*THE INTERNATIONAL JOURNAL OF SCIENCE & TECHNOLEDGE*

# Tracing Ecological Disasters through Poor Planning of Infrastructure for Housing Developments: The Ikot Nkebre Episode in Calabar, Nigeria

**Itam, Ekpenyong Bassey**
Lecturer, Department of Architecture, Cross River University of Technology, CRUTECH, Calabar, Nigeria
**Ukorebi, Ukorebi Asuquo**
Lecturer, Department of Architecture, Cross River University of Technology, CRUTECH, Calabar, Nigeria
**Yaro, Margaret Abba**
Lecturer, Department of Urban & Regional Planning, Cross River University of Technology, CRUTECH, Calabar, Nigeria
**Ita, Ekpe Esien**
Lecturer, Department of Civil Engineering, Cross River University of Technology, CRUTECH, Calabar, Nigeria
**Ugbong, Innocent Akwazi**
Lecturer, Department of Urban and Regional Planning, Cross River University of Technology, CRUTECH, Calabar, Nigeria
**Ipia, Oka Bassey**
Lecturer, Department of Estate Management, Cross River University of Technology, CRUTECH, Calabar, Nigeria
**Ekeng, Patricia. Orok**
Technologist, Department of Architecture, Cross River University of Technology, CRUTECH, Calabar, Nigeria

***Abstract:***
*Land-use changes from peri-urban agricultural settlements into urban residential communities have become prevalent in Calabar (Nigeria) over the last few decades. This trend has evolved as a response to the rapid population growth and the concomitant urbanization pressures, which have continued to induce phenomenal dimensions of urban growth in the city, since the last quarter of the 20th century. Faced with escalating land prices in the inner residential sectors of the city, many residents of the city are compelled to embrace these options that offer them the opportunities of acquisition of housing plots not too far from the city centre. One of the agricultural settlements, in which such conversions have recently taken place in Calabar, is Ikot Nkebre. Studies that have been conducted on Ikot Nkebre in this research project have shown that these conversions have not always been based on sound professional judgments or practices. In the present instance it was discovered that the layout plans used for the development of the urban residential community lacked essential professional details, such as the preliminary layouts of essential urban infrastructures (namely roads and stormwater drainage programmes). In the processes of poorly coordinated housing and urban infrastructural developments at Ikot Nkebre, stormwater was discharged without necessary precautions on agricultural and forest lands; and this has turned Ikot Nkebre into one of the gravest ecological disaster sites of Calabar in the present day. Massive destruction of lands that could have been useful for urban agriculture has also been observed. In conclusion, it has been shown that conversions of peri-urban agricultural settlements into urban residential communities could result in serious ecological consequences; unless the processes are properly subjected to sound professional guidance.*

***Keywords:*** *Land-use changes / urban infrastructures / sound professional guidance / ecological consequences*

## 1. Introduction

Calabar in Nigeria occupies a very peculiar geographical location. It is bounded on three sides by water bodies, which severely constrain urban growth in those directions. On the east there is the Great Kwa River with its wetlands; the Calabar River together with its wetlands occupies the western boundaries while a very large expanse of mangrove swamp wetlands separates the city from the estuary situated at the south (see Figure1). The only outlet left for the city to contain its rapid population growth and rapid urbanization is in the direction of the north (Efiong, 2011). In Nigeria, in general, a major constraint to sustainable urbanization is "the obsolescence and weakness of the existing planning tools" (Okosun, Ndukwu and Chiemelu, 2010). On account of these specific deficiencies, urban development is very often not well ordered in many of the country's emerging cities. Under situations of intense urbanization pressures, it does happen that new residential communities spring up with rapid advancements in housing development; while government agencies are forced into playing catch-up roles in providing roads and other forms of essential urban and social infrastructure (Nebel, and Wright, 2000). All these have added up to make sustainable urbanization a very difficult target to attain in present-day Calabar.

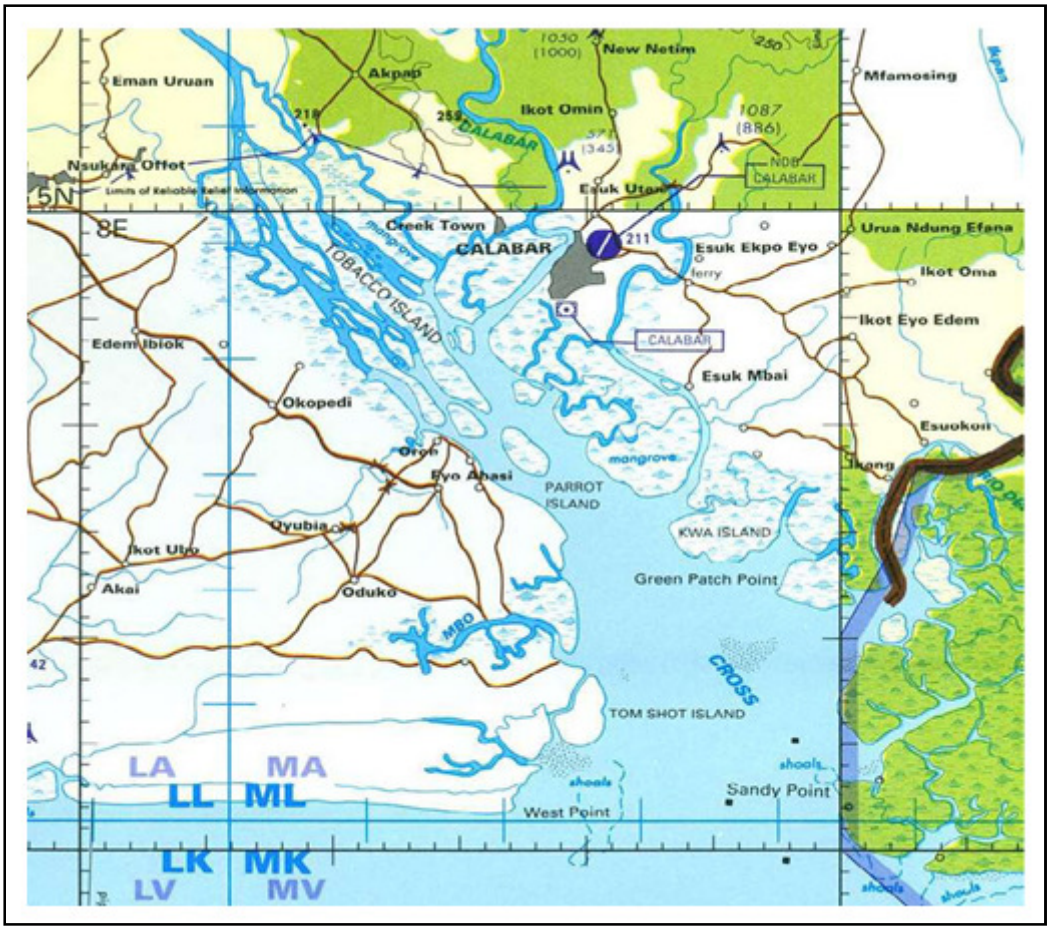


*Figure1: Calabar, capital city of Cross River State in Nigeria (as compiled in April 1995)*
*Source - URL: http://www.lib.utexas.edu/maps/africa/calabar_tpc_1996.jpg Retrieved: March 14, 2015*

