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Brihanmumbai Municipal Corporation Integrated Solid Waste Management at Mumbai

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ABSTRACT: The excessive consumerism in 21st century has led to increase of generation of solid wastes in town and cities. The increased per capita income in cities also contributed to increased diversity of solid waste. The solid waste handling has become a burden on the economy of the Municipalities and corporations. Hence, in all the developing countries, open dumping of solid waste is the common practice. Solid Waste includes all the discarded solid materials from commercial, municipal, industrial and agricultural activities. Land filling is the preferred method of Municipal Solid Waste (MSW) disposal. However, poorly designed land filling can create contamination of ground water, soil and air. As water percolates through the landfill, contaminants are leached from the solid waste. Leachate is produced when moist enters the refuse in a landfill, extracts contaminants into the liquid phase and produces moist content sufficient by high to initiate liquid flow. The initial change of quality appears in pH, Total Dissolved Solids, total Hardness and chlorides. The young dumpsites, where the dumping is actively carried out, generate more leachate and as the dump gets older the solid waste gets stabilized and the adverse impacts are also minimized.

The peri-urban areas face severe problem of ground water contamination from MSW dumpsites. Owing to the importance of the topic, the present work has been carried at Mumbai, Maharashtra. The collection of waste from various places is done through storage bin at various locations. In addition to the above scheme of waste collection, there is provision of door-to-door collection of waste from approximately 90,000 nos of houses weighing approx 150MT. The provision of additional handcarts is envisaged for collection of waste from house to house. At present there is no technique of decentralized method of disposal of solid waste. The transportation of waste up to compost depot at Sukhli road is done through open trucks and dumper placer is done, but not through decentralized technique. The total length of roads is approx 1000kms out of which 321kms of tar roads and 50kms of cement road is swept on daily basis. About 30 nos of penguin shaped bins and 40nos of litterbins have been provided for collection of waste generated by pedestrians.

KEYWORDS: Text detection, In painting, Morphological operations, Connected component labelling.

I. INTRODUCTION

1.1 GENREAL:

Of all the natural resources, water is unarguably the most essential and precious. Life began in water, and life is nurtured with water. There are organisms, such as anaerobes, which can survive without oxygen. But no organism can survive for any length of time without water. The crucial role of water as the trigger and sustainer of civilizations has been witnessed throughout the human history, no life without water is a common saying (Abbasi et al., 1996). Water is the most abundant and essential compound in all the living systems. Water has played a crucial role in the process of chemical evolution by facilitating the formation of living molecules from simple molecular arrangements. It is a universal solvent, and as a solvent it provides the ionic balance and nutrients, which support all forms of life (Shastri, 2000). The amount of water on the planet earth is estimated to be approximately 1388 million billion cubic meters. Of this total amount, major part 1348 million billion cubic meters (97.3%) is constituted by the salt water in the oceans. Only 37.5 billion cubic meter (2.7%) water occurs in the form of fresh water. Of this total fresh water, 28200 thousand billion cubic meter (2.04%) is in the form of polar ice and glaciers, 8450 thousand billion cubic meter (0.61%) as ground water and 127 thousand billion cubic meters in the form of lakes, rivers, etc.(CPCBI,1991). In India, the major source of water used to meet the domestic, agricultural and industrial needs is the ground water. Almost 61% of the needs are fulfilled with ground water, 29% from canals, 5% from reservoir tanks and another 5% from other sources; in Maharashtra state the dependence on the ground water is still more reaching up to about 65% (CPCB, 2005).

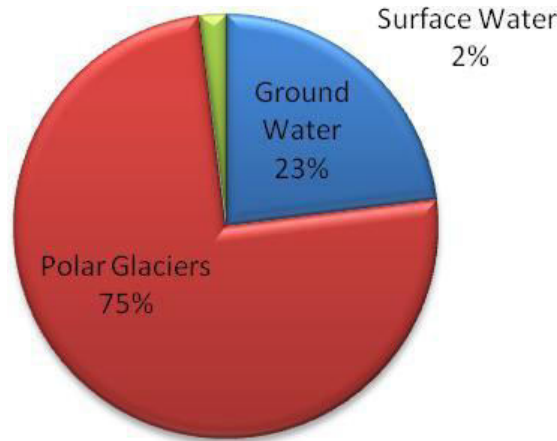


Fig 1.1 : Distribution of fresh water in nature (CPCB,1991)

The ground water is defined as water that is found underground in cracks and spaces in soil, sand and rocks. This source has two distinct functions; firstly, it is a significant source of both urban and rural population’s water supply and secondly it sustains many wetland ecosystems (Jagloo, 2002). The sources for ground water supply mostly depend upon the rainfall and the resulting percolation of the water in the earth, another important factor is the type and quality of the soil (Engle et al., 1993). This resource is particularly favored for domestic purpose, since it is of high quality and requires little treatment before use. This is due to the fact that, as the water percolates down through the soil and rocks, bacteria, fungi and other such biological pollutants are naturally filtered out or diluted (Sampat, 2001). The daily demand of drinking water of a man is normally 7% of his body weight. Thus, it is vital for the healthy growth of the persons. But the same water may become a hazard, a threat to the continuation of life, if it gets polluted with harmful or toxic substances and potentially pathogenic microorganisms able to cause the diseases (Gupta and Gupta, 1997). Usually the groundwater is considered as less polluted as compared to the surface water, due to the reduced exposure to the external environment. But lack of sanitation, improper waste management, have a potential to spoil the purity of the ground water leading to increased pollution levels. Hence, it has been reported that about 40% or even more disease outbreaks are attributed to be water borne in nature (Cocchi and Scalgiarini, 2005). According to UNESCO report, a majority of Indian population has no access to safe drinking water and that about 66 million people rely on un-safe ground water for consumption (Swahney, 2006). The importance of water for the life processes, its“ easy availability and the nature of water, has caused uncontrolled human interventions in the natural water cycle, which has resulted in the degradation of water both qualitatively in the form of decrease in water level index and quantitatively in the form of heavy loads of pollution. These unbalanced exploitations, during the last few decades have created serious problems of water quality and quantity. It appears that if such exploitation is continued, the conditions may still worsen (Sia Su, 2008).

