GLOBAL JOURNAL OF SOCIAL SCIENCES VOL. 7 NO. 2 2008: 121 - 127
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# PROBLEMS AND PROSPECTS OF POOR DRAINAGE SYSTEMS AND URBAN SUSTAINABILITY IN CALABAR, NIGERIA

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(Received 27 October, 2008; Revision Accepted 13 January, 2009)

## ABSTRACT

Urban environments in Nigeria are facing a lot of problems consequent upon poor drainage systems. Calabar is a fast growing city in terms of infrastructural development, which involves construction and concretization of the city land surfaces, thus, leading to flooding. However, the study is hinged on evaluating the quality of drainage systems: the remote and immediate causes of poor drainage systems; environmental and infrastructural problems caused by the drainage systems; and ways of managing the associated problems in the area under study. Based on this, the study reveals that the drainages in Calabar were not well designed due to the low level of technical know-how. The disposal of waste into gutters has added adversely to the problems of flood in Calabar metropolis. Flooding was observed to be the principal consequence of poor drainage systems. The result of the tested study hypothesis revealed that poor drainage systems were actually the cause of incessant flooding, loss of lives and destruction of properties in the area with a correlation coefficient of 0.98 and validated using the student t-test at 0.05 significant level two tail test.

**KEYWORDS:** Urban Sustainability; Problems; Prospects; Drainage Systems, Calabar

## INTRODUCTION

Poor drainage systems in Calabar Metropolis have in no small measure caused tremendous environmental problems. These problems are basically associated with floods, which in tum bring about environmental hazards. Flood hazards occur basically in two distinct areas: coastal areas and areas bisected by rivers. But today in Calabar, flooding has become a frequent hazard which is related to heavy precipitation, which can collapse the natural or man made dams and the release of impounded waters (Hagget, 1975). Poverty has forced many to occupy areas prone to floods and mud landslides in areas which have no good drainage systems. Due to these, as observed in Caracas, Venezuela over half a million people live in the flood prone areas and so many lives and properties have been claimed by this hazard (Awake, 2005).

In the words of Mba (1996), poor planning as it has to do with the hydrologic and topographic characteristics of some areas; run-off is forced to flow along the roads, gutters and overflow into depression where seasonal lakes develop which would ultimately flood with subsequent rains. A recent study of Folorunsho (2000) has shown that the frequent flooding of the Victoria and Ikoyi Island in Lagos is predominantly caused by excessive rains which are very prevalent during the months of September to October. She also noted that even though the Island had a network of drainage channels consisting of both annually and main channels without falls to Lagos lagoon, flooding hazards are worsened when heavy rains or storm coincide with high tides.

Sule (2001) has given examples of cities where houses are constructed directly on drain channels to include Lagos, Calabar and Ibadan, and that this practice has resulted to blockage of storm drains and consequently leading to inundation and flooding of streets. Eze and Abua (2003) said that floods are very destructive on croplands, forest and in some cases residential buildings, Factories and highways are also affected. They pointed out that in urban areas, the basic network of flooding is modification of the basic network and channel characteristics as a result of settling down on the flood plain.

The perennial flooding in Calabar metropolis has left a lot of persons and there are sad tales to tell. This is consequent upon the fact that, the topography of Calabar is such that urban hills tilt to the coast. Rainwater usually empties into the low lands. In effect, only those areas dissected by those natural channels felt the spanks of the ravages yearly. Calabar over the years has been known to be an erosion prone zone especially in areas such as Barracks road, Otop Abasi, Target street, Goldie, Mayne Avenue, M.C.C Road, Yellow Duke, Parliamentary road, Big Qua town, Iso Oqua and the Crutech staff quarters. In these areas when ever there is down pour, problems such as flooding of houses, poor accessibility, distortion of the environmental beauty and neatness through the deposition of waste carried by running water, destruction of infrastructural facilities such as roads, gutters and houses, farms and gardens, pollution and sedimentation of the adjourning streams and so on are observed in the area. Another problem of serious concern at this point is that of the provision of adequate numbers of drainage channels in the city.

In view of the stated problem at hand, this study seeks to highlight the environmental implications of poor drainage systems in the area under study and make possible solution and suggestions towards the amelioration of the problems.

