Urban Sprawl Monitoring and Modeling of Aligarh City Using Remote Sensing and GIS Techniques

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Abstract:

All human settlements sustain on land and it is the land which constitutes the single most important component of the total environment. Any environmentally compatible, urban planning must begin with a comprehensive look on the use of land. So, the planners need detailed information about the extent and spatial distribution of present various urban land uses, housing characteristics, population growth patterns, urban sprawl, existing condition of infrastructure, utilities etc. For planning of these utilities in a better way, planner needs the total information in a map and information related to these aspects for perspective planning and management. The need of the hour is to create an urban land information system for development to retrieve, integrate and create various planning scenarios for decision making. The Remote Sensing and

Geographic Information System has proved its potentiality and its vital tool appropriate for creating such type of information systems for country and it provides the planner to handling and evaluates the demographic conditions, growth trends, utility, services and resources in a multi-disciplinary approach for timely results with less cost. This study presents the significance of these techniques in creating information system useful for urban fringe development. Land consumption for urban purposes is increasing every year at a very fast rate. Besides, substantial land acquired by city dwellers for intended urban purposes along the urban-rural fringe has been rendered saline.

Keywords:
Urban Sprawl; Monitoring and Modeling
Remote sensing and GIS; Urbanization

Introduction:

The present formations for the most part of Indian cities urbanized through growth of antique urban cores trespassing to rural firings areas. One third of country's population already living in urban areas, it become to very important present information on urban development pattern and impact on existing environment, is evident that present trend of urban development is disorganized along the urban rural fringe areas in Indian cities. Sprawl has been criticized for eliminating agricultural lands, spoiling water quality, and causing air pollution (Allen and Lu, 2003). So in India, present to need for planners and administrators to monitor the disorganized development pattern and altering land use along to urban rural fringes areas, surrounded by densely populated of urban core areas. The uncontrolled urbanization has been responsible for many problems, our cities experiences today, resulting in substandard living environment, acute problems of drinking water, noise and air pollution, discharge of water, polluted the ground water resources, disposal of waste, traffic congestion etc. Some researchers have

employed an array of indicators, including land-use conversion,

Population change, traffic and vehicles, miles travelled, energy consumption, and fiscal measures (Nelson, 1999). To improve these environmental degradations in and around the cities, the technological development in relevant fields have to solved these problems caused by rapid urbanization, only then the fruits of development will reach most of the deprived ones. The physical expressions and patterns of sprawl on landscapes can be detected, analyzed and mapped using remote sensing and GIS techniques (Gadal et al., 2009; Hasse, 2007; Kumar et al., 2008; Pilouk and Abdu Rahman, 2007; Rashed, 2007; Yang, 2007; Zhu and Hu, 2010; Hurd et al., 2001). Devoted software programs developed for simulating urban sprawl, for example NAUTILUS (2001) and Impact (USEPA, 2002).

The modern geomatic technology such as namely remote sensing and gis as well as satellite based systems, allow us to collect lot of physical data easily, with speed and on cyclical basis, to analyze the data spatially, offering possibilities of generating various modeling, thereby optimizing to the total planning procedure. These information systems also offer interpretation of spatial data with other socio-economic data, and given that an essential linkage in the total planning process and creation it more valuable and meaningful. Recent technological advances made in domain of spatial technology cause considerable impact in planning behaviors. This domain of planning is key of significance for a nation. The purpose of using geomatic techniques is that, maps provide an added dimension to data analysis which carry us one step closer to visualizing the complex patterns and relationships that characterize real-world planning and policy problems. Visualization of spatial patterns also supports modify investigation, which is significant in monitoring of communal indicators. This in turn should result in improving need assessment. The progressive satellite based used in geomatic techniques of land surface mapping give a batter opportunity for making of more accurate and detailed maps of our cities. These maps can gives urban planners with a better understanding of city growth, dynamics of the urban rural boundary, monitoring of stress on the existing civic amenities and urban infrastructure. They may also help in taking remedial measures and future developmental planning.

Study Area:

The study area consist of Aligarh city and its surroundings, which is separated an area of 56.23 Sq Km. latitudinal and longitudinal extend of study area is 27^0 50' 49" to 27^0 57' 02" is 78^0 02' 01" to 78^0 06' 34" which is speadover an area of 132 km approximates is southeast of Delhi in western Uttar Pradesh. The city was initially established as a Koil fort in the 12^{th} century and was taken by the British in 1803. The remains of prehistoric fort at a standstill the distance of 3 km north of Aligarh city. The study area is located in Koli tahsil of Aligarh district. The city is administrative headquarters of the district and agricultural trade center. The study area municipal limits as notify in 1955, in 31.57 km^2. The Aligarh district Percentage decadal variation in population is 12.45 in 1951, 22.16 in 1981, 29.95 in 1991 and decreasing in 22.08 in 2001. The population of Aligarh in 1901 is given as 70127. It has since increased progressively to 669,087 in 2001, and is predictable to be

832,575 up to 2010 and expected to be 10,37,418 in 2021.

