

Demography, Urbanisation and Urban Planning of Smart Cities using Geographical Information System

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Abstract

"The 19th century was a century of empires; the 20th century was a century of nation states. The 21st century will be a century of cities" -Wellington E. Webb". In 2008, more than half of world's population lived in cities for the first time in history. This number is predicted to reach about 5 billion by 2030. By 2050, India will have a population of nearly 400 million urban residents. In all, India's metropolitan areas will require 2.5 million sq. meters of new roadways & 7,400 km of new metros & subways. This represents a 20-fold increase in capacity over the previous decade. The GOI has set an ambitious objective of developing "100 Smart Cities" to complement this rapid & unavoidable expansion. This geographical study aims at analyzing the concept of smart cities & role of GIS in the Indian context which has emerged as one of the major component or policy for the future development of urban areas in the country. The research will pay way for the GIS based technological solutions for the effective building & functioning of smart cities in India. This research study is a positive step in this direction & will pave way to find out: Whether smart city services are needed in Rajasthan? Whether smart cities will help in flourishing development of Rajasthan? The research study is conducted on the concept of smart cities & use of GIS in the effective functioning of smart cities in Rajasthan. In the present study, an application of geospatial technologies like GIS techniques is vigorous for evaluation of smart city concept/ components in the urban planning. The research study will help to formulate the concept of smart city in the Indian context & to understand the essential role of GIS in the smarter cities.

Keywords: Demography, Urbanisation, Urban Planning, Smart Cities, Geographical Information System.

Introduction

For the first time in history, in 2008, more than half of the world's human beings (3.3 billion people) were living in urban areas. By 2030, this is expected to swell to almost 5 billion. Then, the towns and cities of the developing world will make up 80% of urban humanity (United Nations Population Funds, 2007). 3 In India the percentage of people living in cities and urban area almost doubled to 27.78% in year 2001, was low when compared to developed countries. This kind of uncontrolled, haphazard, low-density settlement will lead to urban sprawl.

Cities in the 21st century will account for nearly 90% of global population growth, 80% of wealth creation, and 60% of total energy consumption. It is a global imperative to develop systems that improve the livability of cities while dramatically reducing resource consumption. According to the United Nations, in July 2007, the urban population surpassed

the rural population in the world. Moreover, this proportion is expected to increase dramatically in the coming years to the point that by 2050, almost 70% of the world population will be living in the cities and India is no exception.

Currently, 31% of the Indian population stays in the cities and contributes about 65% to the national GDP. Indian cities will grow faster than those of any other country in the coming years. By 2050, India will add over 400 million urban inhabitants, while China will see an increase of 290 million inhabitants over the same period. By 2030, seven Indian cities will have a population of over 10 million; in 2011, only Mumbai and Delhi had populations over 10 million. This amounts to a 37% increase in India's urban population. Cities will generate over 70% of the GDP and 70% of new jobs by 2030, driving a four-fold growth in per capita incomes nationwide. Indian cities are projected to require 700-900 million square meters of new commercial and residential space by 2030, or the size of a new Chicago every year.⁹ Overall, 2.5 million square meters of roads and 7,400 kilometers of metros and subways must be added to India's urban expanses. This is 20 times the capacity that has been added over the last decade. According to UN 2/3rd of the population will be urban dwellers by 2050.

India needs 500 more cities to accommodate such large-scale urbanizing. Keeping this in mind Indian government has proposed to build satellite towns near existing urban areas, upgrade existing mid-sized cities and to build settlements along industrial corridor. Relaxation in FDI norms have also been undertaken to push investments in smart cities. To complement this rapid and inevitable growth, the government has set an ambitious goal to develop "100 Smart Cities." This plan was supported by a public investment of over \$1.2 billion in the 2014- 2015 fiscal year, with additional funding from private investors.¹⁰ Several top technology companies including Cisco and IBM are already working alongside the government to upgrade India's technology systems. Not surprisingly, the government's report on Smart Cities asserts, "to accommodate this massive urbanization, India needs to find smarter ways to manage complexities, reduce expenses, increase efficiency and improve the quality of life."

In the budget speech of July 2014, the finance minister has stated as follows: "As the fruits of development reach an increasingly large number of people, the pace of migration from the rural areas to the cities is increasing. A neo middle class is emerging which has the aspiration of better living standards. Unless new cities are developed to accommodate the burgeoning number of people, the existing cities will soon become unlivable. The Prime Minister has a vision of developing 'One Hundred Smart Cities', as satellite towns of larger cities and by modernizing the existing mid-sized cities."

