Urban growth is a complex process which is an outcome of natural and cultural forces acts in the environment. It is generally found that, the small villages are transforming into towns and towns into large cities. The history of Sangli and Miraj can be traced up to 1800 A.D. or even prior to that. Initially, both Sangli and Miraj were different towns but after 1990s both were expanded very fast and merged together. This new formed urban area is known as Sangli-Miraj-Kupwad urban agglomeration. Sangli is a well-known trading centre while Miraj is famous for medical services. These two cities are located in close proximity and in due course of time the urban expansion occurred very fast as a result small agglomeration has formed. Hence, the spatio-temporal growth and expansion of Sangli-Miraj urban area is undertaken for the present study for a period of 1800 to 2007 as the evolution and growth process was initiated during 1800. The rise in urban population and expansion of area has been computed to comprehend the direction and consequences of growth. It is investigated that, the city growth has been taking place very haphazardly which can be controlled through planning. There are various spatial determinants, which caused the expansion and growth of the city. Therefore, an attempt is made to study the growth of Sangli-Miraj urban area by making best use of various datasets along with Remote Sensing data and GIS.
1. INTRODUCTION

Urban areas are considered as the most dynamic regions on earth and its expansion is a ubiquitous process. Landscapes are always changing, as they are the expression of the constant interaction between natural and cultural forces in the environment. By identifying the past urbanization patterns, policy makers and planners can gain better insight into the present problematic development patterns and future (Esbah, et. al., 2007). Remote sensing and GIS technology is an appropriate and effective tool to understand the phenomenon for future planning. Urban growth is a complex and continuous process noticed all over the world. The cycle of converting the small villages into towns and towns turning to cities can be noticed all over the world. Sangli - Miraj are known as the twin cities in the western Maharashtra. Initially both were different towns but after 1990s expansion starts very fast and urban agglomeration is formed. This new shaped urban agglomeration is known as Sangli-Miraj-Kupwad urban agglomeration.

2. OBJECTIVE OF THE STUDY

The main objective of this paper is to study the physical growth that has taken place in Sangli - Miraj urban area.

I. To study the physical expansion of Sangli - Miraj region from 1800 to 2007.
II. To look into the major spatial determinants of urban growth in the study area.
III. To comprehend the obstacles in the growth and expansion of the city.

3. STUDY AREA

Figure 1: Location Map of Study Area

Location Map of Study Area

Sangli – Miraj - Kupwad

The selected study area is governed as a Municipal Corporation. Sangli and Miraj are the administrative headquarters especially Sangli is a district headquarters and Miraj is a tahsil headquarters. The study area is situated on 545metre altitude on the bank of Krishna River. It is located within coordinates of 16º 46’ 28” to 16º 53’ 45” North latitude and 74º 31’ 08” to 74º 40’ 51” East longitudes which covers 111.74 sq hectare areas.

There are total 69 wards in Sangli-Miraj-Kupwad Municipal Corporation, wherein Sangli city contains 38 wards, in Miraj there are total 24 wards and Kupwad is having 7 wards. The climate of the study area is characterized by general dryness throughout the year except during the south-west monsoon season. From December to about the middle of February is a cold season and in hot season, May is the hottest month. The south monsoon season is June to September and post monsoon season is October to November (District Census Handbook, 1991).

4. DATABASE

The present study is based on both primary and secondary sources of data. The intensive fieldwork is carried out to understand the growth direction and its trends. Global Positioning System (GPS) is used to collect the primary data and for mapping the present expansion of the city. The informal interviews were conducted to collect the information about city and its limits. Following are the secondary data sources used for the study.

i.) SOI Toposheet 47L9/SE, 47L9/NE (1 :25000 Scale)
ii.) Cadastral Map of Sangli-Miraj city, Satellite Data,
iii.) District Census Handbook of Sangli District
v.) Sangli-Miraj-Kupwad (SMK) Municipal Corporation Reports

5. METHODOLOGY

The present study has been carried out to look into the growth of Sangli – Miraj area. For this purpose old (historical) map, toposheets satellite images, etc. are used. The collected hard copy maps were scanned then georeferencing was done using software. The vector layers are generated for mapping the temporal growth. The satellite data is used for mapping the extension of city at different time intervals. To check the growth direction and its extension the overlay analysis has been done.

