SPATIAL INFORMATION FOR SUSTAINABLE URBAN DEVELOPMENT: USING TECHNOLOGY FOR INFORMED DECISION MAKING

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ABSTRACT

As regions with high rates of urbanisation and weak financial bases, many local authorities in Kenya are struggling to keep up with the rapid pace of change. Despite commitment to sustainable development by the Kenya government, poor or inappropriate data management practices have posed constraints towards realisation of its set goals. The potential for digital data technology is therefore being recognised by many government and local authority managers as a necessary aid to informed decision making during planning and delivery of services to the urban residents. However, it is common practice for spatial data within the same local authority to be stored in formats not conducive to their effective use as a common resource and information being withheld unnecessarily from other users. With reference to Nairobi, this paper draws on Kenya's relatively well developed cadastre system to explore how a cadastre-based postcode address system can be developed for easy identification of properties and their owners/occupiers; and the formation, and implementation of databases to facilitate efficient processing and dissemination of spatial data for sustainable management of urban resources and delivery of services. Despite the initial high cost of implementing a Geographic Information System, and although it might be argued that the circumstances are different, the paper draws parallels with the initial land registration process in Kenya whose records are still generating revenue for the government through data sales many decades later and argues for its (GIS) implementation. The paper focuses on providing technical solutions for better spatial data management and does not attempt to consider other equally important issues concerning governance and/or accountability as they relate to the management and delivery of urban services in Nairobi.

1. INTRODUCTION

"The world population has more than doubled in the past fifty years and is increasingly concentrating in towns and cities… (Home 1997:1)". Concern for the resulting problems has received its due attention during many workshops and conferences in various parts of the globe, the most recent major conference being the "City Summit" in Istanbul (Turkey), 1996. The uncontrolled increase in urban population keeps exerting a lot of pressure on infrastructure facilities leading to an increase in their frequent malfunctioning, sprawling squatter settlements and social problems. Respective local authorities have tended to be

blamed by the public for these inadequacies however, part of the problem is due to lack of the necessary and easily accessible data for effective planning and management with a view to minimising effects of these phenomena.

Given the economic hardships affecting many local authorities in Kenya whereby a small margin of error during planning of a project or delivery of services may lead to failure; availability of data in the required quantity, quality, currency, where and when it is wanted is of utmost importance for successful management of their activities. Dale (1997:24) however, cautions that "availability of good information is not an end in itself but a means whereby risks associated with decision making can be minimised". The onus is therefore on those involved in the management of urban resources to ensure that perceived targets are met. Many cities in developing countries have well-developed cadastral systems which can be used as units for data collection and taxation about properties and people during planning of infrastructure facilities and delivery of services, and also for strengthening their financial bases. One way of achieving this in Nairobi is through the development of cadastre-based postcode address systems to act as units for data collection for every property, business, individual or organisation.

2. DEVELOPING AN ADDRESS SYSTEM

An 'address' in Kenya, like many other developing countries is generally a "small numbered box" usually leased from a post office where one collects mails, bills etc. It can be withdrawn if the lessee violets conditions for the lease. For many people, it is more convenient and economical to use institutional, friends' or relatives' addresses for communication. In its current format, the above address system serves its purpose well - mail/bill delivery. However, for identification purposes and record keeping about individuals, businesses, properties, and to monitor the general trend of economic development in the cities, there is need for such information to be based on a fixed legal entity such as landed property. With a strengthened and reliable information base, it is easier for local authority managers to effectively plan for the needs of the city residents and forecast future trends. Therefore, such an address system as envisaged by this paper would constitute a developed/undeveloped geo-spatial unit which may be a permanent/ temporary abode/use owned by an individual, family, organisation etc for residential, business, agricultural, industrial, etc. purpose for a specified time frame or in perpetuity.

Nairobi city council has records of all properties within the city environs together with their unique land parcel identifiers. However, the high volume of land transactions resulting from the buoyant property market and the rapidly changing patterns of land use, has made it a tedious task for the land registry at city hall to cope adequately with land/property queries. Such difficulties when retrieving property data for public consumption may be used as a good recipe for soliciting bribes during delivery of services. This is further abetted by the current system of data storage in Nairobi city council which is a paper/card index system that easily lends itself to unnecessary delays during data processing. To alleviate this problem, a multi-purpose cadastre (Henssen, 1990-1) - to be updated

