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The ecological consequences of conversion of agricultural lands into housing estates in the subequatorial regions of Nigeria: The Ikot Nkebre episode in Calabar

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Abstract

In the course of the 20th century, the theatre of intensive urbanization shifted from the Global North to the Global South. At the beginning of that century there was yet no megacity in the world; the most highly populated city at the time (London) had a population of 6.5 million people. Not even one of the world's ten largest cities belonged to the Global South. By the end of the century, six of the world's ten largest cities (all megacities) were located in the Global South. In order to keep pace with these phenomenal rates of rapid urbanization cities have been labouring under unprecedented scenarios of urban growth; culminating in urban encroachment on peri-urban forestlands or farmlands. In this study this situation has been investigated at Ikot Nkebre (in the peri-urban districts of Calabar, Nigeria), where a whole farming settlement has been converted into an urban housing district in less than one decade. The study has shown the two unpleasant ecological consequences: urban poverty and inappropriate management of stormwaters. In conclusion it has been shown that with correct management of the situation, significant ecological assets could have been derived out of these scenarios.

Keywords: Agricultural Lands, Ecological Consequences, Urban Growth

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1. Introduction

Population explosion is turning Africa into one of the most critical zones of the world, within the context of human settlement developments. Africa is currently the world's second most populous region (after Asia); it attained that position by surpassing Europe in 1996. It is true that compared with Asia (that holds 50 percent of the world's population) Africa holds 15 percent; but in Africa the challenge lies in the population growth rate. The population growth rate for Africa stands at 2.3, in contradistinction with that of Asia, which is 1.0 (less than half) (UNDESA, 2011). The population of Africa reached the 1 billion mark in 2009 and is expected to attain the 2 billion mark by 2044. It has been projected that the population of the continent will stand at about 3.6 million by the year 2100. The projection is also that Africa's share of the world's population will rise to 24 percent by 2050 and further to 35 percent by 2100(UNDESA, 2011). As greater numbers of people continue to relocate daily from Africa's rural regions to the cities, this population challenge of Africa will be located in the realms of disorderly urbanization and uncontrolled urban growth.

Although megacities that hold human populations of 10 million and above command attention by reason of their very awesome sizes, they actually do not account for the highest concentration of global urban populations. Studies of the global urbanization scenarios of 2014 have actually shown that the existing 28 megacities of the world collectively provide home for 12 percent of the world's urban dwellers (453 million people) (UNDESA, 2014a). Across the world, the global urban population has increased by a factor of five, since 1950 – from 0.7 billion in 1950 to 3.9 billion in 2014 (UNDESA, 2014b).These trends of global urban population growth suggest that there is need to place greater attention on urbanization scenarios in smaller cities. In the Global South, relatively smaller cities (with less than 0.5 million inhabitants) account for 1.4 billion of the world's urban dwellers, by the 2014 global statistics. This amounts to 56 percent of the urban dwellers of the region. On the whole, the average population growth rate for this category of cities has been placed at an average of 3 percent, covering the period from 1990-2014 (UNDESA, 2014a). The peculiarity of the smaller cities of the Global South, which collectively hold more than 50 percent of the region's urban populations and are growing faster than the large cities, is that urban development control mechanisms are usually weak; being that they usually do attract the attention of national governments. However, it would be very prudent for national governments in Asia and Africa (especially China, India and Nigeria) to direct appropriate attention to urbanization in relatively smaller cities. It is projected that Asia and Africa will provide homes for 90 percent of the 2.5 billion people that will be added to the world's urban population by 2050. One third of this global urban growth is expected to occur in three countries - China, India and Nigeria (UNDESA, 2014a).

