DYNAMICS OF LANDUSE CHANGES IN OTAMIRI WATERSHED OF OWERRI, SOUTH EAST NIGERIA.

Paper 7536: **TS03I - Urban and Rural Land Use Planning**

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BY

AC-CHUKWUOCHA, NGOZI (MRS.)

Dept. of Environmental Science, Federal University of Technology (FUTO), Owerri.

Background Information

- **Otamiri river is the only surface water that provides domestic and industrial water needs to an estimated population of over 450,000 persons.**
- **In addition to the water needs the watershed provides rich economic resource to the inhabitants- coarse (sharp) and fine sand for construction purposes.**
- **The study area is within the upper sections of the watershed situated in an urban -Owerri Capital Territory.**

- **The watershed is fast being encroached upon with diverse and conflicting activities such as sand excavation, expanding infrastructural developments-traversed road networks, auto repair works, block industries, bus terminals; municipal dump sites at river valleys etc.**

- **This upper course of the watershed, is increasingly faced with ecological stresses-siltation of rivers, threatening gully erosion sites (stream bank erosion,) loss of arable lands among others.**

Statement of Problem

- **There is growing increase in magnitude, rate and nature in land use conversion of Otamiri watershed landscape.**
- **This may probably be resulting to the expanding threatening gully erosion sites (stream bank erosion), widening of the flood plains, sedimentation of some sections of the river courses (Nworie river)**
- **Others are loss of productive lands, biodiversity and human settlements to gully erosion.**

Aim/Objectives

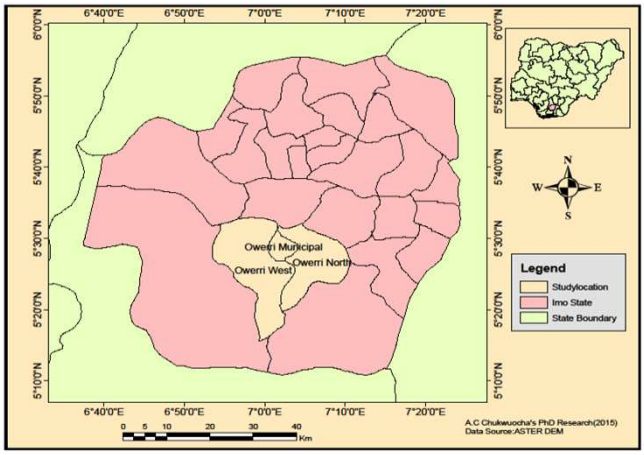
- **The aim was to analyse the spatial structure of land use changes in Otamiri watershed using the tools of GIS and RS.**
- **The objectives include:**
- **Carrying out a watershed survey by taking inventory of all land use activities existing in the immediate watershed.**
- **Determining and classifying the landuse distribution in the time periods**
- **Quantifying the magnitude, rate and nature of changes**
- **Exploring the implications of the changes**

Study Area

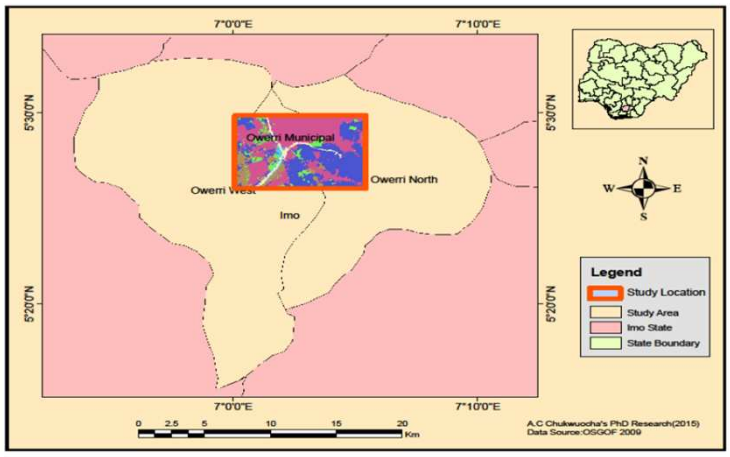
Description of the Study Area.

