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Geospatial Analysis of Indian States

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Abstract

In this competitive world taking better decisions is very important. To take better decisions in complex situations a proper analysis is to be made. To inspect the complicated, critical social problems GIS is creating an innovative platform for decision makers and analysts. This paper demonstrates how GIS can be used in analysis of Indian states on various aspects like total population, male's population, female population, kids population, total literates, male literates, female literates, total effective literacy rate, male's effective literacy rate, female's effective literacy rate, total graduates, male graduates, female graduates, rainfall's in India covering 80% of urban population. Comparison between states in India is also done on these aspects in this paper. Lots of decisions can be drawn from this geospatial analysis.

Keywords: *GIS, Geospatial, Analysis, EDA, Maps, literacy, India.*

1. Introduction

Business information management system which helps in capturing, analyzing, storing, producing insights and presenting spatial information on a physical map is said to be Geographic Information System (GIS). The aid of GIS is to make better decisions using location reference system. The combination of Hardware, Software, Data and People makes GIS. GIS is an economically used tool over past few years. It is applied for emergency movement and transportation management [1] [2]. GIS has come up with information management and mapping, which have its roots in modeling and analysis which facilitates decision making [3]. The uniqueness of GIS that kept ahead compared to other information systems is having proficiency in achieving actions on Geospatial data. GIS can integrate information from multifarious sources. The data collected must have location reference in order to analyze visually in the form of maps. This type of analysis is very complex. The Geospatial data also known as geographically referenced data describes both the location and the characteristics of the feature called spatial feature which may consist of roads, land extents, and vegetation on the Earth surface [4]. There are two types of spatial data Raster data and Vector data. Raster data is organized in the form of series of grid cells, the picture clicked will be in this grid format. Vector data is represented as points, lines or polygons. Vector data has exact location, or hard boundaries like Administrative Boundaries, roads, water bodies etc. In this paper we use Vector data format in analysis.

In our day-to-day life plenty of decisions are driven by GIS. It has its own applications from retailers to business analysts. To develop any business understanding the people is important in terms of their culture, interests, preferences etc. They have to conduct surveys, collect feedbacks from the people and a proper analysis must be done on them. This develops one’s business. Similarly, this type of analysis is to be done on geographic

maps in order to understand various aspects like water bodies, roads, railroads, crime rates, economy, Administrative Boundaries. In this paper geospatial analysis made on India and analyze Indian geography, Indian resources, water bodies, crimes in India. For analysis we use python language because of having rich libraries to visualize maps.

2. Literature Survey

There might be no problem around us, but on a whole, collectively definitely we are in a big problem. According to the Glass Door survey, 60% of the companies are failing to analyze their own data. Analyzing the data is most important before launching any scheme, manufacturing any product, to establish a company, to select college/school to study, to know the problems facing by people, to increase sales, to grab customers etc. So, let's produce some insights of Indian states. The data for analysis is collected from government source. The complete dataset containing population, population of males, population of females, total literates, male literates, female literates, total graduates, male graduates, female graduates, sex ratio, population of children aging between 0-6 years, population of male kids, population of female kids and the geographical locations of the cities in India are not found in a single dataset alone. So, to make perfect analysis census data, graduate's data, geographical locations (latitude and longitude) are separately collected and merged. Geospatial analysis is made on this data and comparisons are made with other cities and states in India.

This paper concentrates on visualization of top20 most populated cities, male's population, female population, kids aging between 0-6 years, total graduates, male graduates, female graduates, literacy rate for all states. Comparing various aspects among states will play a beneficial role, where one's local government can be able to concentrate on that issue or central government can visualize which state left behind, so that some important schemes can be introduced. Companies can also analyze whether their product/software will be successful or a disaster. Companies can manufacture certain type of products which gives profits, more sales in certain states. They can also establish new branches by seeing state's literacy rate. Based on this analysis one can know where he must go in order to study, to keep a business etc. Safety measures can also be taken for the problems from analysis.

