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Investigating The Landuse/Landcover Behavior From Satellite Imageries Along The Lower River Orashi Morphology, Niger Delta Region, Nigeria

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Abstract
The study examined the landuse/land cover behaviour along the lower River Orashi morphology, Niger Delta Region, Nigeria. Landsat satellite of 2020 was downloaded from the United States Geological Survey website to determine the landuse/land cover classification and spatial coverage. The supervised classification method using the maximum likelihood algorithm was adopted for the identification and delineation of major landuse/land cover. Buffering analysis at 1000m zone of influence was made used of to capture the landuse/land cover to determine the level of encroachment into the river course of the Lower Orashi River. Descriptive statistics were used to explain the results. Findings showed that among the identified major landuse/land cover, mangrove (805.72 sq km (26.95%) and thick vegetation/plantation (805.82 sq km (26.95%)). The level of encroachment into the river course showed that built up area had 17.57%, thick vegetation, 30.17%, farmlands/sparse vegetation (13.88%). Considering the extent of encroached landuse rate, it is clearly shown that built up area had the highest encroachment of 7.42% and followed by farmlands/sparse vegetation had 6.05%. The study is concluded that the landuse/land cover along the entire lower Orashi River Basin was dominated by mangrove and thick forest but the river course and morphology was observed to have been encroached mostly by the built up area and farmlands/sparse vegetation. It is therefore recommended that the anthropogenic activities at Lower Orashi River Basin should be control and subjected under the functional and executable environmental laws.

Keywords: *Landuse, Lower Orashi River, Landsat, Encroachment,*

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I. Introduction

Land use/land cover is an essential component in understanding the interactions of the anthropological and social activities with the environment and thus it is necessary to monitor and detect the changes to maintain a sustainable environment. In recent time, human activities and social factors are recognized to have a paramount importance for understanding of land use change (LUC) [19]. Driving forces are generally subdivided into two broad categories: proximate causes and underlying causes. LUC is never static; it constantly changes in response to the dynamic interaction between underlying drivers and proximate causes (Lambin et al., 2013). The conceptual understanding of proximate causes and underlying forces has a crucial importance to identifying the causes of LULC changes [20]. [1] examined the land use/land cover changes that have taken place in Lagos for the last two decades (1984-2002) due to the rapid urbanisation. The land cover change map revealed that forest, low density residential and agricultural land uses were mostly threatened: most land allocated for these uses were legally or illegally converted to other land uses within and outside the metropolis. The urban/built up had 35.5% increases, bare soil nearly doubled its size with 96.3% increase from the initial area coverage in 1984.

There was an increase of 1.6% in water 6 bodies which was attributed due to sensor difference or canalization projects in the study area. There was 57.8% decrease in the forest and agriculture land cover. The spatial growth or expansion in other land cover types had directly taken place on the agricultural land and forest as indicated by being the only land cover type with decrease in area coverage for the period under study.

[9] assessed the land use and land cover changes in Obio/Akpor in Rivers State between 1986 and 2000 using remote sensing and GIS while [4] explained that vegetation changes are often the result of anthropogenic pressure (e.g. population growth) and natural factors such as variability in climate. They reported that Tropical forests are exploited for varied purposes such as timber, slash-and-burn cultivation and pasture development. They further explained that degradation of forest or woodland has impact on catchment processes and biochemical cycles and leads to soil erosion and water shortage not only in the regions immediately affected by deforestation, but also in reasonably distant areas. Analysis of detected change is the measure of the

distinct data framework and thematic change information that can lead to more tangible discernment to underlying process involved in upbringing of land cover and land use changes [2].

The surface landscape is often fundamentally altered during economic and social development, and quantity, morphology, and structure of river systems are usually inadvertently influenced along with land use change [13]. [26] initially outlined erosion and aggradation as system responses when a steady state was upset by human activities. [29] further revealed how river channels respond to three stages of urban development: an equilibrium pre-development stage; a period of construction during which bare land is exposed to erosion, leading to sedimentation within river channels; a stage of urban landscape that is dominated by an impervious surface, leading to increased runoff and decreased sediment production, followed by continued river channel erosion from increased runoff coupled with a decline in sediment that yield enlarged river channels.

As river systems have a fundamental role in the movement of organisms and dead matter [8], being an important carrier of water source, river channel and riparian zone [28], the status of river systems is closely related to water resources [22]; [30], the water environment, and the water ecosystem [24].

