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1.1 Introduction

Geography is writing about the earth. It describes the world and its inhabitants, also known as the science of the earth and human ecology. It is a science that deals with the earth and its life, the description of land, sea, air, and the distribution of plant and animal life including human beings and their activities. It is the science of distribution and is concerned with spatial variations in any physical or cultural phenomena.

The Contemporary world is an urban world. This is apparent in the expansion of urban areas and the extension of urban influences across much of the habitable surface of the planet. Today, for the first time in the history of humankind, urban dwellers outnumber rural residents. Urban places – towns and cities – are of fundamental importance: for the distribution of population within countries; in the organization of economic production; distribution and exchange; in the structuring of social reproduction and cultural life; and in the allocation and exercise of power. Furthermore, in the course of the present century the number of urban dwellers and level of global urbanization are likely to increase. Even those living beyond the administrative or functional boundaries of a town or city will have their lifestyle influenced to some degree by a nearby or even distant city. We inhabit an urban world in which the spread of urban areas and urban influences is a global phenomenon. The outcomes of these processes are manifested in the diversity of urban environments that characterize the contemporary world.

The study of towns and cities is a central element of all social sciences including Geography, which offers a particular perspective on and insight into the urban condition. The scope and content of urban geography are wide-ranging and include the study of urban places as ‘points in space’ as well as investigation of the internal structure of urban areas. Within the general field of urban geography specialized sub-areas attract researchers interested in particular aspects of the urban environment (such as population dynamics, the urban economy, politics and governance, urban communities, housing or transport issues). This eclectic coverage, allied to the synthesizing power of a geographical perspective, is a major advantage for those seeking to understand the complexity of contemporary urban environments.

Urban geography seeks to explain the distribution of towns and cities and the socio-spatial similarities and contrasts that exist between and within them. If all cities were unique, this would be an impossible task. However, while every town and city has an individual character.
Urban places also exhibit common features that vary only in degree of incidence or importance within the particular urban fabric. All cities contain areas of residential space, transportation lines, economic activities, service infrastructure, commercial areas and public buildings. In different world regions the historical process of urban evolution may have followed a similar trajectory. Increasingly, similar processes such as those of suburbanization, gentrification and socio-spatial segregation are operating within cities in the developed world in former communist states and in countries of the Third World to affect a degree of convergence in the nature of urban landscapes. Cities also exhibit common problems to varying degrees, including inadequate housing, economic decline, poverty, ill health, social polarization, traffic congestion and environmental pollution. In brief, many characteristic and concerns are shared by urban places. These shared characteristics and concerns represent the foundations for the study of urban geography. Most fundamentally, the character of urban environments throughout the world is the outcome of interactions among a host of environmental, economic, technological, social, demographic, cultural and political forces operating at a variety of geographic scales ranging from the global to the local.

Global Trigger Factors for Urbanization are- Economic change, Demographic change, Social change, Technological change, Cultural change, Political change and Environmental change. This triggers leads to the processes called Reurbanization, Exurbanization, Suburbanization, Urbanization, Counterurbanization, Exourbanization and Peripheralurbanization.
Processes of urban change: Interaction of global ‘trigger forces’ and locally contingent factors results in a number of different processes of urban change. Urbanization occurs when cities grow at the cost of their surrounding countryside. Suburbanization and Exurbanization: when the inner ring or commuter belt grows at the expense of the urban core. Counterurbanization: when the population loss of the urban core exceeds the population gain of the ring, resulting in the agglomeration losing population overall and Reurbanization: when either the rate of population loss of the core tapers off or the core starts to regain population while the ring still loses population. These processes of urban change are visible to varying degrees in metropolitan areas of both the developed world and the Third World. The phenomena of peripheral urbanization and Exurbanization are characteristics of cities in the Third World. The concept of peripheral urbanization reflects the expansion of capitalism into Third World regions and employs a political economy perspective to describe the impact of global capitalism on national urban systems in the Third World. Exurbanization is promoted by foreign direct investment in Third World countries leading to a pattern of urban growth based on labor-intensive and assembly manufacturing types of export-oriented industrialization, as in the Pearl River delta region of China.

The distinction between the urban as a physical entity and the urban as a quality helps us to understand the complexity of urban life, and illuminates different approaches to the study of cities. Four principal methods are employed to identify urban places: Population size, Economic base, Administrative criteria and Functional definitions.

An Urban Agglomeration is a continuous urban spread constituting a town and its adjoining urban outgrowths (OGs) or two or more physically contiguous towns together and any adjoining urban outgrowths of such towns. Examples of OGs are railway colonies, university campuses, port areas, etc., that may come up near a city or statutory town outside its statutory limits but within the revenue limits of a village or villages contiguous to the town or city. Each such individual area by itself may not satisfy the minimum population limit to qualify it to be treated as an independent urban unit but may deserve to be clubbed with the town as a continuous urban spread. For the purpose of delineation of Urban Agglomerations during Census of India 2011, following criteria are taken as pre-requisites: (a) The core town or at least one of the constituent towns of an urban agglomeration should necessarily be a statutory town; and (b) The total population of all the constituents (i.e. towns and outgrowths) of an Urban Agglomeration should not be less than 20,000 (as per the 2001 Census). With these two basic
criteria having been met, the following are the possible different situations in which Urban Agglomerations would be constituted: (i) a city or town with one or more contiguous outgrowths; (ii) two or more adjoining towns with their outgrowths; and (iii) a city and one or more adjoining towns with their outgrowths all of which form a continuous spread.

1.2 Statement of Research Problem

The main focus of the research “Modeling Peri-urbanization of Bangalore Metropolitan City – a Geoinformatic approach,” mainly confines to peri-urban growth, modeling using the basic criteria’s. The study area is a class one city, 5th biggest among the population in India according to 2011 census. The study areas covers, BDA, BBMP, some fringe areas of Bangalore Rural and Urban Districts. The present study emphasizes this urban and its peri-urban related aspects. Individual attention is given to criteria selected for the cellular automata model. Proper investigations are made on these to achieve the goal of the research. Any individual urban modeling study in its systematic comprehensive approach must provide planned strategies to overcome some of the major problems. The present investigation has such aspects for the management of peri-urban region in the metropolitan city. Peri-urbanization is one of the problems in the modern cities, because of the rapid growth in the population, industrialization, modernization and globalization. Bangalore City also faces the same problem related to the peri-urbanization, because of the fastest growing nature in all the aspects. Peri-urbanization reflects on the urban and rural settlement areas. Research attempts to create a model for the peri-urbanization by analyzing the available model all over. The Bangalore metropolitan city has large proportion of population which leads to the development of the peri-urbanization.