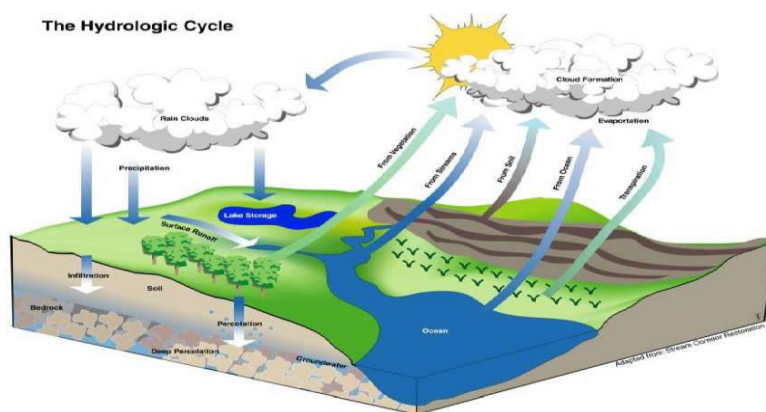


Fig 1.2: The water Cycle (ISWA, 2006)

1.2 WATER POLLUTION

Pure water is animating fluid, while polluted water is a real curse for living beings. The global consciousness towards freshwater system arose in the beginning of the century and the International Biological Programme (IBP) and Man and Biosphere Programme (MAB) were floated to generate information on structure and function of inland aquatic environment, their productivity and the impact of human interference. The water pollution has been described differently by different authorities; some of the several definitions assigned to pollution are as follows:

1. Water pollution is the presence of any foreign substance (organic, inorganic, radiological or biological) in water, which tends to degrade the quality so as to constitute a hazard or impair the usefulness of water (USPHS and Drinking water standards, 1974).
2. Water pollution includes “discharge of wastes including radioactive or other substances actually or potentially harmful to such uses and alteration of properties of water, in such a way to be harmful including temperature, taste, turbidity or odour. (Agarwal, 1991).
3. Water pollution is an alteration in physical, chemical and biological characteristics, which may lead to harmful effects on humans and aquatic biota (Abassi, 1989). Based on the above definitions, the water pollution could be broadly summarized as any change in the water bodies, which may impair their future use for the usual desired purpose, caused by the introduction of organic or inorganic substances or a change in temperature of water. The pollution loads contributed to the water bodies are physical, chemical and biological in nature. Classification of common water pollutants is summarized in Table. 1.1. (Trivedy and Goel, 1986)

The ground water originates as infiltrations from precipitations, stream flows, lakes and reservoirs. The quality of water therefore depends on the type of materials on the passage routes, the dissolved salts and general human activities especially those bordering on waste disposal systems. Ray (1988) has reported that, where the water table is shallow and the soil is porous, dissolved gases, nitrates, sulfates, soluble organic compounds and dissolved salts might be introduced into the groundwater system. Thus, if the solid waste disposal sites are not chosen wisely, high concentrations of chemical and gaseous compounds or decayed organic matter may leach through the soil and contaminate ground water. Ground water pollution usually arises from four main origins, viz., industrial, domestic, agricultural and over exploitation. Studies carried out in India revealed that one of the most important causes of ground water pollution is unplanned urban development without adequate attention to sewage and waste disposal from industries and other sources as well. The incidence of ground water pollution is highest in urban areas, where large volumes of wastes are generated and discharged into relatively small areas (Prasad, 2003). In India, majority of industries are located in and around cities. There are 142 major cities in India, of which 112 lie on river basins, 17 are coastal and 13 non-coastal. (Fokmare and Musaddiq, 2001). In recent days, the water pollution is mostly attributed to the human activities, occurring in more frequent and widespread manner. Therefore, access to safe and sufficient water is now recognized as basic human right and is given high priority in Millennium Development Goals (MDG). Due to increased industrial activities, a number of chemical pollutants including heavy metals find their way into the water reservoirs due to inefficient effluent management practices.

Ground water pollution can occur where industrial waste waters are discharged into pits, ponds, or lagoons, thereby enabling the waste to migrate down the water table. Ground water can be associated with both active and abandoned mines (Veera Bhadram et al, 2004, Jain et al., 2006). The ground water table of a source, changes with the regular withdrawal and hence, the water quality (Tambekar et al., 2007). Garg et al. (1990), Kaur et al. (1992), Rajmohan et al. (1997) and Singh et al. (2000) have reported the seasonal as well as annual changes in the ground water quality. The usual and the most neglected cause of water pollution is uncontrolled dumping of Municipal Solid Waste (MSW). Infiltration of water by rainfall, water already present in the waste, or water generated by biodegradation, cause the leachate to leave the dumping ground laterally or vertically and find its way into the groundwater thereby causing contamination (Kumaravel et al., 2003). Open dumps- unfortunately still mostly observed in developing countries – where the waste is dumped in uncontrolled manner, can be detrimental to the urban environment. These wastes come from a varied range of sources from domestic, agricultural and industrial. In Mumbai city, the solid waste is dumped in the most unscientific manner not like in many developed countries, where the waste is dumped on the basis of their nature, such as biodegradable and non-biodegradable. The solid waste collected and dumped in Mumbai city is heterogenous in nature. The municipal solid waste, in addition to biodegradable waste such as cellulose, hemicelluloses, lignin, pectin, starch, protein, lipids also possesses a variety of chemicals like detergents, inorganic chemicals, complex organic chemicals and metals. These components are themselves very much toxic for the environment and additionally uncontrolled microbial action may result in release of more toxic elements, which were