Recent studies by [6] and [16] proved that the natural and anthropogenic activities are the main cause of river morphology changes. The Johor River Basin (JRB) located in the southern state of Peninsular Malaysia has an important role to supply water for local usage and to support part of the water demand of Singapore [6]. Many of the previous studies considered the morphometry and landuse separately. Thus, the studies investigating the impact of LULC changes on river morphology are limited and only a few studies have been conducted to date in Portugal [11], India [31), Iran [31], Nigeria [16]; and Malaysia [6]. Previous studies have attended to morphometry and landuse separately without having any way to show the influence of the landuse along the river course. Thus, the present study is examining the landuse/land cover behaviour along the river course of Lower Orashi River, Niger Delta Region, Nigeria.

II. Study Area

The study was carried out in the lower Orashi River, Niger Delta Region, Nigeria. Orashi River takes off as a stream, from the rocks, at the base of a waterfall, 183 m above mean sea level, in the Orashi enclave of Ezeama in Dikenafai, Imo State, Nigeria. From Dikenafai, Urashi flows through several towns, including Urualla, Akokwa, Okija, Orsu, Ukpor, Ihiala, Uli, Oguta, Osemotor, Omoku, Obiakpo, Ebocha, Ukodu, Okarki, Mbiama and Epie. The river forms tributaries along its flow from Imo through Anambra, Rivers to Bayelsa, before empting into the Atlantic. It splits into two at Egbema. The larger portion (right), continued the flow through Eluku before splitting further into two and emptying its waters and sediments at Edi Kalama (Degema) and Abonnema into the gulf of Biafra [3].

The Orashi Region is home to over 35% of the oil wells in the Niger Delta States of Imo and Rivers. The Orashi River is located geographically within latitude 4^0 47' 20'' N and 5^0 06' 20'' N and longitude 6^0 24' 40'' N and 6^0 43' 40'' N (Figure 1).

The study area features a tropical monsoon climate, designated by the Koppen climate classification as "Af", and it is mostly found in the southern part of the country. This climate is influenced by the monsoons originating from the South Atlantic ocean, which is brought into the country by the (maritime tropical) MT air mass, a warm moist sea to land seasonal wind. Its warmth and high humidity gives it a strong tendency to ascend and produce copious rainfall, which is a result of the condensation of water vapour in the rapidly rising air [10]. The tropical monsoon climate has a very small temperature range. Then temperature ranges are almost constant throughout the year. For example, Warri Town in the southern part of Nigeria, records a maximum of 28 °C (82.4 °F) for its hottest month while its lowest temperature is 26 °C (78.8 °F) in its coldest month. The temperature difference of Warri town is not more than 2 °C (5 °F) (Park, 2004). The study area experiences heavy and abundant rainfall. These storms are usually convectional in nature due to the regions proximity, to the equatorial belt. The annual rainfall received in this region is very high, usually above the 2,000 mm (78.7 in) rainfall totals giving for tropical rainforest climates worldwide. Over 4,000 mm (157.5 in) of rainfall is received in the coastal region of Nigeria around the Niger Delta area. Bonny town found in the coastal region of the Niger delta area in southern Nigeria receives well over 4,000 mm (157.5 in) of rainfall annually. The rest of the southeast receives between 2,000 and 3,000 mm (118.1 in) of rain per year (Geographical Alliance of Iowa, 2010). The coastal sedimentary basin of the region has been the scene of three depositional cycles. The first began with a marine incursion in the middle Cretaceous and was terminated by a mild folding phase in Santonian time. The second included the growth of a proto-Niger delta during the late Cretaceous and ended in a major Paleocene marine transgression.

