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ABSTRACT

This work investigates land-use factor on the occurrence of flood in Ilorin, Kwara State, Nigeria. Data used were generated from direct field measurements, satellite imagery interpretation and questionnaire administration. Such data were on distance of houses from river banks, landuse/vegetation characteristics frequency of flood experience and damage caused by flooding. Collected data were subjected to descriptive statistics and cross tabulations. Results obtained indicate that substantial portion of the floodplains in the river channels of the basins studied have houses located on them. Most alluvial plains hitherto being used for farming now have buildings on them. The study also revealed that most resident of the city dump refuse into flowing water when it rains. This practice has made most of the respondents to suffer losses from flooding with damages incurred reflecting the degree of encroachment on floodplains. The study thus, suggests landuse planning and environmental education towards solving the incessant flood problem in the city.

INTRODUCTION

Floods can be defined as any high streamflow which overtops natural or artificial banks of a stream. This extreme hydro-climatic event is daily becoming a city life experience in most urban centres in Nigeria causing untold hardships and sometimes loss of lives (Table 1).

Table 1: Flood problems in Nigeria

Year of flood	City	Damage caused
1980	Akure	20 houses collapsed, 3 people killed
1982	Ibadan	3 people killed
1984	Ibadan	5 people died and millions of naira worth of properties destroyed
1984	Port-Harcourt	Thousands of people rendered homeless and properties worth millions of naira destroyed
1987	Sokoto	Loss of farm produce worth N14 million and destruction of 85,000 hectares of land.
1987	Borno	13 people killed, 68 rendered homeless
1988	Kaduna	4 lives lost and thousands naira worth of properties destroyed
1988	Kano	55 people died, 80,000 homes washed away
1988	Ibadan	Millions of naira worth of properties destroyed
1990	Minna	Thousands of naira worth of properties destroyed
1992	Jos	Thousand rendered homeless
1994	Borno	Over 200 lives lost and properties damaged
1994	Bauchi	Over 3,500 hectares of farmland destroyed
1994	Ikot Epene	3 lives lost and thousands of naira worth of properties destroyed
2003	Kaduna	22 villages submerged, several people killed & thousand rendered homeless
2003	Sokoto	Houses submerged and million naira worth of properties destroyed

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2006	Obbo-Ile	20 lives lost and several acres of farmland destroyed
2008	Minna	7 people killed, houses submerged
2008	Benin	8 lives lost and million of naira worth of properties destroyed
2010	Lagos	2 people killed, properties destroyed
2010	Lagos	Millions of naira worth of properties destroyed
2011	Oshogbo	2 people killed, houses submerged and properties destroyed
2011	Ibadan	130 people killed and millions of naira worth of properties destroyed

Sources: Faniran, 1991; Sule, 2003; Federal Ministry of Water Resources and Rural Development, 2008; The Punch Newspaper, 2011

Harun (1984) observed that the extreme hydro-climatic event has degenerated into serious ecological problems in the Southern part of Nigeria. As population and desire for accommodation space rise in urban areas, floods become a great problem both economically and as threat to safety due to increase in runoff production which is caused by deforestation activities (Bosch and Hewlett, 1982; Hamilton, 1984; Odemerho, 1993; Oriola, 1994; Eze, 2008), increase in percentage paved area (Hollis, 1988) and blockage of waterways (Jimoh, 2000) among others). Floods are however unique events, this is because, identical flood generating mechanisms may result in different floods from one catchment to another, or indeed within a given catchment from time to time.

Ward (1978) identified four main thrusts of flood studies to include understanding of the natural and man induced reasons for flooding, evaluation and education of man's awareness of flood hazards, prediction of flood frequency and development of sound economic responses to flood situation through properly costed programme of adjustment, abatement and protection. This particular work was carried out with the first two objectives in mind. The study seek to analyse the different ways by which land is being currently managed in the study basins, particularly areas bothering the river channels, which predisposes the rivers to flooding.

STUDY AREA

Ilorin, the capital city of Kwara State, Nigeria is the study area for this investigation (Fig. 1) and the experimental sites are the four urbanized basins of Agba, Alalubosa, Aluko and Okun river catchments (Fig. 2). Ilorin lies on latitude $8^{\circ}30'N$ and longitude $4^{\circ}35'E$. The city has humid tropical climate and it is characterized by wet and dry seasons (Ilorin Atlas, 1981).

