Urban expansion has become a universally observable fact. While in 1900, only 9.2 per cent inhabitants of the earth were living in the localities of more than 20,000 inhabitants (Davis & Heartz, 1957). In 1990, the number went up to 45.7 per cent. It is quite likely that by 2025, 65.2 per cent population (5.3 billion) of the earth will be living in urban areas (Diwakar, 1991). Cities and towns most often develop on the surrounding prime agricultural land, and, therefore, the physical expansion of urban areas invariably makes inroads on the country’s agriculturally productive land. So, surrounding land of the cities and towns provides a base to urban expansion.

If it is controlled, coordinated and planned, urban expansion is a gift to the human society. However, unplanned urban expansion is a curse and creates a number of problems such as overpopulation, congestion, lack of adequate water supply, unhealthy living conditions, noise, land and air pollution, slums etc. Due to lack of proper planning these outgrowths are devoid of basic amenities like water, electricity, sanitation, availability of certain transportation facilities like new roads and highways which ultimately result in inefficient and extreme change in surrounding rural land and ecosystem. Urban expansion and land use/land cover change of Sonipat city has been observed in the present study which points out a dramatic change in the cityscape and land transformation. This study brings out the extent and direction of growth and spatial extension of Sonipat city over a period of nearly four decades using spatial data from different sources.

It has been examined that the rate of urban expansion in terms of built up area of Sonipat city has not been uniform in all the decades and in all directions; rather it has fluctuated. Highest sprawl of city was noticed during 1991-2002 and minimum during 1968-1981. The increase in population and economic activities in the city has been followed by sprawl of urban area. In recent decades, Haryana Urban Development Authority (HUDA) and private builders such as TDI builder, Parsvnath, Ansal, Omaxe, Aldeco, Parker Residency, and Divine City have developed various residential, industrial and commercial sectors around the city, which accommodate thousands of people. Further, many outgrowths in the surrounding rural villages of city have been incorporated into city administration during different decades.
The sprawl brings large number of problems like shortage of living space, lack of good accommodation, pressure on transport network, services and deficit of farming land. There has been a continuous increase in the amount of urban growth from 1968 to 2011. The urban growth in 1968 was just 4.61 sq. km, which increased to 7.80 sq. km in 1981, recording an increase of only 3.19 sq. km in thirteen years. During this period, the growth rate was 69.20 per cent. In 1991, the built up area touched 10.36 sq. km and in 1981 to 1991 the growth rate was 32.82 per cent. In 2002, the built area attained an area of 17.13 sq. km and by the year 2011 it became 25.50 sq. km, therefore recording almost one half increase in built up area in nine years. The rate of growth during 1991 to 2002 was highest and lowest was between1981 and 1991.

The transport network of the city has played an imperative role in the changing direction of growth and spatial extension of the city. The urban growth and land use models represent the real expansion of the cities on the bases of some assumptions. The growth of Sonipat as an urban centre in district of Haryana is due to the connection of Delhi-Chandigarh railway line, National Highway-I, State Highway 11 (also known as Gohana Road), State Highway 20 and development of educational institutes and number of industries of various goods. The land use in peripheral rural segment is mainly devoted to agriculture and residential sites and central business district, whole sale and small/large industries, low class residential, middle class residential and high class residential land use categories are found in the city. So far as the development of urban land use is concerned, there is only one location i.e. Kutche Quarter as the form of C.B.D. The evaluation of different models reflects that at present except sector model to some extent, no model is applicable in the context to Sonipat city.

While observing the demographic characteristics of study area, it has been found that the population of Sonipat city has increased near about three times from 1901 to 1951. In 1901, the city population was 12990, which reached 30189 showing an increasing growth rate of 69.78 per cent. After independence with certain ups and downs in decadal growth of the city, the population increased 2,78,149 in 2011 from 30,189 in 1951 which is an increase of about ten times within a span of 60 years. As compared to 1951, in 1961 and 1971 census, the population has noticed a decreasing growth rate when it increases at a growth rate of 52.31 per cent and 35.99 per cent respectively. In 1981, there was a boom in population when growth rate reached 75.29 per cent.
It was the period of population explosion in the population history of India as mortality rate has witnessed a great decline due to availability of better medical facilities and other factors.

