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Anthropogenic Activities and Stream Disappearance in the Middle Enyong Basin of South-Eastern Nigeria: A Perceptual Approach

by

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Abstract

Anthropogenic activities responsible for stream disappearance were examined in the Middle Enyong Basin of Southeastern Nigeria. Interview and structured questionnaire was used to collect data on the anthropogenic activities that may contribute to disappearing streams in the study area. Secondary data sources were both published and unpublished materials including existing maps of the Enyong Basin. It was observed that man has been the major cause of stream disappearance through his various activities. Farming on stream slope, mining, deforestation, bush burning and road construction have been the major human activities responsible for stream disappearance. This was confirmed by hypothesis testing. The research shows that alternative sources of water have reduced the impact of stream disappearance to some extent, although it is felt as a burden in terms of the economic power of sourcing for alternative water. It is argued that if environmental education to the people, dredging of the major stream and diversification of economy is done, it can abate such catastrophic occurrence.

Key words: Anthropogenic Activities, Disappearing Streams, Middle Enyong Basin, South-Eastern Nigeria

1. Introduction

Disappearing streams have been viewed as the streams that disappear underground channel due processes of deposition or harsh weather condition. Disappearing or dry streambeds are subject to flow disturbances that mobilize, deposit, and scour bed sediments. A temporary streambed can be dry for much of the time and may only be "aquatic" for a brief period after a flood or a period of heavy rainfall (Datry, Arscott and Sabater, 2011). They can also be exposed to intense solar radiation, wind, and extreme temperatures (Steward, Marshall and Sheldon, 2011). Dry streambeds may be devoid of vegetation. Although often linked with negative connotations, dry riverbeds are associated with a range of important societal and ecological values. Unfortunately, dry

streambeds have been largely ignored by aquatic and terrestrial ecologists, probably because they are perceived regions; they can be where the greatest diversity and density of vegetation is found to be outside the domain of their respective disciplines.

Disappearance is a common phenomenal problem associated with streams all over the world (Whitford, 2002; Millennium Ecosystem Assessment, 2005 and Levick *et al.*, 2008). Streams which intermittently cease to flow and "run dry" are representative of the world's river systems than those with perennial flows (Williams, 1988). These temporary streams are a truly global phenomenon (Larned, Datry, Arscott, and Tockner, 2010). Their spatial and temporal extent is likely to further increase resulting from the combined effects of altered land-use patterns, climate change, and increased water extraction for human uses (Meehl, Stocker and Collins, 2007; Palmer, Reidy-Liermann, and Nilsson, 2008).

According to Ekop (1998) and Enoh (2000), stream disappearance or stream extinction has been caused by both natural and anthropogenic factors such as erosion, deposition, road construction and uncontrolled runoff. Streams are ever changing because erosion is in progress all the time. But Freedman (2007) and Fellmann, Getis and Getis (2008) stressed that natural factors like landslide, soil erosion, mud flow, etc., are chiefly caused by anthropogenic activities. Sheet erosion occurs commonly in Nigeria although its effect is not easily perceived because of its 'deceitful' slow progress. Soil erosion has been identified as being active in many parts of Nigeria like Anambra, Imo, Plateau and Sokoto States, parts of Kwara and Akwa Ibom States. While this type of erosion is a natural process, human activities can change that. Drainage and irrigation activities can change natural stream characteristics. Acho-chi (1998) on his part related variations in climate, geology and the rate of forest degradation on spatial and seasonal variations in water yields.

In a study by Elmore and Kaushal (2008), headwater streams (which Briney, 2014 referred to as first through third order streams) are buried more extensively than are larger streams at all levels of urban development whether it is low residential, suburban or urban. Due to high-density urban development, headwater streams in any watershed are more likely to be completely buried on coastal plains than in upland reaches. Dry riverbeds can be created by anthropogenic influences. Dams and weirs can intercept flow, drying riverbeds downstream. Water extraction from rivers and groundwater during droughts can reduce river flows, causing riverbeds to dry (Steward, Marshall and Sheldon, 2011).

