Global Journal of Science Frontier Research: H
Environment & Earth Science
Volume 15 Issue 2 Version 1.0 Year 2015
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Effects of Flood on Infrastructural Development in Uyo Metropolis, Akwa Ibom State, Nigeria

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GJSFR-H Classification : *FOR Code: 960699*

Strictly as per the compliance and regulations of :

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I. Introduction

Flood is the overflow of water into an environment that is normally dry thereby causing inundation and harm to plants and animals, including man. Its harm can be extended to man's buildings and infrastructures (Udosen, 2011). Most flood definitions include damage they cause and depend on their sources or types and magnitude. In the case of flood resulting from rivers, Ating (2003) defines it as a relatively high flow which overtakes the natural channels provided for run–off as well as a high stream which overtops its natural or artificial banks.

Wolf (1965) also describes flood as high rate of discharge in water sources and the inundation of normally dry lands. West (1991) further states that flood is a body of water which rises to overflow its banks or low- lying areas. All over the world, flood is known to cause great damage to people's lives, belongings and properties. Flood causes one third of deaths, one third of all injuries and one third of all damage from natural disasters (Askew, 1999 and Etuonovbe, 2011). This damage is normally felt by various "receptors" being people, buildings, infrastructure, agriculture, and open recreational spaces.

Even social and emotional costs from flooding are significant and are often widespread and indiscriminate in flooded areas. They include : displacement from homes, loss of personal valuables, fear and insecurity caused by such experience. The economy can be serially affected by flooding as businesses may lose patronage, stock, data and productivity. Tourism, farming and livestock can equally be affected.

Utilities and transport infrastructure can be rendered inefficient by flood. Portable water supplies may be contaminated in a flood which has immediate health effects upon human beings and animals. Other vital infrastructures may also be damaged just like the loss of electricity experienced in Britain in 2007 summer floods (RIBA, 2009).

Even in a developed country such as the United Kingdom, the Association of British Insurers has estimated the cost of the July, 2007 flooding, in insurance claims alone at over 3 billion pounds (RIBA, 2011). The pattern of flooding is similar in all parts of the world. In Nigeria for instance, flooding has forced millions of people out from their homes, destroyed businesses, polluted water sources, and increased the risk of diseases (Baiye, 1988, Akinyemi, 1990, Nwaubani, 1991 and Edward- Adebiyi, 1997).

a) Sources of flooding

Generally, there are six recognized sources of flooding namely: tidal flooding, fluvial flooding, ground water, pluvial flooding, flooding from sewers and flooding from man – made infrastructure.

- *Tidal Flooding*

  Sea and river defenses may be overtopped by a combination of low pressure weather systems and high tides. Its duration is limited by the cycle of the tides where drainage is available.

- *Fluvial Flooding*

  When rainfall or snow occurs in rivers, the capacity is exceeded and as a result, there is a rising water level which can in turn overflow into the floodplains close to the river.

- *Ground Water*

  As ground water levels rise, low lying area sitting over aquifers may flood. This type of flood is mainly seasonal and slow.

- *Pluvial Flood*

  This refers to surface water from rainwater – run-off mainly from urban or rural land that has low absorbency. As developments increase in urban areas, land surfaces increase in their areas of non-permeable surfaces and

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combines into intense rainfall which gives rise to localized flooding.

- *Flooding from Sewers*

  This occurs where there are faulty sewers or where sewage capacity is exceeded normally due to large surface water runoff over a short time.

- *Flooding from Man – made Infrastructure*

  This occurs when man-made structures like canals and reservoirs fail resulting in flooding areas downstream (RIBA 1999).

b) Causes of flood

The main thrust of this study has been to assess the immediate and remote causes of frequent flooding in Uyo metropolis. It was to determine which of these causes may be more responsible for the recent incidences of flooding in Uyo city. To be able to do this successfully, a number of physical flood characteristics were evaluated. These critical physical characteristics include:

a) depth of water
b) duration of inundation
c) area of inundation
d) velocity of flow
e) frequency – recurrence relations
f) flong time (Flood time lapse or flood-to-peak interval)
g) Seasonality
h) peak flood
i) rate of discharge increase and decline.
j) sediment load and
k) total flood run-off volume.

