

Flood management in an urban Area
(A case study of Benin metropolis)

Igbinoba J.O[1], Omorodion .I. I[1],Amiebenomo .S.O [2],Nathaneil A[1]
1.Department of Materials and Production Ambrose Alli university ,Ekpoma
2.Department of Mechanical Engineering Ambrose Alli university,Ekpoma
Email: igbinscoker@yahoo.com

Abstract
In spite of efforts at controlling flood hazards in Benin metropolis, the magnitude of flood problem have more than doubled in recent years. A critical review of some recorded cases of flooding coupled with the analysis of the causes and effects of flood on properties and human population was done. Data were collected from the Ministry of Environment and Public Utilities, Hi-tech Construction Company and personal interaction with effected resident local authorities workers, including Engineers of contracting companies on site.
Result from this study shows that illegal disposal of refuse on drainage channels, high intensity of rainfall, poor drainage system, poor construction of roads and building of houses on stream channels and non implementation of strict town planning laws were identified as the causes of flooding in the Benin Metropolis. The study recommends that good road construction works, controlled dump sites and proper town planning policies and methods should be adhere to in the Benin metropolis to reduce the effect of flood.
Keywords: flood management, culvert, flowrate Gutters and stream channels

CHAPTER ONE
INTRODUCTION

Background : Over the years there had always been one form of crises or another resulting from disasters. Prominent among these crises is flood disaster. Flood is the overflow on an expanse of water such that it submerges or cover the land while moving with a particular speed. I t has the potential of causing great harm to lives properties and the environment .
There are three major types of flood viz Slow onset flood, Rapid onset flood and flash flood.
Slow onset flood– This is the kind of flood that usually last for a relatively longer period, maybe one to two weeks or even a month while the rapid onset flood is the type of flood that lasts for a shorter period usually between one to two days. Even though this type of flood lasts for a shorter period it can cause more damages as people usually have less time to take preventive measures against the challenges it might pose. Lastly flash flood may occur within minutes or a few hours after heavy rainfall ,tropical storm, dam or levee failures or release of ice jams are the main causes, They are however very hazardous as they uproot anything in their path leaving tales of woes and sorrows that includes destruction of properties, landmark and even lives.

1.0. AIMS AND OBJECTIVES: To examine the environmental effect of flood in the Benin Area its challenges and management.

- By examining the dimension and causes of flooding in the metropolis
- Examine the role of city authorities in the management of flood.
- By having under spot assessment of flood prone zones in the cities with a view of suggesting ways of tackling them.

Study Area – This research focuses on the ancient city of Benin – A town located in Edo state Midwest of Nigeria – a country with population of about 160million.Today the local authorities in the state through its relevant ministries and agencies have re–emphasize the need for a well planned city structure with policies and measures to mitigate the destructive hazard of flood.

1.11. CAUSES OF FLOODING: Flooding can generally be attributed to the factors of climate change, such as storm ,heavy and continuous rainfall, sudden melting of snow ,landslide dam failure or release of water from dam including activities of man. Inadequate provision of basic infrastructure poor urban planning and design as well as non adherence to healthy environmental practices.

1.20. LITERATURE REVIEW

Edo state and Benin city in particular is vulnerable to climate change impacts due to it geography climate vegetation, soils economic structure population and settlement according to the international federation of red cross and red crescent societies , in ten years between 1993 to 2002 flood disasters affected more people across the globe(140million per ,year on average) than all other natural or technological disasters put together (Ifrc,2004) A review of climate change impacts on urbanization by the international institute of environment and development (Hugel etal), 2007, found that the floods are already having several impacts on cities, smaller urban centres and rural areas in many African nations. Despite the considerable effort through the century to

