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# Landscape planning: A bioregional conservation tool in Lower Ogun River Basin

## Tunji Adejumo

Department of Urban and Regional Planning, University of Lagos, Lagos, Nigeria

ABSTRACT: Demarcating conservation areas requires a bioregional planning where environmental characteristics define boundaries. Besides preserving bio diverse species, protected vegetation is a 'soft' engineering that emphasize ecosystems as buffers to mitigate flood related impacts. This paper explores sustainable landscape planning in the definition of conserved areas at lower Ogun River basin that is seasonally flooded. The study is underpinned by the concept of landscape ecology. Land use and land cover data were obtained from the interpretation of satellite images, topographical maps and personal observation. Questionnaires administered at support communities provided necessary socio economic information.

Three terraces were identified namely broad flood plain adjacent to the main river corridors, old alluvial plane and outer terrace developed on the steep slope erosional residues. The terraces supported two broad eco zones namely fresh water and degraded low land rainforest ecosystems. Freshwater ecological zone corresponds with alluvium floodplain. Conservation strategy emphasized the delineation of 926 hectares from fresh water wetland as State Park, Forested plains, 250 hectares Green Belt Plantation and Firewood Plantation. This is 25% of Lower Ogun River Basin land area and will serve as natural defence line - safe guarding lives and properties from climate change driven flood regimes.

Conference Theme: Sustainability and Urbanism.
Keywords: conservation, landscape planning, biotope, ecotope

### 1.0 INTRODUCTION

Land degradation is a major threat to environmental performance of both rural and urban Nigeria. Indiscriminate logging, poverty driven reliance on fire wood, peasant farming, bush burning, uncoordinated mining, oil spillage and urbanization continue to strip the landscape of its vegetative cover. The long term effect includes declining biodiversity index and frequent destructive flooding. NBSAP (2006) statistics show that 0.4% of the nation's plant species are threatened and 8.5 % endangered. The report that less than 6% of the national land area is under protection is worrisome (NTWG, 2009). This is in view of unpredictable and extreme weather events driven by climate change phenomenon. Such weather abnormality is on the increase in their frequency, severity and impact. The national concern is frequent flooding of previously safe littoral settlements. Climate change powered ocean surge and flash flood have more devastating impact on coastal villages that depend largely on peasant farming and aquatic resources for their livelihoods. Other groups affected by flood related natural disaster are urban poor and estate developers lured by relatively cheap sub urban lands on broad flood plains.

Adopted conventional planning to mitigate flooding over the years had been 'hard' engineering solutions including retaining walls, massive concrete channels, dams, levees and sea walls. As noted by ProAct (2008), they are very expensive and in certain cases had not worked as designed. In others, they are accompanied with unforeseen negative consequences. This was the case of Bagauda dam disaster that washed away 18,000 houses and rendered 200,000 people homeless in Kano (NEST, 1991). In recent years, consideration for the use of less expensive ecological engineering alternative to reduce the threats from many natural hazards is on the increase. It is a 'soft' engineering approach, where natural ecosystems or enriched planted degraded wetlands are used as buffers against many flood related natural hazards (MEA, 2005). Research works have shown that partially destroyed mangrove forest by storm surge will regenerate naturally, while the maintenance cost for a dilapidated concrete sea wall remains high (ProAct, 2008). Floodplain ecosystems including mangroves and riparian vegetation reduce the magnitude of storm surges by absorbing storm energy, reducing flow depths and velocities, and enhancing sedimentation. The principle is that the greater the friction a wave encounters the greater the energy that will be dispersed. ProAct (2008) study shows that a 50 meter band of Avicennia species reduced a one meter high wave to just 0.3 meter while a 100 meter buffer of Sonneratia forest reduced wave energy by up to 50 percent. Protected ecosystem constitute coastal and flood plain defence lines safe guarding lives, properties and grey infrastructures. Reducing disaster risk of lives and properties within the flood plains; preventing biodiversity loss; restoring already degraded areas; and protecting ecologically sensitive landscapes demand an increase in protected forest cover from the present 6% to at least 15% of the landmass by 2020 (NTWG 2009) . If Ogun State must meet the 15% national target then all the sub-regional areas must

contribute to the preservation of the degraded land areas. This paper explores landscape planning to delineate conservation area of flood prone Ogun River basin.

