

GIS for Urban Environmental Management Plan: Making it through the Crisis

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1 ABSTRACT

Ever increasing population on urban areas is the biggest concern in developing countries. With the increase in population and related activities, the demand for supportive services viz. transportation, water supply, drainage/sewerage, garbage collection and disposal etc. that are essential is far exceeding the supply of these services. Each developmental activity includes a land use and these land uses are likely to have impact on the environment. The environmentally relevant land uses are trade and industry, housing construction, transport facilities, utilities, refuse/hazardous waste and wastewater installations, quarrying/mining, power generation, recreation and tourism etc. While taking up developmental activities, the assimilative capacities of the environment to air or water or land pollution are rarely considered. Also, due to lack of proper land use controls, the developmental activities tend to be haphazard and uncontrolled thus leading to over use, congestion, poor land use compatibility etc. The environmental pollution problems in urban areas are becoming complex and are creating high risk environment. The solutions of pollution control in individual sectors viz. transport, industry etc. are not entirely solving the problems.

Conventionally, the environmental pollution problems are solved by introducing environmental management techniques such as control of pollution at source. Like the various causes of air pollution are particulate matter (e.g settling chambers, inertial separators, wet scrubbers spray scrubbers, fabric filters and electrostatic precipitators etc), gaseous emissions, fugitive emissions, odour and noise. These measures are proving to be inadequate because of the complexity associated with the urban dynamics. In large urban agglomerations, the problems cannot merely be solved by pollution control measures only. The consequences of neglecting environmental factors in planning are severe. They are felt as deterioration of the natural systems and likewise the socio-economic living conditions. The environmental problems of concern and increased environmental risks.

There is a need for safer, healthier and sustainable cities. The cause of the pollution problems is to be identified and solutions provided for short-term mitigation measures and long-term prevention measures. For this to be possible is for better understanding of the problems, collective efforts and improved approaches/techniques in planning practice. This may be done through environmental planning by preparing environmental management plans by using modern techniques. This includes mapping the characteristics and environmental profile of an urban area and to identify the environmental pollution hot spots; preparing an environmental management plan that includes rehabilitation and mitigation measures; and recommend guidelines for environmentally compatible land use planning.

Geographic Information System (GIS) is a technique which makes series of maps with one outcome. The comprehensive environmental management plan requires a series of maps to understand the area and to identify the trends to make way out the solution. GIS technique helps to prepare from reference map or base map to other theme maps which characterise the urban area including land use, drainage, topography etc in one hand and specific environmental quality assessment like air pollution potential at source (domestic, industrial, traffic) in different grids (of 1 km X 1 km), water pollution potential, land pollution potential, garbage/solid waste/hazardous waste pollution potential area in other hand. This mapping technique is able to produce all the environmental hot spots due to air pollution, water pollution, solid waste disposal, land use incompatibility etc. and the sources for the same identified. Urban environmental management plan includes mitigation measures and abatement infrastructure and land use controls of an urban premise. The areas of incompatible land uses could be easily identified through overlay analysis in GIS and accordingly planned for shifting either of the source or the receiver to make resilient city. The paper describes the process how GIS can be used for pollution abatement and environmental management measure for making Sustainable City.

2 INTRODUCTION

Three fold increase of population in urban centres in India makes uncontrollable demand for basic needs. The demand for supportive services i.e water, electricity, solid waste disposal, drainage/sewerage line is

accelerating day by day which is beyond the capacity of area services. This demand is not confined not only in one place but through spillover population forms new area as urban sprawl. This development activity has certain positive as well as negative environmental impact on land use. The environmentally relevant land uses are mainly trade and industry, housing construction, transport facilities, utilities, refuse/hazardous waste and wastewater installations, quarrying/mining, power generation, recreation and tourism etc. While taking up developmental activities, the assimilative capacities of the base environment i.e. air or water or land pollution are rarely considered. Due to malpractice land use zonation and controls all the developmental activities tend to be haphazard and uncontrolled thus leading to congestion or over use or poor land use compatibility. The environmental pollution problems in urban areas are becoming complex and are creating high risk environment. Pollution abatement control for individual sectors for as an example Transportation or industry etc. are not entirely solving the problems.