The Government of India (GoI) initiated the '100 Smart Cities Mission' in 2014. This has triggered deliberations across the country on the concept of smart cities, the need, and the orientation of the Mission in the context of India's present urbanisation scenario. The concept of a 'Smart City' is a relatively new phenomenon in India.

GIS (Geographic Information Systems) have become an integral part of our daily lives in smart cities. GIS provides an IT infrastructure that integrates not only every stakeholder but also every smart city process, starting from planning and conceptualization to development and maintenance. Smart cities present a substantial growth opportunity in the coming years, but there are still many challenges to successful smart city implementation. Many of these

issues can be solved through the implementation and integration of GIS. For example, overcrowded cities can lead to a shortfall in further infrastructure development potential.

The main goal of a smart city is to use smart technologies and data analysis to optimize city functions and promote economic growth while also improving citizens' quality of life. The value of technology is determined by how it is used rather than how much of it is available.

Material and Methods

Study Area:

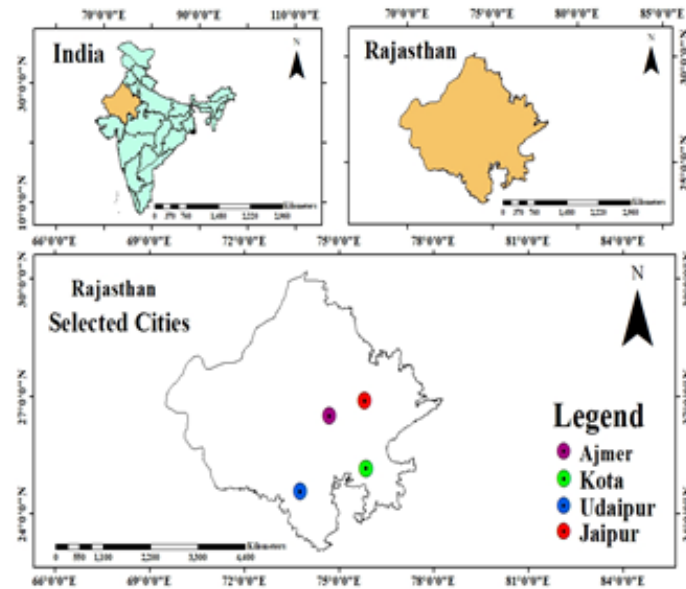


Fig 1.1 Smart Cities of Rajasthan.

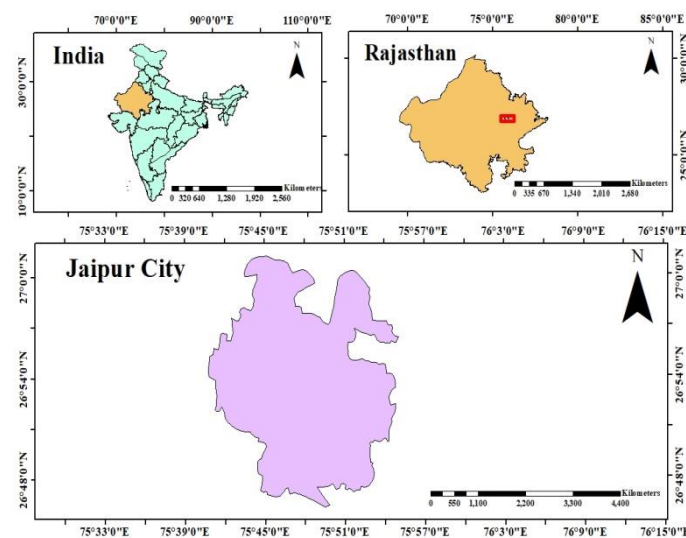


Fig. 1.2 Smart City Jaipur.

Jaipur is located on 26° 55' north latitude and 75° 49' east longitude. Its municipal boundary extends from 26-degree 46 minutes north latitude to 27-degree 01 minutes north latitude and 75-degree 37 minutes east longitude to 76-degree 57 minutes east longitude. The city is surrounded by the Nahargarh hills in the north and Jhalana in the east, which is a part of Aravalli hills - ranges. To the south and the west of the city are also prevailing hillocks,

but they are isolated and discontinuous in formation. The southern end of the city is open to plain and stretches far and wide towards Sanganer and beyond. The walled city was originally located on rocky streets to provide an easy drainage system on either side of the city but the. Future expansion of the city took place in the south and west on the alluvial plains formed in the confluence's zone of the Amani Shah nala in the west and Jawahar Nagar nala in the east and beyond. The general slope of Jaipur city and its surroundings is from north to south and then to south-east. Nearly all the ephemeral streams flow in this direction. Higher elevations in the north exist in the form of low, flat-topped hills of Nahargarh (587 meters). Jaigarh, Amber and Amargarh, which are deeply dissected and eroded. An isolated hillock called "Moti Dungari" upon which an old royal castle exists, is near Rajasthan University. Further in the south, topographical levels of the plain areas vary between 280 meters along Bandi and Dhund rivers in the south to some 530 meters in the northeast of Chomu near Samod hills. The overall trend is a decline of level from the areas bordering the hills in the north to plain in the south slopes of the plain areas are in general gentle.

