6.1. Summary

Jorhat town forms the most urbanized area in the district of Jorhat. In the backdrop of the growing urbanization in the Jorhat town and subsequently its sprawl in the surrounding areas, an understanding of its nature and dimensions is a much need. And, this is why; the study on the nature and dimensions of urban sprawl of the Jorhat Town has been undertaken here. The entire study is summarized here chapter wise in the succeeding paragraphs.

Chapter 1 deals with the problem under study, extent of study area, objectives, research questions, significance of the study, database and methodology, review of literature and organization of the entire study.

The study area that has been considered for the research undertaken here is the Jorhat town along with its surrounding area, basically comprising 6 km buffer area of the Jorhat Municipality Area. The problem under study states that with the increase in population during the last few decades, Jorhat town has experienced a gradual expansion of economic activities and infrastructural development. This expansion has slowly led the town to sprawl in a highly unplanned manner causing a haphazard mix of the residential, industrial and commercial zones. In addition to this situation, it is of much concern that the historic town is devoid of any regulation of an updated master plan. In such a situation, the earlier master plan is not feasible to solve the ever-growing problems of the expanding town. As a result, the residential zone, commercial zone, industrial zone, public zone, green zone and open space and recreational zone have lost their former shapes and sizes and merged into one another without leaving the scope of demarcation. Moreover, it has been a concern during the recent years, that the process
of urbanization has been altering the landscape of the town, making it more prone to flooding and putting the residents’ and their livelihoods at risk of suffering damage during climate-related hazards. Here arises the challenging fact that the urban dwellers of the Town are at the risk of the gradual impacts of change in pattern of rainfalls, change in temperatures; and extreme events of rainfall. The dwellers are either adapting or bearing the brunt of the effects by responding to water scarcity, heat wave, flash flood and waterlogging problems.

It is here that the study acquires immense significance for understanding the various components and processes that play an important role in the growth of the town and its subsequent implications. Moreover, the findings on direction, magnitude, pattern and problems of urban sprawl and analysis for probable suitable sites for future growth of the town have been significant in addressing the problem under study.

In order to study the nature and dimensions of urban sprawl in the Jorhat town and its surrounding areas, few objectives have been formulated. The most important among those is to analyze the causes of urban sprawl and also spatial expansion of urban area in the study area in terms of its temporal changes, direction, pattern and magnitude over a period of nearly 4 decades. Further, mapping of the state of land use land cover with buffer analysis has also been undertaken. Looking at the implications of urban sprawl on the present land use land cover of the study area, a site suitability analysis for urban area expansion has also been undertaken. Few research questions pertaining to the problem under study have also been formulated.

In order to give the study a systematic approach, the methodology that has been adopted is simplified in six parts viz. selection of study area, extraction of base layers of maps collected from different sources; extraction of layers from satellite images; other datasets used in the study; primary data collection; and data analysis. GIS has
given a tremendous platform to analyze the different datasets prepared, collected and acquired from different sources in a single window.

Review of literature has been undertaken considering six (6) areas, viz. characteristic and setting of an urban area; urban sprawl and its impact; controlling the sprawl: role of green belt; use of GIS and Remote Sensing in the study of urban sprawl; site suitability analysis and study area in research studies. The entire study has been organized in six chapters.

**Chapter 2** gives the historical as well as geographical background of the study area. The chapter has given an account of the major events of history that the town has treaded through and has come to attain its present shape. Further, an account of the physical characteristics of the study area relating to location, physiography, terrain, slope, geology, soils, groundwater, natural vegetation, and climate has been given in the chapter. Socio-economic characteristics of the study area with relation to population, literacy, household size and pattern, economic characteristics, drinking water, source of lightning, transport and communication has also been given an account at length.

**Chapter 3** gives a detailed analysis for addressing the problem under study. In order to observe the nature and dimensions of urban sprawl in the study area, analyses have been made considering causes of urban sprawl and spatial expansion of urban area in the study area in terms of its temporal changes, direction, pattern and magnitude over a period of nearly 4 decades.