### 1.1 Study Area

The study covers Development Pressure Area (DPA II), one of the eight sub regional areas of Ogun State in south western geopolitical zone of Nigeria. DPA II is defined as the area immediately to the north of Lagos State which is under severe development pressure from Lagos metropolis (CPMS 2008). There is rapid flow of people from Lagos metropolis into the area, especially urban poor in search of cheaper accommodation; land speculators; and real estate developers. Religious organizations also found the area attractive as sub urban camp ground. The intensity of land use is rapidly changing from predominantly rural to urban.

DPA II is framed by Papalanto/Sagamu expressway to the north at an average elevation of 30 meters above sea level. The remaining patch of lower Ogun forest reserve in Lagos State serves as the southern boundary at a much lower mean elevation of about 5 meters above sea level. Ewekoro and Ogun rivers serve as western boundary with a 45 meters above sea level dissected steep slope platform. The eastern boundary is defined by Owuru River with a smaller scarp background. DPA II is a 413 square kilometres drainage basin accessed mainly through the Lagos-Ibadan expressway. The frequency of flooding in lower Ogun River basin increased tremendously in recent decades especially during the September equinox which tallies with minor rainy season peak. The year 2010 flooding was unprecedented. The climate change driven intensive rainfall exceeded the absorptive capacity of watershed soil thereby generating surplus runoff that also exceeded the storage capacity of the poorly-drained DPA II floodplain area downstream. Secondly high tides, storm surges from coastal Lagos and silted natural drainage corridors contributed to high water table and caused river levels to back flow inland. The flooding was compounded by massive reclamation of the flood plain to accommodate three major estates downstream namely Sparklight, River View and OPIC Schemes; sprawling cattle market; and the partial de-reservation of the 5,600 hectares Lower Ogun Forest Reserve to accommodate Lagos State Property Development Corporation at Isheri (Ashiyanbi, 2006).

## 2.0 CONSERVATION PLANNING

Sustainable management of natural estates require a bioregional planning where environmental characteristics constitute practical determinant of boundaries. Such physical planning is underpinned by landscape ecology conceptual framework. Landscape ecology is geared towards the identification of the various ecosystems, habitats, flora associations and species relative to the geomorphologic formations. It is equally interested in how the local communities relate to the landscape for livelihood. Since the objective of sustainable living is continuous derivation of social, economic and cultural benefits from the environment, a conservation planning that respects the geomorphology, fauna, flora and the people must be conceived.

Baja et al (2007) generated a conceptual land suitability assessment (LSA) model for productive agricultural land identification using geographic information system (GIS). Their land suitability assessment was concerned with the process of estimating the potentials of land for alternative use. LSA plays an important role in the identification of areas where higher sustainable land values can be highlighted and where the use of a particular land type may be restricted. Their procedure in essence, involved eight main components including choice of land use and land unit; pre determined land use requirements; pre determined land qualities; defined evaluation criteria of both land use requirement and qualities; and suitability rating and validation. Adapting this study to some components of Baja et al (2007) conceptual land suitability assessment especially land unit, predetermined land use requirement, predetermined land qualities and suitability for conservation purposes enhanced the delineation process. The adaptation is based on the consciousness that conservation area within DPA II is valuable peri urban green infrastructure sandwiched between 15,000,000 metropolitan Lagos to the south and rapidly growing Ofada, Mowe, and Ibafo stretch with a projected population of 3,000,000 people by 2030 (CPMS,2008). Peri urban green infrastructure of this nature will offer valuable biodiversity reference to encourage conservation planning (Shih et al, 2009). Such reference is better achieved through biotope mapping. Biotope refers to a distinct space, which is endowed with specific environmental conditions and suitable for particular flora and fauna (Hong et al., 2005). Detailed study of individual biotope, its ecological characteristics, geographical location and distribution in the basin are necessary. The objective of this study is dual. The first is to identify a sizeable conservation area that will constitute lower Ogun basin flood plain defensive wall safe guarding lives, properties and grey infrastructures from climate change triggered incessant flooding. Secondly, is to increase Ogun State protected forest area to meet the national standard of 15% land under protection by 2020.