1.3 Background of the Research Area

Bangalore city situated at 920 meters above MSL is the principle administrative, industrial, commercial, educational and cultural capital of Karnataka state, in the South-Western part of India. Blessed with a strong educational and technological base and agreeable climate, Bangalore is witnessing a tremendous growth in industry, trade and commerce leading to a rapid growth of the city and large scale urbanization. The population of Bangalore city stands at 8425970 People as per 2011 census records, and continuing with this growth rate, the city’s population is expected to reach around 16 and 24 million in 2021 and 2041 respectively. This unprecedented growth is due to several factors, such as good infrastructure facilities, availability
of abundant technical manpower and skilled labour and sound scientific and industrial base, a salubrious climate, and in recent times due to the coming golden age of Information Technology (IT) which, today is the prime driving force fuelling the growth of Bangalore city. While most of the infrastructure aspects such as energy supply, urban water supply and sewerage system, road and rail and air network, telecommunication systems etc., are reasonably met with in Bangalore. It is the domain of public transport, which appears to be woefully inadequate to meet even the existing demands, let alone meet the future requirements of this fast growing city. The city’s mass transport system is presently operated by the state owned Bangalore Metropolitan Transport Corporation Ltd. (BMTC), which is exerting to do its best, but still unable to meet the rapidly rising commuter community’s demand for a rapid, more efficient and user friendly mode of public transport system. This has led to an explosive growth of private vehicle population comprising of two wheelers which form the bulk, three wheelers, four wheelers, and other miscellaneous motor vehicles. The size of vehicle fleet, operating in the urban area is around 1.8 million in the year 2003, and this large vehicle population has naturally had a spiraling effect on many aspects of city’s life, namely (i) severe air pollution levels. (ii) High congestion problems. (iii) Growing number of road accidents often resulting in human fatalities and injuries. (iv) More non-productive man hours during transit and waiting points etc., thus inviting the wrath of Bangalore citizen’s community.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>City</th>
<th>Urban Metropolitan</th>
<th>City Population</th>
<th>Male</th>
<th>Female</th>
<th>Sex Ratio</th>
<th>Literacy</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Mumbai</td>
<td>18,414,288</td>
<td>12,478,447</td>
<td>6,736,815</td>
<td>5,741,632</td>
<td>852</td>
<td>90.28</td>
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<td>2</td>
<td>Delhi</td>
<td>16,314,838</td>
<td>11,007,835</td>
<td>5,871,362</td>
<td>5,136,473</td>
<td>875</td>
<td>87.60</td>
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<td>3</td>
<td>Bangalore</td>
<td>8,499,399</td>
<td>8,425,970</td>
<td>4,401,299</td>
<td>4,024,671</td>
<td>914</td>
<td>89.59</td>
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<tr>
<td>4</td>
<td>Hyderabad</td>
<td>7,749,334</td>
<td>6,809,970</td>
<td>3,500,802</td>
<td>3,309,168</td>
<td>945</td>
<td>82.96</td>
</tr>
<tr>
<td>5</td>
<td>Ahmadabad</td>
<td>6,352,254</td>
<td>5,570,585</td>
<td>2,935,869</td>
<td>2,634,716</td>
<td>897</td>
<td>89.62</td>
</tr>
<tr>
<td>6</td>
<td>Chennai</td>
<td>8,696,010</td>
<td>4,681,087</td>
<td>2,357,633</td>
<td>2,323,454</td>
<td>986</td>
<td>90.33</td>
</tr>
<tr>
<td>7</td>
<td>Kolkata</td>
<td>14,112,536</td>
<td>4,486,679</td>
<td>2,362,662</td>
<td>2,124,017</td>
<td>899</td>
<td>87.14</td>
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Source: Census of India 2011
**Naming of Bangalore:** There are numerous versions related to the naming of the city as 'Bangalore'. As per the information available in the Gazetteer of India, the term 'Bangalore' is an anglicized version of "Bengalooru," a Kannada term. The word Bengalooru was in turn derived from the phrase 'bende kaalu ooru', meaning 'the town of boiled beans'. There is a story behind naming the city as the 'town of boiled beans'. It is said that King Ballala of the Hoysala dynasty once got lost in the jungle and was very tired and hungry. In the jungle, he came across a poor and old woman, who offered him some boiled beans. As an expression of his gratitude towards the woman, the King named the place as 'bende kaalu ooru'. However, there are other historical evidences that reveal that the name 'Bengalooru' was recorded much before the reign of King Ballala. Kempe Gowda, known as the founder of Bangalore, played a very important role in shaping the city. A feudal lord himself, used to serve under the Vijayanagara Kings. A hunting enthusiast, Kempe Gowda once saw his dog being chased by a hare. Amused as well as impressed by this incident, he started calling Bangalore as 'Gandu bhoomi' (heroic place). He, with the help of King Achutaraya, built a mud fort in Bangalore and inside it founded the towns of Balepet, Cottonpet, and Chickpet. Later, his son got the four watchtowers erected on the boundaries of the city, visible even today. In the year 1638, the Vijayanagara Empire fell to the Sultan of Bijapur, Mohammed Adil Shah. For the next sixty years, the city was under the rule of the Sultans. Thereafter, Mughals took over the city. However, their rule did not last too long and in 1687, they sold the kingdom to King Chikkadevaraja Wodeyar of Mysore. He got another fort built in Bangalore, to the south of the one built by Kempe Gowda. Hyder Ali received Bangalore in the form of jagir in 1759, from Krishna Raja Wodeyar II. He converted the city into an army town. In the year 1799, when Tippu Sultan died, the British returned the kingdom back to Krishna Raja Wodeyar III. However, the British again took over the kingdom in 1831, citing misrule by Krishna raja Wodeyar III as the reason. It was under the British rule that Bangalore started developing into a modern city, with all the contemporary facilities like railways, telegrams, post and telegraph, etc. The city was again given back to the Wodeyars in 1881. However, since the British Commissioners were based in Bangalore, its development into a contemporary city continued unabated. After India gained independence in the year 1947, Bangalore became the capital of Karnataka. From then onwards, the city has witnessed large-scale development and has grown in leaps and bounds. The introduction of information technology in Bangalore, somewhere around the year 2000, led to the development of the city as the IT Capital of India. Today, it has become the hub of IT professionals in India. There are numerous other names given to Bangalore, like 'India's Silicon Valley', 'The Fashion Capital of India', 'The Pub City of
India’, etc. The city of Bangalore got renamed as Bengalooru in the year 2006. Even though the term 'Bangalore' is still very common, now the official name of the city is Bengalooru.

1.4 Review of Literature

Many researchers and academicians have attempted to evaluate the characteristics of urbanization and peri-urbanization. A perusal of the literature on metropolitan cities registers several studies relating to internal and external structure, using which researchers have tried to establish the typology of cities. In a few studies the urban growth has been studied in terms of its effect on its surroundings and in identifying the losses due to such an expansion. However, with the availability of Remote Sensing Technology and GIS, studies of urban monitoring and modeling have been carried out using satellite data.

**Michael Pacione**: The famous Urban Geographer who wrote “Urban Geography – A Global Perspective”, one of the all time best reference book in the field of Urban Geography. He explained the Urbanizing of the world, urban structure and land use in the western cities, urbanization in the third world and causes and consequences of the urban and its related phenomena. He concentrated on the urban sprawl, fringe and the peri-urbanization.

**Mayer and Kohn**: These two giants of Urban Geography have edited, Readings in Urban Geography. In their classical work on urban Geography Mayer and Kohn provide basic literature whether for a large or small urban settlement. These to pioneer writers have given urban literature pertaining to towns and cities of USA and other western countries. It is well known that they have covered topic wise literature right from definition of urban settlements to historical growth, land use, functional classification, heroes of urban structure to basic and non basic aspects. They have covered valuable topics like Central Business District, Urban fringe, Peri-urbanization with their methods of delineation. Inspite of availability of new literature on urban geography their classical work is still popular and is a must for a researcher.

**Singh R. L**: has written a seminal work on Bangalore City. It is not only an authoritative book on Bangalore City. But provide a basic framework for any individual urban settlements. Highly useful methodology on the delineation or urban hinterlands under various socio-economic as also cultural variables has been adapted. It is a valuable work on an Indian town, which stands as a yardstick for comparative studies of urban settlements of similar type.
author goes to the very genesis of urban issues on Bangalore city of early 1960’s. Aspects of public utilities like water supply and its management for the expanding city have been done with excellent cartographic support. In fact, the present study took the credential from this work.