II. Research Methodology

The research design used for this study is descriptive. It is based on data already available in addition to responses from structured interviews from respondents who have experienced this malady. It was also based on current data that expose methods adopted by architects in solving flood problems in Uyo metropolis. It stems from the needs of a co-relational study of the effect of flood on architectural developments in Uyo metropolis.

a) The Study Area

The area of study is Uyo metropolis. This metropolis is situated in Uyo Local Government Area. It is highly urbanized, virtually all parts of Uyo lie within the Capital City Development Area (UCCDA) except Ikono clan. Uyo Local Government Area is bordered to the north by Itu, Ikono and Ibiono Ibom Local Government Areas, to the south, by Etinan, Nsit Ibom and Ibesikpo Asutan Local Government Areas, to the east by Uruan which stretches from north – east around Ibiaku Uruan to Ndon Uruan in south eastern corner. It is located between latitudes 4^0 53' and 5^0 04' north of the equator and longitudes 7^0 48' and 8^0 02' east of the Greenwich Meridian (Fig. 1). The total estimated population based on 2006 Population Census is 273,000 persons. While ecological problems cannot be directly linked to population pressure, steep marginal lands around Uyo metropolis which should otherwise be conserved, are developed due to increased need for sites for housing and other architectural developments apart from cultivation. The consequences of this practice are well known.

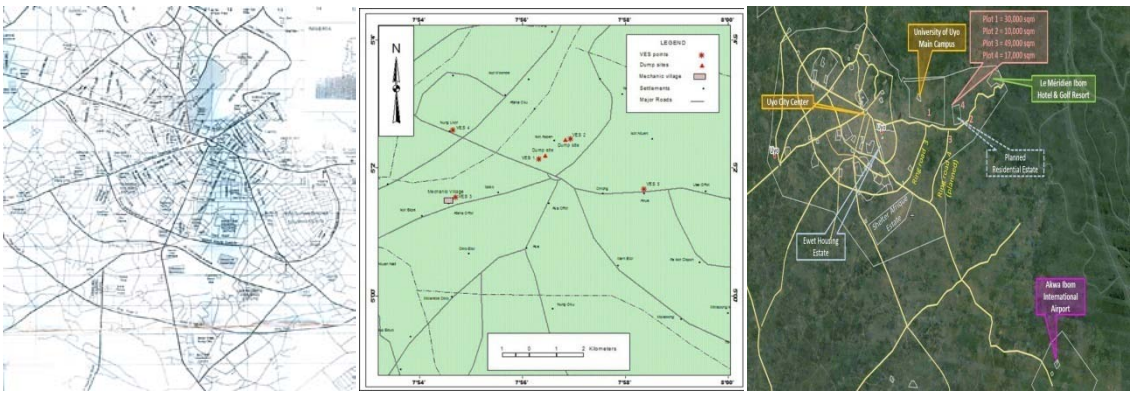

Fig. 1 : Uyo City

III. Flood in Uyo

Flood in Uyo is generally caused by rains. Other factors that cause flood include; the size of the land area from where rainfall is collected, the shape of this area, its average slope along the main channel through which the rain water is led to the site, the rate of urbanization, soil type, moisture content of soil, land use and similar factors, all contribute to the relative magnitude of floods in the metropolis.

The catchment areas or watersheds that collect rainwater to the drainage system are a great factor to be considered when assessing the effects of floods. Most flood problems in Uyo metropolis are associated with depressions in the undulating plains. For example, flood prone depressions include Abak road/Nkemba area,

Udo Eduok Street, middle of Nsentip Street, Port Harcourt street, Ikot Ekpene road (near former AKTC) and Ewet/Uruan street. (Fig. 2).