Jaipur, the capital of the state of Rajasthan in India was founded in 1727 by Maharaja Sawai Jai Singh II, a Kachwaha (Suryavanshi/ claiming descent from the sun) Rajput. Initially its capital was Amber, which lies 11 km from Jaipur. He felt the need to shift his capital city owing to growing population and scarcity of water. Jaipur is the first planned city of India, and the King took great interest in designing the city. In the recent times Jaipur has emerged as one India's major tourist place. Every year it welcomes thousands of tourists from India as well as abroad leading to the high requirement of planning and development.

Jaipur city has been enlisted as among 100 smart cities of India, for that purpose it is being renovated but as every work has some loopholes thus in the present work an effort has been made to analyse the present status of the amenities.

Significances of the Study:

The research study will have following significances in the development of smart cities in Rajasthan:

1. The research study will help in the better understanding of the concept of smart cities at global level.
2. The research study will help to formulate the concept of smart city in the Indian context.
3. The research study will help in the proper effective functioning of smart cities in smarter ways.
4. The research study will help to understand the essential role of Geographical Information System in the smarter cities.
5. The research study will present the various applications of Geographical Information System in smart cities.
6. The research study will provide valuable suggestions for the sustainable development of Indian cities using Geographical Information System.

Hypothesis:

- This geographical study aims at analyzing the concept of smart cities and role of Geographical Information System in the Indian context which has emerged as one of the major component or policy for the future development of urban areas in the country.
- The research will pay way for the Geographical Information System based technological solutions for the effective building and functioning of smart cities in India.

- This research study is a positive step in this direction and will pave way to find out:
 1. Whether smart city services are needed in Rajasthan?
 2. Whether smart cities will help in flourishing development of Rajasthan?

Methodology:

- The research study will be conducted on the concept of smart cities and use of Geographical Information System in the effective functioning of smart cities in Rajasthan.
- In the present study, an application of geospatial technologies like GIS techniques is vigorous for evaluation of smart city concept/ components in the urban planning.
- The research study will be initiated by collecting data from both primary and secondary sources.
- The data will be collected and brought into the GIS software partially by geo-referencing, image registration, and directly adding.
- The data will be standardized by adopting geographic transformation techniques from Geographic Coordinate System to Projected Coordinate System and each data was clipped based on respective shape file boundary.
- The transformed data will be used to calculate area, length, and number of each feature. By adopting the methodology basic amenities map will be calculated.
- This data will be further integrated to find out the places of urban problems like traffic congestion, AQI zone and water logging.
- Smart cities must have location of infrastructure at the right place for that site suitability for urban development as well as location of smog tower will be found out using vector data analysis techniques with the help of various parameters.

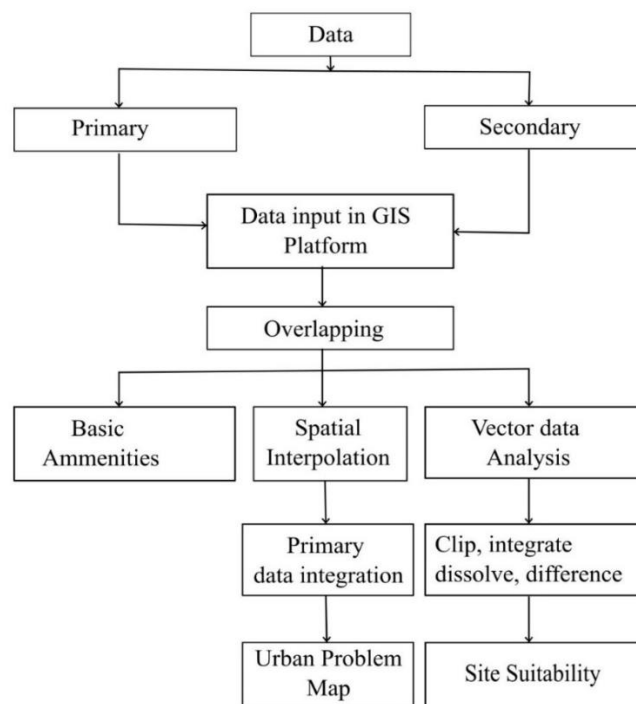


Fig 1.3 Methodology / Data Collection Process.