not present in a free or reactive form in the waste. In case of unplanned dumping of the MSW, the longer degradation time results in the longer retention of the waste, thereby, increasing the chances of movement of leachate down the ground to reach the ground water sources and contaminating them. This solid waste harbors a wide variety of microorganisms. In an open uncontrolled landfill, these microorganisms under favorable growth conditions, such as, temperature, moisture and availability and non-availability of oxygen start performing innumerable enzyme mediated reactions leading to decomposition of solid waste. Especially during monsoon the biochemical activities are at peak. These biochemical reactions result in the degradation of the organic chemicals and formation of a liquid “leachate”. This leachate being rich in organic content also solubilize many heavy metals like lead, copper, zinc, manganese, cadmium, etc. As a natural consequence during rainy days, this leachate either percolates through the soil in land fill area to underground water reservoirs or simply may drain-off to any surrounding water body, if present. These heavy metals do have a serious problem for the environment, since they cannot be biodegraded and remain in the soil/water and may affect humans and livestock (Gandhimathi and Mohan, 2005). In natural or uncontrolled conditions (traditional landfill methods) solid waste does gets degraded, but the process is usually anaerobic in nature, which leads in formation and release of green house gases (methane, CO₂, etc.). Hence, such degradation may lead in the further health hazards by polluting the water bodies and atmosphere (Laine et al., 2004). The solid waste usually comprises of organic waste, paper, glass, metals, plastics, hazardous wastes and other waste (Prabhakarachary et al., 1998). Table 3, depicts the types of chemical components and their average percentage present in solid waste.

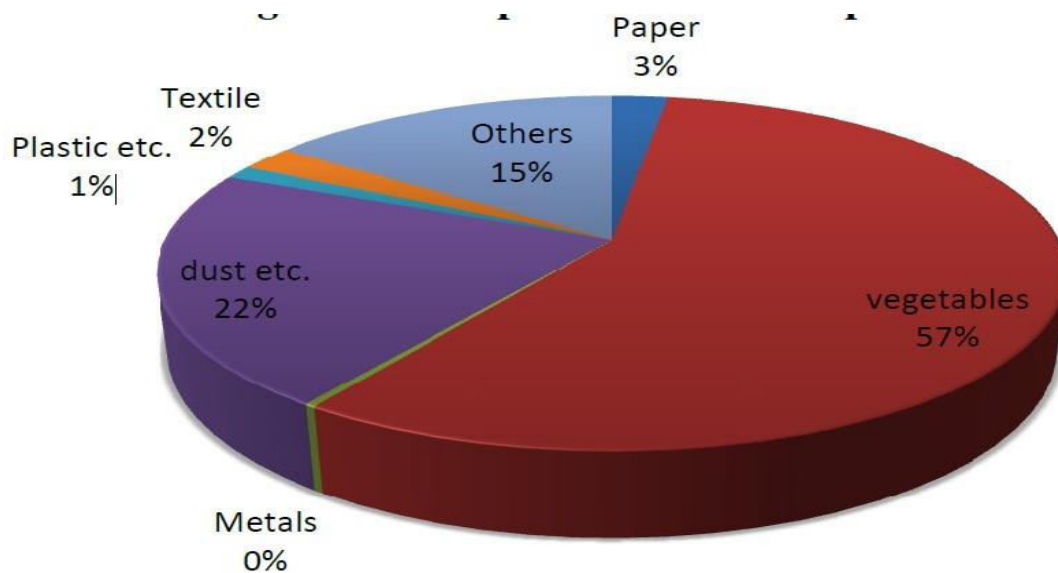


Fig 1.3: Composition of municipal solid waste

The quality of groundwater depends on a large number of individual hydrological, physical, chemical and biological factors. Generally, higher proportions of dissolved constituents are found in groundwater than in surface water, because of greater interaction of ground water with various materials in geologic strata. The water used for drinking purpose should be free from any toxic elements, living and non-living organisms and excessive amount of minerals that may be hazardous to health. Some of the heavy metals are extremely essential to humans, for example, Cobalt, Copper, etc., but large quantities of them may cause physiological disorders. The contamination of groundwater by heavy metals has assumed great significance during recent years due to their toxicity and accumulative behavior. These elements, contrary to most pollutants, are not biodegradable and undergo a global eco-biological cycle, in which, natural waters are the main pathways. The determination of the concentration levels of heavy metals in these waters, as well as the elucidation of the chemical forms in which they appear is a prime target in environmental research today. A vast majority of groundwater quality problems are caused by contamination, overexploitation, or combination of the both. Most groundwater quality problems are difficult to detect and hard to resolve. The solutions are usually very expensive, time consuming and not always effective. An alarming picture is beginning to emerge in many parts of our country. Groundwater quality is slowly but surely declining everywhere. Groundwater pollution is intrinsically difficult to detect, since problem may well be concealed below the surface and monitoring is costly, time consuming and

