An Assessment of Urban Drainage, Sewage Condition and Solid Waste Management in Gobardanga Municipality, West Bengal

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Abstract:

Solid waste management is a global environmental problem in today's world. There is an increase in commercial, residential and infrastructure development due to the population growth and this has negative impact on the environment. Urban solid waste management is considered as one of the most serious environmental problems confronting municipal authorities in developing countries. The study is mainly concentrated to investigate the present status of Municipal Solid Waste Management (MSWM) in Gobardanga Municipality. In order to carry out the study a detailed survey was conducted out on existing facilities of Solid Waste Management (SWM) such as manpower resources and management systems. A detailed study comprising the methods of practices associated with generated quantity of waste, collection, transportation, treatment and disposal of MSW in Gobardanga Municipality is conducted.

Keywords: *per capita waste generation,* solid waste, sewage, urban drainage, Construction of landfill site.

1. Introduction :

Solid waste has been produced since the beginning of civilization. During the earliest periods, solid wastes were conveniently disposed of in large open land spaces, as the density of the population was low. However, today, one of the consequences of global urbanization is an increased amount of solid waste. About 1.3 $X10^9$ ton of municipal solid waste (MSW) was generated globally in 1990 (Beede and Bloom, 1995), and, at present, the annual generation is approximately 1.6 $X10^9$ ton. The urban population in Asia generates around 760 X 10^3 ton of MSW per day, and this is expected to increase to 1.8 X 10^6 ton by 2025 (Pokhrel and Viraraghavan,2005).

Rapid urbanization and modern living have led to generation of huge quantities of Municipal Solid Wastes. Due to lack of serious efforts by municipal authorities, solid waste and its management has become a tenacious problem. The collection and disposal of Municipal Solid Waste (MSW) is one of the facing problems of city life which has assumed great importance in the recent past. With the growing urbanization as a result of planned economic growth and industrialization, problems are becoming acute and call for immediate and consulted action. The proper disposal of urban waste is not only absolutely necessary for the preservation and improvement of public health but it has an immense potential for resource recovery. Municipal Solid Waste (MSW) is a

heterogeneous mixture of different constituents out of which around 50% is organic. Most of the municipalities practice uncontrolled disposal of solid wastes resulting in surface water and groundwater pollution, odour nuisance and air pollution. Remembering this emerging issue, the current geographical study is focused on the emerging problems of urban drainage and solid waste management in Gobardanga municipality, North 24 Parganas district, West Bengal.

2. Objectives:

The main objectives of this geo-environmental study are to find out the glimpses of environmental stress in each corner of Gobardanga municipality. So to achieve that goal the following objectives are considered:

I. Providing a brief outlook of ward wise population pressure.
II. Study the types and major sources of solid waste in Gobardanga Municipality.
III. Identify the gap between solid waste generation and collection.
IV. Assess the adverse impacts of waste disposal on the urban environment.
V. Analyzing quantitatively the ward wise surface drainage condition and solid waste pollution including flaws of urban drainage system.

3. Methodology :

Different methods and techniques have been adopted to fulfill the aforesaid objectives. At the initial stage of investigation information has been collected from various secondary sources like District Census Handbook (North 24 Parganas, 2011), Official Website of Gobardanga Municipality and other necessary information from books, journals, research report published as well as unpublished including retrieved web resources have been consulted. Primary information has been collected through intensive field survey.

Then that information is integrated in the cartographic engine, i.e. Geographic Information System (GIS), creating an updated database. Here softwares like 21stCenturyGIS Solutions and TNTmips- geospatial software solution are used as the cartographic tools in the area of specific requirements. After creating a Georeferenced baseline ward map of Gobardanga, all the spatial information is stored in GIS and then it is represented as thematic maps and suitable charts. Then to validate the spatial information rechecking, ground observations and surveys are done and many photographs are taken to prove those information as ground reality.

4. Indian Scenario of Solid Waste Management:

The solid waste management approach in India is extremely inefficient, using old and obsolete system, technology for storage collection processing, treatment and disposal. There is no formal organized system of segregation of biodegradable and non-biodegradable solid waste. The recovery and recycling of waste is only done by scavengers and scrap dealers which is highly hazardous to those which are involved in this job. No serious efforts are made to adapt latest methods and technologies of waste management, treatment and disposal. Though a large portion of the municipal budget is allotted for solid waste management, most of it is spent on the wages of sanitation workers whose productivity is very low. There are no clear plans to enhance their efficiency or improve working conditions through the provision of modern equipment and protective gear. Unionization of the workers, politicization of labour unions and the consequent indiscipline among the workforce are all results of bad working conditions and inept handling of labour issues.

Table- 1 Quantity of waste generation in Indian Cities

Population Range	Average per Capita Value (Grams/Capita/Day)
Less than one lakh	210
One lakh to five lakhs	210
Five lakhs to ten lakhs	250
Ten lakhs to twenty lakhs	270
Twenty lakhs to fifty lakhs	350
More than fifty lakhs	500

Source- National Commission on Urbanization

The waste generation rates in India are lower than the low-income countries in other parts of the world and much lower compared to developed countries. However, lifestyle changes, especially in the larger cities, are leading to the use of more packaging material and per capita waste generation is increasing by about 1.3 per cent per year. With the urban population growing at 2.7 per cent to 3.5 per cent per annum, the yearly increase in the overall quantity of solid waste in the cities will be more than 5 per cent. The Energy and Resources Institute (TERI) has estimated that waste generation will exceed 260 million tonnes per year by 2047—more than five times the present level.

