

# Land Use System Approach for Sustainable Urban Land Management in the African Environment

## The Case of Ibadan in Nigeria

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### 1. Abstract

Emanating from the UN Conferences on Human Settlements (HABITAT) is an Urban Environmental Management (UEM), premised on the notion that urban sustainability is highly correlated with the capacity of the natural resources environmental system, and that long term sustained development cannot occur in a situation of unplanned and unmanaged urban growth, which can lead to irreversible destruction of the natural resources environment.

The UEM, promoted jointly by the World Bank and UNCHS/UNDP as a global programme has a goal to provide urban planners and managers with improved capacity to deal with the challenges of achieving sustainable urban development. Specific country projects are being run as Sustainable City Projects (SCP) based on four principles, namely: the environment is a resource to be managed on a sustainable basis; there is a two-way relationship between environment and development; the urban environmental problems are complex, cross sectoral and require an inter-organisational approach: the environmental problems affect all people, (the stake-holders), therefore there is the need for broad-based community participation and a bottom-up problem solving approach. To practise these four laudable principles there is the fundamental need for an information system with capability for determining ecological and social carrying capacities of the various urban land management zones. It calls for a system-oriented land unit and land use mapping of the urban landscapes along the lines that have been developed already for rural land evaluation. This paper is about a particular situation where an urban natural drainage basin's land units and land use types have been systematically described.

### 2. General Principles of Urban Environmental Management

There is world-wide concern for Urban Environmental Management (UEM), which is being patronised under the auspices of World Bank and the UNDP based on the following four principles

- the environment is a resource to be managed on a sustainable basis;
- there is a two-way relationship between environment and development ;
- the urban environmental problems are complex, cross-sectional and require an inter-organizational approach;
- the urban environmental problems affect the stake-holders, therefore there is the need for broad-based community participation and a bottom-up problem solving approach.

### **3. Application to Sustainable Ibadan Project**

To implement the UEM principles, a city project has been institutionalized called Sustainable Ibadan Project, (SIP), whose Objectives have been defined in an environmental charter which outlines the goals of the SIP. Priority issues outlined in the charter are: Waste management, Water supply, Protection of urban watersheds, Hydrological surveys, Drainage and flood control, Urban poverty, Street trading, Neighbourhood upgrading, Transportation and air pollution, Development of a comprehensive metropolitan plan, Environmental management information system. Land Use System Approach to Ibadan's environmental management.

Land use system (LUS) is a combination of LAND FORM and LAND COVER/USE in a way that creates a unique spatial entity in terms of its biophysical and management personality.

The term land use system invokes a search for uniqueness and the interest to ascertain possibilities and limitations within that uniqueness of the spatial entity to achieve a given set of economic and /or social objectives.

One of the overriding environmental problems of the SIP is degradation of the watersheds of the numerous headstreams (which dominate the metropolitan landscape). To develop an environmental management information system for solving this overriding problem, the basic environmental research activity is the creation of a land use system map.

For the theme of watershed degradation the land form unit could be defined using hydrological and ecological criteria.

### **4. Hydrological Considerations**

Ibadan's hydrology is dominated by first , second and third order streams. The base map used for stream enumeration of the metropoiftan region covers an area of approximately 37 (west-east) km by 34 (north-south) km area, 1,258km<sup>2</sup>. Within this space the number of first order streams is 475, the second order 65, the third order 63, the fourth order 4, and the fifth order 2. Within the 1,258km<sup>2</sup> the number of third order basins is about twenty-seven. In line with the SIP's goals of community mini-water supply project development, urban flood control, stream water pollution control, the third order basin presents itself for three applications, namely: catchment-based stream control engineering, watershed for community mini-water supply engineering and a drainage area for integrated pollution and erosion control land management.

The Ibadan metropolitan landscape conveys a picture of a humid tropical lowland with a high density of short, swift streams grooving an expansive human settlement which carries not less than 2 million people, (1991 Census). These streams have served multipurpose functions in the city's historical development, principally the uses for human and animal consumption. Some of the streams have valuable spring water with potential for commercial production as drinkable water.