somewhat hit-or-miss by nature. Many times the contamination is not detected until obnoxious substances actually appear in water used, by which time the pollution has often dispersed over a large area. Essentially all activities carried out on land have the potential to contaminate the groundwater, whether associated with urban, industrial or agricultural activities. Large scale, concentrated sources of pollution, such as industrial discharges, landfills and sub-surface injection of chemicals and hazardous wastes, are obvious sources of groundwater pollution. These concentrated sources can be easily detected and regulated, but the more difficult problem is associated with diffuse sources of pollution like leaching of agrochemicals and animal wastes, sub-surface discharges from latrines and septic tanks and infiltration of polluted urban run-off and sewage, where sewerage does not exist or is defunct. Diffuse sources can affect entire aquifers, which is difficult to control and treat. The only solution to diffuse sources of pollution is to integrate land use with water management. Once pollution has entered the sub-surface environment, it (Source: Central pollution control board of India, 2005) Heavy metal pollution is also been a matter of concern for the water reservoirs, resulting from the increased industrial and mining activities. Most of the heavy metals are toxic to many fresh water organisms and man (Khan, 2006). Presence of high concentrations of toxic metal ions in natural water is subject of serious concern, when such water resources are used for drinking purposes by human and other living organisms (Mazher and Dawood, 2005). Apart from the chemical pollutants, another matter of concern in the water pollution is the contamination with the potential human and animal pathogens. According to World Health Organization, about 80% of all the diseases in human beings are caused by water. In case of groundwater, the water is usually used untreated and hence poses a significant risk for disease transmission. The polluted water not only presents a threat to the life by causing or transmitting various diseases, such as, many microbial infections, cardiovascular ailments, cancers and may remain concealed for many years, becoming dispersed over wide areas and rendering groundwater supplies unsuitable for human uses. Land use activity along with potential threat to groundwater is presented in Table 1.4. neurologic disorders, but also, it has been found to be affecting the usability of the water for other than drinking purposes, viz. occurrence of corrosion in the pipe fittings, utensils and equipments (Wasserman 2005). In the past few decades natural polluted waters have been studied in detail all over the world and a considerable data is now available on most kinds of pollutants and their effects on ecosystems as well as organisms. The need of water is increasing day by day, invariably due to the population explosion; unplanned urbanization. Wastes are being dumped into waters, thus lowering its quality with respect to chemical as well as microbiological aspects.

1.3 COMMON GROUNDWATER CONTAMINANTS

A wide variety of pollutants have been reported to cause deterioration of physico-chemical properties of water, consequent to rapidly increasing population, urbanization, industrialization and new technological development (Verma, et al., 1978). Some of the important water pollutants and their significance are listed as follows:

- 1) Nitrates: Dissolved nitrate is most common contaminant in groundwater. High level can cause blue baby disease (Methemoglobinemia) in children, may form carcinogens and can accelerate eutrophication in surface waters. Sources of nitrates include sewage, fertilizers, air pollution, landfills and industries.
- 2) Pathogens: Bacteria and viruses that cause water borne diseases such as, typhoid, cholera, dysentery, polio, and hepatitis. Sources include sewage, landfills, septic tanks and livestock's.
- 3) Trace metals: Includes Lead, Mercury, Cadmium, Copper, Chromium and Nickel. These metals can be toxic and carcinogenic. Sources include industrial and mine discharges, fly ash from thermal power plants, either due to fall out or disposal in ash ponds. Industrial solid waste dumping and leaching into groundwater through rainwater.
- 4) Inorganic Constituents: Inorganic dissolved salts accumulation, such as, SO₄, Chloride, etc. along with Na, K, building up high dissolved solids and combination of Carbonates, Bicarbonates along with Ca and Mg building up high hardness of water and converting soft/sweet water into hard water creating gastro-intestinal problems in human beings if they consume groundwater as drinking source.
- 5) Organic compounds: Includes volatile and semi-volatile organic compounds like petroleum derivatives, PCBs pesticides. Sources includes agricultural activities, street drainages, sewage landfills, industrial discharges, spills, vehicular emissions fall out, etc. It is evident from the above discussions that the water is one of the essential most requisite for sustaining the life on the planet earth. Water need is to be fulfilled through the limited available sources only. The uncontrolled and unplanned exploitation has very much deteriorated the quality of the water and now, it has become a potential cause for many of the diseases in human and other living beings. Hence, it is necessary that one

must wisely use the water in order to avoid any possible adverse consequences; there is an urgent need to take necessary steps to monitor the water quality and to avoid any deterioration being caused. Topography The location of Mumbai is on N 19° 53' 47" - E 75° 23' 54". It forms the part of the vast Deccan plateau of India. The total area of Mumbai is of 200 km². It is bounded by the Akola on the North, Palghar on the East, Thane on the South-west. The population until 2009 is 1,210,000. The population density is 6,051 souls /km² Ratnagiri is the main river. Mumbai is situated at an average height of about 300-650 m. above mean sea level, gradually sloping from West to East and is traversed by hill ranges originating from the the Satpudas in the North. Geology and soil The geological formations of the regions are characterized by the Deccan traps (Upper cretaceous to lower Eocene). The granitic rocks have given rise to red as well as black cotton soils. Major part of the region has deep black soil derived from the trap rock. Certain variations occur due to exposure and protection. A mixture of laterite and black soil, for example, is encountered in the eastern parts together with sandy soil along river banks. Most of the hill tops are bare or covered by coarse gravel, while the low lying area accumulates clay and loam.

1.4 SOIL CHARACTERISTICS

Chemically the soils are below normal and alkaline in reaction. The pH range from 6.5 to 8.5, soluble salts as measured in terms of Electrical Conductivity and is in normal range with an average EC of 0.3 – 0.67 μ mhos/cm. Organic carbon content of most of the soils mostly low to medium. The phosphorus is within the medium range. Zinc available to the crops varies from 0.8 to 6.4 ppm. Thus, the soils in general, are rich in calcium and magnesium carbonates and are deficient in nitrogen and phosphorus. This chemical composition is mainly responsible for cracking of the soil during summer.