Objectives:

1. The research study is based on the following objectives:

2. To map out the current situation of smart cities and its problem
3. To find out the need and scope of smart city services in Rajasthan
4. To analyze the applicability of GIS in smart city concept
5. To make a comparative analysis of smart city services.
6. To prepare a raw plan for smart cities which can help in further urban planning.
7. To examine the infrastructure of amenities of smart cities
8. To analyze the master plan of the cities
9. To examine the environmental sustainability of smart cities.

Results

The present study is initiated by collecting data from both primary and secondary sources. The data sources are enlisted in below table:

Table 1.1 Data Collection-I.

S.NO.	DATA	SOURCE
1.	Roads	BBBike
2.	Railway	BBBike
3.	School	Google Earth
4.	College	Google Earth
5.	Hospital	Google Earth
6.	Industry	Google Earth
7.	Overhead Water Tank	Google Earth
8.	AQI	Aqicn.org
9.	Tourist places	Google Earth
10.	Settlement	Generated from landsat8
11.	Waterlogged area	Field observation
12.	Waste disposal	Field observation
13.	Traffic congestion	Field observation
14.	Agriculture	Generated from landsat8
15.	Barren Land	Generated from landsat8
16.	Groundwater data	Secondary source

The data were collected and brought into the GIS software partially by georeferencing, image registration, and directly adding. The data were standardized by adopting geographic transformation technique from Geographic coordinate System to Projected coordinate system and each data was clipped based on respective shapefile boundary. The transformed data was used to calculate area, length and number of each feature. By adopting the methodology basic amenities map of each area was calculated. These data were further integrated to find out the places of urban problems like traffic congestion, AQI zone and water logging. Smart cities must have location of infrastructure at the right place for that site suitability for urban development as well as location of smog tower was found out using vector data analysis techniques with the help of various parameters. Every city is divided into wards. So, the study must start with a ward delineation.

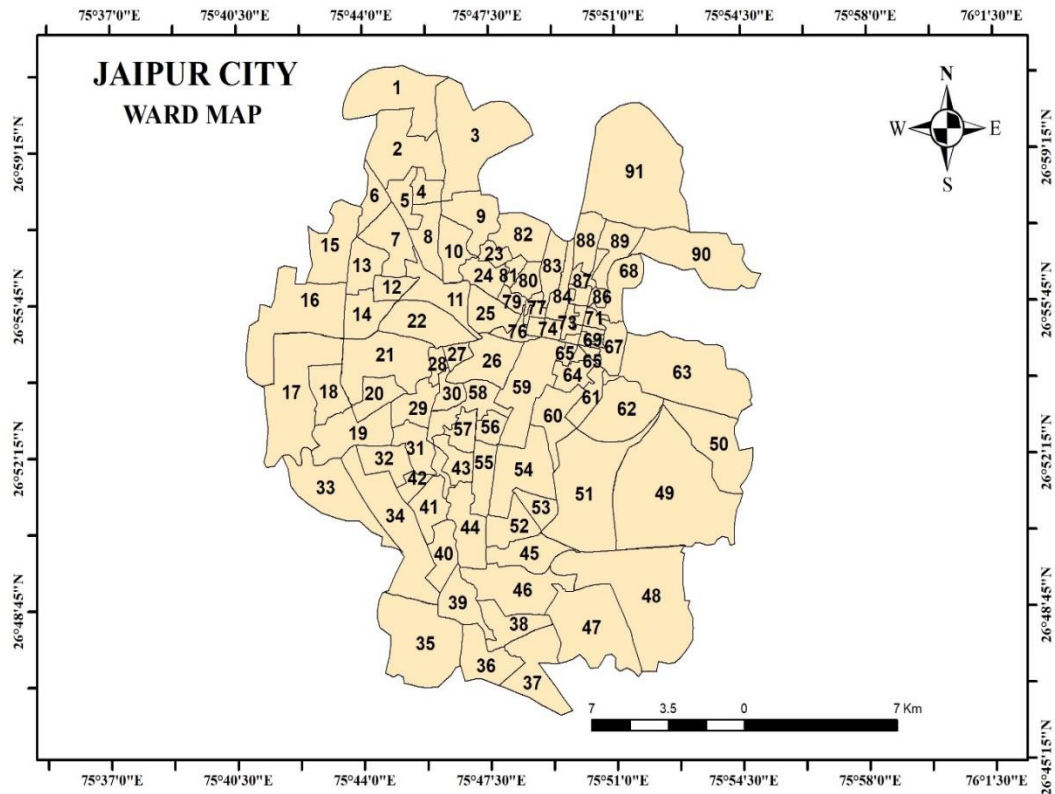


Fig. 1.4 Ward Map of Jaipur.