From pilot field observations, poor construction techniques by incompetent engineers who 'kill' rivers by diverting them from their natural courses to enable the construction of bridges have also been responsible for stream disappearance in some other basins, e.g. the Ikot Usop – Ikote Osudu river along the Ikot Abasi-Ekparakwa Road, the Ekpambit River in Ikot Edeghe along the Mile 49-Ikot Ekpuk Road and many others all in Akwa Ibom State, Nigeria. Elsewhere, James and Marcus (2006) observed that the effects of agriculture, forest clearing, urbanization, fire, and other human activities leads to runoff and soil erosion that eventually bury streams. The emphasis was usually on the socio-economic and cultural changes that led to these impacts. The emphasis on upland

changes rather than riparian impacts reflected a pervasive contemporary bias of the soil-conservation movement towards on-site issues while disregarding off-site effects. Along the same vein, Ituen (2004) opined that indiscriminate timber exploitation, increased demand for fuelwood, destruction and farming of forest areas along stream slopes contribute much to deforestation in Ibesikpo Asutan Local Government Area of Akwa Ibom State and with serious ecological consequences including stream silting and accelerated rate of soil erosion.

Stream burial, according to Elmore and Kaushal (2008) is where streams are directed into culverts, pipes, concrete-lined ditches, or simply paved over and is probably the most extreme impact of development and urbanisation on streams. This scenario results in the destruction of natural stream channels and contributes to downstream habitat degradation, aquatic habitat fragmentation, enhanced transport of water and toxic contaminants, and reduction of ecosystem services such as nutrient and sediment retention (Paul and Meyer, 2001 and Walsh, Roy and Feminella, 2005). In the United States, for example, the Colorado River completely dried up in most years before reaching its once rich and thriving delta in the Gulf of California. The delta that once supported thousands of wetland species of plants and animals is now desiccated and dead (Postel, 1997).

The link of anthropogenic activities with disappearing streams, according to Daily Nation (2009) is that wild animals which are of economic and cultural value to the people are likely to die due to thirst of water at Lake Nakuru National Park. UNDP (2015) reported that people in the downstream of Lugulo River which had once supported the lives of the families and agricultural communities that live along its bank is no longer flowing as it used to more than 60 years ago. It is now full of sand. The rocks have disappeared in the sand and the water is flowing under the sand and more often times dry.

Population growth will make the problem worse, so will climate change. As the global economy grows, so will the competition for the available water supplies continue to increase until some radical measures are taken. Many more conflicts lie just over the horizon. The nexus of anthropogenic activities with disappearing streams pose threats to water resource utilisation and management in the area. Studies rarely focus on disappearing streams in terms of its connection with human activities. Despite the socio-economic and environmental consequences of human activities on environment in the basin, the studies of impacts of human activities on streams are deficient in literature. This study therefore, examined the nexus of anthropogenic activities as they relate to disappearing streams in the Middle Enyong Basin of Southeastern Nigeria, with a view to examining the major anthropogenic activities that may contribute to phenomenon.

The study was based on two main concepts – the Concept of Perception and, the Concept of the Hydrosocial Cycle. Perception means perceiving, which entails giving meaning to the environment. It has to do with a set of processes by which individuals become aware of and interpret information about their environment. Knowledge of perception is, therefore, useful for a proper evaluation of the human environment. The study also emphasized the complex hydrosocial cycle concept which is a means of theorising and analysing water-society relations. The hydrosocial cycle is based on the concept of the hydrological cycle but modifies in some ways. While the hydrological

cycle has the effect of separating water from its social context, the hydrosocial cycle deliberately attends to water's social and political nature (Linton and Budd, 2013). The hydrosocial cycle is, therefore, conceptualized as a socio-natural process by which water and society make and remake each other over space and time. This concept is an analytical tool for investigating hydrosocial relations and as a broader framework for undertaking critical political ecologies of water. Schmidt (2014) opined that there are at least two sources for the idea of the hydrosocial cycle. The first is in reference to social contract theories, such as those found in the political philosophy of Thomas Hobbes or John Locke while the second posits and critiques a society and nature dualism for how it implicates modern categories of thought that sort things to "society" on the one hand, and "nature" on the other. Since the hydrological cycle did not adapt itself to man's space, time and quantity requirement; modification process was established in order to achieve some convergence between water resources and water demands on both spatial and temporal scales. The problems of too much or too little water had been solved by man through alternative water sources. The modification of the hydrological cycle by man for the benefit of man was slowly having impact on surface water like streams in the Middle Enyong Basin. Hydrosocial cycle concept determined the relationship of man with streams, and why streams changed in quantity and water resource capacity in the Middle Enyong Basin in Akwa Ibom State, Nigeria.