The strongest driving force of urban sprawl is the population growth. The more population size of an area, the more urbanized it will be and it is positively related to the growth of urbanization. It has been realized that outgrowths or the adjoining areas of the municipality area in the study area have been under tremendous population pressure and the trend shows that it is further increasing. This causes the land area to feel the brunt of
the exploits of their needs and demands in the form of housing, services and utilities. With the increase in population, there is a strong need for these utilities and services to provide optimum services fulfilling the needs of the people. The other major causes that have triggered a sprawl of the Jorhat town to its surrounding areas have been found to be the rising number of households, expansion of social and urban infrastructures and lastly devoid of master plan regulation which could have otherwise played an important role in controlling and regulating the haphazard urban growth in the study area. The town experienced improved types of houses, construction of new roads and institutions during different periods and initiating various stages of urbanization. An account of the establishment of the social and urban infrastructures consisting of housing, roads, retail establishments and various utilities and services over time has showed that it has led to congestion in the hub of the town and slowly sprawling away to the peripheries. There has been a pressure on the urban areas exerted by the overlapping and scattering of services and utilities without following any regulated zonation. Moreover, this has also led to a haphazard expansion of urban infrastructures in the study area.

The Master Plan boundary, prepared in 1978 through a thorough survey by Town & Country Planning Department that has not been implemented at all and expired in 1991, surpassed more than 1 km area of the existing Municipality boundary and has been already exhausted with urban expansion. The master plan boundary with an area of 75.52 sq. km itself exhibited devoid of proper zoning with ever expanding town. In absence of the Master Plan which provides guidelines in carrying out the developmental activities, earlier demarcation has been crossed with expansion of commercial and residential areas into the adjacent countryside. The earlier demarcations done decades ago has lost its importance and gradually becoming meaningless. The haphazard expansion of urban activities in the study area has been aggravated by the absence of
any regulatory demarcations either by the Town & Country Planning Department or the Municipality. It has been observed that in about more than hundred years (1901-2011), the municipality board area has increased by only nearly 2 times (4.95 in 1901 to 9.25 in 2011) while the population has increased by almost 25 times (2899 in 1901 to 71782 in 2011).

The second part of the chapter deals with spatial expansion of urban area as indicated by built-up area of the town in terms of its temporal changes, direction, pattern and magnitude over a period of nearly 4 decades. In the analysis, observing the expansion of urban hub of the study area from 1974 – 2010, it has been found that urban area has expanded to all the four directions from the central point of the town, but in varied densities. In 2010, it has been observed that, the density of urban area is totally compact to a distance of 3 km from the central point of the town exhibiting density of the same from 40 per cent to 100 per cent. In 1974, the urban hub expansion was only upto 2 km, although in varied densities in its four sides. In 2010, the total area of the urban hub further expanded up to a distance of 5 km with varied densities. It has been thereby observed that the south east direction, in 2010, is experiencing the highest density of urban expansion. The south west, north east and north west follows by. The growth in the northern parts is considerable but it has been restricted by the presence of the wetlands and the Brahmaputra River.

Chapter 4 deals with the implications of urban sprawl. In the recent past, it has been observed that over a period of time, the adverse effects of haphazard urban expansion of the town have already started to create a bane to the dwellers of the city in the form of waterlogging problems, drinking water scarcity, sewerage problem, forming of heat-islands, waste disposal, traffic congestion etc. Most of the problems roots out from the recent changes in the climatic variables viz. change in pattern of rainfalls,
temperatures and extreme events of rainfall. It is the need of the hour to redefine the areas of the town to avoid confusion and to retain its capability to face the challenges of the impacts of climate change.

Chapter 5 gives an analysis of site suitability analysis for urban expansion. The entire process of urbanization in the study area has taken into its stroll a tremendous threat to the land cover, environment and population itself. The built-up land is expanding in a highly unplanned and haphazard manner to accommodate the growing population and their socio-economic needs at the cost of the open agricultural and green areas. This has led to haphazard mix of residential, industrial and commercial zones. Green cover is being consumed up at the cost of expansion of urban activities in the study area. The study area has been under the pressure of the gradual impacts of of the variables of climate, as that of changes in pattern of rainfalls, change in temperatures and extreme events of rainfall. These impacts have been slowly casting its negative effects on the existing urban system of the historic town. In the recent time these effects can be seen in the town in the form of waterlogging problems, drinking water scarcity, lack of sewerage, forming of heat-islands, creating a bane to the dwellers of the city.

