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Full Length Research Paper

Valuing the cost of environmental degradation in the face of changing climate: Emphasis on flood and erosion in Benin City, Nigeria

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There are numerous environmental problems that plague different parts of the world in the face of climate change. These range from pollution, deforestation, indiscriminate bush burning and natural wild fire, desertification, climate change, rain and windstorms, flood, earthquake, volcanicity, drought and erosion among others. Of these environmental problems, Nigeria is affected by all except natural wildfire, volcanicity and earthquake. In Benin City, flood and erosion are two major environmental problems seriously affecting the city in recent times causing damage to property and loss of lives. The seriousness of these problems necessitated this study, which investigated the cost of environmental degradation in Benin City. Climatic trend (air temperature and rainfall) in Benin City between 1940 and 2010 were analysed while the flood and erosion characteristics in Benin City were also measured between 2008 and 2010. 741 questionnaires were administered to analyse the impacts of flooding and erosion on the respondents. The service of experts in estate valuing was sort and with that, the cost of damage caused by flood and erosion was determined. The data were analysed using time series and percentages among others. The results show that the length of the gullies ranges between 168 m and 695 m while the depth was between 0.6m and 24 m. The cost of damage to buildings and property due to erosion and flooding was ₦3.9billion ($23.9million) while flood claimed 14 lives between 1999 and 2010.

Key words: Climate change, eateries, rainfall, damage, property, commercial activities, gullies, urban forestry.

INTRODUCTION

There are lots of environmental problems that plague different parts of the world. These range from pollution, deforestation, indiscriminate bush burning and natural wild fire, drought, desertification, climate change, rain and windstorms, flood, earthquake, volcanicity and erosion among others. These are conceptualized in Figure 1. These environmental problems are caused either by unsustainable human activities, nature, or both, leading to environmental hazards or disasters. Of all the environmental problems in Figure 1, Nigeria is affected by all except natural wildfire, volcanicity and earthquake.

Although these environmental problems affect all parts of Nigeria, some are more pronounced in specific geographical regions of the country. While drought and desertification are major environmental problems associated with northern Nigeria, deforestation, flood and erosion are the main environmental issues affecting the southern and eastern parts of the country (Odjugo and Ikhuoria, 2003; Odjugo, 2009). This research focuses on erosion and flood. While the destructive impact of erosion is relatively gradual, that of flood is more sudden and devastating. The devastating effects of flood on buildings can be categorized into different structural groups as shown in Adedeji (2008), and they include; (1) Buildings washed away due to the impact of the water under high stream velocity. Such buildings are usually destroyed or dislocated beyond feasible reconstruction. (2) Floatation of buildings caused by rising water. This occurs when light–weight houses are not securely anchored or braced. (3) Damage caused by inundation of buildings: A building

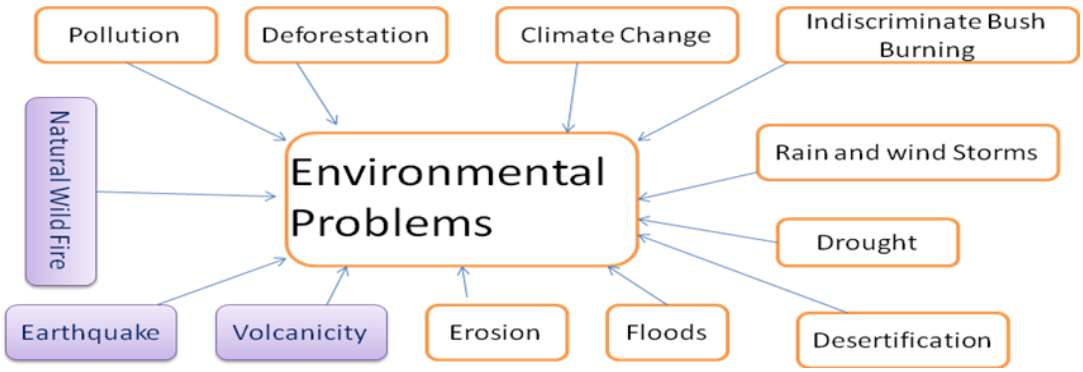

Figure 1. Global environmental problems. Nigeria is not currently affected by the shaded environmental issues. Source: Author.

may remain intact and stable on its foundation, while its material is gradually and severely damaged. (4) Undercutting of building: here the velocity of flood may scour and erode the building's foundation or the soils under the foundation. This may result in total collapse of the affected buildings. (5) Damage caused by debris: massive floating objects like trees and materials from other collapsed houses may have impact significant enough to cause severe damage to the standing buildings. Structural impact like serial numbers 3 and 4 above are most common in Benin City.

