Journal of Environments
Vol. 4, No. 1, 9-14, 2017
ISSN (E) 2313-660X
DOI: 10.20448/journal.505.2017.41.9.14

Effect of Human Induced Sediments Inflow on Habitat Quality in River Chanchaga, Minna, Nigeria

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Abstract

A developing nation like Nigeria should be much concern on environmental management particularly in the area of drinking water, air, soil or general ecosystem. Sediment inflow has become public concerns on aquatic life and habitat loss as well as fragmentations of biodiversity of River Chanchaga. The study assessed the effects of human induced sediment inflows on habitat quality in River Chanchaga. The inhabitant population data, rainfall data and remote sensing data were collected to determine sediment inflow and land use cover of the study area. A total of 250 people accounting for 0.5% of the total population were interviewed, making it eight per each community in thirty communities along the study area. The findings of the study revealed a significant correlation between rainfall and runoff at r = 0.991 accounting for 99% indicating strong positive relationship between them. Pearson correlation is 99% with remain 1% for other parameters like wind, institutional and industrial activities accounting for negligible percentage that are responsible for sediment inflow of River Chanchaga as depicted in Table 3. The implication of this is that the higher the mean monthly rainfall, the higher the runoff volume in River Chanchaga, which may result into subsequent increase of sediments inflow into the river. The result from the study is that land use covers have been affected by population increase, which have direct impact on soil erosion that influences sediment inflow into the study area. The study recommended that anthropogenic activities that lead to generation and transportation of huge volume of debris and sediment loads along River Chanchaga should be regulated to control or reduce aquatic habitat quality damage and to ensure making good use of aquatic resources. There should be programme to enlighten general public on implications of indiscriminant human activities that can affect habitat and water quality along the study.

Keywords: Sediments, Degradation, River, Runoff, Land use.

Citation | Wakili, B. Y; Nsofor G.N; Suleiman, Y. M; Mohammed. A. E (2017). Effect of Human Induced Sediments Inflow on Habitat Quality in River Chanchaga, Minna, Nigeria. Journal of Environments, 4(1): 9-14.
History:
Received: 13 November 2017
Revised: 27 November 2017
Accepted: 12 December 2017
Published: 21 December 2017

Publisher: Asian Online Journal Publishing Group

Contribution/Acknowledgement: All authors contributed to the conception and design of the study.
Funding: This study received no specific financial support.
Competing Interests: The author declares that there are no conflicts of interests regarding the publication of this paper.
Transparency: The author confirms that the manuscript is an honest, accurate, and transparent account of the study was reported; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained.
Ethical: This study follows all ethical practices during writing.

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1. Introduction

Sediments are soil particles and other small particles often brought by running waters or wind into streambeds, lakes or oceans and can be classified as pollutants especially if present in large amounts [1]. Soil erosion produced by the removal of soil trapping trees near water ways carried by rain and flood water from crop lands, trip mines and roads, can damage a stream bed with gravel in which many fish such as salmon and trout lay their eggs [2].

River Chanchaga presently is undergoing extensive land use and land cover changes since the attainment of independence and subsequent population growth. The development has been a threat to the sustainability of its natural resource endowments.

However, soil erosion is a principal challenge along River Chanchaga made mention that reservoir sediment deposition is a reflection of river erosion and deposition process which are enrolled by topography form, type of soil, surface cover drainage system and rainfall-related environment attributes. Most places in Minna experience deforestation, mainly from agricultural expansion and reduction of land quality (degradation) which result in erosion and sedimentation [3]

Rivers are subject to some extent of sedimentation that is continuously supplied by rainfall, runoff, snowmelt and river channel erosion [4]. The accumulation of sediments in the river reduces its storage capacity and expands the width of the river channel [5].