After this period, the population has recorded an increase with surprisingly decline in growth rate and in 2011 it recorded only 23.58 per cent. As per 2011 Census, the total population of Sonipat city is 2,78,149 persons. The city has experienced rapid increase in population. The decadal growth rate of population during 1971 to 1981 was about 27 per cent, during 1981 to 1991 it was nearly 50 per cent and during 1991 to 2001 it was nearly 39 per cent.

The highest literacy rate in 2011 has been recorded in ward nos. 11, 14, 15, 16, and 17 which is near around the core part of the city because this part of the city has good schooling facilities due to well planned development and the area has central business district (C.B.D.) characteristics. The maximum wards (16 wards) of the city have moderate (75 to 80 per cent) literacy rate whereas the lowest literacy rate has been recorded in the outer part of the city because these wards mostly belong to scheduled caste and lower income groups. Sex ratio is a very important demographic indicator for analyzing socio-economic features of population. In the ward wise analysis from 1991 to 2011, we find the fact which supports the male dominance in the society because in entire investigation there is not a single ward where female population is greater than male population. It is also a matter of great concern for the humanity.

It has been observed that the value of location quotient indicates a higher concentration of scheduled caste in central part of the city which was the village of economically and socially deprived population before the origin of the main city. The other patch of SC population of workers category is observed in south eastern part of the city along the industrial area. The south and south eastern part of the city except some area is found nearly balanced. Similarly the population of Scheduled caste is found to be highly dispersed in north, north eastern and north western part of the city along some central part which is planned residential area of the city (as the value of L.Q.<1).

There is a broad regional variation in density of population from one ward to another. The core area of the city has high density of population whereas the low population density is found in outer part of the city. Most of the high density wards lie in the old part of the city. Moderate dense areas are outskirts of the city within low dense areas. Wards with lowest density (towards northern and eastern part of city which the city) have been growing more rapidly since last two decades, because this type of areas are marked with planned residential sectors (through
Haryana Urban Development Authority and private builders) having good life style of living.

There has been recorded a remarkable (1,46,59,866.82 sq. meters) loss of fertile productive agricultural land due to the city’s expansion during 1991 to 2002. Within a short span of 11 years, this category has faced a decline of 13,32,715.17 sq. meters per year due to various socio-economic factors. From 2002 to 2011, it got reduced to 54,23,538.92 sq. meters with an average annual loss of 6,02,615.44 sq. meters. Loss of agricultural land creates lack of food crop production. The total estimated loss of food grain production due to urban expansion in the study area from 1991-2002 was about 12,75,130.56 quintals (average annual food grain production in the study area is 1,15,920.96 quintals per year) while it has been estimated 3,85,971.84 quintals loss of food crop production during 2002 to 2011 (average annual food grain production in the study area is 42,885.76 quintals per year). In this regard, there is need to adopt new technologies to increase the agriculture production because due to urbanisation agriculture land has undergone a great decline.

Sonipat city has its nuclei around the railway station, bus stand, and along the major transport routes. Across the span of last century, tremendous increase in the population of the city remained fluctuating. The reasons for growth in population varied from one decade to another. Post-independence a large number of refugees settled in the city. Since the creation of Sonipat as a district on December 22, 1972, the city has experienced an overall increase in the population. With the development of industries, educational institutions and infrastructure in the city, people have migrated from the surrounding rural periphery to the city. Establishment of technical institutions (like Murthal University) and decent schooling facilities further impacted the increase in city population. The appearance of manufacturing industries (Atlas Cycles, Sugar miles and Bulb and Tube light) as a source of employments also has attracted people from peripheral areas of the city.

The study also reveals the change of land use/land cover of Sonipat City during 1991, 2002 and 2011. It expresses that during this period, the area of public and semi-public and industrial sector has increased but slightly. The public and semipublic category area was 1.97 per cent in 1991, 3.46 per cent in 2002 and 3.90 per cent in 2011. In the same way, the industrial sector has a cover of 1.95, 2.92 and 3.03 per cent in 1991, 2002 and 2011 respectively.