The population data of various time-periods have been collected and computed the decadal growth, growth rate, density, etc. The decadal growth rate has been computed employing the following formula:

\[ \text{Growth Rate} = \frac{P_{t2} - P_{t1}}{P_{t1}} \times 100 \]

Where, \( P_1 \) = Population of previous decade
\( P_2 \) = Population of current decade.

GPS is used for capturing the ground coordinates, which are used for georeferencing of historical maps and ground truth verification. The satellite images are utilized for
mapping the present landuse, demarcate fast developing areas in and around the city and to understand the direction of expansion of the city. Finally for minimizing the obstacles in the expansion of city some suggestions are made, which will help for its smart growth.

6. LITERATURE REVIEW

Several scholars have focused on urban areas through their work in India as well as overseas. Urban growth is the most important indicator of development of a country or region (Mulik, 1989). After independence a number of articles, which are related to urban growth have appeared in the distinguished national level geographical journals in India. The study related to urban growth and urbanization has been carried out by different scholars, such as Singh R.L. (1965) studies Banaras city and Mookarji S. (1958) made a study to check the growth of Nagpur city. Ramotra, K.C. (2004) studied Spatial Patterns of Urbanization in Maharashtra. Shekhar S. (2005), in her thesis “Monitoring urban sprawl of Pune by using Remote sensing and GIS techniques”, explained the changing space of Pune.

7. SPATIO-TEMPORAL GROWTH OF SANGLI-MIRAJ URBAN AREA

The spatio-temporal growth of Sangli - Miraj urban area is studied systematically by considering the role of spatial determinants.

7.1 Sangli

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**Figure 2: Expansion of Sangli 1800-2007**
‘Sangli’ was one of the 11-gun salute princely states of British India, under the Kolhapur-Dekkan Residency in the Bombay Presidency, and later the Deccan States Agency. Until 1801, Sangli was included in Miraj Jahagir (‘Jahagir’ was a small territory granted by the ruler to an army chieftain). The First Chintamanrao Appasaheb Patwardhan established a different principality with Sangli as the capital city (Wikipedia, 2010). That time village Sangli was restricted into six lanes (‘Saha Galli’ in Marathi). The establishment of new habitat and Ganpati Market area (Petth) took place in 1807 (Samaranika Report, 1977). In the beginning habitation was restricted within the Krishna River - Maruti temple – Sheri nala. The construction of ‘Ganesh Drug’ was done in 1813. The surrounding open area was developed in a rectangular pattern. Sangli Municipality was established on 21st February 1876. The real growth of Sangli commenced after 1900 when various constructions took place in and around the town. It is noted that of as: 1913: Sangli – Miraj metre gauge railway started, 1919: Construction of Willingdon College, 1929: Irwin Bridge is constructed, 8-2-1937: King Jorge Jubilee Electric Works started (Urban Planning Report, 1971).

The cities of 19th century were centres of trade and commerce where goods were distributed to various minor centres (2011, Mondal). Until 1950 Sangli expanded towards North but, due to ‘Sheri Nala’ growth was restricted with which the expansion took place in East and North-East direction. Due to establishment of Market Yard (1965), Sangli became major commercial place in the Maharashtra- Karnataka border area. The growth of the city has begun with the establishment of Sugar Factory (1956), Cotton Mill, Industrial Estate, etc. The emergence of Chintamanrao Commerce College (1960), Police Headquarters (1965) and Vishrambag colony further boosted its growth and expansion. In 1970-71 Sangli was connected with broad gauge railway. After 1975, Police line, Irrigation department offices, Warnali, Vishrambag surrounding area, etc. came into existence. The rapid expansion of Sangli was noticed after year 2000 when city started spreading in circular pattern to all directions with which many unplanned habitats known as ‘Gunthewari’, were emerged. (Gunthewari is an unplanned residential dwellings developed in urban area.) The settlement patches such as Shamrao Nagar, Datta Nagar, Sainath Nagar habitat along Karnal road, Shiv Nagar, built-up along 100 feet ring road, etc. are emerged very fast. The suburban areas towards Kupwad i.e. Laxmi Nagar, Balaji Nagar, Vaant Nagar, Ram Krishna Nagar, etc. came into existence. In a very short period several constructions took place as the space availability in and around the city. The advancement in automobile industry and road transportation facility plays important role in the urban expansion (Sui 1992). In case of Sangli the extension areas came in to existence in which transportation play an important role.