According to 2011 census of India the total population of India is 1,210,193,422. The annual growth of population is 1.8%. The total urban population of India is 377,105,760 which is about 31.16% of the total population of India. The urban population of India has the annual growth rate of about 3.21%. As per 2011 India has 7935 towns. The no of towns grow over 2800 for last 10 years. The urbanization in India mainly is due rural to urban migration of population. The fast growth of urban population impose pressure on urban infrastructure, land, natural resource. The Indian cities are getting suffocated every day due to influx of population.

Sustainable city is the dream of every planner. The concept of sustainable city is thoroughly interconnected with environmental protection and economic development. The sustainable city can be defined as one which is able to support the basic need of the people along with the necessary infrastructure of civic amenities, health and medical care, housing, education, transportation, employment, good governance etc. The fundamental Characteristics of a sustainable city are as follows:

- Adequate governance set up which can meet the need of the population and ensure civic responsibilities, community participation, a sense of identity, transparency and equity in local institution.
- Planned housing system with sufficient infrastructural facility like local market school, medical facility, facility towards waste disposal etc.
- An appropriate transport system acts as the nervous system for any habitation it has also effect on the environment.
- Environmental consideration in the planning and effective environmental infrastructure for environmental monitoring and pollution control.

The success of sustainable city is entirely dependent upon monitoring and management of various aspects of urban and city life practically which is impossible without dynamic information system.

3 NEED OF THE STUDY

There is a need for safer, healthier and sustainable cities. The cause of pollution is to be identified and solutions provided for short term mitigation measures and long term prevention. For this can be possible through better understanding of the problems, collective efforts and improved approaches/techniques in planning practice. This may be done through environmental planning practice by preparing environmental management plans by using modern techniques. This includes mapping the characteristics, environmental profile of an urban area and identification of the environmental pollution hot spots; preparing an environmental management plan that includes rehabilitation and mitigation and recommend guidelines for environmentally compatible land use planning.

Geographic Information System (GIS) is a technique which prepares series of maps with one result. The comprehensive environmental management plan requires a series of maps to understand the area characteristics, to identify the problems and to make way out the solution. GIS technique helps to prepare from reference map or base map to other thematic maps which characterize the urban area including land use, drainage, topography etc in one hand and specific environmental quality assessment like air pollution potential at source (domestic, industrial, traffic) in different grids (of 1 km X 1 km), water pollution potential, land pollution potential, garbage/solid waste/hazardous waste pollution potential area in other

hand. It means this technique is eligible to prepare point data to areal data in one format. This mapping technique is able to produce all the environmental hot spots due to air pollution, water pollution, solid waste disposal, land use incompatibility etc. and the sources for the same identified. This techniques can analyse the impact of point data to areal impact. Urban environmental magement plan refers mitigation measures and abatement infrastructure and land use controls of an urban premise. The areas of incompatible land uses could be easily recognised through overlay analysis and accordingly planned for shifting either of the source or the receiver to make resilient city. The paper emphasises the process how GIS can be used for pollution abatement and environmental magement measure for making Sustainable City.

4 AIM OF THE STUDY

The aim of the study is to develop a urban management information system that can act as one of the important input of information to the decision making authority and town planner with the help of which they would be able to regulate the utilization of natural resources, development and expansion of the city, development of infrastructure facility, monitoring of environmental quality and pollution control.

5 OBJECTIVE

- To understand the characteristics of the information input required for urban environmental planning and management.
- To develop a overall architecture for urban information management system
- To develop a module based information system.

6 URBAN ENVIRONMENTAL MANAGEMENT INFORMATION SYSTEM

In the 21st century Indian cities are growing at a very fast rate in terms of its population size and geographical area. The main area of concern for any town planner is that the basic nature of distribution of development in India is regional imbalance. The primacy of the metropolitan towns are acting as magnetic force for pulling the population and it is the major cause for the rural to urban and urban to urban migration of population. There is always a gap between urban resource, infrastructure supply and demand for the same. Under this circumstances society demands for the development and management of a urban planning and management mechanism based on latest updated spatial information fully and reasonably, will have the capability to provide information system for urban planning management, decision making urban planning administration, development of new developmental and pollution monitoring and control mechanism. The uniqueness of GIS technology lies in its basic capability like data capturing, presentation, categorization, data synthesis, simulation of spatial data, easy updation of data spatial analysis.