Cities are ecosystems that host man (a natural species); the point that cities are created by man does not alter the fact they areecosystems.As ecosystems, cities are subject to the ecological principle of *carrying capacity*. According to Rees (1992) the term*carrying capacity* is defined by ecologists as "the population of a given species that can be supported indefinitely in a given habitat without permanently damaging the ecosystem upon which it depends" (Rees, 1992). Through their demands for diverse resources as well as the burdens of wastes that theygenerate within the ecosphere, cities exert very significant ecological footprints on the planet. Rees (1992) has further shown that within the contexts of *carrying capacity*, human

populations and cities (human settlements) "The corresponding population is a function of per capita rates of resource consumption and waste production (i.e. sustainable production divided by per capita demand)" (Rees, 1992). Many cities are already solely dependent on food supplies that are transported daily from rural regions that are located at very long distances away from the cities; thus extending the ecological footprints of the cities far beyond the discrete boundaries of the metropolitan regions (Rees, 1992). The chronic famines that occurred in Africa in the 1980s (together with low productivity and disease) have been cited as evidence of limitations of carrying capacity (Wackernagel, 1994). The trends of limitations in the quantum of ecologically productive lands that is available to man, following the scenarios of rapidly expanding global populations, have been discussed in the work of Wackernagel (1994):

> *While in 1950 there were still 3.6 hectares of ecologically productive landremaining per capita, less than 1.6 are left in 1994. A global population of 10 billion – expected by 2030 – would leave humanity with only 0.9 hectares per capita, with some of it degraded.* (Wackernagel, 1994: 19)

All these call to question the wisdom of the urban development model that encourages urban sprawl by which ecological productive agricultural lands, locatedin the peri-urban regions of rapidly expanding cities, are being consumed for housing developments. *Should governments continue to permit cities to expand with complete disregard for the ecological costs of uncontrolled urban growth?* The population challenge that is currently the engine of uncontrolled urbanization in the Global South did not suddenly erupt in the 21st century. In Calabar, the capital of Cross River State of Nigeria, the challenge, over the last 44 years, has been the phenomenal urban growth that has been induced by the rapid expansion of the city's population from between 70,000 and 80,000 (in 1970) to about 0.5 million by 2014. The figures themselves do not convey the picture as wellas the quantum of population change or the population growth rate.

2. Urbanization, urban growth and sprawl

Population explosion is one phenomenon that has been intensifying in the Global South, virtually without any visible signs of respite, since the second half of the 20th century. It dragged along its course scenarios very intensive urbanization in a region in which the mechanisms of control of the urban development processes have often been very weak. This has led to the frequent use of the term *uncontrolled urbanization* to describe the urbanization processes in many areas of the Global South.

The phenomenal increases in human populations that occurred in many sectors of the Global South, throughout the second half of the 20th century, provided sufficient warning for the scenarios very intensive urbanization that were apt to follow. It would appear that the warning was not heeded. The world's population practically reached the mark of 6 billion people by the close of the 20th century. It had risen from the figure 2.5 billion (in 1950); thus making the second half of the 20th century turn out to be the first time that the world's population had ever doubled within the period of a half century. About 90 percent of the total addition that occurred in the world's population in that half century took place in the Global South. Similarly also, the additional 2.8 billion people that will be expected to be added to the world's population in the first half of the 21st century will be located almost exclusive in the Global South, which is already

habouring the most densely populated or over-populated cities of the world (Brown et al., 1999). According to O'Meara (1999):

> *Population increase in developing-countrycities will continue to be the distinguishing demographic trend of the next century, accounting for nearly 90 percent of the 2.7 billion people projected by U.N. demographers (in their medium-growth scenario) to be added to world population between 1995 and 2030.* (O'Meara, 1999)

As a natural follow up to the above observation, it would also be apt to posit that population increase will continue to be the most dominant factor that will continue to affect the shapes and sizes of the cities of the developing countries in the present century. The proactive actions that are taken in urban development and governance, or the omissions thereof, will finally determine the ecological integrity of cities of the Global South.

