Annals of Industrial Technology

Research Article

Investigation of Drainage Network and Its Effects on Dwellers within Makurdi Metropolis

Comfort A. Adadu[1], Daniel A. Nevkar[2] and Michael A. Enaboifo[3]

[1,2]Department of Vocational and Technical Education, Benue State University, Makurdi, Nigeria.

[3]Department of Agricultural Engineering, University of Benin, Benin City, Nigeria.

Received 1 August 2024; Acceptance 5 September 2024; Published 11September 2024.

Abstract

This study was aimed at the investigation of drainage network and its effects on dwellers within Makurdi metropolis. A survey research design was used for the study. The population accessed for data collection of the study was 200 respondents, sampled from affected areas. A structured questionnaire was used as an instrument in collecting the data. Four research questions were formulated. Mean and standard deviation were used to analyze the data for answering the research questions. It was found that poor drainage establishment, network and maintenance were identified as factors responsible for flood occurrence and other drainage related challenges in Makurdi metropolis. Based on the findings, it was recommended among others that government should enact possible laws that will guide drainage construction and maintenance, establish drainage monitoring and maintenance agency, be involved in educating people on the possible impacts of drainage related issues.

Keywords: Drainage network, Dwellers, Drainage maintenance, Flood.

Introduction

Drainage is a natural or artificial removal of surface water and sub-surface water from an area. It can be defined as the natural or artificial removals of unwanted or excess water from any surface or sub-surface area [1]. As a result of natural or artificial occurrences the ground then turns to be saturated with water. During rain or irrigation, the fields become wet. The water infiltrates into the soil and is stored in its pores. When all the pores are filled with water, the soil becomes saturated and no more water can be absorbed.

Correspondence to: Comfort A. Adadu, e-mail: comfortadadu@yahoo.com

How to Cite: Adadu et al. (2024). Investigation of Drainage Network and is its Effects on Dwellers within Makurdi Metropolis. *Annals of Industrial Technology,* 1(9). DOI: 10.5281/zenodo.13748234

If rain or irrigation continues, pools may form on the soil surface. The water flowing from the saturated soil downward to deeper layers, feeds the groundwater reservoir. As a result, the groundwater rises. Following heavy rainfall, flooding or continuous over-irrigation, and the groundwater table may even reach and saturate part of the top soil. As this water increases the dwellers of the soil becomes casualties except efforts are made to avert the situation. This has drastically affected Makurdi metropolis. Excess soil water has been affecting dwellers of Makurdi metropolis for some time now and therefore displaces the immediate dwellers of this locality. However, this may vary in different years depending on the volume of water on the surface of the soil for that particular year.

The drainage system in Makurdi seemed to be poor and this has serious effects on the dwellers some areas within Makurdi town has poor or no drainage system. Makurdi is located in the plains of the River Benue in the Benue Trough. The relief is generally low-lying ranging between 73m to 167m on the average. There are interfluves in certain parts of the town where elevation is above the average. In terms of geology, Makurdi town is basically composed of sedimentary rocks, which sandstones are the dominant rock type. Low lying areas like Wadata are overlain by shale [2]. The sandstone is divided into micaceous and feldsphatic sand-stones. Some of these are exposed in parts of the town. Soils in the area reflect the geology. There are two major soil types in Makurdi town: 1) hydromorphic soil– this is developed on alluvium sediments found along the River Benue and 2) red ferrasols- this is developed on sedimentary rocks away from the immediate river channel [3]. The climate of Makurdi town is the tropical wet and dry type, Koppen's Aw classification, with double maxima [4]. The rainy season lasts from April to October, with 5 months of dry season (November to March). Annual rainfall in Makurdi town is consistently high, with an average annual total of approximately 1173 mm [5]. The River Benue is the main drainage channel traversing the town. It truncates the town into the North and South Banks. There are also several streams draining Makurdi town on both banks which are tributaries of the River Benue. Most of the streams are perennial and include Kpege, Genebe, Kereke, Adaka, Asase, Idye, Urudu and Demekpe amongst others these are natural drainages with little artificial drainages. There has been a rapid growth in the number of people displaced by floods, health hazards and also in the amount of economic damage caused. An estimated number of over 1.5 million people were displaced between 2008-2012. Poor urban drainage system, poor maintenance and poor structural planning are likely to have been a factor resulting on the flood menace. The effects of recent flooding in Nigerian cities include, among others, loss of life and properties, spread of diseases, deformed livelihoods, assets and infrastructure [6]. The influx of people from both rural and adjoining states led to increased demand for housing. Houses are hurriedly built to meet the burgeoning demand for shelter and thus without proper planning and drainage system. In recent times the influx of water from Lagdo dam in Cameroun also increases the volume of water on the Benue River. These causes flood in Makurdi town, alter the aesthetic image of Makurdi, stagnated waters favourable for insects breeding and reducing the durability of buildings erected. For this reason, this study aims to investigation of drainage network and its effects on dwellers within Makurdi metropolis.