The current worldwide rate of biodiversity loss can be attributed to over exploitation of wildlife populations, introduction of invasive species, diseases, climate change and anthropogenic disturbances mainly through habitat alteration, resource exploitation and human settlements. Public concern is now focused on how human impact on aquatic life or habitat loss and fragmentation are predominant factors affecting biodiversity loss [6]. Conservation strategies are therefore, needed in order to offset such impacts on animal populations. Threatened species, however, often inhabit environments of economic interest e.g. forest harvesting and mining [7] and conservation strategies in such areas should daily be economically variable while still benefiting the overall ecology of the system. When the physical and chemical conditions of ecosystem altered, this may affect individual organisms, population and communities of the ecosystem [8].

River Chanchaga, presently, is receiving huge volume of effluents, sediments, raw sewage and solid wastes that influence the biological and chemical characteristic of the river, which if not check can lead to aquatic habitat quality and ecosystem damage.

2. The Study Area

River Chanchaga transverses Muya, Shiroro, Paikoro, Bosso and Katcha Local Government Areas and can be located on Longitude 6°33'E – Longitude 6°38'E and latitude 9°37'N – Latitude 9°40'N. The total land area covered by the basin is 159,259 km (Muhammad, 2012)

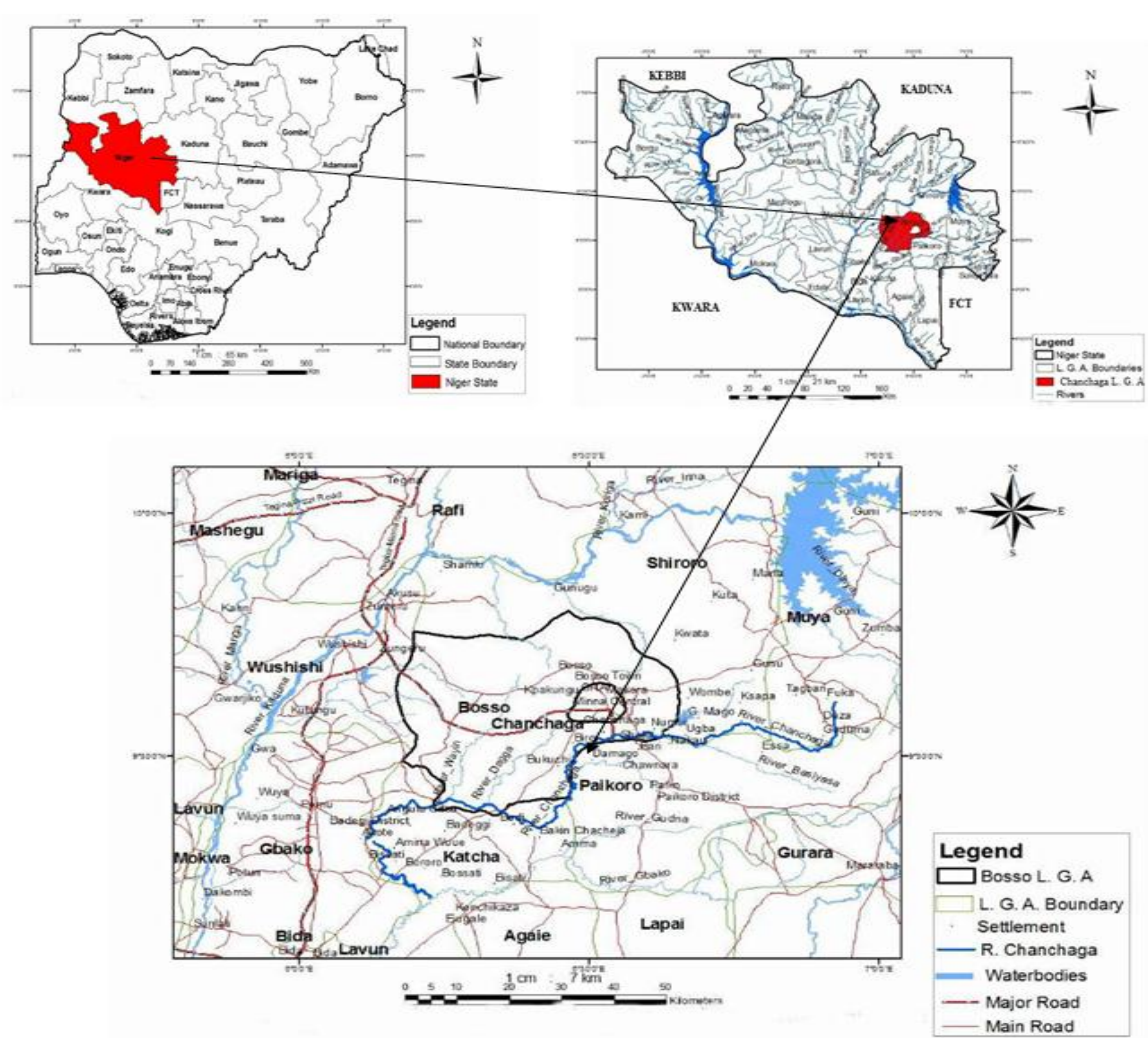

Figure-1. The Study Area (River Chanchaga, Niger State, Nigeria
Source: Remote Sensing Laboratory, Department of Geography, Federal University of Technology, Minna, Nigeria

3. Materials and Method

The both qualitative and quantitative methodology were used, that is observations and descriptions of the various phenomena treated in the study. A total of Two Hundred and Fifty questionnaires were administered to the people living along River Chanchaga accounting for 0.5% of the total population, making it eight per each community in over thirty communities to ascertain salient environmental features along the study area. The tables, figures, plates and graphs were as well used for easy analysis and discussions.

Physical visitation to study sediments inflow, habitat features, urban discharge and land use cover using camera and measuring tape along the study area were done and analyzed.