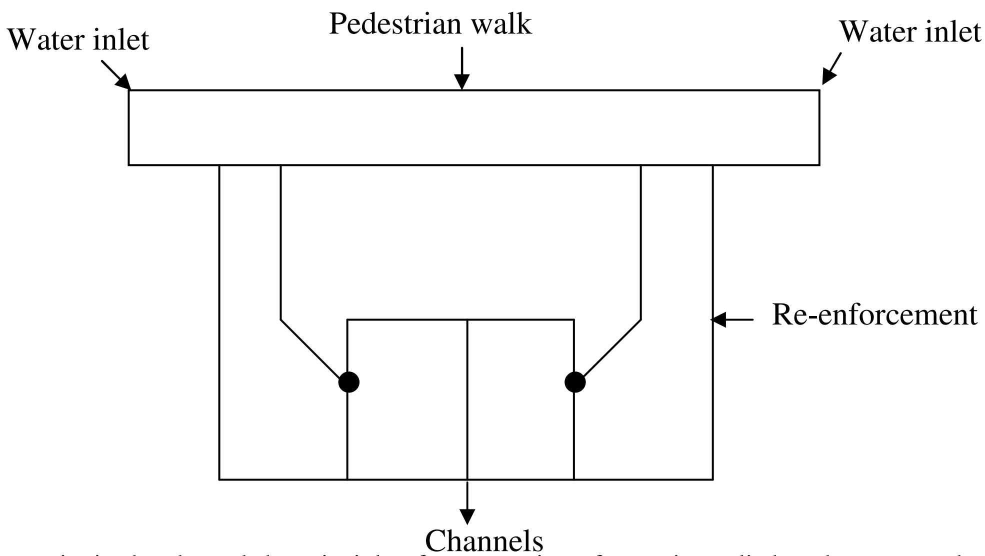
eradicate flood it is still the most prevalent and most devastating disease in the tropics(UNICEF 2004).
Glanahan etal(2007) discovered that economic activities and urban development often increases the environmental pressure that leads to flooding and slums. Coming back home specifically to the area under study. Benin city fortunately is blessed with natural moat that acts as receptacles to flood but linkages hitherto present has been demolished or blocked as a result of human activities.

2.00. METHODOLOGY

This research is approached from two main perspective vis-à-vis data collection and data analysis.
Data collection was carried out in phases. by first visitation to the areas of study .i.e Areas like Queen–ede gully erosion sites located at Ikpoba hill area of Benin city, Third east circular gully erosion site upper mission road extension uselu tom line area ,Egor area etc.Visit was also paid to the Ministries of environment and public utilities in order to get firsthand data on previous environmental hazards as well as how they were handled .Others include Visitation and interaction with officials of construction sites, Benin city master plan which is the area under study was also looked at.

2.10. DATA ANALYSIS

Analysis was carried out on flood control, maps and various indications were observed. Fig 1.0, shows the flood control map done on Uwelu west and Uwelu East in the Benin metropolis carried out by Hi-Tech Construction Company designed by Aurecon.
The project description is to study and design of flood erosion control structures and associated road workers in Benin City.
In the diagram, the arrows show the direction of flows of flood with indication that drainage while the one flowing backward is an already existing drainage. It is observed from the map that the channels are constructed in a directing from a high topography to a very low topography leading to the streams or rivers.
Sub-catchment boundaries are observed these boundaries show the minor rivers leading to the catchment boundaries which are Ikpoba and Ogba River. Proposed detention ponds on new drainage system are sited at various points to accommodated flood waters from streets and minor roads leading to the main channel which directs the water to the stream.
It is important to observe those historical moats at various areas within the metropolis and then ensure that the volume and speed of water moving through or passing along the moats is reduced to the minimum in order to prevent it from excavating into larger gully erosion spots like the queen Ede gully erosion in Ikpoba hill, Benin City.
It is also important to ensure and observe that all floodwater from streets and road should be directed towards the power lines canal or box culvert, and the flows along the produces canal through an existing channel or a proposed new channel to the stilling basin such as the near-by Rivers or streams.
Fig 2.1.1: A CULVERT CHANNEL



If steady flow exist in the channel the principle of conservation of mass is applied to the system, there exist a continuity of flow defined as the mean velocity of all cross section having equal areas are then equal and if the area are not equal the velocity are inversely proportional to the area of the respective cross section.