The study sought to investigate the impact of anthropogenic activities on stream disappearance in the study area.

2. Study Area

Middle Enyong Creek Basin is located between longitudes $7^{0}43^{1}55^{0}$ and $7^{0}53^{1}49^{0}$ East of the Greenwich Meridian and between latitudes $5^{0}14^{1}49^{0}$ and $5^{0}25^{1}00^{0}$ North of the Equator. It is located at the northern flank of Akwa Ibom State, Nigeria. It occupies three local government areas of Akwa Ibom State, namely: Ini, Ikono and Ibiono Ibom as shown in figure 1.

Geologically, the basin is made up of the alluvial deposits of the late tertiary age (which Usoro (2010) called the younger Benin Formation Coastal Plain Sand) from homogenous structure of sand stone, shale and clay have resulted in the Middle Enyong Basin physiographic region underlain by coastal plain sands, which vary in texture, colour and thickness. This is seen in the sub-catchment of Enyong Basin known as Idim Ibom. Geology of the basin is under the structural control of Enugu-Okigwe escarpment (Obianwu, George and Okiwelu 2011 and Udosen and Etok, 2016).

The climate of the area is typical of humid tropical climate where the weather is almost wet all year round with annual rainfall of over 3000mm, high temperature of 26.9^{0}C and high relative humidity averaging 70% to 80% (Ukpong, 1997, Ekpeyong and Okoji, 1998, Inyang, 2000 and Akpabio, 2002). According to Udosen, (2008) and Ekanem, (2010), it has two seasons of wet and dry as a result of Inter-Tropical Discontinuity (ITD).