Table I. Top 10 cities with the largest populations (in millions) in the world at the beginning of the 20th century (Source: O'Meara, 1999)

Ranking Order	City	Population (millions)
1	London	6.5
2	New York	4.2
3	Paris	3.3
4	Berlin	2.7
5	Chicago	1.7
6	Vienna	1.7
7	Tokyo	1.5
8	St. Petersburg	1.4
9	Manchester	1.4
10	Philadelphia	1.4

Table II. Top 10 cities with the largest populations (in millions) in the world at the end of the 20th century (Source: O'Meara, 1999)

Ranking Order	City	Population (millions)
1	Tokyo	28.0
2	Mexico City	18.1
3	Bombay	18.0
4	Sao Paulo	17.7
5	New York	16.6
6	Shanghai	14.2
7	Lagos	13.5
8	Los Angeles	13.1
9	Seoul	12.9
10	Beijing	12.9

The fact that the phenomenal increases in world populations that occurred in the 20th century were skewed in the direction of the developing world was demonstrated in the rankings of the world's cities at the beginning and the end of the 20th century. At the beginning of the 20th century, all the ten cities with the largest populations (reckoned in millions) in the world were located in the industrialized world (see Table I). By the end of the century (by the year 2000) six (Mexico City, Bombay, Sao Paulo, Shanghai, Lagos and Beijing) out of the topmost ten of the world's cities with the largest populations (reckoned in millions) turned out to be cities of the developing world (see Table II). A very significant aspect of these population scenarios is that, while the cities of the industrialized world had time to plan for and adjust to population rises, the cities of the developing world got confronted with the realities without sufficient time for preparation. It took 100 years for the population of London to rise from 0.86 million (in 1800) to 6.5 million (in 1900); but in the case of Lagos in Nigeria, it took only 25 years (1975 to 2000) for 10.2 million more people to be added to the city's population. These dramatic changes in urban populations are inducing

equally dramatic scenarios of urban growth; and the "most explosive urban growth is expected in Africa and Asia, where only 30–35 percent of people live in cities now" (O,Meara, 1999). Explosion of urban populations is expected to be very intense in the first half of the 21st century; and Africa is located in the eye of the storm. While in the year 2000, the urban share of Africa's population (784 million people) was placed at 38 percent, it has been projected that 55 percent of Africa's estimated population of 1,406 million will be living in cities by 2030. The world's fastest-growing cities are in Africa (Sheehan, 2001).

In a bid to cope with rapid increases in the populations of cities urban development agencies have adopted urban sprawl as the perfect urban model. A number of factors that operated in the 20th century made urban sprawl to appear to be a logical option. Sprawl is a product of the car-dependent life style or car-dependent urban model that was first introduced by the USA was adopted in other regions of the world in the 20th century (Sheehan, 2001). According to this Sheehan (2001) “sprawl and progress became intertwined long ago” (Sheehan, 2001) and as more urban dwellers became more affluent they began to considered car ownership as some form of *status symbol*, even in poorer countries. As the mindset of car-dependency continued to permeate societies, people (who could afford automobiles) began to embrace the idea of being located far away from cities as the preferable option, thus embracing urban sprawl.

- Personal automobiles became cheaper in the 20th century, on the urban scale, than other forms of urban transportation systems.
- Fossil fuel became available at relatively cheap and affordable prices in the 2oth century.
- The initial investments that were demanded of city authorities (on urban transportation systems) were much lower than was necessary for installation of alternative modes ofurban transportation.

Above all, the root cause of urban sprawl is located in government: “government decisions about transportation and housing that have created sprawl” (Sheehan, 2001). However, urban sprawl is both ecologically and economically very unwise. According to O'Meara (1999): “Sprawling cities require not only more fuel for transportation, but also more land, building materials, water lines, roads, and other infrastructure than compact ones do.” Urban sprawl induces the car-dependent urban life style, because many urban dwellers who reside in the peri-urban regions have to depend extensively on automobiles for transportation to work, recreation, shopping, visits to relations and all other livelihood activities. While all these are taking place, the energy capital of the nation is consumed on urban transportation; and other energy-demanding activities (like agriculture, cottage industries, water etc) are made to suffer. Increased use of automobiles means increase in the consumption of fossil fuel, resulting in further increases in air pollution. Sustainable cities minimize fuel expenditure on automobiles and encourage public transit, in order to reduce atmospheric pollution and ensure that some of the fuel is directed towards the satisfaction of other competing needs, such as agriculture and water. In the case of the compact city, lengths of infrastructural lines (roads, electricity and water) are minimized, while urban sprawl induces increases in the overall infrastructural lines. In many cases government is compelled to follow up with the distribution of infrastructural services to housing districts that are scattered in every direction from the city centre (Sheehan, 2001). In the end, government expenditure on widely extended infrastructural lines would very far outstrip what could have been government expenditure on housing in a compact city. Furthermore, another

major ecological cost of sprawl is the conversion of agricultural lands (located in the peri-urban regions) into housing estates and thereby curtailing the capacity of the peri-urban dwellers in the satisfaction of the food demands of the teeming populations of the metropolitan region.