- The study area is Otamiri watershed, the upper section situated in Owerri Capital of Imo State, Nigeria.
- Owerri capital territory is located between latitudes $05^{0}25^{1}$ and $05^{0}32^{1}$ North and longitudes $06^{0}\,57^{1}$ and $07^{0}\,07^{1.}$

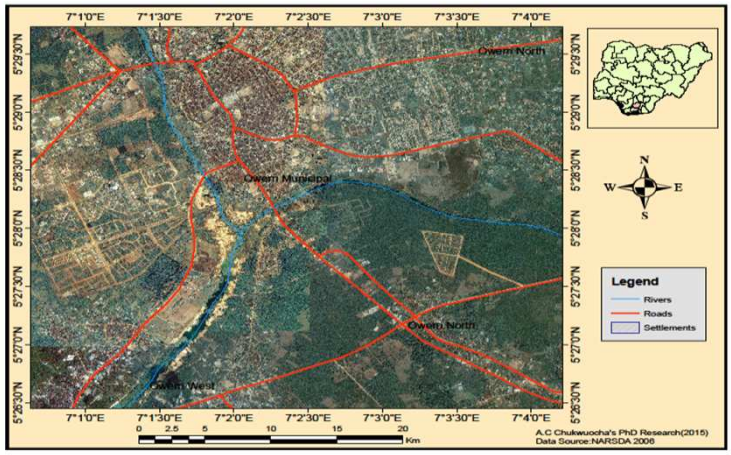
THE STUDY AREA



THE STUDY AREA WITHIN THE THREE LOCAL GOVERNMENT AREAS



IKONOS IMAGE OF THE STUDY LOCATION



MATERIALS AND METHODS

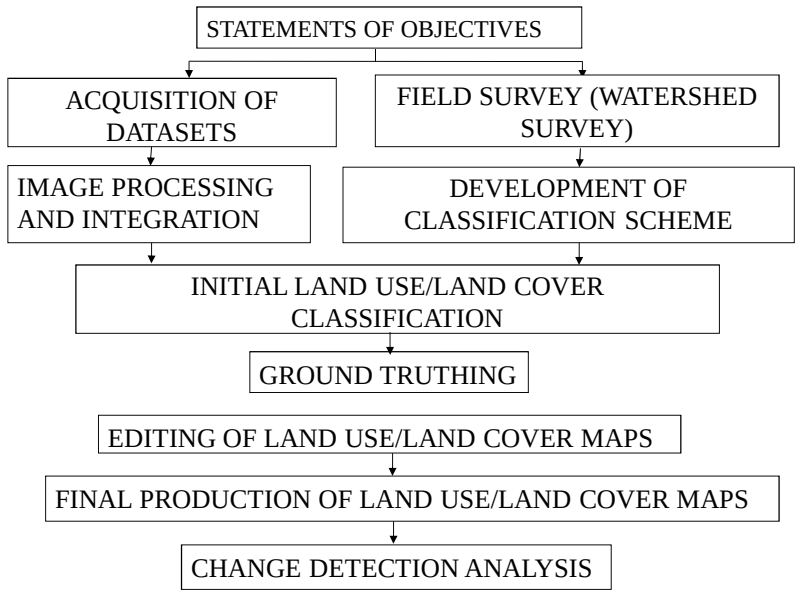


Figure 1.1 Flowchart of the steps taken in the study.

Materials and Methods

- **Data sources: 1977 Aerial Photographs, 2006 IKONOS satellite image and 2012 Google Earth Extraction**
- **Image Processing: a) Analog to Digital conversion . b) Mosaicing of the images. c) Registration of the images to UTM Coordinate system zone 32.**
- **Image Classification: Vector data structure was as the model. Landuse themes were classified by polygonization methods**

- **Image Integration and Analysis in ArcGIS 9.2 environment using the geoprocessing tools**
- **Overlay tool: the classified land use maps of 1977, 2006, 2012 were overlayed two at a time**
- **Intersection method: the change maps were overlaid with the attribute tables to produce results for change detection.**

LAND USE ACTIVITIES DURING THE WATERSHED SURVEY: SAMPLE 1

Table 1.1 INVENTORY OF LAND USE ACTIVITIES DURING THE WATERSHED SURVEY

LOCATION 1: Egbu (Head Source-Rural area)

The terrain is gently sloping with lots of vegetation adjacent to the river (riparian vegetation). The soil is sandy and lateritic.