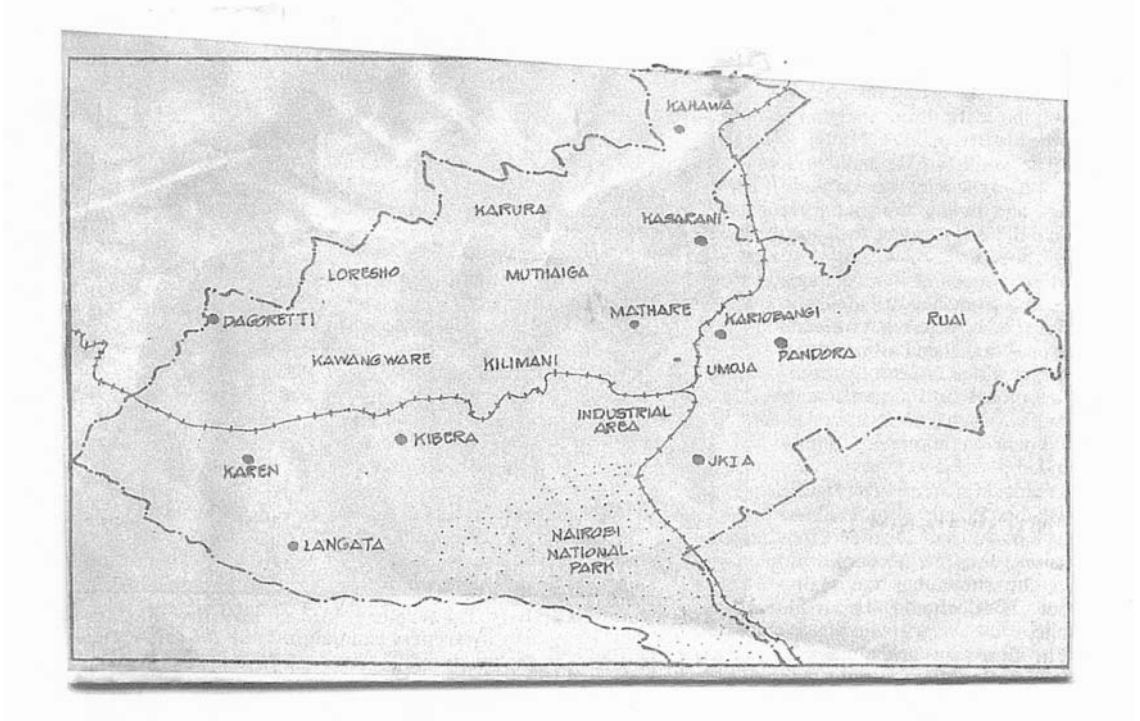
continuously should be compiled containing attributes of the land parcels - development, occupiers/owners, use, encumbrances, etc. Identification of attributes of the multi-purpose cadastre should then be based on a cadastre postcode identification (CPI) address system for example,

25.9 Outering Road
Madaraka House (First floor)
NRB 209 8274, Dandora, Embakasi, Nairobi

The above address identifies the named property and may be used for census taking; tax collection, access by the fire brigade/ambulance/police service; connection/disconnection of utility services and may be interpreted as follows:

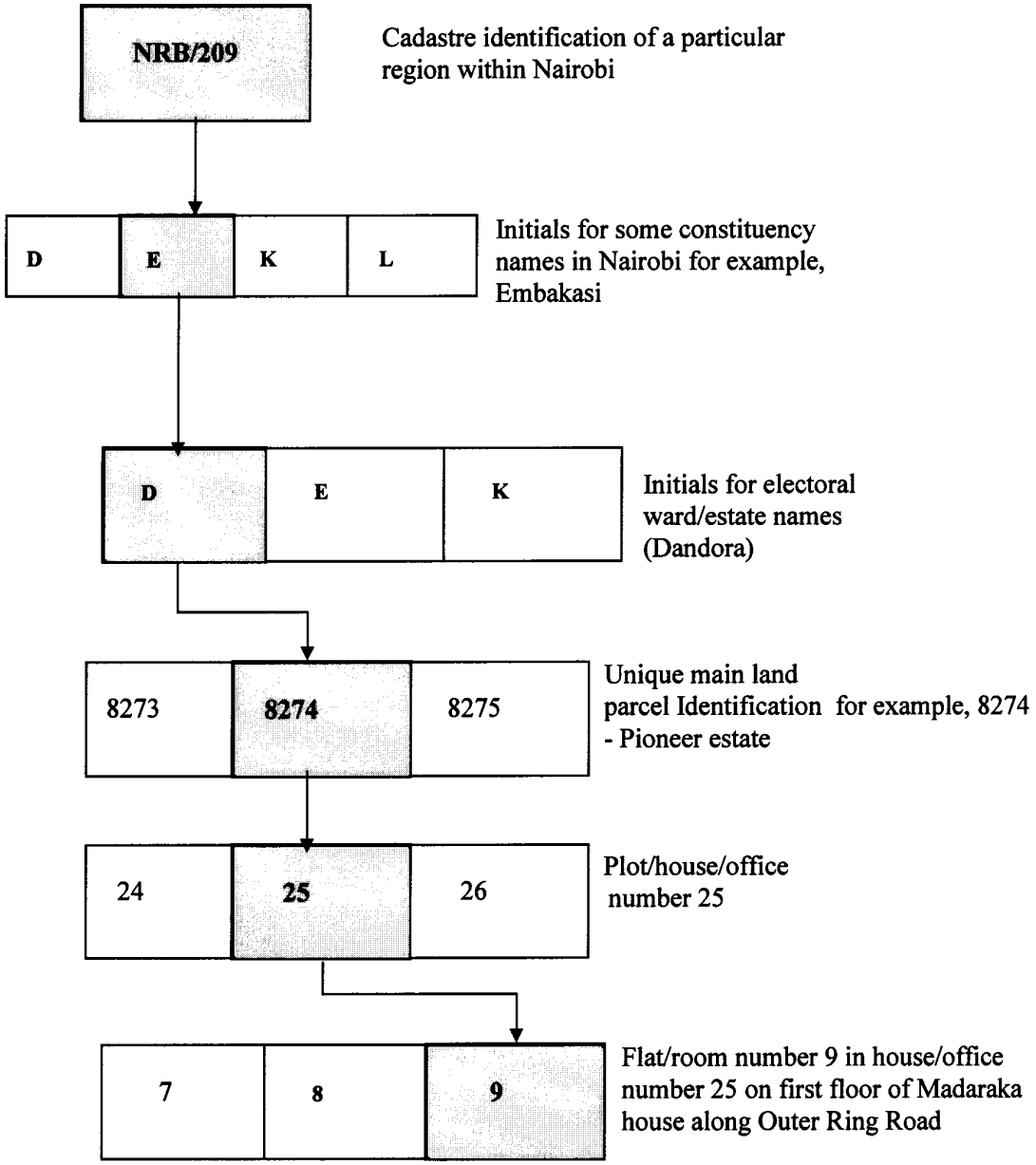
NRB/209 – a particular region in Nairobi (Figure 2).
NRB/209/**8274** – unique identification number for the land parcel in this region.
NRB/209/8274/**DAN** – initials for Dandora administration unit (Figure 1) in which land parcel number 8274 is located.
NRB/209/8274/DAN/**25** – plot/house/office number 25 in Dandora administration unit.
NRB/209/8274/DAN/**25.9** – flat or room number 9 in plot, house or office number 25, on the first floor of Madaraka house.

Figure 1. Administrative Units of Nairobi



Source: Daily Nation, 6/1/99

Figure 2. Cadastre Based Postcode Address System for Dandora, Embakasi, Nairobi.



To facilitate easy collection, aggregation, and dissemination of data based on the suggested cadastral postcode identification system for individual addresses, there is need for development of databases and other spatial data infrastructures for Nairobi and Kenya as a whole. The need for development of databases as engines for urban and general development in developing countries has been emphasised during various conferences on information technology focussing on geographic information management (Stadler 1998, and http://www.africaonline. com.gh/AITEC/about.htm visited on 16th September, 2001).

As part of the spatial data infrastructures, creation of databases is necessary since they have the advantage of holding large amounts of data based on a common theme which can be accessed by a wider audience with guarantee of content and quality.

3. THE NEED FOR A CADASTRE IN NAIROBI

As an economic giant in East Africa, Kenya and indeed Nairobi has developed to become a centre for commerce and industry, communications, and a popular venue for both international and regional conferences. This has accordingly attracted very many local, regional and international entrepreneurs in business, research, academia etc. to set up bases in the city and various parts of the country. Local institutions, besides the large contingent of the international community based in Nairobi for example, UNEP, UN Habitat, etc. and the Regional centre for services in surveying mapping and remote sensing, and Kenya as a whole generate enormous amounts of data which is scattered in various formats and currency suitable for the respective organisation's use. Some of this data (most of which can be geo-referenced) needs to be aggregated with other data (such as from the proposed database for Nairobi) to generate information for informed decision taking. Of more concern to Nairobi city council is accessing necessary data to plan for the needs of its more than 2 million residents who are increasing rapidly. While there may be variations in the content of thematic data used by different organisations in Nairobi, most of them need similar basic data as a backbone for their textual or graphic presentations which may be obtained from databases for: geodetic control network; administrative boundaries; topographic data; cadastral data; geographic names; property attributes.

