

Effects of Poor Drainage System to Built Environment: A Case Study of Auchi Metropolis

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Abstract

This study focused on the adverse effect of poor drainage system in Built Environment in Nigeria using Auchi metropolis in Edo State as a case study. Three research questions guided the study. Using a descriptive survey, a well-structured questionnaire was administered to the stakeholders in built environment; and their perception of House Owners and Tenants in Auchi community was equally sought. Using proportionate sampling and random sampling techniques, a total of 150 questionnaires were administered and retrieved from the field. The data obtained were subjected to statistical analysis using percentages, mean scores, and percentile. This study reveals inadequate layout plan and design or absence of well-constructed drainage system and dumping of refuse on drains are the major causes of floods in Auchi as this ranked 1st and 2nd with a mean score of 3.54 and 3.37 respectively. The study recommends among others, that rain barrels and cisterns, Permeable Pavements; Permeable Concrete design roads and Interlocking Concrete Pavement should be used.

Key words: Drainage, Maintenance, Impact, built environment, risk hazards

Introduction

A built environment is described as man-made environment constructed to provide housing, businesses, estates and cities (Wikipedia, 2016). These environments are meant to support working, living, playing and to support infrastructure, S for habitable existence. However, over the years, it

has become very common to see flooded houses with litter floating everywhere after a short period of rainfall. Such situations create very unsatisfactory and unhealthy living conditions for residents of a neighborhood and contribute to the degradation of the environment. Despite the upsurge in physical development in Nigeria, in terms of construction and reconstruction of residential and private buildings, offices, stores, markets, industries among others, adequate attention has not been paid to put sustainable drainage systems in place to channel surface and run-off water along the roads, from canals, or premises. These experiences have made flooding to be a call for concern in most urban and developing communities in Nigeria (Aderogba, 2012).

Although, drainage systems are expensive to install, if they are well maintained, their benefits outweigh their initial cost. The main objective of a drainage system is to collect waste water and matter and quickly and systematically disposed to maintain healthy conditions in a built environment. A drainage system can either be natural or artificial. The natural drainage system is a means whereby water flows from the fields to swamps or lakes and rivers. Often times, natural drainage is always inadequate, and an additional artificial or man-made drainage is required. A typical drainage system consists of the following: outlets, ditches, side ditches, culverts, inner/out slopes, road structures and under drains. In choosing drainage systems for installation, certain factors are paramount, the expert considers the following factors: the *soil characteristics*, such as soil permeability, *suitability for mole drainage* (clay, type and content) and section of materials. Due to heavy rainfall onto surfaces, and runoff from different premises which are channeled across the road surface, a layer of water with variable thickness is created which may become problem for other road users as splashes and heavy sprays are thrown up by moving vehicles and thus creating a safety risk to the built environment.

In Auchi Metropolis, existing canals, drainage basins and other drainage systems are not enough. They may be blocked or damaged by human activities such as construction of roads, buildings, factories which have reduced drainage channels and erosion passages, or diverted the natural courses of the flow of water resulting to flooding. (Agbonkhese, Malayi & Okoye; 2014). Although, flooding is a common phenomenon all over the world, it has become more rampant and distressing in the developing countries like Nigeria with flood risks in states of Kano, Nasarawa, and Niger Adeyinka, Okomayi and Okoye, (2008) as in Victor, (2010).

Auchi Town is the administrative headquarter of Etsako West Local Government in Edo State, Nigeria. The town is located on the intersect of latitude 7°N and longitude 6°E in the tropics.

It is bounded to the north by Jattu, to the south by Aviele, to the east by Iyakpi, and to the west by Iyaro in Owan local government area with a population of 150,000 people(Wikipedia). In Auchi Town today, there seems to be a great need for properly managed sustainable drainage systems around the buildings in order to help manage surface runoff water. The Federal and state governments are carrying out rehabilitation works in and around erosion gully sites, extending culverts structures, and stilling basins in some major parts of the districts this rehabilitation work has diverted the natural flow of water to other parts of the cities whenever it rains. It seems as if the construction firms that handled these works did not make adequate provision for runoff water before commencing their rehabilitation work.