Erosion and flood have seriously affected man for millennia and despite prodigious efforts to stop them, the problems still remain till today causing damage to property and loss of lives. The first ever recorded flood in the Bible destroyed all global property and lives at that time except that of Noah and his immediate family (Genesis 7: 17 to 24). The Japanese Tsunami of 2011 killed over 18,000 people while the Asian Tsunami of 2004, claimed 150,000 lives in 12 countries across Southeast Asia and Eastern Africa (Mbamba, 2004). In the U.S.A. flood disasters from hurricanes like Rita, Katrina, Wema etc, have claimed many lives and destroyed properties worth millions of dollars since 2005. The Pakistan flood claimed over 1,500 lives, displaced over 3. 2 million people and destroyed property worth millions of dollars in August 2010 (Hung, 2010). In Nigeria, the collapse of Baguda dam near Kano in 1988 with its associated flood destroyed 18,000 houses and left 210,000 people homeless. The Ogumpa River's flood of 1983 claimed 30 lives, destroyed many houses and left 15,000 people homeless. The flood that hit Lagos the most populous city of Nigeria on the 10th of July, 2011 claimed 25 lives (Akoni et al, 2011), that of Ibadan, Nigeria that happened in August, 2011, killed 98. Both floods rendered over 35,000 people homeless (Anibokun, 2011).

Ahmad and Ahmed (2002) shows that erosion in eastern Nigeria is caused more by relief followed by rainfall intensity and exposed earth surface materials. Such view was also held by Osahon (2007) who says that in Auchi, Edo State, relief is the major cause of soil erosion followed by lack of vegetal cover occasioned by deforestation, poor agricultural practices and urbanization effects. The major causes of flood in urban areas of Nigeria are blocked gutters and water channels, poor drainage systems, increasing rainfall intensity, building on natural water causes, nature of topography and reduced infiltration occasioned by concrete and cemented compound (Odjugo and Iweka, 2006).

Although environmental problems have been affecting mankind throughout the ages, researches have shown that climate change has started aggravating these problems and the situation will be worse as the climate change impacts intensify Intergovernmental Panel on Climate Change (IPCC, 2007). Climate change is found to be caused by both natural and anthropogenic factors (Figure 2), but the current climate change has been attributed mainly to the former, which upset the global climate system.

Earlier studies on flood and erosion concentrated more on analyzing the causes and the physical impacts of these environmental problems. The financial implications of these environmental problems have not been receiving adequate attention in Nigeria whereas it is the financial implications that can push home the point clearer to policy makers to take action. It is on this premise that this study is structured to analyze the cost of erosion and flooding in a tropical town of Benin City, Nigeria.

MATERIALS AND METHODS

The study was carried out in Benin City, Nigeria. Benin City is located on latitude 6.20°N and longitude 5.37°E. It is situated within the equatorial climatic belt (Af Koppen's climatic classification). It has an annual rainfall of above 2000 mm, and its mean monthly temperature and relative humidity are 28°C and 80% respectively. Benin City occupies the lower plain of the Esan Plateau. The eastern edge of the city tilts towards the Ikpoba River, which drains