7.2 Sangliwadi

Sangliwadi is a suburb of Sangli city. Initially this habitat was known as ‘Gauliwada’ (Habitat of Milkmen) and located on Sangli-Islampur road near Laxmi temple but, due to the flood occurred in 1853 it was shifted near Sangli and started knowing as Sangliwadi (Deshmukh and Kulkarni, 1978). The Irwin Bridge was
constructed on the Krishna River in 1929, since then rapid transaction has started between Sangli and Sangliwadi. The road connecting Sangli and NH4 is passing through this habitat, which promotes the expansion of city towards West. Now Sangliwadi is one of the parts of existing urban agglomeration.

7.3 Miraj

Miraj is an ancient town of which the footprints may be seen in 13th century. It was one of the important military camps on the bank of Krishna River. Until 1800 A.D. the growth of this town was restricted within Miraj fort and around Mirasaheb Dargah. Afterwards Jumma Masjid, Black Masjid, old Gauthan, etc. came into existence. The population of this town in 1762 was around 50,000 (Sangli District Gazetteer, 2006).

During 1800 to 1900 various public constructions took place like Krishna Gath, Temples and Dharmsala. In December 1807 Miraj-Belgaon metre gauge railway was started after that Miraj-Pune Broad gauge (1890), Miraj-Latur narrow gauge (1927) as a result Miraj became one of the important junctions. Miraj Municipality was established in 1875. During 1875 to 1881 Kalayan Market, Mutton Market, Post Offices, Town Hall and many
schools were constructed. The establishment of Mission Hospital (1891) accelerated the growth of town along Pandharpur road. The expansion of Miraj took place haphazardly like a leap frog urban development. The Marathe textile Mill (1943), ‘Miraj Milk Collection and Processing Centre’ (1961), Miraj Medical College (1963), Arts, Commerce & Science College (Bapuji Salunke), etc. were established due to that Sanjay Nagar, Adarsh colony and adjacent areas were emerged around Miraj. ‘KOCIL’ (1968), a fertilizer factory has boosted the expansion of Miraj towards Sangli as a result Shivaji Nager and surrounding area emerged. In 1970-72 Miraj Glass Work started on Miraj-Bedad road but the town was not developed towards East and Southern directions due to the good agricultural land and railway tracks (Urban Planning Report, 1971).

After 2000 encroachment has taken place to the agricultural land and started converting into ‘Gunthewari’. Many patches of dwellings are developed along the Pandharpur, Kupwad and Malgoan roads. Miraj is famous for its Medical services hence, numbers of hospitals, medical-stores, laboratories are established all over the town wherever the space was available. Later on new suburbs like Vijay Nagar, Khatib Nagar, Laxmi Nagar, Vidyanagar, Vitthal Nagar and Datta Nagar, etc. came into existence.

7.4 Kupwad

Kupwad was a small village located in a triangular position from Miraj and Sangli. The revenue territory of the village was large on the contrary the built-up area was quite small restricted in to wall fence. Its boundary is sharing with both Sangli and Miraj. Up to 1970 Kupwad was not having any major existence but thereafter in 1974, M.I.D.C. (Maharashtra Industrial Development Corporation) acquired land on eastern side of village and since then Kupwad has been changing. Initially Kupwad was restricted into ‘Gaothan’ but due to the establishment of ‘Bharat Sat Girani’ (Textile Mill) in 1972-73 it starts spreading towards Sangli. The adjacent M.I.D.C. has generated employment and many employees are staying in and around Kupwad.