A peculiar scenario of urbanization, which is presently taking place in the small and medium-sized cities of the Global South, has turned out to be exceptionally worrisome. This scenario follows the fast pace of urban growth insmall and medium-sized cities and results in the rapid transformation of agricultural lands into housing estates (UNDESA, 2014b). This subject has been selected for more detailed scrutiny in this work. The peculiarity of these types of cities is that they constitute the first resorts for persons migrating from rural regions to cities. Many of such persons often end up in the agricultural settlements located in the peri-urban regions of small cities. Such locations offer them the opportunities to put to practice their agricultural skills; and the larger city populations, in turn, offer them better markets (than the rural markets) for their harvests. Indiscriminate and sudden transformation of such peri-urban agricultural lands into housing estates terminates the livelihood activities of these groups of urban dwellers; thus escalating urban poverty. It also escalates hunger in the city because the sweling of the urban populations actually means increasing demands for food; while the large-scale change in use of the peri-urban agricultural lands (from agriculture to housing), on the other hand, means the reduction of the access of the urban dwellers to food supply.

3. The significance of urbanization issues to Nigeria

In the case of Nigeria the population dynamics that are already playing out are expected to create significant challenges in urban development in the 21st century. The rural/urban migration is expected to be significantly high, resulting in equally high rates of change in the country's urban populations. For the period 2010-2015, therates of change of urban populations for three of the country's major cities have been established: Abuja (5.9),Port Harcourt (5.1) and Lagos (3.9). Similarly also, for the period spanning from 2025-2030, the projectedrates of change of urban populations are still expected to be above the global norm:Abuja (3.9), Port Harcourt (3.9), and Lagos (3.8). These figures for Abuja, Port Harcourt and Lagos (in numerical orderof rates of change of urban populations) are among the highest on the United Nations' listing of 2014 for the world's major cities. However, this fact ought not to mislead one into thinking that urbanization scenarios of other smaller Nigerian cities are not sufficiently significant to merit intense scrutiny. The contrary is indeed the case; other smaller cities have also been experiencing varying (but significantly enormous) dimensions of the population challenge all over Africa. The population challenge facing the smaller cities of Asia and Africa has been summed up by the United Nations as follows (UNDESA, 2014d):

> *Several decades ago most of the world's largest urban agglomerations were found in the more developed regions, but today's large cities are concentrated in the global South. The fastest growing urban agglomerations are medium-sized cities and cities with less than 1 million inhabitants located in Asia and Africa.* (United Nations 2014d: 1)

Calabar in Nigeria, where Ikot Nkebre is located, is a typical example of the cities with less than 1 million inhabitants, where the rates of growth of the urban agglomerations significantly high. In 1970 when the first master plan report of the city was published, the population was estimated at 70,000 to 80,000. In 2014, the estimated population is in the order of 0.5 million.