Materials and Method

Research Questions

The study is guided with the following questions:

i. What are the effects of poor or unavailability of drainage system on the inhabitants of Makurdi metropolis?
ii. How does poor drainage network affect the dwellers of Makurdi metropolis?
iii. What are the effects of poor drainage maintenance in Makurdi metropolis?
iv. What are the effects of urban structural developments on drainage system in Makurdi metropolis?

Research Design

The survey research design was used in this study. The design involves the collection of data about a phenomenon with a representation sample by the use of questionnaire, interview and appraisal approach.

Area of the Study

The study is confined to Makurdi Metropolis that lies between latitudes 7°38' - 7°50'N, and longitude 8°24'-8°38'E. Makurdi town is the headquarters of Makurdi Local Government Area and capital of Benue State. It is situated in the Benue valley in the North Central region of Nigeria. It is traversed by the second largest river in the country, the River Benue.It is located within the floodplain of the lower River Benue valley its physiography spans between 73m – 167m above sea level [7]. Due to the general low relief, sizeable portions of Makurdi is waterlogged and flooded during heavy rainstorms. Makurdi town is drained principally by river Benue which divides it into Makurdi North and South banks. The climatic condition in Makurdi town is influenced by two air masses, the warm moist south-westerly air mass and the warm dry north-easterly air mass. The south-westerly air mass is a rain bearing wind that brings about rainfall from the months of April to October. The dry north-easterly air mass blows over the region from November to March, thereby bringing about seasonal drought [8]. The mean monthly relative humidity varies from 43% in January to 81% in July-August period.

Temperatures are generally high throughout the year, with February and March occurring as the hottest months. Temperature in Makurdi varies from a daily of 40^{o}C and a maximum of 22.5^{0}C [8]. In terms of geology, Makurdi town is basically composed of sedimentary rocks, which sandstones are the dominant rock type. Low lying areas like Wadata are overlain by shale [7]. The sandstone is divided into micaceous and feldsphatic sand-stones. Some of these are exposed in parts of the town. Soils in the area reflect the geology. There are two major soil types in Makurdi town: 1) hydromorphic soil– this is developed on alluvium sediments found along the River Benue and 2) red ferrasols- this is developed on sedimentary rocks away from the immediate river channel [4].

The climate of Makurdi town is the tropical wet and dry type, Koppen's Aw classification, with double maxima [4]. The rainy season lasts from April to October, with 5 months of dry season (November to March). Annual rainfall in Makurdi town is consistently high, with an average annual total of approximately 1173 mm [6]. There are also several streams draining Makurdi town on both banks which are tributaries of the River Benue. Most of the streams are perennial and include Kpege, Genebe, Kereke, Adaka, Asase, Idye, Urudu and Demekpe amongst others these are natural drainages with little artificial drainages.

Population

Population for the study constituted of 200 people randomly sampled from residents in the affected areas in Makurdi Metropolis.

