SUMMARY AND CONCLUSION

The solid waste management is an important element of environmental protection and cares. Problems in solid waste management are common in any part of the human settlement particularly in large urban cities. Though the nature and magnitude of the problem varies from place to place depends on number of factors, Municipal solid waste is an unavoidable consequence of human civilization and has to be effectively, scientifically and efficiently managed.

In every urban centre, huge quantity of solid waste is generated during various activities. These wastes are to be stored, collected, transported, processed and disposed of in an environment friendly manner, so as to keep the city neat and clean. The most important aspect of solid waste management is the quantity of waste to be managed. The quantity determines the size and number of functional units and equipment required for managing the waste. Now a day the waste is quantified on the basis of total waste generation in the city. It has not been categorized so far is different categories to examine the quantity of every component of the waste, source specific solid waste quantification and characterization is very much required to assess the quality and quantity of solid waste generated.

Kanpur is the largest and one of the most important city of Uttar Pradesh. The city covers an area of about 291.78 square kilometers which consist 34,15,058 persons (projected population, 2010). The main source of waste generation in Kanpur city are residential areas, commercial, industrial, hospital, nursing homes, restaurants, hotels, open drains, slaughter houses, animal husbandry and dairies. The large amount of waste, garbage generated every day is the city has become serious concern for environmental policy makers and scientists.

The annual waste generation increases in proportion to the increase in population and urbanization, with the rapid development and changing life styles in cities have also changed waste composition from mainly organic to mainly plastic, paper and packaging material that are complex in nature of storage and
collection systems are becoming more sophisticated and costly as the types and sources of waste produced become more diversified and as the availability of disposal sites within the collection areas become limited, insufficient and improper method of disposal of solid waste which results in scenic blights, create serious health hazard to public health, air pollution, ground water pollution and also creates nuisance.

It has been observed that waste characteristics varies significantly from ward to ward and it also varies seasonally and also varies with time to time the huge amount & solid waste are just thrown in depression or pond a period without having preliminary knowledge of its characteristics. Solid waste is not a direct threat to health but if allowed to accumulate and thrown indiscriminately in an unscientific manner whether inside the house or in the neighborhood it becomes a health hazard because it decomposes and encourages fly breeding, attracts rodents and vermin’s, the pathogens which may be present in solid waste may be conveyed back to man's food through insects, flies etc. Disposal of solid waste is a serious issue and challenging task in the context of ecological sustainability. There is an urgent need to develop best of alternative methods of solid waste handling and disposal problems.

In the present work data have been analyzed in order to test the hypotheses which have been put forwarded to deal with the solid waste management problem in Kanpur city. The major findings have been summarized below.

Increased quantity and changed characteristics of waste is directly related with growth and increase of population in the city. Enormous quantities of municipal solid waste are being generated due to huge population in limited area to dispose of solid waste. The population of Kanpur city has increased from 1,51,444 in 1881 to 2,16,436 in the year 1921. There is an increase of only 64992 person in fifty years of time. The increase of population can be noticed from the data of 1921 to 1971. It has been observed that there is an increase of 10,58,806 persons during fifty years span of time, again from 1971 to 2010 it is reported that there is an increase of 31,39,816 persons in the last fifty years of
time and it is likely to be 42,99,577 persons in the year 2021 in just 291.78 square kilometers of geographical area.

The projected waste generations in the year 2021 will 19,96,294 kg/day. So it can concluded the there is positive relationship between growth of population in the city with the amount of waste generated. The expansion of huge amount of solid waste municipality requires more workers and an extra and advance infrastructure to combat with the extra load of solid wastes in the city.

The most important aspect of solid waste management is the quantity of waste to be managed at source specific. Solid waste quantification and characterization is very much required to assess the nature of its quantity and quality of solid waste generated in their spatial perspective. In many localities of Kanpur city there is problem of lack of awareness of the peoples. It is because people are mixing up the hazardous and non-hazardous waste at source. Knowledge about the characteristics of solid waste enables to decide the type of disposal method and desired frequency of the collection system should be adopted. The detailed study of sources and types of solid waste is necessary. The garbage is generated mainly from residential and commercial complexes with rising urbanization and change in life style and food habits, the amount of municipal solid waste has been increasing rapidly and its composition changing over last few years, the consumer market has also grown rapidly leading to products being packed in cans, aluminum foils, plastics and other such as non-biodegradable items that cause and adverse impact to the environment of the city. Municipal solid waste generation in among the most significant sources which threatens the local environment. So an analysis and detailed study on generation aspects of waste sources, types and nature and composition of solid waste is necessary and an integral part of waste management studies.

