GIS Based Assessment of Satellite Town of Jaipur City for Sub Urban Planning

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Abstract— Explosive increase in urban population especially in major cities and towns has brought the strain on sustainable development of the city. Jaipur is one of the rapidly growing cities of India, facing several problems. One of the major issues is to find new area as well as restricted areas for further urban development. Therefore effective and efficient planning becomes mandatory for sustainable development of Jaipur. This research aimed to ascertain the built up growth of Jaipur city and its satellite towns; as well as connectivity of satellite town with all the basic amenities and facilities. In this paper satellite images are used to map built up growth and proximity analysis using GIS deployed for assessing connectivity to Jaipur city. Built up are showed enormous increase for Jaipur city and its satellite towns in last four decades. However proximity analysis provided details of distance to basic amenities and facilities from all towns. Although all towns are very well connected with road network but distances from facilities and basic amenities are almost lie in the range of 30-40 km, which indicated requirement of efficient transportation to avail facilities. Results can be used as preliminary guidelines for local governments and planners regarding development and management to achieve sustainable city.

Keywords: GIS, Remote Sensing, Urban Growth, Satellite Town

I. INTRODUCTION

Urban growth is common phenomena for a megacity, and this becomes serious concern due to unplanned or illegal development taking place in the absence of proper plans and monitoring [1, 2]. Rapid urban growth is mostly influenced by rise in population, economic growth and migration of people from nearby towns and villages to the city for better future prospects and to avail basic amenities and facilities. The extent of urbanization not only transforms the land use patterns but also considerably affecting the urban environment and existing infrastructure, which may threaten the urban sustainable development [3,4].With proper and effective transportation system, a city could become an example of transit oriented development (TOD) city else in absence of efficient transportation system an unplanned growth visible and leads to growth oriented developments

[5]. However, growth oriented developments are very common in developing cities and countries, which lacks effective plan and policies for a city development [6, 7]. India also has many cities which are developing with high growth rate from last two decades. Jaipur is the one of them which is also rapidly growing due to high population growth rate. Therefore stress on city is continuously increasing on basic Amenities as well as on natural resources such as water, sand, agriculture land and forest etc. There are several studies and research, which shows planning and requirement for sustainable development of city [8, 9]. Development of satellite town can be one of the innovative approaches to reduce the stress on main city. A satellite town defined as a development of town located near the main city and has good development prospects using TOD concept. This approach can lead to sustainable development as well as will help to manage and maintain the urban ecosystem of city [10]. Remote sensing and GIS (Geographic Information System) is suitable for urban change detection and to get detailed information for sustainable urban development [11]. In this scenario, remote sensing and GIS based outcomes would help the planning body/ decision makers to demarcate the city boundary and its expansion limit. Otherwise such issues will increase in future with the increase in population, non-availability of services and amenities, hence need to find out the sustainable solutions for city development [6, 10].Therefore, the aim of this paper is to implement the GIS approach to find out the most promising satellite towns of Jaipur city for future development strategies and to reduce the impact of migration and unplanned development in Jaipur city.
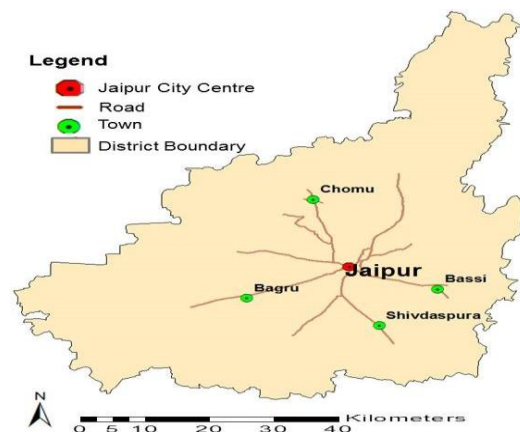
II. STUDY AREA