It is common to see flooded houses with litter floating everywhere after a short period of rainfall. Such situations create very unsanitary conditions for residents of the neighborhoods and contribute to the degradation of the environment. The study therefore seeks to find out the threats and hazards of poor drainage system in built environment and what is responsible for flooding in Auchi community despite the rehabilitation work done on the existing drainage systems and also to proffer a feasible solution to the menace.

Research Questions

The following questions guided this study:

- i) What are the different types of drainage system used by construction firms in Auchi Metropolis?
- ii) What are the effect of poor drainage system in the Auch Metropolis?
- iii) What are the necessary remedial actions to be taken to mitigate the effect of poor drainage systems in Auchi Metropolis?

Literature Review

Drainage design involves providing facilities that collect, transport and remove storm water from the highway. Globally, about 2.6 billion people are living without proper sanitation of which Africa is not exempted (WHO/UNICEF, 2012; Olukanni, 2013). The increase in the population of a settlement and the attendant growth of the needs of the residents bring about intensive exploitation of the resources of the environment. Such exploitation might increase to a level that the resources would not be able to sustain the population, and in some cases the environment would collapse resulting in serious environment problems (Asoegwu (2009) as cited in Olukanni, 2014). In

construction of drains, the designer should put into consideration the low velocities which usually occur during dry weather. Nevertheless, a successful drainage maintenance depends on early detection of problems before conditions require major action. These problems may give the following signs: puddles on the surface area; poor surface flow; slope erosion, clogged ditches, pavement edge raveling, preliminary cracking, pavement pumping, and surface settlement (Nyuyo, 2012).

Also Ufua, Salau, Dada, & Adeyeye, (2020) enumerated casual factors of flood in Nigeria to include: indiscriminate dumping of refuse on drainage channels; channel adjustment and poor drainage conditions; among others factors. Disposal of solid waste into the drains and drainage paths seems to have majorly accounted for water logging in Nigeria including Auchi community Agbonkhese, Malayi and Okoye, (2014) and Nkwunonwo, (2016) stated.

Types of Drainage Systems

There are two major types of drainage system, these include: natural and artificial drainage system. Artificial drainage is subdivided into surface drainage system, subsurface drainage system, downspout and gutter systems and Slope drainage system.

Natural Drainage: In this method excess water flows from the fields to swamps or lakes, however, this is often inadequate and therefore artificial or man – made drainage will be required as support. (Smith, 2016).



Fig 1: A Natural drainage ditch (SOURCE: Aquabrightllc.comSource: www.google.com.)

Artificial drainage system: Artificial drainage system is the use of pipes, wells, and other constructed materials to remove water from the environment.

- a. **Deep open drains:** The excess water from the root-zone flows into the open drains. The disadvantage of this type of subsurface drainage is that it makes the use of machinery difficult.
- b. **Buried Pipe drains:** These are buried pipes with openings through which the soil water is conveyed to a collector drain. These pipes are made of clay, concrete or plastic which are usually placed in trenches by machines, and water enters through perforations distributed over the entire length of the pipe.



Fig 2. Buried Pipe Drain



Fig 3. Downspout and Gutter systems (Source:

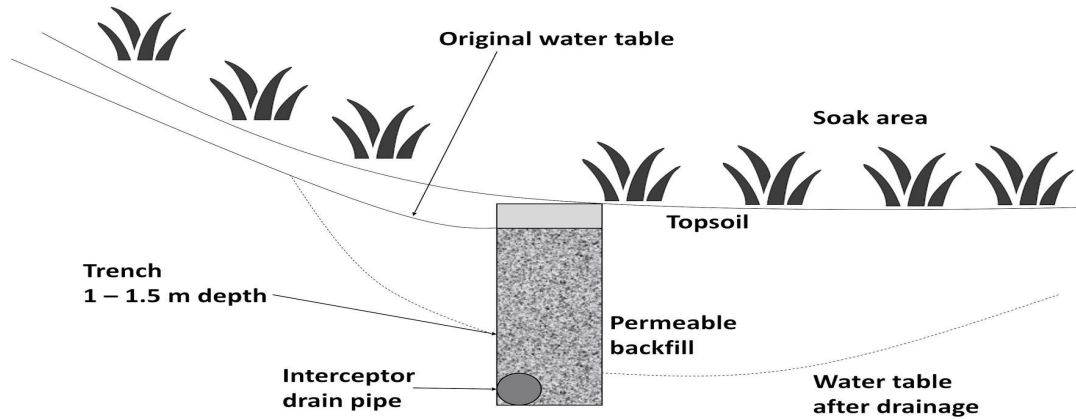
www.google.com)

ii. Downspout and Gutter systems

Downspouts collect water from gutters and divert it to the ground. A downspout is typically connected to a gutter system on a building and carries water away from the roof down to the ground. Downspouts empty out the water on a slope so that the water does not pool at the base of the downspout.

iii. Slope Drainage Systems

Slope drains allow water to flow downward from a structure with the aid of pipes moving down a slope. A pipe is installed and anchored into a small incline, which causes water to flow through the pipe and away from the structure. Interceptor drains is an example of slope drainage.



SOURCE: www.vic.gov.au

Fig 1. Slope Drainage Systems

e. Dry Well Drainage System: A dry well is an underground system that is responsible for removing unwanted water from storms. The system is comprised of a porous-walled chamber, covered at the top that slowly disperses the captured water into the ground. This process helps to alleviate ponding or flooding.

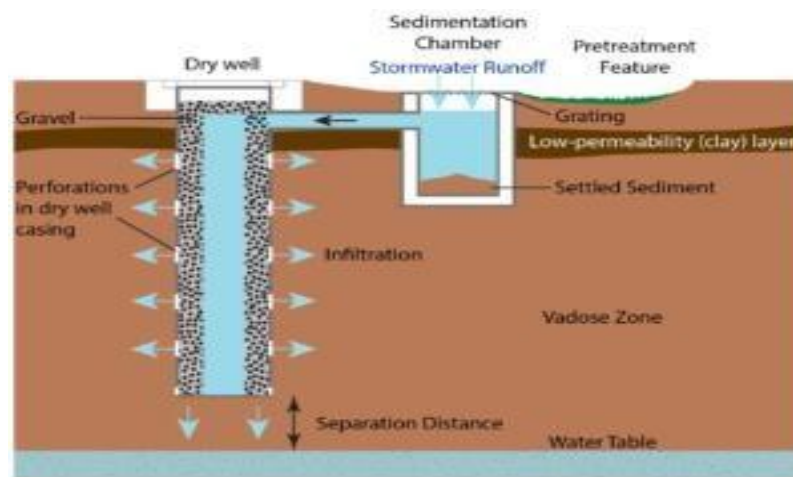


Fig 2 Dry Well (SOURCE: Aquabrightllc.com)



Fig 3. A Slot Drain System (Source: sportsedge.com)

Causes of Poor Drainage System

The most common causes of poor drainage system include: **blockages, heavy storms and rain, damaged pipes, inadequate layout planning and design, Shallow drains, lack of maintenance; displaced or open joints; root intrusions among others.**

ii) Heavy storms and rain:

After heavy rain or storms, drains outdoors are usually blocked by the leaves, cellophane bags, broken plastics and other debris/dirt. These drains are not made to manage large volumes of water. Therefore, this may lead to flooding outside the property as shown below in Plate 5(a-b)

Shallow Drains /Damaged Pipes

Another major cause of poor drainage is a broken or collapse section of a major pipe. For water to flow freely, it needs perfect pipes, or else it may collapse. This could be as result of shallow drains, or the growth of tree roots. And water may flow into the terrain around the pipe this could cause foul smell, and lead to damp or growth of mold on the walls of the building.