Uncontrolled housing expansion, commercial and industrial activities have contributed to the degradation of stream waters. It has been found out that all the streams in the built landscape have been rendered highly risky for direct water consumption by humans. In addition, flooding is becoming a serious hazard posed by some streams which hitherto have been unconnected with serious inundation. The rugged topography has potentially erodible soils developed from coarse-grained granites and gneisses and fine-grained gneiss and schist. The removal of the protective vegetative cover for roads and buildings has precipitated severe erosion in some parts of the city.

For hydrologically related land conservation the spatial unit for LOCAL LEVEL management will be the interfluvial uplands, conceptualised after Strahler as the overland flow area associated with the headstreams and inter-confluence stream segments. Each stream segment is associated with two Land Mapping Units (LMUs), which are basically the left and right flank overland flow surface of the stream segment. For the kind of land management this study anticipates, the LM U has been perceived as Stream-segment Overland Flow Surface -SOFS.

## **5. Ecological Considerations**

There were the ECOLOGICAL considerations for land use system description of the SOFSS. The parameters were:

- slope length as a determinant of stream-segment catchment area,
- slope steepness as a determinant of overland flow velocity
- land cover type as a determinant of surface roughness which facilitates or impedes the surface run-off,
- soil properties such as moisture storage capacity and saturated hydraulic conductivity as determinants also for the amount of surface run-off.

These parameters are relevant for assessing soil loss, stream water pollution and also for proposing stream buffer width for the purpose of reducing stream water pollution.

## **6. Land Cover/Use Considerations**

The land cover conditions in terms of hydrology are related to surface roughness, which in turn influences the velocity of erosion and stream pollution. The Manning roughness coefficients are used in many hydrological models for estimating water detention time of run-off as it relates to velocity.

Description of the vegetation type, and other non-vegetal covers are a means to select the appropriate Manning roughness coefficient for the modeling of land management type.

There are the pollution implications of LAND COVER/LAND USE. For example, in the residential zone, the traditional type, the sewage management is generally open and drains freely into the nearby streams. In the modern residential areas the sewage is collected into closet and therefore protected from outward draining into the natural waterways. The land uses were classified in terms of the associated waste management. Among the land uses classified were residential traditional, intermediate and modern. The three types were subclassified by building intensity into three levels: dense, open and sparse, which correspond with the volume of domestic waste generation.

The traditional markets were recognized as centers of intensive solid waste generation, and so were the transportation nodes (passenger stations) and their associated retail clusters. The main urban transportation routes are waste littering corridors and sites for small scale auto-mechanical, auto-electrical shops, metal and wood works, miscellaneous craftworks. These dispose the associated industrial wastes in a haphazard manner into open drains, which lead to streams nearby. The government reserve areas (GRA), the housing estates, and allied formal land uses are relatively more efficient in waste handling.

## **7. Considerations for the Land Use Systems**

The two map systems, namely, the land (system) unit map and the land cover/use map were united in the database for the purpose of creating the land use system map. The intersection of the map units of the two overlays create the third layer, which is taken as map units of the LAND USE SYSTEM map. The derivative map units are considered as the land management units.

## **8. Application for Stream Water Pollution Control**

Two spatially related third order streams in a peri-urban zone were chosen to be studied. One hundred and thirty-nine SOFSs were mapped as LM Us. Within them were identified (through interpretation of 1:16 000 scale aerial photographs and SPOT XS and P imageries), nine residential land use types/intensities, other urban and rural non-residential land uses. The associated waste management of each SOFS was described. The surface conditions were also considered for the purpose of deriving Manning roughness coefficient, soil saturated hydraulic conductivity and soil moisture storage capacity, which are the relevant parameters of a GIS-related stream buffer MODEL for non-point source pollution control of the stream waters.