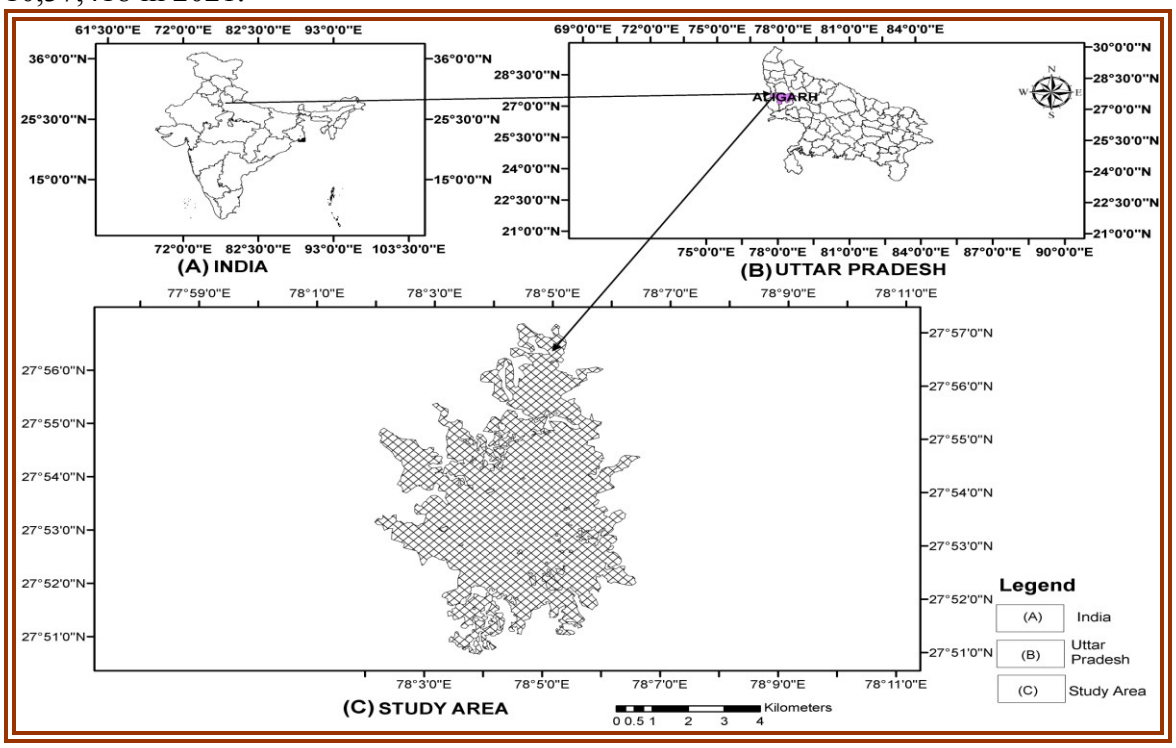


Fig:1- Study Area Map of Aligarh City

Data Used and methodology:

The data acquired for the present study comprised topographic map, satellite imagery and demographic details. For mapping the extent of the urban area as it stood at the 1971 level, Survey of India Topographic map 54I/1 (surveyed 1971 Published 1975) was used. A part from the extent of the urban area, this has detailed of drainage, water bodies and irrigation system, rail and road network, built-up area, and administrative boundaries. Landset data made available under NASA sponsored Global Land Cover Facility (GLCF). For 1989, Landsat TM data was used whereas for 1999 Landsat ETM+

data was used. Simple image data of Modis satellite for study area acquired April 05, 2010 was used to map the extent of sprawl as it stand today.

The topographic map of Aligarh on 1:50,000 scales has been groreferenced using Erdas software. The extent of urban area of Aligarh as it stood in 1971 was vectorized from the survey of India topographic map. Cultural features viz., roads and rail were also vectorized. Various classifications of the Landsat data for 1999, in conjunction with numerous field checks in the core and fringe areas, provide the basic for identification and delineation of urbanized areas.

For delineation of urban sprawl Landsat data for 1989 and 1999 and Modis data of 2010 were enhanced in different ways using Erdas and Arc GIS software. All images were georeferenced using

coordinate of well established GCPs from the survey of India toposheets on scale of 1:50,000.