Fig 4 (a) **Blocked Drains**Fig 4b: **Flooded road in Lagos**

(Source: encrypted-tbnO.gstatic.com)

Fig 4c: **Submerge Building in flood**

4d)

Refuse**Dump in drains****Along Solo Street in Auchi****Along Iyekhe Street in Auchi**

iv) **Inadequate Layout Planning and Designs:** With increasing trends in ‘doing work on your own’ has created many problems. This has led to poor installation of drainage pipes by inexperienced plumbers. Inadequate layout planning and designs of pipes could cause serious damage to the drainage system. In many houses the vents are not well located or it seems not there at all. So foul air from the sewer flow into some of the rooms. And also these could disturb the free flow of waste water to the soak ways and septic tanks which might damage other parts of your property.

b) **Lack of Maintenance:** The lack of maintenance often results in deterioration of structures which leads to total collapse of the structure. Plumbing work requires an annual or regular servicing of the plumbing systems in the home, which include repairs, inspection, and testing for preventive

measure to minimize or avoid future damages. Other causes of poor drainage include: **Shallow Drains /Damaged Pipes;Water Flow Problems;**Displaced or Open Joints;Root Intrusions;**Blockagesamong others.**

Effect of Poor Drainage System in Auchi Metropolis

1. Hydroplaning: This occurs when a layer of water builds between the wheels of the vehicle and the road surface leading to a loss of grip that prevents the vehicles from responding to control inputs, (Wikipedia). The water prevents tires from gripping the road this could lead to loss of steering control and accidents.

This is a serious problem facing motorists that ply the roads whenever heavy rainfalls occur, the runoffs water from premises is channeled to the roads. This occurs mainly along Auchi - Aviele road by Cattle Market, Auchi - Okene road by NNPC Filling Station, and within the town along ICE road, Igbe road, Warrake road, Igbo Shade among others.

2. Erosion: Poor drainage system or failure of drainage system can also result to erosion problems; this has been experienced in many areas in Nigeria including Auchi Community. This has led to abandonment of some major streets and houses within the community, big gullies are created, blockage of roads, washing away of the fertility of the soil. Although the federal and Edo State government are giving assistance to arrest this situation by constructing bigger gutters and drainage basins more need to be done to arrest the situation in the Town.

3. Diseases: Poor drainage system could result to deterioration of health of both old and young persons, this is due to increase in water borne diseases and unsanitary conditions. This could cause serious health hazard- air borne disease, water-related vector borne disease among others. Persons living in such environments are also exposed to air pollution with stagnant water, chronic health issues related to exposure to residues of agrochemicals. A total of 871 persons were diagnosed with Lassa fever between January and March and 12 deaths were recorded in 2019 according to NefisatIkerodah – the director, Disease Surveillance, Etsako West Local Government Area. (www.premiumtimesng.com).

4. Indiscriminate Waste Disposal: Some residents regularly dump waste in gutters, along the road and in market places, so whenever it rains it is common to see flooded streets with these waste, litters, floating everywhere. This often leads to unsanitary conditions which contribute to the degradation of the environment and risk to the building industry.

5. Flooding: Poor drainage system can also result in flooding which destroys lives and property. Destruction of crops and farmlands can also cause loss of livestock. In 2019 the major rivers in Auchi were over flooded, including River Ole, and Egbogwo river, such that vehicles travelling to Akoko Edo, Owan and Benin Okene roads stood still for hours and some for days.

Other effects of poor drainage system include: Pollution by organic or inorganic substances; It can also affect quality and quantity of water source to the community; It causes remnants in soils keeping it moist and plastic for long periods; Runoffs water can also wash away some sections of a building exposing the foundation. It can also make a building to submerge in water or cause partial settlement which could be a risk to the occupants and adjoining buildings (Smith Russel, 2021). In summary, the problems and risks associated with poor drainage in built environment are enormous.