It is the need of the hour to redefine the areas of the town to avoid confusion. It is essential to understand the implication of recent changes in the climatic variables on the urban environment also so as to introduce climate resilience agenda to the urban planning. Here lies the importance of a site suitability analysis of urban area expansion in the study area. Subsequently, such an analysis has been made taking into consideration the viz. (i) urban area of 2010 of the study area (ii) buffer zones of certain utilities of the study area for maintaining the ecological balance of the town, (iii) categories of existing land use/land cover, (iv) elevation (v) road density and (vi) flood
hazard. It has been observed that these factors play a very important role by affecting one another resulting in different effects on the spatial sites.

Further, more buffer areas has been considered for industries; railway station and airport; services and utilities like hospitals, schools, colleges, stadium, religious places, fuel pumps and LPG Godowns etc.; roads and railway; and so on. The buffered regions have been considered with an objective to restrict further urban activity as this is so much essential to keep those areas undisturbed from overlapping or congestion of urban activities. Moreover, buffer area from the edge of the Bhogdoi river, teagardens and wetlands has also been considered. Site suitability for urban expansion has been derived from the effect of these factors or the relationship of these different factors on the land use land cover and has been indexed with scores of 1, 2, 3 and 4 indicating the classes viz. 1- suitable, 2-least suitable, 3- suitable and 4- most suitable.

The analysis has resulted in identifying the patches of land which can be specifically used for urban purpose. Simultaneously, the analysis has also given an account of the areas which has been either overused or cannot be used for urban activity for having some other characteristics not suitable for such activity.

6.2. Conclusion

The facts and the findings of the urban sprawl phenomenon in the study area have been found to be the most crucial ones in understanding its driving forces. Some of the findings may somewhat be of generic nature but acquires a great importance in facilitating decision making and planning for urban activities in the study area. The following are some of the observations unveiling the facts and findings related to urban sprawl in the study area:
6.2.1. **Observation related to Population Growth inducing Urban Sprawl**

i. In about more than hundred years (1901-2011), the municipality area has increased by only nearly 2 times (4.95 sq.km in 1901 to 9.25 sq.km in 2011) while the population has increased by almost 25 times (2899 in 1901 to 71782 in 2011).

ii. It has been found that, in 2011, there has been about 38 per cent increase in population from the year 1991 in the villages covered by the entire study area.

iii. The urban areas as defined in the Census of India, are experiencing the highest growth of population in the 3 decades i.e. from 1991 to 2011. About 60 per cent of the villages in 2011 have a population more than 1500 population and 28 per cent villages have population of 5000 and above.

iv. The Municipality Area has felt the highest brunt of the population congestion with 6309, 7307 and 7760 persons per sq. km. in 1991, 2001 and 2011 respectively. In 2011, density of population ranged from 616 – 4546 persons per sq. km in the outgrowths which forms the major urban area in the study area.

v. Moreover, it has been observed that the number of villages with more than 400 people per sq. km is increasing from 1991-2011, viz. 77 per cent of villages in 1991, increasing to 83 per cent in 2001 and further increasing to 86 per cent in 2011. More than half of the populations of the study area i.e. 57 per cent in 1991, 58 per cent in 2001 and 59 per cent in 2011 are found to be in the Municipality, Out Growth and Census Towns of the study area.

vi. The urban area of the study area has facilitated the population with employment opportunities in trade, commerce, business, transport, banking, construction, factory etc. apart from services of government organizations, municipality, educational institute, entertainment. So, the other workers group, which is
basically involved in the above mentioned areas forms the highest proportion of main working population i.e. 86.11 per cent followed by the proportions of cultivators (5.75 per cent), household industries (4.51 per cent) and the lowest proportion of agricultural laborers (3.63 per cent).