3. Exploratory Data Analysis

It is the prior analysis to be done in order to understand the main characteristics of data. In this exploratory data analysis, we come to know about various characteristics like size, shape, data type, null values, unique values, outliers, central tendency of distribution, measure of variance, measure of asymmetry, correlation etc. By doing these basic insights are produced which will be useful in further analysis. Now, let's visualize number of cities taken from each state.

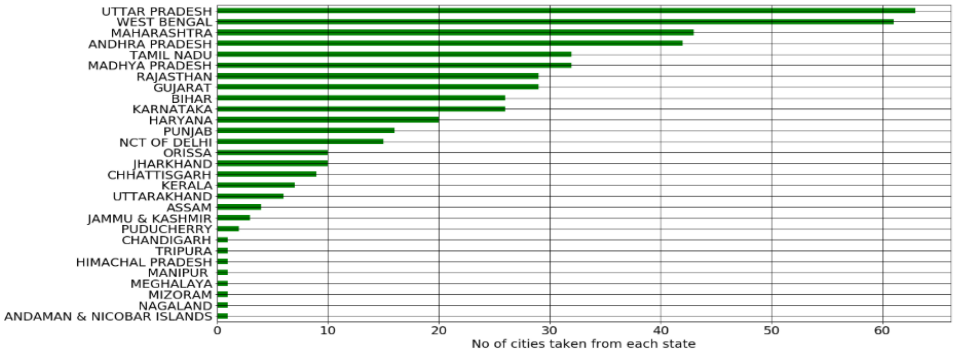

Figure 1. Number of cities taken from each state to analyze

From Figure 1, Uttar Pradesh and West Bengal has more than 60 cities in our data. Where-as the states like Chandigarh, Tripura, Himachal Pradesh, Manipur, Meghalaya, Mizoram, Andaman and Nicobar Islands and Nagaland has least number of cities in our data.

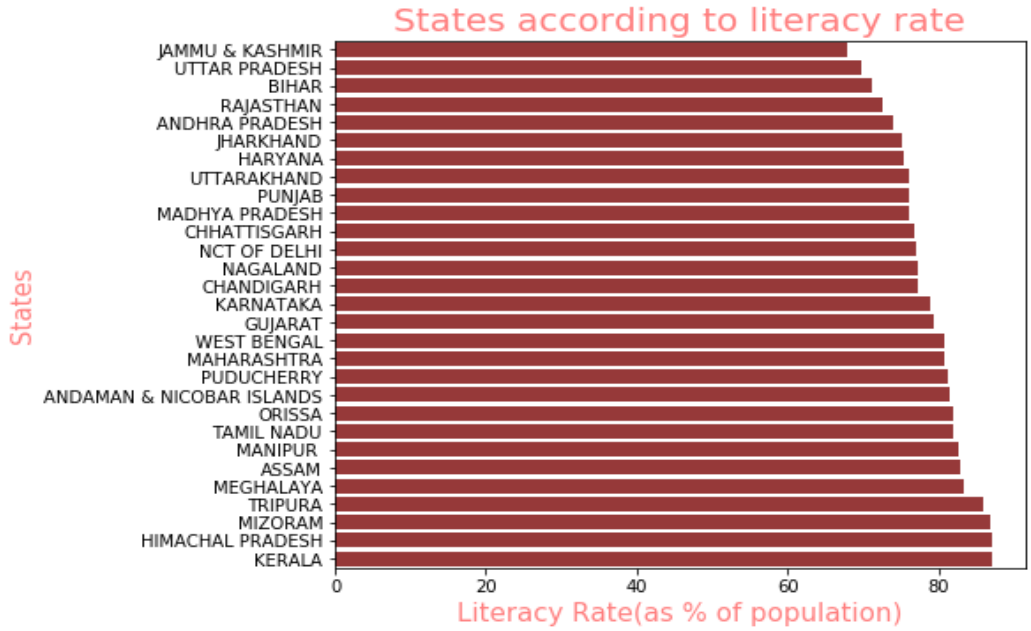

Figure 2. States according to Literacy rate

Kerala and Himachal Pradesh have highest literacy rate and followed by Mizoram shown in figure 2. Uttar Pradesh has least literacy rate though the cities considered are highest. States like Jammu and Kashmir, Uttar Pradesh, Bihar and Rajasthan has least literacy rates. These states have to concentrate more on literacy rates.