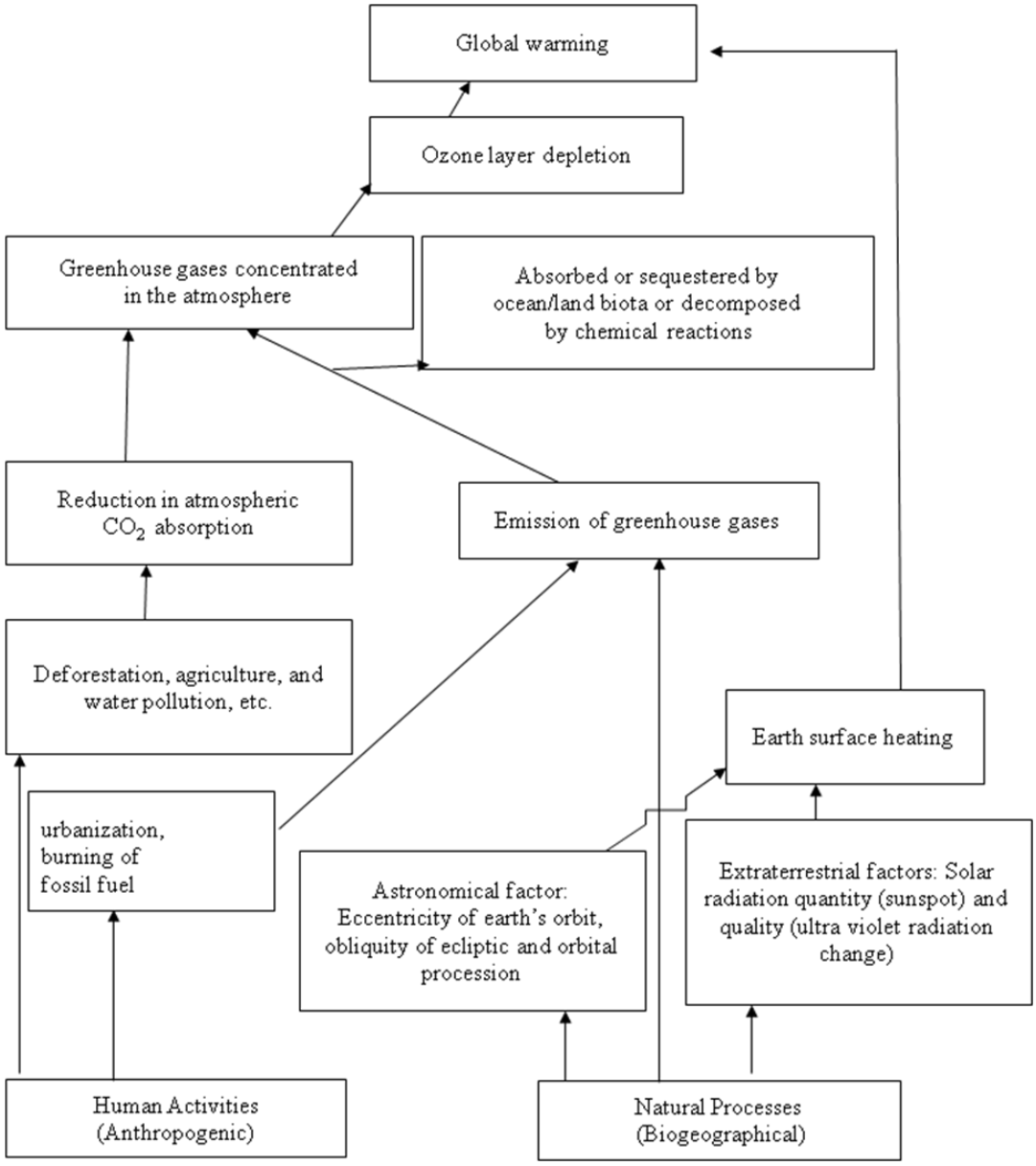

Figure 2. Causal factors of climate change. Source: Odjugo (2010).

the north eastern portion of the city, while the western edge slopes gently toward Ogba River (Figure 3). Benin City is about 85 m above the sea level at the highest point.

The Edo State Ministry of Environment identifies 60 flood sites and 25 erosion sites within Benin metropolis. While some of these are still minor environmental problems, others are major and devastating. Of these sites, 5 erosion sites and 7 flood areas (Figure 3) were purposefully selected because they are the worst erosion and flood areas in Benin City as indicated by the Ministry of Environment. The erosion sites include the University of Benin (E1), Costain Street (E2), Ogiso quarters (E3), Oregbeni estate (E4) and Ogbesan quarters (E5). The flooded sites are Adolo College Road (F1), Uwasota road (F2), Tomline (F3), Five Junction (F4), Siloko/Uwelu Roads (F5), Ogiso (F6) and Dumez Road (F7) (Figure 3).

Data needed for this study include erosion characteristics like the length, width, depth and area coverage, while flood data collected are flood depth and area coverage. The Ministry of Environment did not have current data on erosion and flood of the affected areas. The data available were measured depth and width of two gully sites and four flood areas in 2002. These data are dated since the current area coverage and magnitude of damage by flood and erosion is far more than that of 2002. As a result of this deficiency, direct field measurement was conducted between 2008 and 2010. The flood characteristics were measured at the end of September every year while the erosion characteristics were measured at the end of December. The month of September usually record the highest rainfall intensity and in most cases rainfall amount with associated flood problems in Benin City (Odjugo and Iweka, 2006), that is why September is selected for the flood measurements. The