6.2.2. Observations related to increasing number of households

i. The municipality area felt the highest brunt of the urbanization process, as it shared the highest density of households in all the three decades, viz. 1589, 2061 and 2415 households per sq. km. in 1991, 2001 and 2011 respectively.

ii. The higher density of households slowly sprawled to the adjoining areas of the municipality area ranging from 500-1000 persons per sq. km approximately. However, these areas also exhibited villages with more number of households.

iii. The number of villages with 400 or more households in 1991 was 26; which increased to 42 in 2001 and 48 in 2011.

iv. Thus, it has been observed that the urban areas adjoining the municipality area accommodates most of the houses in three decades, viz. 57 per cent in 1991, 57 per cent in 2001 and 60 per cent in 2011.

6.2.3. Observations relating to Retailing sector in the face of Urbanization

An analysis of the retailing sector covered by the municipality area that has been made here resulted the following observations:

i. The analysis of the retail sector reflected a highly unspecialized and unorganized character and quality.

ii. The sector exhibited an arterial pattern in the spatial extent. Higher mobility of the people has been observed from the adjoining villages of the municipality area as the commercial hub of the town attracts customers not only from the urban areas but also from all corners of the district. This mobility has been
augmented by the public service facilities like, academic, recreation, service etc. that exist in the town mixed with the commercial sector.

iii. Inspite of a highly fragmented nature of the retail sector in the municipality area, it provides a considerable platform for self-employment of the youths in the face of the fast challenging employment scenario.

iv. In the analysis it has been found that the number of total retail establishment increased only by 1.43 times in 2011 from the year 2004. The growth is not a huge one in the in a span of 7 years. But whatever the increase is, when coupled with some new trades satisfying the new tastes and fashion of the people of the area, has a certain impact of urbanization in the area of 9.25 sq. km.

v. The major roads across the town viz A.T. Road, Gar Ali, J. B Road, Na Ali, K. B Road, Malow Ali and M.G Road are the main locations where most of the retail establishments are nested. Thus spatial pattern of sector has been observed as mostly arterial.

vi. The growth in the number of retail establishments is not a huge one in a span of 7 years (2004 & 2011). However, the density reaching to more than 2000 shops in a ward (ward nos.: 4, 5, 6, 7 and 8) is a matter of concern. It has been observed that whatever the increase be in the number of shops during the years, what catches the attention is that opening up of some new trades for satisfying the new tastes and fashion of the people of the area reflects certain impact of urbanization.

6.2.4.Observation related to expansion of utilities and services

i. While the study area covers 7.34 % of the total district area, it exhibited a number of 210 major services and utilities which is 28% of the total utilities of the district.
ii. While the municipality area covers only 4.42% of the study area, it shares about 33.81% (71 nos. of utilities) of the total utilities of the study area.

iii. As has been observed the urban development has sprawled over the municipality boundary. As such, the urban hub of the town (2010) as indicated by the built up area of the town has been mapped out. It has been found that it covers 7.26 per cent of the study area but has the highest pressure of major utilities and services as it covers about 41.43 per cent of the same.

iv. The urban hub area of Jorhat Town, experiences the highest congestion and overlapping of utilities and services of similar as well as different sectors in the study area. It is found to be scattered in the surrounding areas and thus resulting in lesser overlapping of the utilities and services over there. The congestion in the urban hub with the manifold utilities and services creates much disorganized traffic problems during the peak hours of the day.

6.2.5. Observation on the spatial expansion of urban area in the study area

i. The urban area as indicated by the built-up area of the Jorhat town in a period of nearly 4 decades i.e. 36 years, expanded from 2.65 sq. km to 15.18 sq. km., which is about 472.83 per cent increase. This is basically due to the expansion of households and other social and urban infrastructures in the study area triggered by growing population over the recent decades.

ii. It has been observed that urban area in the center of the study area expanded to all its four sides. In 2010, it expanded highest in the South –East, followed by South West, North East and North West. The growth is primarily influenced by the road network and the favorable terrain feature of the study area. This growth is somewhat restricted by presence of tea gardens in the south east as well as in the south west direction. Moreover, due to the presence of Brahmaputra to the
extreme north, flood hazard areas are found in the north western part of the study area. These areas away from the central hub of the town exhibit lesser density of road network thus restricting growth of urban areas to that direction.