The planned residential area has not significantly changed. It was 1.32 per cent in 1991 and 6.19 per cent in 2011. On the other hand, a remarkable change has been noticed in unplanned
residential area. It has increased from 11.70 per cent in 1991 to 18.84 per cent in 2002 and 26.07 per cent in 2011. This was the result of unintended urban growth which became the cause of slum and unauthorized development in the city. The highest but negative change has been observed in agriculture sector. In 1991, the agricultural land covered an area of 80.26 per cent of total area of the city. This cover has decreased to 61.64 per cent in 2002 and remains only 53.17 per cent in 2011. Due to increasing demand of land, the area of waste/scrub land category has reduced and remains 0.22 per cent in 2011 as compared to 2.18 per cent in 1991 and 1.12 per cent in 2002. In 2011, the area of open/vacant stood at 0.37 per cent whereas plotted land was 4.00 per cent in 2011. The land use category of commercial and recreational area has also increased but not so significant whereas the forest area has declined.

This study demonstrates which kinds of land use changes are responsible for land transformation from one class to another during the study period (1991-2011). The public and semipublic area has increased from 11,82,305.18 sq. meters to 20,93,315.71 sq. meters, gaining land from agriculture (9,02,597.83 sq. meters) and water bodies (10,208.42 sq. meters) while 1,795.72 sq. meters area also shifted in commercial category. The industrial area increased from 11,69,211.93 sq. meters to 17,66,813.90 sq. meters, gaining land from agriculture 5,97,601.97 sq. meters. It has captured land mainly from surrounding agricultural land because this progress is mostly away from the city centre. The commercial area increased from 4,47,947.13 sq. meters to 6,05,990.28 sq. meters, gaining land from unplanned public semipublic (1,795.72 sq. meters), unplanned residential area (1,38,732.66 sq. meters), agricultural land (17,511.86 sq. meters), and forest (2.9 sq. meters) of the total area. The water bodies area has increased from 2,18,989.15 sq. meters to 4,10,091.21 sq. meters, capturing land from agriculture (2,32,379.95 sq. meters) and waste/scrub land (11,073.66 sq. meters) whereas water bodies also shifted in public semipublic 10,208.42 sq. meters followed by unplanned residential area and agricultural land i.e. 325.76 and 41,817.37 sq. meters respectively.

Unplanned residential area has recorded a massive increase, from 70,33,953.18 sq. meters in 1991 to 1,14,07,138.14 sq. meters in 2002, gaining land from water bodies (325.76 sq. meters), agriculture (45,08,243.19 sq. meters), waste/scrub land (603.21 sq. meters), and forest land (2,745.46 sq. meters) while losing mainly due to commercial activities i.e. 1,38,732.66 sq. meters. Planned residential area has reached, from 7,95,722.01 sq. meters in 1991 to 20,29,901.08 sq. meters in 2002, gaining land from agriculture (12,34,179.07 sq. meters) from
peripheral part of the city. Recreational area has got a boom from 70,139.33 sq. meters to 4,92,421.57 sq. meters during this period, gaining land from agriculture 4,22,282.24 sq. meters. A massive decline has been recorded in waste/scrub land, from 1309552.34 sq. meters in 1991 to 6,80,234 sq. meters in 2002, shifting from agriculture 6,73,812.92 sq. meters, unplanned residential area 603.21 sq. meters, water bodies 11,073.66 sq. meters, open vacant land 7,478.94 sq. meters and plotted land 4,054.52 sq. meters, while 67705.55 sq. meters land has also been shifted in waste/scrub category in advance for industrial use. Forest area has increased from 66,168.21 sq. meters to 63,516.21 sq. meters from 1991 to 2002, gaining land from agriculture (30,150.68 sq. meters) while shifting in 2,745.46 sq. meters in unplanned residential area, 30,053.75 sq. meters in agriculture and 2.91 sq. meters in commercial land. Agriculture land has got a huge decline, from 4,82,42,203.99 sq. meters in 1991 to 3,73,12,938 sq. meters in 2002, shifting to public semipublic (9,02,597.83 sq. meters), industries (5,97,601.97 sq. meters), planned residential area (12,34,179.07 sq. meters), unplanned residential area (45,08,243 sq. meters), water bodies (2,32,379.95 sq. meters), plotted land (36,62,297.16 sq. meters), commercial (17,511.86 sq. meters), recreational area (4,22,282.24 sq. meters), waste/scrub land (67,705.55 sq. meters) and forest land (30,150.68 sq. meters). It was also shifted from water bodies (41,817.37 sq. meters), waste/scrub land (6,73,812.92 sq. meters) and forest (2,745.46 sq. meters) to agriculture land.