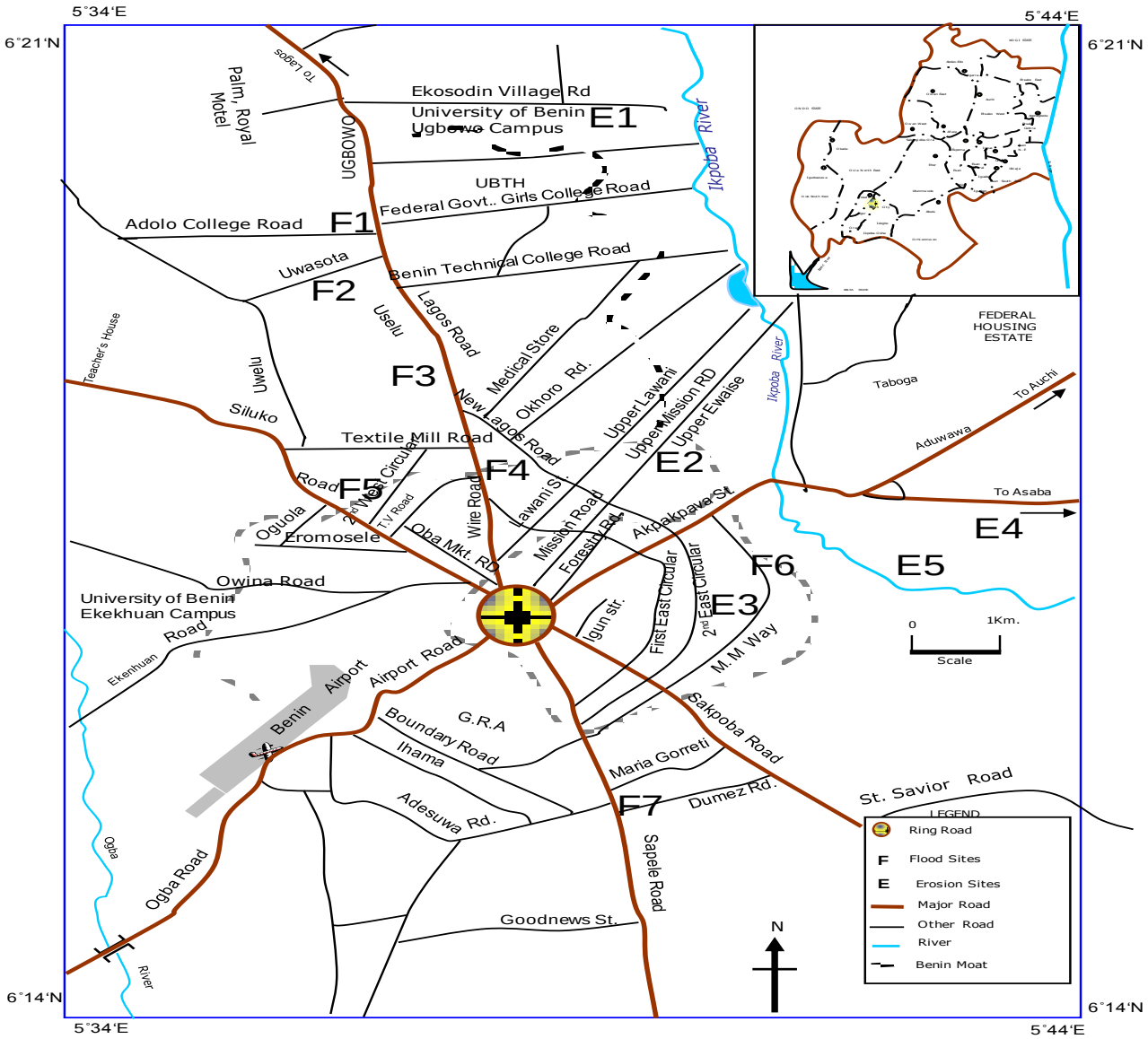

Figure 3. Benin City showing the study area.

rains decline drastically in the month of October and dry seasons sets in by November. So by the month of December soil erosion caused by rainfall must have ended for that year hence December was chosen for the measurement of erosion.

The length, depth and width of the eroded and flooded areas were measured using the ranging poles, ropes and tapes. For the eroded sites, the length and width were measured with a tape. At the length of every 10 m, the width and the height of the gullies were measured. The ranging poles were used to align the gully width before they were measured with the tape. The depth was also measured with the aid of rope and tape. A heavy metal nut was tied to the rope and lowered into the gully. When it gets to the bottom, the person inside the gully will signal the person on the earth surface and the point is marked on the rope. This will be drawn up and the depth is measured. The area of the gully was computed at every 10 m length and then all the computed areas were summed up.

The extent of the flooded areas was marked with pegs then the length and width of the flooded areas were measured between September 20th and 28th of every year. A traverse of the flooded area was taken and the depth of the flooded areas was measured with the aid of ranging roles and tapes. The area was computed by measuring the length and the breadth. The cost of landed property destroyed by the gullies and flood were arrived at by the aid of an expert in estate valuing.

The impact of flooding on vehicular damage was also assessed in four of the flooded areas where road is covered with water for hours after the rains in the month of September. The areas were Adolo College Road, Tomline, Siluko Road and Five Junction. In these areas, the number of vehicles that water enters their engines and stopped in the flooded water was counted and the phone numbers of the vehicle owners were taken on each rainy day. Between three and seven days after, these individuals were contacted to know what it cost them to repair their vehicles.