This continuity equation is given by

Q = A1V1 = A2V2

Where

Q = The volumetric flow rate A = Cross sectional area of flow

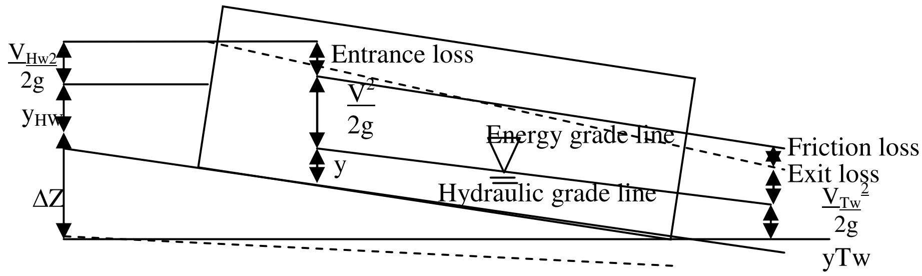
V = the main velocity

2.12. THE CULVERT

Culverts have been utilized for thousands of years as a means to transmit water under walkways or roads. Often, a culverts is simply installed without much thought to how much water it need to convey under extreme condition if a culvert cannot convey all of the incoming water, then the water will flow over or around the pipe, or simply back up behind the culvert. Culvert creating a pond or reservoir. If any of these conditions are unacceptable. Then the proper culvert diameter and number of culverts must be selected prior to installation in order to convey all of the anticipated water through the pipe(s). This calculation helps the designer size culverts as well as present a headwater depth Vs discharge rating curve.

The LMNO Engineering calculation is primarily based on the methodology presented in hydraulic Design of Highway culverts by Normann (1985) and published by the Department of Transportation's Federal Highway Administration. It is also known as HDS-5 (Hydraulic Design series NO. 5). HDS-5 focuses on culvert design. Culvert design is usually based on the maximum acceptable discharge = thus the HDS-5 methodology is geared toward culvert in addition to programming the HDS-5 methodology. LMND Engineering wished to computer headwater depths for lesser flows. Therefore in addition to the HDS-5 methodology. In the HDS-5 methodology the tail depth (yE) must be known before it is used.

Fig 2.22: CULVERT HYDRAULIC CALCULATIONS



The hydraulic calculations from the culvert outlet to the culvert headwater immediately upstream of the inlet are based on the conservation of energy and mass.

This is described in the basic energy balance equation :

$$YHW + \frac{VHW2}{2g} + \Delta Z = YTW + \frac{VTW2}{2g} + Yfriction\ loss + Yentrance\ loss + YExis\ loss$$

Where

Y = Depth (ft, m)

V = Velocity (ft/s, m/s)

ΔZ = Change in elevation (ft, m)

TW = Tail water

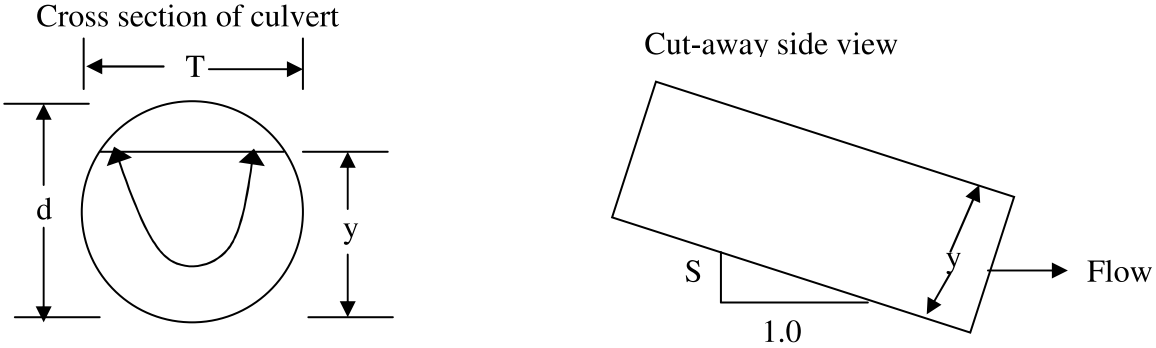
HW = Head water

g = Acceleration due to gravity (ft/s2)