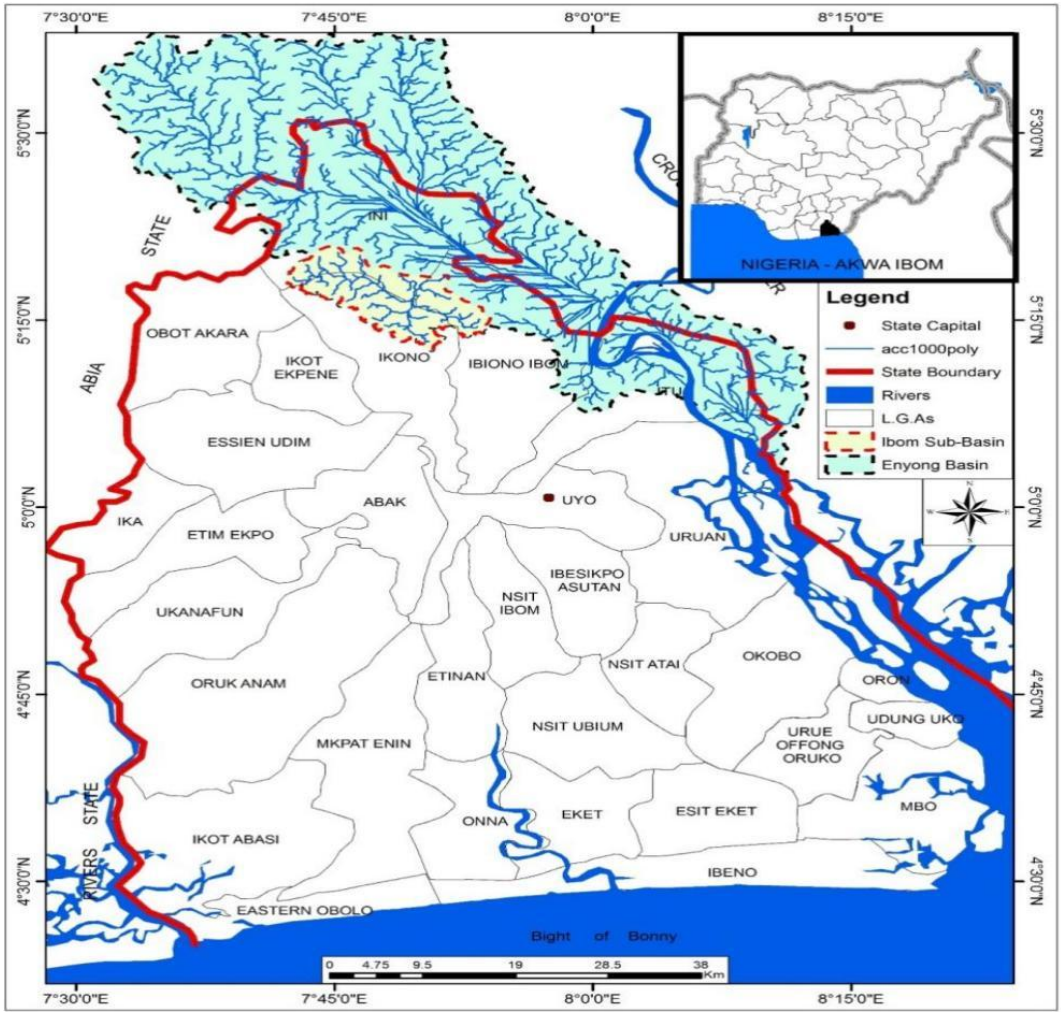

Figure 1: Location map of Enyong Creek Basin.

The principal source of water in the Middle Enyong Basin in is rainfall which recharges both the surface water and groundwater. According to AKS (1989), the hydro-geology of the watershed based on the regional water table is over 55m. The northern boundary of the aquifer is formed by the impervious clays and shale of the Ameke and Imo shale formations. This geological condition makes it difficult for ground water extraction and where such extraction is possible, there is the other problem of mineral-based water pollution. According to Akpabio (2003), these classifications make water resources availability highly variable across spatial areas. According to Essien (2013), the content of organic and/or coarse particles influence produced moderate to rapid, rapid or very rapid saturated hydraulic conductivities leading to high flow-through of unfiltered water, hence groundwater or sub-surface flow which reduces the chances of surface poundage in micro-topographic depressions and erosive flows on slopes in erosional channels.

The Middle Enyong Creek area is drained chiefly by the tributaries of the Enyong Creek and to a small scale the Ikpa River (Inyang, 2000). According to Udosen and Etok (2016), the drainage patterns of stream network from the basin have been observed as mainly dendritic type. Soil type is developed on the coastal plain sands and is dominated by sandy-loams and sandy-clay-loams which are sometimes prone to excessive leaching (Akpabio, 2002). These soils sometimes possess a mixture of hydrated oxides and aluminum at the depth of at least 60cm or 0.6m. According to Ukpong and Ibia (1998), the soils of Enyong Creek basin were classified based on Food and Agriculture Organsation (FAO) system as Eutric Fluvisol or fluvents under the United States Department of Agriculture (USDA) system. The soils in the Middle Enyong Creek on sandstone and shale may be less severely weathered hence the relatively high effective cation exchange capacity (ECEC) of 18.26 cmol/kg. In general, the soils have low chemical fertility (Effiong and Ibia, 2009) and may require quality soil management practices to sustain increases in crop production in the wetland soils when intensively cultivated. The productivity of these soils depends on the supply of litter by the vegetation (Udofia, 2008). Essien (2013) found out from analysis that the predicted K-factors which were soil erodibility potentials of Enyong Creek basin were high which ranges between of 0.0827 and 0. 121.The soil characteristics of the Middle Enyong Creek are therefore determined by the nature of the parent material. The characteristics vary widely because of local geology and the degree of weathering occurring in the catchment (Ogban, Effiong, Obi and Ibia, 2011).