iii. It has been observed that the combined density of roads and utilities and services is found to be highest in the central part of the town covering rather 3.59 per cent area mainly covering areas in and around the Municipality Boundary. Their density pattern very well corresponds to the pattern of urban expansion that has been observed in the study area. This density sprawls away from the center taking some irregular shapes to the northern and southern sides. While the irregularity of the urban expansion is somewhat lessened by the NH-37 By-Pass running at the northern side of the urban hub area of the study area. The urban expansion towards the southern side is more prominent with more irregularity mainly following an arterial pattern along the roads. It has become tapering towards its north east as well as south west along the A.T.Road that passes through the central part of the study area and basically taking an arterial pattern. It has been found that the entire area with the highest density is found in the central part followed by its immediate surroundings.

iv. It has been observed that that the urban hub is totally compact in an area of 1km around the central point of the town in the years 1996, 2000 and 2010 as it exhibited 100 per cent built-up density. This was not so in 1974 as in the south-east and south-west it was dispersed and in 1987 the growth was dispersed in the south-west direction. During 1974 and 1987, urban expansion was restricted to an area of 2km from the central point of the town. By the year 1996, the built up area expanded to about 3 km especially in the south east and north western side from the central point of the town. In 2000, the urban expansion was same as
that of 1996, but the south eastern side expanded to about 5 km. In 2010, the urban area expanded to an area of 5 km. around the central point of the town, with varied densities. Hereby we can see the SE direction is experiencing highest density of urban expansion. The growth in the northern parts is considerable but it has been restricted by the presence of the wetlands and the Brahmaputra River.

6.2.6. Devoid of Regulation

It has been observed that the first master plan of the district with an area of 75.52 sq.km was prepared in 1978 but it has not been implemented at all and it expired in 1991. However, Jorhat Development Authority was created in 1986 but the unfortunate scenario for the district is that due to the absence of the master plan the demarcation of zones has been jeopardized. It has, thus, been observed that as the town is devoid of an effective master plan regulation, it is expanding haphazardly without any planned demarcation for the utilities and services that exist in the study area.

6.2.7. Implications of Urban Sprawl

i. Loss of Green Belt

The existing land use / land cover of the study area has been under tremendous influence from the varied dimensions of the causes of urban sprawl in the study area. The open and green areas are losing their identity with the takeover of land by the built-up area in the course of urban expansion. It has been found that if an area of 6 km buffer area of the municipality boundary has been taken into account, more than 40 per cent agricultural land or open land is found to exist. If the area taken is smaller than that, the area leaves no or less than 30 per cent of it. Hence, it has been found that the study area only leaves some scope for preserving the green cover which could otherwise serve the purpose of contributing to the sustained urban development.
ii. Water logging and unscientific disposal of waste

In a period of nearly 4 decades, there has been an increase of about 472.83 percent in urban area expansion in the study area. In 2010, it has been observed that built-up area increased in all the directions, highest in the South–East, followed by South West, North East and North West respectively.

In the face of such an expansion, the study area has been under the pressure of the gradual impacts of the recent changes in the variable of climate like change in pattern of rainfalls, change in temperatures and extreme events of rainfall. In the recent time these effects can be seen in the town in the form of waterlogging problems, drinking water scarcity and forming of heat-islands thus creating a bane to the dwellers of the city.

The most evident is the water logging problem. The low-lying areas and former open fields in both the northern and southern parts of the A.T Road passing through the middle of the study area has been turned into residential areas with haphazard construction of buildings of varied purposes. The natural run-off, thus, do not have the sufficient place to accumulate and this leads to water logging in the study area. Moreover, about 69.7 per cent of the wastewater in the district is not connected to any drainage and most of the waste water finds no outlet to flow out. The entire area of Tarajan, Brahmingaon, Sonarigaon and Kakotigaon was severely hit by artificial flood due to continuous showers recently. Chandan Nagar, Suruj Nagar, Club Road and all the by-lanes between Na-Ali and Club Road, also remain submerged under artificial flood.