In the present research work. An attempt has been made on the basis of sampling and analysis of physical parameters, characterization of waste, moisture content in biodegradable and non-biodegradable waste in selected thirty sites/wards has been carried out for a period of one year w.e.f. January 2010 to December 2010 and the inferences drawn after are assessment of bio-degradable and non-biodegradable waste at different sampling sites/wards. It has been
observed that the annual average composition of non-biodegradable waste shows a wide variation in the composition of wastes reported 15.66 percent for plastic, polythene 23.67 percent, Glass 12.78 percent, metal 12.92 percent and miscellaneous 35.98 percent. It is evident that plastic and polythene bags contributes more than 1/3rd to total non-biodegradable waste whereas the average composition of bio-degradable waste was found for paper 14.48 percent, cardboard 16.68 percent, food waste 23.98 percent, clothes 11.39 percent and 33.89 percent for miscellaneous category. The minimum average value of moisture content was reported 3.35 percent in zone-1 and maximum value of moisture content for bio-degradable waste reported 21.23 percent in zone-6.

The maximum annual average value of plastic and polythene was reported 18.89 percent and 29.59 percent in zone-4 due to the residential area mixed with market area. The annual average composition of food waste under the category of bio-degradable wastes was reported very high percentage i.e. 25.74 percent in zone - 6 followed by 24.59 percent in zone-5, 24.46 percent in zone-3, 23.92 in zone-4, 23.41 percent in zone-2 and 21.75 percent in zone-1 respectively.

The average total waste generation is about 15,85,611 kg/day with an average per capita generation of 0.4643 kg. The generation rate of polythene was estimated. It has been observed that consumption of polythene in Kanpur city is about 14359.89 kg/day. The zone wise generation rate of polythene is varies reported. 11.54 percent in zone 6 followed by 11.31 percent in zone-2, 8.91 percent in zone-5, 9.21 percent in zone-3, 7.40 percent in zone-1 and 5.67 percent in zone-4.

The total generation of solid wastes also varies in terms of quantity, zone-1 reported 2,21,267.736 kg/day of total waste generation i.e. 13.95 percent of total waste generated in Kanpur city. Out of total generated waste 107226.45 kg/day generated from the household. Zone-2 reported 3,15,800.600 kg/day i.e. 19.92 percent of total waste generated 1,51,584.288 kg/day from the household. Zone - 3 reported 2,67,624.377 kg/day i.e. 16.88 percent of the total waste generated in the city out of total waste generated 1,28,459.700 kg generated from
the households. Zone-4 reported 2,15,467.236 kg/day i.e. 5.64 percent of the total waste generation of Kanpur city. Out of total waste generated 1,03,424.273 kg/day generated from the household. Zone-5 reported 310154.257 kg/day and total 1,48,874.043kg/day generated from the household, Zone-6 reported 2,55,297.212 kg/day i.e. 16.10 percent of total waste generated in Kanpur city. Out of total 1,22,542.661 kg/day generated from the households. It has been observed that zone-4 reported that highest value of waste generation of waste/household i.e 5.64k.g/day/household followed by zone-1 reported 4.32 k.g/day/household, zone-3 reported 3.89k.g/day/household, zone-5 3.59 k.g/day/household, zone-2 2.82k.g/day/household and zone-6 reported 2.77 k.g/day/household of waste.

It has been observed that household generate both type of solid waste i.e. bio-degradable and non bio-degradable. It has been observed that the higher income households generate more amount of waste both bio-degradable and non bio-degradable. They generate maximum waste because they are consumerist in nature. Due to higher living standard they generates more amount of waste in volume and weight. They are aware of the part of waste is not stored properly it will create various types of problems in the surrounding areas as compare to lower income groups. The lower income household generates lesser amount of waste in comparison to higher and medium income households. The major problem to be addressed here to lack of awareness among the community those are residing in the dense and congested areas of Kanpur city peoples are mixing up the hazardous waste and non-hazardous waste at source because of no civil information system on waste minimization techniques or procedures.

Door to door and neighborhood surveys in the study area helped in identifying the shortcoming and the deficiencies in solid waste management in Kanpur city. It has been observed that collection, storage, transportation, processing and disposal system are lack in proper planning. There are various short comings can be noticed like improper collection and disposal system, lack of house to house collection system, inefficient waste collection and handling by the municipal staff, improper or no storage at household level, haphazard dumping by community, improper, or inadequate number of collection bins, lack
of segregation/quantification of waste facility, lack of infrastructure for processing of waste can be identified easily lastly absence of scientific disposal site like engineered landfill site are not available in the city except few existing landfill sites. Waste should be segregated efficiently in an appropriate manner. Waste heap can be seen in congested areas of the city particularly in lower income group localities because they throw waste mostly on open roads or in drains or in open plots/dumps. They lack proper drainage most of the time households water accumulates near or around the house particularly during rainy season which poses threat to health hazards. It has been observed that door to door collection system is limited to few localities particularly in high income group colonies. The bio-degradable waste is not segregated either at the primary collection points, secondary collection points, or dumping sites. Most of the bio-degradable waste was found to be eaten by animal at the grazing on the open dumping sites. There should be separate incineration facility for Bio-medical waste generated from Government and private hospitals.