A database is a collection of data organised according to a conceptual scheme with a set of procedures for adding, changing or retrieving data held in this structure (McDonnell and Kemp 1995). By following set routines of developing instructions through the structured query language (SQL), mathematical formulae, or programming; secondary (hybrid) data can be derived from data in these databases with much more ease and within a short time on large amounts of data. Most of the planning for services and future land uses in urban areas is based on such derived secondary data which must be available in the right quality and quantity. Using the flexibility of modern technology, (spreadsheets, databases, and GIS based software), the required data can be accessed easily and aggregated from a wide range of sources to generate both qualitative and quantitative maps. Audenhove et al (1999) concur with this view and emphasise that through networking, data in the same format is not limited to departmental or national boundaries for particular use where its fitness for purpose has been accepted. However, access to geo-spatial data in an electronic friendly format is a necessary pre-requisite to exploiting the potential of modern technology. Therefore all data in Nairobi city council has to be captured digitally and stored in digital databases. Since some of this data will be common for the different departments at city hall, establishment of shared databases will ensure better use of the available resources.

3.1 Shared databases

Many departmental managers appreciate the need for databases, however in their current format (hard copies) the focus tends to be restricted to the needs of the department/ section during design. Some of the common excuses advanced for this approach include: limitation of funds since the central government encourages them to be more careful with their expenditures, or the whole exercise being geared towards the department's survival in the competitive market. Substantial savings in resources can be realised by these departments depending on how its databases have been designed so as to take advantage of other quality and compatible data available in similar formats elsewhere. Gillespie (1994) provides an overview of the benefits which can be derived from the use of shared databases as an aid to sustainable management of urban resources by grouping them into two broad categories of *efficiency* and *effectiveness.* The two themes of efficiency and effectiveness in terms of service delivery by local authorities are the common criteria used to measure the quality of service provided to the public, and hence justification for the use of the tax-payers' money. Studies by Antenucci et al (1991) show that despite organisational problems which need to be resolved, on the whole there are more benefits to be derived by transforming data into electronic friendly formats and use of shared databases in local governments.

Data from shared databases will for example, save utility companies a lot of time and money when planning layout/checking of their street-furniture or road construction companies against litigation for damaged infrastructure as was the case in Nairobi in 1999 along Langata dual-carriageway (Photograph 1) during its expansion. In business terms, the inconvenience and financial loses incurred by the affected clients and the general public at large due to disruption to services or businesses is un-quantifiable.

Photograph 1: KPTC Cables damaged during the construction of the Langata Dual Carriageway, Nairobi.

Source: East Africa Standard, 4/3/99

Damage to cables in photograph 1 would have been minimised by using shared databases to access the necessary data, and suitable GIS packages for their graphic representation which would have provided an underground map of the affected area to aid in planning the layout of the construction work, maintenance of existing cables or laying of new ones so as to pass through the most cost-effective and least disruptive routes. In the event of such damage, where an underground graphic network of the area is available in electronic format, it is much easier to:

- identify the location of the damaged utility service;
- inform the affected clients promptly as repair work continues to restore the service;
- turn the supply off at easily identifiable strategic points to minimise loses (for example damaged water pipe);
- analyse the problem with a view to providing a long term solution (where such action is the most appropriate) instead of concentrating on short-term measures of quickly restoring the service which tends to take precedence over analysing the possible extend of the problem.

The advantages of shared databases assume that data in the databases is compatible and to the same standard. Pearman (1993), Cassetari (1993), and Glover (1995) argue that implementation of common standards during data compilation is a necessary process to minimise costs and maximise on the benefits of modern technology by: -

- facilitating easy data transfer from common fields between different databases designed to the same specifications without loosing data integrity;
- enabling database users to access the same data with consistency of content, accuracy, currency and format;
- encouraging inter-departmental/organisational/regional exchange of data leading to savings in resources for data collection and processing;
- enabling more value-added retailing of data between different organisations such as government departments, non-government departments, and utility companies.