Rainfall data were collected from NIMET and analyzed to correlate it with surface runoff that has direct impacts on sediments inflow of the study area. Rational formula was used to determine the amount of surface *runoff inflow* in the study area. The mean coefficient value used was 0.25. i.e. 0.08 + 0.41 = 0.49/2 = 0.25 is given as

Q (Runoff/discharge peak) = C.i.A

Where Q = Runoff/discharge

C = Rational runoff coefficient

i = Rainfall intensity (mm)

A = Drainage Area [9]

Runoff as % of Rainfall = Monthly Mean Runoff X 100 Annual Mean Runoff

Data on population of the communities along the study were collected from National Population Commission (NPC) and projected using National Population Growth Rate of 2.4 for 20 years (1997-2016) to study the potential anthropogenic influence on the environment of the area. Remote sensing data like satellite imagery of medium resolution type to study land use cover of the study area were acquired and analyzed [10].

4. Results and Discussions

The result shows that anthropogenic activities increase as population increases putting land use and aquatic resources at risk. The result also depicted that the higher the mean monthly rainfall over the study area, the higher the runoff volume inflow into River Chanchaga, which has led to subsequent increase of sediments inflow into the river.

Sediments deposit is more prominent at lower course, followed by middle course and with lowest accumulation at the upper course. This could be as a result of highest human activities at the middle course with the increasing tributaries as one goes further downstream of the study area. The severe sediments inflow areas along River Chanchaga are presented in Table 1 and Plate 1.

Table-1. Sediments Accumulation along the Courses of River Chanchaga

S/No	Courses of River Chanchaga	Length (m)	Depth (m)
1	Upper Course	254.83	1.39
2	Middle Course	298.75	2.02
3	Lower Course	401.93	2.98

Source: Author's Field Work (2016)

Plate-1. Channel Sedimentation in River Chanchaga

Table 2: Amount of Annual Rainfall Distribution in the Study Area

The month of June, July, August, and September are major months responsible for high volumes of rainfall and surface runoff as presented in Figure 2. The volume of surface runoff (peak discharge) responsible for the triggering of sediments inflow is 1622.9 m^3 with mean annual rainfall of 1193.7 mm for the period of 20 years (1997 to 2016) in the study area as presented in Table 2