	name_of_city	state_name	location
count	493	493	493
unique	492	29	490
top	Aurangabad	UTTAR PRADESH	18.9894007,73.1175162
freq	2	63	2

Figure 3. Frequency table

Figure 3 focuses that there are two Aurangabad's. One is in Maharashtra and the other is in Bihar. Most of the cities are from Uttar Pradesh.

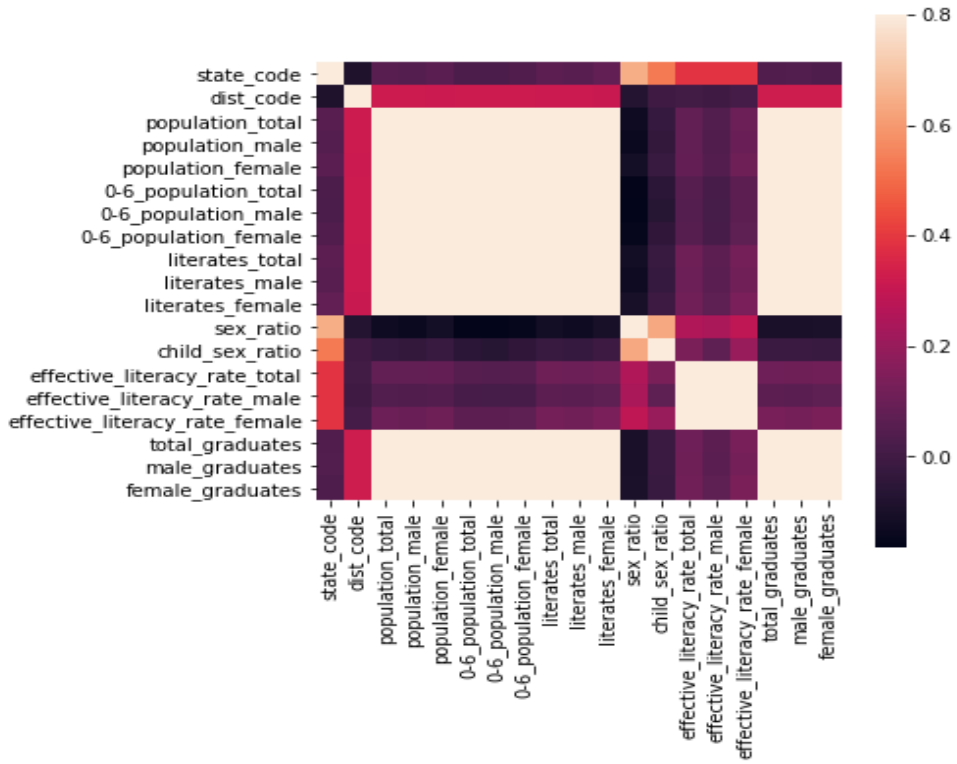

Figure 4. Correlation Heat map

From figure 4, Dark color represents less correlation and lightest color represents highest correlation. Many features are correlated with other features. Population total feature is correlated with literate's total and total graduates. Sex ratio, child sex ratio, effective literacy rates are not correlated with any other features. There are also no outliers in the data to remove. The required Exploratory Data Analysis is done and completed.