**V. L. S. Prakash Rao:** The land use changes and associated farming activity of Bangalore City and its surrounding region has been studied. The parameters considered for finding the impact of the city on its surrounding region causing land use changes included population density, sex ratio, literacy, concentration of non-agricultural population and population dependence on commerce, accessibility to the city and increasing distance from it, in particular.

**R. Ramachandran:** This substantive and original contribution to the study of urbanization in India critically analyses the strengths and weakness of the Indian urban system and provides new insights into contemporary urban problems. The author’s perspective of urban development in India interrelates the geographical dimension with historical and socio-economic aspects. The book focuses on the process of urbanization and the nature of interdependence among urban centers and between urban centers and their hinterlands. The approach is at the macro level.

**Johnson:** presented a generalized model of the structure of an Indian City. According to the model, the city has an origin of distant past with its location close to a water supply, having a fort at the center in the medieval times. This, the city core is a walled nucleus, within which is located a commercial center. Cantonment was located outside the walled nucleus during the British period. This is well planned with parks, large houses, railway station, racecourses, etc. After independence, the development of industry, transportation, the location of the upper, middle class and low class houses and universities have taken place in the periphery. Considering, the case of eight cities in India. Johnson describes how these cities fit into his model, and Bangalore is one of the eight cities studied by him. However, the model proposed by Johnson is not suitable to those cities which have a colonial or planned past and it explains only the structure of cities having a single centre or node.

**Bore Gowda and Mahadev:** In 1978 made an attempt to study the impact of Bangalore Metropolitan centre on the villages surrounding it and the transformation that has occurred in
these villages due to urban impact. The aspect of transformation has been studied over a period of 25 years with respect to land use, demographic and socioeconomic structures.

**Farhat Gulzar**: Made a research on A Urban Fringe of Lahore City – A functional study, in his research, he in detail mentioned all the functional classes. He used the Residence, industries, transportation, commerce, education, health and recreation, its causes and consequences on urban fringe of the Lahore city.

**Jianquan Cheng**: In his research “Modeling Spatial and Temporal Urban Growth”, he applied some concept like complexity of urban growth, modeling and evaluation. CA based, Agent based, spatial statistics, ANN based, Fractal based model are the major models used for the research and applied the conceptual models to understand the spatial and temporal process of urban growth.

The studies on Bangalore city also shows that internal structure of Bangalore city has been studied upto 1971 by various authors using conventional methods. However, the satellite based study of urban growth of Bangalore has been upto 2010. But no one used the cell based model for the peri-urbanization in the Bangalore metropolitan city. The present research made an attempt to apply cellular automata modeling for the Bangalore metropolitan city. Use of high resolution satellite imageries and it is useful for deriving urban land use, land cover maps applying GIS, GPS and Remote Sensing Technologies.

### 1.5 Scope of the Study

The research on modeling peri-urbanization of Bangalore Metropolitan City has its own merits and demerits, and the growth and development of the Bangalore metropolitan city have both positive and negative impact on the local bodies and as well as governing bodies. And the scopes of the present research are,

► It is very useful to understand the land use and land cover changes happened in the Bangalore city and its surrounding regions.

► To assess the impact of urban development in the peri-urbanization on the living styles of the residents in the surrounding areas of a growing city.

► To identify the potential areas of urban development in the surrounding regions of a growing city using selected criteria’s for the modeling.
Provides better understanding of the chronological and current issues involved in spatial and temporal characteristics of Bangalore metropolitan and peri-urban of the city, and it is useful for the local governing bodies to make planning and decisions.

To demonstrate the potentials of remote sensing data, especially, the high resolution data, received from the indigenously development Indian Remote Sensing satellite data for generating urban development plans.

1.6 Terminologies (Urban, Urbanization, Peri-urbanization)

Central Business District (CBD): The nucleus of an urban area, containing the main concentration of commercial land use, decentralization of the characteristics commercial land uses to suburban or exurban location, such as planned shopping centers and highway-oriented office parks, can undermine the traditional dominance of the CBD.

City proper: The population living within the administrative boundaries of a city, e.g., Washington, D.C. Because city boundaries do not regularly adapt to accommodate population, increases the concepts of urban agglomeration and metropolitan area are often used to improve the comparability of measurements of city populations across countries and over time.

City-region: An urban development on a massive scale: a major city that expands beyond administrative boundaries to engulf small cities, towns and semi-urban and rural hinterlands, sometimes expanding sufficiently to merge with other cities, forming large conurbations that eventually become city-regions. For example, the Cape Town city-region in South Africa extends up to 100 kilometers, including the distances that commuters travel every day. The extended Bangkok region in Thailand is expected to expand another 200 kilometers from its centre by 2020, growing far beyond its current population of over 17 million.

Conurbation: A Built-up area created by the coalescence of once-separate urban settlements, initially through ribbon development along major inter-urban routes.

Counter urbanization: is a demographic and social "process" whereby people move from urban areas to rural areas. A process of population deconcentration away from the large urban settlements.

Edge City: An office, entertainment and shopping node with ‘more jobs than bedrooms’ that has emerged in suburban locations to challenge the dominance of the metropolitan downtown (city centre).

Exo-urbanization: A pattern of foreign-investment-induced urbanization in the Third World characterized by labour-intensive and assembly-manufacturing types of export-oriented
industrialization based on the low-cost input of large quantities of labour and land, which has in turn promoted rural-urban population migration.

**Megacity:** An urban agglomeration with a population of 10 million or more. In 2009, 21 urban agglomerations qualified as megacities, accounting for 9.4 per cent of the world’s urban population. In 1975, New York, Tokyo and Mexico City were the only megacities. Today, 11 megacities are found in Asia, 4 in Latin America and 2 each in Africa, Europe and North America. Eleven of these megacities are capitals of their countries.

**Mega region:** A rapidly growing urban cluster surrounded by low density hinterland, formed as a result of expansion, growth and geographical convergence of more than one metropolitan area and other agglomerations. Common in North America and Europe, megaregions are now expanding in other parts of the world and are characterized by rapidly growing cities, great concentrations of people (including skilled workers), large markets and significant economic innovation and potential. Examples include the Hong Kong-Shenzhen-Guangzhou megaregion (120 million people) in China and the Tokyo- Nagoya-Osaka-Kyoto-Kobe megaregion (predicted to reach 60 million by 2015) in Japan.

**Metacity:** A major conurbation – a megacity of more than 20 million people. As cities grow and merge, new urban configurations are formed. These include mega regions, urban corridors and city-regions.

**Metropolitan area/region:** A formal local government area comprising the urban area as a whole and its primary commuter areas typically formed around a city with a large concentration of people (i.e., a population of at least 100,000). In addition to the city proper, a metropolitan area includes both the surrounding territory with urban levels of residential density and some additional lower-density areas that are adjacent to and linked to the city (e.g., through frequent transport, road linkages or commuting facilities). Examples of metropolitan areas include Greater London and Metro Manila.

**Metropolitan village:** A dormitory settlements within commuting distance of an urban workspace and in which more than 20 percent of the resident population are employed in towns or cities.

**Peripheral urbanization:** A model that employs a political economy perspective to provide a generalized description of the impact of global capitalism on national urban systems in the Third World. The expansion of capitalism into peripheral areas is seen to generate a strong process of urbanization.

**Peri-urban area:** An area between consolidated urban and rural regions.
**Rate of urbanization:** The increase in the proportion of urban population over time, calculated as the rate of growth of the urban population minus that of the total population. Positive rates of urbanization result when the urban population grows at a faster rate than the total population.