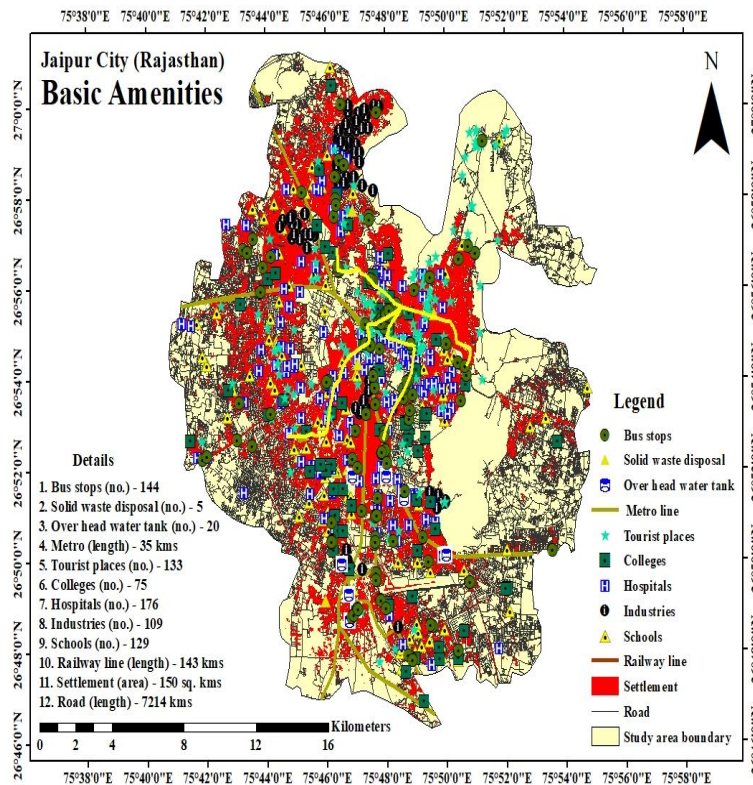


Fig 1.5 Basic Amenities (Jaipur).

As Rajasthan is emerging as a centre of urban conglomeration, in this present study an effort was also made to make a comparative study of selected cities of Rajasthan as well like Kota, Ajmer and Udaipur. Jaipur is the capital of Rajasthan which is transforming as a

major tourist as well as educational hub in northern part of India. Therefore, Jaipur needs to get smart city services. Before planning for the smart city services the present status of available amenities needs to be known. The basic amenity of Jaipur is discussed in the figure below:

The available amenities were compared with Indore city which recently got the tag of most developed smart city of India.

Every city has got a darker side too which always acts as a stumbling block in the path of development. The major urban problem categories in this study are:

1. Water logging
2. Traffic congestion
3. High Air Quality Index zone

In the present study an effort was made to highlight the urban problem of Jaipur and Indore city.