Figure 1: Study area

In this research Jaipur is selected as working location to analyze. Jaipur district, covering geographical area of 11,061.44 sq. km and extending between 26° 25'N to 27° 51'N latitudes and 74° 55'E to 76° 15'E longitudes forms east-central part of the Rajasthan State. Jaipur city is the capital of Rajasthan, popularly known as Pink city is located in the Aravali hills at an altitude of 431 meters above mean sea level. Jaipur city is main political and administrative center of Rajasthan state and also have many industrial zones, commercial areas, sports facilities, and specialized hospitals. It is also selected as heritage city by UN due to many heritage locations, fascinating forts and magnificent palaces; so it is a major gateway for tourist from India and abroad. Jaipur is the most promising city of northern India and developing with high growth rate. Jaipur is well connected to other cities of India by railway, air as well as bus and with many international cities, which make this city very favorable city. Physiographically, the city area is characterized by sandy-plains, hills, intermountain-valleys, pediments etc. Major part of the city is covered by the alluvial sandy plains. Jaipur has a semi-arid climate and annual rainfall is 650 mm. Most of the rainfall is received in the monsoon months between July and September. The mean daily maximum temperature is highest (40.6°C) in May, whereas mean daily minimum temperature is highest (27.3°C) in June. The on-set of monsoon in June end/July brings down the temperature.

III. METHODOLOGY

To achieve the objective of this research, a method is defined, which includes classification of satellite image and database creation using GIS and image processing software. Satellite image of Landsat were acquired for 1975, 1989, 2002 and 2016 to determine the Jaipur city growth changes and its satellite towns. Basic image classification approach is used followed by image layer stacking, subset and mosaic. Supervised image classification deployed to create land use/land cover map of Jaipur city and its satellite town.

Road network, industrial zones, railway station, bus stand, airport and hospitals locations were generated in GIS environment. Proximity analysis was performed to find out the distance of satellite town from city centre. The database for proximity analysis was created for different parameters such as distance from city centre, railway station, airport, bus stand, major hospitals and industrial as well as special economic zones located in all over Jaipur. To perform proximity analysis buffer zones with distance of 10 km radius were generated in an increasing pattern for all the parameters.

IV. RESULTS

All the four selected towns were analyzed using distance based parameters mentioned in methodology. It is found that towns located in northern and southern part of Jaipur are more promising compare to other two towns. There are several reasons but important are proximity to emergency services such as Sawai man Singh hospital in northern Jaipur and Mahatma Gandhi hospital in southern Jaipur as well as industrial zones such as Sitapura area in southern Jaipur whereas Vishwkarma industrial area in northern Jaipur.
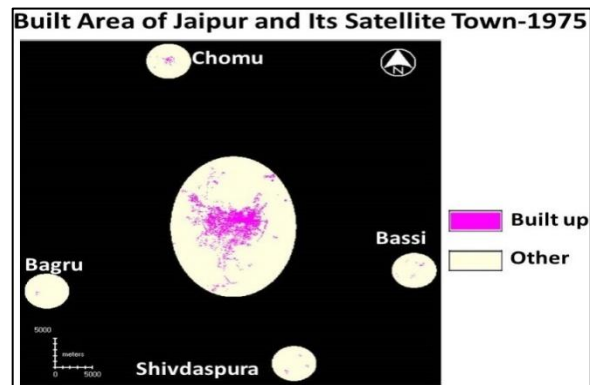

Figure 2:Built up area (1975)