1.5 GOVERNMENT LEGISLATIONS AND RULES

Maharashtra Pollution Control Board is enforcing to implement various environmental enactments for the protection of environment. Due to rapid population growth, urbanization and industrialization all our valuable natural resources are depleting at an alarming rate. Apart from the above sources, there are many waste generating sources which ultimately lead to environmental pollution. Maharashtra Pollution Control Board at their different Regional and Sub- regional level grants consents/authorizations for prevention and Control of pollution. The rule and regulations i.e. Legislations and notifications which is implementing by the Board is as follows:

- 1) Water (Prevention and Control of Pollution) Act, 1974
- 2) Air (Prevention and Control of Pollution) Act, 1981
- 3) Water (Prevention and Control of Pollution) Cess Act, 1977
- 4) Environmental (Protection) Act, 1986
- 5) Hazardous Wastes (Management and Handling) Rules, 1989 and amendments thereto
- 6) Recycling Plastic (Manufacture and Uses) Rules, 1999
- 7) Municipal Solid Waste (Management and Handling) Rules, 2000.

Although the Board has a wide range of functions to perform, the priority areas are identifying the polluting sources, ensuring quick disposal of applications for consent to establish/operate and for authorization for hazardous waste disposal under the three relevant acts, monitoring sources of pollution and environmental quality, checking compliance to standards by polluters and taking legal action against defaulters (MPCB web site).

1.6 AIMS AND OBJECTIVES OF THE WORK

The present work was aimed towards the assessment of effects of solid waste dumping on the ground water quality of the Deonar and surrounding areas and to develop and assess composting of municipal solid waste using efficient microorganisms in shorter period of time to minimize the risk of pollution of water bodies. The work has been carried out in two sections, which are briefly outlined as below.

I. Determination of groundwater quality at Deonar dumping site In the present investigation a detailed seasonal evaluation of the ground water quality with respect to its physicochemical and bacteriological status has been under took for a period of two years i.e. 2007 and 2008, to study the effects of solid waste dumping on the ground water quality at Deonar site. The Water Quality Index (WQI) of the selected water samples was assessed.

II. Studies on microbiological composting of Municipal Solid Waste (MSW) at Deonar Studies in this section were carried in two parts:

Part-I: Development of Beneficial Microbial Consortia (BMC) for accelerated aerobic composting of the Municipal Solid Waste: In this section of the investigation, attempts were made to search for suitable microorganisms capable of carrying out organic waste conversion under aerobic conditions at a rapid pace. The microorganisms were screened from the available natural sources like soil. A consortium of bacteria and fungi both thermophilic and mesophilic is developed.

Part-II: To assess the effectiveness of developed consortia In this section of the study the developed BMC was thoroughly assessed for its effectiveness in the process of accelerated aerobic composting of the Municipal Solid Waste (MSW) in a shorter period of the time as compared to natural composting. Attempts were also made to study the utilization of distillery spent wash as moisturizer during the composting and its effects on the composting process and quality of the final compost. The final composts obtained were assessed for their chemical composition and comparison was made between compost obtained with consortia, without consortia and that obtained with spent wash.

**Leachate flowing
from the MSW**



**A nullah flowing
near the MSW
dump site**



**The leachate
flowing in to
the water body**



Fig 1.4: MSW dump site near Deonar

1.7 SCOPE OF THE PRESENT WORK

Prolonged exposure to dangerous toxic ambient air, water and soil in and around MSW dumpsite area could lead to severe health hazards to living beings. Hence, we are facing a great challenge by trying to reduce the impact of MSW on the environment because lack of education, public policy and civil action. The goal is to achieve an integrated solid waste management, in order to go towards a sustainable future. The main objective of the study is to concentrate on the physical analysis of solid waste in order to study generation of solid waste in the particular area. Hence it is necessary to study the physical and chemical analysis of water and soil to see how much it is being polluted.

II. RELATED WORK

The concept of image inpainting was first introduced by Bertamio et al. [1]. The method was inspired by the real inpainting process of artists. The image smoothness information interpolated by the image Laplacian is propagated along the isophotes directions, which are estimated by the gradient of image rotated by 90 degrees. Exemplar Based method proposed by Criminisi et al. [2] used a best exemplar patch to propagate target patch including missing pixels. This technique uses an approach which combine structure propagation with texture synthesis and hence produced very good results. In [3], the authors decompose the image into sum of two functions and then reconstruct each function separately with structure and texture filling-in algorithms. Morphological technique is used to extract text from the images presented in [4]. In [5], the inpainting technique is combined with the techniques of finding text in images and a simple algorithm that links them. The technique is insensitive to noise, skew and text orientation. The authors in [6] have applied the CCL (connected component labelling) to detect the text and fast marching algorithm is used for Inpainting.

The work in this paper is divided in two stages. 1) Text- Detection 2) Inpainting. Text detection is done by applying morphological open-close and close-open filters and combines the images. Thereafter, gradient is applied to detect the edges followed by thresholding and morphological dilation, erosion operation. Then, connected component labelling is performed to label each object separately. Finally, the set of selection criteria is applied to filter out non text regions. After text detection, text inpainting is accomplished by using exemplar based Inpainting algorithm.

III. METHODOLOGY

METHODS

The physico-chemical analysis was done for four years at all the six stations selected for the present study. Six samples were collected in alternate months in a year. A total of 144 samples were collected during the study period from these six stations. The parameters studied were: pH, total dissolved solids, total hardness, chlorides, nitrates, sulphates, phosphates, phenols, cyanide, iron, zinc, nickel, copper, chromium and cadmium. Standard procedures of Bureau of Indian Standards (2012) were adopted for analyses of the parameters. The samples were collected in one litre polyethylene bottles. All the parameters were analyzed within 24 h after collection of samples. The estimated values of the parameters were expressed in mg/l, except where specifically stated. The monthly and annual means and standard deviations were calculated for each parameter and were mentioned in the respective tables.