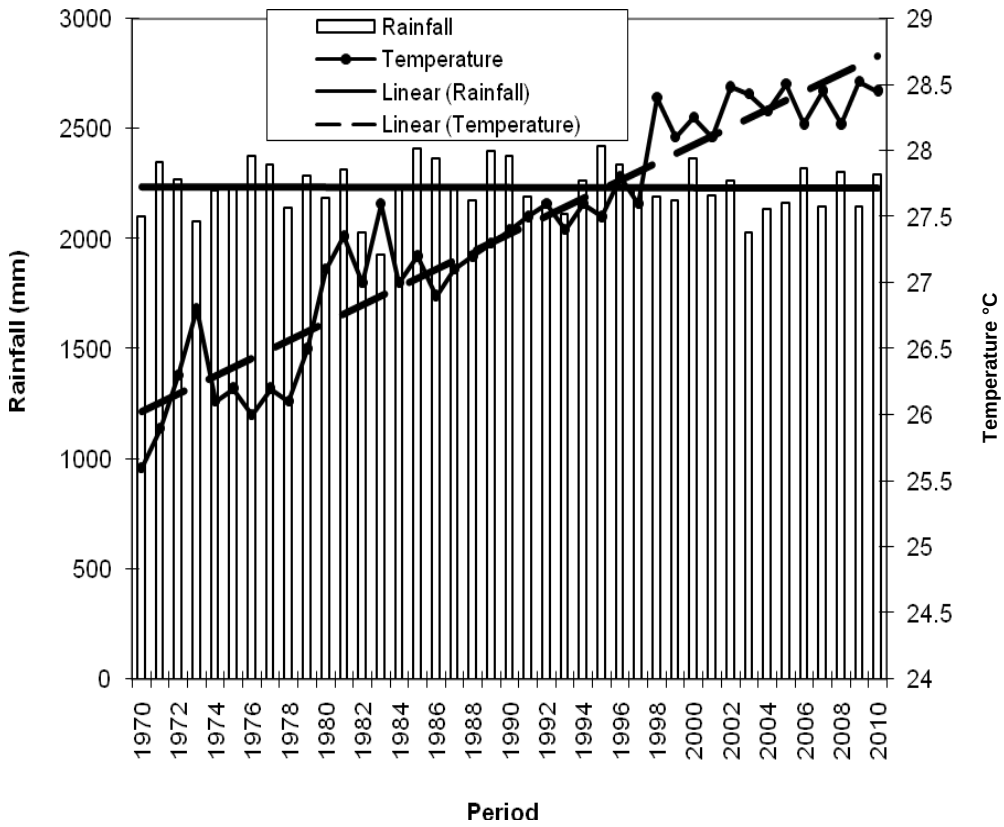

Figure 4. Temperature and rainfall trend in Benin City between 1970 and 2010.

Questionnaires were administered to 15 to 25 traders (store owners) in each flood site who accepted to respond to the questions. This gave a total of 147 questionnaires administered. Their daily sales in the month of February and March (dry season) and June and September (Rainy season) were recorded. Four months were chosen in order to reduce the pressure of daily stock taking on the traders since it was not their custom. Secondly, February and March are the driest months in the study area while June and September the wettest.

Flooding also has advantages since it encourages street trading in Nigeria and hike in prices of public transportation. In each flooded site, 10 street traders were randomly selected and given a questionnaire to record their sales on flooded and non-flood days in the month of September. This gave a total of 40 respondents. Moreover, 60 transporters (bus drivers and motor - cyclists) were selected randomly and given questionnaires to fill in the number of passengers and the total amount earned during flooded and non-flooded days in the month of September. In all, 741 questionnaires were used for the study and they were analysed using the time series and percentages.

RESULTS AND DISCUSSION

The general climatic pattern in Benin City between 1970 and 2010 shows increasing trend in both rainfall and temperature (Figure 4). While the increasing trend in temperature tends to be sharp, that of rainfall is very gentle. The observed increasing trend in both rainfall and temperature is a major feature of, or evidence of, climate change in Benin City. Although there is a gradual decrease in rainfall in Nigeria, annual and decadal fluctuations are noticed (Figure 4). There is a sharp drop in rainfall in the following years – 1973, 1982 to 1983, 1992 to 1993 and 2003. These decadal reduction in rainfall pattern coincided with the El Nino and drought years in Nigeria with the worst drought in 1983 (Odjugo, 2005). Like rainfall, the temperature pattern also shows annual variations with 2010 recording the highest temperature followed by 2002, 2005 and 1998. These are also the world's warmest years ever recorded World Meteorological Organization (WMO, 2011). In Nigeria, the decade 2000 to 2010 is the hottest decade on record. Ahmad and Ahmed (2000), IPCC (2001) and Nigerian Environmental Study/Action Team (NEST, 2003) provided indicators that one could use to assess the evidence of climate change in a region. These include increasing temperature and evapotranspiration, decreasing rainfall amount in the continental interiors, increasing rainfall in the coastal areas, increasing disruption in climate patterns among others. This study reveals at least two of these features namely, increasing temperature and rainfall.

Table 1. Physical characteristics of erosion sites.

Site	Length (m)	Width range (m)	Depth range (m)	Deposited area (m^2)	Rate of head-on erosion
University of Benin	560	5 to16	0.6-12	113.321	4.2
Costain Road	322	4 to 26	0.9-17	16.570	1.3
Ogiso Quarters	168	4 to13	0.4-9	121.871	2.1
Ogbesan Quarters	695	3 to 25	0.9-22	140.301	5.1
Oregbeni Estate	484	7 to 29	1.1-24	136.271	7.6
Total				528.334	

Table 2. Financial cost of erosion and depositions.

Site	Building		Eroded and Deposited area		
	No	Cost ₦ ($)*	Area (m^2)	No. of plots	Cost ₦ ($)
University of Benin	5	₦45 m ($300,000)	119,481	132.8	₦292.219 ($1.95 m)
Costain Road	8	₦72.3 m ($513.372)	21,722	24.1	₦192.8 m($1.39 m)
Ogiso Quarters	9	₦91.100 m ($303.000)	123,383	137.1	₦383.900 ($2.560 m)
Ogbesan Quarters	25	₦283.500 m ($1.89 m)	143,531	159.5	₦366.9 m ($2.45 m)
Orogbeni Estate	16	₦137.6m ($917,333.3)	152,464	169.4	(₦ N355.7 m) ($2.37 m)
	58	₦650.5 m ($4.33 m)	560,582	622.9	₦ N1.524b ($10.17 m)

*Throughout the paper, the exchange rate used was ₦150 to $1.