	name_of_city	state_code	state_name	dist_code	population_total
185	Greater Mumbai	27	MAHARASHTRA	99	12478447
141	Delhi	7	NCT OF DELHI	99	11007835
72	Bengaluru	29	KARNATAKA	18	8425970
184	Greater Hyderabad	28	ANDHRA PRADESH	99	6809970
7	Ahmadabad	24	GUJARAT	7	5570585
119	Chennai	33	TAMIL NADU	2	4681087
274	Kolkata	19	WEST BENGAL	16	4486679
449	Surat	24	GUJARAT	25	4462002
380	Pune	27	MAHARASHTRA	25	3115431
225	Jaipur	8	RAJASTHAN	12	3073350

Figure 5. Top 10 Populated Cities

From figure 5, Greater Mumbai is the highest populated state and followed by Delhi. There are two most populated cities in Maharashtra alone in top10.

4. Geospatial Analysis

The geospatial analysis on the collected data has been performed in this research work under GIS environment [5]. Let's make some insights by plotting the data into a map. Geospatial analysis helps in decision choosing, it gives solution to the critical, complex questions. Based on this government can release schemes, funds to develop certain aspect in certain state. This analysis is very useful in taking decisions.

4.1 Population Analysis

Increasing population is one of the biggest problem worlds is facing. It is not a problem when the population is skilled. The population must be turned into skilled, for this analysis of population is very important. Here, this paper visualizes total population, male population, female population, kid's population aging between 0-6 years, male kid's population, female kid's population for all cities.

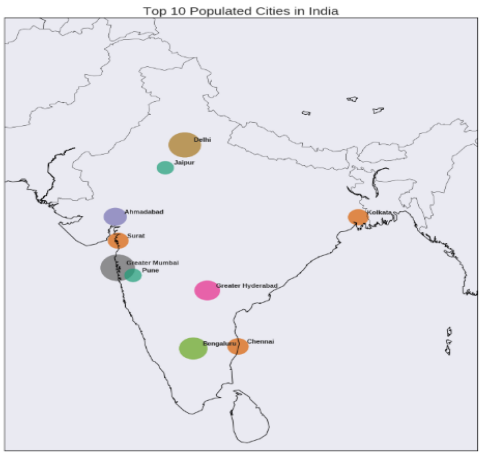

Figure 6. Top10 populated cities locations

Top 10 cities are plotted on India map shown in figure 6. The size of circle is based on the population of respective city. The top 10 cities populated in India produced in exploratory data analysis is used here to make this geospatial analysis.

