

GIS as a decision making support tool for urban planning and management:: A Practical case of Tanzania

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ABSTRACT

Urban planning and management demands efficient accessibility to more, better, and timely information. This is a key factor to applying Geographical Information System (GIS) technology as a tool in supporting urban planning and management. Using GIS to support a wide range of urban planning and management operations has made an enormous impact towards guiding the development and growth of our urban centres.

By developing and integrating GIS into urban planning and management practices and in the institutional structures of the urban authorities it has become possible to overcome serious lack of valuable information needed for making various decisions at different levels for the proper planning and management of our urban areas.

It is from this premises that the integration of Geographical Information System (GIS) in the urban planning and management practices has become imperative. It is an important element in guiding a sustainable urban growth and development process as well as in the implementation of physical development plans.

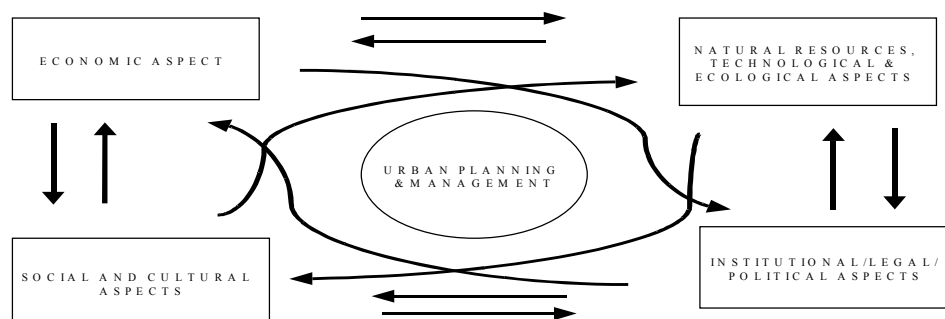
This paper will concentrate on two specific issues. First it will look at the main aspects in urban planning, secondly, it will dwell on the use of GIS as decision support tool in urban planning and management; the Case of Tanzania.

1 INTRODUCTION

Urbanization is taking place ever so quickly that most of the Tanzanian urban authorities are caught in a whirlpool of change-urban development. In response to this growing challenge, urban authorities are striving to built up their capacities in the areas of urban planning and management. The main areas of focus include strategic urban planning and strengthening information management capacities to ensure efficient and effective plans and decisions.

Urban planning and management is an extremely complex process, combining political, socio-cultural, economic, natural and physical aspects of urban growth and development (figure 1.). The majority of the information about these aspects is based on spatial relationships, hence the Information System in urban planning and management should entail an information technology capable of incorporating and integrating spatially-referenced and non-spatial attribute data particularly in this context is the Geographic Information System (GIS).

GIS is fundamental to this process, whether we are considering the provision of socio-economic services or the conservation of natural resources upon which our livelihood depends.



THE INTERRELATED ASPECTS

Figure 1

Decisions in urban planning and management involve complex interrelationships. It therefore needs a thorough analysis of these interrelationship, which in turn requires better and relevant information for decision making. The success of management depends on the decisions that are made.

Agencies involved in urban planning and management to become more responsive to the needs of the communities in their spheres of duty and to properly address their responsibilities; requires improved quality and promptness of the decision-making process preceded by a thorough knowledge and understanding of the issue(s) of concern. One of the prerequisites is information; information in terms of relevance and timeliness, for problem identification and analysis, setting objectives, for shaping alternative strategies, for making decisions and for measuring results against planned goals. Whether urban plans can be effectively implemented depend very much upon the co-ordinative power an urban authority has over the sectoral representatives and other key stakeholders –this can be fostered if an effective information system is in place. The handling of spatial data usually involves processes of data acquisition, storage and maintenance, analysis and output. For many years this has been done using analogue data sources, manual processing and the production of paper maps. The introduction of modern technologies has led to increased use of computers and information technology in all aspects of spatial data handling (Aronoff, 1993). The software technology used in this domain is the GIS.

2 GIS AS A DECISION-MAKING SUPPORT TOOL IN URBAN PLANNING AND MANAGEMENT

Effective urban planning and management demands efficient accessibility to more, better, and timely information in main aspects (figure 2). This is a key factor to applying GIS technology as a tool in urban planning and management. Using GIS to support a wide

range of urban planning and management operations has made an enormous impact towards urban planning practices, it provides much of the impetus for a guided urban growth and development.