Sample and Sampling

The research adopted a simple random sampling. A sample of 50 persons was randomly selected in the affected areas of Achusa, Wadata, Wurukun and Demekpe of Makurdi metropolis.

Instrumentation

The instrument used for data collection for this research was a structured questionnaire. The response option of the questionnaire was a structured four point rating scale.

Validation of Instrument

The instrument for data collection of this research work was validated by two experts one from The Directorate of Physical Planning Benue State University Makurdi, and another from Federal University of Agriculture Makurdi.

Reliability of Instrument

To establish the reliability of the instrument, the responses were analyzed and the reliability estimate was determined using Cronbach Alpha (α) reliability coefficient.

Method of Data Collection

The questionnaire for this study was distributed to the respondents in the areas of concern. Research assistants assisted the researcher in the administration and collection of the questionnaire. Before the exercise, each of the research assistant was briefed about the objectives of the study, the research design, arrangement of the questionnaire and method to be used in its administration and collection. This was to enable the research assistants' answer any questions of clarity any issue concerning the questionnaire during its administration. A letter introducing the research and the nature and purpose of the study was attached to each questionnaire, directions were provided on each copy of the questionnaire to guide the respondents on how to respond to each section of the questionnaire.

Method of Data Analysis

The analysis was done using simple descriptive statistics and a modified 4-point Rating Scale of 4- as Strongly Agree (SA), 3- Agree (A), 2- Disagree (D) and 1- Strongly Disagree (SD). The scale as used specified the level of agreement or disagreement on a symmetric agreement-disagreement scale for the factors causing flooding and other drainage related hazards in Makurdi town. The mean score of each point was then used as the degree of response for a factor causing flooding in the town. A decision will be agreed if the mean response equals or greater than 2.50 and will be disagreed if below 2.50.

Results and Discussion

Table 1 shows the mean response of the dwellers on challenges associated with drainage. Most of the respondents live in flooded areas and some have been displaced by floods and other drainage concerns. The respondents agreed with all the items because the mean response of each item is greater than 2.50 which is the cut off mark and showed the grand mean of 3.46 above cut off.

Table 1: Mean and Standard Deviation Response of Respondents on the Effects of inadequate Drainage System on the Inhabitants of Makurdi Metropolis

SN	Items	N	X	St.D	Decision
1	Unavailability/poor drainage construction is the major causes of flooding in Makurdi metropolis	200	3.44	0.81	Accept
2	Poor drainage establishment has affected the aesthetic phase of Makurdi metropolis	200	3.20	0.80	Accept
3	Stagnated waters due to poor drainages serves as breeding habitats for mosquitoes and other vectors	200	3.84	0.37	Accept
4	Undrained waterlogged soils affects the stability of building found in the affected areas	200	3.40	0.85	Accept
5	Undrained/stagnated waters on the road delay activities and causes poor movement	200	3.40	0.63	Accept
	Grand mean		3.46		Accept

Source: *Field survey 2018*

Table 2 shows the mean response of the dwellers on lack/poor drainage network (channeling) in the affected areas which are frequently displaced by floods and other drainage concerns. The respondents agreed with all the items because the mean response of each item is greater than 2.50 which is the cut off mark and showed the grand mean 3.38 above cut off.

Table 2: Mean and Standard Deviation Response of Respondents on How Poor Drainage Network Affect Makurdi Metropolis

S/N	Item Statement	N	X	Std.D	Decision
1	Poor drainage network causes stagnated waters around houses and roads.	200	3.68	0.47	Accept
2	Poor drainage network discharges effluents and surface waters in open places causing increased runoff and increase water concentration in such places.	200	3.08	0.69	Accept
3	Poor drainage network litters the city as effluents and other materials carried by the available open drains discharge such materials and effluents in open places	200	3.44	0.50	Accept
4	Poor drainage network (channeling) affects houses at their lower courses and displaces the inhabitants after heavy rains as the increased waters enters poorly constructed houses.	200	3.60	0.63	Accept
5	Open ended drainage network deposit sand on roads and houses.	200	3.12	0.87	Accept
	Grand mean		**3.38**		Accept

Source: *Field survey 2018*

Table 3 shows the mean response of the dwellers on poor drainage maintenance in the affected areas which are frequently affected by drainage effects. The respondents agreed with all the items because the mean response of each item is greater than 2.50 which is the cut off mark and showed the grand mean 3.26 above cut off.