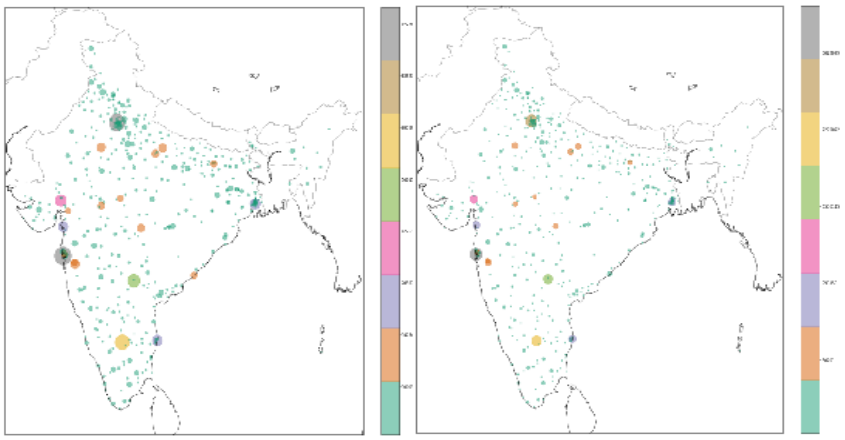

Figure 7. Left: Total Population, Right: Male Population

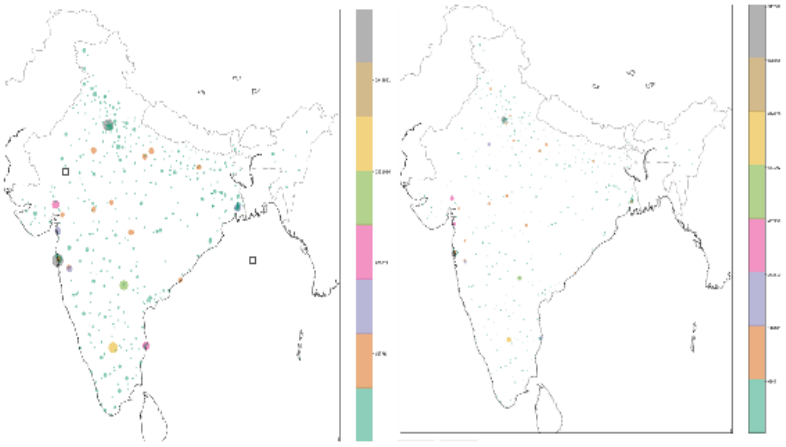

Figure 8. Left: Female Population, Right: Total Kids Population

From above maps this paper analyzes where the overall population is concentrated. The circles and color are based on the population count. Based on this analysis one can make his own decisions. Politicians can choose a city where resources are less and can release some funds or some beneficiary schemes. Businessman can come up with new innovative products where population can adapt his products. In this way, many decisions can be taken person to person.

4.2 Literates Analysis

A person is said to be Literate if he knows to read and write. There are many people who can't even read and write. A state which has a greater number of literates contributes more literacy rate. Number of literates and Literacy rate are correlated to each other.

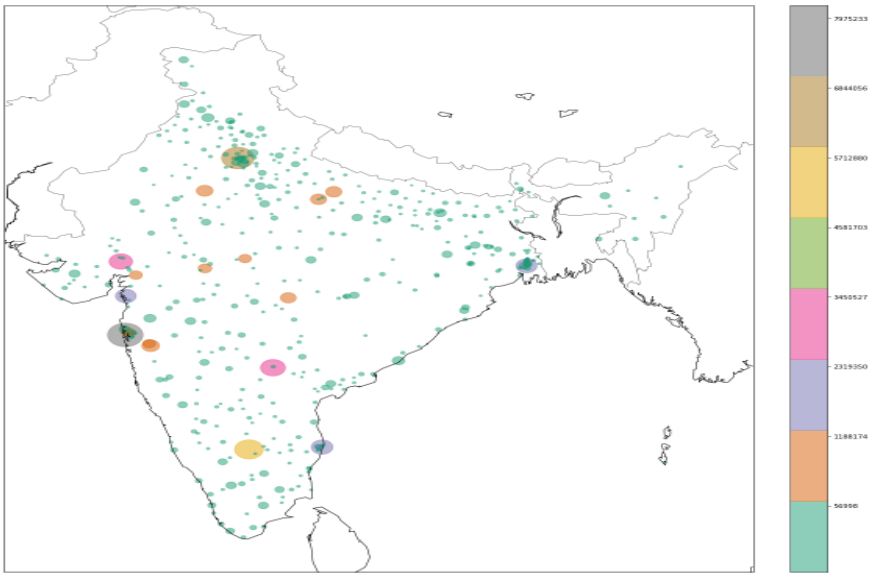

Figure 9. Total number of Literates

Figure 9 focuses that Maharashtra has a greater number of literates. Cities like Bangalore, Delhi and Hyderabad also had a greater number of literates. The color and size of circle represents the count of literates in particular city.

4.3 Effective Literacy Rate Analysis

Effective literacy rate is defined as percentage of literates to population aged 7 years and above. Literacy rate contributes low poverty, High economic stability. State will be developed if this effective literacy rate high.

Figure 10. Effective Literacy Rate of states.