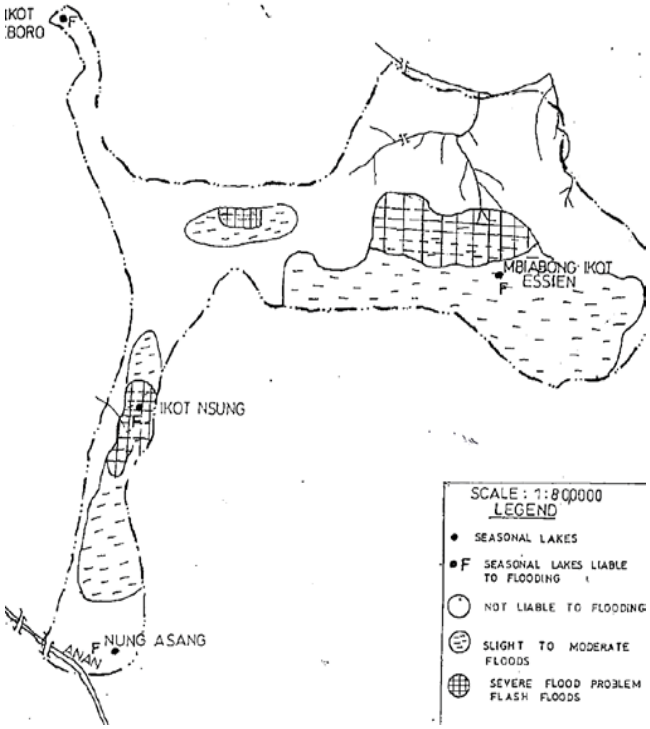

Fig. 2 : Flood Susceptibility Map of Uyo (Source: Field Study 2014)

According to (Udosen, 2011) eight critical flood prone areas are prevalent in Uyo metropolis. Six out of the eight areas were used as sample, that is, clusters of buildings around these flood prone areas are selected randomly for study. Five buildings from each of the six areas were duly selected from the sample. The sample size was thirty.

IV. Presentation and Analysis of Data

It was found out that the prevalent methods used in mitigating flood in these areas include: raised floor levels; the use of drainage to ward off flood water from buildings and the use of soft landscape features like shrubs. It was also observed, however, that most buildings were constructed before the actual resultant flood consequences were experienced. This led to the flood mitigation practices, being mainly rehabilitation and/or reconstruction work around these buildings as mentioned above. Apart from a general description of data collected in the field, an attempt was made to quantify the methods adopted in solving the problems of flood in Uyo metropolis. Among these methods are:

a) Provision of Drains

In all the six flood areas, the open v-shaped drains are used especially as street drains; covered drains are, however, used in some buildings at Ewet/Uruan street flood areas, which are also seen connected from compounds to the street drains (Plate 1).

Plate 1: New Drain channels under construction at Uruan Street

Source: Researchers' field work (2013)

Table 1 : Measurement of Street Drains (Gutters) In Uyo Metropolis

Flood area	Dimensions of drain (width x height)
Abak road/Nkemba street Udo Eduok flood area	750mm x 1200mm 600mm x 600mm
Ikot Ekpene Road (near former AKTC) flood area	75omm x 900mm
Ewet/Uruan Street flood area	600mm x 750mm
Middle of Nsentip street flood area	600mm x 600mm
Ibom Plaza	750mm x 900mm

Source : Researchers' field work (2013)

The Ikot Ekpene road (near former AKTC) and Uruan street drains are channeled to a covered cesspool and soak away pit. These pools trap water in order to control its percolation into the earth after heavy of rain. Many of the drains need removal of sand from drain, to help the water flow quickly from these flood areas.

b) Use of Vegetation in Flood Mitigation:

Out of the flood areas under study, vegetation is notably used for erosion control purposes in the middle of Nsentip flood area. This vegetation (ornamental plants) is used to support the fence walls (Plate 2).

Plate 2 : Flood Control at Nsentip street flood area.z

Source: Researchers' field work (2013)

c) Raised Flood Levels and Half Walls in Building Verandahs

As illustrated in Plate 3, most buildings have 125mm ground floor levels above the natural and assumed ground level. This implies that the foundation foot is approximately 450mm from the natural ground level. It was discovered that dwarf walls of various heights were introduced to stop flood water that exceeded the ground floor levels of these buildings.