Calabar is the capital city of Cross River State of Nigeria; one of the 36 states that, together with the Federal Capital Territory of Abuja, constitute the Federal Republic of Nigeria. It was first named a state capital in 1967. This followed the political dispensation that took place on the 27th May 1967, by which Nigeria was transformed from a federal republic consisting of 4 regions into one made up of 12 states. To Calabar, this dispensation actually turned out to mean the transformation of an ancient provincial town into a conurbation that would be under very intense pressure to expand, in the aspiration to fulfill its new role as a capital city. Thus, like all other major Nigerian cities, Calabar has been undergoing dramatic transformations in its urban structure over the last four and a half decades, beginning from the early 1970s.

Located at latitude 04.58 degrees north of the Equator and longitude 08.20 degrees east of the Greenwich Meridian (see Figure 1), Calabar has a typical subequatorial climate. This climatic type is characterized by very heavy rainfalls. The annual average precipitation for Calabar is about 300mm. Much of this rainfall is recorded within the four months spanning from June to September. The average rainfall for this period is about 405mm: June (390), July (440), August (390), September (400). During these months, on the monthly average, the volume of rainwater that pours over a parcel of land measuring 1 hectare in this city amounts to 100 x100 x 0.41 (0.41 x $10^4$) cubic metres; i.e. 4,100 cubic metres of water. If, on account of increasing imperviousness that follows unplanned urbanization, much of this water is permitted to remain on the surface as stormwater, then very dire consequences are bound to ensue. Appropriate interpretation of this phenomenon constitutes the foundation for sustainable human settlement development in Calabar.

**2. The Challenge of Urbanization in Small Cities**

Trends in world urbanization and population have shown that while there is tendency to place focus mainly on megacities (with human populations exceeding 10 million) in matters pertaining to urbanization and urban growth, this position could be entirely misleading. Megacities of the developed world as well as the developing world together hold slightly less than 10 percent of the global urban population. On the other hand, small cities and towns, with populations less than 0.5 million people, hold more than fifty percent of the world's urban population; thus constituting the principal theatre upon which the scenarios of world urbanization and urban growth are playing out most dramatically in the present day (UN 2014; Cohen, 2006). Urbanization and urban growth in the smaller cities (like Calabar) deserve special attention for two principal reasons. Firstly, while they collectively contain the majority of world's urban dwellers today, they often lack the finances to cope with the pressures. Secondly, the mechanisms for control of

urbanization and urban growth are weaker (and often more obsolete) in the smaller cities and towns than in the megacities. According to Cohen (2006):

In thinking about an urban future, it is perhaps only natural to imagine a world in which everyone is living in mega-cities the size of Sao Paulo, Mexico City, Beijing, or Lagos. But that is not correct. In fact the bulk of urban population growth for the foreseeable future will take place in far smaller cities and towns, a point that receives little media recognition. Large cities will play a significant role in absorbing future anticipated growth, but for the foreseeable future the majority of urban residents will still reside in much smaller urban settlements of fewer than 500,000 residents ….. (Cohen 2006: 73)

Calabar in Nigeria falls within the category of smaller cities with populations below 500,000 residents. It started off in its tempo of rapid urbanization with the estimated population of between 70,000 and 80,000 people in 1970 (Tesco-Kozti, 1970). Today the population of the city is between 0.45 and 0.50 million; and indeed the ecological challenges are already very enormous. There is growing evidence in support of the position that the city's development control mechanisms are becoming overwhelmed by the current pace of urbanization. Ecological challenges are emerging on account of improper articulation of critical urban infrastructural facilities into the development of urban residential communities. Ikot Nkebre is one of the most recent of several such ecological challenges in Calabar. In Figure 2, two new urban residential communities are shown, separated by a valley: Ikot Nkebre to the west and Ikot Enebong to the east.

The constraints to urbanization in the east, west and south have created a great impetus for accelerated urban growth in the direction of the north in Calabar (Efiong, 2011). In Figure 1, there is the human settlement *Ikot Omin* that appears as a discrete settlement located to the north of Calabar. This indeed was the situation about the last decade of the 20th century when the map was compiled; but today Ikot Omin is entirely within the metropolitan territory of Calabar. Ikot Nkebre and Ikot Eneobong are two urban residential communities that emerged (by land-use conversions of agricultural lands into urban residential development communities) over the past two to three decades in the vicinity of Ikot Omin. The road that leads northwards out of Calabar passes through Ikot Omin, separating it into two sectors: the eastern sector and the western sector (Figure 1). At the point 7.8 kilometres, reckoned from the Millennium Park in the Central Business District (CBD) of Calabar (the origin for reckoning all road distances into and out of Calabar), a road that runs off the major highway leads to Ikot Nkebre, a few kilometres to the east. Similarly also, the road that leads to Ikot Eneobong braches off the major highway at an earlier point – at the point of 7.5 kilometres and runs eastwards. The two neighbouring urban residential communities, Ikot Nkebre and Ikot Eneobong, are located on two hillsides that slope gently towards the valley that separates them (see Figure 2). Thus, Ikot Nkebre (as well as Ikot Eneobong) is located at a distance of about 10-12 kilometres of road journey from the CBD in Calabar.


*Figure 2: Ikot Nkebre (on the east) and Ikot Eneobong (on the west)*

*Ikot Nkebre and Ikot Eneobong are twin settlements (in Calabar) separated by a valley. A close scrutiny reveals evidence of the incipience of ecological disasters in valley (from the direction of Ikot Nkebre) as far back as January 20, 2011, when this image was recorded.*

*(Source: Google-Earth imagery of January 20, 2011)*

**3. The Theoretical Platforms**

*3.1. The Urban Community of the 21st Century*

The urban residential community of the 21st century is a unique agglomeration of three distinct habitats: the habitat of people, the habitat of cars and the habitat of nature. Every urban residential community had once been an exclusive domain of nature. The advent of people into the domain began to alter the exclusive dominance of nature, turning it into a realm that is shared by people, cars and nature (CWP, 1998).