In most cases the approach velocity (VHW) is low and the approach velocity head is neglected. Similarly, the exit velocity can be neglected in the energy equation if the upstream and downstream channels are similar, reducing and energy equation to:

$$YHW + \Delta Z = yTW + yfriction\ loss + yentrance\ loss + yExis\ loss$$

Fig 2.23: CIRCULAR CULVERT USING MANNING EQUATION



Q = VA, V = K R2/3S1/2, R = A, A = d2(Q-sin(θ))

N P g

P = θd , y = d [1-cos(θ)], T = 2 y(d-y)
2 2 2

F = V T
gAcos(Tan-1s)

VARIABLES

A = Flow cross- sectional area, determined normal (Perpendicular) to the bottom surface [L2]
d = Culvert diameter [L]
F = Froude number. F is a non-dimensional Parameter indicating the relative effect of inertial effects to gravity effects. Flow with F<1 are high velocity flow called supercritical. Subcritical flows are controlled by downstream obstructions while supercritical flows are affected by upstream controls. F = 1 flows are called critical.
g = acceleration due to gravity = 32.174ft/s2 = 9.8066m/s2. g is used in the equation for Froude number.
K = Unit conversion factor = 1.49 IF English units
= 1.0 if metric units. Our software converts all inputs to S.I units (meters and seconds), performs the computations using K = 1.0, then converts the computed quantities to units specified by the user.
n = manning coefficient. N is a function of the culvert material, such as plastic, concrete, brick etc.
P = Wetted perimeter [L]. P is the contact length (in the cross-section) between the water and the culvert.
Q = Discharge or flow rate [L3/T]
R = Hydraulic radius of the flow cross-section [L]
S = Slope of channel bottom or water surface [L/L]
Vertical distance divided by horizontal distance
T = Top width of the following water [L]
V = Average velocity of the water [L/T]
y = Water depth measured normal (perpendicular) to the bottom of the culvert [L]. if the culvert has a small slope (s), then entering the vertical depth introduces only minimal error.
θ = Angle representing how full the culvert is [radians]. A culvert with θ = 0 radians (00) contains no water, a culvert with θ = pi radians (1800) is half full, and a culvert with θ = 2 pi radians (3600) is completely full.

Fig 2.24: CULVERT DESIGN INLET AND OUTLET CONTROL FLOW THROUGH CULVERTS AND ROAD OR DAM

Diagram of flow through a culvert

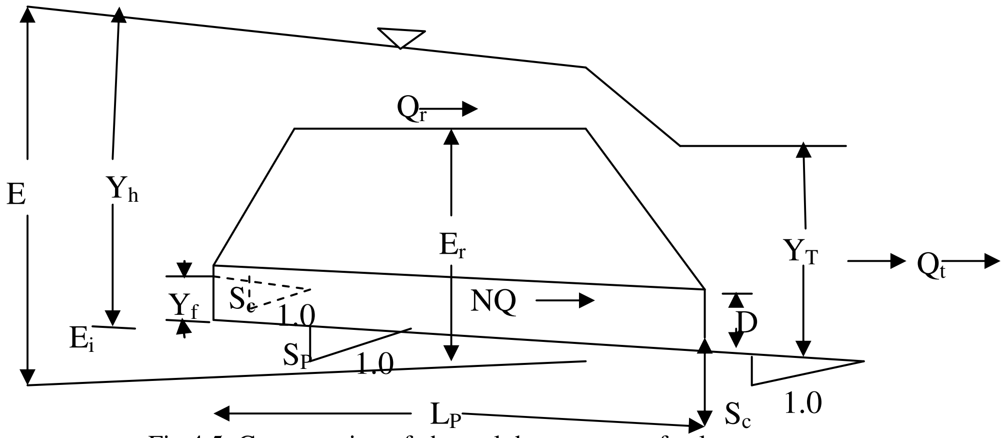
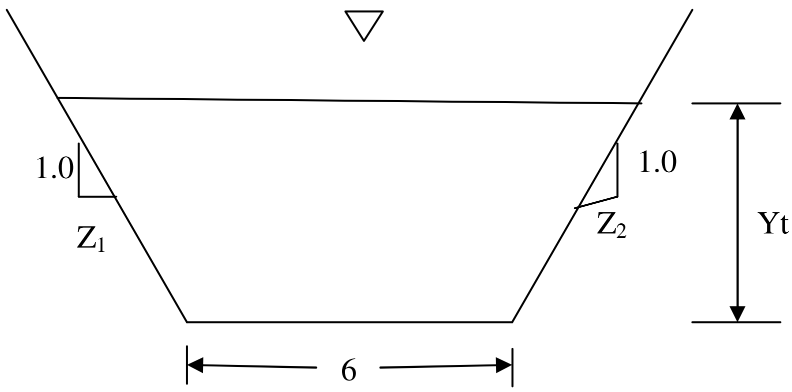