The physical features of the erosion sites are shown in Table 1. The length of the gullies varies between 168 m in Ogiso quarters to 695 m in Oregbeni Estate. Ogbesan quarters recorded the deepest (24 m) and the widest (29 m). While Oregbeni Estate recorded the largest area coverage (140,301 m^2) of sand deposits of the gully erosion, the smallest area coverage was Costain Road (16,570 m^2). The total area eroded by the gullies was 32,248 m^2 while that of deposition was 528,334 m^2. The five gullies together with their sand deposits covered an area of 560,582 m^2 (5.6 km^2). The lowest head-on erosion was recorded in Constain Road and the highest in Ogbesan (Table 1). With the exception of Constain Road, the rate of head-on erosion increases with increasing gully depth. Okechukwu (2010) also notes that increasing depth and gradient were major factors that accelerated gullies development in eastern Nigeria. The exception noticed in Constain is due to human factor that used the head-on side of the gully as dumpsite. Most of the solid wastes from the nearby New Benin Market (the second largest market in Benin City) and the domestic wastes by people far and near are dumped in the Constain gully. This act of refuse dump drastically reduced the rate of head-on erosion in the Constain gully.

The number of buildings that caved into the gullies and those abandoned due to the threat of the gullies and sand deposits were 58 and they were estimated to cost N650.5 m ($4.33 m) (Table 2). Out of these 58 building, the Ogbesan Quarters gully erosion has engulfed two blocks of 16 classrooms of Queen Ede Primary School and the third classroom building has been abandoned since part of it has caved into the gully (Plate 1). The Ogbesan quarters gully has cut two roads into two and the head-on erosion is just 30.4m away from the Benin-Agbor Express Road. If no urgent and serious action is taken now, judging from the rate of head-on erosion (Table 1), the gully will cut the road into two in the next six years. The most worrisome is the University of Benin gully that has claimed one-fourth of the western fence of the University, staff quarters and buildings of individuals of Ekosodin community sharing common boundary with the University. The largest Block of Flats of the University that house both staff and students and other staff quarters are under serious threat. Gully erosion in Benin City has caused a lot of hazard not only to individual property but also to government infrastructure. The total area eroded by the gullies together with the sand deposits measured 560,582 m^2. This area was converted to building plots of 30 by 30 m (the standard building plot of land in the study area) to ease estimation. The total building plots were 623 and these amounted to N1.52 billion ($10.2 m) (Table 2). Magbemi (2008) and Okechukwu (2010) also mention that buildings worth millions of Naira have been destroyed by gullies in Nigeria, but these works did not carry out detailed study of the number of buildings affected and the cost of gully damage to property in their study areas.

The flooded areas covered 913,313 m^2 and the number of buildings abandoned as a result of the flood (Plate 2) was 67 and these cost N1.05 billion ($7.02 m) (Table 3). The flood in Dumez Road and Siloko/Uwelu Roads has totally covered the two primary school buildings and the

Plate 1. Ogbesan Gully, Benin City showing school building caving in and the failed community effort of drain construction to solve the gully problem.

Plate 2. One of the flooded and abandoned buildings along Siloko Road by Teachers' House.

Table 3. Financial cost of flooding.

S/N	Location	Area coverage (m^2)	No. of buildings	Cost	No. of plots	Cost
1	Adolo College Road	54.000	2	76.3 m ($108.666)	3	**9.30m ($62,000)**
2	Tomeline	143.261	6	47.8 m ($318,666)	16	124.4 ($826,666)
3	Five Junction	95.761	-	-	-	-
4	Siluko/Uwelu Road	391.240	12	414.4($2,763 m)	32	153.6 m ($1.024 m)
5	Dumez Road	121.500	14	438.2 m ($2,921 m)	25	135.6 m ($904,000)
6	Ogiso Quarters	79.200	5	33.4 m ($222,666)	18	81.7 m ($544,666)
7	Uwasota Road	28.351	4	42.1 m ($280,660)		46.4 m (309,333)
	Total	913.313 m	67	1.052b ($7,015 m)	102	551 m (3.671 m)

Table 4. Number of vehicles damaged and the cost of repairs.

S/N	Location	Vehicle damaged/cost			Vehicles not damaged but pushed across flood /cost	
1	Adolo College Road	108	₦496,800	$3212	465	₦608,400 ($6528)
2	Tomline	171	₦ 752,400	$5016	612	₦979,200 ($6528)
3	Five Junction	28	₦ 748440	4989.6	471825	₦919800 ($6132)
4	Siluko Road	72	₦ 320,400	$2136	254	₦259,200 ($1728)
	Total	495	₦ 2,181,200	$14,541	2064	₦2,766,600 ($184,044)

Table 5. Volume of sales during rainy and dry season in flooded areas.