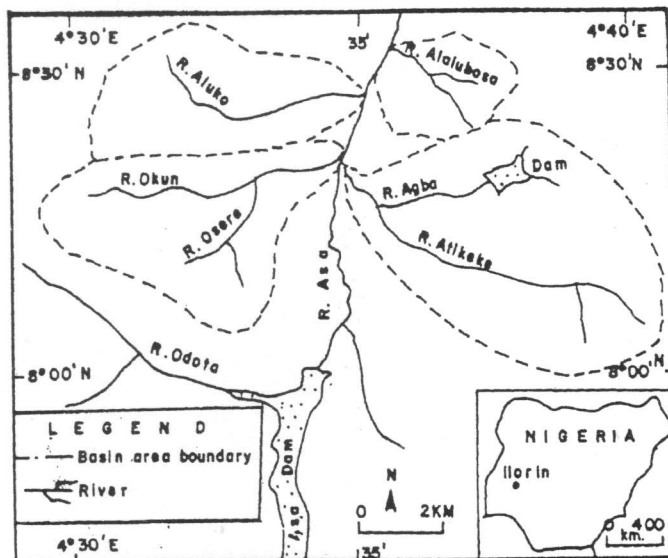


Fig. 2. Map of Ilorin, showing the four drainage basins as the study area
Source: Oyegun (1986)

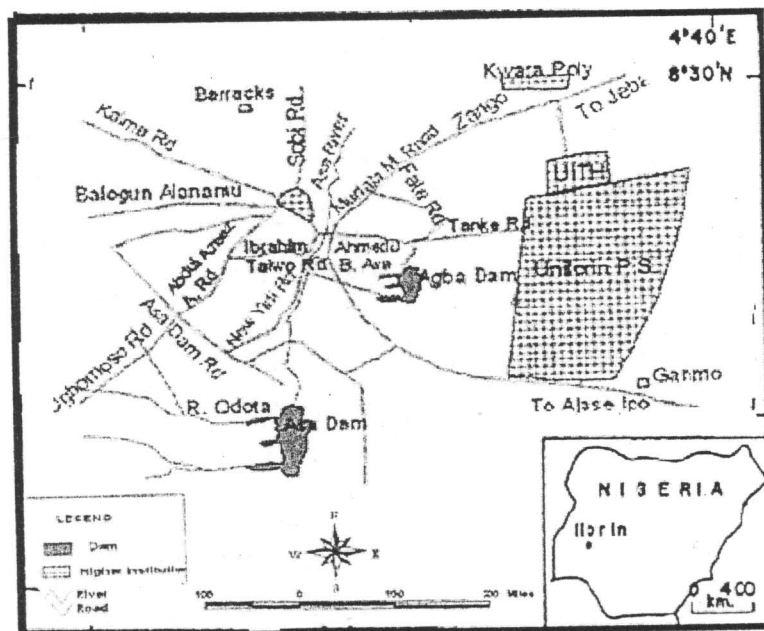


Fig. 1 Map of Ilorin, showing the study area

Wet season in the town begins towards the end of March when Tropical maritime airmass is prevalent and ends in October, often abruptly. Dry season in the town begins with the onset of Tropical continental airmass which is predominant between the months of November and February. The mean annual total rainfall for Ilorin is 1200mm (Olaniran, 2002). Analysis of rainfall values for the town shows that rainfall scarcely occur in the months of January, February, November and December (Oyegun, 1983). Rainfall concentration is usually between the months of March and October, exhibiting double maxima rainfall pattern with peak periods in the months of June and September and a period of dry spell in July. Temperature in the town is uniformly high ($25^{\circ}\text{C} - 28^{\circ}\text{C}$) and open-air insolation can be very uncomfortable during the dry season (Oyegun, 1983). Evaporation values in Ilorin range between 3.1mm and 7.8mm while potential evapotranspiration is usually highest in January. Ilorin is covered mainly by ferruginous tropical soil on crystalline acidic rock (Areola, 1978). The soil type has both sandy and clayey deposits lying on each other. The city is drained mainly by River Asa, tributaries of which form the four sub-drainage basins under this investigation.