Basically GIS is a tool towards automation of regional and urban planning department, up to date development and management mechanism and dynamic scientific policy making system. The basic system architecture towards urban management information system is given in fig – 1

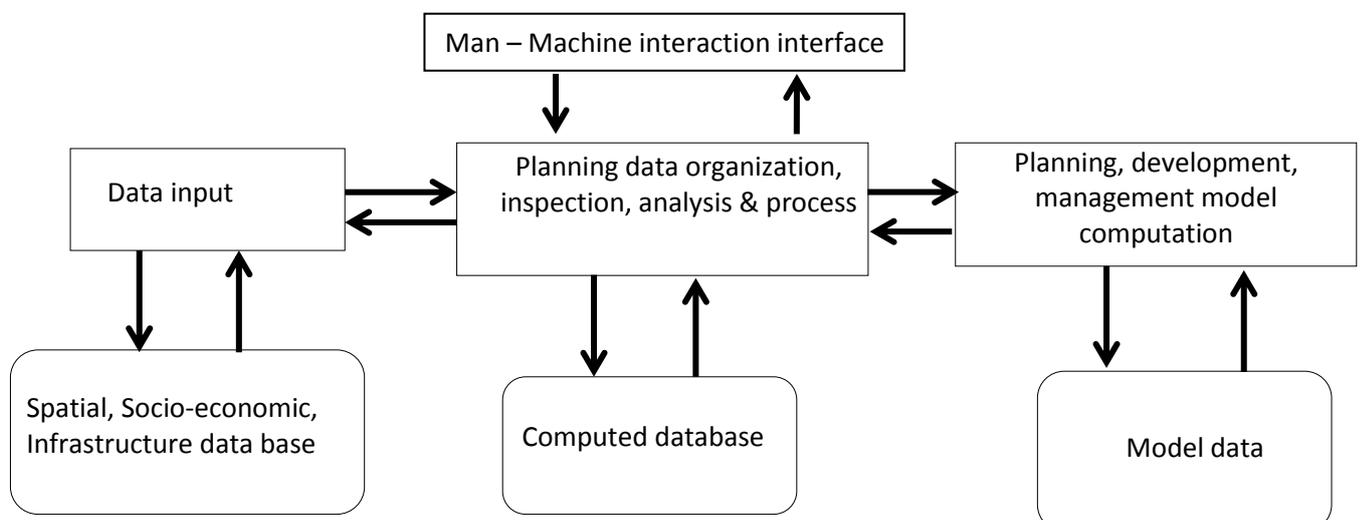


Fig 1: Basic system architecture towards urban environmental management information system

7 DATA MODULES FOR URBAN ENVIRONMENTAL MANAGEMENT INFORMATION SYSTEM

The data and information for urban planning and management information system is basically very complex, multi-disciplinary, and dynamic by nature. The layers of information are spatially and temporally braided. It has spatial data of various natural resources, attribute data to the spatial information, socio economic information, infrastructural information, government policy and planning initiatives. The scale of representing the attribute data should be different at different level . The figure 2 represent interrelationship of various data modules for urban information management system.