3.1 Physico-chemical analysis

The monthly and annual means and standard deviations were calculated for each parameter and were mentioned in the respective tables.

1. pH @ 25°C
2. Total Dissolved Solids & Total Suspended Solids
3. Chloride
4. Total hardness
5. Nitrate
6. Sulphate
7. Iron
8. Zinc

1. pH (potentio Hydrogeni)

The digital pH meter model SensION+ pH3 by HACH instrument after calibrating at 4.0, 7.0 and 9.25. 100 ml of water sample was taken in a beaker and stirred slowly, then the electrode was dipped into the sample. After 5 seconds, the value displayed on LED screen which was recorded directly

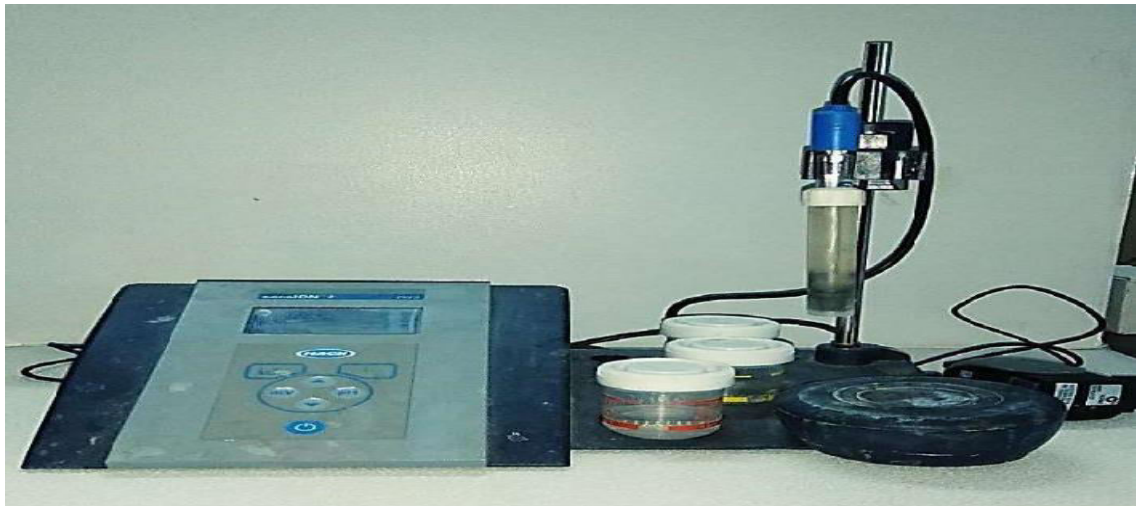


Fig 1.5: SensION+ pH3 by HACH

2. Total Dissolved Solids (TDS):

A two step process was followed as described in the NEERI Manual. First the total solids were estimated followed by total suspended solids. By deducting the total suspended solids from the total solids, the total dissolved solids were estimated.

a. Total Solids:

A clean evaporating dish was ignited at 550° C in a Muffle furnace for one hour. Then dish was cooled weighed (W1) and kept in a desiccator. 50 ml of sample was transferred to the dish and evaporated to dryness on a steam bath. After complete evaporation the sample was oven dried at 103°C for one hour. The drying was repeated at 103°C till constant weight was obtained (W2). Total solids mg/L. = $(w_1 - w_2) * 1000 / \text{ml of sample}$

b. Total Suspended Solids (TSS):

A filter disk was placed on the bottom of a clean Gooch crucible. 20 ml distilled water was poured and vacuum was applied. The crucible was oven dried at 103°C for one hour and then inserted in a desiccator. The crucible was weighed (W1) and placed on a suction unit. 25 ml sample was poured using a pipette. The pipette was washed with distilled water and the washings were also poured into the crucible. After filtration crucible was oven dried at 103°C for one hour and then cooled.

Then the Total Dissolved Solids were estimated as follows:

Total Dissolved Solids (TDS) mg/l = Total Solids — Total Suspended Solids

3. Chlorides:

50 ml of water sample was taken in a distilled water rinsed 250 ml conical flask using a precalibrated 50 ml bulb pipette. One ml of Potassium chromate indicator was added using a 2 ml graduated pipette. Titrated with 0.0141 N silver Nitrate standard solution using a 50 ml graduated burette with a white porcelain tile underneath the conical flask till a reddish-tinge precipitate appears through the sample solution, which is the end point of the titration. The burette reading was noted down (Consumption volume of standard silver nitrate solution). A blank titration with 50 ml of distilled water was also carried out and noted the reading.

4. Total Hardness (mg/l):

50 ml of the sample was taken in a conical flask to which 1 ml of buffer and 1 ml of 1ml of inhibitor were added. The contents were mixed well and a pinch of EBT indicator was added. The contents were stirred well and titrated against 0.01 M EDTA till wine red changed to blue. A reagent blank was also taken. The vol. of EDTA rundown was recorded. Calcium hardness: 50 ml of sample was taken in a conical flask and 1 ml of Sodium hydroxide was added then a pinch of Murexide indicator was also added and the contents were mixed well. The contents were titrated against 0.01 M EDTA till the colour changed to purple. The vol. of EDTA rundown was recorded.