LAND USE ACTIVITY	NATURE OF LAND USE	STATUS	POLLUTANTS OF CONCERN	POSSIBLE SOURCES	SOURCE WATER CONTAMINANT	SIGNIFICANCE
1. Agricultural activities Farming:	Widespread farming.	Active farming is one of the occupation	Phosphates, Nitrates, Potassium, Sediment.	Fertilizer, organic manure, Agro chemicals.	High	Contaminants cause eutrophication, reduce water quality, .
Animal rearing (grazing goat and cattle).	cattle are grazed over the area.	Active.	Viruses, bacteria, nitrates, phosphates etc.	Animal droppings	Low	Results in eutrophication
2. Domestic Activities: Bathing and washing.	Bathing and washing with chemicals	Active source of pollutants.	Pathogens, sulphates, organophosphates, chloride, nitrogenous compounds	Faeces and urine, soap and detergents.	Medium	Reduce water quality eutrophication, etc.

LAND USE ACTIVITIES DURING THE WATERSHED SURVEY: SAMPLE 2

LOCATION 2: Egbu road, Owerri. (Urban area, not fully developed)

Landform: Gently sloping terrain and a sandy soil surface with trees and shrubs surrounding the river.

) USE VITY	NATURE OF LAND USE	STATUS/	POSSIBLE POLLUTANTS OF CONCERN	SOURCE	SOURCE WATER CONTAMINANTS POTENTIAL	SIGNIFICANCE
;ricultural ities: ing.	more built areas, scattered farmlandfarming land.	Active fewer agricultural lands.	Phosphates, nitrates, potassium, sediments	Fertilizer, organic manure, disposed agricultural waste and farm runoff.	High	Eutrophication , siltation and reduction in water quality.
ıal rearing e grazing).	Cattles graze on the agricultural land	Active. There are more grazing practices here.	Viruses, bacteria (coliform), nitrates, phosphate and sediments.	Animal dropping and exposure of the ground to erosion.	High	Eutrophication , siltation

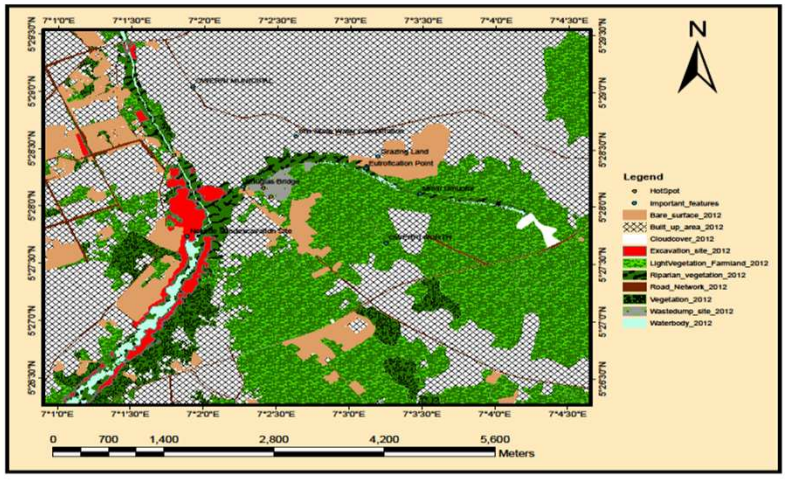
LAND USE ACTIVITIES DURING THE WATERSHED SURVEY: SAMPLE 3

LOCATION: UZOMIRI, NEKEDE (Rural built up area)

Landform: The terrain is sloping with mostly lateritic soil. Runoff is high.

LAND USE ACTIVITY	NATURE OF LAND USE	STATUS	POLLUTANTS OF CONCERN	SOURCES	SOURCE WATER CONTAMINANT POTENTIAL	SIGNIFICANCE
Farming and hunting.	Peasant farming.	Active	Phosphate, potassium, nitrates, sediments.	Fertilizer, organic manure,	Medium	Eutrophication , sedimentation, .
Runoff from municipality	Waste waters from student hostels channeled to the river	Active	Organic compound, nitrates, amino acid, fats, salts, phosphates, etc.	Waste water from domestic activities.	High	eutrophication, increased nutrient content, reduction in DO, increased acidity.
Sand excavation and gravel mining	Excavation of sand inside the river and by the riverbank.	Very active because site is just by the river.	Sediments, hydrocarbon, lead, spent oil.	In stream sand and gravel mines, and tippers.	High	Increase in SS and TDS, disrupts aquatic organisms.
Other factories and workshop	There are lots of small mechanic workshops situated in the watershed.	Active	Calcium, silicates, sediments, hydrocarbon, inorganic chemicals.	Chemical waste generated from these industries.	Low	Reduction in the aesthetic quality, increase in SS.