**Reurbanization:** Re-urbanization is usually a government initiative to counter the problem of inner city decline. Inner city decline is brought about when problems such as inadequate housing, transport problems, pollution and over-population occur in the city. With these problems, the attractiveness of the city center is drastically reduced, resulting in loss of potential investment and an economically less productive city. Reversal of urban decline, often through city center redevelopment acts as a catalyst to increase attractiveness of the city. Thus encouraging people to move back to the city.

**Ribon development:** The process of urban sprawl along the main roads leading from a built-up area. Within urban areas the term refers to commercial strips along roads.

**Rural-urban fringe:** A transition zone between the continuously built-up urban and suburban areas of the city and the rural hinterland.

**Rural-urban continuum:** A continuous gradation of ways of life between the two poles of truly rural community and truly urban society. The concept has been used as a theory of social change which emphasizes the transformations in ways of life from one pole to the other.

**Suburbs:** are defined in various different ways around the world. They can be the residential areas of a large city, or separate residential communities within commuting distance of a city. Some suburbs have a degree of political autonomy, and most have lower population density than inner city neighborhoods.

**Suburbanization (or suburbanization):** is just a "term" used to describe the growth of areas on the fringes of major cities.

**Urban (area):** The definition of ‘urban’ varies from country to country, and, with periodic reclassification, can also vary within one country over time, making direct comparisons difficult. An urban area can be defined by one or more of the following: administrative criteria or political boundaries (e.g., area within the jurisdiction of a municipality or town committee), a threshold population size (where the minimum for an urban settlement is typically in the region of 2,000 people, although this varies globally between 200 and 50,000), population density, economic function (e.g., where a significant majority of the population is not primarily engaged in agriculture, or where there is surplus employment) or the presence of urban characteristics (e.g., paved streets, electric lighting, sewerage). In 2010, 3.5 billion people lived in areas classified as urban.
**Urban agglomeration:** The population of a built-up or densely populated area containing the city proper, suburbs and continuously settled commuter areas or adjoining territory inhabited at urban levels of residential density. Large urban agglomerations often include several administratively distinct but functionally linked cities. For example, the urban agglomeration of Tokyo includes the cities of Chiba, Kawasaki, Yokohama and others.

**Urban corridor:** A linear ‘ribbon’ system of urban organization: cities of various sizes linked through transportation and economic axes, often running between major cities. Urban corridors spark business and change the nature and function of individual towns and cities, promoting regional economic growth but also often reinforcing urban primacy and unbalanced regional development. Examples include the industrial corridor developing between Mumbai and Delhi in India; the manufacturing and service industry corridor running from Kuala Lumpur, Malaysia, to the port city of Klang; and the regional economic axis forming the greater Ibadan-Lagos-Accra urban corridor in West Africa.

**Urban Fringe:** Urban fringe is the most sought after and at the same time most problematic area of a peri-urban region. This is the area of future growth, the area in which the city expands, yet, is often subjected to a chaotic development before it is finally merged in the city. An area of transition, between the rural and the urban, the fringe has been the subject of study by different disciplines.

**Urban growth:** The (relative or absolute) increase in the number of people who live in towns and cities. The pace of urban population growth depends on the natural increase of the urban population and the population gained by urban areas through both net rural-urban migration and the reclassification of rural settlements into cities and towns.

**Urbanism:** A way of life associated with residence in and urban area.

**Urbanization:** The process by which an increasing proportion of a national population lives in towns and cities.

**Urban sprawl:** Also ‘horizontal spreading’ or ‘dispersed urbanization’. The uncontrolled and disproportionate expansion of an urban area into the surrounding countryside, forming low-density, poorly planned patterns of development. Common in both high-income and low-income countries, urban sprawl is characterized by a scattered population living in separate residential areas, with long blocks and poor access, often over dependent on motorized transport and missing well defined hubs of commercial activity.

**Satellite towns:** A town that is located close to a major city, with which it is closely associated. It is purposefully developed to meet the pressure on the associated city.
1.7 Peri-urbanization – Global, National and Regional Level

As a specific and non-neutral space, a peri-urban area refers to a transition or interaction zone, where urban and rural activities are juxtaposed (Place or deals close together for contrasting effect) and landscape features are subjected to rapid modifications, induced by human activities (Douglas, 2006). Peri–urban areas include valuable protected areas such as forested hills, preserved woodlands, prime agricultural lands and important wetlands can provide essential life support services for urban residents. McGranahan observed that peri–urban zones are often far more environmentally unstable than either urban or rural settings. From ecosystem’s point of view, physical, chemical and biological factors generally interact among themselves and are interrelated with socioeconomic forces. These factors have their own functions which can be enhanced or reduced depending on the conditions of other factors in the same system. A peri-urban area is not only a zone of direct impact, experiencing the immediate impacts of land demands from urban growth and pollution, but is also a wider market-related zone of influence that is recognizable in terms of the handling of agricultural and natural resource products. When the urban grows disorderedly and sprawls to peri-urban area, the process can be referred to as peri-urbanization. Peri-urbanization can be regarded both as a driver and an effecter of global environmental changes. Observing land use and land cover change over period of time can perceive effects and impacts of urbanization on peri-urban areas. The complex interactions between urban land use, environmental changes, and socioeconomic system on peri-urban area must be approached from systems perspective to understand their dynamic interactions, functions and services of peri–urban’s ecosystems provided to cities.

**Facts on peri-urbanization:** Today, the European areas classified as ‘peri-urban’ have the same amount of built-up land as urban areas, but are only half as densely populated. There is a real risk of increasing urban sprawl: The growth of peri-urban areas will be up to 3.7 times as high as in urban areas. European-wide projections of built development in peri-urban areas are 1.4 – 2.5% per annum – if such trends continue. Total built development in peri-urban areas could double between the years 2040 – 2060. Similar modeling on the impacts of urbanization shows that land fragmentation, loss of habitats and amenity values will all be more serious in the peri-urban than today. Meanwhile, the peri-urban is also a place of innovation and increasing employment in the service and IT sectors. 25% of peri-urban regions are classified as ‘highly innovative’.
Why the peri-urban? The peri-urban – the space around urban areas which merges into the rural landscape – is growing rapidly across Europe. There is about 48,000 km² of built development in peri-urban areas, almost equal to that in urban areas. But while, most urban areas are now slow growing (at 0.5–0.6% per year), built development in peri-urban areas is growing at four times this rate. There are many impacts of such rapid expansion. In many cases the result is sprawl, with increasing problems of social segregation, urban decline, waste land, and dependency on oil for transport. However, there are examples of alternatives, with opportunities for improved quality of life, green infrastructure, better linkages between city and countryside, are more sustainable urban and rural development.

What is the peri-urban? The peri-urban is the area between urban settlement areas and their rural hinterland. Larger peri-urban areas can include towns and villages within an urban agglomeration. Such areas are often fast changing, with complex patterns of land use and landscape, fragmented between local or regional boundaries.

The term peri-urbanization refers to a process often a highly dynamic one, in which rural areas located on the outskirts of established cities become more urban in character. This transformation occurs in physical, economic, and social terms, and often in piecemeal fashion. Peri-urban development usually involves rapid social changes, as small agricultural communities are forced to adjust to an urban or industrial way of life in a very short time. High levels of immigration are an important driver of social change. Rapid environmental deterioration and infrastructure backlogs are usually the characteristics of the peri-urban landscape. Typically, peri-urbanization is stimulated by an infusion of new investments, generally from outside, including foreign direct investment. In spatial terms, Rakodi defines the peri-urban area as the transition zone between fully urbanized land in cities and area in predominantly agricultural use. It is characterized by mixed land uses and indeterminate inner and outer boundaries, and typically is a split between the numbers of administrative areas.