There are many residential patches developed around Kupwad i.e. Yashwant Nagar, Vasant Nagar, Ahilya Nagar, Sham Nagar, Ulhas Nagar, etc. These are the suburban areas of Kupwad but having their own identity. In 1996 village Kupwad is converted in to Kupwad Municipality. Later on emerged settlements viz. Hanuman Nagar, Kapase Plot, Bajrang Nagar, Shant Colony, Khare Mala, etc. have filled the gaps between these urban centers. Sangli, Miraj and Kupwad Municipalities were functioning in a close proximity; considering its expansion and proximity Government of Maharashtra merged all these three Municipal towns into one and formed Sangli-Miraj-Kupwad (SMK) Municipal Corporation in 1999.

These Spatial determinants have contributed to the growth of Sangli. After independence many government offices, local boards, District Police headquarters, Treasury, etc. came into existence and ‘Sangli’ became the district headquarters.

7.5 Wanlesswadi

Initially Wanlesswadi was a part of Kupwad, which was emerged due to Wanless Chest Hospital. After 2000 this area got developed very fast and experiencing
several transformations. By considering the growth and its location, in 2002 Wanlesswadi was merged into SMK Municipal Corporation. The central administrative building is recently shifted at Wanlesswadi due to that this area gets more demand as a result it is growing very fast.

8. DEMOGRAPHIC STRUCTURE

Miraj Municipality was established in 1875 on 28.54 sq km area and that of Sangli Municipality in 1876. In 1901-11 population growth rate of Sangli was -4.09 per cent because of epidemics and of Miraj it was 1.21 per cent. Thereafter their growth rate starts increasing continuously. The growth rate of population in Sangli was comparatively higher than Miraj. In 1961 it was 46.83 per cent which increased to 55.93 per cent in 1971. The process of industrialization started after 1975. Being Sangli and Miraj administrative headquarters and adjacent Industrial sectors the people have migrated to explore the employment opportunities. As per 2001 census this agglomeration was possessing 436781 population which is increased by 65,916 and becomes 502697 in 2011. As per 2011 census the male percentage is 50.78 and females are 49.22%. Average literacy rate of Sangli Miraj Kupwad city is 88.08 percent of which male and female literacy was 93.39 and 82.67 percent.

9. THE GROWTH DIRECTION AND ITS TREND

Urban open spaces are vital element of urban landscape with its own specific set of function. Open spaces contribute to the quality of life in many ways (Roy, Dwivedi and Vijayan 2010). Up to 1950 the growth of Sangli and Miraj was in binuclear direction. During 1970s Sangli started spreading in North and North-East direction towards Madhavnagar and Kupwad. Miraj has also been expanding towards Sangli along Sangli-Miraj road. After 2000 various suburban centres like Wanlesswadi, Sangliwadi, Vishrambag, etc. developed so fast and the growth became multi-nuclei. The spatio-temporal pattern of growth of the city is discussed at the very
outset. The figure- 5 depicts the growth direction and expansion of Sangli and Miraj region throughout last 200 years.