(i)Built up Change Mapping

Built up changes were mapped for 1975, 1989, 2002 and 2016 using Landsat satellite images. Results indicate that all towns were very less developed compared to Chomu. Built up area in Jaipur was 3209.4 hectares, if we compare area wise it is less than 1% for all towns in 1975 (Figure 2) of Jaipur City. Figure 3, clearly depicts the built up growth in Jaipur city as well as in satellite towns in year 1989. Built up of all the towns increase more than thrice of 1975 built up where as built up of Jaipur city increased by 98% of 1975 built up.
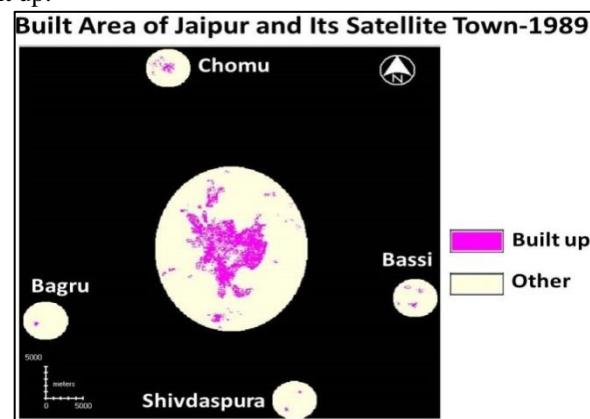

Figure 3:Built up area (1989)

Built up growth was increased to 100% of Jaipur city in 2002 as shown in figure 4. At the same time Chomu, Bagru and Bassi also increased enormously in last 13 years whereas Shivdaspura is growing with slow pace compared to others.
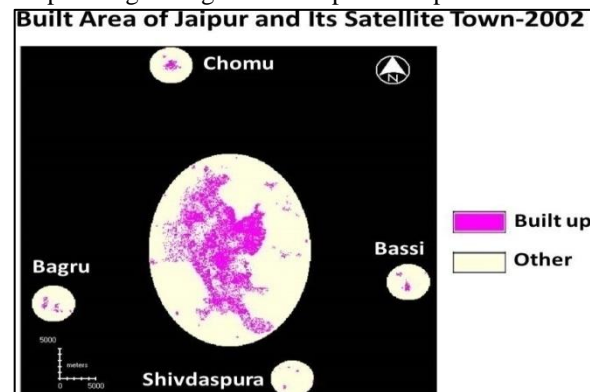

Figure 4:Built up area (2002)

In 2016 Jaipur city emerged as huge city which expanded more than 30km from north to south and same in east to west, as shown in figure 5. Jaipur growth rate is also increased compared to other two periods of study. Dynamic change in built up is shown in figure 6, which indicate that Bagru had highest growth in 1989-2002 period compared to others whereas Jaipur city is growing with same pace in last four decades.
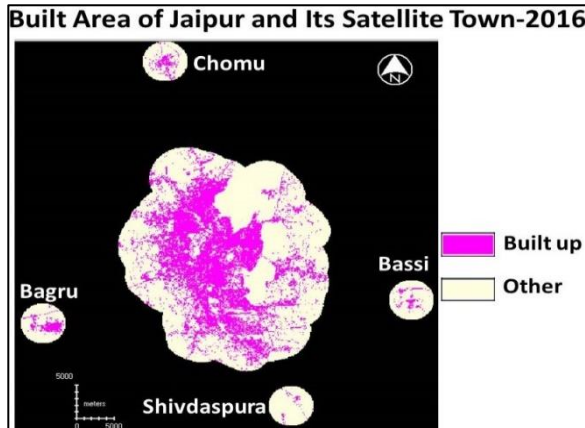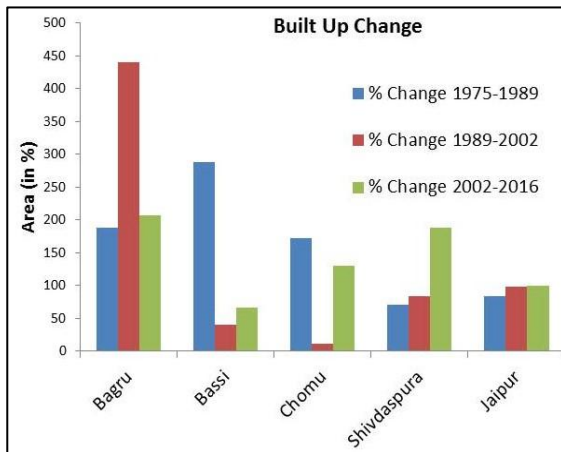