The problem of data compatibility and standards is normally addressed during database design. Different users will normally require different data with varying levels of accuracy and currency. This necessitates collection of more information about the data (metadata) so as to meet the heterogeneous needs of the users.

4. METADATA

Metadata is generally referred to as 'information about information'. However, Williamson et al (http:/www.geom.unimelb.edu.au/re…lications/IPW/Phillips_NZ_981. htm visited on 12/8/2000) classify metadata into two different forms: (a) a set of rules which tells a software program how to handle data, commonly found in GIS and CAD packages; (b) description of characteristics of datasets for example, quality, currency, ownership (copyright), origin, spatial scale of capture, the purpose for data capture/ creation – which

may be more suitable for certain uses than others. With metadata information, data consumers are able to ascertain the reliability of the data in question leading to improvements on the quality of their final products. Table 1 shows an example of a database format for purposes of easy aggregation of data in Nairobi. Various sub-databases as suggested above and others on metadata can be created within the respective departments at Nairobi city hall for their specific 'house-keeping' needs.

Table 1. Suggested Database format.

Field Name	Field Size
Geodetic reference	
House/Door Number	
Main Address	
Unit Address	
Residential/Industrial/Office/Building name	
Road Name	
Province/District	
Division/Location/Ward	
Cadastral Postcode Identification (CPI)	
Map Sheet Number	
Title Deed/Plan Number	
Area	

Key

Geodetic reference - Co-ordinates of the centre of the property.

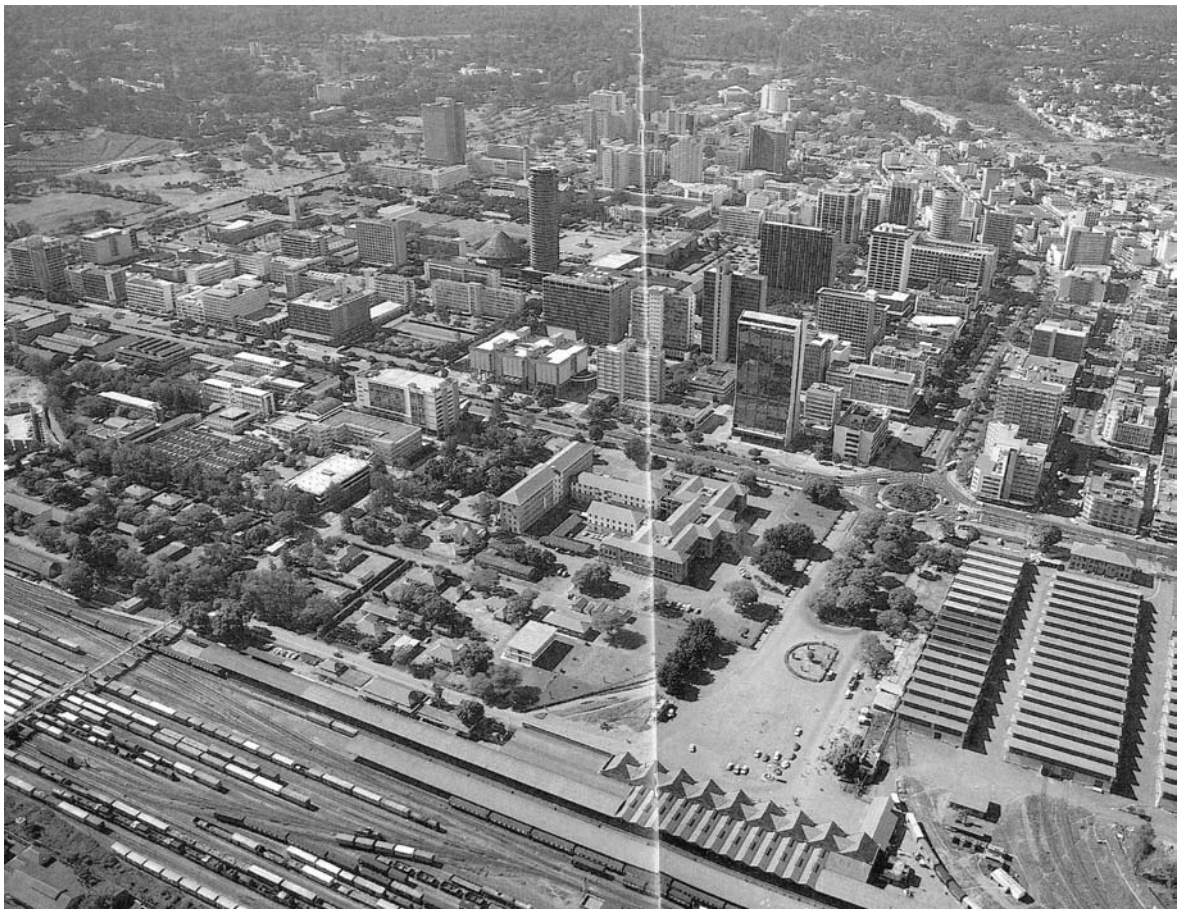
*Main address***:** Land parcel number, regional names, smallest administrative unit and House/door number for example, 25.9 Outering Road, Makadara House (First Floor), 209 8274 Dandora Embakasi, Nairobi