INVENTORY OF LAND USE ACTIVITIES IN STUDY AREA



FALLEN BRIDGE AT THE OTAMIRI RIVERBANK

LAND USE LAND COVER DISTRIBUTION FOR 1977, 2016 & 2012 PERIODS

Land Use/ Land Cover Classes	1977		2006		2012	
	Area (Ha)	Area (%)	Area (Ha)	Area (%)	Area (Ha)	Area (%)
Thick Vegetation/Shrub	556.12	8.46	233.27	3.55	498.55	7.59
Water Body	36.65	0.56	43.39	0.66	51.68	0.79
Riparian Vegetation	136.72	2.08	111.67	1.7	149.03	2.27
Farmland/Light Vegetation	4956.21	75.44	3054.8	46.5	2481.11	37.76
Excavation site	65.34	0.99	94.71	1.44	84.35	1.28
Built-up Areas	611.37	9.31	2627.91	40	2759.16	42
Bare Surface	186.92	2.84	284.12	4.32	399.49	6.08
Cloud cover	0	0	73.9	1.12	0	0
Waste dump site	0	0	13.49	0.21	19.02	0.29
Road Network	20.67	0.31	32.74	0.5	127.61	1.94
TOTAL	**6570**	**100**	**6570**	**100**	**6570**	**100**

RATE OF CHANGE OF LANDUSES /LAND COVERS OF OTAMIRI WATERSHED

	Percentage Change in Land Use			Annual Rate of Change	
LAND USE/ LAND COVER CLASSES	**1977 - 2006**	**2006- 2012**	**1977 - 2012**	**1977 - 2006**	**1977 - 2012**
Thick Vegetation/Shrub	-58.05	113.72	-10.35	-11.13	-1.64
Water Body	18.38	19.1	40.98	0.23	0.43
Riparian Vegetation	-18.32	33.46	9	-0.86	0.35
Farmland/Light Vegetation	-38.36	-18.78	-49.94	-65.57	-70.72
Excavation site	44.95	-10.93	29.11	1.01	0.54
Built-up Areas	329.84	4.99	351.31	69.54	61.37
Bare Surface	52	40.6	113.73	3.35	6.07

Land use Transfer Model 1977-2006

Landuse	Bare surface	Built up	Cloud Cover	Excavation Sites	Light Vegetation/ Farmland	Riparian Vegetation	Water body	Vegetation	Road Network	Waste Dump
Bare surface	24.07	127.05	0.00	9.71	19.96	1.43	1.76	1.26	1.45	0.15
Built up	37.57	518.79	0.14	2.07	33.20	1.65	0.15	9.35	9.71	0.00
Cloud Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Excavation Sites	0.14	17.75	0.89	21.17	10.07	5.80	4.15	0.87	0.07	4.59
Light Vegetation/ Farmland	214.69	1683.09	62.99	22.11	2783.86	31.06	7.64	133.81	19.01	8.27
Riparian Vegetation	3.66	17.75	0.00	27.02	39.01	47.39	19.31	0.31	0.07	0.06
Waterbody	0.04	0.07	0.00	6.73	3.52	15.93	9.19	0.00	0.02	0.00
Vegetation	7.38	277.21	9.09	6.04	157.30	8.02	1.01	85.88	2.26	0.43
Road Network	1.13	16.16	0.22	0.13	2.47	0.14	0.01	0.00	0.39	0.06
Waste Dump	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Land use Transfer model 1977-2012