The peri-urban zone begins just beyond the contiguous built-up urban area and sometimes extends 150 kilometers from the core city or as in the Chinese case, as far as 300 km. The land that can be characterized as peri-urban shifts over time as cities, and the transition zone itself expands outward. What frequently results is a constantly changing mosaic of both traditional and modern land use. Peri-urbanization does not necessarily result in an end state that resembles conventional urban or suburban communities.
Characteristics of Peri-urban – Changing economic structure, encompassing a shift from an agriculturally based to a manufacturing dominated economy. Rapid population growth and urbanization, a phenomenon often not captured in official data because the population of peri-urban regions tends to be significantly under-counted in many countries. Immigrants do not officially register as local residents. Many peri-urban areas furthermore are still defined as rural, contributing significantly to an undercount of the urban population.

In India, with an unprecedented population growth and migration, an increased urban population and urbanisation is inadvertent. More and more towns and cities are blooming with a change in the land use along the highways and in the immediate vicinity of the city. This dispersed development outside the compact urban and village centres along highways and in rural countryside is defined as sprawl (Theobald, 2001). Urbanisation and peri-urbanization is a form of metropolitan growth that is a response to often bewildering sets of economic, social, and political forces and to the physical geography of an area. Some of the causes of the peri-urban include - population growth, economy, patterns of infrastructure initiatives like the construction of roads and the provision of infrastructure using public money encouraging development. The direct implication of such peri-urban and sprawl is the change in land use and land cover of the region. Peri-urban generally infers to some type of development with impacts such as loss of agricultural land, open space, and ecologically sensitive habitats. Also, sometimes peri-urban is equated with growth of town or city (radial spread). In simpler words, as population increases in an area or a city, the boundary of the city expands to accommodate the growth; this expansion is considered as peri-urban. Usually peri-urban takes place in the transition zone between urban and rural areas.

In Bangalore, the peri-urban edge is the most active frontier of urban development, a space where squatter settlements, paddy cultivation and new gated enclaves about one another. In the last decade, the urbanization of these rural fringes has proceeded with brazen speed. Farmland has been rapidly converted into residential subdivision, shopping malls, and entertainment complexes to ensure the production of the bourgeois city. At the same time, Indian cities have deployed aggressive strategies of slum demolition, criminalization of the poor and evicting squatters. The result is not unlike what Graham and Marvin designate as “Splintering Urbanism” or what Benjamin, in his work on Bangalore. Bangalore metropolitan city has the improvement of peri-urbanization in all the corners. Peri-urban agriculture has brought out two clear impacts on farmers and the rural economy. The first is the long-term
impact of rise in land prices associated with reduced size of holding for agriculture and the second, the short-term impact of rise in agricultural wages. In peri-urban and rural agriculture, the contribution from wage income exceeds 50%. Nevertheless, the per capita income of farmers in these scenarios is 50% lower than the per capita income of an average Indian. Steps are suggested to improve the economic situation of peri-urban farmers.

1.8 Societal Benefits of the Research

Every research concern is to provide something to society, either directly or indirectly. Through the research, society gets some advanced benefits. Automata model applied for modeling peri-urbanization of Bangalore Metropolitan City reach the goal of the research.

♦ using the satellite imagery of Bangalore Metropolitan City, land use and land cover map and future data set has been prepared, these can be used for the future prediction in the urban planning and management.

♦ applied some criteria to prepare basic Cellular Automata Model for the Bangalore Metropolitan Region and 4 pockets of the study area. These cellular automata can be useful to interpret and predict peri-urban expansion.

♦ The Data / information is useful for the BDA, BBMP, BMR(Bangalore Metropolitan Region) and other governing bodies for creating infrastructure because data shows the area and pockets where and when urban occupy rural area.

♦ at the same time the issue revised provided the present scenario in a systematic manner either to migrate the urban problem or improve the living conditions of the population of Bangalore Metropolitan City.

♦ converting non-favorable factor into favorable factor, this reason give some measures and treatment.

♦ Research is mainly useful to meet the development for the public amenities.

1.9 Limitations of the study

The scope of the research on Modeling Peri-urbanization of Bangalore Metropolitan City is dependent on several factors. The research strictly restricts to the scope because of certain limitations in term of restricted time, money, technology and some other key factors.

The base maps are published from various sources. The study area restricted is to 1500 sq km, because with the small period of time we can’t cover the entire Bangalore Metropolitan
Region. For the cellular automata model we chose only important 5 criteria’s, because of the lack of data’s and facility to modify those data’s. Long term data on urban land use and land cover are uniformly not available or though available may not follow the same criteria of classification due to which comparisons becomes a great issues. The remote sensing data used for the research pertains to the year 2001, 2003, 2005, 2008 and prediction of 2010. But these satellite imageries are not the same resolutions, and the same bands. At the time of processing, this factor plays a vital role. Imageries are IRS 1C/1D, LISS III, LISS IV, Cartosat I of different resolutions. Toposheet is published by Survey of India, other secondary data’s are from Census of India, and local governing bodies. High resolutions of satellite imageries are used only for the selected pockets of the study areas such as Whitefield, Kengeri, Peenya and BIAL Road. The study area covers BBMP, BDA, BMRDA and parts of Bangalore Rural District, and Urban District. For all these difficulties, research has been limited to certain scope.

1.10 Aims and objectives of the study

♠ To build conceptual model for Bangalore Metropolitan City and Urban growth.
♠ To prepare the land use and land cover maps of 2001 -2009 temporal duration.
♠ To know the Land value pattern of Bangalore Metropolitan Region – 2009 and examine the causes and consequences of land Value changes.
♠ To build a Cellular Automata Model for the Bangalore Metropolitan Region.
♠ To construct Cellular Automata Model for selected pockets of peri-urban - Peenya, Kengeri, BIAL Road and Whitefield.
♠ To examine the urbanization and peri-urbanization of Bangalore Metropolitan City.
♠ To examine and cross check the Bangalore Master Plan and Comprehensive Development Plan.

1.11 Sources of research data

Spatial Data’s

➢ Toposheet published from survey of India as a base map.

➢ Satellite images from IRS P6, LISS III and CARTO SAT 1 to analysis the 2001, 2005 and 2007. All the imageries are multispectral expect Cartosat 1.

➢ GPS data to know the latitude, longitude and altitude of the area of interest.
1.2 Methodology

In the present study, as the secondary data used are from different sources and in different formats, various techniques such as remote sensing, GIS and GPS etc. have been used at different stages of analysis. Specifically, Remote sensing techniques have been used for generating photographic products from the raw satellite data suitable for data interpretation and preparation of various thematic maps. The interpreted satellite data and other information available from various sources have been analyzed using Geographic Information System. Descriptive statistical techniques have been used for analyzing the demographic data of the villages in the study area and also the primary data generated through household survey. Thus the techniques followed in this study for analyzing the data can be broadly grouped under four categories, namely RST, GIS, GPS and Mathematical and Statistical techniques.

Remote Sensing Technology – Remote sensing is the acquisition of information about an object or phenomenon without making physical contact with the object. In modern usage, the term generally refers to the use of aerial sensor technologies to detect and classify objects on Earth (both on the surface, and in the atmosphere and oceans) by means of propagated signals(e.g. electromagnetic radiation emitted from aircraft or satellites). ERDAS Imagine Processing is used for the Remote Sensing technology. The methods used under the ERDAS are
Data preparation including geo-referencing of the base map and satellite imagery, Generation of merged objects, image to image geo-referencing, supervised and non-classification, and image processing.