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The aim of this study is to highlight the problems of poor drainage systems in Calabar metropolis as well as suggest ways of ameliorating such problems in the metropolis. This will be achieved through the following specific objectives:

(i) To determine the quality of drainage system in the area
(ii) To assess the adequacy of drainage systems in the area
(iii) To examine the remote and immediate causes of poor drainage systems in Calabar metropolis
(iv) To evaluate the environmental and infrastructural implications of poor drainage systems in the area under study.
(v) To suggest ways of managing the associated problems.

In an attempt to achieve the above stated aim, a null hypothesis was stated such as:

$H^{o}$: Poor drainage systems have not significantly influenced environmental degradation in Calabar metropolis.

**Study area**

Calabar metropolis is located between latitude $8^{0}15^{1}$ E and $8^{0}20^{1}$E, and longitude $4^{0}45^{1}$ N and $5^{0}30^{1}$ N as shown in figure 1. The city lies on a peninsula formed by the Calabar River, Great Kwa River, the Cross River State estuary and the Atlantic Ocean. Calabar has a sub-equatorial type of climate; the temperature is moderately high and not fluctuating greatly. The maritime position of Calabar exercises considerable ameliorating influence on its climate.

The mean temperature is about $25^{0}$C with a range of about $8^{o}$C. The annual rainfall exceeds 300 millimeters, most of which comes in the wet season from May to October. The relative humidity is high throughout the year, giving a mean annual figure of about 84%. The vegetation of the area is mainly that of mangrove swamp, the raffia swamp and cultivated vegetable gardens, numerous isolated stands of cultivated semi-wild oil palm and coconut palm trees (Udo, 1975).

There are two major drainage systems in Calabar. These are the Calabar River system and the Great Quo river system. Calabar can be sub-divided into four main relief units, namely the central plain: this is a gentle sloping to moderately undulating region, stretching roughly NNE-SSW and with elevation of 40-50 meters above sea level. The western scarp: this is the termination of the central plain with the Calabar river valley. The eastern scarp: this is the termination of the central plain with Great Kwa river valley. Geologically, Calabar is composed of two main formations. The coastal plain sands, the equivalent of Benin formation, are of tertiary period. This formation consists of light brown to grayish white sands. Sometimes with decomposed feldspar fragments and pockets of clay (Ekwueme, 2001).