Urbanization process is fast replacing the natural surfaces in the town with artificial surfaces with its consequent effects on runoff generation. Oyegun (1987) observed the builtup area in Ilorin to have grown from 20.40sqkm in 1963 to about 58.00sqkm in 1982, while the area occupied by grass, fallowland and tall covers decrease from 35.84sqkm to 9.70sqkm within the same period. In the same vein, Aderamo (1990) observed that urban development in the city increased from 1235.8 hectares in 1963 to 4515.8 hectares in 1988 representing almost 400% growth rate within a period of 25 years. This indicates the level at which the hydrological process is being affected in the town.

METHODOLOGY

This work was based on data collected from direct fieldwork exercise, satellite image interpretation and questionnaire administration. The direct fieldwork involved measurement of house distance away from river channels on both flanks of rivers in the study basins. This was carried out to determine the degree of human encroachment on floodplains. Landuse/vegetation characteristics of the study area (Fig. 3) was prepared from satellite imagery obtained from Regional Centre for Training in Aerospace Survey (RECTAS), O.A.U. Ile-Ife using Ilorin N.W. topographical map sheet No 223 of scale 1:50,000 and landuse and infrastructure map of Ilorin (1984) as basemaps. Landuse types were analysed from the imagery using spectral signatures based on colour, tone, texture, shape and size. This task was carried out after repeated visits to the area covered by the imagery to discern the relationship between the actual landuse and the mosaic of colours on the imagery. A grid transparency of 1mm² was later imposed on the delineated satellite imagery from where the areas occupied by each landuse types were calculated by graphical method.

Questionnaire was administered on the residents of buildings located within 30 meters distance away from the river valley on both flanks of the 24.9km total stream length in the four drainage basin that constitute the study area. This was used in gathering information on the

previous pattern of runoff discharge, its effects and the management techniques being adopted in curtailing the extreme hydro-meteorological events. The questionnaire was however administered only after a pilot survey to statistically determine the optimum sample size derivable from the sample frame. Hence, the 24.9km total stream length in the four basins was divided up at equal intervals of 250meters; this resulted in a sample frame of 72 sampling points, as some sites do not have buildings on them; they are either forested or made up of farmlands or fallow areas. The standard deviation of number of buildings in the 72 sampling frame was then calculated as 0.385; thus, the optimum sampling size required was determined using the formula;

$$n = \frac{Z^2 \cdot S^2}{L^2}$$

where,

n = Optimum sample size

Z = Table value at 0.05 significant level

S = Standard deviation of the pilot survey

L = Confidence limit

This gave an optimum sample size of 227.76 (approximately 228 questionnaires). However, 250 copies of the questionnaires was administered using ratio analysis (Table 2) as values of total stream length differ in all the studied basins.

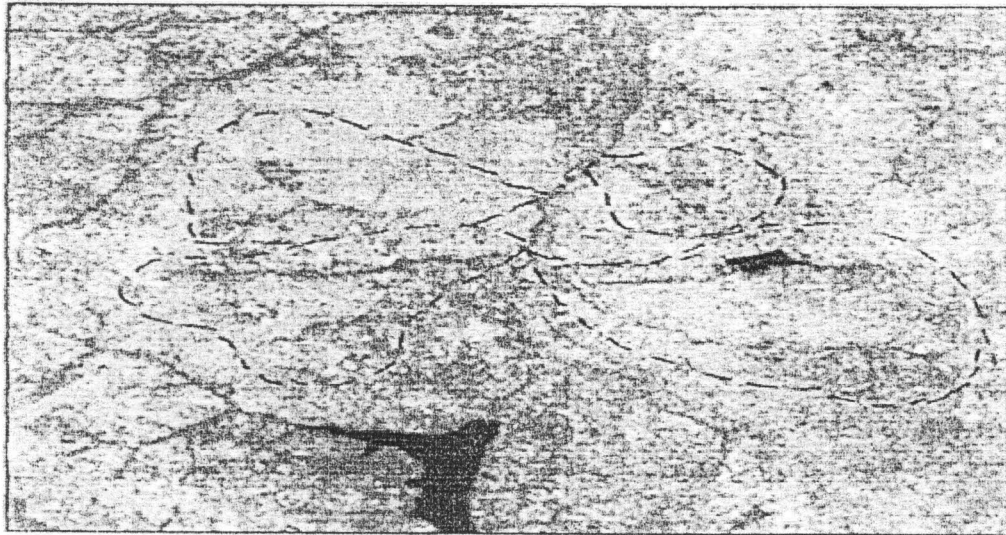


Fig.2 Land use classification of a portion of satellite image showing the study basin
Source: RECPA, O.A.U (1990)