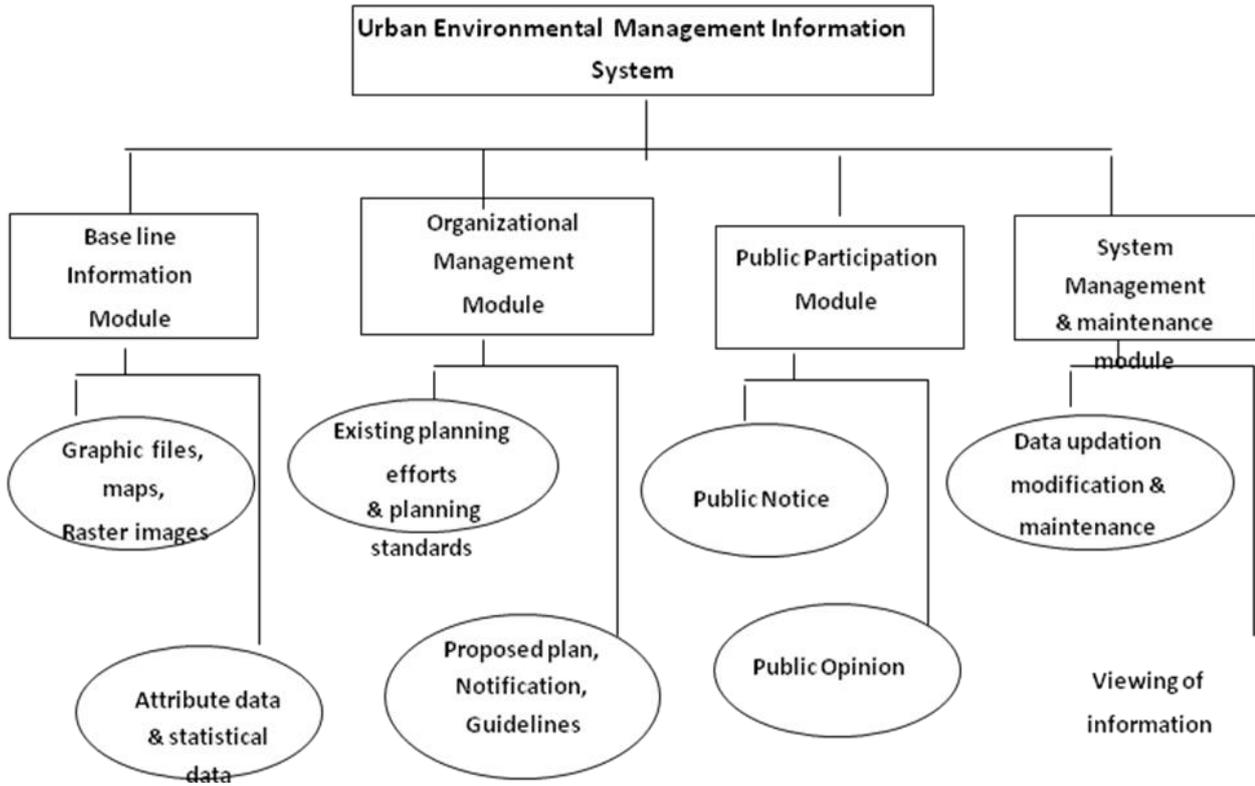


Figure 2 : Data modules for Urban Environmental Management Information System.

(1) Base line information Module:

The base line information module basically comprise of map, graphic, raster image, base line information , attribute data related to spatial information. The module will have the have capabilities of querying building, presentation of the result of the query in both graphical and tabular presentation. The information system will have zooming facilities starting from 1:1or 2 million scale and zooming up to 1: 1000 scale depending upon the resolution of the input map imagery and the level of study (Figure :3)

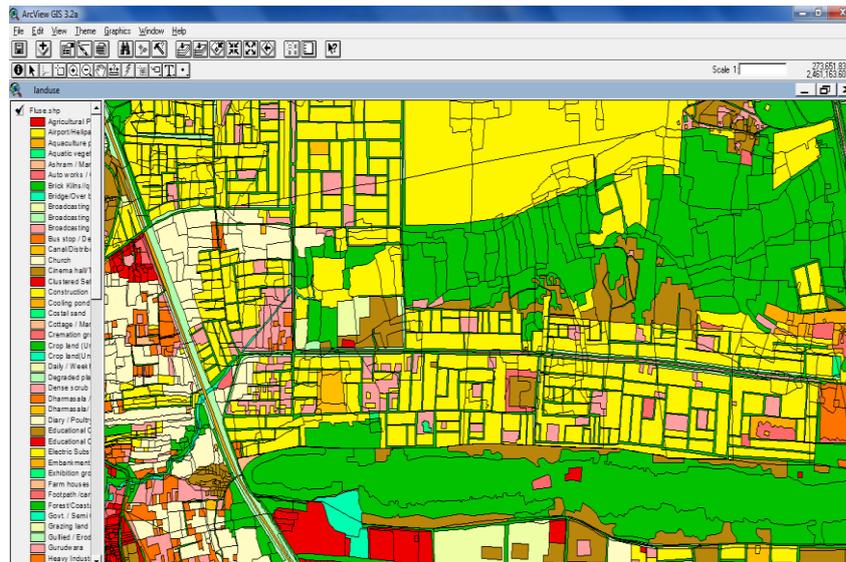


Figure :3 Graphic view of landuse of urban area

The information content of this module will be regional setting, physiography, Demography, Climate , Soil, Drainage system, Landuse, Physical and Social infrastructure, location of Industrial sites, industrial cluster, housing, open areas, natural vegetation, transportation (road, rail, waterways), utilities (water supply, electricity), hot spots, location of monuments, polluted stretch, problem areas, tourist spots, pilgrim areas, tribal settlement , earth quack prone areas and environmental status etc. The statistical information like census information industrial year book, gazetteers etc. information will be the part of this module (Figure: 4)