LANDUSE TRANSFER ANALYSIS (AREAS IN HECTARES)										
Land use	Bare surface	Built up	Cloud Cover	Excav. Sites	Light Vegetation/ Farmland	Riparian Vegetation	Water body	Vegetation	Road Network	Waste Dump
Bare surface	0.00	130.98	0.00	14.06	13.41	2.27	4.47	2.25	4.69	0.00
Built up	20.26	0.00	0.00	2.30	22.92	1.83	0.30	15.67	11.39	0.00
Cloud Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Excavation Sites	0.41	21.29	0.00	0.00	4.50	15.95	3.13	1.75	0.34	5.30
Light Vegetation/ Farmland	350.82	1770.94	0.57	24.48	0.00	45.67	6.77	385.06	99.34	13.34
Riparian Vegetation	2.87	0.51	1.18	20.82	24.95	0.00	27.33	3.27	0.26	0.06
Water body	0.08	0.28	0.00	4.59	0.14	21.38	0.00	0.04	0.12	0.16
Vegetation	10.62	298.79	0.74	2.88	134.76	5.72	0.69	0.00	11.25	0.15
Road Network	0.97	16.37	0.00	0.03	1.84	0.08	0.01	0.11	0.00	0.06
Waste Dump	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

SPATIAL POSITION CONVERSION AND QUANTITY CHANGE OF LANDUSE 1977-2012

SPATIAL POSITION CONVERSION AND QUANTITY CHANGE OF LANDUSE					
Land use	Converted into	Converted from	Total Change	Spatial position Conversion	Quantitative Change (Absolute Change)
Bare surface	264.61	162.78	427.39	325.56	101.83
Built up	2139.08	93.84	2232.93	187.69	2045.24
Cloud Cover	73.32	0.00	73.32	0.00	73.32
Excavation Sites	73.82	44.33	118.14	88.65	29.49
Light Vegetation/ Farmland	265.52	2182.68	2448.21	531.05	1917.16
Riparian Vegetation	64.02	107.19	171.21	128.05	43.17
Water body	34.03	26.31	60.34	52.61	7.73
Vegetation	145.59	468.73	614.32	291.18	323.14
Road Network	32.61	20.32	52.93	40.64	12.28
Waste Dump	13.56	0.00	13.56	0.00	13.56

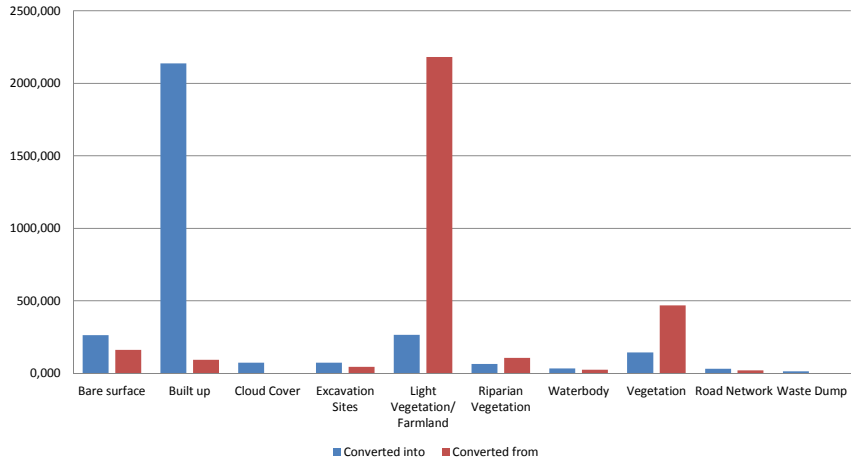
Land Use Dynamicity Model of 1977 - 2006

AREA AND DYNAMICITY OF INITIAL AND LAST STAGE OF LANDUSE CLASS			
Land use	Area of 1977	Area of 2006	Dynamicity (%)
Bare surface	186.85	288.68	1.88
Built up	612.63	2657.87	11.51
Cloud Cover	0.00	73.32	0.00
Excavation Sites	65.44	94.93	1.55
Light Vegetation/ Farmland	4966.54	3049.38	-1.33
Riparian Vegetation	154.58	111.41	-0.96
Water body	35.50	43.23	0.75
Vegetation	554.61	231.47	-2.01
Road Network	20.71	33.00	2.05
Waste Dump	0.00	13.56	0.00

