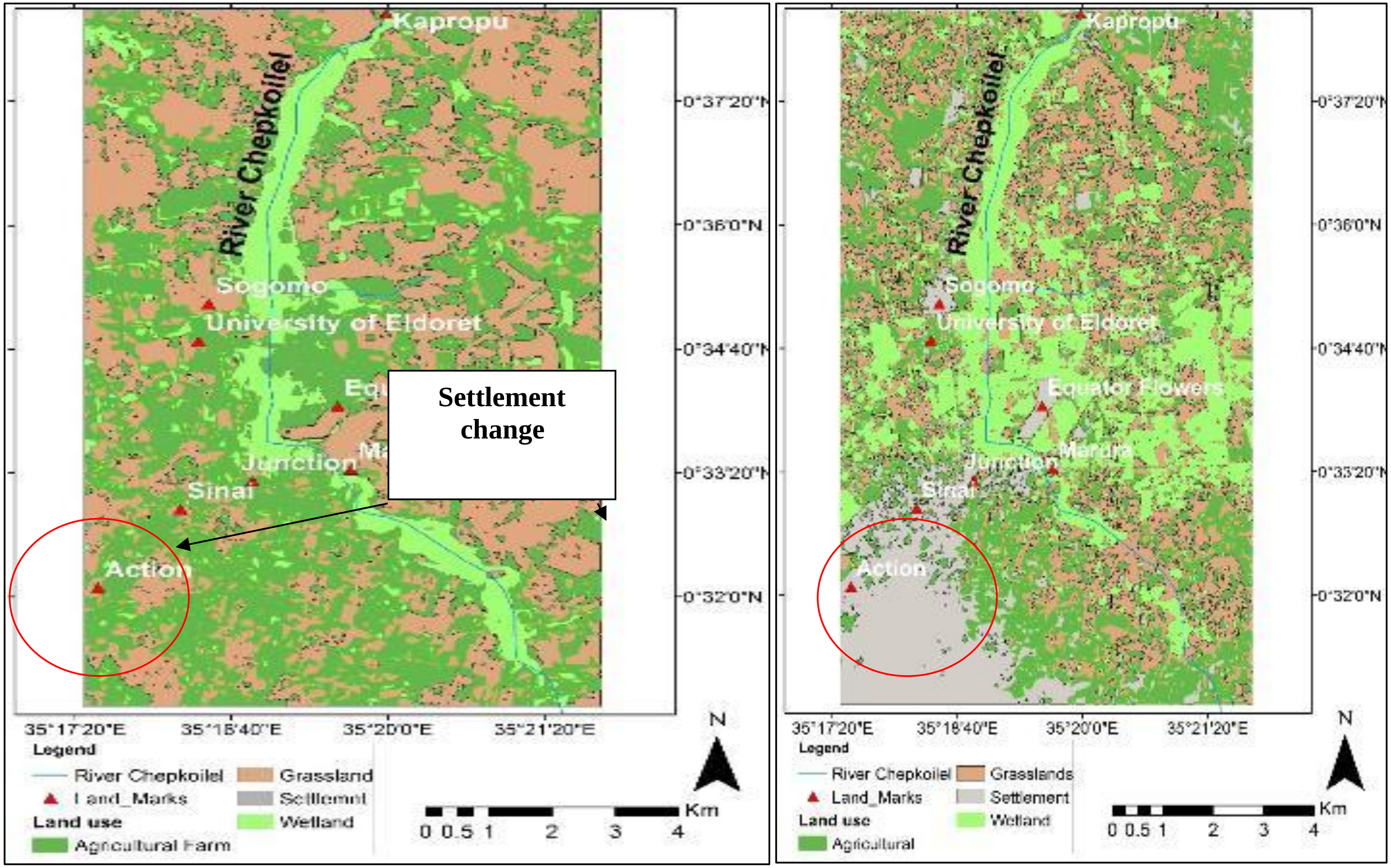


Figure 5b: Left 2006 and Right 2015 Land use change depicting settlement
Source: *GIS, (2015)*