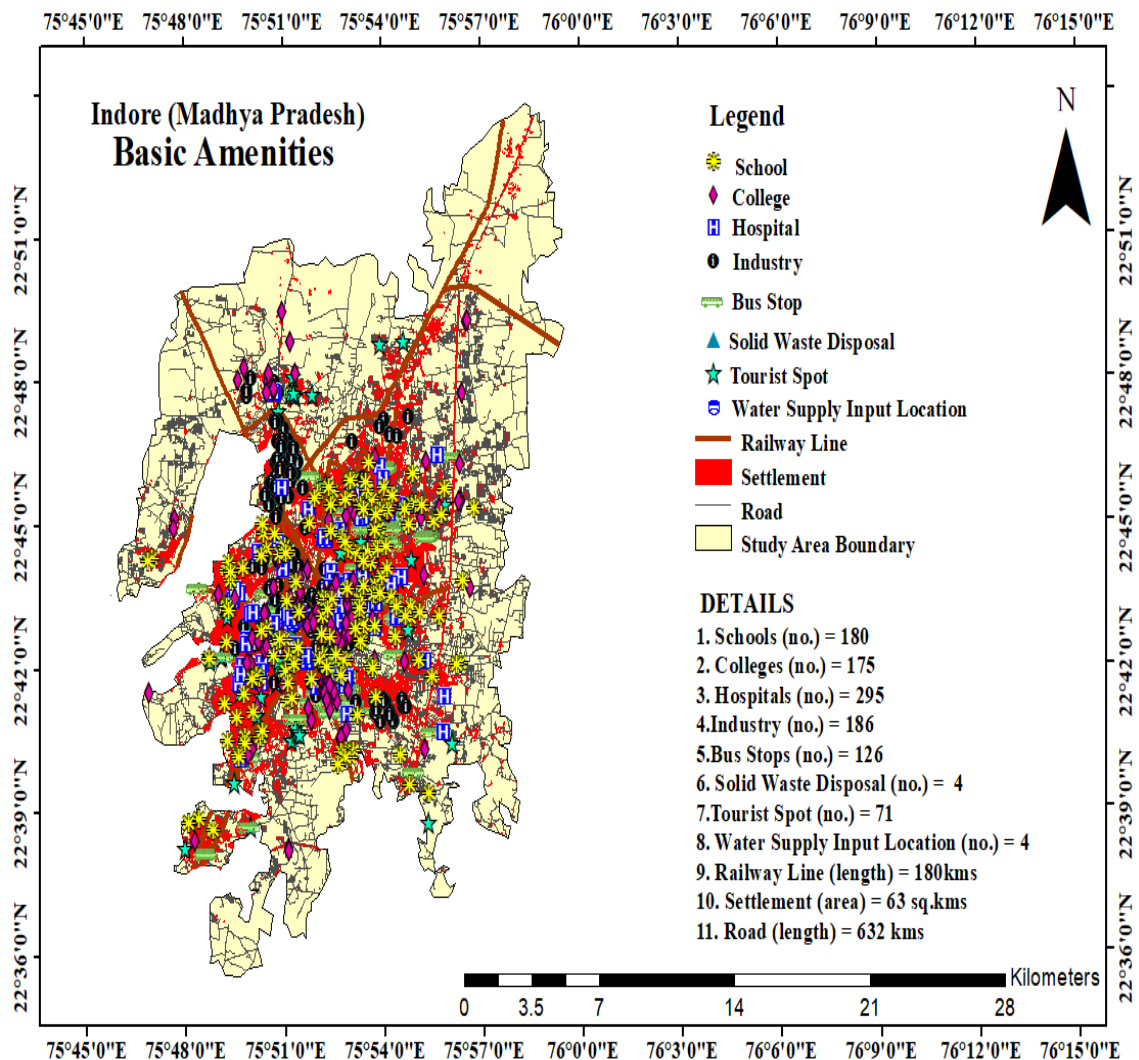


Fig. 1.6 Basic Amenities (Indore).

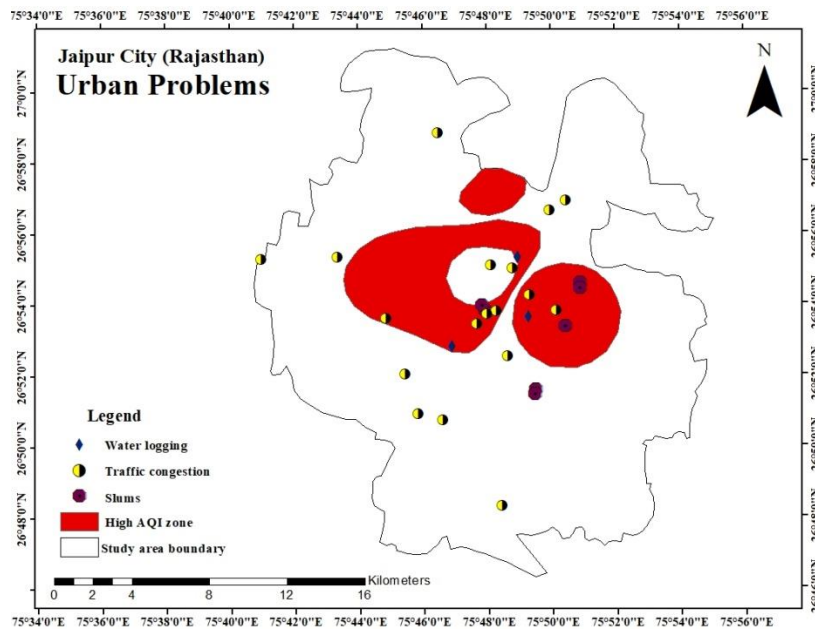


Fig. 1.7 Urban Problems of Jaipur City.