Unit address - To facilitate accessing multi-storey addresses like different offices in a tower Block (photograph 2), individual flats or rooms in a storey house, sites-and-services housing schemes for example, Dandora; and condominium housing units (Umoja) where a number of specific houses/ rooms/ businesses relate to one land parcel (Ndengu, 1996b). In these examples, individual tenants own/lease their houses, flats, rooms, or business space separately with the land parcel being collectively owned in un-divided shares.

Administrative units – Province, district, division, location and ward.

Cadastral Postcode Identification (CPI), Map sheet number, area and plan number - as allocated by relevant government departments or local authority.

Photograph 2: Part of Nairobi City Centre showing different tower blocks with offices on the same land parcel.



Source: Tomkin, 1995

5. IMPLEMENTATION

Like basic topographic mapping, development of a database within a country is generally assumed to be the responsibility of the government. Such assumptions on the exchequer are no longer feasible in the current economic hardships in Kenya. Setting up a database will therefore have more resource (financial and personnel) implications than can be managed by Nairobi City. Consultations with relevant government departments as the custodians of most of the data will minimise future problems of incompatibility between databases or loss of data integrity during data transfer. However, a 'user requirement analysis' (URA) of various stakeholders in Nairobi should involve as wider an audience as possible during design and implementation so as to carter for the expected array of needs. While some departments by virtue of their duties may hold large amounts of data, geographic information is generally expensive to collect, which justifies the whole exercise being centrally organised and adoption of the collaborative approach (Peng 1997, and Frank

1992). This however calls for managers from different departments to rise above institutional, technical, individual etc. barriers with the objective of maximising on their weaknesses (resources) through data sharing. Nedovic-Budic et al (http://www. urisa.org/abstract/understanding%20interorg/11-1 pages 53-64.pdf visited 16/8/1999) note that data sharing arrangements may be manual exchange of digital data, access only to fully shared, distributed or centralised GIS and databases. Realising the common tendency to withhold data unnecessarily by public organisations to other users, the Ad-hoc Expert Group of UNECA (Working Group No. 1. Policy and Institutional Issues) on the "Study on the future Orientation of Geoinformation activities in Africa", re-iterates that:

> "all data collected with public funds form part of the nation's corporate data resources and the individual agencies involved in their collection and management are viewed as custodians, and not owners, of such data" (http://www.uneca.org/search_home.htm, visited 12 September, 2001)

Van Helden as quoted by Stadler (1998:31) cautions that " collecting data is relatively easy but it is the maintenance that creates problems". Each department should therefore take responsibility for its data besides putting in place security checks to ensure that only authorised users get access to the data. An authorised user can be anyone with a right to use the database (Wall, 1998). The issue of copyright in data management is complex and deserves more space than is available in our discussions. However, since there are two issues in this case of copyright and database rights' which may/may not be administered separately, the respective data owners need to define clearly how they can be resolved without loss of income or posing security risks to their operations.

6. CONCLUSION

One way of facilitating sustainable management of cities in developing countries is through availability of the required spatial data for planning the needs of the city residents and being able to model future trends. The problem however, is how this data is handled and processed as besides the issues of governance and accountability, current manual methods in many local authorities are partly to blame for inefficiencies in responding to the changing needs of the urban residents. Development of a cadastre-based postcode as suggested in this paper will not only help quick identification of all properties in Nairobi and their users/uses but aid in strengthening the city's financial base through an up-to-date potfolio of its assets. Creation of databases will enhance the capacity for storage, analysis and dissemination of geo-spatial data. Success of the suggested database will necessitate technical, institutional, and organisational changes which whenever possible should be let to evolve to facilitate smooth transition in the management of data.

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BIOGRAPHICAL NOTES

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