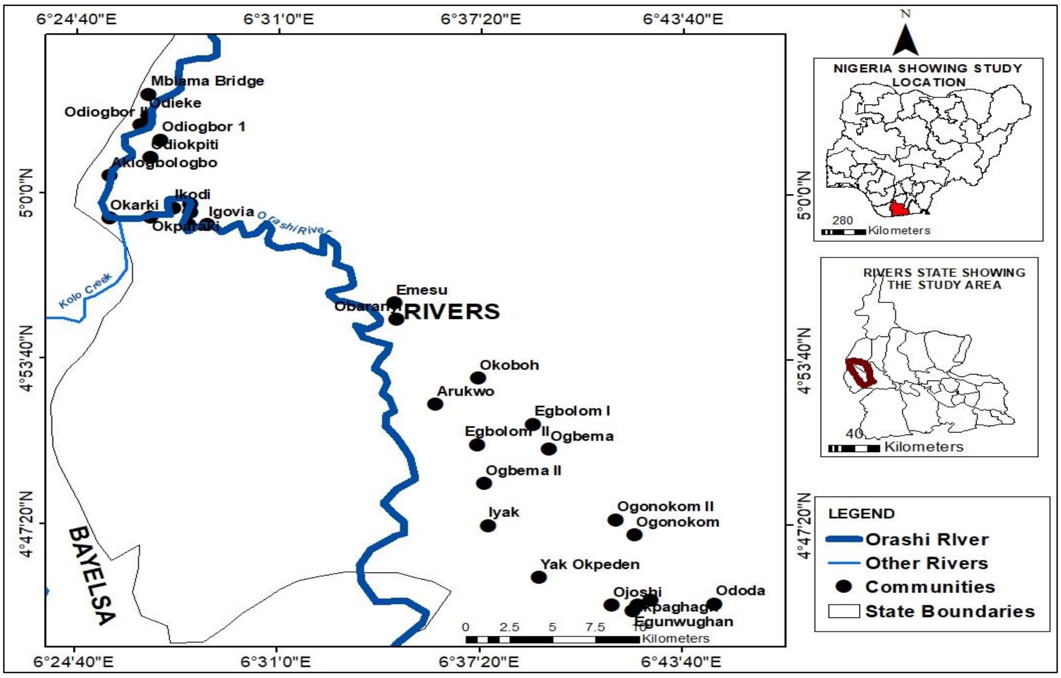


Figure 1: Orashi River and Surrounding Communities
Source: Adapted from Google Earth (2021)

The third cycle, from Eocene to Recent, marked the continuous growth of the main Niger delta. A new threefold lithostratigraphic subdivision is introduced for the delta parts subsurface, comprising an upper sandy Benin formation, an intervening unit of alternating sandstone and shale named the Agbada formation, and a lower shale Akata formation. These three units extend across the whole delta and each ranges in age from early Tertiary to Recent.

They are related to the present outcrops and environments of deposition. A separate member of the Benin formation is recognized in the Port Harcourt area. This is the Afam clay member, which is interpreted to be an ancient valley fill formed in Miocene sediments. Subsurface structures are described as resulting from movement under the influence of gravity and their distribution is related to growth stages of the delta [26]. The study area is well drained with both fresh and salt water. The salt water is caused by the intrusion of seawater inland, thereby making the water slightly salty. The vegetation of the study area consists mainly of forest swamps. The forests are of two types, nearest the sea is a belt of saline/brackish Mangrove swamp separated from the sea by sand beach ridges within the mangrove swamp. Numerous sandy islands occur with fresh water vegetation. Fresh water swamps gradually supersede the mangrove on the landward side. Some of the forest zone's most southerly portion, especially around the Niger River and Cross River deltas, is mangrove swamp. North of this is fresh water swamp, containing different vegetation from the salt water mangrove swamps, and north of that is rain forest [10]. According to [26], the region is endowed with mosaic of fragile sensitive and diverse ecosystem. The major ecological zones of the region include mangrove forest and coastal vegetation zone, freshwater swamp forest zone, lowland rainforest zone and the derived savannah zone found in the northern part of the region.

The primary economic activities in most rural communities in the around the Orashi River include peasant farming, petty trading and fishing, shifting cultivation (Slash and burn), which involves cultivating a piece of land for a number of years and then abandoning it for a more fertile land is traditionally practised in the area. Some of the cash crops grown in the study area include oil palm (*Elaeis guineensis*), cacao (*Theobroma cacao*), cassava (*Manihot esculenta*) and rubber (*Herea brasiliensis*) [10].

III. Materials And Methods

The study adopted mixed research design which included both descriptive and longitudinal research designs. A pre-field survey was carried out which involved site visitation of the study area which is the lower Orashi River segment in River State. The survey exercise aided in establishing points of references for the study. The possibility of carrying out an empirical survey of this nature was also justified through the reconnaissance survey exercises.

The primary data sources involved data gathering of points of references for the study with the help of a hand-held global positioning system (GPS). It also involved the measurements in situ of lower Orashi river physical attributes like depth, width, and flow velocity. The study used download imageries of the Orashi region in order to delineate and determine the land use/land cover systems in the area, as this information aided the study in the mapping analyses for the study. The secondary data sources included obtaining satellite imageries of the study area from the United States Geological Survey (USGS) 2022. The landuse classification was done using the Supervised Classification Method with the use of Maximum Likelihood Algorithm. The level of encroachment of the landuse was detected by buffering the river channel by 500m radii in both sides of the river, covering 1000m within the river ecosystem.