From figure 10, Mizoram has the highest effective literacy rate. Uttar Pradesh and Jammu and Kashmir has lowest effective literacy rate. Female effective literacy rate is very lowest in Rajasthan. In every state female effective literacy rate is less than male effective literacy rate. After Mizoram, Manipur has the highest male effective literacy rate.

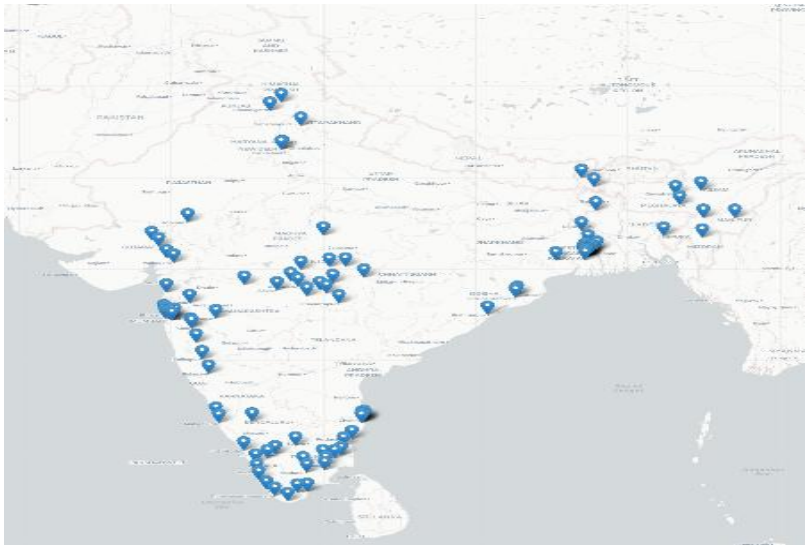

Figure 11. Effective literacy rate above 90

4.4 Graduates Analysis

A person is a graduate if he successfully completed his degree from college or university. Graduates are literates but all literates are not Graduates. This Graduates analysis is very helpful for companies to establish their branches. Companies can open their branches where graduates are more so that the staff will be available easily. The places where

Graduates are less government can open new colleges, schools and motivate people to join. This in turn increases the number of literates and effective literacy rate.