A major contributing factor to the rapid growth of urban agglomerations in Nigeria is the migration of rural residents to urban areas. In 2014 the estimated distribution of the Nigeria's national population between urban and rural residents has been placed at 83.8 million (urban) against 94.7 million (rural)- 46.9 against 53.1percent. By 2030, significant changes are expected to occur in this relationship: 159.2 million urban residents to 113.9 million rural residents (58.3 to 41.7 percent). This relationship is expected to exhibit further significant changes by 2050: 295.5 million urban residents to 144.9 million rural residents (67.1 to 32.9 percent) (UNDESA, 2014e). Three countries are expected to dominate in the world in the sphere of phenomenal increases in urban populations in the first half of the 21st century: China, India and Nigeria. It has been projected that these countries will together account for 37 percent increase in global urban populations between 2014 and 2050. In numerical terms the contributions of these countries to expansion of global urban populations have been estimated as follows: India (404), China (292) and Nigeria (212) (UNDESA, 2014c). Already, the experience of the last half century of national independence has shown that population explosion is the single factor that has been throwing up the greatest challenges for the post-independence Nigerian cities. Lagos, the former national capital (until the beginning of the last decade of the 20th century) provides the most visible example towards the demonstration the true nature of these challenges. At the point of national independence in 1960, the population of Lagos was below 1 million people; but four decades later at the end of the century, the estimated population of Lagos stood at 13.5 million people. Between 1975 and 2000, the population growth rate for Lagos stood at 5.8 and the total numerical value of the addition to the city's population amounted to 10.2 million people (O,Meara, 1999).

In essence, the peculiar feature of urbanization in Nigeria of the 21st century will be the migration of rural people into the cities. Where this scenario is properly managed, it will provide skilled hands in urban agriculture, which has already been receiving wide acceptance in the present world. Proper management of the situation would require the reservation of land in the peri-urban regions for farming. Where the contrary is the casole, the ecological footprints of the city (in food supply) would continue to be progressively extended far beyond its discrete boundaries. Daily food supplies that are transported through very long distances from remote rural regions would turn out to be unaffordable to many. This would end up creating urban populations that would be vulnerable in food supply and would also be constantly exposed to the twin incubus of hunger and poverty.

4. The Ikot Nkebre episode in Calabar

Calabar is located in the Subequatorial climatic zone of Nigeria: at latitude 04.58 degrees north of the Equator and longitude 008.21 degrees east of the Greenwich Meridian (see Figure 1). Ikot Nkebre is situated about 12 kilometres from the central business district (CBD) of Calabar. At the time that Calabar became the

capital city of Cross River State of Nigeria in May 1967, Ikot Nkebre was up to 10 kilometres away from northern boundaries of Calabar city. In the 1970 master plan of the Calabar, Ikot Nkebre was designated as a remote satellite farming settlement outside the city's peri-urban regions. Over the last decade the settlement has been transforming rapidly into a peri-urban residential sector, where the middle class and the urban poor have been developing their private homes by their own means. In Nigeria, more than ninety percent of the national housing capital consists of privately developed residential property (Weatherbase, 2014). Understanding the ecological problems that have arisen as a result of the conversion of Ikot Nkebre from an agricultural settlement into a dense urban residential sector would demand the interpretation of two very important factors.

i. Rainfall is a significant factor in the determination of human settlement developments strategies in the Subequatorial regions of Nigeria.

ii. Physical developments in the form of housing and infrastructures result in increases in imperviousness and such increases in imperviousness, in the long, induces very dramatic changes in the characteristics of the land at its surface.

iii. The constant discharge of large torrents of stormwaters over unhardened land surfaces of agricultural and forestlands are prone with serious ecological hazards.

Figure 1. Location of Calabar in the Subequatorial climatic zone of Nigeria

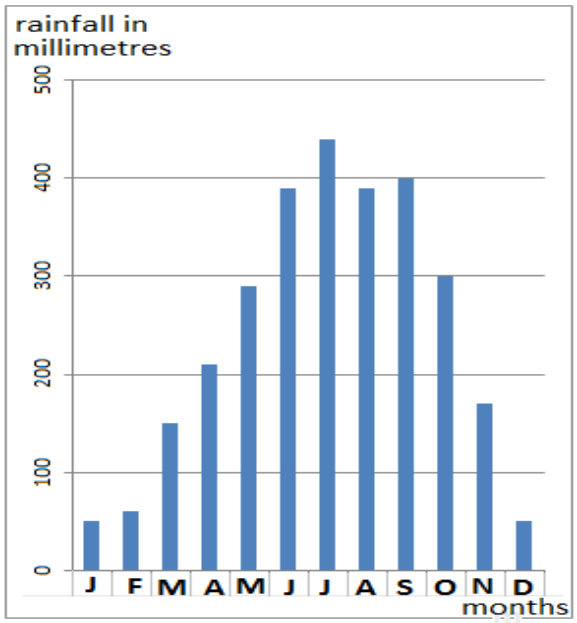

Figure 2. Annual rainfall averages for Calabar

4.1. Rainfall as the preeminent environmental factor

In the Subequatorial climatic zone of Nigeria (as well as other Subequatorial regions of the world) rainfall is very heavy. It often occurs in the form of very torrential downpours, by which large volumes of rainwater are released over the surface of the earth, within a relatively short period of time. Average precipitation for