Descriptive statistics was used to explain the values for the landuse/land cover in the entire river basin and the level of encroachment in the river morphology. All the statistical analyses for the study were computed using Statistical Package for Social Scientists (SPSS) Version 24.0 and Microsoft Excel 2010 Version.

IV. Results

Land use/ land cover Analysis of the entire Lower River Orashi Basin and its Environs

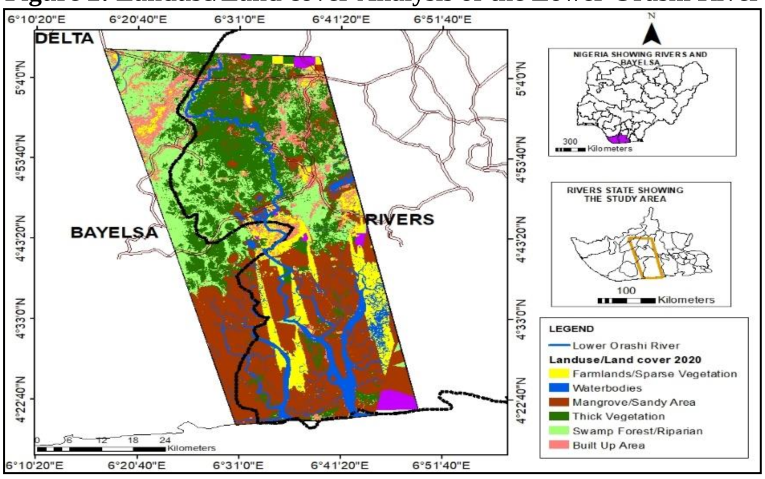
The landuse/land cover results of the entire Lower River Orashi Basin can be viewed in Table 1, and Figure 2. The landuse/land cover analysis reveals that waterbodies, swamp forest/riparian vegetation, built up area, thick vegetation/plantation, farmlands/sparse vegetation and mangrove were the major landuse/land cover in the study area. It is further revealed that waterbodies covered 8.04% (240.41 sq km), swamp forest/riparian vegetation had a spatial extent of 578.07 sq km (19.33%) while the built up area had a spatial extent of 284.34 sq km (9.51%). It was discovered that thick vegetation/plantation had spatial coverage of 805.82 sq km (26.95%) while farmlands/sparse vegetation covered 275.66 sq km (9.22%) and mangrove covered 805.72 sq km (26.95%). The landuse/land cover vulnerability showed that thick vegetation/Plantation was categorized to be of low flood vulnerability which covered 805.82 sq km (26.95%). The farmlands/spare vegetation and swamp forest/riparian vegetation are considered to be of moderate flood vulnerability and these landuse/land cover had spatial coverage of 853.73 sq km (28.55%) while waterbodies, built up area and mangrove were categorized to be of high flood vulnerability and they covered 1330.47 sq km (44.50%). In the analysis, it can be revealed that thick vegetation/plantation and that of mangrove were the highest. Relating each of the landuse/land cover with their rate of flood vulnerability, it is clearly shown that waterbodies, built up area and mangrove were rated highly while Thick vegetation/plantation were rated low and farmlands/spare vegetation were rated moderate. This showed that greater proportion of the landuse is observed to be more vulnerable to cause high flood impact in the basin.

Table 1: Landuse/Land cover Analysis for Flood Vulnerability in the Lower Orashi River

Landuse	Spatial Extent (sq km)	Percentage (%)	Vulnerability Assigned Values	Vulnerability Interpretations
Waterbodies	240.41	8.04	3	High Vulnerability
Swamp Forest/Riparian	578.07	19.33	2	Moderate vulnerability
Built Up Area	284.34	9.51	3	High Vulnerability
Thick Vegetation/Plantation	805.82	26.95	1	Low Vulnerability
Farmlands/Spare Vegetation	275.66	9.22	2	Moderate vulnerability
Mangrove	805.72	26.95	3	High Vulnerability
Total	2990.02	100.00		

Source: Researcher' Analysis,2022

Figure 2: Landuse/Land cover Analysis of the Lower Orashi River



Landuse Enchroachment along the River Course of the Lower River Orashi Basin

Table 2 and Figure 3 shows different landuse examined along Lower Orashi River Basin. It is observed that 6.32% of swamp forest/riparian was involved to have encroached the river course, 17.57% of built up area was seen to have encroached the water course while 30.17% of thick vegetation/plantation had encroached the river course. It is also revealed that 13.88% of the entire farmlands/spare vegetation had impacted the river course of Lower Orashi while 12.62% of mangrove had encroached and impacted the river course.