Mitigation Measures for Effective Drainages System

Good drainage system needs to be taken into consideration at the early design stages in order to secure a long life for a building, road or other structures. The following facilities are readily available and if put in place could help to control the storm water generated from premises. These facilities include: *storage tanks* that capture runoff water from catchment areas such as the roofs; *Rain Barrels and Cisterns*; *Permeable Pavements*; *Bio-retention areas*; *Riparian Buffers* are some facilities that collect, transport and remove storm water. Mitigation measures also include:

- Roads should be de-watering to remove the ponding water from the roads. Cross fall and impermeable pavement leading water away from pavements, road shoulders to the ditches should be built around the major roads.
- Ditch slopes should be built using concrete slabs along both sides of the roads to prevent erosion
- Outlet ditches should be excavated in a way that natural water course could be discharges into channels or excavated away from the road to minimize any accumulation of silt, mud or other harmful materials.
- Detention ponds should be provided to gather and allow the runoff water to drains into the ground slowly over a period of time and be ready for the next rain storm event.
- Education/information on waste treatment/emergency events should be provided to building occupants and house own
- Standard practice flood resistant construction techniques should be adopted in areas potentially prone to flooding.
- Rehabilitation in and around erosion gully sites – stone revetment to reclaim and protect road ways, extension of culvert structures to the ditches, shut channels, stilling basins, should be built in some areas prone to floods.

- Use of rain barrels, Polyethylene Cistern, building of Permeable Pavement, Permeable Concrete, Interlocking Concrete Pavement should be encouraged in premises.



Fig 5: Permeable Concrete
(Source: roohome.com)



Fig 6 Interlocking concrete
(Source: 3driverswetweather.org)



Fig 7: Sustainable Design Road



Fig 8: Rain Barrels

(Source:kingcounty.gov)



Fig 9: Underground Polyethylene Cistern



Fig 10: Permeable Pavement

(Source: watercache.com)

Source: nacto.org

Methodology

A descriptive Survey was carried out using 150 professionals -*Builders, Architects, Quality Surveyors*, Engineers in the building environment and house owners and some tenants in Auchi community, in Edo State. Using random sampling techniques 150 well-structured questionnaire on poor drainage system in built environment was draft, validated by two experts in built environment. A pilot study was carried out to ascertain the consistency of the instrument. The data collected were analyzed using Cronbach reliability index and 0.74 was obtained which shows the fitness of the instrument. The data collected, were measured on a four point likert scale, and analyzed using percentages, mean scores and percentile. The minimum mean score accepted as agree was 2.5.

Tab 1: Causes of Poor Drainage System

<i>S/N</i>	<i>Identified causes of poor drainage system</i>	<i>Mean (x)</i>	<i>Rank</i>
1	Inadequate layout plan and design or absence of well-constructed drainage system	3.54	1 st
2.	Dumping of refuse on drains could block the drainage system	3.47	2 nd
3.	Heavy storms and rainfall during the period.	3.37	3 rd
4.	The most common drainage problem is blockage of pipes	3.37	3 rd

5.	Growth of molds on walls	3.31	5 th
6.	Lack of ventilation in drains could cause a breakdown in the system	3.30	6 th
7.	Open joint in pipes result to structural damages	3.27	7 th
8.	Broken/collapsed pipes can attract pests and rodents	3.19	8 th
9.	Use of unskilled personnel	3.01	9 th
10	Use of poor materials	2.91	10 th
11	Fracture and cracks	2.87	11 th
12	Root intrusion often affects the sewer system creating punches or holes in pipe lines	2.64	12 th
13	The topography of the community could affect the drainage system	2.20	13 th

Fig 1: Field Survey (2022)

Table 1 result shows that inadequate layout plan and design or absence of well-constructed drainage system has average score of 3.54 ranked 1st among the causes of poor drainage system. This is perceived to be as a result of the use of inexperienced plumbers. While dumping of refuse on drains has average mean score 3.47 (Agree) ranked 2nd. **Heavy storms and rainfall** during the period and blockage of pipes has an average mean score of 3.37 each.