Cities with 100,000 plus population contribute 72.5 per cent of the waste generated in the country as compared to other 3955 urban centres that produce only 17.5 per cent of the total waste (Table 2).

Table- 2 Waste Generation in Class 1 Cities with Population above 100,000

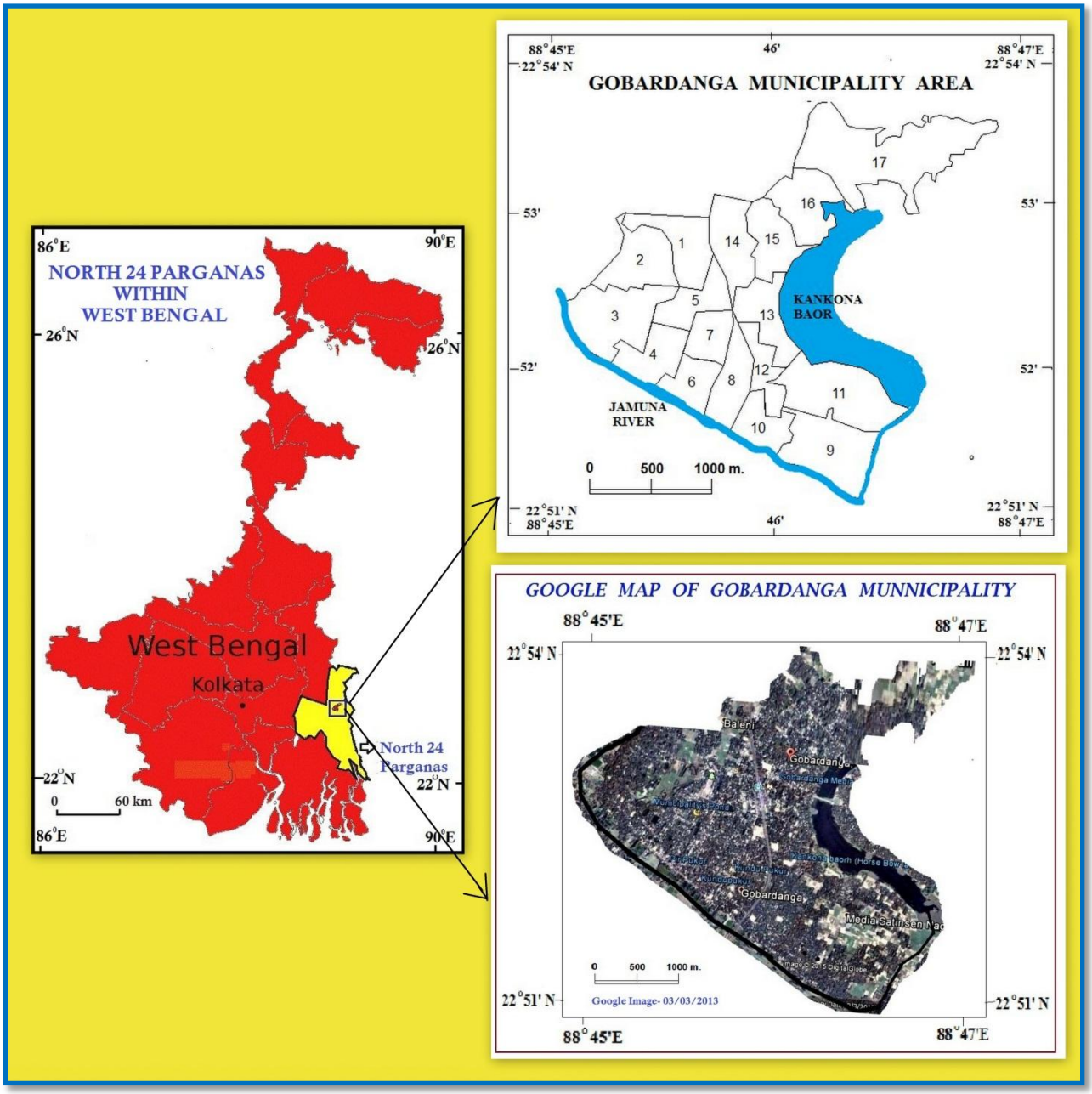
Type of cities	***Tonnes/day***	***Percent of total garbage***
The 7 mega cities	21,100	18.35
The 28 metro cities	19,643	17.08
The 388 class 1 towns	42,635	37.07
Total	83,378	72.50

Note: Mega cities are above 4 million population and metro cities (also known as million plus cities) are the same as the identified cities under the proposed JNNURM (Table A1.1). Class 1 cities with population in the 100,000 to 1 million range are 388 in number.