The vegetation of the study area is the tropical rainforest type (Akpabio, 2002). Despite the importance of forest to mankind, the forest in Middle Enyong Creek Basin is exploited through careless logging which has irregularly degraded the environment especially on steep slope and on fragile ecosystem, and this problem has continued to occur irrespective of the teaching of environmental education in the curriculum of schools and the activities of Government and Non-Governmental Organization (NGO's) towards preserving the environment (Ogo, Effiong, Eyo and Akpan, 2013). It has now degenerated into secondary bush which is not allowed to revert to forest on account of continued farming activities. Since the oil palm is never destroyed in the process, the entire vegetation is dominated by this single tree, with grass and shrubs under layer. In recent years, the sudden appearance of *siam* wood (*eupatoumoduratum*) added a new dimension and character to vegetation composition of this zone (Inyang, 2000).

The indigenes who are living in the Middle Enyong Creek Basin are chiefly the Ibibio people of Akwa Ibom State of Nigeria. They migrated from Ibom Village, now in Arochukwu in Abia State of Nigeria to the present places (Ukpong, Akpan and Akong, 2001). They operate the African system of government. Obong Idung (now called Ete Idung) is the head of each village. Clan head is called Nsobom and paramount ruler is called Edidem.

Based on the report of the 2006 National Population Commission, the three local government areas covered by the Enyong Basin have a total population of 131,673, 188,605 and 99,084 respectively (NPC, 2011). The projected population of Ikono, Ibiono Ibom and Ini Local Government Areas as at 2015 stood at 177,902, 254,823 and 133,872

respectively based on the population growth rate of 3.4% of Akwa Ibom State. The projection of Ministry of Economic Development (2014) was based on the Compound Interest Formula, $P_n = P_o + (1 + r)^n$, where; P_n = projected population for year n, P_o = 2006 population census figure, 1 = constant, r = population growth rate for Akwa Ibom State and n = number of years.

The land is used for settlement and agriculture. Settlement is densely seen in the centre of the communities in Middle Enyong Creek Basin in Akwa Ibom State and around major markets in the area. According to Ituen (2010), agricultural practices in the basin are bush fallowing and bush rotation with period of rotation not exceeding five (5) years. Crops planted include yam, cocoyam, and maize. The exposure of soil for agricultural purposes is sometimes twice a year. The first phase of planting is done in the normal planting season while the second phase is done in the late planting season. Agriculture is generally practiced at subsistence level mainly through slash and burn mode of land preparation with the use of locally fashioned farm implements.

3. Materials and Methods

Interview and structured questionnaire were used to collect data on the anthropogenic activities that may contribute to disappearing streams in the study area. Secondary data sources were collected from both published and unpublished materials for example books, journals or articles, seminar papers, existing map of Enyong Basin, internet and other relevant literature. To obtain the sample size for the streams selection, sampling fraction concept agreed by Enoh (1997) was used in this study. Sampling fraction concept makes use of fraction or percentage to show the ratio between the parent population of streams and the sampled streams. This was used to save time in the collection of an unnecessarily large sample.

Total number of stream segments = 64

Sampling fraction = 64 x (10÷100) = 6.4, approximately 6 sampled streams. However, the six (6) major streams of Ibom sub-basin of Enyong Basin that were picked were: Ibom, Okon, Afia, Urua Uko, Adiaha Eka and Otime. To obtain the sample size, a list of all the settlements in the area making up the study area was obtained from the NPC. Godden (2004) expressed a formula called "Bill Godden formula" for sample size of infinite population (where the population is greater than 50,000) as:

$$SS = \frac{Z^2 * (p) * (1-p)}{C^2}$$

Where:

SS = Sample Size.

Z = Z-value[A] which was given as constant of 1.96 for a 95 percent confidence level.

P = Percentage of population picking a choice, expressed as decimal[B] was given as constant of 0.75 for a population greater than 50000. The total population of the basin stood at 566597.

C = Confidence interval was 0.05 for a 95 percent confident level.