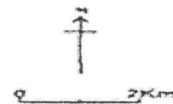
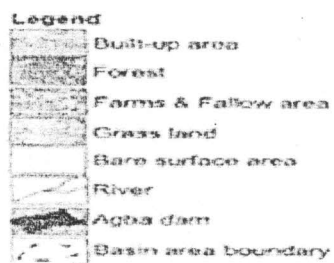


Table 2: Ratio analysis of number of questionnaires administered in the studied basins

Basin	Total stream length (Km)	Number of questionnaires administered
Agba	11.3	114
Alalubosa	2.7	27
Aluko	3.8	38
Okun	7.1	71
Total	24.9	250

Source: Author's fieldwork (2006)

OBSERVATIONS AND DISCUSSION

Landuse characteristics in the studied basins

Five landuse types were identified in the studied basins, these are builtup area, area covered by forest, area covered by farms and fallow, area covered by grassland and bare surface area (Table 3)

Table 3: Landuse types in the studied basins

Landuse types		Agba (17.1sqkm)		Alalubosa (5.8sqkm)		Aluko (9.3sqkm)		Okun (12.5sqkm)	
		km ²	%	km ²	%	km ²	%	km ²	%
1	Builtup area	11.4	66.5	4.9	84.5	9.1	97.8	8.4	67.2
2	Areas covered by forest	1.9	11.3	0.1	1.7	-	-	1.3	10.4
3	Areas covered by farms and fallow	1.4	8.2	0.2	3.5	-	-	0.3	2.4
4	Area covered by grassland	2.1	12.2	0.5	8.6	0.1	1.1	2.3	18.5
5	Bare surface area	0.3	1.8	0.1	1.7	0.2	2.3	0.2	1.6

Source: Author's fieldwork (2006)

Aluko drainage basin is the most urbanized among the four basins being studied. Its percentage built-up area is 97.8% and vegetation is virtually absent in the basin. Houses in Aluko basin are built close to one another without well defined layout. Oyegun (1986) tagged this part of Ilorin city as traditional residential area.

Agba is the most forested among the studied basins. In this basin, houses are interspersed with vegetation. There is also large expanse of vegetated land in reserve, while grasses surface a substantial area of the basin, for example, the golf court close to government house. There is also a large lake in the basin that is used in provision of pipe borne water supply for the residence of the city. Okun drainage basin compares well with Agba. The basin covers an area of 12.5sqkm. Though, Okun has a higher percentage built-up than Agba, large expanse of land covered with trees and grasses can also be found in the basin, for example, the moslem praying ground. Bordering the praying ground is another large expanse of land being used as cemetery. River Okun drains through this vegetated part of the basin. Alalubosa is the fourth basin investigated, it is also highly urbanized. However, the basin is dotted with trees, farms and

fallow areas, particularly around the confluence of River Asa with the basin's main tributary, River Alalubosa; an area also designated as cemetery. Evidently, as Viramontes and Descroix (2002) observed, changes in landuse, especially the replacement of vegetated surfaces with built up area will increase the 'source area' from which streams collect water directly on account of reduced infiltration capacity of the surface.

URBAN GROWTH FACTOR ON RIVER DISCHARGE

Though, the rate of catchment runoff depends in part upon the channel configuration and nature of soil, it is also being influenced by ways land is being managed. Results obtained from this study indicate that substantial portion of the floodplains in all the river channels investigated have houses located on them (See Plates I, II, III and IV). Table 4 also shows that, more than 61% of the houses sampled are erected within 10 meter distance from the river channels. Most of the alluvial plains hitherto being used for farming have been occupied with residential houses.

Table 4: Distance of buildings from nearest stream

Response	Number of respondents	Percentage of respondents
Less than 10 meters	134	61.8
10 – 15 meters	57	26.3
More than 15 meters	26	11.9
Total	217	100

Source: Author's fieldwork (2006).