The identification of urban structure and its evolution rather than mapping of typical land use/ land cover classes. The approach was only to map the settlement pattern under densely built-up and sparely built-up areas. Visual interpretation techniques of satellite data were used to interpret and delineate of Aligarh city area. Due consideration was given to delineate the broader levels of land use zones within the old city areas.

For identification urban area of Aligarh city and field check was considered an essential exercise, where by relationships between different ground features and their corresponding spectral signature was established. A handheld GPS receiver was used for determining the location of different type in the field and relating these with pixel clusters in image to identify their spectral characteristics. In addition to relating spectral signatures with land use type, ground data collected through field surveys provided the basic for determination of accuracy of manual classification and identification of empirical relationships between surface properties and satellite observations. Hence, the collection of an impartial data set for ground information was imperative for successful image classification and interpretation.

Result:

In the present study, the extent of the urban area has been charted from 1971 onwards. The urban area of Aligarh consists of the old, thickly populated core constituting the ancient city which was in existence before the master plan for Aligarh, was put in place in 1981. This is almost completely covered and there appears to be no patch available for any kind of development. The core area is subject to a mixed and complex land use and it is not possible to assign any one category of land use in this part. The enhanced image and FCCs prepared from these were interpreted using tendered image interpretation techniques based on

Table 1: Trends of Urban sprawl in various years

Sl. No.	Years	Area in Sq. Km
1.	1971	17.32
2.	1981	22.10
3.	1989	27.53
4.	1991	29.12
5.	1999	39.89
6.	2001	45.76
7.	2010	56.23
8.	2021	75.23

Source: Census of India

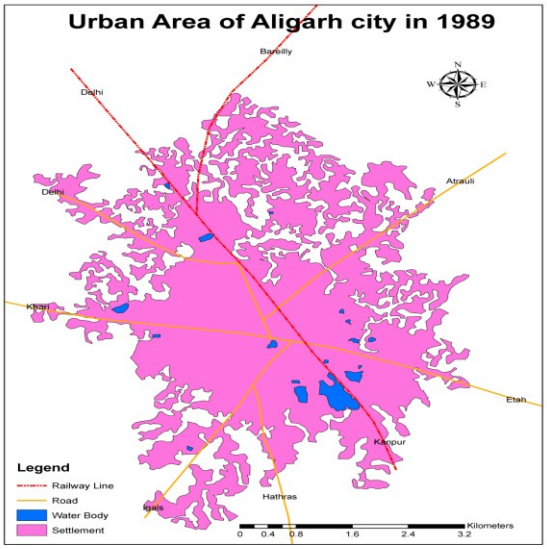
shape, size, tone, texture, pattern, location and association so on, for delineating the urban extent. In the Landsat TM data for 1989, as also in the ETM data for 1999 and MODIS data for 2010, of band combination 7, 4, 2, the built up area shows as clear in mottled brownish purple patches. The extent of identified urban area have been check during field survey at suitable spot locations were made as detailed above, for overall improvement in mapping accuracy. The extent of urban area in year 1989, 1999, and 2010 are shown in Fig 2, 3 and 4.

The figure one shows the built-up area of city in 1989 and 1999 the pattern of growth changed from a low density to a high density ribbon sprawl as evident from the extensions of city along the major transportation corridor shown in figure: 4, Connecting Aligarh with Delhi, Mathura and Bareilly. Similarly figure:4 displayed that the sprawl of city, particularly along the Aligarh with Delhi, Mathura, Bareilly, Etah and Atrauli highways, but increased in length and width, but there has been substantial low density Sprawl development along the eastern fringe of the city.

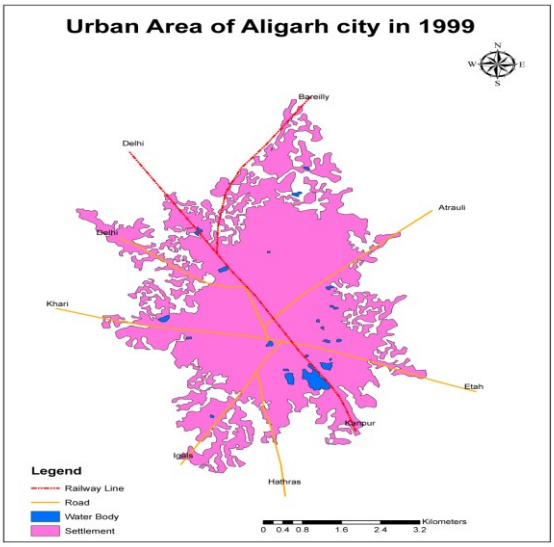
Table 2: Trends of Population Growth in Aligarh City