The principal objective of people in an urban residential community is the quest for shelter. Since the second half of the 20th century, a very prominent feature of urban development has been car-dependency, which does vary in scope from country to country and from region to region (Nebel and Wright, 2000; Levy, 2009). In the 21st century, many of the people seeking shelter in peri-urban residential communities are car owners or other persons, who altogether depend on automobiles for movements to and from the central business districts (CBD) pursuant to their daily livelihood activities. Most Nigerian cities (like Calabar in Cross River State) are entirely car-dependent; devoid of other alternative means of urban transportation, such as light rails, trolley buses or inland water transport systems. Under such circumstances, the urban residential communities depend exclusively on good roads for the easy movement of the cars of the people who propose to take up shelter within the community. Thus, the prerequisite conditions for the acceptance of an urban residential community turn out to be the existence of good prospects for good roads and comfortable houses. However, the roads and the houses add up to create very fundamental changes (increases in imperviousness) in the natural landscapes that had previously occupied the same locations. In order that urbanization should be sustainable, the ecological consequences of these changes must be clearly understood and appropriately resolved.

*3.2. The Importance of Imperviousness*

The development of houses and roads actually proceeds at the overall cost of the natural environment; resulting in drastic reductions in the habitat of nature. Territories that had previously been covered by vegetation (natural cover) are replaced by hard impervious roof surfaces of buildings as well as hard impervious road surfaces – collectively described as impervious cover. The terms impervious cover and imperviousness have been defined in CWP (1998) as follows.

Impervious cover: Any surface in the urban landscape that cannot effectively absorb or infiltrate rainfall. (CWP, 1998: G.3)

Imperviousness: The percentage of impervious cover within a development site or watershed. (CWP, 1998: G.3)

The characteristics of a given environment determine the ratio of infiltration to surface runoff in the events of rainfall. In a natural forested environment the porosity of the soil allows it to absorb much of the rainwater that falls upon it. On the other hand, in urbanized territories, much of the rainwater remains at the surface – a consequence of the increases in imperviousness. During and after the rains impervious covers within the built-up urban residential community prevent the rainwater from soaking naturally into the subsoil (infiltration), forcing it to remain on the surface of the ground in the form of stormwater. Studies have shown that in an urbanized territory (with imperviousness ranging between 75-100 percent) the surface runoff generated in the event of rainfall is reckoned at about 55 percent of the total downpour; in contradistinction to this, 10 percent of the total downpour is reckoned as the estimated value of runoff in a forestland of a similar area (USEPA, 2003b). Although these facts are logical enough to be very easily appreciated, experience has shown that they have often not been reckoned with in the development of urban residential communities in territories that had previously been agricultural or forested estates; for example, the case of Ikot Nkebre in Calabar. Appropriate understanding of these facts should lead to the timely establishment of mechanisms for management of the large volumes of stormwater that are bound to ensue, following increases in imperviousness as more homes as well as more roads are built. In essence, sustainable development of the habitat of man demands greater sense of responsibility towards the management of stormwater, than the business-as-usual approach of simply transporting stormwater out of sight from the urban space; without minding their potentials (of the stormwater) for inflicting grave ecological damage at the remote and unseen discharge points (Zhou, 2014; Chocat et al, 2007; Chocat et al, 2004).

*3.3. The Green Scenario of Stormwater Management*

Advances in water science and technology have shown that channeling urban stormwater into urban surface waters is fraught with diverse dangers. Firstly, urban stormwater picks up loads of pollutants, from point sources and non-point sources, and transports them along to the discharge points, thus causing pollution in urban aquatic ecosystems. Secondly, transportation of urban stormwater away from the locations at which they are generated on the urban landscape to distant surface waters amounts to a distortion of the water cycle of nature. Finally, poorly controlled flow of stormwater over the urban landscape is responsible for two major ecological hazards: flood and erosion (Zhou, 2014; USEPA, 2003a; USEPA, 2003b; Beasley et al, 2002; O'Meara, 1999).

The above understanding has compelled a paradigm shift from the classical stormwater management systems to the green scenario of stormwater management. The classical system (old paradigm) consists in the transportation of stormwater by means of drain channels (grey infrastructure) away from the urban space for discharge into nearby surface waters; it was originated over 5000 years since the days of the ancient Babylonian empire (Chocat et al, 2007; Chocat et al, 2004). The new paradigm consists in the application of diverse soft and hard technologies directed at facilitating the infiltration of stormwater (for groundwater recharge) at the point at which it is generated on the urban landscape – green infrastructure. In 2008 the United States Environmental Protection Agency (USEPA) reported "… the cost of wastewater and conventional infrastructure in the United States to be $298.1 billion. Conventional stormwater infrastructure, or gray infrastructure, is largely designed to move stormwater away from urban areas through pipes and conduit. (USEPA, 2012)" In contradistinction, green infrastructure is far cheaper because it "uses natural processes to reduce and treat stormwater in place by soaking

up and storing water" (USEPA, 2012). By means of green infrastructure diverse ecological hazards are averted, namely: depletion of groundwaters, pollution of urban freshwater resources, destruction of streams, floods, erosion and destruction of urban landscapes (USEPA, 2014; Cunningham, Cunningham and Saigo, 2007; Nebel and Wright, 2000).

Green infrastructure offers divers ecological, social and economic benefits that act together to promote sustainability and urban livability (USEPA, 2012). The ecological benefits include recharge of groundwaters, water for urban agriculture as well as forestalling floods and erosion. A prominent aspect of the social benefits is the possibility of using stormwater to create water environments for recreation within the city – urban amenity. In Calabar, such recreational parks are very few. From the point of view of the cost benefits of green infrastructure over grey infrastructure, as have been analyzed in USEPA (2012), it is evident that for countries located in the regions of weak economies green infrastructure ought to be the more preferable option. Among the major regions of the world, sub-Saharan Africa is the region that is facing "a greater set of development challenges than any other major region of the world"; and these challenges include "low productivity in agriculture and industry, a lack of foreign exchange, high indebtedness, a poor balance of payments position" (Cohen, 2006). Thus, green infrastructure for stormwater management ought to be the more preferable option for the cities of sub-Saharan Africa; but uncritical fixation on gray infrastructure is proving to be a very formidable obstacle.