The land transformations during 2002 to 2011 have been observed from satellite data. The public and semipublic area increased from 20,93,315.71 sq. meters to 23,62,390.01 sq. meters, gaining land from agriculture (2,22,687.56 sq. meters) and water bodies (3,060.56 sq. meters) while 1,795.72 sq. meters area has also shifted in commercial category from public semipublic category. The industrial area increased from 17,66,813.90 sq. meters to 18,34,704.28 sq. meters, gaining land from agriculture 66,486.53 sq. meters and plotted land 1,403.85 sq. meters adjoining industrial area. The commercial area has increased from 6,05,990.28 sq. meters to 8,32,628.79 sq. meters, advancing land from public semipublic (13,989.57 sq. meters), unplanned residential area (1,81,655.52 sq. meters), water bodies (12.70 sq. meters), agricultural land (8,390.83 sq. meters), plotted land (10,914.53 sq. meters) and forest (11,675.36 sq. meters) of the study area. The water bodies declined from 4,10,091.21 sq. meters to 2,80,722.40 sq. meters, due to capturing of land by public semipublic areas (3,060.56 sq. meters), planned residential land (22,417.83 sq. meters), unplanned residential land (1,41,395.18 sq. meters),
agriculture (21,461.54 sq. meters), plotted land 5.82 (sq. meters), commercial (12.70 sq. meters), recreational (1,615.88 sq. meters), and forest land (0.01 sq. meters) whereas 52,907.24 and 7693.68 sq. meters agricultural and plotted land has also shifted in water bodies during 2002 to 2011. Unplanned residential area has reached, from 1,14,07,138.14 sq. meters to 1,57,82,447.61 sq. meters in 2002, gaining land from water bodies (1,41,395.18 sq. meters), agriculture (26,92,625.02 sq. meters), plotted land (14,88,555.86 sq. meters), waste/scrub (2,12,876.74 sq. meters) and forest land (21,512.19 sq. meters) while losing for commercial activities i.e. 1,81,655.52 sq. meters. Planned residential area has increased, from 20,29,901 sq. meters to 37,48,058.85 sq. meters from 2002 to 2011, gaining land from water bodies (22,417.83 sq. meters), agriculture (2,05,320.65 sq. meters) and plotted land (14,90,419.29 sq. meters) from marginal part of the city for residential and commercial purposes.

Recreational area has augmented, from 4,92,421.57 sq. meters to 6,53,045.82 sq. meters during 2002 to 2011. It has gained land from water bodies (1,615.88 sq. meters), agriculture (1,11,849.71 sq. meters) and plotted land (47,158.66 sq. meters) in the form of playgrounds and parks. Waste/scrub land has declined, from 6,80,234 sq. meters to 1,30,445 sq. meters from 2002 to 2011. It has been shifted to public semipublic 274.63 sq. meters, unplanned residential area 2,12,876.74 sq. meters, agriculture 2,74,820.67 sq. meters, open land 25,264.49 sq. meters and plotted land 67,595.60 sq. meters while 31,043.34 sq. meters land also shifted in waste/scrub category from agriculture land. Forest area has reached from 63,516.21 sq. meters to 83,460.60 sq. meters during this period, gaining land from agriculture (31,043.34 sq. meters) while it shifts 370.39 sq. meters in public semipublic area, 21,512.19 sq. meters in unplanned residential area and 11,675.36 sq. meters in commercial land. Agriculture land has also recorded a huge decline, from 3,73,12,938.53 sq. meters in 2002 to 3,21,85,681.82 sq. meters in 2011, shifting to public/semipublic (2,22,687.56 sq. meters), industries (66,486.53 sq. meters), planned residential area (2,05,320.65 sq. meters), unplanned residential area (26,92,625 sq. meters), water bodies (52,907.24 sq. meters), open land (1,88,860.26 sq. meters), plotted land (17,99,983.88 sq. meters), commercial (8,390.83 sq. meters), recreational area (1,11,849.71 sq. meters), waste/scrub land (31,043.34 sq. meters) and forest land (43,383.90 sq. meters). It has also a shift from water bodies (21,461.54 sq. meters) and waste/scrub land (2,74,820.67 sq. meters) to agriculture land.
The projected master plan for Sonipat-Kundli region is a part of NCR Plan which has been designed through the agreement between Planning Department of Haryana and NCRPB and subsidized by both authorities. The long term plan of next 18 years for Sonipat-Kundli, has been set up to ensure the systematic direction and uniformity in rapidly changing urban expansion of the city and its surrounding region for avoiding the inconvenience generated by unintended and illicit spreading out. According to the estimates of the planning department, up to 2021, a huge number of 10 lakh people will be added to Sonipat-Kundli region. This gathering has been planned to settle in defined seven land use classes of the territory of nearby 65 villages (Table: 5.10) which will also reduce the pressure on the resources of Delhi. In this plan Sonipat-Kundli urban compound has been notified as regional center in National Capital Region in which a big amount of whole expenditure will be invested on developing basic infrastructure such as roads, drainage, water supply, heath facility, educational centers and community places etc. The land prices in Delhi having touched the skies, the proximity of well managed and reasonably priced residential, commercial and industrial sector of urban complex in Sonipat are becoming substitutes for people so that the city is being hailed as ‘The Future City of Haryana’.