Sl.No.	Years	Population
1.	1901	70127
2.	1971	252314
3.	1981	320816
4.	1991	480520
5.	2001	669,087
6.	2011	872,575
7.	2021	10,37,418

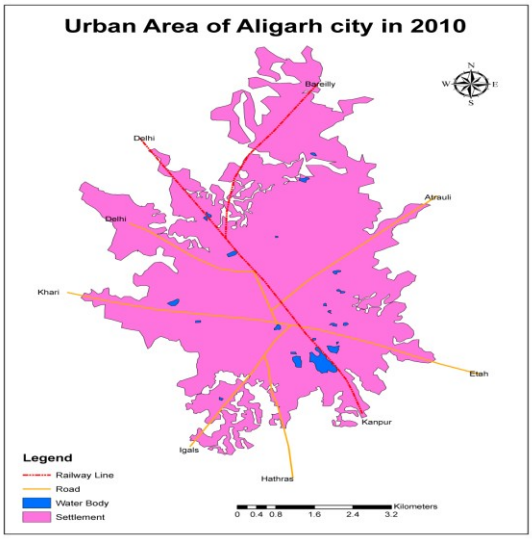
Source: Census of India



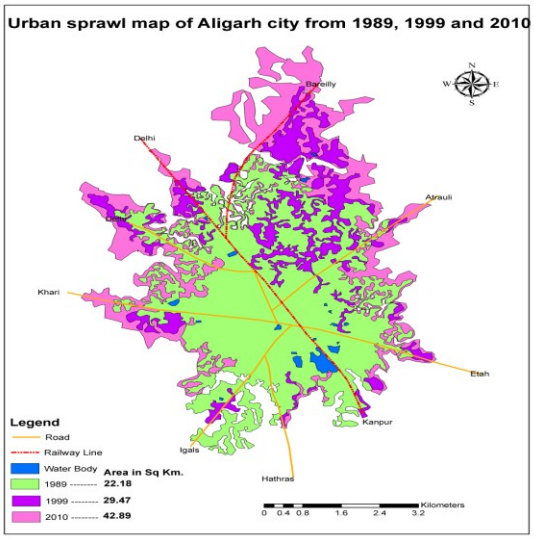
(Fig-2)



(Fig-3)



(Fig-4)



(Fig-5)

Discussion:

The total urban population of India is estimated 285 million approximately. It is more than the total population of several countries. It is also a little over 10 percent of the total urban population of the world. These are 5161 urban centers in our country, a thousand more than in 1981 (Sivaramakrishna el al., 2005). The urban population of Aligarh city alone has scored from 2, 52, 314 in 1971 to more than 7, 89, 529 in 2006 that is more than three fold increase over a three and half decadal time span. This has been accompanied by an unprecedented wave of development. Notwithstanding the poor population control facilities, every person added to the population consumes additional resources and creates additional waste.

Investigating the interrelationships between sprawl development and available civic amenities/infrastructure reveals the

plight of administrators in maintaining and developing these. In the case of Aligarh, increase in tax revenues has obviously not been commensurate with urbanization as is evident from the fact that as of now, 17.74 km^2 of the urban area lies outside the municipal boundary, and therefore taxable

boundaries. This implies that where as the existing public services and infrastructure such as road, water supply, sewage, schools and hospitals are under sever stress, the demand of extension of these has increased manifold. It also means that the municipal authorities are not able to cope with the situation because of low revenue collection. All this has resulted has decline in the quality of life, especially for the growing urban underclass. Land consumption for urban purposes in the last 15 years is estimated to be 1.428 km/ year (Urban Health Initiative Report of Aligarh city February 2010 /Page 2 of 4).

In the context of sprawl development, one of the primary issues is the loss of primary Agricultural land due to urbanization on average, an estimated 95 ha of agricultural land has been covered to urban use per year in the last 21 years. It is alarming to note that the rate of land consumption for urban purposes in the last 11 years has been a high as 171 ha per year.

Conclusion:

Mostly Land use activity in urban areas spells irreversible changes. There is a need to balance present requirement of land against future needs. Preserving agricultural land in the fringe area of expending cities is vital for preserving and maintaining open spaces and therefore, environmental quality. The regulate and control the development of sprawl, land use control regulation through legislation may be warranted. To adopt an informed and scientific approach towards urban planning and management. Remote sensing data coupled with Geographic information system (GIS) is a vital tool to generate and handling the large volume of idea in a suitable manner for proper urban land use planning and management.

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