The reason for this action, according to the respondents, is due to the increase in pressure on land for residential purpose and inefficiency on the part of town planning unit. This action by the people has, over the years, been causing flood events in the city. Building on the flood plains, hem in river banks, block the right way of water and reduce the channel capacity to carry load. Consequently, such rivers are forced to deposit their excess loads on the beds of their channels. Thus, the river beds are gradually raised; hence, the quick initiation of floods in such area following, even moderate rainfall, most especially, between the months of June and September, when water table in the city is unusually very high. This support an earlier finding by Olaniran (1983) which linked flood incidents in Ilorin to heavy rainfall greater than 25.4mm/day when they occur in a month about three or more times during the period of moisture surplus.

As a result of urban growth accompanied by high population density, waste generation and disposal has become a serious issue of concern in the city. Peoples' poor attitude towards refuse disposal which make them dump refuse into flowing water whenever it rains also encourages flooding. Adedibu (1983), Jimoh (1994), and Olorunfemi (1995) have also observed this problem in the city. While light weight materials such as leaves, nylon materials, broken plastics, and woods thrown into gutters flow into the main rivers when runoff volumes are very high; these materials stop moving when rain ceases, thus causing debris pile-ups which obstruct the flow of subsequent storm flow and cause flooding. The dumping of heavy materials such as

stones and iron debris into moving water reduces the channel's depth, affects the river competence to carry load, and results in flooding. Thus, most of the respondents had at one time or the other experienced or suffered losses from flooding. These losses ranged from material damages to loss of lives. Damages incurred, however reflected much degree of encroachment on floodplains (Table 5).

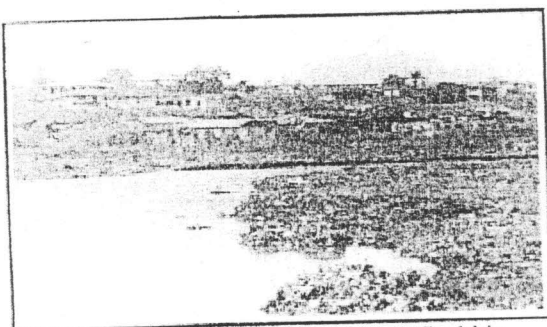


Plate 4 Residential buildings on River Alalubosa floodplain

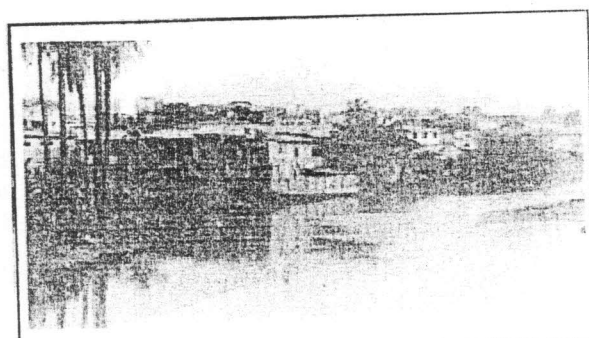


Plate 2 Residential buildings on River Aluko floodplain

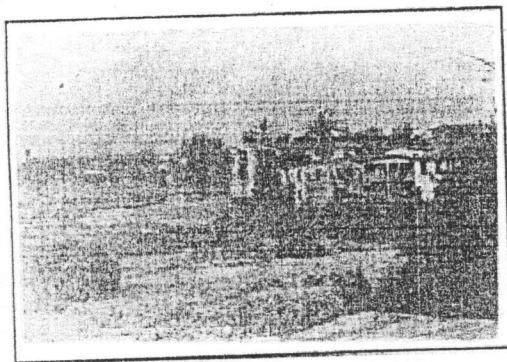


Plate 1 Residential buildings on River Okun floodplain

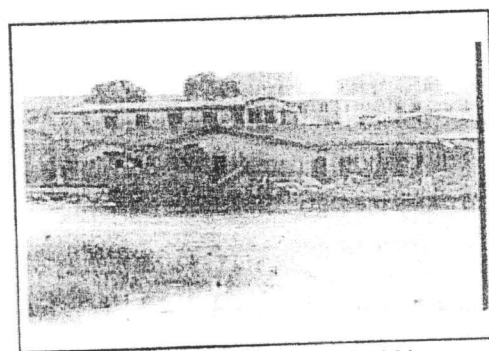


Plate 3 Residential buildings on River Agba floodplain

Table 5: Damages caused by flooding

Response	Number of respondents	Percentage of respondents
Fence collapse	13	6.6
Destruction of food items	23	11.7
Vehicle damage	09	4.6
Disruption of electricity supply	11	5.6
Erosion of roads	7	3.6
Washing away of farms	12	6.1
Building collapse	07	3.6
Washing away of household properties	112	57.1
Loss of life	02	1.0