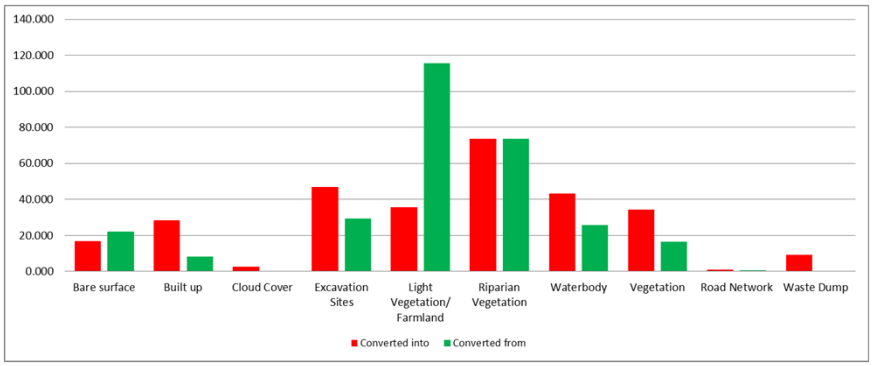
Land Use Dynamicity Model of 1977 - 2012

AREA AND DYNAMICITY OF INITIAL AND LAST STAGE OF LANDUSE CLASS			
Land use	Area of 1977	Area of 2012	Dynamicity (%)
Bare surface	186.91	400.80	3.27
Built up	611.46	2775.96	10.11
Cloud Cover	0.00	2.48	
Excavation Sites	65.55	82.03	0.72
Light Vegetation/ Farmland	4967.93	2473.47	-1.43
Riparian Vegetation	137.75	149.41	0.24
Water body	35.31	51.23	1.29
Vegetation	554.50	497.03	-0.30
Road Network	20.67	128.58	0.15
Waste Dump	0.00	19.08	

SPATIAL POSITION CONVERSION 1977-2006



SPATIAL POSITION CONVERSION 1977-2012



FINDINGS

- The results showed a striking contrast between vegetated land use and built-up area. Thick vegetation, farmland/light vegetation, and riparian vegetation decreased relatively fast (58.39%, 52%, and 44.95% in 1977-2006) while built-up had rapid percentage growth (329.84% in 1977-2006).
- In 35years time (1977-2012) farmland/light continued to decrease with 70.72% as against the increase in built-up area with 61.3%
- the critical resource-the surface waterbody continued to increase in size from 18.38% in 2006 to 40.98% in 2012

Findings

- Conversion of farmland/light vegetation into built-up was the highest in value, accounting for 1683.09 ha or 77% of the total decreased area of farmland/light vegetation class.
- The next highest in transition to built-up is thick vegetation/shrubs, which accounts for 227.21ha or 48% of the total decreased area of thick vegetation.

Findings contd.

- The next highest in transition to built-up is thick vegetation/shrubs, which accounts for 227.21ha or 48% of the total decreased area of thick vegetation.
- In 2012 year, 20.82 ha (22.92%) and 4.59 ha (6.64%) of riparian vegetation and waterbody respectively were converted into excavation sites.
- Between the periods 1977 and 2006, 27.02 ha (36.60%) and 22.11 (29.95%) of riparian vegetation and light vegetation/farmland were converted to excavation site.

Socio-economic and Environmental Implications

- Adverse socio-economic and environmental implications include:
- Loss of productive lands to gully erosion sites
- Displacement of human settlements due to landslides
- Loss of source of livelihood to the rural men who depended on fishing occupation
- A near total siltation of Otamiri tributary-Nworie river

Conclusions

- The study revealed that the watershed is experiencing a fast rate of land use transition.
- Urbanisation processes and its pathways were deduced to be major proximate causes of this rapid land conversion.
- The pressure from the direct infrastructural developments being witnessed in the study area is amplified by mediating factors such as government policy and increase in economic activities.
- The parcellation of the floodplains of the river by the government agencies is a strong driver of the increase in development encroachment in the 150m wide watershed protection zone.
- .

Conclusions Contd.

- This unprecedented rate of land use transformation in the study area is degrading the capability of the ecosystem to provide services.
- Services such as domestic water needs that the river provides is threatened (increase in treatment and maintenance cost)
- Regulatory service of flood mitigation and erosion control are highly compromised. Cases of flooding of buildings and lands situated in the floodplains abound (Chukwuocha, A. C. and Igbokwe, J. I ;2014).

Recommendations

- Enforcement of the state watershed management regulation (1985) of protection of 150m from the sides of the river
- Empowernment of the state Ministry of Environment (Forestry unit)
- Provision of guidelines that will clearly spell out sustainable ways and methods of excavation
- Collaboration of govt. and private sector in rehabilitating the degraded sites- planting of trees at the headwaters

- THANKS AND GOD BLESS YOU