In Kanpur city the waste collected from door to door is transported to dustbin and open dumps. This stage of collection system is not very efficient. There are many areas mainly dense unplanned and haphazard settlement often unrecognized and ignored by the local authorities. It has been observed that the waste is cleaned only on main roads in open areas while undeveloped areas and old areas do not have sufficient infrastructure and proper management planning. The waste management in Kanpur city in difficult in areas having narrow street, congested localities which restrict vehicles, careers, big dumpers, truck and tractor movement. There is no proper storage resulting in the waste littered on the ground thus creating condition for mosquito breeding which is direct threat to health. In many places city suffers from the problem of water logging. This is due to the peculiar location and the city in the low lying, narrow congested tract and faulty natural drainage and condition of drain is not very satisfactory.

The huge amount of polythene which creates various environmental problems in the city. The municipal authorities have failed to provide sufficient supervision of the dumping of the waste as a result of polythene waste are continually poorly dumped particularly in open drains.
There are several important aspects of humanly and management of municipal solid waste observed in the study area. Segregation of solid waste as a source not practiced. The unorganized disposed methods have resulted in accumulation of solid waste on road sides and vacant plots and in low lying areas. It has been observed that open over loaded trucks of waste littering waste on roads during transportation creates nuisance in the city. Workers do not have any personal protection equipments such as face mask, disposable gloves, and boots. Hygienic condition, can be maintained in the city of regular clearance of waste from temporary waste storage depots is ensured. Due to inadequate number of vehicles transportation of waste does not take place regularly. The washing facility of vehicles is not available and workshop is inadequate to manage all the vehicles and careers.

The system of routing of the vehicles and the clearance of the bins on day to day basis in not proper. The selection of the type of vehicles should also be done keeping in mind the quantity of waste to be transported the distance to be travelled, the road width, road condition, locality etc. The Kanpur Nagar Nigam does not have a long term plan of siting of waste disposal. Number of handcarts are inadequate in relation to the number of sweepers. Kanpur city has clear demarcation between older part city and newly built areas. The old part of city is very congested and having narrowed congested street where heaps of solid waste could be easily seen. Relative relief demonstrates variation in altitude as well as problem of water logging particularly low lying areas during the rainy season. Another important reason for water logging is the presence of and open drains choked with accumulation of silt and polythene from which water over flows in low lying areas. Level of literacy increases the ability of understanding the various issues. It also enhances the level of awareness to keep neat and clean their surrounding. In other words higher the level of education greater would be the possibility of accepting modern methods to keep surrounding neat and clean there is positive relationship between incomes with generation of waste. It has been observed that in many wards there is complaint of regular frequency of collection and disposal of solid waste due to shortage of man power for handling and management of waste disposal.
It has been observed that Kanpur city has great disparity in sweeper road length ratio. There are many wards reported very high length of road served by one sweeper. It has been observed that distributions of bin in the study area are inadequate in number. It is recommended that distribution of bin should be on the basis of density of population not in terms of geographical area. It has been observed that maximum length under open drain's (Nala's) shows high risk of vulnerability as compare to those areas reported low length of open drains. These areas may be the breeding ground of mosquito due to poor sludge disposal, blocked drains and generally poor drainage system facilities generate conditions for mosquito breeding, so these areas are having more risk of various types of diseases like malaria, chicken guinea and dengue as compare to other parts of the city.