Essentially urban planning is spatial data management; GIS offers the possibilities of integrating spatial data sets from different kinds of sources, such as surveys, remote sensing, statistical databases and paper maps. So it is the potential combination of different data sets that is paramount.

With the use of GIS technology urban planning and management process is supported through;

- Building capacity to collect useful information on urban conditions and trends,
- Converting that information to knowledge through appropriate analytic techniques and
- Applying that knowledge in formulating and modifying urban plans and programmes.

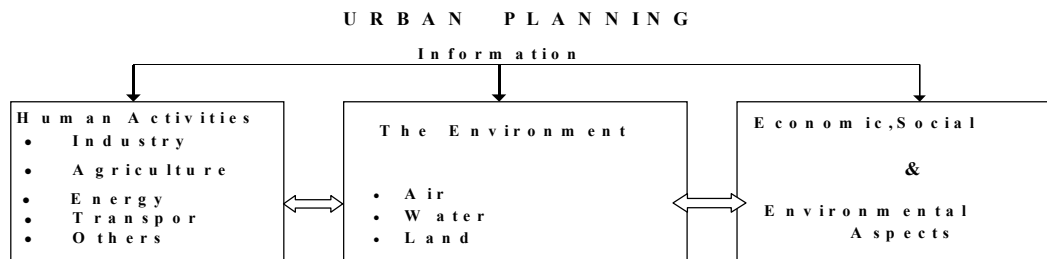


Figure 2:

Decision-making is a process of choosing among alternative courses of action for the purpose of attaining a goal or goals.

According to Lewis (1994), it involves three major phases; *intelligence phase, design phase and choice phase*.

The basic role of decision support tool is to provide information to decision makers in an effective and efficient manner that expedites the decision process in all the three phases.

The Lewis's three phases of decision making implies that each phase must be provided with certain inputs. A good GIS should be able to assist in all the three phases; for instance, to help decision-makers in land use planning to understand the ramifications of selecting a particular land use type. This is done through organising and analysing the information about various alternatives in the process of modelling.

2.1 The Intelligence phase:

In this phase the decision maker surveys the economic, technical, political, social and other aspects to identify new conditions that call for new actions. A variety of data on all the different aspects are required. The surveying of the current situation of a particular problem area provides a decision maker with an insight of the real world picture. The GIS cover an array of methods to acquire, organise and analyse large amount of diverse information. This information is packaged to address a specific issue. The support in the intelligence activity assist the decision maker in which in Lewis's language is described as the need for a "decision" in order to elude an undesired situation (the problem).

2.2 The Design phase:

Using available data decision-makers can model the real world and generate alternative courses of action. This implies that it is possible to explore with GIS a wide variety of "what if" type of questions using different scenarios to forecast the future results of various management options. It is this modelling capacity of GIS, which is of paramount importance with reference to urban planning and management.

2.3 The choice phase:

The process of making choice among alternatives particularly in a participatory planning and management process attempts to satisfy objectives and values of all stakeholders. It is important that decision-makers understand the trade offs and consequences of each alternative as well as interrelationship between alternatives and objectives. Optimisation and priority setting methods, which include map overlaying, zoning, are available to decompose more complex problems into simpler components, therefore enabling the decision maker to make a rational decision.

GIS as a decision support tool can improve the quality of the information on which the decision is based and consequently the quality of the decision by providing not only a single solution but also a range of alternative solutions.

A Decision Support System (DSS) assists the decision-maker in the need for a "decision" in order to elude an undesired situation (the problem). It is the development of approaches for applying information systems technology to increase the effectiveness of decision-makers.

The following domains are of significance:

- Problem identification and analysis
- Setting objectives
- Shaping alternative strategies
- Reducing uncertainties
- Decision-making

- Transparency
- Knowledge
- Participation

3 THE PRACTICAL EXPERIENCE OF GIS APPLICATION IN DAR-ES-SALAAM CITY FOR URBAN PLANNING AND MANAGEMENT

Dar-es-Salaam is the commercial capital and, by far the largest urban centre in Tanzania. It has an estimated population of 3 million with an area of 1500 square km. Infrastructure and service investments have lagged far behind effective demand.