Source: MOUD (2005)

5. Study Area:

Gobardanga is a town and a municipality under Habra police station of Barasatsadar subdivision in North 24 Parganas district in the Indian state of West Bengal. It is one of the oldest municipalities of West Bengal. The town is situated within the boundary of Habra I C.D. Block. The Gobardanga railway station is well connected by eastern railway. It is situated on the right bank of Jamuna River [a tributary of Ichamati River]. Latitudinal extension varies from $22^0$51'27'' N to $22^0$53'30'' N and longitudinal extension varies from $88^0$45' E to $88^0$46'30'' E. According to Census of India (2011) Gobardanga municipality has an administrative area coverage of 13.50 km^2 and divided into 17 wards. It has an average elevation of 6 metres (19 feet).



gure 1: Location Map of Gobardanga Municipality [Source: Municipality, Google]

6. Results And Discussion

6.1. Demographic Configuration:

The Gobardanga Municipality is divided into 17 wards. The Gobardanga Municipality has population of 45,377 of which 23,025 are males while 22,352 are females as per report released by Census India 2011. Literacy rate of Gobardanga city is 91.80 % higher than state average of 76.26 %. In Gobardanga, Male literacy is around 94.46 % while female literacy rate is

89.07 %. Gobardanga Municipality has total administration over 11,502 houses to which it supplies basic amenities like water and sewerage.

At first the whole town was a single ward in 1870 (the year of establishment of municipality) and then the town was divided in wards few times. During 1994 the municipal area was last delimited and previous 11 wards were divided and constituted 17 ward. At the time of census 2001 the population was 41618 and municipal area was 10.40 sq km. During the latest census date i.e. in 2011, the population is 45377 and municipal area is 13.50 sq. km. The increasing urban population is considered as level and phase of urban development as well as burden on provision of urban facility.

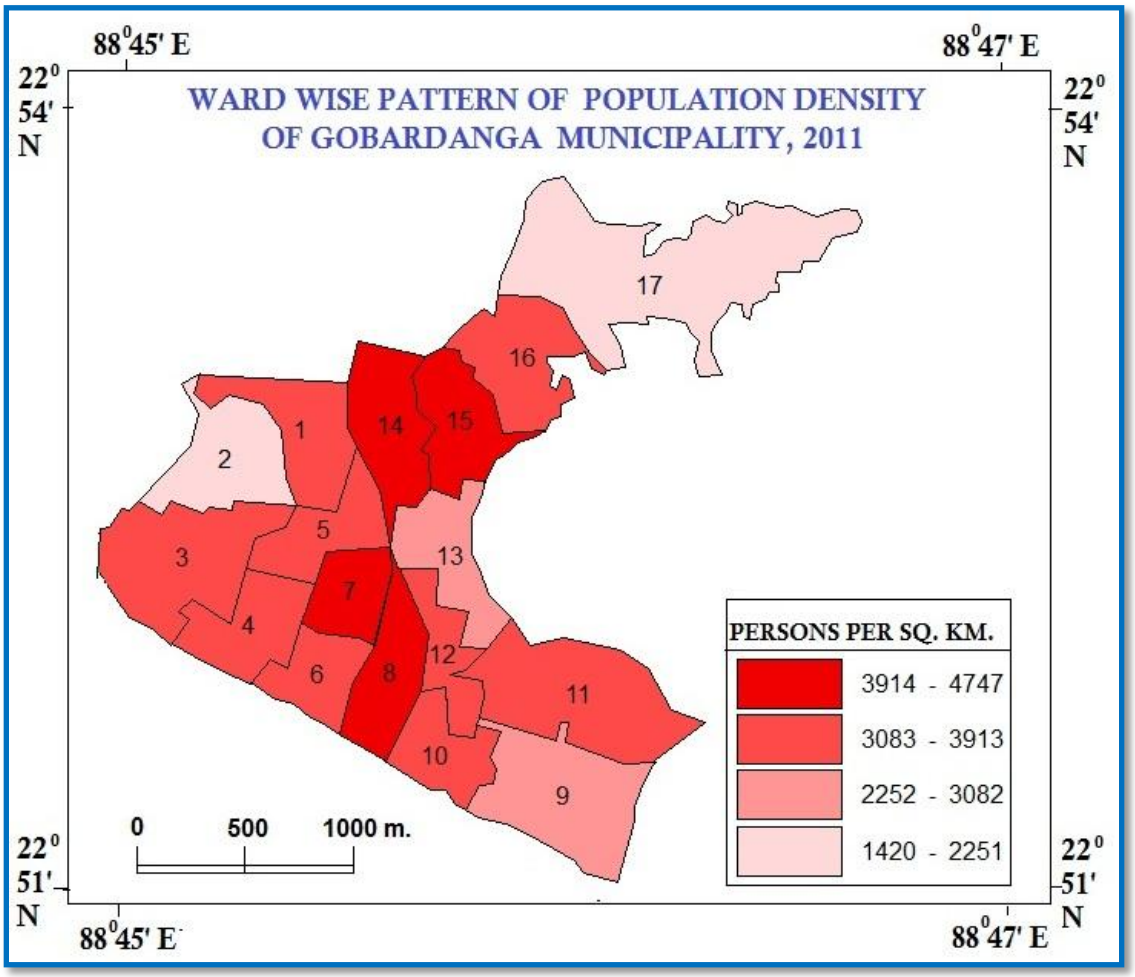


Figure 2: Ward wise pattern of population density (after Census of India, 2011)

6.2. Urban Drainage:

Urban drainage includes rivers, streams, surface and subsurface drains. Boundary of Gobardanga Municipality is bounded by Jamuna River [a tributary of Ichamati River] and Kankona Baor from the three sides' viz. east, west and south. These channels work as natural drainage of solid waste generated from the municipality. But due to high liquid waste discharge, encroachment and obstacles by built-up areas and bridges, low cross-sectional area, low gradient of Jamuna River,

sediment load and solid waste load cannot travel for a longer distance. So there is an urgent need to decrease the large scale disposal of urban effluents and solid wastes into Jamuna River.