**4. The Ikot Nkebre Episode**

The concept of the human settlement being in part the habitat of nature is often construed within the premise of certain limitations that ought not to be. There is the possibility of attributing the concept of nature in the built environment exclusively to beautiful lawns with rich vegetation; and this creates the limitation of ignoring other elements of nature. However, the concept of nature in the built environment embodies several other elements, such as: daylight and solar radiation, wind and storms as well as rain and other forms of precipitation. At Ikot Nkebre, a community that had lived in harmony with the diverse elements of nature for several generations suddenly came to the realization, in 2014, that if not properly harnessed, rainwater could be an adversary – the threat of poorly managed stormwater culminating in rapidly expanding gully erosion. In the Google Earth image of the territory, recorded on January 20, 2011 and shown in Figure 2, there is the impression of a gully in its formative phase. At the time, it was fairly remote from the last building in the community and many of the residents and new housing developers actually considered it to be a very distant phenomenon. By the end of the rainy season of 2014 a serious ecological disaster had erupted; forcing some residents to abandon their homes while new housing developers were compelled to terminate their on-going housing projects. As the rainy season of the current year 2015 continues to run its natural course, some of the residents are already living in very great apprehension, following uncertainties about the probable extent of the extant ecological threat. Some of the home owners are already scouting elsewhere for rental apartments to which to relocate from their private homes.

*4.1. Transformation of Ikot Nkebre into an Urban Residential Community*

Up till 1970, the time of commencement of the intensification of urbanization in Calabar, Ikot Nkebre was an isolated rural community located some kilometres north of the metropolitan boundaries of Calabar. Urbanization pressures, propelled by intense housing needs in the city, generated rapid urban growth. In Efiong (2011) the peculiarities and characteristics of the urban growth and changing land-use patterns of Calabar have been discussed.

In Calabar (the Cross River State Capital), current land development has shifted towards the northern part of the city as further development towards the west, east and south have been restricted by the Calabar river, Great Kwa river and the wetlands of the Cross river estuary, accordingly. (Efiong 2011: 92)

In the course of the rapid urban growth towards the north of the city, dramatic changes have occurred in land-use patterns; peri-urban agricultural settlements have been persistently transformed into urban residential communities. This scenario began to play out at Ikot Nkebre beginning from the last two decades of the 20th century.

*4.2. Infrastructural Planning, Land Values and Sustainability*

In Calabar, the transformation of rural communities into urban residential communities has not always been conducted with a view to sustainability. It usually consists in the registration of the baseline layout plans of the proposed residential community with the land registry; in conformity to extant statutory requirements. A very common deficiency in these baseline layout plans is that they usually are not accompanied by preliminary layout designs of essential engineering infrastructure and associated ecological services. This appears to be an omission from the schedule of statutory documents required for approval. Roadways are indicated on the survey plans of the layouts; but no schematic designs for the roads and rights of ways for services are developed as accompaniment of the baseline layout designs. Levels of roads and drains, relative to building plots, are usually not specified. In the circumstance, developers have no authentic technical reference points by which to determine the finished floor levels of their houses. The alternative processes adopted are premised on diverse kinds of conjectures and surmises. It is not uncommon to have to confront situations in which finished floor levels of houses are below road levels, when road construction works would have been accomplished in the later days. This is a reflection of the critical problems of rapid urbanization in small cities, where institutional controls on physical development are usually very weak (Cohen, 2006).

This problem of uncoordinated planning and development of social and physical infrastructural facilities is not new. In the years that followed immediately after the end of World War II, similar problems were encountered in USA in association with the rapid urban growth and urban sprawl that were driven by the intense housing needs of the period. According to Nebel and Wright (2000):

Thus, the mushrooming development around cities did not proceed according to any plan; rather, it happened wherever developers could acquire land ….. Local governments were quickly thrown into a catch-up role of trying to provide schools, sewers, water systems and other facilities – and most of all roads – to accommodate the uncontrolled growth. (Nebel and Wright, 2000: 580)

The situation cited above refers to problems of unplanned development of urban residential communities that accompanied the post-war scramble for housing, in USA, in the middle of the 20th century. However, in Calabar the distinction must be observed since the context is different; it refers to the development of urban residential communities, under the normal course of urbanization, at the beginning of the 21st century. There are, therefore, very valid reasons for suggesting that the above scenarios ought not to be permitted to play out in the situation of present-day Calabar.

At Ikot Nkebre, the haphazard system of development of housing and infrastructural facilities has been observed. This has been identified as a major contributory factor to the Ikot Nkebre Episode. Increases in imperviousness that followed the advancements in the development of roads and housing led to very dramatic increases in quantities of stormwater generated within the territory. This became manifest in 2014 when large volumes of stormwater continually overran the territory, pulling down the fences (see Plates 3a & 3b). In Figure 3a the section of the fence that was pulled down is shown whilst in Figure 3b the new construction indicates the section of the fenced that had previously been pulled down by torrents of stormwater.

*Figure 3a: By reason of the dramatic increases in volumes of stormwater that followed rising imperviousness, random overflow of stormwater occurred frequently in the territory. The two openings in the fence of this compound represent the portions that were pulled down during the rainy season of 2014; they have not been repaired ever since.*

*Figure 3b: A part of the fence of another compound, located in the same housing row, was pulled down during the rainy season of 2014. The fresh masonry work on the fence shows the part that was repaired after the incident.*

There is no reason for permitting the practice of uncoordinated planning of urban social and physical infrastructural facilities to continue to prevail in the development of urban residential communities in Calabar in the second decade of the 21st century; in view of the prevailing situations of relatively high values of urban lands. The new urban residential communities that are currently springing up on converted peri-urban agricultural lands are not the domains of the shanty settlements of the urban poor. They are occupied by persons who have sufficient family income to purchase one or two automobiles with which they regularly travel to the city centre. The families or communities that embark upon the business of conversion of peri-urban agricultural lands into urban residential communities are actually on the paths of earning substantial profits from a very lucrative urban land market. The cost of a few standard urban plots (within the new urban residential community) would be sufficient to offset the professional charges of the consulting engineer and environmental experts that should be engaged for the preparation of preliminary infrastructural designs and the conclusion of necessary studies; in order to establish the correct framework for sustainable development. The community landowners are the losers if, in the long run, the land values are low by reason of poor planning. Government also derives no benefit from permitting community landowners to avoid payment of

professional charges and embark upon poor planning; because, in the long run, the emerging ecological hazards would be the burden of government. Thus, in the long run, everybody is the loser; and the public is exposed to ecological hazards in spite of the fact that there are qualified experts to perform the required services.