It has been truly said that some times, the development of one area becomes the curse for another. As both the state and Sonipat-Kundli region has dominance of agriculture and adds a momentous share at national and state level agricultural production, the acquisition of fertile and productive land for urban expansion has remained a big concern among the canvassers and an issue of debate between administrative authorities and conservationists. So without disquieting the farming land, the acquirement of waste and unproductive land for shaping the urban expansion will be an intelligent and eco-friendly decision for sustainable development. In fact, the speedy and proper directed growth of Sonipat-Kundli complex has generated a hope of its becoming the next cyber city in Haryana.

A remarkable change has been recorded in transport network in the study area. In 1991, major road length was 30,685 meter i.e. 11.64 per cent. The minor roads recorded highest road length i.e. 2,26,332 meter (85.83 per cent) and increased to 4,99,041 meter (90.72 per cent) in 2011. It has got an increase of 4.89 per cent in total proportion of transport network. Whereas the rail network has declined by 1.31 per cent in proportion (railway lines length remained same) of total transport network and went down to 1.21 per cent in 2011 from 2.53 per cent in 1991. The city has also experienced the facilities of two state highways namely S.H. 11 and S.H. 20 which
provide good connectivity to surrounding areas. This study has emphasized the rapid growth of city at the cost of fertile agricultural land. The planned area has marked to the east and west part of the city by Haryana Urban Development Authority (HUDA). The study area has a significant increase in unplanned residential area which provides housing to accommodate the city’s rapidly growing population in all directions but it increased least in eastern side due to planned development by HUDA. There has been a very big increase in unplanned residential area. This indicates haphazard expansion. The city administration authorities should prepare a well city plan for the future urban growth in advance and make strict rules to avoid unplanned expansion of the city.

The primary survey reflects that in the city, the working age group (15-49 years) category comprises major segment, i.e. 61.25 per cent of the total population and in this statistics, the backward caste has emerged as a major class followed by general and scheduled caste. The education level scenario shows that there is a lack of higher education and only 18.91 per cent respondents are highly qualified, whereas 24.29 per cent respondents have got education up to matriculation. The proportion of respondents who were illiterate was 8.92 per cent, out of which the share of scheduled castes was highest. If we analyse the types of schooling, pre and post urban expansion of the area then it is found that there is improvement in schooling after the urbanisation process and the quantity of schooling in private institutes has increased. Before urbanisation 85.83 per cent schooling was from government institutions while this share has decreased up to 67.50 per cent after urbanisation as a result of this the proportion of private schooling has increased up to 32.50 per cent. A psychological feeling of brotherhood in the society is also disappearing due to the process of urbanisation as a major chunk (88.33 per cent) of the respondents has admitted that there has been a decline in the fraternity while 11.67 per cent go with the opinion of ‘can’t say’. The level of decline can be estimated by this that not even a single respondent was found in favour of increase in fraternity. The increasing cash prices of the agricultural land as well as the feeling of superiority to each other are major causes of loss of fraternity. Alike the above problem, there is a lot of change in family types as most of the joint families have converted to nuclear families after urban growth and all the three caste groups of the society have seen this drastic change in the family types.