Thus,

$$SS = \frac{1.92^2 * 0.75 * (1-0.75)}{(0.05)^2} = \frac{3.6864 * 0.75.0.25}{0.0025} = 276.48 = 276 \text{ Approximately.}$$

The sampled communities were Nkwot Ikot Imo, Aba Itiat Ukwok, Ikot Iduot Ukwok, Nkwot Ikot Essen, Ikot Ekpe and Ukpom Ibakachi. Two Hundred and Seventy-six (276) copies of the questionnaire were distributed to the household randomly in the 6 chosen communities. Each community then had 46 copies of the questionnaire since the basin is a system. The questionnaire contained information on socio-economic and demographic characteristics, causes and implications of disappearing streams on the Middle Enyong Basin in Akwa Ibom State, Nigeria.

Descriptive statistics methods were employed to simplify the mass of raw data to show that the occurrence of stream disappearance was independent of anthropogenic activities. This was done because of the use of non-parametric data.

4. Results and Discussion

Causes of Disappearing Streams in the Study Area

Table 1: Broad causes of stream disappearance

Broad causes	No. of respondents	%No. of respondents
Nature	125	45.29
Man	151	54.71
Total	276	100

Source: Field Survey (2016).

From Table 1, 45.29% of the respondents accepted that nature could cause stream disappearance and 54.71% of the respondents identified man as the main cause of stream disappearance. From oral discussion with the respondents, greater percentage, mainly the elderly, saw nature as having influenced by God or a deity depending on one's faith. They believed that if God is offended He could cause stream to dry off. One of the informants in his early 70s remarked:

> *…I knew of a stream in this area which used to have water in it…two communities used to maintain it. Along the line, the two communities had issues which affected their relationship to a point that the other community stopped going to the stream to fetch water. On a fateful day, the stream that the two communities used to share dried off. It took the mercy of God to rejuvenate the stream which is now very small as compared to what it used to be in my youthful days*.

On the other hand, an educationist in his early 50s in the area stated:

> *…we humans are the causes of stream disappearance because of various activities performed by man. For example, we farm on stream slope, we cut trees and we dig ground…these are the causes of instability of soils which are later washed down slope to streams*.

Earlier studies by Akpabio (2012) on beliefs and perception of water in Southeastern Nigeria found that it is the local prevailing belief that water bodies are the dwelling place for the spirits. Therefore, some of the people of Ibom Sub-basin of Enyong Basin are still attributing natural phenomenon to an act of God.

Table 2: Level of anthropogenic activities in the study area.

Anthropogenic causes	No. of respondents	%No. of respondents
Farming on stream slope	69	25
Mining	61	22.1
Deforestation	80	29
Bush burning for agriculture	61	22.1
Road construction and dam building	4	1.8
Total	276	100

Source: Field Survey (2016).

From Table 2, 29% of the respondents agreed that deforestation is the cause of stream disappearance in the area. 25% of the respondents said that farming on stream slope is the anthropogenic activity that can cause stream disappearance. Mining and bush burning had 21.1% of respondents attested to it while 1.8% of the respondents said that road construction and dam building cause stream disappearance. An elderly man in the area remarked thus:

> *...mining of gravel has made silt to deposit in the streams of this area…the width and depth have reduced gradually…who knows what will happen tomorrow…whether streams will dry up totally or not".*

The area is rural, therefore, greater percentage of the population engaged in searching for fuel wood and timber which consequently leads to deforestation. An elderly woman in her 80s remarked

> *…we used to manage stream through communal efforts by clearing debris…it was local dredging when modernisation was not known in this part of the world…it is not so today as we tend to promote activities of streams disappearance*.

A young man in his middle 20s noted:

> *...my father told me that traditional rulers and their cabinet enforced stream maintenance. Hahaha! I don't think at my level in this time would listen to such command whereas my mates are enjoying outside the country. With stream or no stream, we can still survive.*

This nonchalant attitude has led to abandoning the maintenance culture of stream. A woman in her 40s made a statement:

> *I use the income I get from sand mining to send my children to school… I don't care where it is mined after all we believe we can get borehole water like other places.*

This remark has raised ethical question as to whether they do not understand the implications of such human activities on stream slope. It is perceived that human beings cannot be predictable on certain actions.