On the parts of community landowners, faulty notions of immediate profit could lead to practices that would be lacking in futuristic perspectives; with the resultant consequences of great losses in land values in the long term. A common example of such faulty notions in urban residential community development is the avoidance of payment of necessary professional charges for comprehensive layout planning, which in the contemporary era ought to be mandatory at the outset for all developments, such as Ikot Nkebre. According to Levy (2009), comprehensive layout planning encompasses the preparation of lots surveys, determination of minimum building plot sizes, street layouts, linkages among lots as well as easements for utilities (rights of ways). Above all, layout plans are expected to conform to municipal master plans. Comprehensive layout planning could help developments attract public capital investment, which is the most powerful driver that shapes development; creating the powerful economic forces that act together with accessibility and urban infrastructure to constitute the most fundamental determinants of land values.

A study of the Ikot Nkebre situation has shown that fixation on short term profits made the community ignore critical aspects of land development that would have promoted high land values in the long term. Among these are design of roads and green infrastructure for stormwater management. These omissions resulted in an urban residential community in which some of the building plots lacked adequate unhindered access to the internal roads; while the risks of floods and erosion continued to loom ominously. Such urban conditions usually make an urban residential community incapable of realizing its full potentials in land values, because of its inability to attract public capital investment. Correspondingly, compared with other urban residential communities in Calabar, land values have been very low at Ikot Nkebre (see Table 1).

| S/No | Location | Land values | | Residential rental rate per annum (Nigerian naira) | | | Remarks |
|---|---|---|---|---|---|---|---|
| | | Land area (sq. m) | Value (Nigerian naira) | 2-bedroom flat | 3-bedroom flat | 3-bedroom house | |
| 1 | Ekorinim | 900 | 12.0 million *(or over)* | 800,000.00 | 1.0 million | 1.5 million | *Based on studies conducted in 2015* |
| 2 | Asari Eso | 900 | 8.0 million *(or over)* | 550,000.00 | 650,000.00 | 800,000.00 | |
| 3 | Ikpai Omin | 900 | 1.5 million *(or over)* | 250,000.00 | 350,000.00 | 450,000.00 | |
| 4 | Ikot Nkebre | 900 | 1.5 million *(or over)* | 200,000.00 | 300,000.00 | 350,000.00 | |
| 5 | Anantigha | 900 | 1.0 million *(or over)* | 250,000.00 | 300,000.00 | 350,000.00 | |

*Table 1: Analysis of land values and rental rates in selected urban residential communities in Calabar*

*4.3. Stormwater Management and the Ikot Nkebre Episode*

Ikot Nkebre urban residential community occupies a landmass that slopes gently and steadily from its western boundary eastwards, towards a shallow flat valley that separates it from the neighbouring urban residential community located further eastwards – Ikot Eneobong, (see Figure 2). The steady slope ensures that stormwater does not settle to create floods. On the other hand, it provides sufficient head of gravity that drives stormwater from west to east across the entire territory of the urban residential community, terminating ultimately in the valley. Such persistent uncontrolled torrents of stormwater that were driven across the estate resulted in massive destruction of fences in 2014 (see Plates 3a & 3b).

In this work, two sectors have been differentiated at the Ikot Nkebre ecological site. In Sector-A of this residential community the roads and drains were constructed by government agencies. Sector-B; located north of Sector-A, is the section of the residential community containing earth roads and concrete drains that were constructed by community effort. All around, the approach adopted for stormwater management at Ikot Nkebre was exceedingly simplistic and very poorly conceived. In Sector-A as well as in Sector-B, concrete drain channels collected stormwater all over the territory and discharged it on the edges of the valley (see Plates 4a, 4b, 5a, 5b and 5c). Stormwater that issues out at the ends of drain channels comes in excessive volumes and great blasting forces against the urban landscapes or stream banks it comes in contact with. In the original state, the shallow flat valleys that lay between Ikot Nkebre and Ikot Eneobong consisted of natural vegetation cover (see Figure 2). The soils in natural landscapes like forests and grasslands as well as agricultural lands are characteristically porous in nature; and lack the strength to withstand exposure to such immense blasting forces. Under such exposure, rapid destruction of soil structure occurs; followed immediately by massive erosion (USEPA, 2003b).

Good practice would demand, as a prerequisite condition, the strengthening of the sides of the shallow flat valleys with stone-pitching at each of the points of discharge of the stormwater; in order to adequately fortify the valleys against the blasting forces of the stormwater as it issues out of the drain channels. Thereafter, the flow of the stormwater would be properly controlled and led into ponds (and other forms of green infrastructure) located at the bottom of the valleys. Stone-pitching is an age-old practice that is usually adopted for fortifying natural landscapes of valleys or the edges of streams against the impacts of the stormwater and wastewater that issue out upon them, with immense blasting forces, at the ends of the drain channels (USEPA, 2003b, Itam et al, 2015). At Ikot Nkebre stone-pitching was omitted all round, with very grave consequences (see Plates 4a, 4b, 5a, 5b, 5c, 6a, 6b and 6c).The omission of stone-pitching resulted in massive erosion of the sides of the valley. Judging from the state of the valleys in January 2011 (see Fig. 1), it is probably appropriate to place the beginning of the gully erosion at about the rainy season of 2010. However, the situation had not yet gone beyond ecological remediation at that time.

**5. Discussion**

Ikot Nkebre ecological disaster is an urban situation that presents a range of complexities in analysis. Firstly, there is the range of circumstances that can be categorized as contributory factors towards the manifestation and rapid deterioration of the ecological disaster. Secondly, there is the range of circumstances that, in aggregation, constitute the impacts of the disaster on urban dwellers. These complexities can be categorized under five principal headings, namely: (i) weak response to ecological emergencies; (ii) wrong ordering of infrastructural development; (iii) weak urban development control mechanisms; (iv) the plight of the home owners; (v) loss of ecologically productive land.