In Gobardanga municipality 41.5 km drain exists across 13.50 sq. km. Out of 41.5 km drain 9 km is kutcha drain, 25.5 km is pucca and 7 km covered drain.

From the field observation, it has been found that open choked surface drains, nonsewerage line and increasing dumps of solid waste are the chief causes of environmental pollution. Generally speaking, pollutants tend to accumulate in slow segments of the hydrologic cycle. These segments are called sinks, and they function as the dustbins of the environment. The critical stage of waste pollution is reached when a heavy storm water runs off the land (rainy season). That runoff water captures pollutants from lawns, surface drains, public sanitary systems, garbage, driveways, markets, garages because hard surfaces create more runoff. As the Jamuna River is chief pollution sink, waste deposits into the river.

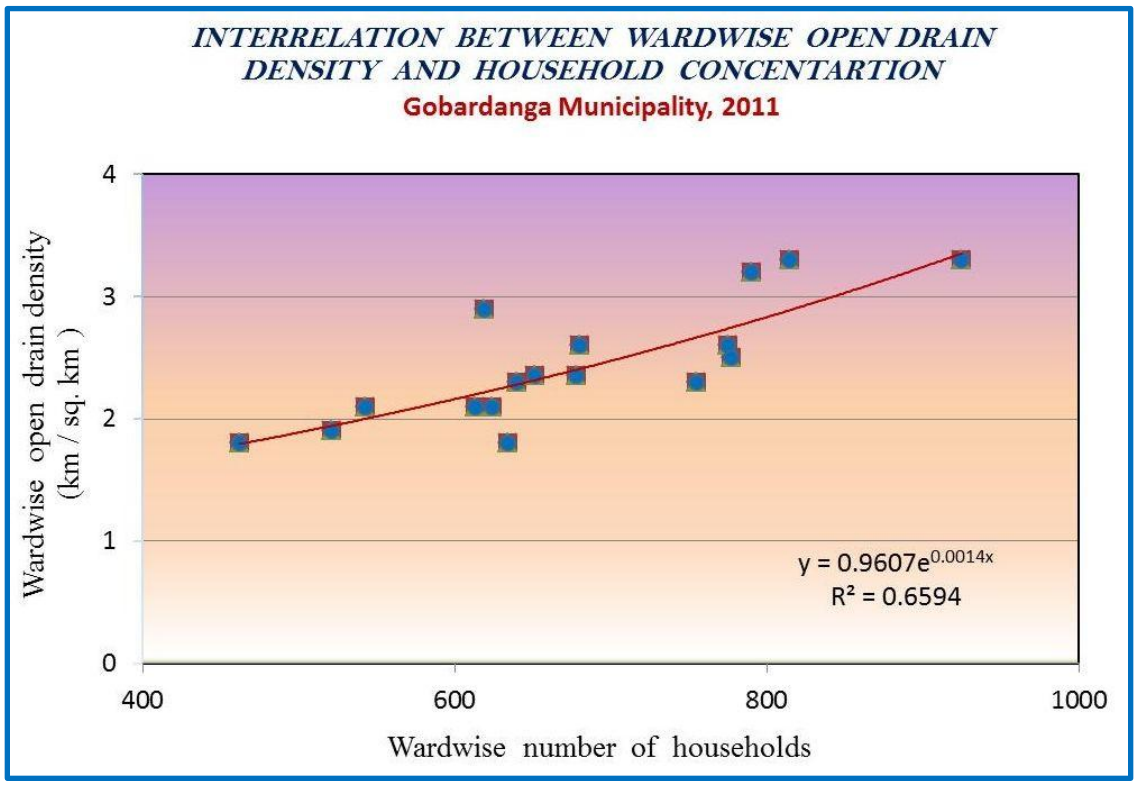


Figure 3: Diagram showing positive exponential relation between ward wise number of households and open drain density. [Source: Municipality officials,2015 and Census of India, 2011]

From figure 3 it is clear that there is a rising trend which signifies that the wards having more households, have sufficient open surface drains to release household liquid waste.Beside this, a significant fact evident when talking about waste disposal is that the particular ward which has high population density or huge number of households should have dense network of drains to release huge amount of household liquid waste. In this case the question is that is it sufficient to carry the increasing load of liquid waste? Because except the ward no. 5, 13, 14 and 15 all the wards do not have covered drainage system. On the basis of field observation, high density of surface drains and population load means high possibility of surface pollution (because most of the drains are choked due to lack of clearing and minimum width depth ratio).

6.3. Sewage Condition:

Gobardanga municipality is basically a nonsewered municipality, but recently covered drain system has been installed in some wards. Most of the open surface drains are choked by solid waste (e.g. plastic, packets and aluminum cans). So, regular flow is very much hampered. This liquid waste is stagnated and it creates bad smell, germs and urban floods in monsoon period. Only ward no. 5, 13, 14 and 15 are installed with total 7 km covered drain. Therefore, due to improper treatment of surface drains, high density of open drains (including 'Kuchha' drain) means possibility of liquid waste pollution. At present due to rapid expansion of town and increasing area of residential space, to minimize the current and future load, the municipal governing body should adopt an underground sewage network.