Table 2: Effect of Poor Drainage System in Built Environment

S/N	Statements	Mean (<i>x</i>)	Rank
1	Poor drainage system can cause health hazards in built environment	3.63	1 st
2.	Lack of maintenance of drainage often results in deterioration of structures	3.55	2 nd
3.	Gullies are caused by poor drainage system	3.53	3 rd
4.	Buildings can be submerged in floods due to poor or shallow drainage system	3.50	4 th
5	Poor drainage system could cause risk to vehicle and other road users	3.48	5 th
6.	Poor drainage system could cause air pollution	3.46	6 th
7.	Erosion water on the road could cause hydroplaning in the tires of vehicles	3.43	7 th
8.	Poor drainage can cause loss of water sources of a community	2.63	8 th

Field Survey (2022)

Table 2 indicates the effect of poor drainage system in built environment and the major effects as identified by the Respondents are health hazard with a mean score of 3.63 (Strongly

Agree) closely followed by deterioration of structures with a mean score of 3.55 (Strongly Agree). Others in the ranked order include: create gullies; buildings submerged in floods as a result of shallow drains, causes hydroplaning of vehicles, with mean scores of 3.53, 3.50 and 3.43 (Strongly Agree) respectively.

Discussion

The result of the study reveals the overall ranking results by the respondent, on the risks of poor drainage system in built environment which are as follows:- inadequate layout plan and design or absence of well-constructed drainage system, dumping of refuse on drains, blockage of pipes and heavy rainfall ranked 1st, 2nd and 3rd position respectively with means of 3.54, 3.47 and 3.37 respectively are among the most significant causes of poor drainage system in built environment-Auchi community.

This is in consonance with the findings of Agbonkhese, Malayi and Okoye (2014) and Ufua, Salau, Dada, and Adeyeye (2020), that indiscriminate dumping of refuse on drainage and canals adjustment, poor drainage conditions are the major causes of poor drainage system in Nigeria including Auchi. On the effect of poor drainage system in built environment, the general views of the parties reveal the followings as the most important effect of poor drainage system in built environment: health hazards (3.63), deterioration of structures (3.55), creation of gullies (3.53), and building submerged in floods (3.50) respectively among others. The result above is in agreement with previous research work of Victor (2010) as stated in Nyuyo (2012) and Nkwunonwo (2016), that runoffs water is the major effect of big gullies on peoples' land, blockage of the roads, and also deterioration of structures in built environment which are also some of the challenges faced by Auchi community. Poor drainage system in built environment in its wide definition affects every section of the buildings and the built environment.

Conclusion

The study has discussed the poor drainage system as a risk to build environment: Using Auchi Community as a case study. The study identified causes and effects of poor drainage system to the built environment; and suggested ways to mitigate these effects in order to protect lives and properties and also to save the built environment from total collapse or face serious ecological problems in the future. The study therefore concluded that a well-designed drainage system should

be put in place such as: drainage wells, detention ponds, rain barrels, polyethylene cistern, building of permeable pavement, should be constructed in premises to reduce the runoffs water in the streets.

Recommendations

Based on the findings of this study, researchers recommends as follows:

- Paved 'Road shoulders' should be built around the major roads to give lateral support to the road. And Ditch slopes should also be provided to divert water to and from highway.
- Education/information on waste treatment/emergency events should be provided to building occupants and house owners.
- Well design deep drains should be installed alongside the new roads to allow quick flow of runoffs water.
- The gutters should be cleared, all refuse disposed properly before the raining season. Everyone should cooperate to save the built environment.
- Adequate layout planning and designs of pipes should be done by qualified engineers and good quality pipes should be used, maintained by a professional plumber to avoid regular plumbing issues.

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