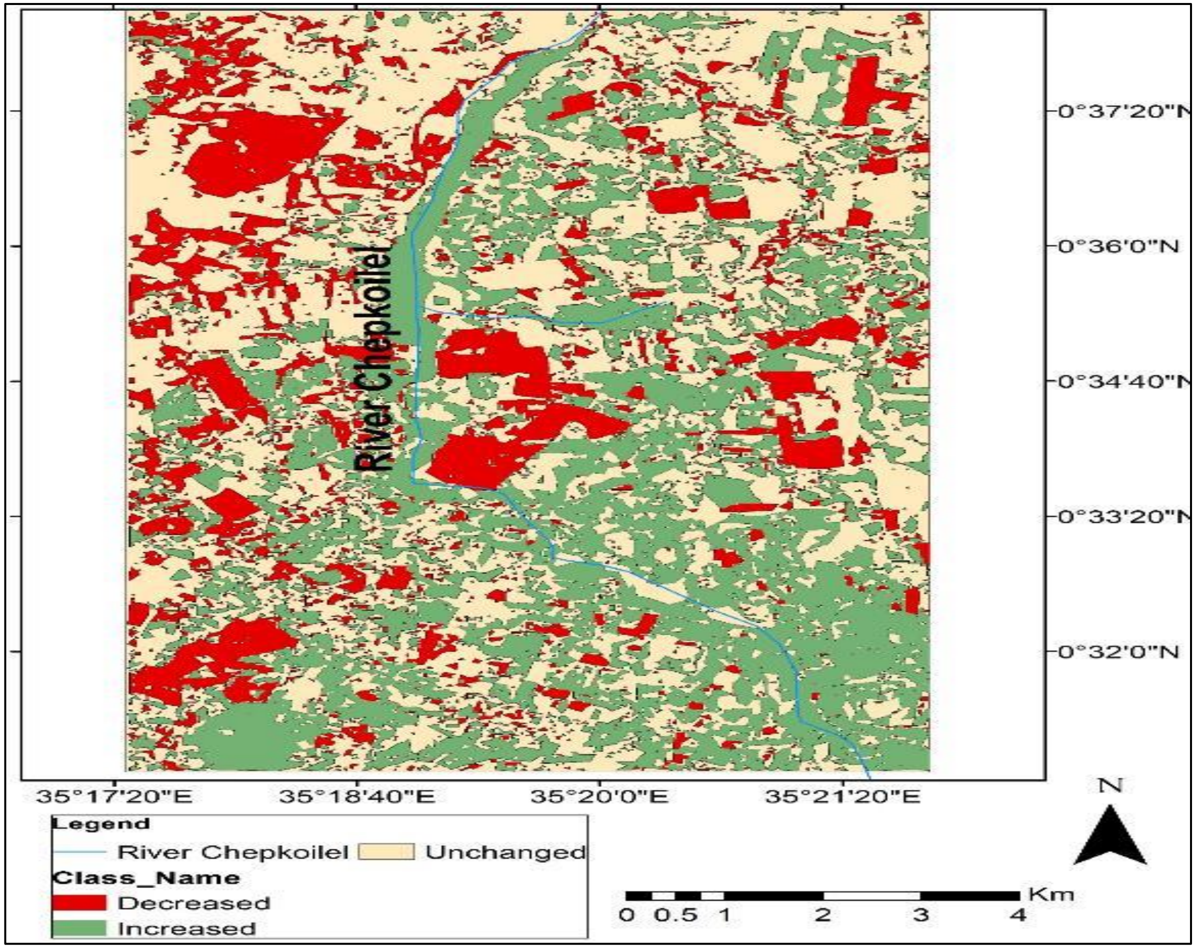


Figure 6a: Land use/Cover change between 1985 to 1995 depicting increased and reduced land size
Source*: GIS, (1995)*

