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The Impacts of Urbanization on River Channels: A Study of Port-Harcourt and its Environs, Rivers State

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***Abstract**: Urbanization which is a product of Physical, social and economic development within cities and regions creates impacts on human and the entire environment. These impacts range from human activities and even on drainage basins causing changes on stream channels. This research work reveals the process in which river channels react to activities of urbanization. The urbanized Amadi Creek in Port-Harcourt and the rural Lubara Creek in Bori (Khana) were selected and studied. The geomorphic parameters of channel morphology, sediment yield, infiltration capacity, channel velocity and discharge were studied in the two river catchments. Primary and secondary data were collected from the studied creeks while Students' t test parametric statistics was used to test and validate the hypothesis that land use whether in the rural or urban settings influences channel response. The result reveals that urbanization of basins triggers changes in channel processes much more than it does in a rural setting. The study maintains that sustainable land use and forest resources management on Creek basins should be enhanced through legislations and effective urban planning.*

***Keywords**: Urbanization, infiltration capacity, rural settlement channel morphology, velocity, sediment yield.*

Introduction

Environment is the complete range of external conditions under which an organism lives including physical, chemical and biological factors such as temperature, light and the availability of food and water. Many developing nations of the world face environmental challenges on two basic aspects: - poverty as well as economic development. Poverty and population pressures clearly result in overuse of land, water, forests without thinking of future. Secondly, uncontrolled economic growth, industrialization and urbanization are equally responsible for deforestation, overuse of ground water system, pollution of natural resources and reduction in the size of water channels. Urbanization is the physical growth as well as a process of population concentration in the cities. It is an index of transformation from traditional rural economies to modern industrial one (Traver. 1996). Despite the gross contributions of urbanization in terms of modernization and economic development, there is increasing concern about the effects of expanding cities, principally on human health, livelihoods and the environment. The implications of rapid urbanization and demographic trends for employment, food security, shelter, sanitation, disposal of solid and liquid waste and water supply that the cities produce are staggering (UNCED, 1992).

In urban areas, a stream represents potential wildlife corridors, wetland multipliers of ecosystem integrity, scenic resources, recreational facilities close to homes and green-way links among neighbourhood and parts (Ferguson, 1991). Understanding the response of a watershed to urbanization and rural land use is important. River basin has intrinsic properties which facilitate their being use as development units, some of which are geomorphic, others hydrological, transportation, landscaping and ecological balance.

Urbanization tends to disrupt stream equilibrium in many ways. Strahler and Strahler (1992), examined the hydrological effects of urbanization. According to them, an increase in the proportion of impervious surface reduces infiltration and increases the rate of runoff from urbanized area. An important result is that, the discharge of a stream increases in response to a period of heavy rainfall or snowmelt. The concentration of runoff in gutters and sewers which act as transmission channels to the man-made drains augments stream flow and sediment discharge (Odemerho, 1984). He further emphasized that, in response to this increased volume of water, the stream channel develops morphological characteristics and hydraulic geometry which approximates a form of stability or quasi-equilibrium that adjust to the prevailing conditions. The sediments and runoff from these concrete surfaces reaching the river channel is large enough base on per capita human discharge, size of urban or rural settlements and the rate of flow. Thus, the stream may not be able to make internal adjustments to maintain its previous equilibrium state. What obtains is that, these additional discharges introduce some imbalances into the stream channel system, sufficient to initiate significant adjustments in both the channel capacity and hydraulic geometry until a new equilibrium state is re-established.

Starkel (2002) while studying rainfall, runoff and soil erosion in India, observed rapid urbanization resulting from deforestation and changes of natural land uses continue to create impacts on stream channel to adjust to additional runoff and sediments production. Such that over years, enlargement of stream channel size occurs which creates alterations in hydraulic exponential relation.

Several factors especially human activities are found to be responsible for these changes in channels. Thus Umeuduji (2000) ascertains that human activities within a drainage basin can trigger off changes in processes that occur in stream channels. Development in the drainage basin can take different forms and can be located on different parts of the basin. It can be direct land phase development (Kinghton 1984), such includes removal of vegetation by logging, deforestation, forestation, and even changes in pattern of land use especially expansion of the urban built environment. While, on the other hand, it can be through channel phase development which takes place for a considerable distance along the river channel like river regulation and channel changes. However, urbanization increases the volume of water in channels. Due to addition to the volume of water in the stream channel, there is the probability of increasing sediment yield. Normally, such sediments may lead to areas down valley being covered with sand and silt deposits. Therefore, channels capacity is reduced as a result of siltation thereby resulting into flood hazards.