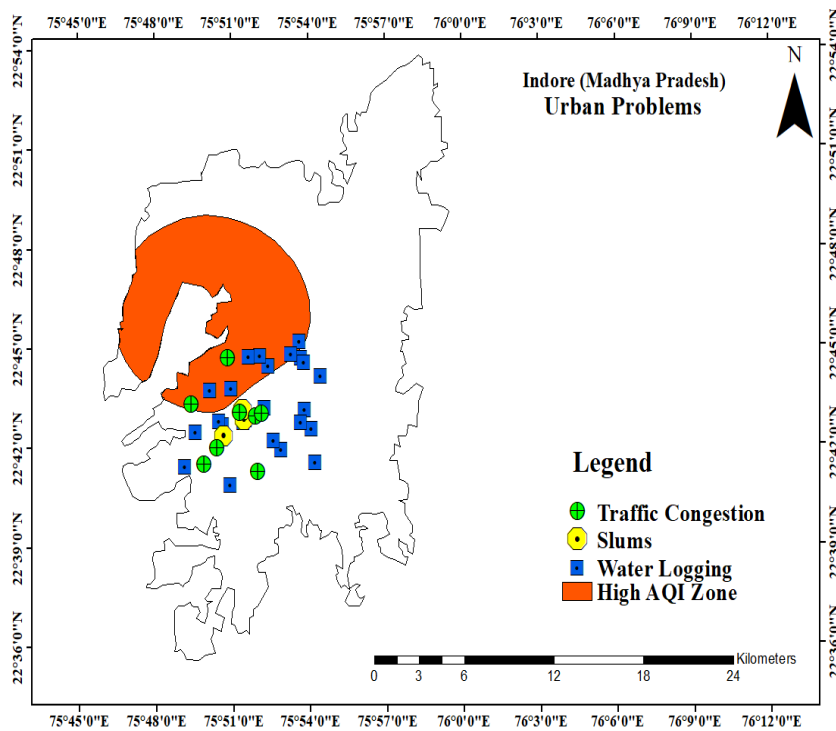


Fig. 1.8 Urban Problems of Indore City.

Discussion

Air quality index has become a major challenge for every urban area, the problem can be minimized by establishing smog tower, for location a suitable site for smog tower following parameters: AQI value, Humidity, Settlement, Industries, PM 2.5 value, PM 10.

These data were collected and spatial distributed using spatial interpolation technique of IDW. Then a buffer was made for all these data.

Table 1.2 Data Collection-II.

Parameter	Buffer
AQI	500 mts
PM 2.5	500 mts
PM 10	500 mts
Settlement	100 mts
Industries	5 KM
Humidity	500 mts

The common area between all these layers is the best site for constructing smog tower. To find out the common area vector data analysis tool of intersect, it uses AND connected of Boolean method. Similar tools were used to find places for urban development in Jaipur. For generating such suitable site, the parameters like Built up area, Open land, Railway, Roads, and Groundwater were considered. The buffered layers were first merged and then intersect layer was intersected to get the common area. The result is highlighted below:

The suitable site is within the specified buffer zones:

Table 1.3 Buffer Zones.

Parameters	Buffer
Built up area	100 mts
Open land	50 mts
Railway	2 Km
Roads	1 Km
Groundwater Zone	Low Depth

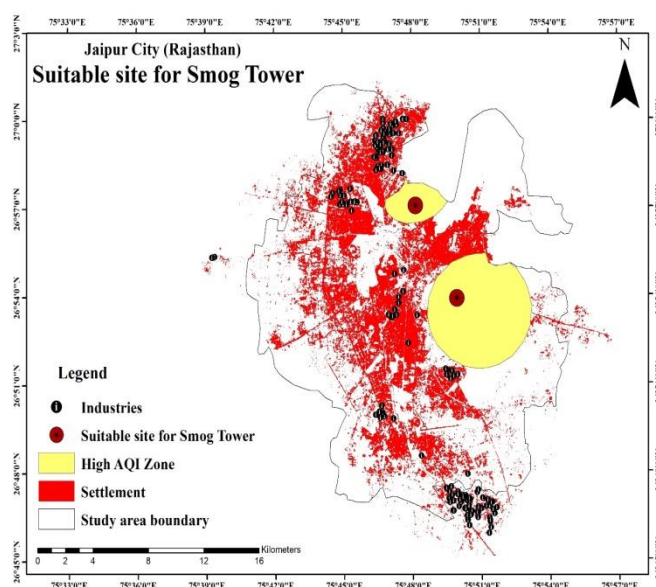


Fig. 1.9 Suitable Sites for Smog Tower in Jaipur City.