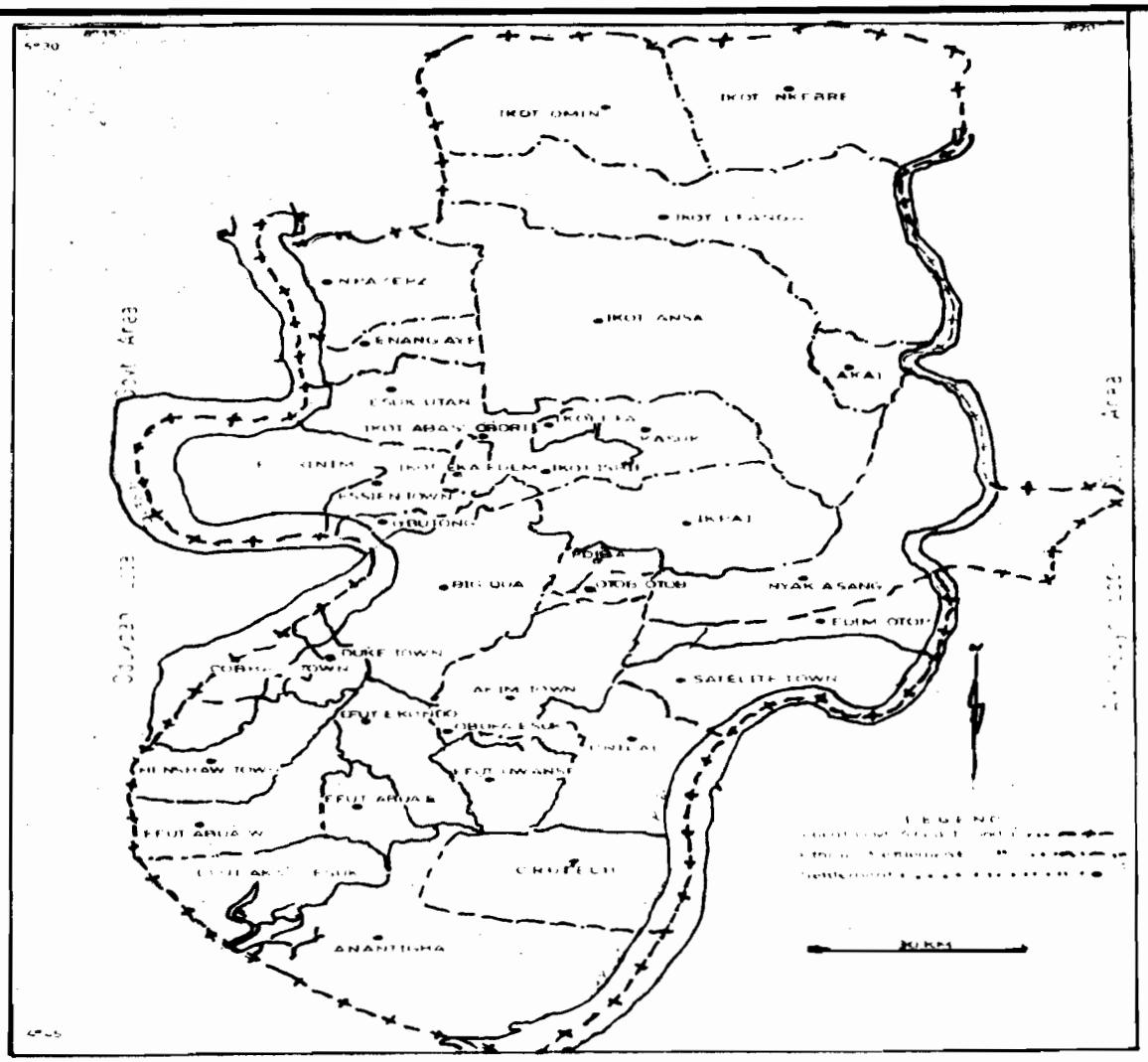


**Figure 1: Map Showing Calabar Metropolis**

## MATERIALS AND METHOD

To achieve the objectives of this research, a combination of primary and secondary sources of relevant literature were used for data collection. The data on which this research is based on were collected using questionnaire, direct field observation, the employment of other research tools such as oral interviews with semi-structured questions and focus group discussions for information gathering. A total of one hundred and thirty five copies of questionnaire were administered.

The sampling technique/procedure that was obtained is simple random sampling. The same population was picked at random as it involved the administration of questionnaire. On the other hand, the stratified sampling procedure was adopted as the researcher decided to sample the members of Cross River Ministry of Works and Calabar Urban Development Authority (CUDA). Data obtained were analyzed using simple averages, percentages, tables, frequency and photographs to bring the research to a clearer perspective.

The study hypothesis was tested using the Pearson Product Moment correlation which is given as:

$$r = \frac{1}{n} \frac{\Sigma(x - \bar{x})(y - \bar{y})}{(\delta x)(\delta y)}$$

Where:

| | | |
|---|---|---|
| r | = | Correlation coefficient |
| N | = | Number of variables |
| x | = | Independent Variables (Drainage system quality) |
| y | = | Dependent variable (Environmental degradation) |
| $\delta X, \delta y$ | = | Standard deviation of x and y |

In view of the above, the students''t' test was further employed to validate the correlation coefficient ('r'). The students''t' test formula is given as:

$$'t' = 'r' \sqrt{\frac{N - 2}{1 - r^2}}$$

Where

| | | |
|---|---|---|
| r | = | Correlation coefficient |
| N - 2 | = | Degree of freedom |
| $r^2$ | = | Square of correlation coefficient |
| I | = | constant |

## RESULTS AND DISCUSSION

This section was focused on the presentation, analysis and the discussion of findings' implications. Furthermore, the data were presented and analyzed systematically starting with the objectives of the study.

With specific reference to study objective one, which was stated as to determine the quality of drainage systems in the area, presented in table one that the drainage systems in Calabar were not well designed as the option had a value of 40%. Furthermore, others were highly fractured and represented with a value of 22.2%. Invariably, the problem of very narrow gutters and not well-plastered gutters were also observed with values of 17.7% and 20% respectively. In general, the quality of drainage facilities in Calabar was seen to be low and poor.

**Table 1: The quality of the drainage facilities**

| Quality | Frequency | Percentage |
|---|---|---|
| Very narrow | 24 | 17.7% |
| Not well design | 54 | 40% |
| Not well plastered | 27 | 20% |
| Highly fractured | 30 | 22.2% |
| Not present at all | - | - |
| | 135 | 100% |

**Source: Author's Field Survey (2008)**

With specific reference to study objective 2 which is concerned with the assessment of the adequacy of drainage systems in Calabar was presented in tables 2 and 3. From table 2, it was observed that the drainage systems in Calabar were inadequate as the option with yes had a value of 55.6%. This was not that much significant as the option with no had a value of 44.%.