Fig 4.5: Cross-section of channel downstream of culvert



Demonstration mode for 0.9m < D<1.1m and N<3
(D is pipe diameter, N is number of pipes)

2.4.6 CULVERT TYPES

"Conc. Sq edge wall" = concrete pipe with square edge inlet and head wall.
"Conc. Groove. Wall" = concrete pipe with groove end at inlet and head wall.
"Conc. Groove proj" = Concrete pipe with groove end at inlet and head wall.
"Conc. Groove proj" = Concrete pipe with groove end at inlet projecting at inlet.
"CMP Head wall" = corrugated metal pipe with head wall at inlet.
"CMP. Mitered" = corrugated metal pipe projecting at inlet.

Tail water depth (Yt) can be entered as negative number, if flow from the culvert drops down to a receiving channel. It is not necessary to know the exact elevation drop, entering any negative number of Yt which have the same effect.

The phase "inlet control" or "outlet control" that appears in the upper right hand corner of the calculated upper left hand corner.

GUTTER DESIGN

EAVES GUTTERS

Flow capacities for individual shapes and lengths for gutters, outlet sizes and down pipe arrangements can be calculated by designers. As eaves gutters are outside the building envelope, the design is less critical than for a valley, hip, parapet or boundary wall gutter. For this reason freeboards (excess capacity) is not usually calculated in eaves gutter design.

3.00 .DISCUSSION

Flooding in Benin City are causes by some environmental causes like heavy rainfall, lack of adequate town planning techniques, poor drainage system, high level of illiteracy, ignorance of dumping refuse on flood paths etc. These environmental causes can cause damages to infrastructures, plants and can result in loss of lives and death of farm animals.

The environmental effects of flood in Benin City Metropolis have many impacts such as rapid water runoff which causes soil erosion and deposit sediments elsewhere such as further downstream or down a coast. Flood can interfere with drainages and economic use of lands such as interfering with farming causes reduced in produce besides structural damages which can occur in bridges, roads, and other structures within floodways.

The type of erosion associated with Benin Metropolis is gully and sheet erosion but gully erosion is more common due to the landscape of the Benin metropolis.

The environmental impact of flood waters covering much region in Nigeria most especially the Benin metropolis is now becoming on the increase, which is now become a slogan to be mounted if not to be executed because mosquitoes are often a concern after a flood event but thankfully they have not become a major problem yet.

Despite the destructive effect of flooding, floods can also bring many benefits such as recharging ground water, making soil more fertile and increasing nutrients in some soils.

3.1.1 CONCLUSION

The availability of accurate methods for flood frequency estimation is an important part of optimal design and operation of hydraulic infrastructure (dams, levee's, flood alleviation channels, culverts etc).