The emergence of extended families shows that with the commencement of innovation and globalization, a string of conversion have taken place in all social associations of almost all
the societies. More than 85 per cent respondents of all social groups have admitted that there is a positive change in the status of women after urbanisation and it has generated a supportive environment for them. It has been seen that post urbanisation, and with the increase of employment opportunities, there is also a change in occupational structure. There is a net decline in primary activities while there is a sharp increase in secondary and service sector activities. All social groups have made a clear statement on the view that increase in household facilities is a result of post urbanisation period.

Suggestions:

- The city planner should use satellite data for city planning for accurate and up-to-date land use information of the city and identification of suitable lands/sites for establishment of new residential colonies, industrialized sectors and educational institutions without damaging agricultural land. They can use remote sensing and GIS tools to develop road planning, bye pass routes and flyovers to resolve traffic jam problems in the city. It will also help in identifying the unplanned residential areas and slum areas for better future development plan.

- The city administration authorities should look after basic facilities such as drinking water, education, good sewerage system and street light facilities. They should prepare a complete record of the city so that they may know the status of the facilities available in different parts of the city. It would help in identifying the areas where the facilities are lacking or need immediate alleviation.

- Appropriate policies to manage the rapid population growth and urban expansion as well as to provide space for future growth should be devised. The fringe areas of the city will decide the future development of the city. Sonipat has expanded towards northern, western and southern parts of the city in an uncontrolled manner, engulfing fertile farming land.

- The horizontal growth of city affects the surrounding fertile productive agricultural land to economic, industrial development as it happened in case of Sonipat city. It would become difficult to provide basic services such as residential, sanitation, education, employment, drinking water etc. if it continues to grow horizontally beyond a certain limit. Vertical expansion can be one useful strategy of urban planning to save the agricultural land.
The main reason of population increase in cities is attraction of employment and education opportunities, good transport accessibility and connectivity and basic facilities. So plans should be made to develop these conveniences in fringe areas to control the migration toward city from villages.

It is suggested that the strict steps should be taken against the private builders who develop the colonies without providing the proper basic facilities such as safe drinking water, sanitation, electricity and drainage system.

In view of lack of greenery in city, it is suggested that green belt should be promoted along the roads. It will go a long way in providing lungs to the city and also improve the health of people.

The exquisiteness of the city is destroyed by the household wastes thrown on open and plotted land or blown into sewer pipes of the city. It blocks the sewerage system and produces several diseases such as malaria, cholera etc. All this can be prevented by providing covered dustbins; moreover, people should be made aware as to how to use them properly.

To mitigate the problem of traffic snares in the city, bridges should be constructed over railway crossings, well laid out parking lots be provided and shopkeepers should not be allowed to encroach markets.

There is an urgent need to create awareness among people about the use of public transport to reduce the traffic burden in the city. In commercial area, multi-level parking should be supported to avoid overcrowding of vehicles.

The industrial area and dairy farming within the city are responsible for many diseases and harmful impact on health of citizens. Steps should be taken to see that it is flushed outside the city.

The government should provide housing for deprived sections to alleviate the problem of slum.

There should be strict legislations on desertion of productive agricultural lands and wastelands to construct the public assets, industrial estates and institutions without harming the city environment.
The practice of strip mining of soil from surrounding productive agricultural lands of the city should be proscribed and coal ash should be used as alternate filling material in the construction of roads.

In urban fringe areas, multifunctional agricultural land use system should be adopted by the adjoining rural people to increase the agricultural production and to ensure soil conservation and water management.

Hence, urban expansion is a worldwide and incessant phenomenon which began with the industrial revolution and economic development. Industrial development paves the way to urban expansion more rapidly. Effective city planning and management is needed for maintaining the urban expansion of the city. It will release the burden from the city in terms of population growth, loss of agricultural land and basic infrastructure facilities.