Figure 4: Jamuna River at Gobardanga Bazar (left side photo) and one of the main drain near railway over bridge on Jamuna River (right side photo) showing polluted water due to solid wastes and growth of hydrophytes.

Figure 5: Municipality Solid Waste Dumping Ground (left side photo) and Choked drain near the railway station (right side photo).

6.4. Present Scenario of Solid Waste Generation and Collection:

MSW includes solid waste as (i) trade refuses,(ii) waste from shops, market areas including papers, straw, cardboard packing, decaying fruits, vegetables etc.,(iii) household wastes such as food items, bottles, polythene, plastic containers, etc.,(iv)carcasses of dead animals and other matter, (v) wastes from building materials (during demolition and construction) and (vi) automobiles spares, machines, cycle parts etc. that are thrown as junk. Types and quantity of solid waste in Gobardanga Municipality are depicted in the figure no.6.

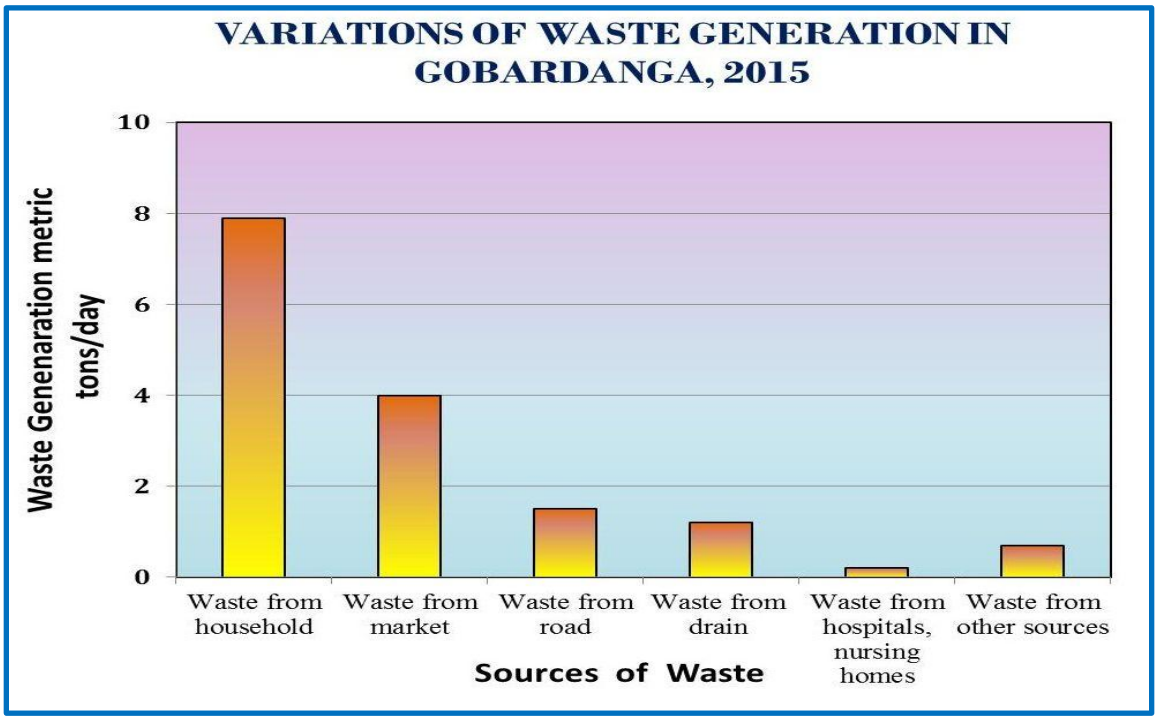


Figure 6: Types and the Amounts of Solid Waste
(Source: Gobardanga Municipality, 2015)

Solid waste is produced at every phase in the economic system, including raw material extraction, processing and transportation; manufacturing, packing and shipping; and advertising and sales, as well as with the products themselves once they are spent and/or discarded. The above bar graph shows that maximum solid wastes are generated from household; maximum is from ward no. 12 [610 kg/ day] and minimum from ward no. 17 [320kg /day]

To collect and transport the municipal wastes, the municipality has put in following people in specific works, equipment and vehicles (2015):

I. 71 persons (permanent, temporary and daily wages) are engaged in street sweeping, transportation, drain cleaning and disposal of waste.
II. 17 van to door to door collection.
III. All total 35 permanent dustbins.
IV. 4 truck
V. 3 Cesspool etc.