Table-2. Correlation of Rainfall and Runoff of River Chanchaga

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean
Rainfall (mm)	2.0	0.8	1.8	55.0	126.9	168.3	198.5	253.8	268.1	123.1	0.4	0.0	1193.7
Runoff (m^3/s)	27.1	10.8	24.4	141.7	172.5	228.8	269.8	345.0	364.4	167.3	5.4	0.0	2363.2
Runoff as % of rainfall	1.1	0.0	1.0	31.6	7.2	9.6	11.4	14.4	15.4	7.0	0.2	0.0	99.0

Source: Authors Field Work (2016)

Table 2 and 3 reveals that there is positive relationship between mean monthly rainfall and runoff of River Chanchaga

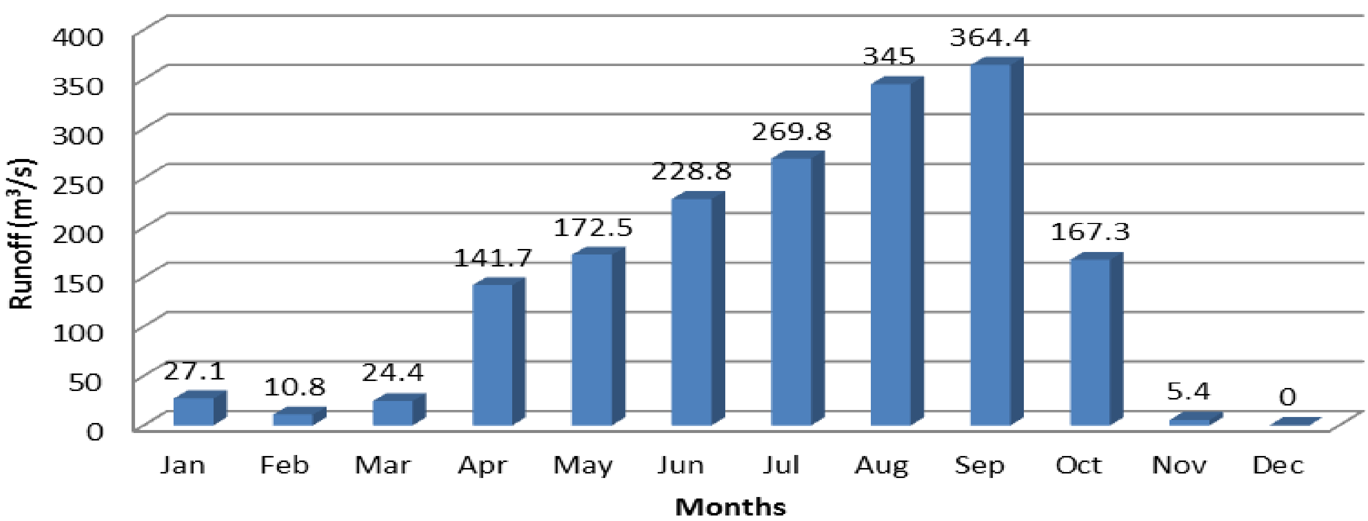

Figure-2. Pattern of Monthly Runoff into River Chanchaga

Source: Author's Work (2016)

Table-3. Correlations between Mean Monthly Rainfall and Runoff of River Chanchaga

				Mean Monthly Rainfall	**Runoff (m3/s)**
Mean Monthly Rainfall	Pearson Correlation			1	.991**
	Sig. (2-tailed)				.000
	N			11	11
	Bootstrap[b]	Bias		0	-.001
		Std. Error		0	.009
		95% Confidence Interval	Lower	1	.966
			Upper	1	1.000
Runoff (m^3/s)	Pearson Correlation			.991**	1
	Sig. (2-tailed)			.000	
	N			11	11
	Bootstrap[b]	Bias		-.001	0
		Std. Error		.009	0
		95% Confidence Interval	Lower	.966	1
			Upper	1.000	1

**. Correlation is significant at the 0.01 level (2-tailed).

b. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Source: Author's Work (2016)

Table 3, reveals the correlation of rainfall and runoff, which stood at Pearson correlation value of 0.991 accounting for 98% indicating strong positive relationship between them. Pearson correlation is 98% with remain 2% for other parameters like wind, institutional and industrial activities accounting for negligible percentage that are responsible for sediment inflow of River Chanchaga. The implication of this is that the higher the mean monthly rainfall, the higher the runoff volume in River Chanchaga, which may result into subsequent increase of sediments inflow into the river.