In Nigeria, several studies have been carried out on urbanization and storm generation but neglecting how stream channels respond to the huge quantity of urban storm runoff. However, Oyegun (1984) was able to establish a relationship between percentage built-up area as the current operational process of urbanization and basin response through variation in sediment yield, discharge and channel capacity of the basin in Ibadan North-East.

Concurrently, Odemerho (1984) while examining the effect of Agricultural land use practice on rural basins revealed significant effects of agricultural land use activities on channels. It is significant to note that the size of the various land uses such as residential, commercial, industrial, recreation, institutional and agriculture and the quality of management [environmental management] or extent of physical planning may constitute serious effects on the available natural drains.

This study however focuses on some of the geomorphic consequences of stream/creeks on channel morphology, infiltration capacity and sediment yield as well as hydraulic consequences of discharge and velocity resulting from physical development of urban areas.

This study assesses how the increasing volume of runoff generated by urban activities in Amadi Creek of Port-Harcourt affects the morphology of the channel. This is compared with a rural third order Lubara Creek in Khana Local Government Area, Rivers State which still in its natural state. The stated aim is achieved through effective implementation of the following objectives.

1. to examine the effects of urban and rural land uses on stream channel velocity on the case studies.
2. to make a comparative analysis of channel discharge, infiltration capacity, sediment yield and channel morphology of an urban catchment (Amadi Creek) and a rural catchment (Lubara Creek).
3. to recommend some alternative policy approach on the use of River basins for resource production and sustainability by government and individual.

The study areas are located in Port-Harcourt and Khana (Bori) Rivers State.Amadi Creek in Port Harcourt is located within Latitude $4^{0}30$ and $5^{0}30$ North and Longitude $6^{0}30$ and $7^{0}30$ East (Fig.1). The Creek passed through the built-up area of Ogbunabali extending to the East and North-East of Rainbow town and Trans-Amadi. It is joined at the Western flank by the Ntawogba Creek crossing Eastern by-pass road. The Lubara Creek drains Bori Town with its source from Kaani through the rural communities of Kor and Kpong as well as other communities of Ken Khana (East of Bori) and finally empty into Imo River which geographically separate Rivers and Akwa Ibom States. (see fig. 2 below).