*5.1. Weak Response to Ecological Emergencies*

The records are not easily available to ascertain the exact point in the time at which Ikot Nkebre ecological disaster began to manifest. However, from inspection of the Google-Earth satellite image of the territory dated January 20, 2011 (see Figure 2), the point of incipience of the gulley erosion is discernable within the valley. This indicates that signs of the ecological disaster certainly began to appear before the commencement of the rainy season in 2011. The inference is that between the end of the rainy season in 2010 and the beginning of the rainy season of 2011 immediate response would have helped in stabilizing the valley and thus forestalling further deterioration. Checking the situation would have involved application of a range of green infrastructure including: (a) ponds and constructed wetlands at the bottom of the valley, (b) stone-pitching to halt the deterioration of the sides of the valley, (c) construction of infiltration trenches at the bottom of valley (USEPA, 1999; USEPA, 2003a; USEPA, 2003b; USEPA, 2014).

The fact that the early signs (of 2010 to 2011) were ignored is an indication of weak response to ecological emergencies in the city. By reason of this, the situation was permitted to degenerate; and in the course of 3 years it was transformed into a full-blown ecological disaster of very immense magnitude. Today, remediation of the situation would cost several orders of magnitude in financial outlay above what would have been required in 2011; judging from the very acute state of deterioration over a short pace of 4 years. Above all, in the place of the ecologically very productive land of the valley (see Figure 2) we now have very barren gullies (see Plates 4b, 6a, 6b and 6c). This is the situation that constitutes a completely irredeemable loss of ecological assets to the present and future generations ─ one that is completely antithetical to the concepts of sustainability.

*5.2. Faulty Ordering of Infrastructural Development*

Ikot Nkebre is a typical example of the frequent cases of poorly articulated transformation of rural communities into urban residential communities; in response to the acute urbanization pressures that have been manifesting in Calabar since the early 1970s. The general scenario is that schematic layout plans are produced, on which plot boundaries are marked out together with the spatial provisions for roads and other urban infrastructural facilities. Following this pattern, housing developments were permitted to advance at Ikot Nkebre in circumstances in which preliminary designs of urban infrastructures did not exist. In Sector-A paved roads (with concrete drain channels) were constructed later and terminated at the edge of the valley (see Plates 4a & 4b). In Sector-B concrete drain channels were constructed later on the sides of the earth roads, and both were made to terminate at the edge of the valley (see Plates 5a, 5b & 5c). In both instances no attempts were made to transport the stormwater safely along the slopes to the bottom of the valley or to fortify the sides of the valley against the blasting forces of the stormwater. It was probably presumed that water would ultimately find its way to the bottom of the valley, in conformity to the popular logic that *water finds its own level*. The stormwater actually did find its way to the bottom of the valley; but at very huge ecological and economic costs.

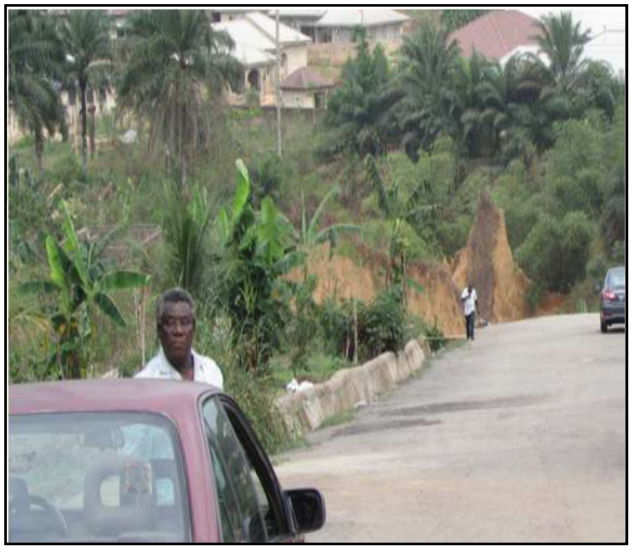

*Figure 4a: The paved road and concrete drains in Sector-A of the study area*


*Figure 4b: The termination of the paved road and concrete drains at the valley's edge in Sector-A of the study area*


*Figure 5a: The earth road that leads to the ecological disaster site in Sector-B of the study area. (Several houses located on this road have been abandoned by the owners. This picture captures a street that is virtually completely deserted).*

*Figure 5b: The huge concrete drain channel that was constructed to convey stormwaters from Sector-B of the study area towards the valley*

*Figure 5c: The termination of the concrete drain channel at the end of the earth road in Sector-B of the study area*


*Figure 6a: The end of the earth road that leads to the ecological disaster site in Sector-B of the study area*


*Figure 6b: View No. 1 of the ecological devastation of the valley in Sector-B*


*Figure 6c: View No. 2 of the ecological devastation of the valley in Sector-B*

The ecological cost of the poor stormwater management scenarios of Ikot Nkebre is the ugly scar of the deep gully erosion (see Plates. 4a, 4b, 5a, 5b, 5c, 6a, 6b and 6c) that has replaced the rich, ecologically productive land that once occupied this portion of the urban landscape (see Figure 2). The huge economic costs consist in the high costs of the buildings that have been destroyed as well as the huge financial outlays required for the remediation of this ecological disaster. All these would have been averted if the development of this urban residential community had been guided by properly articulated blueprints; comprising appropriate portfolios of layout plans, preliminary designs for urban infrastructure as well as green infrastructure for stormwater management.

*5.3. Weak Urban Development Control Mechanisms*

The task of determining the professional inputs that are essential towards the development of sustainable urban residential communities in Calabar belongs to the various urban development agencies and the municipal authorities. This study has shown that there are gross inadequacies in the portfolios of professional blueprints currently being specified for the conversion of forest and agricultural lands into urban residential communities in Calabar.

The concrete drain channels, which were constructed in Sector-B (see Plates 5a, 5b & 5c) in the form of community self-help projects demand further scrutiny. The improper termination of these concrete drain channels at the valley constituted the major contributory factor of the ecological disaster that occurred in Sector-B. Upon closer scrutiny, it has been discovered that no design drawings or blueprints had ever submitted for statutory approval in respect of these projects. Under the stipulated procedures of urban development control, it is mandatory to submit blueprints of private projects as well as community self-help projects for statutory approval. It is essential to view this matter within its professional context only; to the total exclusion of sentiments. It is true that a community self-help project is a demonstration of goodwill; but the consideration must end there. Goodwill projects still have to be subjected to rigorous urban development control processes; in order to ensure that public safety is not compromised. Failure to enforce these conditions has resulted in threats to private property belonging to members of the public in Sector-B of Ikot Nkebre urban residential community. It is essential to demonstrate the necessity for strict controls a little further. If, for instance, there should occur a situation in which some members of a community would wish to develop a mini power station in order to donate electricity to the entire community then the need would arise to ponder over the following questions. Should the fact that it is a goodwill project imply its exemption from statutory control processes? Would it be acceptable to expose the members of public to the dangers of electricity on account of the fact that the project is a goodwill donation? There is, thus, absolutely no doubt whatsoever that the statutory approval processes must be made to apply, to the letter, to private projects as well as goodwill community projects. Correspondingly, therefore, the community goodwill stormwater drainage projects in Sector-B of Ikot Nkebre urban residential community ought to have been placed under the scrutiny of the prevailing statutory approval processes. This includes an authentic Environmental Impact Assessment (EIA) Report, which is a mandatory statutory requirement.