These dwarf walls were seen mainly on building entrances constructed to keep flood water from entering into the enclosures. The table 2 below shows the heights and description of dwarf walls in five (5) buildings in each of the identified flood areas. The buildings were chosen using simple random sampling method.

Plate 3: Sunken compound at Nsentip Street flood area

Source: Researchers' field work (2013)

Table 2 : Height of Fence in Abak Road/Nkemba Street Flood Area

S/no	Height of fence	Wall type	Building use
1	225mm	Concrete block wall with plastering	Shops (commercial)

2	225mm	Concrete block wall with plastering	Shops
3	450mm	Concrete Screed	Residential
4	675mm	Concrete block wall with plastering	Shops (commercial)
5	675mm	Concrete Screed	Residential

Source : Researchers' field work, 2013

The highest flood level in the area was seen at the Nkemba street/Abak road junction. Through flood, water is trapped in the junction and as a result, people are seen washing their vehicles using the flood water, the opposite buildings to the Nkemba Street at the junction are sunken below the road level, especially in the premises of the Church of Christ, Afaha Inang (Plate 4).

Plate 4 : Flooded Abak Road by Nkemba Junction

Source: Researchers' field work (2013)

Table 3 : Height of Fence in Udo Eduok Street Flood Area

S/no	Height of fence	Wall type	Building use
1	450mm	Concrete block wall	Shops (commercial)
2	450mm	Concrete block wall	Residential
3	675mm	Reinforced concrete	Commercial
4	450mm	Concrete block wall	Residential
5	150mm	Concrete block wall	Residential

Source : Researchers' field work, 2013

In Udo Eduok street flood area, residents have fence walls to keep water from entering their compounds. Vehicles were seen packed outside these compounds due to challenges of driving them above these fences into the compounds. (Plate 3).

In Nsentip Street flood area, tall fence walls replace the dwarf walls found in other flood areas. The fence walls are 450mm high above the road surface. As a result of this, the wall is 900mm higher than the ground floor of the building. Vehicles are also parked on the road. (Table 4).

Table 4 : Height of Fence in The Middle of Nsentip Street Flood Area

S/no	Height of fence	Wall type	Building use
1	450mm	Concrete block wall	Commercial
2	300mm	Concrete block wall	Commercial
3	900mm	Reinforced concrete wall	Residential
4	675mm	Reinforced concrete wall	Residential
5	450mm	Concrete block wall	Residential

Source : Researchers' field work, 2013

In Ikot Ekpene road (near former AKTC) flood area, few buildings make use of dwarf walls, most buildings make use of sloppy finished floor levels (ramps) as well as reinforced concrete fences. Fences are normally reinforced to act as retaining walls and also to prevent the flood water from seeping through the fence wall but with openings channeled to the cesspool(s).

Table 5 : Height of Fence In Ikot Ekpene Road (near former AKTC) Flood Area

S/no	Height of fence	Type of wall	Building use
1	150mm	Concrete block wall	Office
2	300mm	Concrete block wall	Commercial
3	225mm	Concrete block wall	Commercial
4	225mm	Concrete block wall	Residential
5	450mm	Concrete block wall	Residential

Source: Researchers' field work, 2013

Table 6 : Height of Fence in Ewet – Uruan Street Flood Area

S/no	Height of fence	Type of wall	Building use
1	No half wall	450mm ((raised floor level)	Residential
2	175mm	Concrete block wall	Commercial
3	450mm (raised floor level)	Concrete block wall	Commercial
4	250mm	Concrete block wall	Commercial
5	200mm	Concrete block wall	Commercial

Source: Researchers' field work, 2013

Apart from buildings in Ewet/Uruan Street flood area having dwarf walls and raised floor levels, it was noticed that most of the residential buildings were well-built and away from the flood area as well. The reason might have been to mitigate flood. Another reason might have been that these residential buildings needed to be away from the usually busy and noisy commercial Uruan street. In addition to these measures, the verandahs were tiled to prevent water from seeping into the interior, especially through the floor from the foundation. (see Table 6)

The Ibom Connection or Plaza is also listed as a flooded area (Udosen, 1999). Before 2003, it was normally flooded especially after heavy rainfall. The development in the plaza was, however, because of its historical significance, being the point of the former "Independence Square" or "Circus" where the British Union Flag was finally lowered after Nigeria gained her independence. But, the effect of flood on this development can be summarized in its coordinated flood control measures as seen in the underground flood drains and sloppy interlocking stone floors (See plates 5 and 6).