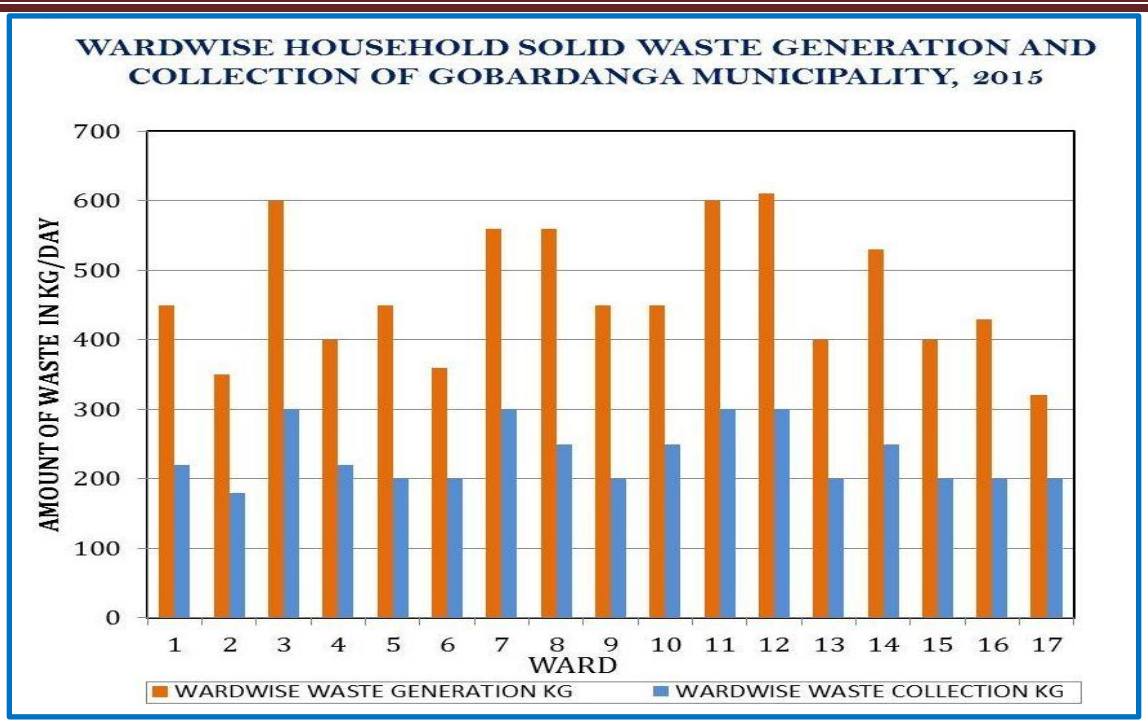


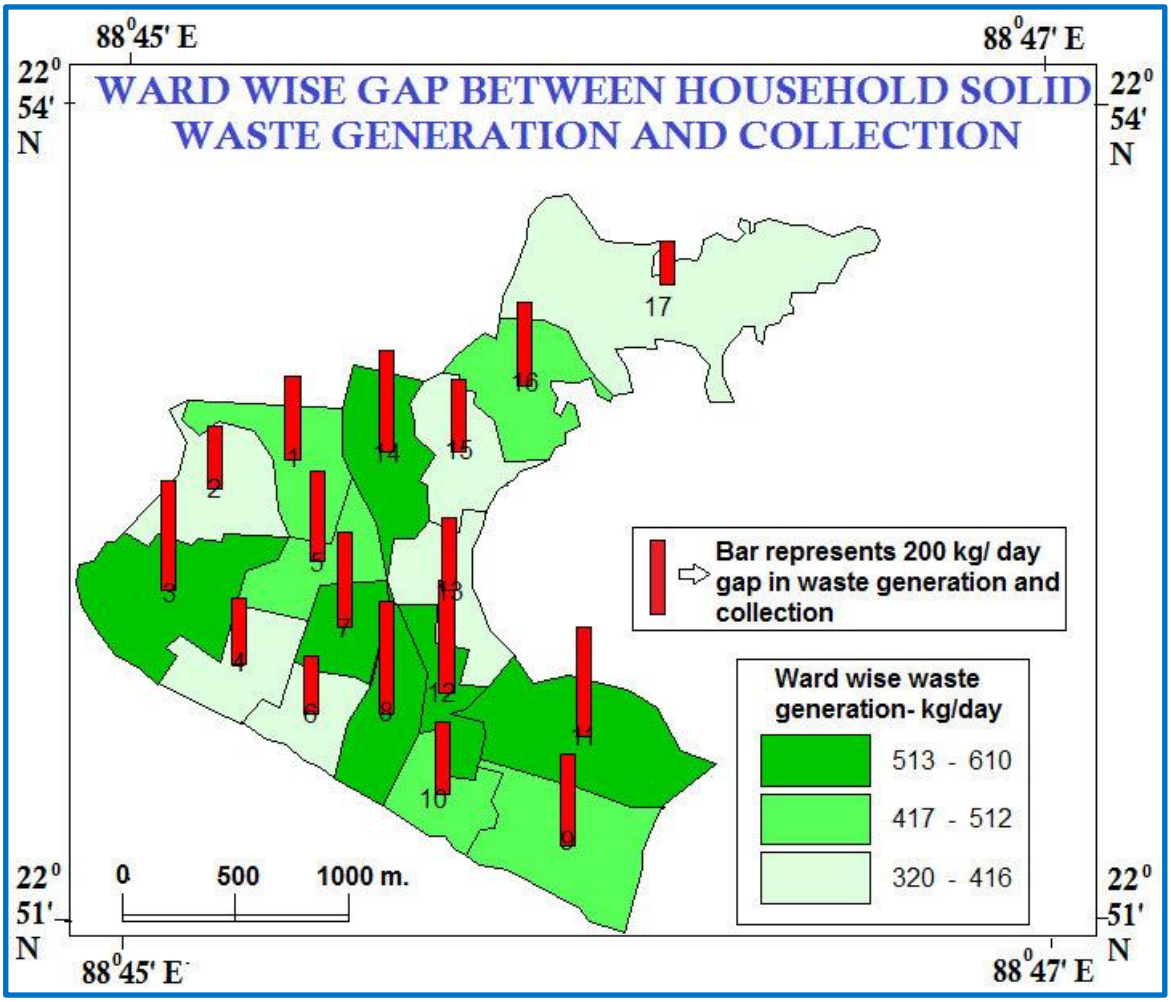
Figure 7: Ward-wise Household Solid Waste Generation & Collection
(Source: Gobardanga Municipality, 2015).