Failure to subject the community goodwill stormwater drainage projects in Sector-B of Ikot Nkebre urban residential community under the mandatory statutory approval procedures resulted in grave ecological consequences at this sector of the estate (see Plates 5a, 5b, 5c, 6a, 6b & 6c). Several houses have been abandoned in the virtually deserted street that has been captured in Figure 5a. All these constitute a very significant object lesson about public interest in the face of goodwill community development projects – no matter how benevolent the intentions of the donors may appear to be in the first instance, the projects must be subjected under the subsisting regulations.

*5.4. The Plight of the Home Owners*

A very unfortunate outcome of the Ikot Nkebre episode is the plight of the victims. It is very significant to note the plight of the victims in Sector-B. An entire street has been deserted (see Figure 6a). Building projects, which the developers had started off with hope, have been abandoned uncompleted (see Figure 6b). Other home owners are facing a very uncertain future (see Figure 6b) – *to vacate or to remain*. On the whole, people who had invested family incomes into home building for old-age retirement have been rendered homeless.

It is impossible to escape from the truth. The stormwater that has created the ecological disasters in Sector-A and Sector-B was transported to each location, from the upland zones (of the Ikot Nkebre urban residential community). Many of the concrete drain channels were constructed as community self-help projects. While those in the upland zones of the community are still enjoying security in their respective homes, others located by the edges of the valley have been forced into a future of homelessness. This is an unmitigated disaster; because it has not yet been possible to locate any evidence to suggest that victims of ecological disasters, such as this, have ever received any form of relieve from ecological funds in Calabar. The matter of granting compensations to victims of ecological disasters deserves to be given some good measure of attention, not only in Calabar but everywhere in Nigeria. This study has shown that the roads and concrete drain channels which precipitated the ecological disaster in Sector-A of the Ikot Nkebre urban residential community, had actually been constructed as government projects. This is a very peculiar and unfortunate situation in which the outcome of a government development project has turned out to be an unmitigated disaster or hazard to some members of the public, who had hoped to be counted among the beneficiaries.

*5.5. Loss of Ecologically Productive Land*

The problem of loss of ecologically productive land is a serious consequence that could accompany urban development if it is not planned with a view to sustainability. Urban growth is propelled by the phenomenon of rapid increases in urban populations. Although it should be logical that increasing urban populations would translate into increasing demands for food within the city, this point has often been neglected in many scenarios of urban development in Calabar.

It is taken for granted that food supply will, as a matter of course, arrive in the city from distant rural regions. This assumption is faulty from several considerations. Firstly, dependence of the city on food supplies brought in from distant places extends the ecological footprints of the city and thus affects its sustainability (Rees, 1992; Wackernagel, 1994). Secondly, research has shown that several cities of the developing world are unable to cope with the logistics and costs involved in the transportation of food supplies and other materials from distant rural regions. On account of this, the problems of urban food insecurity are becoming compounded in the developing world. Urban agriculture would come to the rescue if properly articulated (Rosenburg and Yuen, 2012; Andres and Lebailly, 2011; Halloran, 2011; de Zeeuw, and Dubbeling, 2009). Furthermore, some of the urban poor have good skills in agriculture, but lack the enabling environments for manifestation. Planning the city with a view to promoting urban agriculture would engage these talents, while at the same time curtailing urban food insecurity and reducing urban poverty. A close view at Figure 2 would reveal that, as at January 20, 2011 (the date of the Google-Earth imagery) the valley that lay between Ikot Nkebre and Ikot Eneobong was still an ecologically productive land. Today it is a very severely devastated gully erosion site that offers no prospects, at the present time or in the future, for urban agriculture.

**6. Conclusion**

From this study the following key points have been derived towards the purpose of promoting sustainable urbanization in Calabar, in response to the scenarios of rapid population growth and urban growth that are currently playing out in the city.

- It has been shown that Ikot Nkebre ecological disaster could have been avoided if the correct urban development strategies had been adopted for transformation of the rural community into an urban residential community. By this it is understood that the development of the urban residential community should have been guided by carefully worked out layout plans showing the demarcation of plots as well as preliminary layouts of infrastructural and ecological services. The synergy (between the professionals responsible for land transactions on the one hand and those responsible for essential infrastructural and ecological services on the other hand) that ought to have been mandatory at the beginning of land developments of this nature was absent. The result was a poorly conceived infrastructural development scheme that led progressively to a very grave ecological disaster.
- The application of appropriate green infrastructure would have helped in averting the ecological disaster, by turning the stormwater into an ecological asset applicable for development of recreational facilities as well as urban agriculture. This strategy would have commenced with stone-pitching at the points of discharge of stormwater and would have been concluded with the creation of ponds and wetlands for holding the stormwater in place for the gradual processes of recharge of groundwaters.
- The deterioration of the ecological disaster to the point at which it has gone beyond meaningful remediation could have been avoided if the early signals that appeared in 2011 had been promptly interpreted and intercepted. There is therefore the need for a highly responsive environmental monitoring service for the city.
- While community development programmes need to be encouraged, it is essential to ensure that the implementation of all such projects are made subject to the subsisting urban development control processes. In the case of Ikot Nkebre, the stormwater drainage channels that were developed as community goodwill projects contributed significantly to the emergence and rapid escalation of the ecological disaster.

- Finally, it has become essential to very urgently begin to address comprehensively the subject of payment of compensations for loss of private property, by members of the public, on account of ecological disasters such as the Ikot Nkebre episode. The need to address the responsibility of government is especially underscored where the ecological disaster is due to failures or omissions that are traceable to government projects.