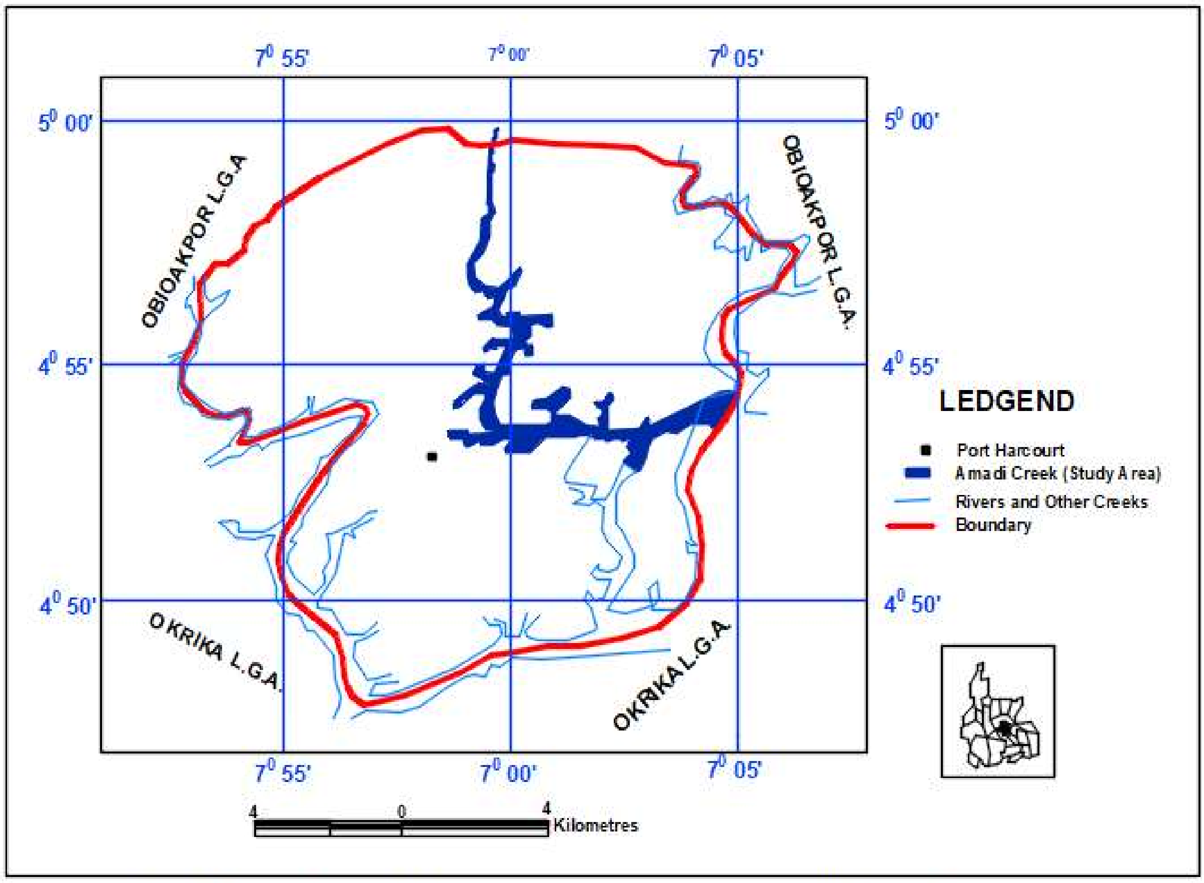

Fig 1 : Map of Port Harcourt Local Govt Area showing Amadi Creek (Study Area)

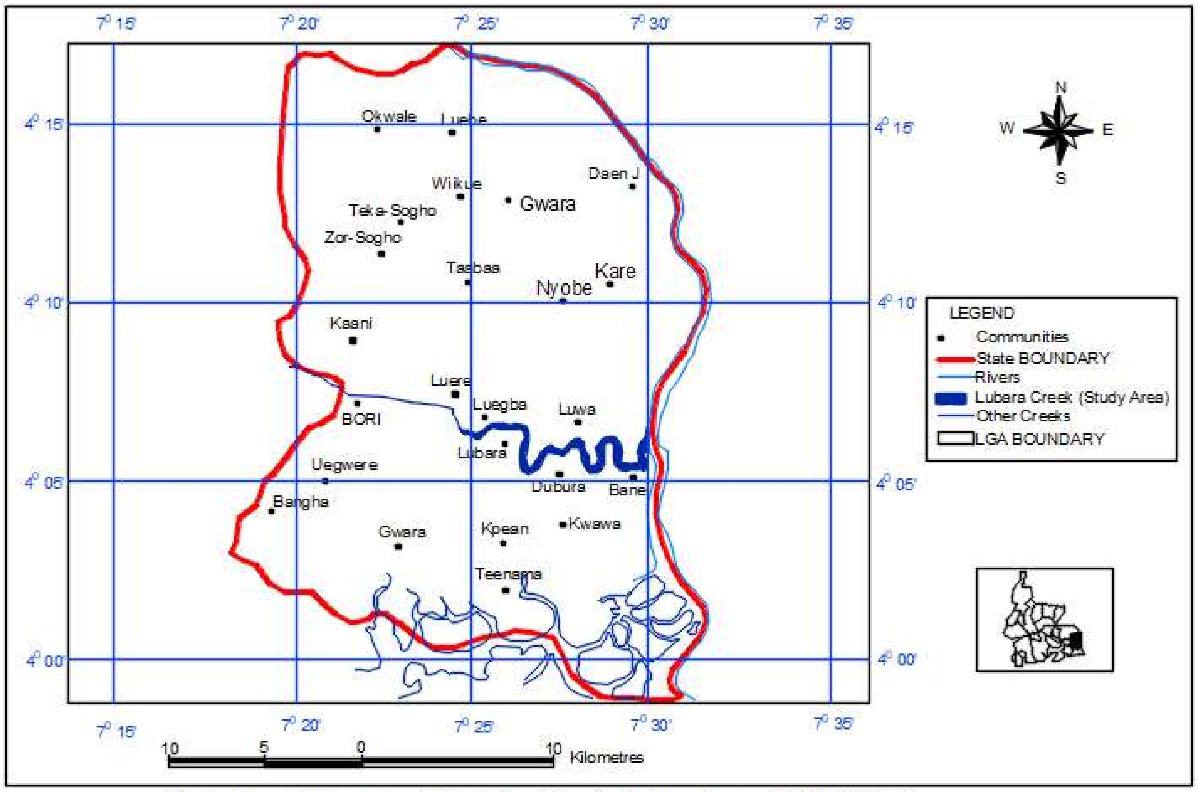

Fig. 2 : Map of Khana Local Govt. Area Showing Lubara Creek, (STUDY AREA)