**Geographical Information Science** - GIS is a system of hardware and software used for storage, retrieval, mapping, and analysis of geographic data. Practitioners also regard the total GIS as including the operating personnel and the data that go into the system. Spatial features are stored in a coordinate system (latitude/longitude, state plane, UTM, etc.), which references a particular place on the earth. Descriptive attributes in tabular form are associated with spatial features. Spatial data and associated attributes in the same coordinate system can then be layered together for mapping and analysis. GIS can be used for scientific investigations, resource management, and development planning. In the present research work Arc GIS 9X version has been used as the core of the spatial database. This is a modular, vector based package and is versatile in the creation, organization, storage, retrieval, analysis, display, and query and for making cartographic quality outputs in the form of maps and generation of statistical tabular reports. The methods used under the Arc GIS are data base creation, digitizing, attribute creation, topology creation, and analysis part including cellular automata model creation, urban land and land cover change analysis, and others.

**Global Positioning System** - GPS is a satellite-based navigation system originally developed for military purposes and is maintained and controlled by the United States Department of Defense. GPS permits land, sea, and airborne users to determine their three-dimensional position, velocity, and time. It can be used by anyone with a receiver anywhere on the planet, at any time of day or night, in any type of weather. This is an amazing capability. Global Positioning System is mainly used in the research because of getting the exact latitude and longitude of the particular place and to trace out the important road networks.

**Mathematical and Statistical techniques** – Demographic data of the BBMP wards and adjoining villages have been collected from the Census of India. Surveying of the data from Bangalore Metropolitan City Region is to create cellular automata model. It has been analyzed using mathematical and statistical techniques like mean, range and bifurcation ratio.
1.13 Organization of the Thesis

The present study “Modeling peri-urbanization of Bangalore Metropolitan City – A Geoinformatic Approach”, has covered fairly good number of themes of Urban Geography and GIS application. The thesis has seven chapters. Each chapter has its heading and subheading with the respective body of literature. The necessary data has been portrayed through tables, consequent thematic maps and plates in the thesis in appropriate sections.

The first chapter deals with formal details relating to the theme of the study and its allied aspects. It contains introduction to study and study area. It mentions briefly about the location, geology, physiographic, topography and physical environment. Important Demographic settings like distribution of population, density of population, literacy, sex ratio of the study area have been explained. Review of literature has been done and gathered the urbanization and peri-urbanization information. It also provides information about the cellular automata modeling. The introductory chapter also covers the information of objectives of the study, limitation of the study and explained as concluding aspects in this formal section giving an over-view of the nature of investigation. This chapter includes details of methodology of data collection and analysis giving the necessary details.

The second chapter examines the conceptual models of peri-urbanization. This chapter includes introductory part, concepts of models in urban geography, Explains the basic urban settlement models including concentric zone, multiple nuclei and sector model, Mathematical models related to peri-urbanization, Constructing conceptual models for the Bangalore Metropolitan City and selected pockets, Examine the conceptual models with the perceived reality and Application of GIS in building conceptual models.

The third chapter provides a brief account of Land use and land cover of Bangalore Metropolitan City. Explain the concept of land use and land cover, classification of LULC based on the National Land Use and Land Cover classification. Major data sources for LULC, Dynamic factors affecting Land Use in Bangalore City. Change detection techniques have been used to show the changes occurred in the temporal durations. Field verification has been made to prove the reality. Concept of land values, differentiation between the government value and real estate values.
Chapter four deals with the cellular automata model, its characterization and application of cellular automata model in peri-urban studies. Cellular automata model comparison with the classic cellular automata structure and its types. It also examines the principles of Markov chain, Fuzzy C A models. Selected criteria for building of cellular automata model for Bangalore Metropolitan City and selected pockets.

The chapter five and six deals with the four pockets of the research area, those are Peenya, Whitefield, Kengeri and BIAL road. In this chapter we are examining the seed point of each pockets, favorable and non-favorable factor for building cellular automata model and Geographical settings of the four pockets. Finally, discussions for the results and the suggestions for the selected pockets.

Chapter seven has been used to give a formal summery and conclusion with a few suggestions for the development of Peri-urbanization of Bangalore Metropolitan City. Strategies for a better urban life and creating infrastructure are hinted at the end of this study. The study has broadly outlined its findings and has arrived at conclusions and suggestions for the comprehensive growth of peri-urbanization.

1.14 Geographical Settings of the study area

Bangalore city has a colorful past and begin life as the “village of the half baked gram”. In 1537, Magadi Kempe Gowda, a devout Hindu and feudatory chief of the Vijayanagara Empire built a mud fort and erected four watchtowers outside the village, marking the limits of its further growth. Bangalore has changed hands many times and in 1758, Hyder Ali; a Muslim king took over it. In 1799, the British overthrew Tippu Sultan, Hyder Ali’s son, and set up cantonment in Bangalore. This made the city an important military station and passed the administration to Maharaja of Mysore in 1881. After Independence, Bangalore was designed as the capital of Mysore state in 1956, and it has retained that status even after Karnataka State was formed in 1973. The impact of the history of Bangalore is seen in its present day structure of the city with remnants of the Kempe Gowda’s fort, the cantonment of the British period and the palaces of Tippu and Hyder Ali.

At the beginning of 20th century, Bangalore city had many sobriquets like “Pensioner’s paradise”, since retired army officers preferred to settle in Bangalore in big sprawling houses; the
“Garden City” with the green and beautiful maintained Lalbagh and Cubbon Parks in the heart of the city, and the “air-conditioned city” because of its pleasant climate. However today, it is known as the “Fastest growing city in Asia”, the city of 21st century” for the potential investors from abroad and the “Silicon Valley of India” for the global electronic and computer giants. The city, with its population of 4.13 million in 1991, ranks seventh amongst the nine millionaire cities in the country, a status which it attained in 1961. The population of Bangalore city in 2001 is 5.68 million. According to recent census in 2011 the Bangalore city population is about 95, 88,910. The location of electronic and software units in Electronic City areas on Hosur road, The Information Technology Park and Export Zone in Whitefield area and the intended International Airport at Devanahalli all indicate that Bangalore City is poised for a futuristic expansion both in terms of population and spatial growth. One of the main aims of the present study has been to monitor the urban growth of Bangalore City over a period of time and space; it was found proper to include the corporation areas of the city as well as the surrounding areas as the study area, instead of considering only the administrative boundaries like a district or a taluk or a city corporation boundary, as usually practiced. Hence in the present investigation, it was found appropriate to consider the Bangalore Metropolitan area as identified by the Planning Authority, Government of Karnataka, in 1995, for studying the urban growth and planning. This area has two components; the first being the area identified for urban development, which is about 565 sq. km, and the second being the green belt measuring 682 sq. km. This area comprises the city corporation area as well as the surrounding areas where urban growth is taking place, and also the areas of potential growth.