## 3.0 METHODOLOGY

Shih et al. (2009) identified proper knowledge of regional landscape biotopes especially ecological characteristics, structure, location and spatial distribution as critical sustainable conservation planning variables. Two stages were involved in this study. The first stage focused on delineating existing natural vegetation areas with minimum human impact. Secondary data from topographical maps, 2007 satellite images, previous soil and geological studies and field work were used to generate updated sub regional map.

The second stage is underpinned by the concept of biotope mapping relevant in mapping ecological value of peri urban landscapes. Three interrelated steps including field surveys, categorization of biotopes and evaluation were followed. Landscape units delineation focused on flora association, soil composition and under laying geological formations. Secondary data relied on information from topographical maps, 2007 satellite images, previous ecological, soil and geological studies. This geospatial information was used in GIS assisted conservation planning process. Field surveys including interviews of identified community leaders from the first stage and Ogun State Government Officials were undertaken. Questionnaire distributed in the communities within identified delineated vegetation belts focused on understanding their conservation perspective; social, cultural and economic values from the forest. Preliminary vegetation studies to understand land cover /landform relationship were carried out in 4 transects established in each of the predetermined 10-vegetation sample sites distributed to enhance true representation of the identified ecosystems. Assessment of preliminary wildlife diversity within the study area took place in the same locations for vegetation studies. This involved a series of conventional methods with the objectives of producing a firsthand checklist of the wildlife. Additional information from local hunters on sighted animals in the swampy terrains was useful in the preparation of preliminary wildlife list.

## 4.0 FINDINGS

### 4.1 Geomorphology

The landscape of this bioregion is characterized by a 3 level terrace flood plain (Figure.1). The first and the lowest terrace is the broad flood plain adjacent to the main river corridors especially Ogun and Owuru rivers referred to as Flood plain Terrace I. The second level is made up of old alluvial plane and is labelled Flat Inter fluvial Surface -Terrace II. The third and final level is outer terrace developed on the erosional residues with a steep slope dissected scrap as the back drop. This is Erosional Residual Table Land Terrace III. The three landforms influence DPA II landscape ecology. The soils are derived from Ewekoro, Ilaro and Alluvium formations.