Methodology

Choice of sampling points was based on careful site and point location. A total of 30 sampled points each were selected for Amadi Creek and Lubara Creek. All the 30 sampled points each were chosen based on an interval of 333.3 meters for Amadi Creek and 733.3 meters for Lubara Creek. Parameters of interest measured include Discharge, Stream Velocity, Infiltration Capacity, Sediment Yield, and Channel Morphology. Equally observations were made on the extent of built up areas along and within the catchments of the River plains. These were conducted to assess areas of building coverage and proper determination of the extent of flow into the drains.

Findings

The students't test alongside its degrees of freedom was employed to compare the means of the various parameters for the data set of interest in this study. Table 1 and 2 below are the summary statistics of data collected for the various parameters for Amadi Creek and Lubara Creek respectively.

Table 1: Summary statistics of data for Amadi Creek

Parameter	Mean	Standard dev.	No. of Cases
Discharge (cumees)	0.98	0.78	30
Velocity (m/s)	0.26	0.08	30
Sediment Yield (ppm)	0.65	0.24	30
Infiltration Capacity (m/s^{-1})	0.64	2.17	30
Channel Morphology (m^2)	7.29	3.35	30

Source: Field Work, 2022

Table 2: Summary statistics of data for Lubara Creek

Parameter	Mean	Standard dev.	No. of Cases
Discharge (cumees)	0.49	0.24	30
Velocity (m/s)	0.12	0.06	30
Sediment Yield (ppm)	0.39	0.07	30
Infiltration Capacity (m/s^{-1})	4.0	0.10	30
Channel Morphology (m^2)	3.21	1.41	30

Source: Field Work, 2022

The calculated value for velocity was found to be 2.05 slightly greater than the 2.10 probability confidence level at 95% (0.05) critical value and 58 degrees of freedom resulting from the rejection of null (H_o) hypothesis, therefore revealing that there is a significant difference in channel velocity of urbanized Amadi Creek and rural Lubara Creek. This is because Amadi Creek is purely a low-land and the high pressure of sewage in storm and sanitary sewers run directly into the channel from highly paved surfaces of urban land uses. Therefore, velocity is influenced by runoff intensity of the basin (Amadi Creek) which is quicker, greater and shorter lag time compared to rural Lubara Creek process and flow velocity is brought about by man's alteration of river basin (Bird, 1980).

On discharge, the calculated value is 2.67 which is greater than the critical table value of 2.01 at 95% (0.05) confidence level and 58 degrees of freedom. We therefore reject the null (H_o) hypothesis and accept the alternate (H_1) that, there is a significant difference in channel discharge of urban landuses as experienced in Amadi Creek channels. Discharge and runoff volumes increase as water quickly runoff paved surfaces with relatively very low infiltration (Pizzuto, 2002).

The parameter of infiltration which is the calculated value of 12.4 is greater than the critical table value of 2.01 at 95% (0.05) probability confidence level and 58 degrees of freedom. We therefore reject the null (Ho) of no significant difference and accept the alternate hypothesis that, there is a significant difference in infiltration on rural and agricultural as well as natural landuse basin of Lubara Creek compared to urbanized Amadi Creek.

Therefore, urbanization reduces the level of infiltration capacity of soil as a result of the high level of reduced vegetation covers and subsequent increase in runoff (Rogowski, 1972; Thornes, 1976; and Dunnin, 1976).

On sediment yield, the calculate value of 2.60 is greater than the critical table value of 2.01 at 95% (0.05) probability confidence level at 58 degrees of freedom (df). Here also, we reject the null hypothesis (H_o) of no significant difference in sediment yield and accept the alternative hypothesis (H_i) that there is a significant difference in sediment yield under different landuses (urban and rural). There is high sediment yield of the urbanized Amadi Creek compared to Lubara Creek. This is due to the high level of both solid and liquid wastes which are disposed indiscriminately in the Amadi Creek channel. Also, debris from vegetation, construction and land reclamation materials contribute in the increment of sediments in the channel (Amadi Creek).