Calabar is about 300 mm; while the monthly averages (in millimetres) are as follows: January [50], February (60), March (150), April (210),May (290), June (390), July (440), August (390), September (400), October (300), November (170), December (50) (Weatherbase, 2014) (see Figure 2). On an average day in July the amount of rainwater that pours over 1 hectare of land in Calabar amounts to (100 x 100 x 0.44 = 4.4 x 10^3 m^3) 4,400 cubic metres. In the event that such amounts of water are allowed to flow uncontrolled over impervious surfaces, significant ecological damage would be bound to ensue. Thus, in physical development planning and construction in Calabar, it is prudent to take note of two very significant points, namely: (a) there is no month without rainfall in Calabar, (b) nine out of the twelve months of the year, there is always some very appreciable measure of rainfall in Calabar.

4.2. The significance of imperviousness

The ecological characteristics of the land surface have been shown to be of great significance in the determination of the runoff/infiltration ratios of rainwater in diverse territories. One extreme is situation in a territory that is complete with natural ground cover (forest lands, agricultural lands or properly landscaped urban parks), in which 50 percent of the water seeps into the earth while only 10 percent occurs as surface runoff. At the other end of the scale is the densely built up city sector, where impervious surfaces (rooftops, hard road surfaces etc) have replaced the natural ground cover. Here, the amount of rainwater that seeps into the earth by infiltration is estimated at 10 percent, while the surface runoff stands at 55 percent. In both scenarios, the balance is accounted for by the amount of water that enters into the atmosphere through evapotranspiration (see Figure 3).