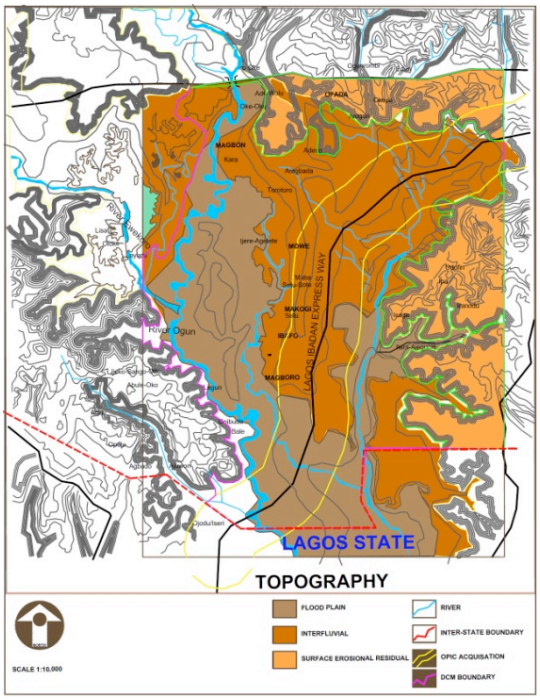


**Figure 1: DPA II Topography**

Terrace I is underlain by recent alluvium deposits. This sedimentary deposit is made up of clay, silt, sand, pebbles, cobbles, gravels and decomposed biomass. The components are mixed together in different proportions to present variations in soil drainage capacity. The general edaphic characteristic of the flood plain is that of poorly drained terrain. Previous soil and geological studies of the flood plain identified 3 drainage zones (UNIFE 1982). The first drainage zone is Ogun river corridor within the first terrace. Typical example is at Isheri Olofin in the south west. It also includes the flood plain between Magbon and Makoloki to the north. This area is subjected to regular flooding and is permanently swampy. The second drainage area within the floodplain is well drained and is behind the described area above. The third subsection of the floodplain is the poorly drained stretch that extends to the footstep of Terrace II. This area is perennially flooded and is made-up of typical floodplain land features including ox bow lakes, marshes and swamps with similar characteristics of the first drainage sub area of Ogun River. The geomorphology of the flood plain do not encourage intense human activities especially urbanization.

The Inter fluvial Surface (Terrace II) is underlain by brown, red and yellow mottled clay sands. It includes land area between Owuru and Ogun rivers floodplain at an average elevation of 15metres above sea level.

The terrace is properly drained by numerous tributaries of both rivers. The second terrace is separated from the flood plain by convex-concave slopes above 5%. The inter fluvial surface supports most of the towns, villages and farmsteads in the bioregion. That makes it suitable for heavy developmental activities. The Erosional Residual Table land (Terrace III) shares the characteristics of the inter fluvial surface. The soil is well drained. Anthropogenic influences include small scale farming and urbanization.

**4.2 Vegetation**

DPA Zone II is a heterogeneous land area composed of interacting ecosystems in defined clusters (Figure 2). The ecological zone delineation focused on flora association, soil composition and under laying geological formations. Two broad ecological zones, namely Fresh water and degraded low land rainforest were identified. The Inter fluvial surface and Erosive Residual Tableland (Terrace 1 & 11) with the characteristics fairly drained soil formation once supported high biodiversity lowland rainforest. Intensive human activities especially urbanization and traditional shifting cultivation farming system have reduced the once luxuriant rainforest ecological zone to patches of secondary vegetation along Ogun and Owuru rivers tributaries. The secondary forest is an impregnable single stratum composed of sampling, seedling, herbaceous species and low land shrubs. Four ecotopes corresponding to the successional level of the new agro ecosystem were noticed including farmland mosaic, secondary forest, forest dominated by oil palm (*Elias guinnesis*) and kola nut (*Cola nitida*). Degradation of the low land rain forest translates to loss of habitat and extinction of typical faunas that once roamed the zone.

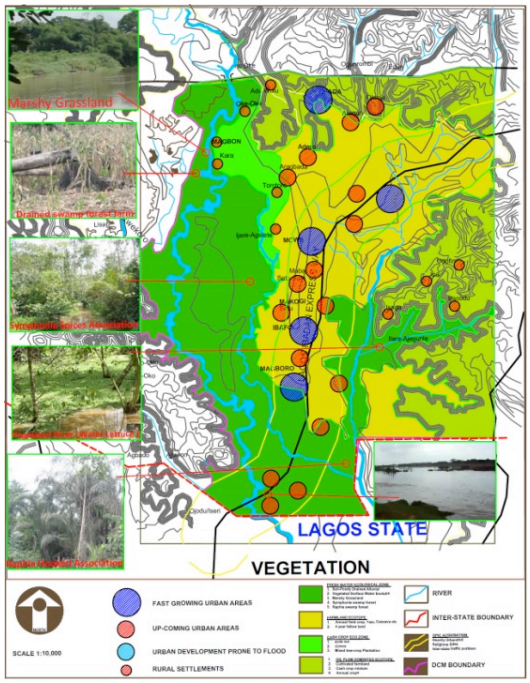


**Figure 2: DPA II Ecosystem**

Information from local hunters confirmed the presence of two species of antelopes (*Cephalophus niger* and *Cephalophus dorsalis*) at the secondary forest ecotopes and the transition to the fresh water ecological zone area. Most upper strata birds have migrated to the high forest outside DPA II and the swamp forest. The lower forest strata birds sighted include Barblers, Bulbuls, Warblers, Sun birds and Forest robins.