S/N	Locations	No. of respondents	Dry season	Rainy season	Reduction of sales during rainy season (%)
1	Adolo College Road	25	₦632,655($4,218)	₦380,700($2,538)	39.8
2	Tomline	26	₦529,050($3,527)	₦284,310($1,895)	46.3
3	Five Junction	28	₦748,440($4,790)	₦471,825($2,146)	37
4	Siloko Rd.	20	₦518,010($3,453)	₦280,462($1,870)	45.9
5	Ogiso	15	₦192,675($1,285)	₦124,740($832)	35.4
6	Dumez Road	15	₦202,879($1,353)	₦84,702 ($565)	41.8
7	Uwasota	16	₦241,170($1,608)	₦128,993($860)	46.5
	Total		₦3,194,199($21,295)	₦1,869,091($12,461)	41.8

two schools have been abandoned and their students and staff relocated. The flood creates poundage which usually last for hours, weeks or months. So the flooding pattern experienced in Benin City is both flash and seasonal. In the areas affected by prolonged poundage (months) most of the building plots were left undeveloped. These were measured and they totaled 102 plots of land, which cost N550.6 m ($3.4 m) (Table 3). The total financial cost of flooding (Number of building and building plots abandoned) therefore amounted to N1.6 billion ($10.6 m).

The flooded areas in Benin City also encompass roads with heavy traffic. This has caused a lot of damage to vehicles that ply the roads as shown in Table 4. The number of vehicles that were damaged by the flood was 495 and it cost the owners N2.2 m ($14,541.3) to repair them. There were 2,064 drivers who could not risk driving through the flood. This group of drivers employed the services of boys who are always in the flooded portion of the roads to push their vehicles across the flood while the vehicles' engines were put off. It cost the drivers ₦2.8 m ($18,444) to pay the boys that helped them to push their vehicles across the water. This amounted to an average of ₦1, 340 ($8.09) per driver. The total amount spent by drivers in the flooded areas was ₦4.95 m ($32,985).

Commercial activities were also affected by the flood as indicted in Table 5. The respondents revealed that during the dry season their sales amounted to N3.2 m ($21,295) while it was N1.9 m ($12,461) during the rainy season. This implies that the flood reduced sales by 42%. It is difficult for the consumers to wade through the water to buy things that they wanted that is why the sales were reduced during the flood period. The total cost of what was lost to flood and erosion in Benin City within the

Plate 3. Flood problem: Local effort of bridge construction to get to homes, business centres and eateries.

study area and period (2008 to 2010) is N3.63 billion $24.2 m). The aspect of commercial activities that was enhanced by the flood in Benin City is street trading and public transportation. The flood leads to various sizes of pot-holes on the road. The flood water and the bad spots lead to traffic hold up that spans for hours in most cases. The drivers and passengers in the long queues of vehicles trapped as a result of the flood become good customers to the street traders who sell various kinds of items ranging from table water, gala, bread to bumper reflectors, fire extinguishers and handkerchiefs among others. The mean sales was ₦4, 600 ($30.7) and ₦1, 480 ($9.9) for flooded and non-flooded days respectively. So while traders with permanent stores who could not involve themselves in street trading either because of their age or the type of items they sell are crying of low patronage, the street traders are laughing home with much money and even praying for more floods and traffic jams. The public transporters (taxi drivers and motorcyclists) always hike their prices between 100 and 500% whenever it rains and the roads flooded. The increase in price is worst when the flood occurs during the rush hours of the day (7 to 9 am and 4 to 8 pm). The public transporters were able to make a mean of ₦5, 400 during flood days and ₦2, 900 in non-flood days. Although the flood reduced the number of trips the public transporters could make in a day, the astronomical increase in fares charged favour their daily take-home.

The aforementioned analysis only depicts the aspect of erosion and flood that could be quantified. The psychological depression and emotional trauma suffered by displaced landlords and tenants due to these two environmental problems, time spent by drivers (non-commercial) and their passengers in the flood, lives lost and those who fell into side drains and sustain various degree of injuries, infections caused by those who wade through the water, possible food poisoning since there are lots of eateries in the flooded areas (Plate 3), malaria fever due to stagnant water that increases mosquito breeding amongst others are difficult to quantify. Available information from the Ministry of Environment shows that while there are no reported cases of death associated with gully erosion in Benin City, flood claimed 14 lives between 1999 and 2010. In Nigeria and other parts of the world, flood has claimed lot of lives and destroyed property. For example, as at April, 2011, the Japan tsunami claimed 18,000 lives and 14,000 people were still missing six weeks after the flood and World Bank estimates that it will cost $145 biliion to repair the damage (McCurry, 2011). The South African floods of January 2011 killed over 120 people and damaged over 13,000 homes and property worth more than $211 million, while that of Rio De Jeneiro caused at least 903 deaths, (Erin, 2011).

Table 6. Perceived major causes of flooding in Benin City.