Table 3: Mean and Standard Deviation Response of Respondents on Effects of Poor Drainage Maintenance in Makurdi Metropolis

SN	ITEMS	N	X	St.D	Decision
1	No/poor drainage maintenance reduces the lifespan of constructed drainages	200	3.28	0.78	Accept
2	Unclean drainages block passage of surface waters and effluents leading to increased water at upper course.	200	3.20	0.75	Accept
3	Un clean drainages serve as habitat for vegetation growth.	200	3.40	0.63	Accept
4	Rodents and other small animals have residing homes in broken/blocked drainages	200	3.12	0.65	Accept
5	Un maintained drainages forms heaps of refuses and litters the environments	200	3.28	0.96	Accept
	Grand mean		3.26		Accept

Source: *Field survey 2018*

Table 4 shows the mean response of the dwellers on the effects of poor urban structural development on drainage system to the immediate dwellers. The respondents agreed with all the items because the mean response of each item is greater than 2.50 which is the cut off mark and showed the grand mean 3.25 above cut off.

Table 4: Mean and Standard Deviation Response of Respondents on Effects of Urban Structural Development on Drainage System in Makurdi Metropolis

SN	ITEMS	N	X	St.D	Decision
1	Houses discharge their effluents system immediately outside their fence.	200	2.96	0.78	Accept
2	Some houses are built in water ways blocking free flow of water.	200	3.28	0.67	Accept
3	Some houses are built in water logged areas with poorly constructed foundations.	200	3.66	0.59	Accept
4	Buildings with paved environment increases water runoff.	200	3.60	0.49	Accept
5	Houses are built without reservation for channels establishment	200	2.76	0.91	Accept
	Grand mean		3.25		Accept

Source: *Field survey 2018*

The findings of this study revealed that drainage construction has affected the immediate dwellers of Makurdi metropolis as poor or no drainage system displaces the inhabitants frequently due to flooding activities, poor drainage litters and pollutes the aesthetics of Makurdi town as flowing waters discharge effluents and other dirt around the environment, poor drainage has serious health hazards as poorly drained stagnated waters serves as breeding environment for mosquitoes and other vectors transmitting diseases, stagnated waters around buildings affects the stability of buildings as continuous moisture affects building foundation fabrics and poorly drained waters delays movement and other activities during or immediately after rainfalls. As the findings also revealed how poor the drainage system of the metropolis is, some areas in the metropolis have poor or no drainage system, some with drainage system but poorly constructed due to negative attitude of contractors and poor funding for construction which tends to collapse after a duration of time. During site survey some drainages were found broken which inhibits proper effluents and surface water conveyance. The author in [9] also said that heavy rainfall, inadequate drainage channel, poor physical planning among others contributes so much to flooding activities.

Findings also revealed how poor the drainage system of the metropolis is, some areas in the metropolis have poor or no drainage system, some with drainage system but poorly constructed due to negative attitude of contractors and poor funding for construction which tends to collapse after a short duration as shown in Figure 1. During site survey some drainages were found broken which inhibits proper effluents and surface water conveyance. Ndoma (2010) in his work also said that heavy rainfall, inadequate drainage channel, poor physical planning among others contributes so much to flooding activities. Eze (2010), also agreed that poor drainage network is often associated with street flooding and this has become critical environmental problem in coastal cities of Nigeria However, it is not only water from water bodies that usually flood these cities but also heavy rains, and the poor drainage network as shown in Figure 2. Other factors include dumping of wastes in drainage and water channels as shown in Figure 3. Some channels in the Makurdi were found blocked with refuse, some filled with vegetation growth as shown in Figure 4 and 5 and others with undrained waters, which turns the place to a slum as shown in Figure 6.