Similarly, as depicted in table 3, it was observed that the major causes of poor drainage systems in Calabar were itemized on the table. However, it was seen that the major cause of inadequate drainage in Calabar was as a result of as low level of technical know-how as it had a value of 33.3%. In the same vein, lack of information and communication on the state of drainage facilities, alongside government negligence, which had a percentage score of 17.5% and 15.6% respectively? Nevertheless, other items such as poor monitoring and evaluation of drainage sites with 11.1% and inadequate funding with 4.4% were seen to be causative factors to drainage systems inadequacy in Calabar as all of the above option had a value of 17.8%

**Table 2: Inadequacy of drainage systems**

| Options | Frequency | Percentage |
|---|---|---|
| Yes | 75 | 55.6% |
| No | 60 | 44.4% |
| | 135 | 100% |

**Source: Author's Field Survey (2008)**

**Table 3: Causes of inadequate drainage system in Calabar**

| Causes | Frequency | Percentage |
|---|---|---|
| Inadequate funding | 6 | 4.4% |
| Government negligence | 21 | 15.5% |
| Low level of technical know-how | 45 | 33.3% |
| Poor monitoring and evaluation of site | 15 | 11.1% |
| Lack of information and communication on the state of drainage facility. | 24 | 17.8% |
| All of the above | 24 | 17.8& |
| Total | 135 | 100% |

**Source: Author's Field Survey (2008)**

**Remote and immediate causes of poor drainage**

With regards to study objective 3, which hinged on examining the remote and immediate causes of poor drainage systems in Calabar metropolis, was presented in table 4. The dumping and disposal of solid waste into the gutter with 44.4% was the major cause of poor drainage in Calabar as the heap of the waste served as an impediment and blockade to running water. Nonetheless, the width level of the gutters is not wide enough to contain the volume of flow in the area as it had a percentage value of 24.4%.

The option with all of the above which had a value of 18.5% though negligible, portrayed the fact that poor drainage connectivity with a score of 6.8% along side the use of sub-standard materials for construction with a percentage score of 5.9 were part and parcel of the causes of poor drainage system in Calabar metropolis.

**Table 4: The major causes of poor drainage system in Calabar**

| Major causes | Frequency | Percentage |
|---|---|---|
| Disposal of solid waste into gutters | 60 | 44.4% |
| The drainage are not wide enough | 33 | 24.4% |
| Poor drainage connectivity | 9 | 6.8% |
| Use of sub-standard materials for construction | 8 | 5.9% |
| All of the above | 25 | 18.5% |
| Total | 135 | 100% |

**Source: Author's Field Survey (2008)**

**Poor Drainage implications on the environment and infrastructure**

Taking into consideration the study objective 4 which was written as to evaluate the environmental and infrastructure implications of poor drainage systems in calabar, was capped the effects of poor drainage system in Calabar. From Table 5: which had 7 options numbered from a – g, it was seen that flooding was the main environmental problem in the area. This was informed by the fact that the option with flood had a value of 37.8%. Invariably, soil erosion with 22.2% was seen to be the next problem in this issue. Several other effects were noticed, such as deposition of debris with 11.1%, distortion of aesthetic environment 11.1%, and all of the above 11.1%, bringing in siltation of streams and other problems with 4.4% and 2.3% respectively.

**Table 5: The effects of poor drainage system in Calabar**

| Effects | Frequency | Percentage |
|---|---|---|
| Flooding | 51 | 37.8% |
| Erosion | 30 | 22.2% |
| Silting of streams | 6 | 4.4% |
| Deposition of debris | 15 | 11.1% |
| Distortion of aesthetic environmental | 15 | 11.1% |
| All of the above | 15 | 11.1% |
| Others | 3 | 2.3% |
| Total | 135 | 100% |