Calculation

Total hardness as CaCO_3 mg/l = $C \times D \times 1000$ /ml Sample

Where, C= volume of EDTA required by sample

D=mg CaCO_3 equivalent to 1 ml EDTA titrant

b. Calcium hardness CaCO_3 as mg/l = $C_1 \times D \times 1000$ / ml sample

Where C_1 = volume of EDTA used by sample

D =mg CaCO_3 equivalent to 1 ml EDTA titrant

c. Magnesium hardness = Total hardness as CaCO_3 — Calcium hardness as CaCO_3 , mg/l

d. Alkaline (Carbonate) hardness and non-alkaline (non — carbonate) hardness

These types of hardness can be calculated from total hardness and total alkalinity as follows:

1. If total hardness as CaCO_3 > total alkalinity as CaCO_3

Then, a. Alkaline hardness = Total hardness — Total alkalinity

b. Non-alkaline hardness = Total hardness — Total alkalinity

2. If total hardness as CaCO_3 < total alkalinity as CaCO_3

Then, a. Alkaline hardness = Total hardness

b. Non alkaline hardness = Nil

5. Nitrates Nitrogen (as NO_3N)

Nitrates of the sample were estimated by using phenol Disulphonic Acid (PDA) method. 150 ml of sample was taken in a beaker and 3 ml of aluminium hydroxide was added to remove colour. Then the sample was stirred well, allowed to settle and filtered. The filtrate was taken for further process. The nitrites were removed using permanganate. 1 ml sulfamic acid was used to suppress NO_2^- . The chlorides were removed by precipitation by adding Silver Sulphate. The sample was taken in a beaker and the contents were evaporated to dryness in a water bath. Then the residue was dissolved in 2 ml of Phenol Disulphonic Acid reagent. The contents were transferred to Nessler's tubes. Then 8 ml of KOH was added. EDTA was added to dissolve the precipitate. Then the contents were filtered and made up to 100 ml. A blank was also prepared using distilled water. Then the colour developed was read at 410 nm in a UV — Visible spectrophotometer (Elico Model SL 177) The NO_3^- was recorded as N in mg/l. A calibration curve was also prepared using known concentrations derived from stock nitrate solution. The stock nitrate solution was prepared by dissolving 721.8 mg anhydrous potassium nitrate and dilute to 1000 ml with distilled water. This solution contained 1 ml 100 mg.

6. Sulphates:

Estimation of Sulphates: (Turbidimetric Method) 1000mg/L. So° stock sulphate solution, 100 mg/L. $\text{So}\%$ working sulphate solutions were prepared. Barium chloride crystals of 20-30 mesh were used. 30g magnesium chloride, 5g sodium acetate, 1.0g potassium nitrate, and 20 ml acetic acid in 500 ml distilled water were mixed and made up to 1000ml buffer solution. A series of standard solutions containing 0 to 50.0 mg/l SO_4^{2-} ; were prepared from standard sulphate solution in 25 ml volumetric flasks. 100 ml of sample was taken in 250 ml Erlenmeyer flask in which 20 ml buffer solution was added and mixed in a stirring apparatus. Barium chloride crystals were added while stirring. The same procedure was adopted for sulphate standard solutions and reagent blank. The turbidity of the solution was measured. A calibration curve was plotted for the concentrations of sulphate in the standards against their corresponding turbidities. To a 20.0 ml of standard sodium carbonate (0.01M) solution, 3 drops of methyl orange indicator was added and diluted to 100 ml with distilled water. The solution was titrated with HCl solution to be standardized with continuous stirring until the color of the solution turned from yellow to pink. The same procedure was adopted for reagent blank. The concentration of HCl was calculated. 20.0 ml of sample was taken without filtration or alteration with which 3 drops of phenolphthalein indicator solution was added and diluted to 100 ml with distilled water. The solution was titrated using standardized HCl, until the pink color of the solution disappears. Next, 3 drops of methyl orange indicator was added. The titration was continued slowly with continuous stirring until the solution color

changed from yellow to pink. The same procedure was adopted for blank also. Total alkalinity (T-Alkalinity) was calculated from the titer values.

7. Estimation of Iron as Fe:

Sample Preparation The standard solutions were prepared by appropriate dilution of the following stock metal solutions with distilled water containing 1.5 mL conc HNO₃/L. The reagents of AR Grade were used. 50 ml water sample is added with 5 ml concentrated metal free nitric acid and digested the content, using EPA method in Micro-wave digestion system Anton Paar along with the distilled water blank. Digested sample and blank were concentrated and made up to 50 ml using standard flask with distilled water. The homogenized sample & blank transferred to pre-cleaned PP bottles. These acid extract samples were analysed for Iron using pre-standardized/ Calibrating Atomic absorption spectrophotometer (GBC — Avantha) in concentration mode and making the absorbance / concentration zero' with blank.

Calculation:

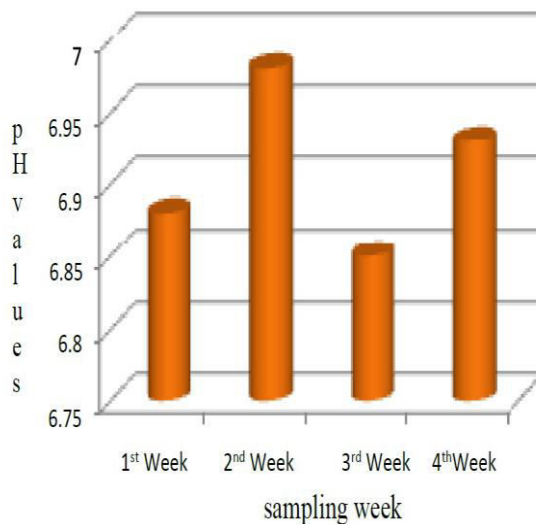
Iron: Concentration from instrument mg/L. x Dilution factor = mg/L Iron as Fe. AAS instrument is standardized with 1.0, 2.0, 3.0, & 4.0 mg/L. standards for Iron