The situation in the city was being characterized by the rapid urbanization and the inability of the city council to effectively respond to the needs of the burgeoning population growth and lack of effective institutional mechanism to manage its outcomes—such as the pressure on urban services and infrastructure. These problems were further exacerbated by a severe lack of current spatial and spatially related information in the form of maps at all scales and basic statistical data necessary to support analytical planning tasks and hence constrained informed urban management decisions. As a result the city faced many problems including inadequate provision of urban infrastructure and services, haphazard development and urban growth patterns along with a general lack of resources, ineffective management and investment.

To abate this situation city embarked on a strategic planning process, and it was felt imperative, therefore, to develop such a comprehensive data base in order to effectively move the process forward, and to assist a number of city, state, and community-based organizations that were beginning to develop new program initiatives to tackle the persistent problems.

A general motivation for use of GIS can be illustrated with the following example. For a planning task usually maps and other data sources are needed. Assuming a conventional analogue procedure we will have to collect all maps and other documents we need before starting the analysis. The first problem we is that maps and other data will have to be collected from different sources at different locations (surveys and mapping division, bureau of statistics, geological surveys etc.) and that they are in different scales and projection . This has to be done manually and requires much time and money ; the expected decision will then get delayed.

With the help of GIS , the maps are stored in digital form in a database. This makes scale transformation unnecessary, and conversation between map projection can be done easily with the GIS software. The spatial analysis can be done relatively quickly by applying the GIS to perform the planning task; this speeds up the decision making process.

3.1 INFORMATION REQUIREMENT

The city found it necessary to identify and clarify issues of common concern and priorities them through a consultative process. One effective way of doing this is through the process of developing a City Environmental Profile, which is a compilation of and synthesis of existing knowledge and data about the city.

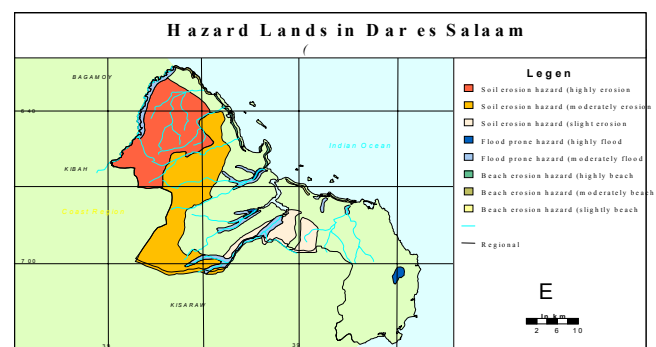
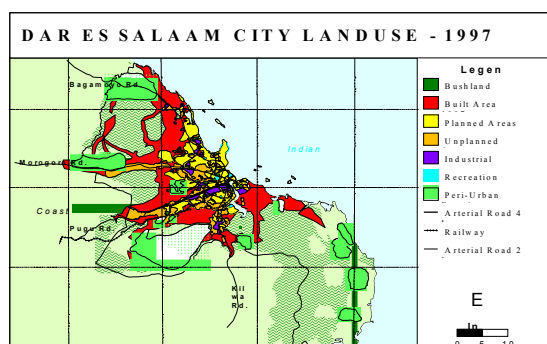
The process of systematic gathering and analysis of relevant information commenced with the preparation of the base map, on the basis of which further information was collected to prepare thematic maps. Thematic maps were overlaid in order to identify competing/conflicting land uses in the different areas of the city. The overlaying exercise resulted into a number of maps on various themes such as land-use suitability, hazardous areas, ground-water levels, and level of utility services which were then used to develop the final strategies for city expansion and urban renewal in the strategic development plan. This procedure of overlaying maps was comprised of the following steps.