The cumulative view of vulnerability assessment of solid waste problem in Kanpur city were obtained by the summation of all the selected possible variables namely relative relief of Kanpur city, population density, waste quantity, quantity of polythene generation, pattern of literacy, sweeper-population ratio, sweeper-road length ratio, population-bin ratio, length of open drains (nala's) give a composite impression of spatial vulnerability of environment with reference to solid waste problems. A total nine variables have been selected to process the data. There is no single factor responsible for waste problems and management, with the increase of both population and area of city not only the amount of waste generation increases but also the work of municipal workers increases. It has to cover a large area. The expanded areas need more municipal workers and better equipments to manage the wastes. Analysis shows that there are fourteen wards comes under very high category of composite score of vulnerability criteria for the assessment of solid waste problem in the Kanpur city, these wards comprises an area of 30.23 Sq. Km. i.e. 10.36 percent area of the total area of Kanpur city which consist 7,11,57 persons i.e. 20.84 percent population of Kanpur city. Whereas twelve wards covers an area of 31.07 Sq. Km. i.e. 10.65 percent area of Kanpur city consist 4,13,857 persons i.e. 12.12 percent population of Kanpur city comes under high cumulative score of vulnerability. About 32.96 percent of total population of Kanpur city comes
under very high to high degree of vulnerability of solid waste problem. These wards cover an area of 21.01 percent of total area of the Kanpur city which consist 32.96 percent population of the city. Whereas another twenty one wards lie in moderate category of composite vulnerability of solid waste problem. These wards covers an area of 38.08 Sq. Km. i.e. 13.05 percent of total area which consist 6.14514 persons i.e. 17.99 percent of total population of the city. Whereas another Twenty eight wards of Kanpur city fall under the category of low composite score of vulnerability of solid waste problem. These wards covers an area of 79.51 Sq. Km. i.e. 27.25 percent of total area of the city which consist 8,16,869 person i.e. 23.92 percent of total population of the city. The remaining Thirty five wards reported very low composite score of vulnerability assessment of solid waste problem in the city. These wards covers an area of 112.9 Sq. Km. i.e. 38.69 percent of the total area which consist 8,58,246 persons i.e. 25.13 percent of the total population of Kanpur City. Cumulative view of vulnerability of solid waste problem in Kanpur city may provide basis for rational, equitable and sustainable planning of the city.

Lastly, waste management strategies and combat plan have been suggested. It has been concluded that the existing solid waste management system in the study area found inefficient and lack of proper planning with respect to waste generation problems. First of all identification of vulnerable areas for the purpose of planning is necessary before the implementation of any plan. in the present work there are fourteen wards have been identified under very highly vulnerable areas namely Maheshwari Mohal, Nazirbagh, Najma North, Naubasta East, Karrahi, Naubasta West, Tilak Nagar, Talaq Mohal, G Waltoli, Barra Gaon, Barra South, Kalyanpur, Nawabganj and Rawatpur Goan. These areas reported various types of problems. There are twelve wards namely Laxmipurwa, Sisamau South, Patkapur, Sujatganj Gaon, Usmanpur, Old Kanpur, Nehru Nagar, Beconganj, Sarai meeta, Maswanpur, kalyanpur and Naubasta comes under highly variable conditions.

In moderate vulnerable areas twenty one words have been identified. There are Raipurwa, Coperganj, Parade, Dana Khor, Om Purwa, Najma South,
Tiwaripur, Harjinder, Nagar, Barra World Bank, K-block, Kidwai Nagar, Sisamau south, Tiwaripur, Vasant Vihar, Bakarganj, Bingawan, Makwawatganj, Jawahar Nagar, Sisamau North, Gandhi Nagar, Colonelganj, Ratan Lal Nagar, Nirala Nagar and Lajpat Nagar. These wards of the city are also not served properly by the municipality in these wards mostly waste is collected in two to three days gaps.

In low vulnerable areas twenty eight wards have been identified these are namely- Harbansh Mohal, Collector Ganj, Civil Lines, Chamanganj, Generalganj, Chakeri, Chandari, Pashupati Nagar, Yashoda Nagar, Kidwai Nagar, Sabzi Mandi, Kidwai Nagar North Block, Juhi, Parmath, Ashok Nagar, Gwal Toli, Barra West, Dabouli Gaon, Panki Katra, Gujaini Colony, Ravidas Puram, Gararian Purwa, Govind Nagar North, Vinayak pur, Nankari, Shastri Nagar, Azad Nagar and Vijai Nagar. In very low vulnerable areas thirty five wards have been identified these are namely Anwarganj, Dalelpurwa, Chatai Mohal, Chaowk Sarrafa, Gandhigram, Hanspuram, Krishna nagar, Delhi-sujanpur, Yashoda Nagar West, Sanigawa, Gaukhera, Transport Nagar, Babu Purwa Labor Colony, Munshi purwa, Lal Hari Peeli Labour Colony, Juhi, Barra east, Begum Purwa, Khalasi Line, Arya Nagar, Chunniganj, Panki Katra, Bhanan Purwa, Kaushalpuri, Govind nagar, Govind nagar South, Naseemabad, Kakadev Gaon, Pandav Nagar, Jai Prakash Nagar, Naramau Bangar, Sarojni Nagar, Kalyanpur, Sarvoday Nagar & Geeta Nagar.

In the view of the solid waste problem in the city some strategies for spatial planning and management of solid waste problems in Kanpur city have been suggested. Planning for urban solid waste management requires an assessment of many complex interaction among collection system, transportation system, land use pattern study, urban growth and development projection studies and public health consideration. A step wise approach for safe and efficient collection, transfer, storage, transportation and disposal of municipal solid waste for Kanpur city is proposed in the study area.