Finally, the channel morphology; the calculated value of 10.25 is greater than the critical table value of 2.01 at 95% (0.05) probability confidence level and 58 degrees of freedom. We therefore reject the null hypothesis (H_o) of no significant difference and accept the alternate hypothesis (H_i) that there is a significant difference in channel morphology of Creek channel under different land uses (urban and rural).

The channel morphology of the urbanized Amadi Creek is generally higher than that of Lubara Creek that is under rural landuse. Therefore, urbanization influences channel morphology of Creek channels. It is also found out that urban channels are wider, straighter and smother than their rural counterparts (Pizzuto, 2002).

Conclusion and Recommendations

Sequel to the results and findings resulting from disparities in the quantity of discharge of sewage through both sanitary and storm sewers, response to land use dynamics, importance attached to creeks as well as changes in quantity of built up areas in urban and rural areas, it becomes acceptable fact that significant difference occurs in creek channel response to both urban and rural land uses. Velocity, discharge, infiltration capacity, sediment yield and channel morphology used as parameters in the study indicate that, urban channel response is higher than the rural channel. Sequel to the above findings, the following are recommended to address the identified problems.

- The Federal and State laws on the environment management should be encouraged and implemented at all levels irrespective of its rural or urban locations.
- The sections of the Nigerian Urban and Regional Planning Laws on the percentage of built-up within the residential and other land uses should be followed.
- Building permits and approval of building documents should be obtained and approved by the relevant government authorities before building.
- Water channels should be protected through enforcement of relevant laws for ecological balances especially environmental laws.

- ❖ Environmental impact assessment should be carried out on proposed developmental projects which may constitute environmental and physical planning challenges to the environment.
- ❖ Educational trainings, orientations and awareness on the importance of flood plain should be conducted in all sectors of the society.

References

Bird, J.F (1980). Geomorphological Implications of Flood Control measures, Lang-Lang rivers, Victoria. Australian Geographical Studies (Journal of the Institute of Austrialian Geographers. Vol 18 No 2 pp. 169-183.

Dunnin, F.X (1976). Infilteration: its Simulation for Field Conditions. In Rodd, J.C. (ed) Facts of Hydrology.Wildey, London pp. 199-229.

Ferguson, B.K. (1991). Urban Stream Reclamation Journal of Soil and Water Conservation Vol. 5 pp. 325, September/October.

Kinghton, D. (1984). Fluvial Forms and Processes. Edward Arnold, London UK.

Odemerho, F.O (1984). The Effects of Shifting Cultivation on Stream Channel Size and Hydraulic Geometry in Small Headwater Basins of South-Western Nigeria. Geografiska-Annalar 66 (A): pp 327-340.

Oyegun, C.U (1984). Predicting Channel Morphology from Sediment Yield, Discharge and urbanization in Upper Ogunpa River Basin M.Sc Thesis (Unpublished) University of Ibadan, Ibadan Nigeria.

Pizzuto, J.E (2002). Comparing Gravelbed Rivers in Paired Urban and Rural Catchment of south-Eastern Pennsylvania. Geology 28. Pp.79-82.

Rogowski, A.S (1972). Watershed Physical-Soil Variability Criteria. Water Resources Research Vol.8 pp.1015-1023.

Starkel, L. (2002). Rainfall runoff and Soil Erosion in Estremely Humid Area Around Cherrapuniji, India (Preliminary observations). Geographic Polomica. Vol75 no.1 Spring 2000 pp.43-68.

Strahler, A.H and Strahler a.N (1992). Modern Physical Geography (4th eds) John Wiley, new-York USA

Tarver, J. D. (1996). Demography in Africa. Westpoint, CT: Praeger, pp 91- 98.

Thornes, J.B (1976). Hydraulic Geometry and River Channel Forms: in Gregory, K.J (ed) river Channel Changes. John Wiley, New-York.

Umeuduji, J.E (2000). Principles of fluvial Geomorphology. Jodigs and Associate, Minna Nigeria.

UNCED (United Nations Conference on Environment and Development) (1992). Agenda 21, Rio de Janeiro.