**Source: Author's Field Survey (2008)**

**Correlation between causes of poor drainage system and effects on the environment**

| S/N | x | Y | $(\bar{x}-x)$ | $(\bar{y}-y)$ | $(\bar{x}-x)(\bar{y}-y)$ | $(\bar{x}-x)^2$ | $(\bar{y}-y)^2$ |
|---|---|---|---|---|---|---|---|
| A | 60 | 51 | 40.7 | 31.7 | 1290.19 | 1566.49 | 1004.89 |
| B | 33 | 30 | 13.7 | 10.7 | 146.59 | 187.69 | 114.49 |
| C | 9 | 6 | -10.3 | -13.3 | 136.99 | 106.09 | 106.09 |
| D | 2 | 15 | -17.3 | -4.3 | 74.39 | 299.29 | 18.49 |
| E | 6 | 15 | -13.3 | -4.3 | 57.19 | 176.89 | 18.49 |
| F | 25 | 15 | 5.7 | -4.3 | 24.51 | 32.49 | 18.49 |
| G | 0 | 3 | -19.3 | -16.3 | 314.54 | 372.49 | 265,69 |
| Σ | 135 | 135 | | | Σ=2044.45 | Σ=2831.43 | 1546.63 |
| x,y | 19.3 | 19.3 | | | | | |

Standard deviation of x and y is given as:

$$\sqrt{\frac{\Sigma(\bar{x}-x)^2}{N}} \quad \sqrt{\frac{\Sigma(y-\bar{y})^2}{N}}$$

$$= \sqrt{\frac{2831.43}{7}} \quad \sqrt{\frac{1546.63}{7}}$$

$$= 20.11 \qquad = 14.86$$

Therefore:

$$\frac{\frac{1}{n}\,\Sigma(x-\bar{x})\,(y-\bar{y})}{(\delta x)\quad(\delta y)}$$

$$= \quad 0.143 \times 6.84$$

'r' = 0.98

**Interpretation**

In relation to study objectives 3 and 4, the study hypothesis which was stated as poor drainage system has significantly influenced environmental degradation in Calabar Metropolis was tested using the Pearson Product Moment correlation and the result was 0.98%. The correlation coefficient of 0.98% indicated a very strong positive correlation between the causes of poor drainage systems and the resultant effect on the environment. This meant that poor drainage facilities had impacted the environment of Calabar metropolis seriously. This actually made the researcher to accept the null hypothesis. From the ongoing, the coefficient determination of 96.04% indicated that the poor drainage systems impacted the environment with 98.01%. Therefore, the researcher went further to validate the high correlation coefficient through the use of the student 't' test statistics. Therefore the researcher postulated another hypothesis stated as:

Ho: The high correlation coefficient of 0.98% occurred by chance.

Hi: It did not.

Hence:

$$t = r\sqrt{\frac{N-2}{1-r^2}}$$

t = 11.0

r – cal = 11.0

t-tab = 2.78 at 0 05 significant level two-tail test. Degree of freedom = 5

**DECISION**

Since the't' cal of 11.0 is greater than the table value of 2.78 at 0 05 significant level (2 –tail) the researchers therefore rejected the null hypothesis and accepted the alternative hypothesis, which meant that the high correlation coefficient did not occur by chance Therefore, poor drainage facilities affect he environment negatively in Calabar Metropolis.

**CONCLUSION/POLICY RECOMMENDATIONS**

Sequel to the statement of problem, the objectives of the study and the adoption of standardized scientific tools of data collection and analysis, it is observed that wherever there is development and urbanization, there is need for increase of infrastructures. Going by the rate of urbanization in the study area, especially in the areas of housing, road construction and concretization of land surfaces which play a significant role in surface runoff volume, drainage facilities of high quality should be provided to commensurate with the level of development. This will definitely ensure the sustainability of other infrastructures that could be damaged by flooding. However, certain problems have been observed to be associated with poor drainage system in Calabar metropolis such as the damaging and degradation of the environment, thus, leading to the destabilization of socio-economic activities and urban infrastructures.

In the light of the above the following recommendations are put forward. They are:

- The drainage systems should be properly channeled
- The topography of the area should be properly studied before the construction of gutters
- The dumping of refuse in gutters should be strongly prohibited
- Large drainages system should be provided
- Greening the area should be encouraged to reduce the amount of run-off that results in flooding
- Proper connectivity of the drainage systems should be ensured.
- The provision of drainage facilities in Calabar Metropolis should be in every street and road.
- The width, length and depth of drainage systems should be expanded.
- The use of standard and quality materials in the construction of drainage facilities should be encouraged.
- Proper drainage designs and technical know how should be improved upon.
- State of facility reporting, monitoring and evaluation should be made a routine.
- Policy makers and the government should promulgate laws that will enable the punishment of those who dump their waste products in the drainage channels.

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