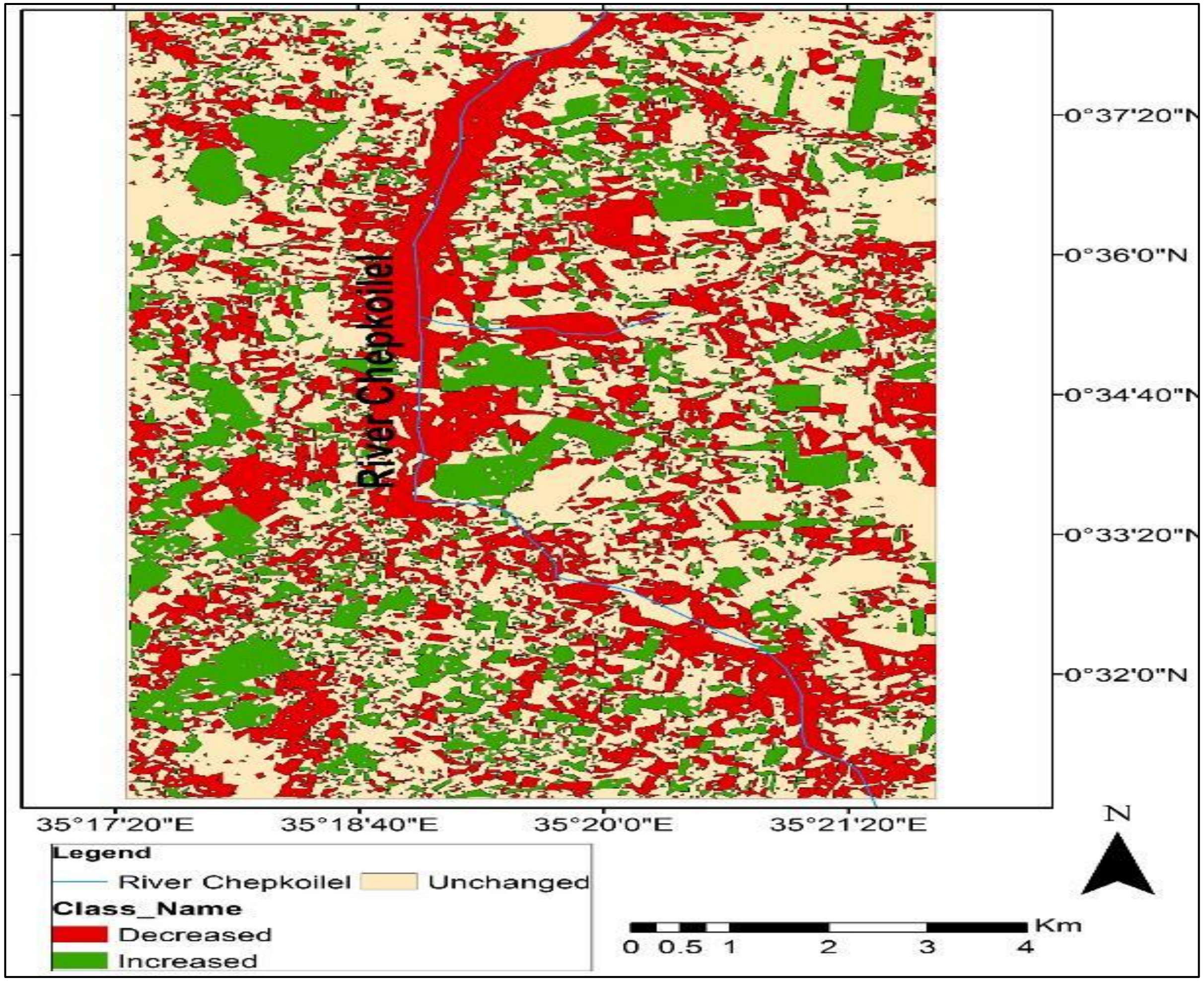


Figure 6b: Land use/Cover change between 1995 to 2006 depicting increased and reduced land size
Source*: GIS, (2006)*