The common area between all these layers is the best site for constructing smog tower. To find out the common area vector data analysis tool of intersect, it uses and connected of Boolean method. Similar tools were used to find places for urban development in Jaipur.

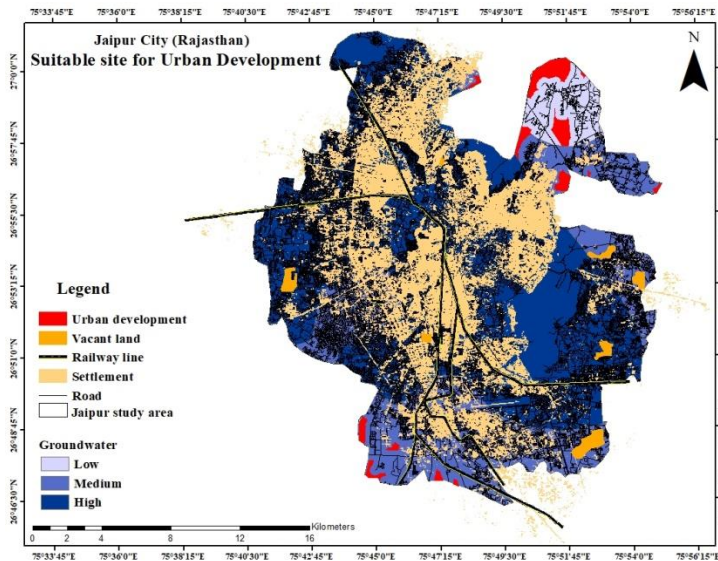


Fig. 1.10 Suitable Sites for Urban Development in Jaipur City.

Conclusions

As Rajasthan is emerging as a centre of urban conglomeration, in this present study an effort was also made to make a comparative study of selected cities of Rajasthan as well like Kota, Ajmer and Udaipur. The available amenities were compared with Indore city which recently got the tag of most developed smart city of India. If a similar comparison is made with the other cities of Rajasthan, then a perfect picture of the present urban condition of Rajasthan can be found out. Every city has got a darker side too which always acts as a stumbling block in the path of development. The major urban problem categories in this study are water logging, traffic congestion & high air quality index zone.

In this present study an effort was made to make to study how the GIS could find its applications in smart cities structure in India. GIS is a rising strategy which can be sufficiently used for making the best use of resources in regular daily existence; in like manner it is an essential instrument for changing the urban regions to Smart urban networks.

Better understanding of demography, urbanization & urban planning is created for effective implementation of the smart cities mission in Rajasthan. In the present study an effort was made to highlight the urban problem of smart cities of Rajasthan. Air quality index has become a major challenge for every urban area, the problem can be minimized by establishing smog tower, for location a suitable site for smog tower parameters AQI value, humidity, settlement, industries, pm 2.5 value & pm 10 are used. These data were collected and spatial distributed using spatial interpolation technique of IDW. Then a buffer was made for all these data.

Further Recommendations:

In the light of the research work, the following recommendations are made:

- 1) Urban planners should lay emphasis on the development of the social, physical, and Institutional infrastructures of smart cities.
- 2) There should be effective partnership between the public and private sectors to develop the existing basic infrastructure of smart cities.

- 3) Emphasis should be given on improving / implementing smart solutions in India such as smart education, smart transport, smart financial services smart health, green economy, safety / security, and good governance.
- 4) In Smart Cities, applications of modern technology / services should be promoted, and preference should be given to smart feedback / high public participation for people-oriented policy formulation, effective implementation of smart solutions and better governance.
- 5) The government, private sector and people must ensure the creation / development of sustainable smart cities for present and future generations.
- 6) There should be effective partnership between the public and private sectors to develop the satellite city for sustainable development or buffer zone.
- 7) Educating mass is necessity to avail the facilities of Smart city.
- 8) Stage-wise implementation is essential as per the availability of funds and requirements of the citizens.
- 9) Urban planners / government should made development of smart cities a long term/ large scale scheme / policy for the development/ upliftment of urban infrastructure in India.
- 10) Skills developments programs should be organized at grassroots level to educate people about the affordable services available in smart cities.
- 11) Effective coordination is recommended between central / state governments and local government bodies for the efficient utilization of financial and human resources.
- 12) The role of the geographical information system in the development of smart cities should be expanded and these cities should be made cyber secure by ensuring data security.

References

[Contact the corresponding author for the list of references.]

Citation

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