Figure 1. A failed drain due to poor construction work

Figure 2. An unconnected drain

Figure 3. A drainage channel turned to refuse dump

Figure 4. A house poorly constructed in a marshy area

Figure 5: A drainage channel covered with vegetation

Figure 6. A paved house that discharges effluents through the fence into the street

Conclusions

The investigation of drainage network and its effects on dwellers within Makurdi metropolis is presented. Findings from the study showed that poor drainage system has series of effects to the study area. As the study revealed, drainage establishment, poor and unlawful structural development, drainage network and drainage maintenance have affected the immediate dwellers of Makurdi metropolis. The presence of waste and other materials in drainage network is responsible for drainage over flowing and stagnated waters in the channels. Negligence of the above displaces the immediate dwellers annually, breeding of insects due to stagnated waters causing diseases to the dwellers, breeding and habitats for rodent and other animal pests transmitting diseases and disturbing our stored products, littering and polluting the supposed aesthetic environment of Makurdi metropolis, as well as causing delayed movement after rains, series of environmental and socioeconomic problems in the city. As proved by the responses collected from those who live within the affected areas and have experienced effects of poor drainage. Additionally, flood and other drainage related hazards remains a very serious environmental problem in Makurdi. Recurrent flood events and other drainage related hazards in the city have been traced to none or lack of drainages in the affected areas, unlawful structural development, inadequate drainage network (channeling) and poor drainage maintenance in the frequently affected areas. Many properties have been destroyed, lives lost and this has subjected the people to unquantifiable trauma. More so, the menaces of flood have been on the increase as a result of incipient and prolong weather conditions, Government spends huge monies on displaced people annually. Based on these findings, it is recommended that stake holders should implement policies that will help checkmate the menace of drainage network and its effects on dwellers.

References

[1]. Ocheri, M. &Okele, E. (2012) Social impact and people's perception of flooding in Makurdi Town, Nigeria

[2]. Ogba, C. &Utang, P (2008) Integrated Approach to Urban Flood Adaptation in the Niger Delta Coast of Nigeria. Integrating Generations FIG working week 2008. Stockholm, Sweden 14-19 June, 2008.

[3]. Abaje, I. B. &Giwa, P. N. (2008). Urban Flooding in Environmental Safety: Urbanization, Resources Exploitation and Environmental Stability, Association of Nigerian Geographer book of proceedings of the 4th annual conference held in the department of Geography, University of Abuja, 15th-19th October, 2007. Kaduna, Joyce publishers

[4]. Abah, R. C. (2012). Causes of seasonal flooding in flood plains: a case of Makurdi, Northern Nigeria. *International Journal of Environmental Studies* 69(6):904-912.

[5]. Hula &Udoh (2015) An assessment of the impact of flood events in Makurdi, Nigeria

[6]. Adedeji, B, H. Bashir, O., Bongwa, A. &Oladesu, O. (2012). Floods of Fury in Nigerian Cities. *Journal of Sustainable Development* 5(7) 69-79.

[7]. Adedeji, B, H. Bashir, O., Bongwa, A. &Oladesu, O. (2012). Floods of Fury in Nigerian Cities. *Journal of Sustainable Development* 5(7) 69-79.

[8]. Eze, E. B., &Efiong, J. (2010). Morphometric parameters of the Calabar river basin: Implication for hydrologic processes. *Journal of Geography and Geology*, *2*(1), 18.

[9]. Ologunorisa, E. T. &Tersoo, T (2006). The changing rainfall pattern and its implication forflood frequency in Makurdi, Northern Nigeria, *Journal of Applied Science and Environmental Management,* Vol.10 (3) 97-102.

[10]. Ndoma, E. E. (2015). Effectiveness of drainage networks on floods in Calabar Metropolis, Calabar, Nigeria.