Thus, improved methods that allowed assessment of the effect of environmental change are important components in flood risk management and the improved advice is likely to reduce the expected annual flood damage in Benin city through better preparedness and flood management.

The new knowledge on the predictive powered of numerous methods have contribute to the openness of consultants to be more competitive in Benin City region in Edo State.

3.1.2 RECOMMENDATION

This study recommends that good road construction works, controlled dump sites and quick response of the ministries in charge of flooding to flooding menace which should be carried out as a matter of urgency to tackle the environmental impact of flooding in the Benin metropolis. This study also recommends that effective laws should be enacted to prohibit illegal disposal of refuses on drainage channels and building of houses on stream channels or flood paths should be prohibited also as an appropriate measure should be put in place to check it.

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Figure 10 : map of Benin Metropolis showing Uwelu East and Uwelu west

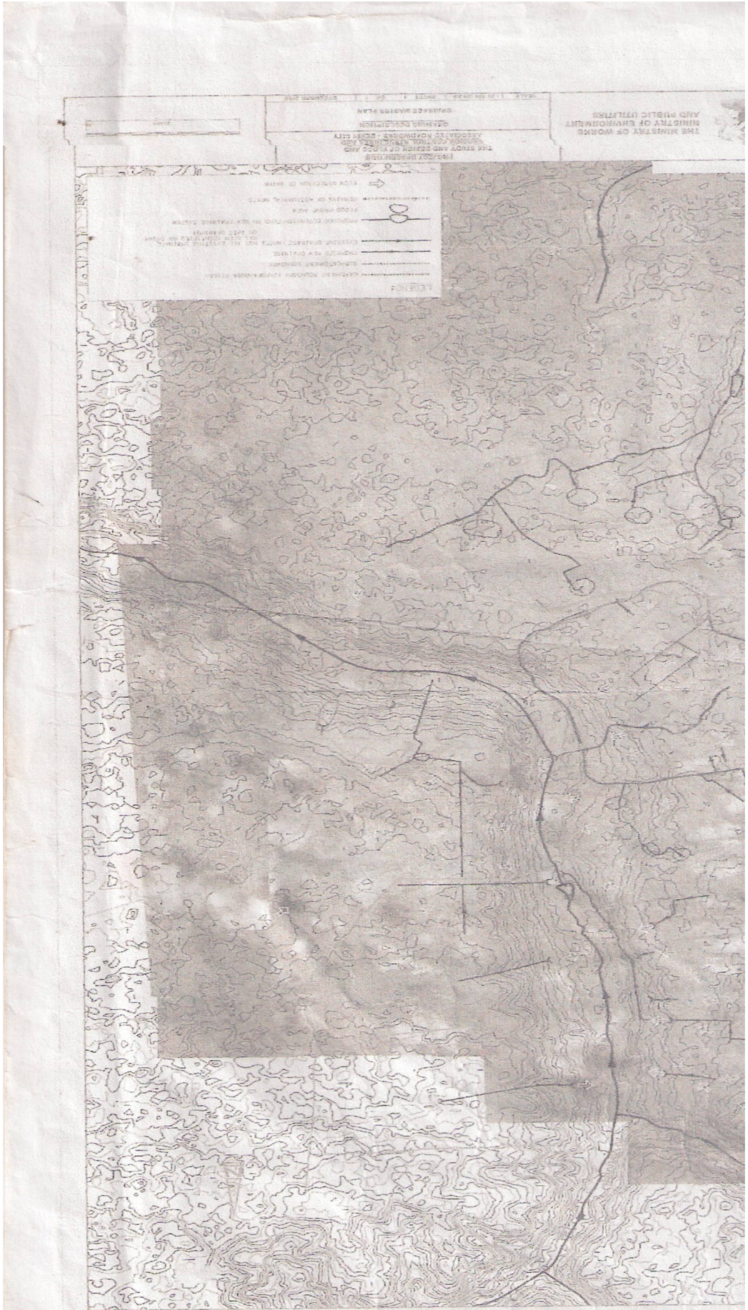

Fig. 4.0