Figure 5:Built up area (2016)

Figure 6: Change in Built up area

Figure 7implies,Shivdaspura and Bassi are having almost same increase of built up during 1975-2016 i.e. 810% and 800% respectively. Whereas built up of Jaipur city and Chomu having same growth rate i.e. 625% and 605% respectively. Bagru is growing exceptionally with high rate compare to other towns.
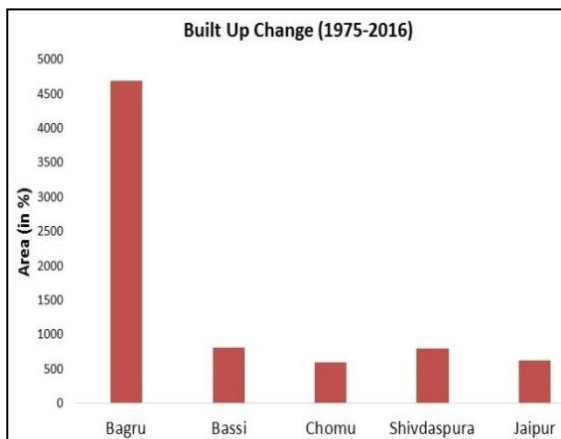

Figure 7: Change in Built up (1975-2016)

(ii) Proximity to City Centre:

Distance from city centre i.e. central business district was assessed using proximity tool of GIS. It is clearly visible in figure 8 that Bassi and Shivdaspura are located within less than 30 km distance where as Chomu and Bagru are located in 40 km buffer ring. All the towns are very well connected with Jaipur city as they lie on the National highways.
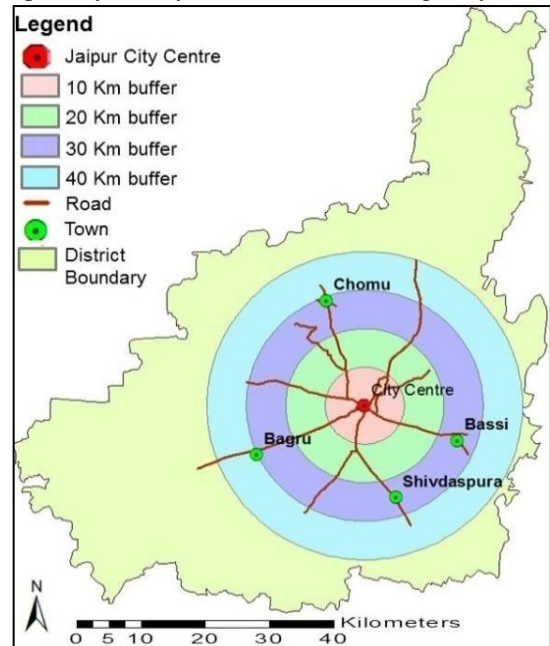

Figure 8: Proximity to City Centre

(iii) Proximity to Railway Station:

Jaipur Railway station is the only major railway connecting station for all these towns. Jaipur is very well connected from all major and minor cities of India. Results (Figure 9) indicate that Shivdaspura is nearest town whereas Chomu is farthest town from Jaipur railway station. Other two towns are almost on equal distance from Jaipur railway station.
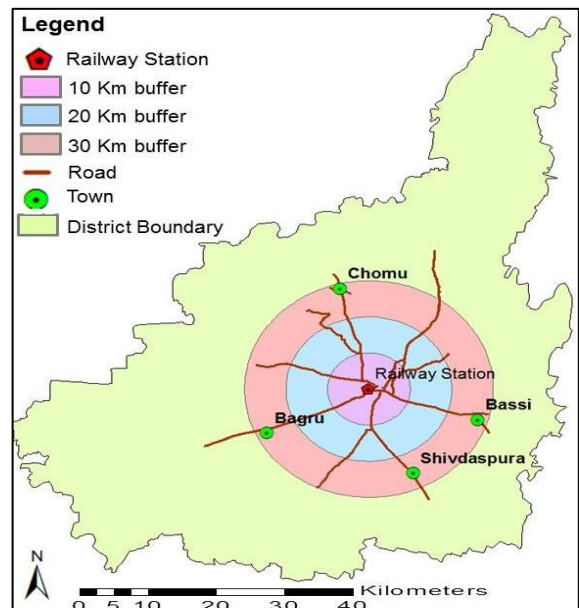