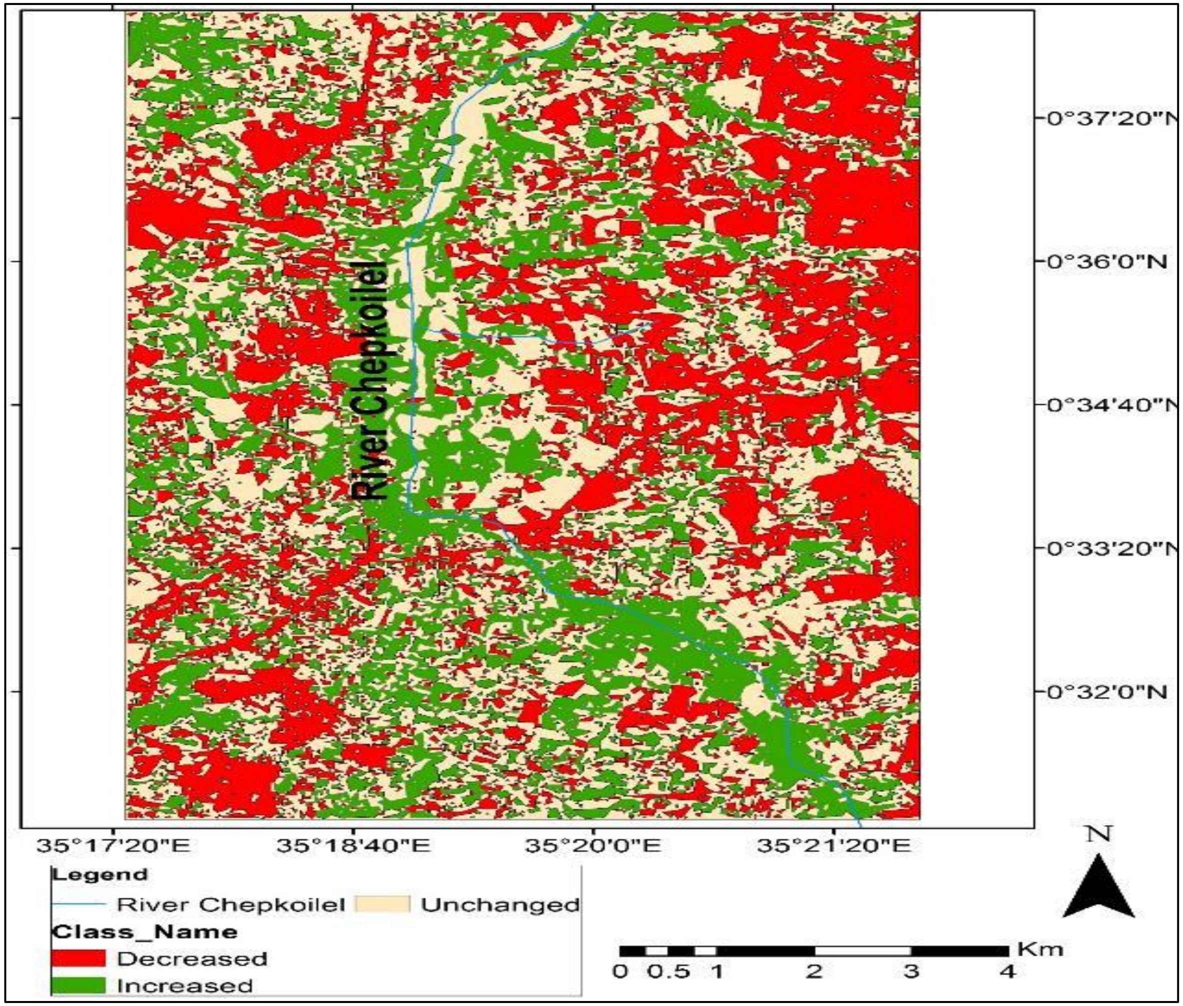


Figure 6c: Land use/Cover change between 2006-2015 depicting increased and reduced land size
Source: GIS, (2015)

Relationship between land use size and years

A Pearson correlation coefficient was plotted and it was observed that there was a significant correlation between the land use activities in 1985 to 2015 with r= 0. 896, this means that the change was so significant between the 30 years.

Table 2: Correlation coefficient Table of Land use size and years

Correlations					
		1985	1995	2006	2015
1985	Pearson Correlation	1	.564	.968*	.896
	Sig. (2-tailed)		.436	.032	.104
1995	Pearson Correlation	.564	1	.432	.847
	Sig. (2-tailed)	.436		.568	.153
2006	Pearson Correlation	.968*	.432	1	.844
	Sig. (2-tailed)	.032	.568		.156
2015	Pearson Correlation	.896	.847	.844	1
	Sig. (2-tailed)	.104	.153	.156	

***. Correlation is significant at the 0.05 level (2-tailed).**

Source: Author's Data, (2016)

Results indicated that there was a moderately positive correlation between the land use sizes in 1985 and 1995 ($r = 0.564$, $p > 0.05$), though this relationship was not statistically significant. A strong and statistically significant positive correlation was observed between the land use sizes in 1985 and 2006 ($r = 0.968$, $p < 0.05$), suggesting that land use in 1985 strongly influenced the sizes in 2006. Additionally, the correlation between 1985 and 2015 was also strong ($r = 0.896$), but not statistically significant ($p > 0.05$).

The correlation between the land use sizes in 1995 and 2006 was weak ($r = 0.432$, $p > 0.05$), indicating a less pronounced relationship between these two years. However, the correlation between 1995 and 2015 was moderately positive ($r = 0.847$), though not statistically significant ($p > 0.05$). Finally, the correlation between 2006 and 2015 was strong ($r = 0.844$, $p > 0.05$), suggesting that land use sizes in 2006 were closely related to those in 2015, although this relationship was also not statistically significant.

Conclusion and Recommendation

Land use activities in Marura include construction, farming and grazing and also mining. Such activities are known to be crucial to degradation of wetlands. For instance, construction of buildings around the wetlands is a threat to reduction of water table as well as the size of wetlands and in that case if there is more construction around the wetlands, it is more likely to be threatened to extinction. It is also evident that farming is the main land use activity in the region. This could be because the soil; and the climate around the wetlands is economically viable and for that reasons most of the people around the wetlands have taken advantage of the farming viability and are therefore farmers. Over the past 30 years there has been reduced farming and grazing as well as increased industrial and residential development and wetland area. This could be attributed to the fact that increased industrial and residential development has eaten into the wetland area and the consequences have been the reduced size of the wetland area resulting to decrease farming and grazing. The study recommends that there is need for a participatory management plan to be developed and implemented to regulate the exploitation of wetland resources and promote environmentally friendly land use practices that ensure the long-term sustainability of the Marura Wetlands.

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