Freshwater ecological zone is very prominent at the valleys of Ogun, Owuru Rivers and their many tributaries that dissected Terrace I and II. At its prime state the zone was structurally composed of tall trees, open canopy and an impenetrable under storey with tangles of shrubs and vines. But most of the commercial tree species within the zone had been unsustainably harvested in the last 70 years leaving thick under storey and tall trees with boles less than 600 millimetres at breast height. Edaphic variation, drainage capacity and geomorphologic features distinguish three ecotopes namely swampy forest, marshy grassland and vegetated surface water. Marshy grassland ecotope is found on poorly drained soils along Ogun River floodplain adjacent to the river course. Patches of this ecotope are geographically located along the meandering courses of the river by Isheri-Olofin in the southern stretch of the DPA II and between Magbon and Makoliki in the north. Vegetation in the patch is made up of ground layer of grasses, sedges and herbs. Human influence on this ecotope is restricted to sharp sand mining especially at Magbon stretch on Ogun River. But the most important agent of change is the continuous deposition of sediments which is able to create flood plain landforms and subjecting the ecotope to natural succession.

The swamp forest ecotope occupy the poorly drained soil areas of the flood plain referred to as back water swamp. They are ox bow lakes and other floodplain landforms that were filled by sedimentation. The organic matter content of supporting soil is very high. The swamp forest ecotope is characterized by an even 10 meters tree height on the average. 90% of the tree foliage belongs to this prominent layer. The biodiversity of the ecotope is average and is often dominated by less than 3 species at the prominent tree layer. The conspicuous tree associations are Raphia species, Elaeis guineensis, or Symphonia globulifera. All but the later belong to the palm family. The dominance of each of the 3 species is influenced by prevailing edaphic variables, soil drainage and water table. This subdivides the ecotope into three units namely Raphia Swamp Forest, Elaeis guineensis Swamp Forest and Symphonia Swamp Forest. In the last 25 years, more pressure is exerted on the fresh water ecological zone through dry season farming on the fertile alluvia soil. Such areas are drained and cultivated as cocoa or kola nut plantations. Typical example is the stretches between Magbon and Makoliki in the north. Comparatively, the fresh water ecozone present a formidable barrier to human activities than the degraded lowland rainforest ecozone. Besides logging, few farming activities, artisanal fishing and sharp sand mining are observed land uses in the area. Mammals on record within the zone include: *Tragelephas* spekei (Sitatunga), *Crossarchus obscurus* (Mongoose) and *Cercopithecus nictitans* (white nose monkeys). All the three ecotopes that constitute the fresh water ecological zone still have fair representation of aquatic species expected of this zone. Fish resources of the zone include *Tilapia nilotica, Clarias lazera and Heterotis niloticus.* Throughout the year, artisanal fishermen from the littoral villages ply their trade on the rivers especially Ogun river harvesting red lobsters.

### 4.3 Land Use

The choice and proposition for protected landscape demands the understanding of frequent changes of what constitute a resource on time scale. The last 25 years witnessed an upsurge in urban activities (36%) within the two kilometres OPIC acquisition (Figure 3). This is in addition to another 37% by religious settlements. 7% farming in this area is mainly vegetable gardening in small plots while firewood sourcing accounted for 11 %. Secondary forest witnessed human activities dynamism in recent years. As shown in Figure 3, arable farming still top human activities in the area with 36% respondents. Ogun State Property Development acquisition of two kilometres set back from Lagos – Ibadan expressway reduced availability of residential plots in the major townships. Land speculators shifted attention to secondary forest area. 25% of this ecotope has been taken over by urban activities. 23% still engage in cash crop farming while fuel wood harvesting is 26%. Illegal logging (28%), fishing (26%), and fuel wood sourcing (22%) are three most important activities in swamp forest ecotope. Hunting (18%), Sand mining (15%) along Ogun River by Magbon and farming activities on the drained Ogun River flood plain (13 %) are other activities.