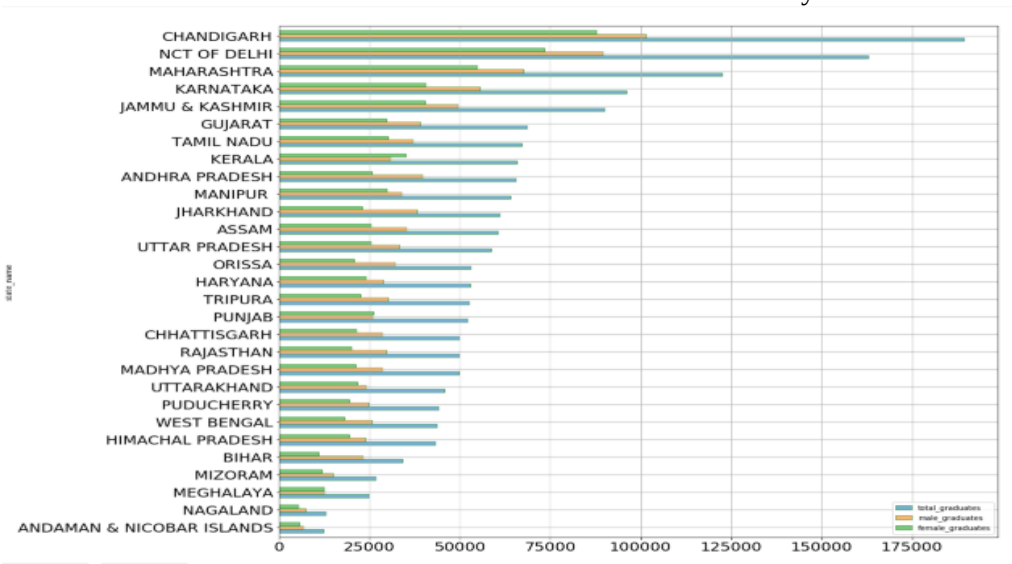

Figure 12. Graduates in States

From figure 12, Chandigarh has highest number of graduates. Nagaland and Andaman and Nicobar Islands have lowest number of graduates. So, companies might look forward to establishing in Chandigarh, Delhi and in Maharashtra. Government must look forward to establishing schools and colleges in states which have lower number of graduates, this not only increases number of graduates but also increases literacy rate.

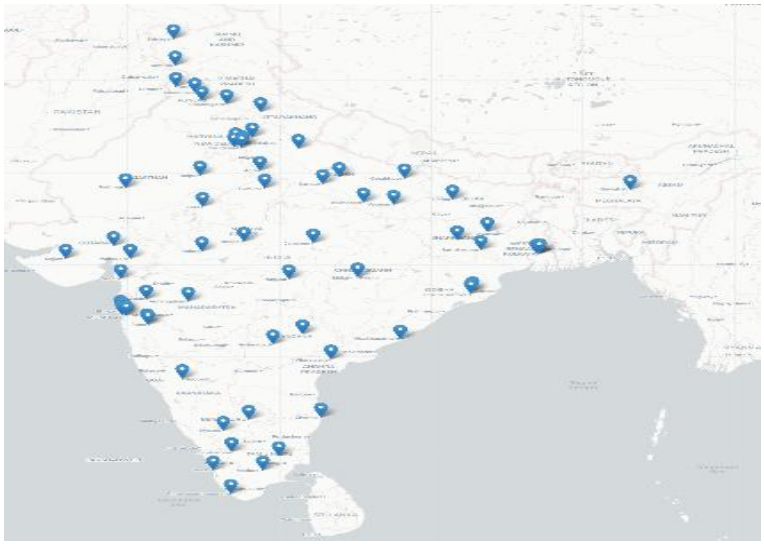

Figure 13. Graduates greater than 1lakh

In figure 13, the cities having greater than 1lakh graduates are marked.

4.5 Rainfall Analysis

Rain brings a lot of benefits, it waters wild plants and crops, humidifies the air, adds minerals to the soil, creates streams and rivers. Farmers grow certain crops based on the rainfalls. So, analysis of this rainfall is very important.

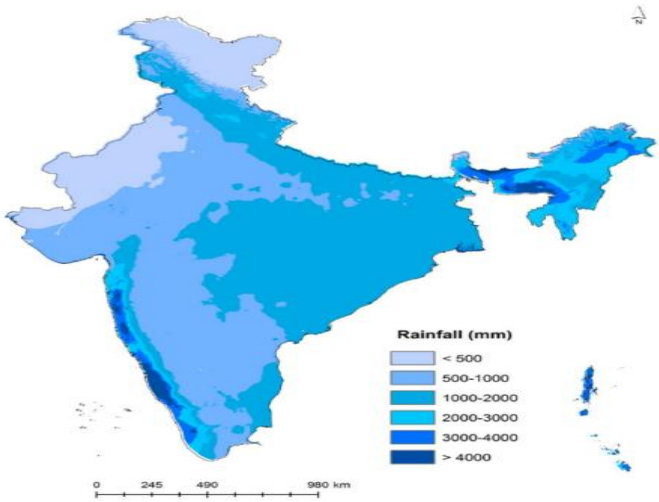

Figure 14. Rainfall in India

Figure 14 concentrates that India receives heavy rainfall in coastal South West region and in the North East. The places Sahyadri and the Himalayan mountain ranges obstruct the clouds which cause heavy rainfall in these regions. East and Central India receive moderate annual rainfall. North West India which includes. Thar desert receives scanty annual rainfall.