4.1. Population Dynamics Impact on Land use and Water Quality Status in the Study Area.

The population change has impacted on land use and water quality of River Chanchaga as shown in Figure 3 and Table 4, that is, percentage of each of the land use of the area in 1986, 2001 and 2015. The percentage change of land use classification of 2001 and 2015 is shown in Figure 4, 5 and Table 9

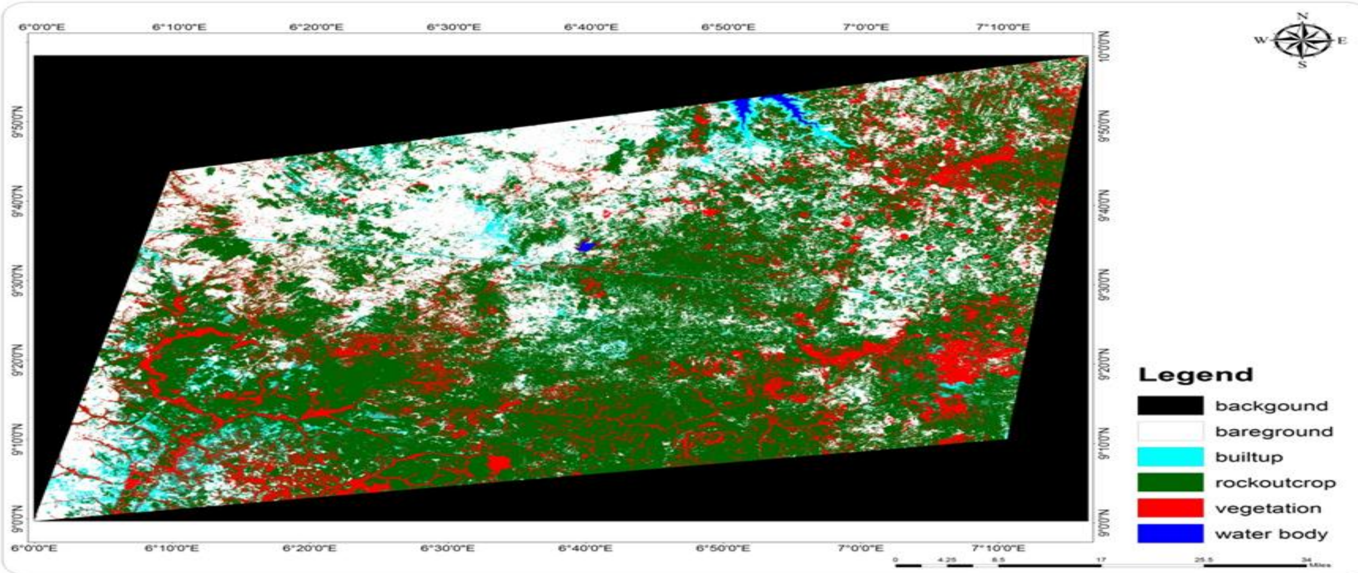

Figure-3. Different Land uses Classes from Satellite Images of 1986

Source: Remote Sensing Laboratory, Department of Geography, Federal University of Technology, Minna, Nigeria

Table-4. Land use Classification of River Chanchaga of 1986

S/No	Land use Classification	Area coverage (hectare)	Percentage (%)
1	Barren ground	294347	28.3
2	Built-up	53010.8	5.1
3	Rock outcrop	534183	51.4
4	Vegetation	155666	15.0
5	Water body	2149.11	0.2
	Total	1039355.91	100