Table 2. Encroached Landuse along the Orashi River Course

Landuse	Encroached Landuse Spatial Extent (Sq km)	Percentage (%)
Waterbodies	23.35	19.44
Swamp Forest/Riparian	7.59	6.32
Built Up Area	21.10	17.57
Thick Vegetation/Plantation	36.24	30.17
Farmlands/Spare Vegetation	16.67	13.88
Mangrove	15.16	12.62
Total	120.11	100.00

Source: Researcher's Analysis 2022

Figure 3: Encroached Landuse along the Orashi River

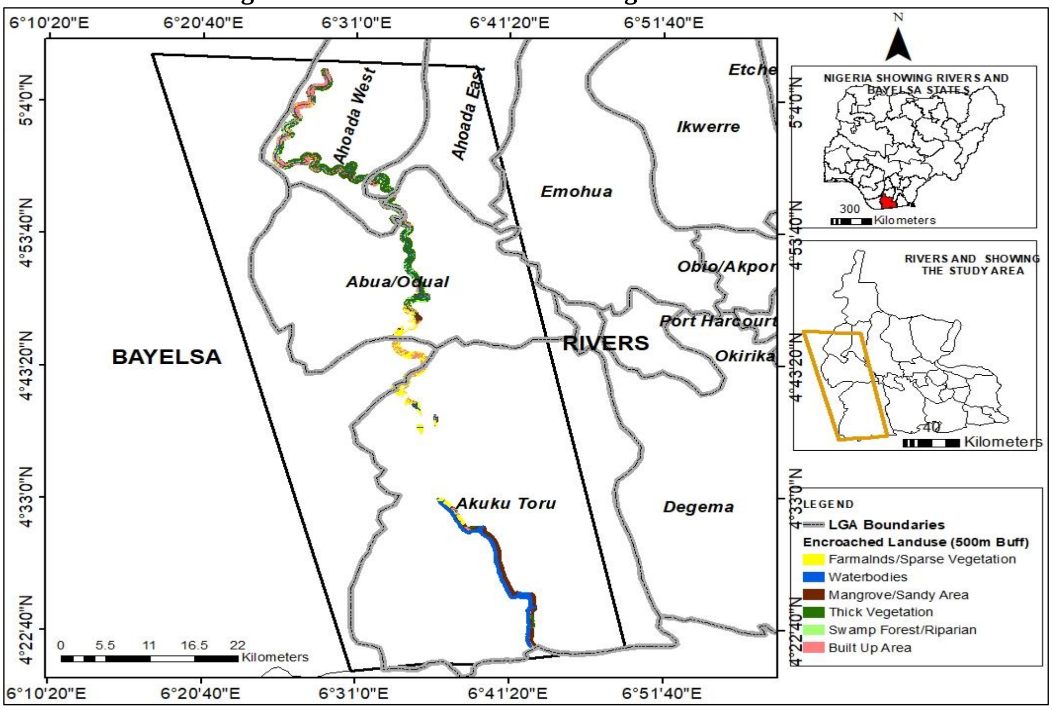


Table3: Encroached Landuse Rate in the Entire Landuse along the Orashi River Course

Landuse	Encroached Landuse Spatial Extent (Sq km)	Spatial Extent (sq km)	Percentage (%)	Percentage Encroached	Vulnerability Assigned Values	Vulnerability Interpretations
Waterbodies	23.35	240.41	8.04	9.71	3	High Vulnerability
Swamp Forest/Riparian	7.59	578.07	19.33	1.31	2	Moderate vulnerability
Built Up Area	21.10	284.34	9.51	7.42	3	High Vulnerability
Thick Vegetation/Plantation	36.24	805.82	26.95	4.50	1	Low Vulnerability
Farmlands/Spare Vegetation	16.67	275.66	9.22	6.05	2	Moderate vulnerability
Mangrove	15.16	805.72	26.95	1.88	3	High Vulnerability
Total	120.11	2990.02	100.00			