(2) Organizational Management module :

Broadly speaking in Indian scenario the development, management and decision making bodies are Town and Country planning Organization, Developmental Authority, Municipality, Municipal corporation etc. This module will have three sub modules like basic for Existing developmental plan , Master Plan, Basic Development , planning directives norms, decision towards future development which will help the urban planner and decision makers to carry out the future planning exercise , comparative study for future development, proposal for planning, phasing of development. This module will contain text, and data, map and graphic files with spatio- temporal evaluation characteristics. The basic booklet to be incorporated in thin module will be Master plan, Basic development plan, Building By Law, Environmental Standards, Government notifications, Planning norms, infrastructure development standards various gazetteer, notifications , guidelines and directions published by Government.

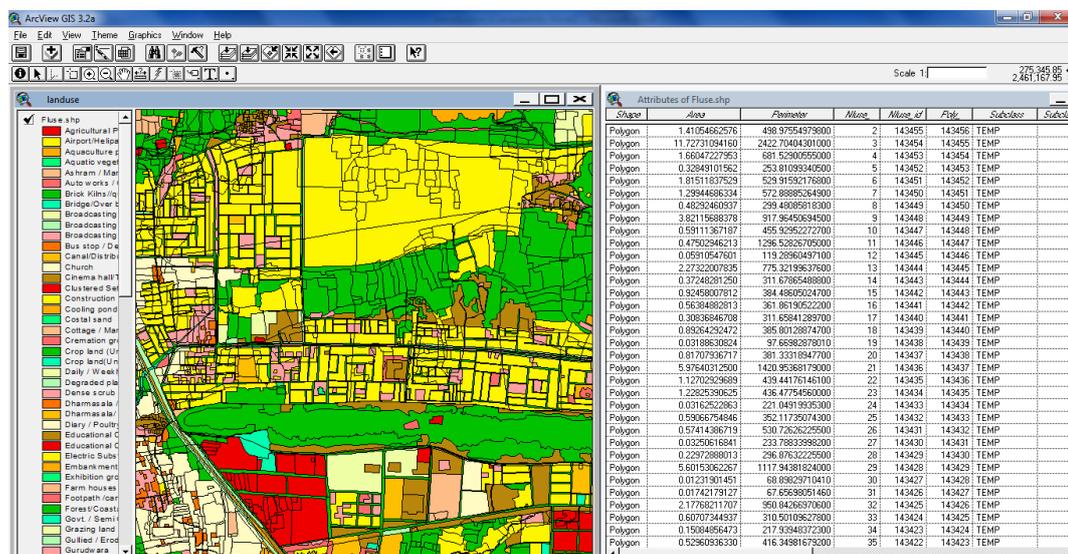


Figure: 4 Attribute Data Presentation

(3) Public Participation Module:

The module will act as a platform for comparing the state physical, social, economic and environmental development of the particular town with the other town, with the developmental standards, Government notice for public opinion for and proposed development and public complaints, suggestion and opinion for the town, and city development. The features of this module will be GDP, total industrial input and out values, industrial emission, vehicular pollution, waste water discharge, waste generation, infrastructure developmental status, landuse change.

(4) The system management and maintenance module:

The module deals with the maintenance and management of the Urban planning and management information system itself. It is basically a user management module. It deals with the various authorization for access, viewing, updation, modification of data, information etc. The user management function may add and delete users for the system and moreover the module-wise authorization will also vary. The data, graphic and map updation may be authorized to different users to update the baseline and other information. The average users will only be able to use data, analyse and compare the data but could not be able to revise, add, delete, modify the data.