Source: Author's Data Analysis (2016)

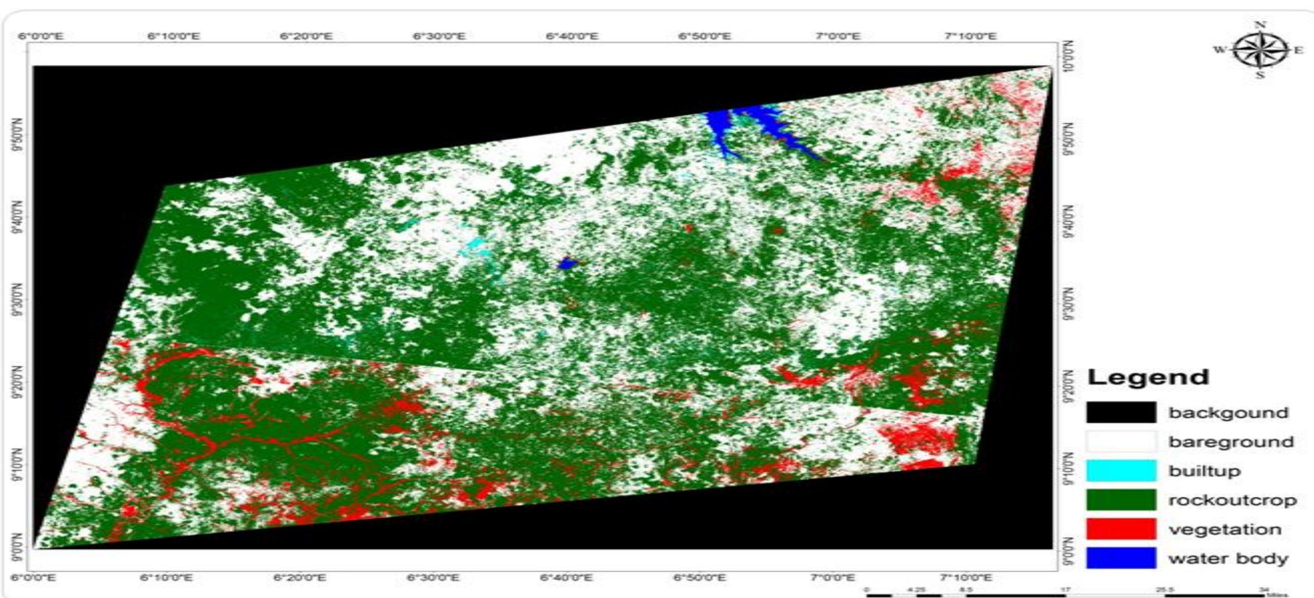

Figure-4. Different Land use Classes from Satellite Images of 2001

Source: Remote Sensing Laboratory, Department of Geography, Federal University of Technology, Minna, Nigeria