Plate 5 : Underground drains at Ibom Plaza

Source: Researchers' field work (2013)

Plate 6 : Landscaped Ibom Plaza including stone floors

Source: Researchers' field work (2013)

The sloppy nature of the finished floors aids in draining run-off water to the drains. The Ibom Plaza is a resort that hosts facilities such as shopping malls, business centres, parking lots, games centre, eateries and a gothic Greco-Roman model of a sitting area or amphitheatre with luminous fountains and a giant elevated screen beamed through satellite.

V. Discussion of Results

Two methods used in mitigating flood were identified in flood areas in Uyo metropolis namely:

» Raised floor levels or raised dwarf walls.

» Use of drains in the built environment.

Out of the afore mentioned, raised floor levels or raised dwarf walls is the most used since all the six flooded areas studied in the metropolis have raised flood/dwarf walls.

The purpose of a raised floor is to keep the flood water from moving into the building. It is however perceived that the dwarf walls used in place of the raised floor level are less expensive since it takes fewer materials to construct.

From the findings, it could be deduced also that the highest dwarf walls used in each flooded area are, 675mm, 900mm, 450mm, 150mm (highest dwarf wall used is in Ibom Plaza). This implies that the highest dwarf wall used is 900mm.

The average dwarf wall used in Uyo metropolis calculated from the research data gotten is as follows:

$$(225 + 225 + 450 + 675 + 675 + 450 + 450 + 675 + 450 + 150 + 450 + 300 + 900 + 675 + 450 + 150 + 300 + 225 + 225 + 450 + 450 + 175 + 450 + 250 + 200 +) \div 5 = 10{,}075 \div 25 = 403 \text{ mm}.$$

This implies that an average of 403 mm half wall or raised floor level is used to keep flood away from entering into building(s) in Uyo metropolis. However, a range of 175mm – 900mm high dwarf walls are used in these flood areas as deduced from the research data.

It can be said that the volume of water that would have wrecked havoc in a particular area can be calculated by the volume of water the street drains from that area. This means that the height of a dwarf wall or

raised floor level is directly proportional to the volume of street drain found in an area.

VI. Conclusion and Recommendations

In flood prone areas in Nigeria, it is best to study the probable effects of flood in an area before designing and constructing any building. The havoc of flood that would be averted by doing this is immeasurable.

a) Conclusions drawn from findings

The nature of flooding in Uyo metropolis has transformed the building patterns in the metropolis. New buildings that took flood issues into consideration are clearly seen to be using these architectural characters. An average of 403mm half walls is used to keep away flood water. The materials used for construction is mainly sandcrete blocks walls. These are reinforced in some cases while some are constructed as retaining walls depending on how much flood water is present in the vicinity. A unique architectural composition of a public space with attention to flood control in Uyo is as seen in Ibom plaza, where all the methods mentioned above are used. This is a clear effect of flood on the architecture of Ibom Plaza flooded area.

b) Recommendations

From the foregoing therefore, the following recommendations are made to be able to alleviate the colossal damage caused by flood on infrastructural development in Uyo metropolis:

- flood mitigating strategies should be encouraged by both government and private developers.
- the Planning Authorities should establish and monitor effective integrated drain patterns in the entire metropolis.
- development control department should ensure that buildings are not erected on high risk flood areas.
- architects and other stakeholders should upgrade their designs strategies, especially if buildings are to be sited on flood pone areas.
- building construction should be properly supervised specifically if designed to tackle flood issues in an area.

It is therefore our belief that if the recommendations made in this study are adopted or adhered to, they will go a long way to militate against the damaging effects of flood on infrastructural development in Uyo metropolis.