Figure 9: Proximity to Railway Station

(iv) Proximity to Bus Stand:

Jaipur bus stand is major bus stand of Jaipur district. Its distance from all towns is same (Figure 10) as railway station but due to the good connectivity through national highways, it facilitates people to use bus service more as compared to railways.
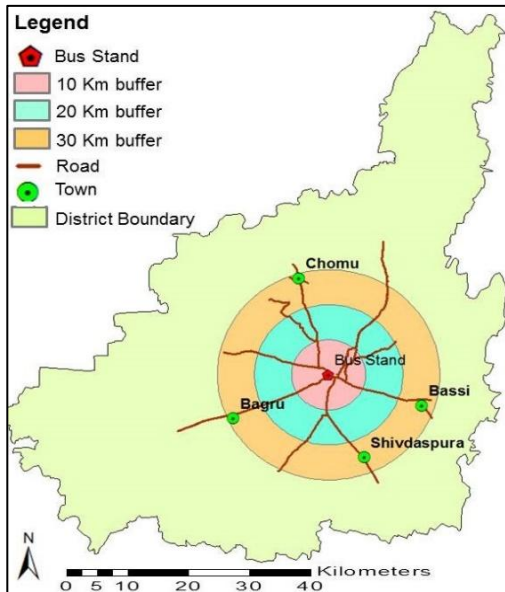

Figure 10: Proximity to Bus Stand

(v) Proximity from Airport:

Jaipur is having an international airport, it is located in southern part of the city. Results (Figure 11) reveal that Shivdaspura is located very near to airport compared to other towns whereas Chomu is farthest as it is located in northern part of Jaipur district.
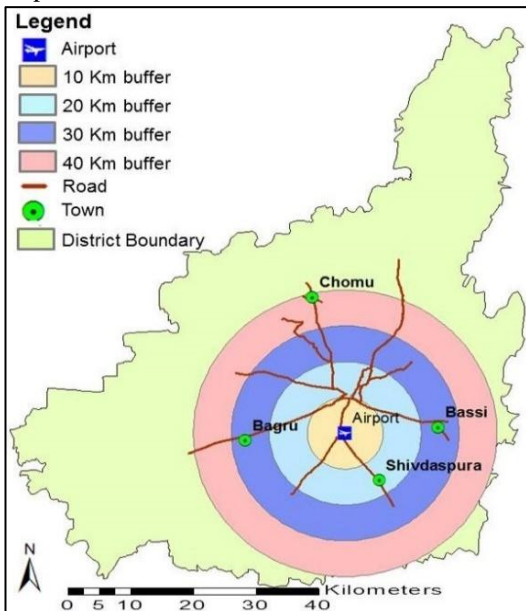

Figure 11: Proximity to Airport

(vi) Proximity from Hospitals:

There are so many good hospitals located in Jaipur which are providing multispecialty facility, among these Sawai Man Singh hospital is largest one and government owned hospital. These hospitals are located in the middle and southern part of Jaipur. In the middle part Jaipuria Hospital however, Mahatma Gandhi Hospital is located in southern part of Jaipur.
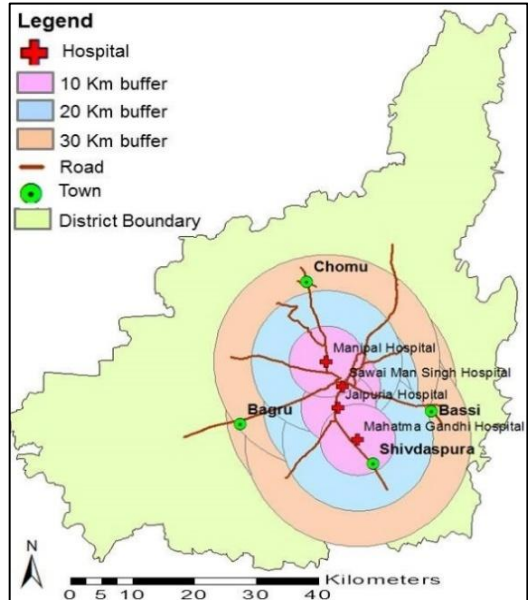

Figure 12: Proximity to Large Hospitals

GIS analysis results (Figure 12) reveal that Shivdaspura is located within 10km area of major hospitals, whereas others are located in 30 km buffer area from Main Hospitals of Jaipur city.
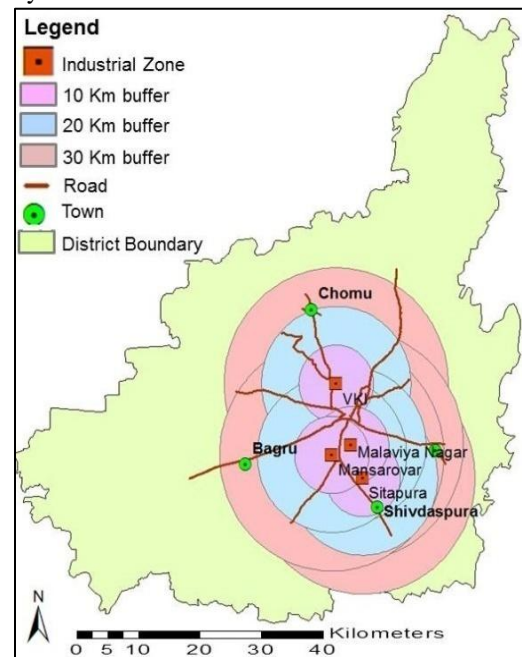

Figure 13: Proximity to Industrial Zones

(vii) Proximity from Industrial Area:

Jaipur is having many industrial zones which are mostly associated with highways and located in sub urban area of city. Sitapura industrial area is located in southern extreme part, whereas Vishwkarma industrial (VKI) area in northern part of city. Two other industrial zones in western part located on Ajmer highway and Mansarovar area of Jaipur. Figure 13 reveals that Shivdaspura is close to Sitapura industrial area, Chomu is near to VKI, Bagru is closed to industrial area located on Ajmer highway and Bassi is located near to Malviya nagar industrial area.

V. DISCUSSION AND CONCLUSIONS

This research brings analytical information for planners to make Jaipur city a sustainable city by developing nearby satellite town using concept of TOD. Satellite town development will decrease the stress on main city and leads to manage the urban ecosystem.

Satellite data derived land use change analysis indicate huge built up growth in all the four towns, which make them favorable for further development and to improve the connectivity with Jaipur city. Bagru and Chomu emerged as rapidly growing town where as Bassi and Shivdaspura showing good prospects for future developments.

Proximity analysis based on different parameters providing noteworthy facts to consider these towns while planning and developing Jaipur city. Bagru, Chomu and Shivdaspura is most approachable as per the industrial, road and hospitals parameters. Shivdaspura is very well connected to airport, industrial area and Major hospital, which make it most important town for planning and development.

Built up growth of all towns and proximity analysis provided significant results those suggest efficient connectivity system such as mass rapid transit system required from town to Jaipur city. Therefore planners and developer need to focus on TOD approach and prospects for sustainable growth of Jaipur.

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