The reality shows that these are not enough to minimize the gap between waste generation and collection of generated waste (including lack of daily treatment and monitoring of drains and dustbins). As the population is ever increasing, inevitable need to employ more modern equipments and human resource in solid waste management. The following figure and map are placed to understand the gap between ward-wise generated household waste and that collected the same per day. As a whole per day 7.92 tons of solid waste generated but only 3.97 tons of waste is collected, uncollected heap of garbage is 3.95 tons and this is what let to the environmental appraisal. The wards numbered 3,7,8,11,12 and 14 have generated approximately 3.4 to 4.5 tons of household solid waste per day (2015). In those wards there is a significant gap between waste generation and collection per day. These wards are covered mainly by rice mill, vegetable-market and slum areas, which are neglected by the municipality workers. Lack of infrastructure and working people in governance enhance the gap between waste generation and collection in 17 wards in Gobardanga Municipality, deteriorating the hospitality of surrounding residential environment of the area.

Table 3: Ward-wise Distribution of Surface Drain in relation to Population Density & Household

Ward	Population	Population Density	Household	Length of drain in km	Ward	Population	Population Density	Household	Length of drain in km
1	2657	3690	678	2.35	10	2610	3480	619	2.9
2	1913	2224	521	1.9	11	3113	3501	755	2.3
3	3769	3695	925	3.3	12	3144	3614	775	2.6
4	2552	3594	640	2.3	13	2008	2642	543	2.1
5	2532	3669	651	2.35	14	2957	4050	777	2.5
6	2282	3510	624	2.1	15	2496	3961	634	1.8
7	3086	4747	790	3.2	16	2687	3401	680	2.6
8	3062	4374	815	3.3	17	1846	1420	462	1.8
9	2663	2773	613	2.1	Source: Census of India (2011) and Municipality office.				

Figure 8: Ward wise gap between household solid waste generation and collection (Gobardanga Municipality, 2015)



Municipal solid waste is refused from households, vegetable markets, businesses and institutions, that is, nonindustrial waste, and it is disposed of in landfills. Landfills are managed disposal sites. As the primary and secondary substances in solid waste breakdown, they yield a chemically concentrated liquid called 'leachate'. If this foul material is allowed to steep from a dump or landfill, through the subsoil and into the groundwater system, aquiferpollution can result. Solid waste can also be a source of pollution in surface water (via runoff) and air (via windblown debris) and solid waste landfills area a source of countless land use problems, including traffic congestion, obnoxious odors, depressed land values and political and legal disputes.

6.5. Problems Related to Solid Waste Collection, Transportation and Disposal:

Unconscious habit as well as consciously disobeying the civic duties of the residents, unplanned and poorly managed waste disposal system has given birth to a number of environmental problems in the area as follows.

[i] There is no provision of segregation of biodegradable waste (such as green waste) and non-biodegradable waste at the source. Only the conscious families collect their own household waste and dispose them in roadside community dustbins. The fact cropped up from the field investigation is that majority of households dump their daily waste in personal dustbin throughout the day and night and at the next morning they release these to municipality garbage van. But in the interior area of several wards, door to door collection of waste has been stopped due to negligence of local authority. As a result residents dump their daily waste in nearby unused space or pond.

[ii] During anaerobic decomposition of wastes carbon-di-oxide and methane gases are produced emitting foul smell. It is a common feature in fish and vegetable market in *Gobardanga bazaar* (ward no. 3),*poultry bazaar* (ward no.11) and railway bazaar (ward no.13).

[iii] The municipal garbage points remain nakedly open throughout day, which become the hot bed. Rats, flies, mosquitos flourish on garbage heaps. Approximately 70,000 flies can be produced on one cubic foot of garbage (Khullar, 2006, p.315).Dog, goat, cow, bird scatters this garbage and as a result roads become dirty. Many cattle are affected by eating plastic waste along with green waste.

[iv] The area of disposal ground is not compatible with the pace of generated solid waste with time. Sometimes, residents have to spent more travel time to dump their waste due to either non availability of dustbins or inadequate numbers of bins, which are unevenly distributed within the residential areas.

7. Management Plan And Suggestions:

Urban place is the most expected residential destination of well of people in developing nations. In rapidly urbanized areas, solid waste management is one of the most essential services for maintaining the sound hospitality for ensuring better standards of sanitation. Before suggesting any remedial measure, a focus has to be given on Table No: 4 that represents time schedule taken by different types of waste to degenerate themselves.