Source: Researcher's Analysis 2022

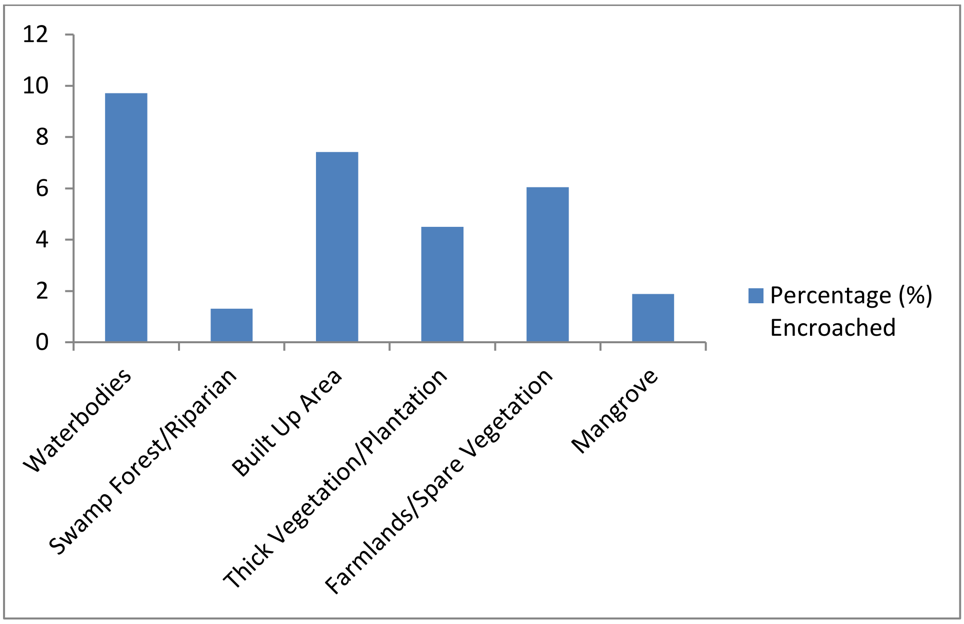


Figure 4: Differentials in the Rate of Encroachment

V. Discussion

The entire study area was dominated by thick vegetation/plantation and mangrove. This could be due to the vegetation make-up of the entire study area whereby thick vegetation and mangrove can be spotted and also Orashi Basin has been designed to be a Ramsar Site especially the Upper Orashi Basin. This might have impact on the lower Orashi River Basin. [10] proved that 40.07 km^2 of Lower Orashi River has been designated as Forest Reserve at National level. The vegetative cover is not so different from others in the Niger Delta which is situated within the equatorial climate belt of Nigeria and characterized by trees and shrubs.

Findings showed that majority of the landuse/land cover were highly vulnerable to flood occurrence in Lower Orashi River. This could be due to the extent at which the area is developing and the intrusion of people which must have reduced the extent of forest or thick vegetation and promote bare soil which can support flooding. [7] reported that about 3% of the forest in the Bayelsa State is lost annually (200,000 forest trees per year) due to different human activities. This study further explains that the pressure on wetlands is as result of urban sprawl and farmland reclamation, which in turn is as a result of the growing population in the region with 25% increase between 1980 and 2000 [10]; [3]. The vulnerability could have led to floodwaters resulting in siltation and soil fertility augmentation.

It is also revealed that 13.88% of the entire farmlands/spare vegetation had impacted the river course of Lower Orashi while 12.62% of mangrove had encroached and impacted the river course. Analysis in Figure 4 clearly shows that waterbodies had the highest impact. This is a natural occurrence in which aquatic ecosystem is highly involved. Apart from this, built up area and farmlands/sparse vegetation had high impact on the river course as they are found with high spatial extent of encroachment. Thus, anthropogenic activities are really playing major roles in determining the landuse behaiour along the river course and as well determine the likely morphological behaviour along the river course. This outcome is similar to that of [32] whereby it is affirmed that human population growth and economic development in recent years, artificial landscapes such as farmland and constructed land have replaced natural landscapes forest land, grassland and so on, which lead to an imbalance of the proportion of “source” and “sink” landscapes types and changes of spatial allocation, and finally lead to a negative environmental effect of water quality deterioration [24]. It is worth noting that the change in hydrochemistry characteristics and the deterioration of water quality are not only related to land use types, but are also deeply affected by the landscape pattern characteristics with scale effects [24].

VI. Conclusion

The study can be concluded that the landuse/land cover along the entire lower Orashi River Basin was dominated by mangrove and thick forest but the river course and morphology was observed to have been encroached mostly by the built up area and farmlands/sparse vegetation. It is therefore recommended that the anthropogenic activities at Lower Orashi River Basin should be control and subjected under the functional and executable environmental laws. This study should be extended to Upper Orashi River so that it can maintain the Ramsar standard of wetland ecosystem it used to be known for.

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