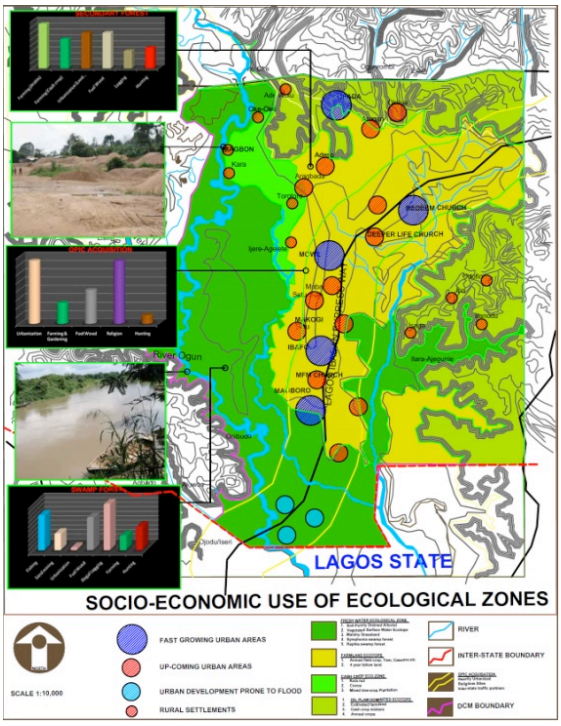


**Fig.3: Socioeconomic use of Ecosystem**

## 5.0 CONSERVATION STRATEGY

The conservation strategy addresses the protection of fresh water ecological zone biodiversity since the degraded rainforest ecozone is a prime area for urbanization (Figure. 4). This is meant to save the fresh water wetland from rapid encroachment that overwhelmed the once luxuriant lowland rainforest ecozone.

926 hectares (20% of total land area) of the concerned ecosystem is required to meet the national forest policy.

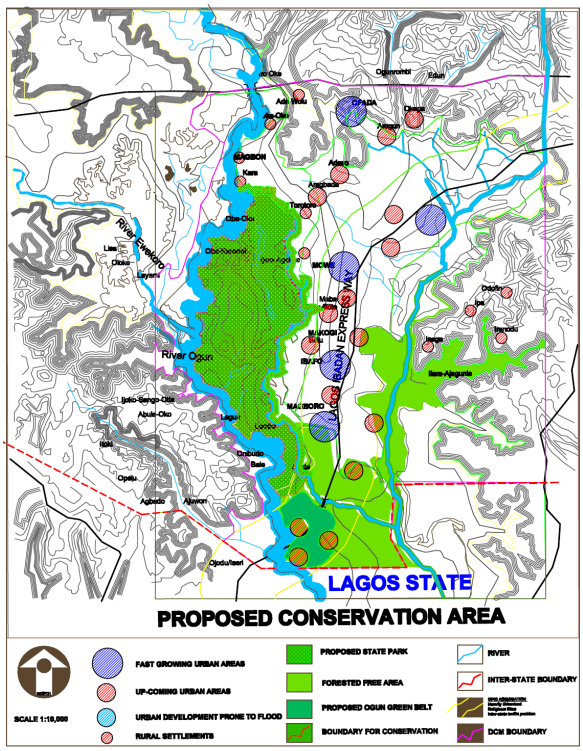


**Figure.4: Conservation Strategy**

Managing the biological diversity of the various fresh water ecosystem demands the understanding of the adjacent communities needs. Figure 3 shows the current benefit derived by fringe villages from the fresh water ecosystem. In order of importance fishing (27%); logging (19%); hunting (8%); and gathering wild fruits and leaves (10%); sand mining (10%); and drained flood plain farming (8%) are beneficial activities derived from the ecozone. Sustainable landscape planning must proactively accommodate the local population in the conservation of the fresh water landscape patches. CPMS (2007) projected three million people as population of OPIC corridor within the next 20 years. This demands a green infrastructure that will accommodate sub urban nature based recreational activities. Much more important is securing lives and properties in most new estates located downstream on Ogun River flood plain at the border of Lagos State. Based on studied land use; existing infrastructure; regional influence of Lagos, Abeokuta, Sagamu/Ijebu-Ode; and set goals, State Park, Forested Free Area, Green Belt Plantation and Firewood Plantation were suggested productive ecological planning units.