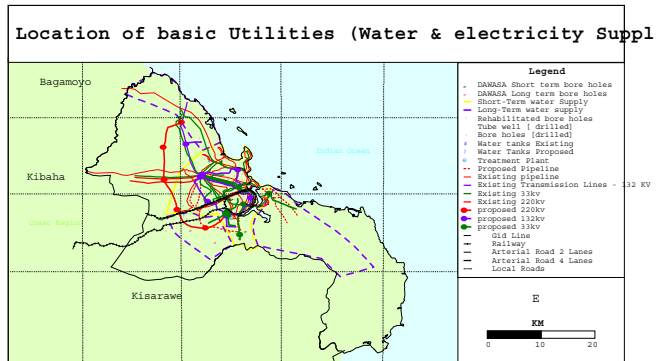
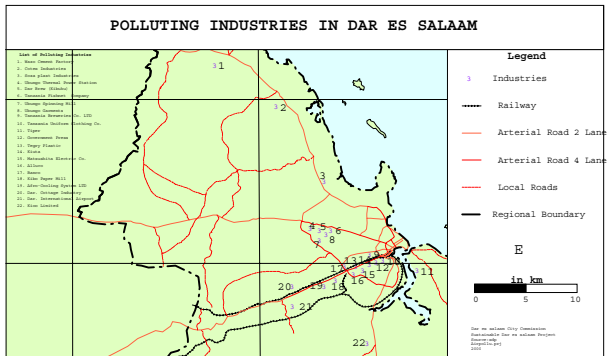
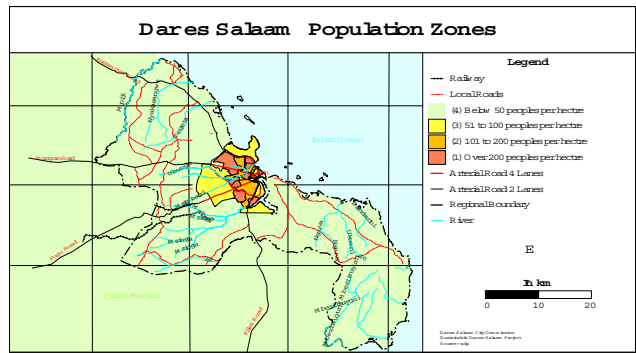
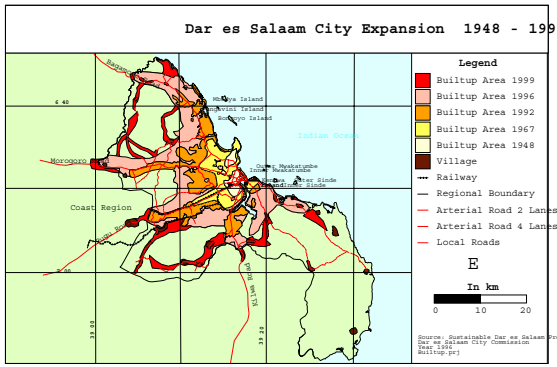
As noted above, the principal reason for creating Geographic Information

System was to provide a comprehensive and systematic database on the city and its neighborhoods, with an emphasis on environmental-oriented data related to problems identified and prioritized in the city consultation, that is:

- Solid waste management
- Upgrading unserviced settlements
- Servicing city expansion
- Managing surface water and liquid waste
- Air quality management and urban transport
- Managing open spaces, hazard lands
- Managing coastal resources
- Urban safety

For all this issues information were needed to provide the foundation for undertaking a comprehensive participatory-based strategic planning process aimed to formulate new initiatives. The GIS provided a powerful means to do the necessary analysis –through integrating spatial and attribute data ,overlaying different layers and visualization; especially in all the areas/issues listed above. solid waste management, liquid waste and surface water management, upgrading unplanned settlements, urban transport and transportation, air and water pollution, crime control etc. among others. A few examples of these are illustrated below.





- The maps created served as the basis for preparing action plans . GIS technology was used to effectively analyze data from several agencies that heretofore had typically been inaccessible. In addition, GIS enabled the analysis of several variables simultaneously (e.g., a demographic variable, location of various services, and public transportation access) and displayed the results of this analysis in a manner that vividly illustrated where a particular problem was most serious.
- These maps readily point out the areas of the city where a particular issue or problem is most serious.

CONCLUDING REMARKS

Urban planning and management involves making decisions, making choices among alternative possible management options, selecting one course of action that meets the set criteria. Solving such complex problems, it is important that these decisions are made well; using the best information, methods and tools available.

Indeed, the use of GIS enabled a wide variety of participants to gain a better understanding of the city, have facilitated the transformation of data into information, and hopefully, new knowledge about various themes. GIS has also enabled the city to more effectively formulate action plans for the required interventions.

In closing, GIS has proven to be an important and useful tool for urban strategic planning. It has enabled the development of a Strategic Urban Development Plan, drawing upon data from a variety of sources and transforming them into more meaningful spatial information/data that has given public, private, as well as citizens, a better understanding of their city and the problems it faces. Based on our experience, we highly recommend other cities especially in the developing world to explore the potential of using a GIS as an urban planning and management support tool.