Jorhat Town does not have a proper waste disposal site to dump the tons of garbage that it produces everyday. Out of the 35 MT garbage generated per, only 31-33 MT can be disposed. The remaining is left out to create health hazard to the people. The refuge is generally kept in the dustbins on the roadsides. Concrete dustbins have been
built from place to place. From these the Municipal authority takes away the refuge to throw on the banks of Toklai River near Engineering College at Garmur, 3 km away from the city, but the ground has got overfull. In addition to that, the absence of proper residential and commercial waste disposal mechanism most of the waste never find its way to disposal site. The Garbage has especially been dumped over the Toklai River at Marwaripatty site and in certain areas in the A.T. Road and Garali huge waste are dumped causing traffic problems and unclear conditions in and around. This eventually manifested to several common urban woes. Unscientific disposal of waste in residential and commercial areas eventually leads to the blockage of existing drains resulting in artificial water logging.

iii. Water Scarcity

It has been observed that the existing 5 projects which are the centralized sources of water in the municipality area cover 45per cent of its total population. This indicates the incapability of the existing infrastructures to cater to the needs of the growing population. All the schemes of JMB have crossed its intermediate stage since commissioning and condition of all the system components have already outlived their life. All the piped water schemes are highly depends on ASEB for power. But ASEB has been facing the problem of power shortage of itself and depending on other sources. There is a wide gap between demand and supply of domestic water in Jorhat town, thus the intensity of shortage increasing at a faster rate (Bhuyan et al., 2013).

iv. Traffic Congestion

Moreover, the increase in number of vehicles every year created added pressure on the existing number and nature of the roads, which seemed to be incapable of sustain the pressure. The number of vehicles has increased by 3 times from 2009 to 2010
indicating corresponding rate of emissions. The existing nature of roads has been unable to bear the pressure of the increasing number of vehicles owned by ever increasing population. This has given rise to traffic congestion in the urban hub of the study area especially in the peak hours. Nevertheless, the road network has paved the way for expanding the built-up areas all throughout the study area.

v. Heat Wave

The rising trend of temperature and extended dry and hot spells has been a threat to the people of the Town. As it has been observed that incessant urbanization increases land surface temperatures and, over time, the city ends up as an island of heat. The recent years, the district has experienced instances of heat wave severely affecting all section of people in the district along with the state. It has been reported in the local newspapers that the spells of heat wave has been very harsh on the health of the people. Ozone and other air pollutants increase during heat waves, affecting respiratory health.

1.2.8. Site suitability for urban area expansion in the study area

i. Looking at the compactness, pattern and expansion of urban area over nearly 4 decades and particularly in 2010, it can be possibly inferred that if a regulation is not exerted in the expansion of the urban areas, it is impossible to think of a sustained urban development in the study area.

ii. In this regard, the most important result that the site suitability analysis has provided is the minimum of 1.5 km buffer area from the outer periphery of the Urban Hub of 2010, to be left more or less undisturbed for urban activities. This has been considered so that it can act as a regulator to the urban pressure as well as to avert a compact growth which may result in adverse effects on the land. In order to keep such regulation for restricting further expansion in the compact
and haphazard urban growth in the study area, this area of 1.5 km buffer area from the outer periphery of the urban hub can possibly be considered so that it can be left more or less undisturbed for urban activities.

iii. An area of about 55.47 per cent covering the major central part and areas in the east, west and north west of the study area becomes not suitable for expansion of further urban activities because of the presence of river, wetlands and teagardens.

iv. Few portions of moderate to very low flood hazard zones that have been identified in the study area in the north and north west becomes the least suitable areas for further urban expansion.

v. The suitable areas for urban expansion comprised about 13.44 per cent area in the study area comprising of the rural built up areas mixed with household plantation situating by the edge of the roads. These areas exhibited less compact built up area, and so leaves some space for future expansion of the town. If a minimum area of 20 per cent or more can be retained for green areas, an expansion of urban activity is very much sensible in these areas.

vi. The open grounds or the agricultural fields situated in continuation to the rural built up areas in the south, north and scattered portions of the north eastern and north western part of the study area possibly provide ample opportunity for urban expansion. These areas are possibly the most suitable areas provided that minimum green areas of 20 per cent can be maintained in each plot.
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