10. LANDUSE

**Table-1: Landuse of Sangli-Miraj-Kupwad Municipal Corporation, 2007**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Land use</th>
<th>Area in Hectare</th>
<th>Percentage to Total Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Residential Area</td>
<td>1810.98</td>
<td>16.21</td>
</tr>
<tr>
<td>2</td>
<td>Trade and Commerce</td>
<td>93.57</td>
<td>0.84</td>
</tr>
<tr>
<td>3</td>
<td>Industrial Area</td>
<td>280.85</td>
<td>2.51</td>
</tr>
<tr>
<td>4</td>
<td>Public and Semi Public</td>
<td>464.76</td>
<td>4.16</td>
</tr>
<tr>
<td>5</td>
<td>Open Space, Parks, &amp; Grounds</td>
<td>31.74</td>
<td>0.28</td>
</tr>
<tr>
<td>6</td>
<td>Cemetery, Public Utilities</td>
<td>59.27</td>
<td>0.53</td>
</tr>
<tr>
<td>7</td>
<td>Transport and communication</td>
<td>1041.89</td>
<td>9.32</td>
</tr>
<tr>
<td>8</td>
<td>Agriculture Land</td>
<td>5429.78</td>
<td>48.59</td>
</tr>
<tr>
<td>9</td>
<td>Water Bodies</td>
<td>147.87</td>
<td>1.32</td>
</tr>
<tr>
<td>10</td>
<td>Vacant Land</td>
<td>1813.29</td>
<td>16.23</td>
</tr>
<tr>
<td></td>
<td><strong>Total Area</strong></td>
<td><strong>11174</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

*Source: Based on Image Classification and Sangli-Miraj-Kupwad Municipal Corporation Report*
11. CITY CENTER AND FUTURE EXPANSION OF THE CITY

Urbanization occurs when cities grow at the cost of their surrounding countryside suburbanization and ex-urbanization when the inner ring or commuter belt grows at the expense of the urban core (Huiping, and Qiming 2005).

Urbanization takes place either in radial direction around a well-established city or linearly along the highways. The geographic mean of Sangli, Miraj and Kupwad town is different, but now these are merged together and formed agglomeration. The geographic mean of the Sangli-Miraj-Kupwad city is near Wanlesswadi, which is shown in Fig-7. Wanlesswadi is in developing state and having lot of potential for future development. Due to the central administrative building this area is developing very fast. Moreover the present vacant area surrounding the city and intermediate patches within Kupwad and Miraj have lot of potentiality on which favourable development can be done in coming days.

In some places, growth in popular educational institutions, such as colleges and Universities, will attract more and more number of students to receive better education. These centres of education in course of time turn into cities, as associated businesses like hotels, residential complexes, stationery shops, etc. develop around the educational

Figure 6: City Centre and Future Expansion

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In some places, growth in popular educational institutions, such as colleges and Universities, will attract more and more number of students to receive better education. These centres of education in course of time turn into cities, as associated businesses like hotels, residential complexes, stationery shops, etc. develop around the educational
Institutions (2011, Mondal). Wlachand Engineering College, Willingdon College and Miraj Medical College are most popular educational centres. At present this agglomeration is expanding in all directions. As discussed in initial section still some patches of vacant land are available around Kupwad. Hence these patches will fill in coming days and then expansion will boost at the peripheral areas of the city. The population projection and present speed of expansion is calculated and future expansion is calculated. It is observed that if proper planning is implemented this agglomeration has potentiality for its sustainable development.

12. OBSTACLES IN THE EXPANSION OF SANGLI-MIRAJ URBAN AREA

12.1 Flood of Krishna River and Sheri Nala

Sangli is situated on the bank of Krishna River and its flood water often causes troubles for the city expansion. The flood condition of Sangli during 2005-06 was very dangerous and the residents in low laying area started shifting to other areas. ‘Sheri nala’ causes major problems to the citizens of Sangli. This stream contains most of the polluted water and industrial waste, ultimately increasing environmental pollution as well affecting hazardously to human health; hence Sangli get restrictions for its expansion towards North direction.

12.2 Good Agricultural Land Around City

The soil around city is good fertile and the Krishna River provides water for irrigation, this facilitates agriculture development in the region. In 2007 out of total 11174 hectare land, 5429.78 ha (48.59 per cent) was under agriculture. This land is precious and productive hence, it cannot be brought under the urban use.

12.3 Transportation Facility

The expansion of city mostly depends on the availability of transportation facility in the region. The public transport system of SMK is not satisfactory.