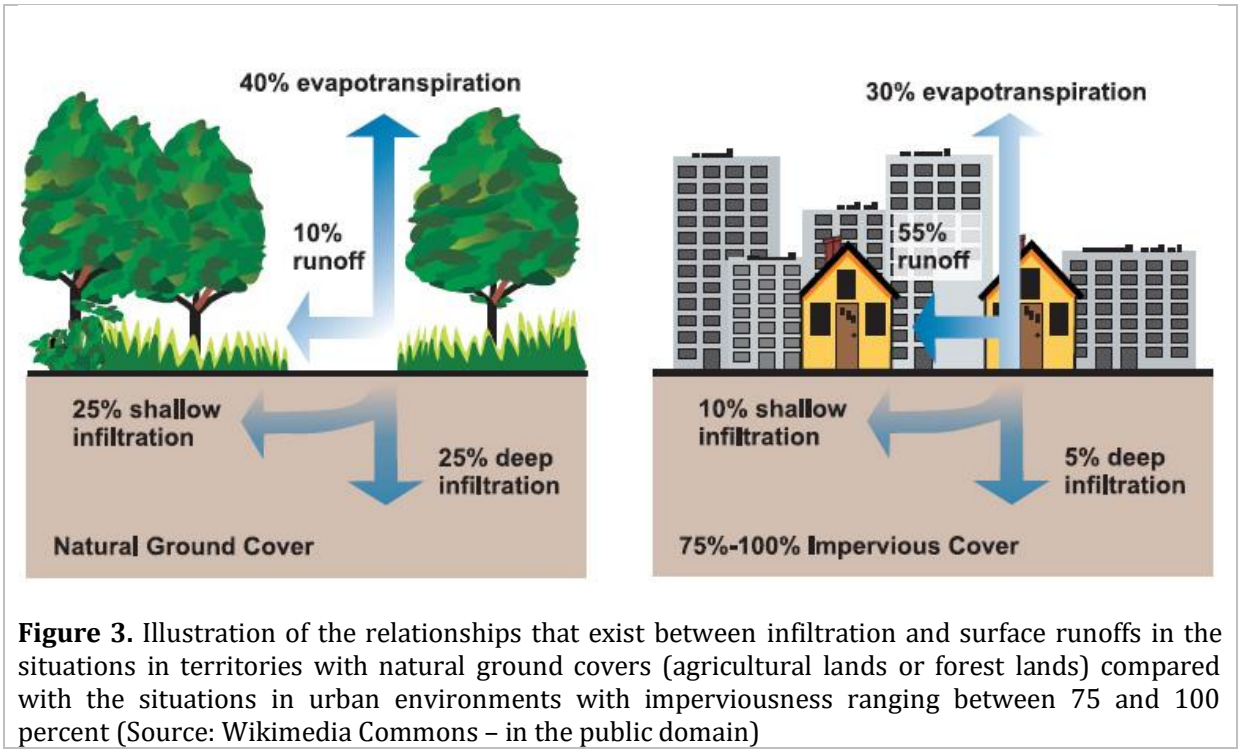

Figure 3. Illustration of the relationships that exist between infiltration and surface runoffs in the situations in territories with natural ground covers (agricultural lands or forest lands) compared with the situations in urban environments with imperviousness ranging between 75 and 100 percent (Source: Wikimedia Commons – in the public domain)

The change in land-use of urban lands from agriculture to housing actually results in the gradual curtailment of the process of infiltration and the rapid accumulation of stormwaters on the surface. The accumulated stormwaters could result in some undesirable negative ecological impacts – erosion or flood.

4.3. The ecological impacts of stormwaters

The two methods by which the presence of excesses stormwaters can result in ecological hazards are flood or erosion. In Calabar risk of both or either of the two scenarios is always present. The topography of the city consists of undulating plains which spread in every direction throughout the city, with flat valleys that are sandwiched between low hills. As imperviousness increases (on account of dense housing developments along the hill sides) increasingly large volumes of stormwaters are generated along the hillsides and are forced down the slopes by gravity, towards the flat valleys below. Along the hillsides there is the risk of erosion, while the risk of flood is always present at the bottom of the valley.

Figure 4 ot Nkebre ecological site in Calabar (Image No. 001)

Figure 5. Ikot Nkebre ecological site in Calabar (Image No. 002)

Figure 6. Ikot Nkebre ecological site in Calabar (Image No. 003)

This study of the Ikot Nkebre Episode in Calabar has revealed the nature of ecological risks that could occur if changes in urban land use, from agriculture to housing, are not undertaken with appropriate professional understanding and diligence (Yaro and Ojikpong, 2012). One major threat that has been found to be associated with these phenomena is the inappropriate evacuation of stormwaters from built-up residential sectors. It has been found that, in the course of conversion of agricultural lands into residential estates, due diligence has often not been taken to ensure the inclusion of comprehensive stormwater management systems in the development plans. This is often fraught with very grave ecological consequences. As a result of the omission (of comprehensive stormwater management systems) individual developers often release, without due diligence, the stormwaters contained in the internal stormwater collectors (located within the respective premises) into the open landscape. The common device often consists of the use of collectors or drains which convey stormwaters to the sides of the hills, in the hope that the stormwaters would roll down, by gravity, to the flat valleys below. This hope is hardly ever realized. Without appropriate preparation of the hillsides (to enable them to withstand the energy of the stormwaters), the hillsides quickly collapse under the force of flowing water and gulley erosion ensues (see Figures 4 and 5).

Agricultural lands usually comprise loose soils that permit the penetration of roots of plants and the infiltration of water. Stormwaters have tremendous energies of flow, which grant them the capacity to break down the cohesive bonds between loose soil particles; thus breaking the entire soil structure apart. This is the phenomenon that plays out when stormwaters are discharged on the open landscape of agricultural lands. The result is the rapid emergence of gulley erosion as has been the experience at Ikot Nkebre in Calabar, Nigeria. The entire gulley erosion that erupted in this site, in the course of the 2014 rainy season

alone, forced many of the residents to quickly abandontheir personal homes and flee for safety. Many of the houses located in the vicinities of the ecological disaster are without occupants (see Figures 5 and 6).