Source: Author's fieldwork (2006)

MANAGEMENT OF HIGH RIVER DISCHARGE

In response to question posed to the respondents on reasons for flood and ways through which it can be managed, all the respondents recognized the importance of rainfall as a factor in flood generation process. However, 88.9% of the respondents considered flooding as a land-use issue, which is caused by changes in landcover (19.8%), encroachment on floodplains (23.5%) and indiscriminate refuse disposal methods (45.6%). Other reasons given for flooding by the respondents include dam overspill (3.7%) and location of the town down the site of Asa dam (7.4%)

Table 6: Causes of flood

Response	Number of respondents	Percentage of respondents
Change in land cover	43	19.8
Encroachment on floodplains	51	23.5
Indiscriminate waste disposal	99	45.6
Other state	24	11.1
Total	217	100

Source: Author's fieldwork (2006)

Though the rate of streamflow depends, in part, upon channel configuration and nature of soil, it is also influenced by the ways land is being managed. Landuse describes human uses of land or the immediate actions that modify or convert land cover (Zerbock, 2005). Thus, while land-cover is the observed physical and biological cover of the earth's land as vegetation or man made features, land use is the total of arrangements, activities and input that people undertake in certain land cover type (FAO/ UNED1999). Both land-use and land-cover changes affect catchment runoff process. Their changes are brought about by population, level of affluence, technology, political economy, political structure and attitudes and values (Niehoff, et. al., 2002).

In response to question on what can be done to stop problem of flood in Ilorin, 60% of the respondents suggests environmental education of the people; 29.5% suggests legislation in order to change people's poor attitude of dumping waste into flowing water, 7.8% considered demolition of buildings on floodplains, though with compensation from government while 3.7%

suggest dredging and channelization of streams in the city to ease water movement. This is because most of the streams in the city are already silted-up due to indiscriminate waste disposal method.

Table 7: Suggestions for reducing flood incidents in Ilorin

Response	Number of respondents	Percentage of respondents
Environmental education	128	60
Legislation	64	29.5
Stream channelization	08	3.7
Demolition of buildings on floodplains	17	7.8
Total	217	100

Source: Author's fieldwork (2006)

CONCLUSION AND RECOMMENDATIONS

The study has revealed flood frequency and magnitude in Ilorin as a function of twins' factor of landuse and landcover in the city. While land cover is the observed physical and biological cover of the earth's land such as vegetation or man made features, landuse is the total of arrangements, activities and input that people undertake in certain landcover type (FAO/UNED, 1999). Both landuse and land cover changes affect catchment runoff process; this is by influencing the infiltration capacity of the land. Their changes here in the study area are brought about by those factors earlier identified by Niehoff, et. al (2002). These factors include population, level of affluence technology, political economy, political structure and attitude and values. Efforts to curtail the extreme hydro-climatic events of flood in the city calls for proper environmental education, landuse planning and management as revealed in the study.

Environmental education can be carried out through public enlightenment programmes using various prints and electronic media. This include visual display in newspapers and billboards and jingles, discussions and drama programmes on radio on the consequence effects of improper land use practices. While the print media will help in re-educating the literate society, the use of radio programme which can be carried out in local languages will help educate the illiterates in the society on the issues of environment. Issues of environmental degradation such as flooding, desertification, solid waste management, soil erosion etc should not only be enshrined in education curriculum from primary to tertiary levels, but such topic should be taught using audio-visual aids as recommended by Jimoh and Ajibade (1995). This effort according to them will help in evolving acceptable pattern of man-environment relationship. Such efforts once started should however be seen as continuous activities until such norms become acceptable by the generality of the people in the society.

Since landuse planning and management decisions are critical determinant of environmental quality in any geographical area, town planning laws and edicts should be effectively implemented by government agencies responsible. Efforts in this direction should include zoning of town for future development, building regulations and codes. If well

implemented, these suggestions will go a long way in reducing the misery being faced by residents of Ilorin from incessant flooding.

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