S/N	Perceived causes of flooding	Percentage (%)
1	Lack of drainage	87
2	Blocked drainage	85
3	Habits of dumping refuse in the run-off	81
4	Habits of building on the natural water ways	75
5	Cemented compounds that prevent infiltration and encourage run-off	72
5	Increasing rainfall intensity (70%	70

PLANNING IMPLICATIONS

The major causes of flooding in Benin City as shown by the respondents are many and they include lack of drainage in some areas (87%), blocked drainage (85%), habits of dumping refuse in the run-off (81%), habits of building on the natural water ways (75%), cemented compounds that prevent infiltration and encourage run-off (72%) and increasing rainfall intensity (70%). Obi (2009) also observes some of these factors as causes of urban flooding in Nigeria. The respondents have the correct perception by showing that the major cause of flood is lack of drainage systems, because most parts of Benin City have no drains that direct the water to the rivers or purposefully acquired drain sites (Table 6).

Moreover, where there are drains, they are always very narrow and shallow thus get easily blocked by sand and refuse dumped into the run-off by the residents. It is a common practice in Benin City that whenever it rains heavily, some of the residents usually dump their refuse into the run-off principally to avert payment of fees meant for refuse collection. The Edo State government needs to urgently embark on the construction of more deep and wide surface and underground drainage systems and restructure most of the existing ones that can accommodate the run-off. These should be channeled to either Ikpoba River or Ogba River. While the government should constantly de-silt the drains, the law enforcement agencies should arrest and prosecute those who form the habit of dumping refuse into the drains. This is going to be a tedious task because for the law enforcement agents to arrest the offenders, they must have to monitor the drains while it is raining since there are no existing automated cameras installed in Benin City that can do such monitoring.

The government should ensure that buildings and other structures on the natural waterways are pulled down to allow free natural flow. Pulled down structures with approved government plans should be adequately compensated. The Urban and Town Planning Department together with the Ministry of Environment should encourage urban forestry and discourage the practice of totally cementing the entire section of the compound not built. Trees, grasses and flowers will not only enhance infiltration, add to the aesthetics of the compound and reduce run-off but also act as sources of vitamins and income if most of them are economic trees. If these appropriate measures are taken, for sure, the drains will accommodate the water despite the fact that the intensity of rains is increasing in Benin City.

The survey also shows that lack of drainage system (92%), poor maintenance of the existing drains (84%), negligence on the part of government (82%) and improper land use (76%) were identified as the major causes of erosion in Benin City. Since the drainages are inadequate to properly channel the water, the water then finds it way thereby creating its channels which may later develop to gullies. The neglect by government in solving the erosion problems when the gullies were small led to the present precarious state of gullies in Benin City. The communities where the gullies are found have been making frantic efforts in resolving the erosion problems in Benin City. For example, the Ogbesan Community raised money in 2007 to channel the water to the river. The drain constructed (Plate 2) could not survive the first rainy season before the lateral erosion led to its collapse. This clearly shows that the problem is beyond their financial and technical reach to solve. The solution to most gullies' problems in Benin City seems hopeless since the cost of resolving the problem is now beyond the financial capability of the inhabitants, institutions and even the State Government. The Edo State Government made it clear since 2003 that the solution to gullies that this study is investigating is beyond her financial reach. To make the situation more hopeless, the Minister of Environment having inspected the gullies in Benin City and other parts of Edo State in 2010 openly declared that the assistance of the Work Bank is needed to tackle the erosion menace in the State. This paper is therefore making a clarion call on the World Bank and other international ecological foundations to come and rescue the inhabitants of Benin City from the hazards of gullies.

Conclusion

The study reveals that different parts of Benin City are affected either by flood or gully erosion. While the length

of the major gullies ranges from 168 to 695 m, their width and depth were 3 to 29 m and 0.4 to 24 m, respectively. The gullies together with their sand deposits cover an area of 560,582 m^2, while flood occupies 913,313 m^2. The number of buildings that caved into the gullies and those abandoned due to erosion threat and deposits are 58 while flood either destroy or forced people to abandon 67 buildings.

The cost of damage caused by erosion and its associated sand deposits amounted to N1.52 billion ($10.17 m). Flood damage to buildings and land rendered useless for any construction purpose cost ₦1.524 billion, while the cost of damage to vehicles is N4.95 million ($32,985). A drop in sales during the rainy season when compared to that of dry season is 42%. Overall, ₦3.9 billion ($23.9 million) has been lost to erosion and flood in selected sites in Benin City. The implication is that if damage caused by 7 flood and 5 gullies is as much as ₦3.9 billion one could imagine the damage the 60 flood sites and 25 gullies in Benin City must have caused. This is outside the unquantifiable cost of gully erosion and flood that caused deaths, psychological and emotional trauma.

The paper shows that while flooding problem in Benin City is still within the reach of the state government to solve, the gully problem has gone beyond the financial limits of the state government. The Federal Government in collaboration with international organizations should as a matter of urgency come to the rescue of those being threatened by gullies in Benin City. The Edo State Government should as a matter of urgency start solving the smaller gully erosion problems in Benin City now before they turn to major gullies that will demand billions of naira to solve. A stitch in time, they say saves nine.

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