12.4 Gunthewari and Town Planning

Town planning department plays vital role in the planning and development of region but, in case of this city it seems otherwise. The haphazard growth of city has created many problems like traffic, encroachment along the roads, sanitation, gunthewari, etc. The basic facilities like parks, gardens, play grounds and open space are lagging in this area. During the establishment of new settlement, the rules and regulation were not properly followed as a result haphazard development taken place in certain parts of the city, which must be restricted.

13. SUGGESTION FOR SMART GROWTH OF REGION

13.1 Town Planning Department

The town planning department in the city has to act more strictly and effectively. The advanced technology like GIS and Remote Sensing must incorporate in the city planning and its functioning. The expansion and development activity should take place in a systematic way as per government rules and regulations. The area that comes under the
floods of the river should not be allowed for residence, in fact it can be used as open space and parking purposes.

13.2 Special Planning for Central Business District and Gaothan Areas

Near about 195000 people reside in the gaothan (CBD) areas of Sangli, Miraj and Kupwad, for which special planning can be done considering roads, footpaths, drinking water, sanitation, etc.

13.3 Transport Facility

The public transportation facility should be streamline. The transportation plays major role in the expansion of city. If transportation facility is developed properly the residents in gaothan can stay on the peripheral area and the additional stress of CBD can be reduced. The share of auto rickshaw is quite big which shows that public transportation is lagging. There should be one central bus depot near Wanlesswadi, where from the buses can run and provide service to the city.

13.4 Utilization of Developing Area

There is quite open land / developing patches available in and around city e.g. the saline land near Sangliwadi, area around Fruit Market, Kupwad surrounding, etc. can be utilized for urban use. The geographic mean center of SMK city is in-between Sangli-Miraj and Kupwad, where quite open land is available (Fig. 8) and with this growth rate, it will become a heart of city in future. Therefore, proper planning needs to be made and implemented for the utilization of developing and un-developed land.

14. CONCLUSION

Sangli and Miraj are twin cities located on border area of Maharashtra - Karnataka and functioning as an administrative headquarters. Both cities are having long historical background and these are growing very fast. The newly formed urban agglomeration is known as Sangli-Miraj-Kupwad urban agglomeration. The eastern edge of Kupwad is having industrial sector hence, it is developed as an industrial town. In fact, at present Sangli, Miraj and Kupwad are parts of Municipal Corporation (i.e. SMKMC). The field of Geoinformatics is having capability to analyze, evaluate and represent the things in a better way. The satellite data is depicting real world picture and one can understand the expansion properly. The use of these advance technology is made in this study to understand the growth trends of Sangli-Miraj urban area. The city expansion is well understood through historical maps, toposheets and satellite images. During 1950 the growth of Sangli and Miraj was in binuclear direction towards each other. The industrial foundation is started during 1970s and Sangli begin to expand in North and North-East direction towards Madhavnagar and Kupwad. This condition is changed after 1995, when several suburban centres like Wanlesswadi, Sangliwadi, Vishrambag, etc. developed fast and the growth became multi-nuclei. There are various spatial determinants, which caused the expansion and growth of the city. It is investigated that the city growth has been taking place very haphazardly, which can be controlled through planning as the space is available.
The growth of urban population and expansion of area have been computed to comprehend the direction and consequences of growth as well as to plan the future development of the city. The landuse statistics shows that 16.2 per cent land is vacant / developing and 48.6 per cent under agriculture. The proportion of developing land is high between Sangli-Miraj and Kupwad where focus needs to be made. Only 0.28 per cent area is under parks / gardens and grounds which should be increased up to certain level as it maintain the health of city. Mdhavnagar and Budhgoan are the census towns, which are located adjacent to Sangli and Kupwad. Therefore, considering the proximity administrators should take step for proper planning as well as future development of these towns.

15. REFERENCES

[15] Survey of India Toposheet (1995): 47/L9 (1:63360 Scale), 47/L9 (1:50,000 Scale) and 47/L9/NW, 47/L9/SW, 47/L9/SE (1:25,000 Scale)