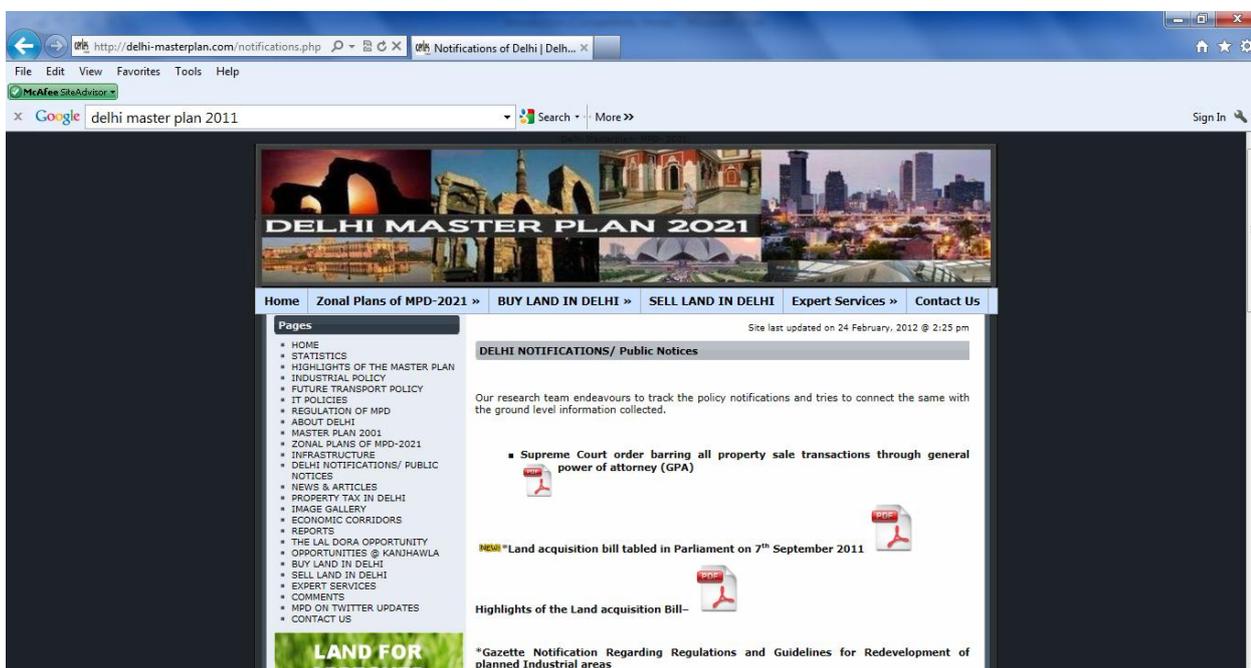


Figure 5: Public Notice

8 OUTCOME OF THE URBAN PLANNING MANAGEMENT INFORMATION SYSTEM:

- A gateway to dynamic planning: A developing country like India which is in the transition stage of office automation this information system will act as platform of integration of traditional data and information system and the modern and dynamic GIS based information system. GIS will not only help in storing, updating, analyzing and presenting the information but also support the information system to connect the site/location specific information with the day to day decision making process.
- Efficient data management : Planning exercise needs a wide range of data and information. In GIS platform every data and information are stored in different coverage, It helps in integration and differentiation of graphic and data base information. This information system will give the capability of comparing the change in landuse pattern, Population density at the national level as well as at the city level. At the city level it can go upto the details of house hold details, location of municipal waste storage point, distribution of power grid, Gas pipelines etc. All these information are to be represented and compared graphically and with the data table and text.
- Tools for data analysis: This information system has the capability of performing the user - based data query. The types of data analysis used by the planners, developer, decision maker will be

different from the academicians, general public. Every user will retrieve, plot, analyze the data as per the requirement.

- **Transparent planning:** The information system will represent the information related to the existing status of infrastructure facility, population density, pollution status, status of solid waste management, status of effluent discharge in one hand and the government proposal, action, plan on the other hand. With the dynamic nature of the information flow the planning, monitoring and management exercise will be more transparent.
- **Active public participation in planning:** the proposed information system will be web based and it would not be software biased. IT could be opened with any operating system. As all the information are easily available the people will be able to take active participation in the planning and developmental activity.

9 CONCLUSION:

Modern GIS integrates various kinds of advanced, dynamic, multi-layered, time series data and graphical information which transform the tedious data analysis job to a faster, dynamic and realistic planning exercise. Regular updation of information makes the monitoring and management of urban space more transparent and realistic approach towards development. This information system can be used as a tool for urban environmental management as well as it can also be a useful support system for property tax collection, land value evaluation etc.

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