State Park manages ecological resources for the educational, economic, recreational and environmental benefits. This permits conservation – recreation symbiotic relationship. It is a concept that explores the principle of ecosystem management, resource preservation and friendly tourism services. The proposed State park will stretch from Torotoro village in the north to fringes of Magboro in the south. The park has a full representation of the three ecotopes namely swampy forest, marshy grassland and vegetated surface water. The proposed park displays high biodiversity association and scenic floodplain land features. With the exception of Magbon sand mining terminal at the edge of the northern boundary, Loki and Oba Oke at the north western boundary there is no village or township within the freshwater wetland. Consideration for private – public participation in the form of day trip picnic facilities at the buffer; ecological lodges; and youth camp provision will provide employment for surrounding communities.

Fuel wood extraction is one of the major agents of degradation in the DPA Zone II. Discouraging firewood extraction from the protected area demands the provision of alternative domestic energy sources or provision of alternative free forest area. The latter is feasible bearing in mind high national poverty index. Introduction of 300 meters plantation buffer between the prime agriculture land area and the conserved fragile fresh water ecosystem will minimize the temptation of illegal fuel wood extraction from the new park.

Extreme weather events driven by climate change have altered the flood regime of lower Ogun River Basin. Ecological engineering in form of adequate vegetation cover as defense wall against flash floods and ocean surges looks at conservation and restoration planting of degraded flood plain. The suggested 926 hectares fresh water state park, 250 hectares proposed green belt plantation, forested free area along Owuru River flood plain and the fuel wood plantation are ideal ecological wall against the flood. The green buffer has an average width of about 500 meters. Other possible 'soft engineering mechanism to mitigate the negative impacts of flooding is the introduction of earth based retention ponds along the tributaries of Ogun River.

Bioregional planning focused on local ecological knowledge in the sustainable use of natural resources. Ecological enterprise highlights small scale business concerns that solely rely on the produce of the various ecotopes. Eco enterprises centre in the mode of cooperative fish farming conceived around retention ponds may serve as the much desired alternative means of livelihood in the adjoining communities. It is an integrated aquatic farm with emphasis on the fish resources of the bioregion including *Tilapia nilotica, Heterabranchus bidorsailis, Heterotis niloticus, Gymnarchus niloticus, Cittrarinus citharus and Lates niloticus*.

## 6.0 CONCLUSION

Green infrastructure is consider as strategically managed interconnected network of waterways, wetlands, woodlands, wildlife habitats; planned greenways, urban parks and streetscapes; farmlands, aqua cultural centres and edible landscapes; and natural areas that maintain ecological processes and sustain air and water resources. The elements of a green infrastructure network needed to be protected on a regional, peri urban and city scale. This requires long-range people oriented planning and management driven by political will. The ecological study of DPA II Zone revealed the ability of man to alter a natural environment within a short period. Urbanization, logging and intense traditional mode of agriculture has completely altered the natural features of the rainforest ecological zone. Conserving the remaining fragile fresh water ecosystem will safe guard life, property and grey infrastructure; increase protected forest areas; and boost fresh water biodiversity. Such conservation demands the accommodation of the socioeconomic needs of the numerous communities especially fuel wood extraction. The success of the adopted peri urban green infrastructure conservation strategy will be influenced by progressive ecological vision that accommodates the interests of both Lagos and Ogun States. This demands maximum cooperation on a megacity scale to ameliorate the frequency of flood related disasters often experienced in the study area. Recommended ecological consideration policies include:

- Clear cut policy statement on the role of wetland conservation on sub urban scale
- Redefinition of set back from identified water body that provides opportunity for natural vegetation to serve as flood buffer.
- Policies that spell out the various benefits derived from green infrastructure.
- Participatory mechanism that accommodates the local people's interest on long term basis.

Further recommendation looks at immediate stoppage to sand mining; introduction of retention ponds to absorb excess water volume; and restoration planting of the degraded Ogun River setback around the residential estates within the flood plain.

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