**7. References**


i. Andres, L and Lebailly, P. (2011). Peri-urban Agriculture: The Case of Market Gardening in Niamey, Niger. African Review of Economics and Finance. Vol. 3, No. 1, December 2011.
ii. Beasley, G. and Kneale, P. (2002). Reviewing the impact of metals and PAHs on macroinvertebrates in urban Watercourses. Progress in Physical Geography (2002); Vol. 26, No. 2; pp. 236–270.
iii. Brown, L.L., Gardner, G. and Halweil, B. (1999). Beyond Malthus: Nineteen Dimensions of the Population Challenge.
iv. Chocat, B., Ashley, R., Marsalek, J., Matos, M. R., Rauch, W., Schilling, W. and Urbonas, B. (2004). Position Paper. Urban Drainage – Out-of-sight-out-of-mind? IAHR/IWA Joint Committee on Urban Drainage. Novatech 2014, GRAIE, pp 1659-1690.
v. Chocat, B., Ashley, R., Marsalek, J., Matos, M. R., Rauch, W., Schilling, W. and Urbonas, B. (2007). Towards the Sustainable Management of Urban Storm-water. Indoor and Built Environment 2007; Vol. 17; 273-285
vi. Cohen, B. (2006). Urbanization in developing countries: Current Trends, future projections, and key challenges for sustainability. Technology in Society 28 (2006) 63-80.
vii. Cunningham, W. P., Cunningham, M. A. and Saigo, B. W (2007). "Environmental Science, A Global Concern." Ninth edition. The McGraw Hill Companies. Inc. New York, USA. 620 pp.
viii. CWP (1998). Better Site Design: A Handbook for Changing Development Rules in Your Community. Center for Watershed Protection. 174 pp.
ix. de Zeeuw, H. and Dubbeling, M. (2009). Cities, Food and Agriculture: Challenges and the Way Forward. RAUF Working Paper No. 3. RAUF Foundation: Resource Centres on Urban Agriculture and food Security. 2009.
x. Efiong, J. (2011). Changing Pattern of Land Use in the Calabar River Catchment, Southeastern Nigeria. Journal of Sustainable Development, Vol. 4, No. 1; February 2011. pp 92-102
xi. Granger, D., Cherqui, F. and Chocat, B. (2010). EAR methodology: an approach to Sustainable Urban Water Management. IWA (Int. Water Assoc.) World Water Congress and Exhibition, Sep 2010, Montreal, Canada. pp.1-4. <hal-00663966>
xii. Halloran, A. (2011). Incorporating Urban Agriculture into Urban Planning: The Tale of Three Cities. University Of Copenhagen, Faculty of Life Sciences. January 21, 2011.
xiii. Itam, E. B., Ukorebi, U. A., Ita, E. E., Ugbong, I. A., Obia, A. E., Yaro, M. A. and Ekeng, P. O. (2015). Ikot Uduak Episode: Stormwater Management as a Challenge in Sustainable Development of Urban Residential Communities in Calabar. The International Journal Of Science & Technoledge, www.theijst.com, Vol. 3 Issue 6, June, 2015, pp 290-302
xiv. Levy, J. M. (2009). Contemporary Urban Planning. Pearson Education Inc., USA
xv. Nebel, B .J and Wright, R. T (2000) "Environmental Science, The Way the World Works", Seventh edition. Prentice Hall Inc., Jersey, USA. 664 pages.
xvi. Okosun, A. E., Ndukwu, R. I. and Chimelu, N. E.(2010). Journal of Environmental Management and Safety. Vol 1, No. 1 (2010) 165-179
xvii. O'Meara, M. (1999). Reinventing Cities for People and the Planet. Worldwatch Paper 147. © 1999, Worldwatch Institute.
xviii. Parkinson, J. (2003). Drainage and stormwater management strategies for low-income urban communities. Environment and Urbanization 2003; Vol. 15, No. 2: 115-12.
xix. Rees, W. E. (1992). Ecological footprints and appropriate carrying capacity: what urban economics leaves out. Environment and Urbanization 1992 Vol. 4 No. 2: 121-130.
xx. Rosenburg, G. and Yuen, J. (2012). Beyond Housing: Urban Agriculture and Commercial Development by Community Land Trusts. Lincoln Institute of Land Policy. Working Paper. 2012.
xxi. Sheehan, M. O. (2001). City Limits: Putting the Brakes on Sprawl. Worldwatch Paper 156. © 2001, Worldwatch Institute. pp. 85.
xxii. Tesco-Kozti (1970). "Calabar Survey and Development Plan." Kozti, Budapest.
xxiii. UN (2014). World Urbanization Prospects - The 2014 Revision, Highlights. United Nations, Department of Economic and Social Affairs. Population Division.
ISSN 978-92-1-151517-6. © United Nations, 2014.
xxiv. UN (1997). United Nations Conference on Environment and Development (UNCED) 1992. United Nations. URL: http://www.un.org/geninfo/bp/enviro.html/ Retrieved March 05, 2015.
xxv. UNEP (1972). Stockholm 1972 – Report of the United Nations Conference on the Human Environment. United Nations Environment Programme. URL: http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=97 Retrieved March 05, 2015.
xxvi. USEPA (1999). Stormwater Technology Factsheet: Infiltration Trench. United States Environmental Protection Agency. Office of Water. Document No. EPA 832-F-99-019. September 1999.
xxvii. USEPA (2003a). After the Storm. United States Environmental Protection Agency. Document No. EPA 833-B-03-002. January 2003

xxviii. USEPA (2003b). Protecting Water Quality from Urban Runoff. United States Environmental Protection Agency. Document No. EPA 841-F-03-003. February 2003
xxix. USEPA (2012). Green Infrastructure. United States Environmental Protection Agency, Office of Research and Development, Western Ecology Division. November, 2012.
xxx. USEPA (2014). Green Infrastructure – Low Impact Development in the Semi-Arid West. United States Environmental Protection Agency. September 23, 2014. URL: http://www2.epa.gov/region8/green-infrastructure#5 Retrieved March 06, 2015.
xxxi. Wackernagel, M. (1994). Ecological Footprint and Appropriate Carrying Capacity: A Tool for Planning Toward Sustainability. PhD Thesis submitted to the Graduate Faculty, School of Community and Regional Planning, The University of British Columbia. © Mathis Wackernagel, 1994.
xxxii. WCED (1987). Our Common Future. World Commission on Environment and Development (WCED). Oxford University Press, Oxford, UK.
xxxiii. Zhou, Q. (2014). A Review of Sustainable Urban Drainage Systems Considering the Climate Change and Urbanization Impacts. Water (2014), 6(4), 976-992