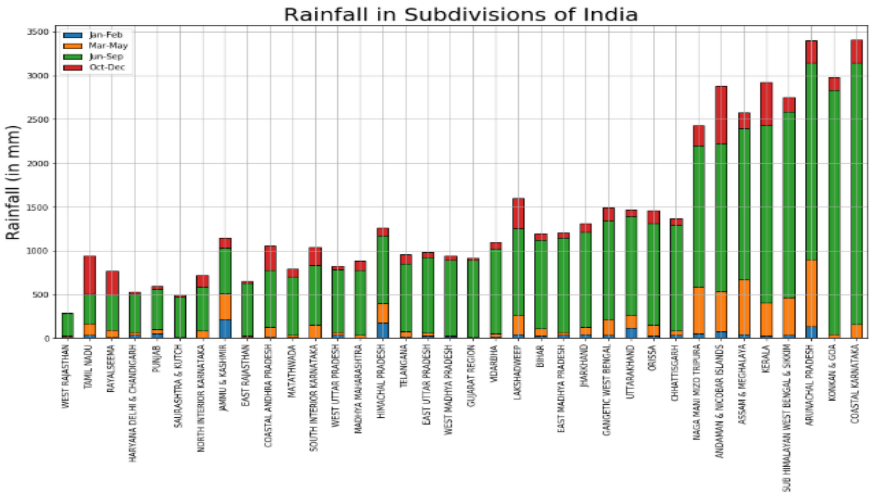

Figure 15. Rainfall in all states

Figure 15 focuses that majority of rainfall is received in the month of Jun-Sep which is the Monsoon season. Oct-Dec is time of return monsoon. Jan-Feb are the winter months. Mar-May is time for summer rains. Coastal Karnataka, Arunachal Pradesh, Goa and Kerala receive highest rainfall. Rajasthan, Gujarat, Haryana and Punjab receive low rainfall. Interesting thing is that Punjab and Haryana have high agricultural output despite low rainfall. Their water requirements are met by rivers and canals.

5. Results

- The insights produced from all this geospatial analysis are:

- Most populated cities in India are Greater Mumbai, Delhi and Bangalore.
- In India Urban population is more in Maharashtra, Uttar Pradesh and West Bengal. These are the top 3 states in urban population.

- Maharashtra is the state in India having most male, male kid's, female kid's and female population living in urban areas.
- The city which has most of the population of both male and female is Greater Mumbai.
- Delhi is the city of having high kid's population.
- Maharashtra is the only state which has huge literate population living in urban areas.
- Highest number of literates both in men and women are in Greater Mumbai and followed by Delhi.
- Effective literacy rate is high in Mizoram and followed by Kerala and Himachal Pradesh.
- The difference between male's effective literacy rate and female's effective literacy rate is very high which must be concentrated more.
- No state has highest female literates than male literates.
- One of the happiest things is that almost all the states have effective literacy rate of more than 80 %.
- Coastal Karnataka and Arunachal Pradesh are the states observed to be having highest rainfall.

6. Conclusion

To examine the complex, critical social problems GIS is creating an innovative platform for decision makers and analysts. This paper demonstrated how GIS can be used in analysis of Indian states on various aspects like total population, male's population, female population, kids population, total literates, male literates, female literates, total effective literacy rate, male's effective literacy rate, female's effective literacy rate, total graduates, male graduates, female graduates, rainfall's in India covering 80% of urban population. The complete analysis has been done on these aspects and comparison between other states and cities is also done. Lots of decisions can be drawn from this geospatial analysis. By analysing these factors business driven decisions can be taken like, Government can start some more colleges or schools in states where literacy rate is very less. Corporate companies can establish branches based on seeing literates and graduates in states. Based on seeing population certain funds, schemes, construction of parks, roads can be issued. By analysing rainfalls in India certain types of crops can be grown. In this way Geospatial Analysis plays a crucial and important role. In this paper lots of analysis is done and outputs were attached.

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