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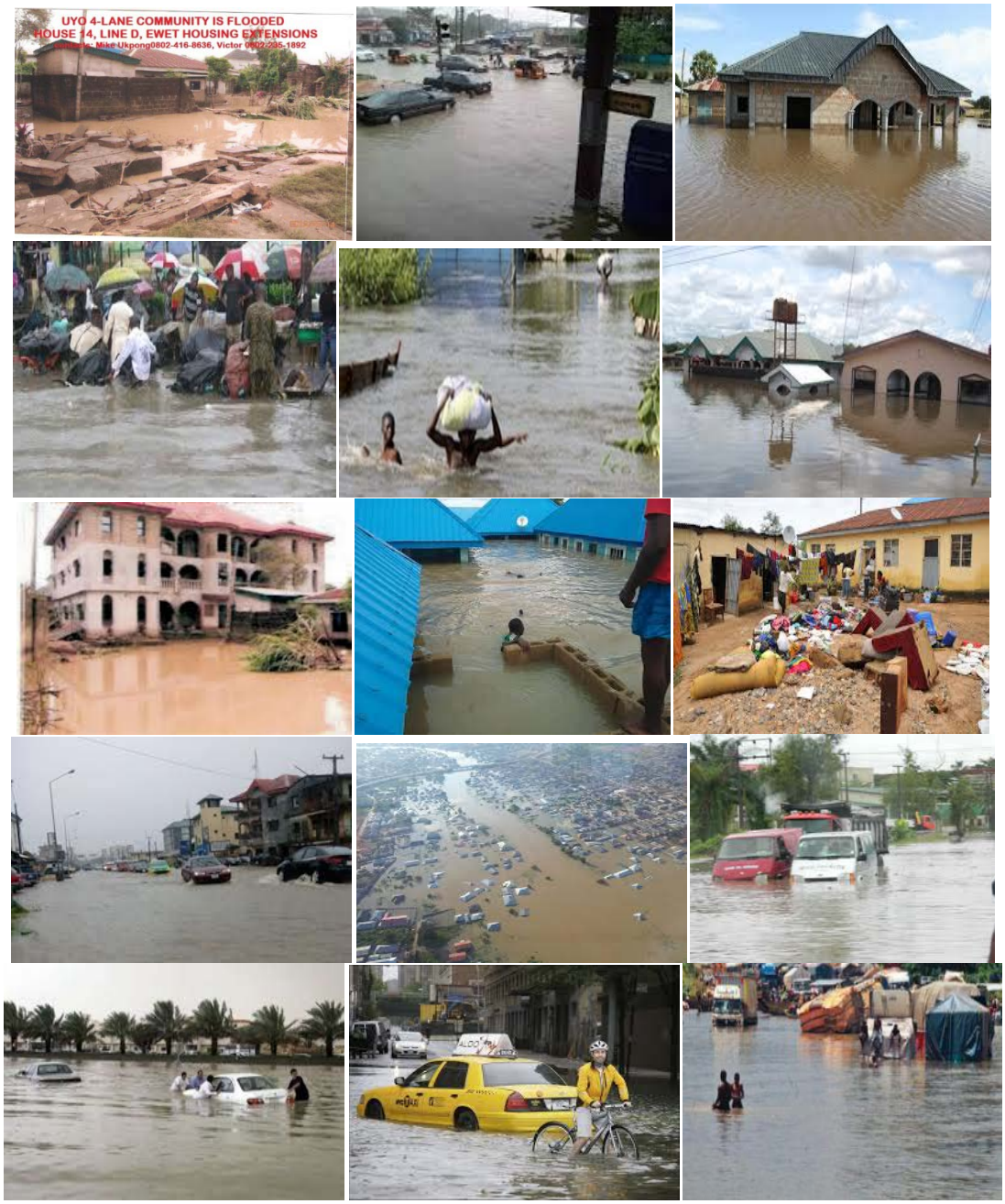

Plate 7 : Examples of Flooding in Uyo Metropolis

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