For drawing an appropriate developmental plan of a region along with the demographic information for examining, the urban land use patterns are essential. Considering this in the present study, an attempt has been made to understand the various physical features of the study area with respect to parameters such as physiographic setting, geology, soil, etc.,

**Location:** The study area forms a major part of the Bangalore Urban and Rural district, which was carved out as a separate district from the original Bangalore district in 1986, to differentiate its urban and rural components. The study area covers the areas of Bangalore Urban districts, 4 taluks namely Bangalore North, Bangalore South, Bangalore East and Anekal. Bangalore rural districts, Part of Hoskote, Devanahalli and Nelamangala. Within these districts study area covers 198 BBMP Wards.
Modeling Peri-Urbanization of Bangalore Metropolitan City – A Geoinformatic Approach
Physiography: The Bangalore city forms an important and dominant part of Bangalore district of Karnataka and spread over an area of about 1279 sq. km as per revised CDP, Bangalore (GO No. HUD 139 MNJ 94 dated 05.01.1995) and is situated on a plateau. The topography of Bangalore is generally flat except for a small rise to form a ridge running through the middle. There are no major rivers flowing in this area. However River Arkavathi flowing for a small stretch in Bangalore North taluk and River Vrishabhavathi a tributary of Arkavathi which presently carries the bulk of city’s sewage are the two small rivers flowing in this region. Bangalore also has a string of freshwater lakes and water tanks dotting the city such as Bellandur, Ulsoor, Hebbal, Nagavara, Hennur lakes, Sankey, Madivala tanks etc., Groundwater occurs in silty to sandy layers of the alluvial sediments and also in the jointed quartzite having secondary permeability under confined conditions. The weathered and fractured granites and gneisses constitute principle aquifers in this area. The chief source of recharge is seasonal rainfall and additional sources are seepage from reservoirs, tanks, lakes, rivers etc.

The ridge and valley topography of Bangalore has uniquely supported the creation of large number of man-made lakes. These lakes form chains, being a series of impoundments across streams. All these streams finally join either the river Arkavathi or the river south Pinakini.

Geology and Geomorphology: The area has mature topography with scattered isolated hillocks around, where rocks are exposed. The rock type exposed in the district belongs to Saugar Group, Charnockite Group, Peninsular Gneissic Complex (PGC), Closepet granite and basic younger intrusive. Saugar group comprises ultramorphic rocks, amphibolites, Quartzite banded magnetites, quartzite occurring as small bands and lenses within the magmatites and gneisses. PGC is the dominant unit and covers about two-thirds of the area, which includes granites, gneisses and magmatites. The bed rocks essentially consist of granites and gneisses intruded by number of basic dykes. The soils of Bangalore district consist of red laterite and red fine loamy to clayey soils. Most of the region of Bangalore is covered by pediplain which shows the predominant fluvial geomorphology. In the Northern most and in the southern part,
dendudational hills are found. Pedimount zones are found scattered here and there and predominantly in the north. Tanks are found scattered almost everywhere.

**Drainage:** The drainage of Bangalore radiates from high grounds in a radial pattern. The area near Krishnaiyanapalya to the north of Ulsoor, illustrates a typical drainage pattern. Broadly there are two drainage systems on either side of the main ridge, eastern and western. To the east of the ridge, the important valleys are those of Koramangala, Challaghatta and Naravanaholla and the overall slope is towards the south. The first two streams unite with Bellandur tank and ultimately find their course through the broken beds towards the South Pinakini. Naravanaholla finds its source beyond Yelahanka joins the Hebbal tank and flows through the tanks of Nagavara Kere, Kalkere and the tank at Rampur and joins Yellamallapachetty Kere. It ultimately unites with the South Pinakini at Kadagodi in Hoskote taluk. The streams, which originate from the northern side of the ridge, flow into the Nagavara Kere, Hennur Kere and Kammanahalli Kere and become a part of the above system of tanks. While on the western side of the ridge are the Vrishabhavathi and its tributaries, which take southerly and southwesterly courses. Important among them is the one which takes its origin from Oyali Dinne and Gavipura flowing southwest and uniting with Arkavathi River in Kanakapura passing through Kengeri and Bidadi.

**Climate:** The climate of Bangalore is pleasant and in fact is the important factor for many people to settle permanently in Bangalore. The district enjoys a very agreeable climate free from extremes. The climates of Bangalore are classified as the tropical wet and seasonally dry with four seasons.

The dry season with clear bright weather is from December to February.

The summer season is from March to May.

South-West monsoon season is from June to September.

The North-East monsoon is from October to November.

The temperature varies from a mean maximum of 33.40°C in April/May to the mean minimum of 15°C in December/January. The mean monthly relative humidity ranges from 44% (min) in March to 85% (max) in October. Rainy season is characterized by spells during June to September and October to November, corresponding to South-West and North-East monsoon. The mean annual rainfall is reported to be 889 mm. The surface winds in Bangalore have a seasonal character with clear cut easterly and westerly predominant directions. The site meteorology has an important influence on the buildup, diffusion and transportation of
atmospheric pollutants and therefore meteorological data was collected from India Meteorological Department (IMD) for a set of meteorological parameters from the IMD station at Bangalore (Meteorological data particulars are discussed in Chapter I, Environmental Baseline Report). During the period May to September, the winds are WSW to W, while during the period November to March, they are ENE to ESE. April and October are transition months when changeover from the Easterly to the Westerly wind regime and vice versa takes place.

In general Bangalore experiences a very high relative humidity during July to October and lowest in March. The humidity level starts gradually dropping from December till March and rises gradually from March till June. The humidity gets stabilized during July and August.

**Seismicity:** Bangalore city has generally remained nearly untouched by major seismic activity due to its location in a seismically stable region (Zone II revised). Only mild tremors have been recorded in the city occasionally as per records of Directorate of Mines and Geology, Government of Karnataka and Bhabha Atomic Research Centre.

**Soils:** The central part of Bangalore is covered by Loamy skeletal soil and sandy soil in combination. Towards south the soil is more coarse loamy and coarse loamy silt. Toward the southernmost it is more sandy skeletal. Pokey land is found in the south, south east and East. Towards East, hilly ranges are present. More of clayey and clayey loamy soil is found here. Clayey soil is found in a scattered pattern in central and northern part of Bangalore. Fine loamy and coarse soil is found towards the north east. Bangalore’s soil is favorable for Agriculture except the few rugged terrains in the East and South East.

### 1.15 Demographical Setting of the Study Area

Bangalore has the dubious distinction as the third fastest growing city among five large metros in India with the growth rate of 43.80% from 2001 to 2011. As an emerging metropolitan city, Bangalore over the last few years has attracted its population from almost every corner of the country chiefly because of its climate, employment opportunities, trade and commerce and academic institutions.

According to census, about 1.6 lakhs people inhabited Bangalore in 1901 and the number has steadily increased over the years. During the last three decades, the population of Bangalore has doubled from 29.21 lakh in 1981 to almost 56.86 lakhs in 2001 and 84.99 lakhs in 2011.
Prakasa Rao and Tewari (1979), has shown that Bangalore accounts approximately 25 percent of urban population of Karnataka. In brief, Bangalore has grown over the decades both in size and population, population growth has been rapid during the last few decades (Rao, 1996).

Bangalore experienced much industrial growth during 1951 to 1971 with the setting up of factories like Indian Telephone Industry (ITI), Bharat Electronics Limited (BEL), Hindustan Machine Tools (HMT), Hindustan Aeronautical Limited (HAL), etc. These industries attracted migrants from the surrounding areas into manufacturing and service sectors. The migrants accounted for the high percentage of population growth during 1951 to 1971. From 1980’s, Bangalore’s industrial growth has been in the electronics sector and it is evident from the setting up of electronic city industrial park on the outskirts of Bangalore. From 1990’s Bangalore has become a major player in the software market and attracted many multinationals such as Motorola, Texas Instruments, Hewlett Packard, Digital, Microsoft etc., to have their offices. Some of the reasons for the upsurge of these multinational establishments have been the recent liberalization of Indian economy, temperate climate, vast reservoir of manpower, strong research and development networks, location of premier research institutions, etc., Multinationals dealing with information technology, consumer products/durables and industrial products also have congregated in Bangalore. Singapore’s selection of Bangalore for the location of International Technology Park Limited (ITPL) in white field has placed Bangalore on the industrial map of the world. The ITPL has the modern manufacturing infrastructure for software companies besides the social infrastructure including housing and entertainment. This situation has attracted thousands of immigrants to Bangalore causing a strain on the city’s infrastructure leading to shortage of electricity, insufficient water supply and a host of other problems.