5. Discussion

The Ikot Nkebre Episode in Calabar is a typical example of an urban development process that has been allowed to proceed in contradistinction with the contemporary principles of ecological urbanism. Ecological urbanism seeks to promote a multidisciplinary approach to urban development by connecting ecology with urbanism towards the objective of generating a final product that is not in contradiction with the environment (Mostafavi and Doherty, 2010). According to Hagan (2014), ecological urbanism "explores the extent to which environmental engineering and natural systems design can and should become drivers for the remaking of cities in the 21st century.

In essence, ecological urbanism advocates a holistic approach to urban development and rejects the paradigm that tended to regard every urban development scheme as independent scheme, without connecting it with the ecology of the city. The experience of the Ikot Nkebre Episode has shown the wisdom that is entrenched in the approach of ecological urbanism. At Ikot Nkebre the specific focus was on creating parcels of housing plots out of the previous agricultural lands. From the limited perspectives of the peculiar slant urban economics that tends to disregard ecology (Rees, 1992), the overriding objective appeared to have been the maximization of the number of housing plots in the urban sector. Towards the satisfaction of the quest forthe maximization of profits through the maximization of the number of housing plots, ample space was not allowed for collection of stormwaters that would increase following increases in imperviousness across the territory. In addition also, no thought was directed towards the development of a comprehensive environmental engineering sheme for stormwater management.

The error of the non-holistic approach to urban development has similarly been demonstrated in the Ikot Nkebre Episode. The sum total of the development fees that have accrued to government from housing developments in this estate is a far cry from the amount of money that would be needed for the restoration of the ecological integrity of the urban sector (see Figures 5 and 6). In addition to this, there is the trauma of the several families that have had to abandon the homes that they had spent their livelong accumulated savings to develop. For some, the result of Ikot Nkebre Episode could be the sliding into the realms of urban poverty.

6. Recommendations

The Ikot Nkebre Episode ought to teach us the wisdom of applying a comprehensive design and development approach to the subject of housing development on agricultural lands in Calabar and environs, as dictated under the principles of ecological urbanism. The holistic approach of ecological urbanism would involve the projection of the quantities of surface runoffs that would ensue as impervious increases in the territory. Instead of leaving everything to chance, the holistic approach would also establish measures for collection

and disposal of stormwaters as they appear on the urban landscape. The recommended stormwater management system would include stormwater collectors or drains and stormwater retention ponds (see Figure 7).

Figure 7. A stormwater retention pond Mettingen-Nordhausen, KreisSteinfurt, North Rhine-Westphalia, Germany (Source: Wikimedia Commons)

Within the context of Ikot Nkebre in Calabar, the recommended ecological approach would involve the establishment of a stormwater retention pond at the lowest points of the shallow valleys located in the landscape of the district. This would be followed up with the construction of stormwater drainage systems that would convey stormwaters from the housing plots to thestormwater retention ponds. Having established the framework for evacuation of stormwaters, housing development would have been made to proceed without any fears of ecological disasters. The omission of these fundamental safeguards of ecological urbanism has resulted in an urban housing sector that has been abandoned by many of the home owners.

7. Conclusion

By this study it has been shown that transformation of peri-urban agricultural lands into housing estates is an urbanization processes that could result in grave ecological consequencesin Calabar. In the course of

housing developments imperviousness spreads rapidly over the territory. Thereafter much of the rainwater that falls over the territory remains at the surface in the form of stormwater runoffs that must be safely evacuated from the territory. In the absence of well-articulated stormwater drainage systems the risks of floods and erosions are very high. This study has shown that permitting individual house owners to work out their individual systems of stormwater drainage amounts to creating the circumstances for the eruption of very grave ecological hazards that would cost the government very colossal sums of money in the development and implementation of ecological remediation schemes.

It is therefore suggested that, in Calabar, every case of change in land use from agriculture to housing should be based on sound ecological studies. In all such cases also, housing development should not be permitted to precede except a properly worked out stormwater drainage scheme would have been implemented in every new housing development sector.

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