Table 4: Types of Litter and Approximate Time it takes to Degenerate

Type of Litter	Approximate time it takes to degenerate
Organic waste such as vegetables, fruit peels,left over food stuffs etc.	7-14 days
Paper	10-30 days
Wood	10-15 days
Cotton Cloth	2-5 months
Wooden item	1 year
Tin, Aluminum, other metal items	100-500 years
Plastic bags	1 million years
Glass bottles	Undetermined

Based on the above observations, we can conclude that there is an urgent need for efficient management of solid wastes in this municipality. The overall solid waste management practices have to be enhanced, improved and implemented on a larger scale. For example, the practice of house - to - house collection should be extended facilitating segregation into biodegradable and non-biodegradable; the primary collection system should be improved involving containerized collection & more number of primary transport vehicles; street littering should be made punishable by law; effective and economical transportation system should be incorporated; eco-friendly treatment and disposal system should be practiced.

Beside these, with reference to the Table No.4, it can be asserted that there should be judicious management and planning for treatment of different types of solid waste. In the spatiotemporal context, a possible remedial measure is given to alleviate the problems.

7.1. Incineration:

Incineration is a waste treatment process that involves the combustion of organic substances contained in waste materials. Incineration and other high-temperature waste treatment systems are described as "thermal treatment". Incineration of waste materials converts the waste into ash, flue gas, and heat. The ash is mostly formed by the inorganic constituents of the waste, and may take the form of solid lumps or particulates carried by the flue gas. The flue gases must be cleaned of gaseous and particulate pollutants before they are dispersed into the atmosphere. In some cases, the heat generated by incineration can be used to generate electric power.

7.2. Construction of landfill site:

At the present situation, in Gobardanga Municipality, construction of landfill is of prime importance, which is more hygienic than open dumping ground (Fig No. 9). This should be well equipped, well managed and lined properly with impermeable materials such as plastics as a protection against contamination of soil, surface water as well as as ground water. The basic principles of the measure are to deposit the garbage, compact it with bulldozer and cover the materials with at least 6 inches of dirt. There must be a provision of tap CO2, methane gas and other greenhouse gases (GHGs) from landfill site during anaerobic decomposition of waste. Before waste disposal in a landfill, the volume of waste can be reduced through thermal treatment. The excessive amount of heat produced during
this treatment can be used as non-conventional energy.

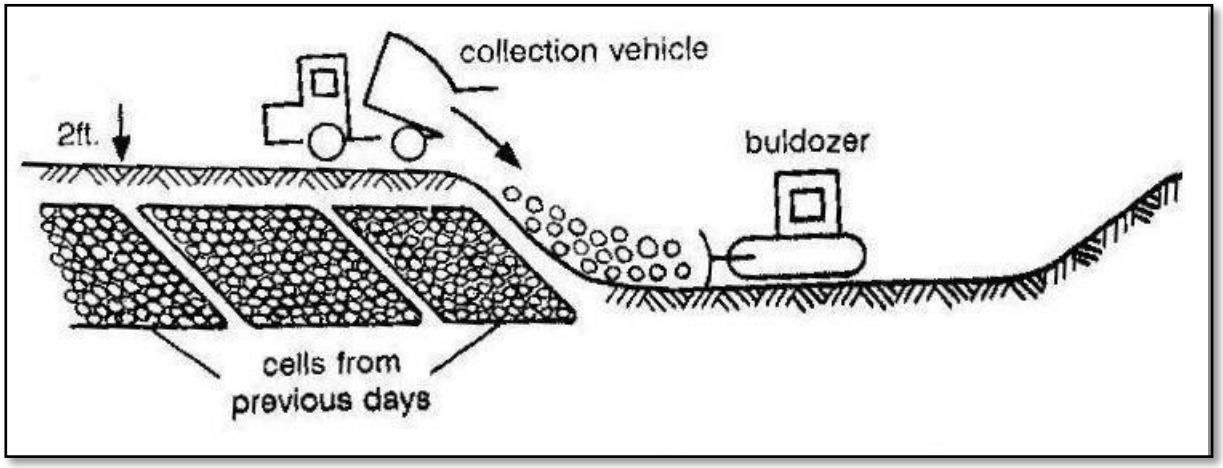


Figure 9: Sanitary Landfill (Source: Sharma p-476)

7.3. Recycling:

Recycling is a process to convert waste materials into new products to prevent waste of potentially useful materials, reduce the consumption of fresh raw materials, reduce energy usage, reduce air pollution (from incineration) and water pollution (from landfilling) by reducing the need for "conventional" waste disposal and lower greenhouse gas emissions as compared to plastic production. Recycling is a key component of modern waste reduction. Recyclable materials include many kinds of glass, paper, metal, plastic, textiles and electronics.

8. Conclusion:

The generation of garbage and the problems associated with it require advanced management practices. MSW management is perhaps the most essential service required by urban population to combat the severe implications that MSW may have on their health and to the overall environment. Recent developments in science and technology have emerging process technologies, which can address these issues in a sustainable manner. Before application of any kind of technology or processes, it is necessary to assess whether it is compatible with the existing area and with the general characteristics of the municipal solid wastes generated.

The ward wise gap between waste generation and collection has induced the worst living condition of residential areas, creating heaves of garbage. Again it is a real fact that ward wise condition of surface open drains is far from satisfying level and there is an urgent need to improve urban sewage condition by underground construction. Moreover public awareness is very much needed to reduce and manage solid waste through regular sharing of information, training volunteers to educate households and persons belonging to commercial activities especially to the fish and vegetable market-owners and expanding mass-media mobilization.

Acknowledgement:

Authors wish to thank the officers of the Gobardanga municipality for their help, cooperation and support rendered on their part and also for furnishing valuable information used for this research article.

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