Some insights were made in Table 3 to understand how anthropogenic activities trigger some physical processes which in turn lead to stream disappearance. This was based on the findings of Ekop (1998) and Enoh (2000) which concluded that

anthropogenic activities can cause stream disappearance as well as natural activities such as siltation, landslide, mudflow, etc. In a related development, it was also in agreement with Ekong and Akpan (2014) that human activities affect wetland development and management. Deforestation, farming on stream slopes and sand/gravel mining were the major anthropogenic activities in the basin. They cleared forest for agriculture by the use of traditional methods such as bush/slash burning, and greater percentage of the population engaged in searching for fuel wood and timber which consequently leads to deforestation. It correlated with Neba and Amumveh (2010) that deforestation has made streams, especially 1st order stream to dry up. The elderly generation in the basin believed that God was the cause of stream disappearance.

Table 3: Physical processes linked to anthropogenic activities.

Physical processes linked to anthropogenic activities	No. of respondents	%No. of respondents
Siltation	155	56.16
Landslide	30	10.9
Mudflow/soil flow	75	27.17
Others	16	5.77
Total	276	100

Source:

It is gathered in Table 3 that siltation (56.16%) top the list followed by mudflow/soil flow (27.17%) while landslide (10.9%) and others (5.77%) take the least in Middle Enyong Creek. It was gathered from a respondent in his 50s that sand mining has been a viable economic activity in the area. A woman in her 40s remarked:

> *…I farm here on the stream slope to cater for my family…sand mining disturbs our stream because soil and mud flow into it. Our stream is now shallow.*

Results from table 4 showed that the occurrence of stream disappearance was dependent of anthropogenic activities in the basin. In essence, physiography could not just cause stream disappearance without stress from man. The calculated value of 56.8 was greater than the table value of 15.507, and the H_o was hereby rejected and H_1 accepted.

Table 4: Anthropogenic causes of stream disappearance.

Anthropogenic causes of stream disappearance / Responses	Farming on stream slope	Mining	Deforestation	Bush burning	Road construction and dam building	Total
Yes (y_1)	40	41	30	15	25	151
No (y_2)	19	8	10	16	5	58
Not sure (y_3)	5	2	20	30	10	67
Total	64	51	60	61	40	276

Source: Field Survey (2016).

5. Conclusion and Recommendations

Findings demonstrated that man has been the major agent of change on environment through his various anthropogenic pressures, causing destabilisation of the physiographic features such as streams. The humid environment like the Middle Enyong Basin has had its nascent disappearance of streams as a result of this neglect. Streams serve both aquatic and terrestrial ecosystems. If this aspect of the ecosystem is neglected, the essential services we derive from it will stop and all other facets of life will be affected as well as groundwater reduction. This will affect the quantity of water use per day; and due to the low purchasing power of the rural population to source for alternative water, progressive possibility of untold future water crisis is underway if left without proper attention to it.

Based on the observed findings, the following recommendations are made:

(a) Environmental education should also be given to every individual on the dangers of indiscriminate anthropogenic activities in the basin. Since streams are a dynamic system and are sensitive to change, the types of management strategies considered for the watershed and the stream must evaluate the short and long term effect(s) of that management strategy on the fluvial system. The geomorphic condition of the stream can be used as both an indicator and predictor of watershed function and health. Applying the science provides tools to manage fluvial conflicts between river processes and human investments by recognizing streams as a continuous system, rather than a collection of unrelated problem sites. Afforestation should be encouraged in the communities since trees play a role in the infiltration process. This recharges the groundwater to a level that can support stream's rejuvenation. Development to water availability should be tailored. There is need to have tools to manage new development and crops in a way that does not place additional strain on aquifers. The anthropogenic activities such as farming on stream slope, mining, deforestation, road construction and bush burning need to be addressed as a way of checking stream disappearance.

(b) People in the basin should have the desire to diversify the economy in order to protect endangered terrestrial and aquatic species. This can be made possible when communities come up with their abandoned stream management methods while engaging in the economy diversification. The use of local knowledge to manage streams will be cheaper for the indigenous people, but scientific knowledge should be applied where local knowledge fails to produce the best results.

(c) Dredging should be done in Okon, Otime and Urua Uko streams. If the mentioned streams are dredged, it may improve water supply in the down slope environment.

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