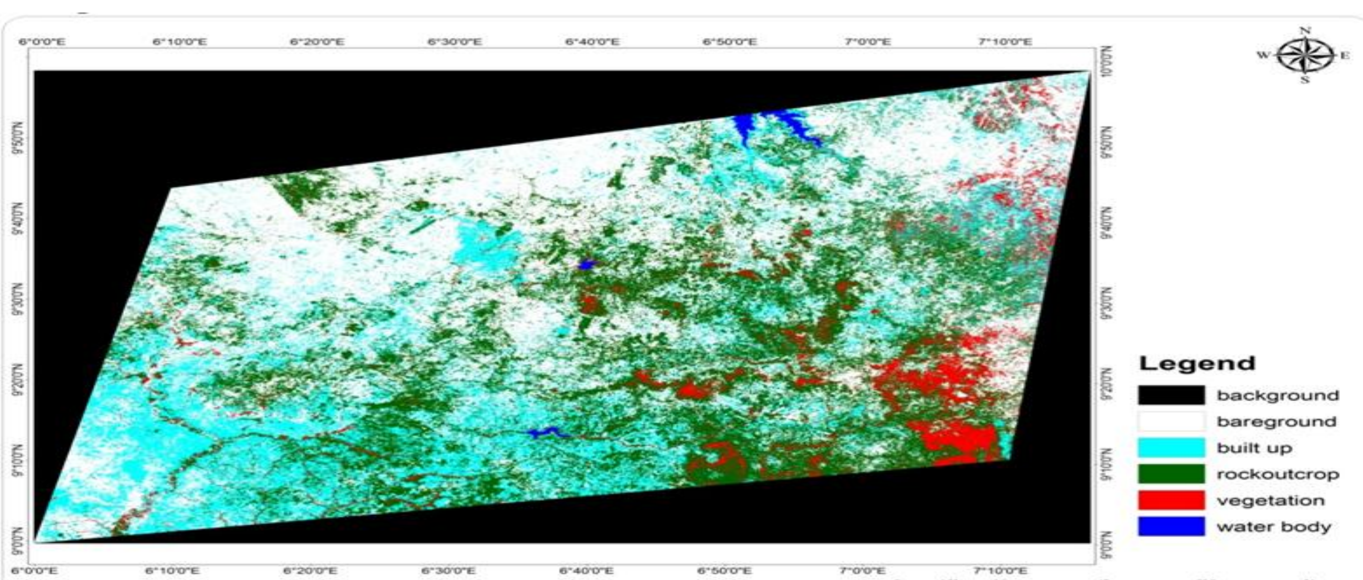

Figure-5. Different Land uses Classes from Satellite Images of 2015

Source: Remote Sensing Laboratory, Department of Geography, Federal University of Technology, Minna, Nigeria

Table-5. Land use Classification of River Chanchaga of 2001 and 2015

S/No	Land use Classification	2001 Area coverage (hectare)	Percentage (%)	2015Area coverage (hectare)	Percentage (%)
1	Barren ground	409082	39.4	478849	46.1
2	Built-up	125000.3	12.0	214540	20.6
3	Rock outcrop	552776	53.2	286134	27.5
4	Vegetation	64187.6	6.2	56264.5	5.4
5	Water body	5426.28	0.5	3568.41	0.3
	Total	1039355.91	100	1039355.91	100

Source: Author's Data Analysis (2016)

As indicated in Table 5, bare ground has increased from 39.4% in 2001 to 46.1% in 2015, built-up has increased from 12.0% in 2001 to 20.6% in 2015, rock outcrop has increased to 53.2% in 2001 and decreased to 27.5% in 2015, vegetation has increased to 6.2% in 2001 and decreased to 5.4% in 2015 and water body has increased to 0.5% in 2001 and decreased to 0.3% in 2015. This shows that human activities have increased in the study area and this has given rise to bare ground and built-up land use classes.

5. Conclusion and Recommendation

The effect of sediment inflow affecting habitat quality was assessed and it was revealed that sedimentation along the river is linked to huge erosion activities caused by excessive human induced activities along River Chanchaga. And Alarming rate of sand and gold mining activities, irrigation farming, over-grazing among others, are major anthropogenic activities influencing sedimentation along River Chanchaga channel. The sediments reduce the depth and increase the width of the river. It was also observed that there is increased in volume of water from smaller tributaries with respective increase of suspended loads in the river channel. The features of the River Chanchaga habitat were investigated and it was revealed that substrates were found eroded due to excessive corrosion of transported sediments loads in the river channel.

Anthropogenic activities that may lead to erosion and intensive alteration of river bank-side that can facilitate inflow of sediment loads into river channel should be regulated to reduce choking up of channel and aquatic ecosystem disorder. This can and will reduce the destruction of the spawning ground for fishes, crabs, reptiles and other aquatic resources.The dwellers along the river should required to fight erosion by laying good traps at construction sites and building sediment traps, planting cover crop and replacing cut-off trees to reduce washing away of soil into the receiving nearby river. These measures could help to maintain water and habitat quality of the river.

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