Decadal Growth and Composition of Population:

Bangalore became the sixth largest city in India. Employment opportunities was initially in the public sector and then in textile and high technology industries which resulted in migration of people to Bangalore. The 2011 census population of Bangalore was 84.99 lakhs, but the (new draft) city development plan of BDA has included population in the peripheral villages and estimated the Study area (metropolitan area) population as 102.31 lakhs. The growth of Bangalore from a town to metropolis has been a result of the five growth events: shifting of the state capital from Mysore; establishment of cantonment; setting up of public sector under taking/academic institutions; development of textile industries and development to information technology/ITES/Bio-technology based industries. The city of Bangalore survived for nearly...
two and half centuries without noticeable physical expansion. But the booms in industrialization and expansion of the city limits. In the decade of 1991-2001, the growth rate urban population in Karnataka was 28.85% as against the aggregate population growth of 17.25%. Bangalore grew at a much faster rate, and its population increased from 56.86 lakhs in 2001 to 84.99 lakhs in 2011, representing a decadal increase of 43.80% which made Bangalore one of the fastest-growing among the Indian metropolitan cities, after New Delhi (51.93%). The demographic graph of Bangalore can be categorized as three phases. The phases unite the economic activities and the resultant growth that occurred in population. **Phase-I** is the time period of 1860 to 1931, when military establishment were operational in Bangalore and there was a boom in textile industries. **Phase-II** is the time period of 1931 to 1971 when Bangalore was the state capital and military based industries were established. Period between 1971 to hitherto can be called as **Phase-III**. It is during this phase, Bangalore had seen an unprecedented growth in all directions and by all means. There was a front role of software industries and services in the economy of the country and Bangalore became a back office for MNCs. About one third of the population increase in the Bangalore region is attributed to the fact that new areas were added to the Bangalore urban agglomeration. Adjusting this factor, the net increase in population during 2001-2011 was approximately 22%.

**Table 1.2: Growth of Population in Bangalore Metropolitan**

<table>
<thead>
<tr>
<th>Census Year</th>
<th>Persons</th>
<th>Area in Sq. Km</th>
</tr>
</thead>
<tbody>
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<td>1861</td>
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<td>1881</td>
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<td>1891</td>
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<td>1971</td>
<td>16,64,208</td>
<td>177.30</td>
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<td>1981</td>
<td>29,21,751</td>
<td>365.65</td>
</tr>
<tr>
<td>1991</td>
<td>41,30,288</td>
<td>455.91</td>
</tr>
<tr>
<td>2001</td>
<td>56,86,844</td>
<td>531.00</td>
</tr>
<tr>
<td>2011</td>
<td>84,99,399</td>
<td>710.00</td>
</tr>
</tbody>
</table>

Source: Census of India 2011
From 1860 to 1931 can be referred as the growth phase I, most of the developmental activities happened during this period. In the year 1862, seven British Commissioners were appointed under the direct rule of the state. In 1863 Bangalore club was formed and central jail was constructed. Cubbon Park cover 120 hectares, was created after the name of Sir. Mark Cubbon, the famous commissioner in the year 1864. The revenues and education department offices were built near K R circle during this year only. In 1865 Central Museum was established. In 1866 the Police Department was formed. Bowring hospital was established. Bangalore Golf Club, Tata Silk Farm, and many industries had been established. The important milestone was establishment of Indian Institute of Science in 1900 decades.

In the period of 1931 to 1971 that is growth phase II, Bangalore established many military campuses. The major industries like Binny Mills, Indian Tobacco Company, United Breweries, Government soap factory, Minerva Mills, Indian Air Services, Hindustan Aeronautics, today’s BMTC, ITI, MSIL, BEL and BHEL. The period between 1971 to hitherto can be referred as growth phase III. It is during this time Bangalore has preferred location for computer hardware and software companies, gave the status as “Silicon Valley of India”. In 1995 ITPL was established. The present total area is 710. It is during this period, Bangalore is undergoing an enormous growth by all means. It is now well fabricated with its cosmopolitan coat, as is the most preferred location in the nation as well as International back office for IT/BT Industries.

In the year 1971, the concept of Urban Agglomeration was introduced for the first time. Thus Bangalore Urban Agglomeration was formed incorporating several constituent units such as Bangalore Municipal Corporation and CITB, BEL Township, Devarajeevanahalli, HMT Township, Jalalhalli, Kadugondanahalli, HAL Township, HAL sanitary board and Duravaninagar. In the year 1981 Baiyyappanahalli, Manavarti Kaval, Hebbal, HMT Watch Factory Township, Kadenahalli (includes R M Nagar), Kengeri, K R Puram, Lingarapuram and Yelahanka were added to Bangalore Urban Agglomeration. In the year 1991 Baiyyappanahalli Vimanapura, Banasvadi, Benniganahalli, Byataguttepalya, Byatarayanapura, Dasarahalli, Geddalahalli, Kammagondanahalli, Kaval Bairasandra, Koramangala, Laggere, Mahadevapura, Nagavara, Peenya, Vijnapura were added to Urban Agglomeration. Herohilli, Pattanagere, Uttarahalli, Bommanahalli, Konanakunte, Gottigere, Kothnur and Hunasamaranahalli have been added to Bangalore Urban Agglomeration according to 2001 census. Before the election of BBMP in 2010 Medahalli, Batarahalli, Kalkere, Ullal, Electronic City, Whitefield and Varthur added to the Bangalore Urban Agglomeration.
### Table 1.3: Population of Bangalore City

<table>
<thead>
<tr>
<th>Bangalore City</th>
<th>Total</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>8,425,970</td>
<td>4,401,299</td>
<td>4,024,671</td>
</tr>
<tr>
<td>Literates</td>
<td>6,775,942</td>
<td>3,664,959</td>
<td>3,110,983</td>
</tr>
<tr>
<td>Sex Ratio</td>
<td>914</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child Sex Ratio</td>
<td>940</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Census of India 2011, BBMP records

### Table 1.4: Population of Bangalore Metropolitan

<table>
<thead>
<tr>
<th>Bangalore Metropolitan</th>
<th>Total</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>8,499,399</td>
<td>4,441,248</td>
<td>4,058,151</td>
</tr>
<tr>
<td>Literates</td>
<td>6,832,072</td>
<td>3,697,180</td>
<td>3,134,892</td>
</tr>
</tbody>
</table>

Source: Census of India 2011, BBMP records

Bangalore city comes under Bangalore Metropolitan area.

### Table 1.5: Population of Study Area

<table>
<thead>
<tr>
<th>Bangalore Metropolitan area</th>
<th>Total</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>10,231,501</td>
<td>5,295,457</td>
<td>4,936,044</td>
</tr>
<tr>
<td>Literates</td>
<td>8,136,547</td>
<td>4,103,560</td>
<td>4,032,987</td>
</tr>
</tbody>
</table>

Source: Census of India 2011, Consolidated from Gram Panchayat, and Hoblis

Bangalore Metropolitan area comes under Study Area (Bangalore Metropolitan City).

Bangalore Metropolitan Area, Hesaraghatta, Shanabhaganahalli, Rajanakunte, Doodajala, Samatenahalli, Hoskote, Tirumenahalli, Chikkabanahalli, Nerie, Sarjapura, Kommasandra, Kumbalagudu, Kenchaphura, Sulekere, Kannanahalli, Kuduregere, Madanayakanahalli.