8. Estimation of Zinc:

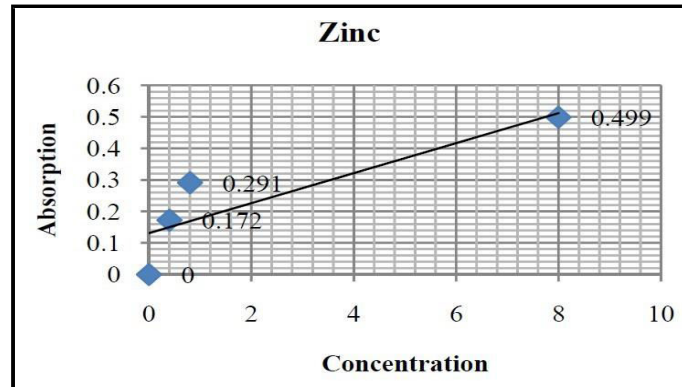
Sample Preparation The standard solutions were prepared by appropriate dilution of the following stock metal solutions with distilled water containing 1.5 ml conc HNO₃/L.. The reagents of AR Grade were used.

Zinc stock solution corresponding to 1000mg/l of Zn Dissolve 0.100 g zinc metal in 0 mL 1+1 HCl and dilute to 1000mL with water; 1.00 mL = 100 lg Zn. Suitable aliquots of solutions were taken for further analysis. Calibration Curve for Zinc Experimental results

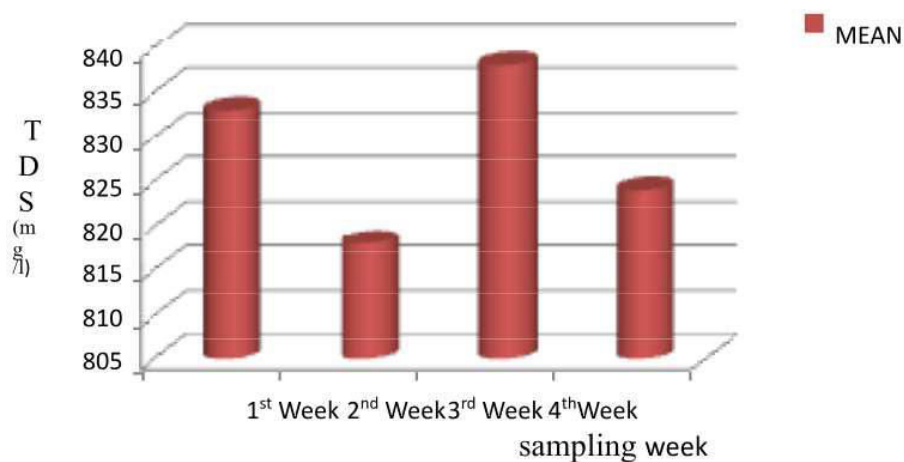
IV. RESULT



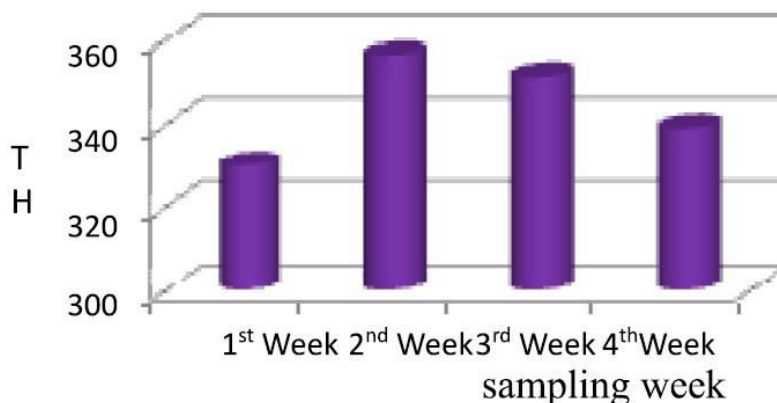
Graph 1.6: Graph showing the annual means of pH of ground water at Gorai (Station I) during the study period



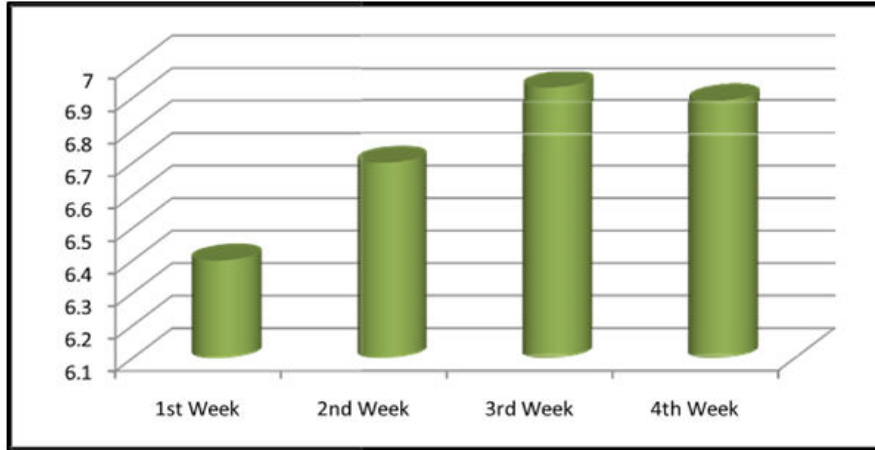
Graph 1.7: showing the annual means of Tot the outskirts of Gorai (Station I) during the study period



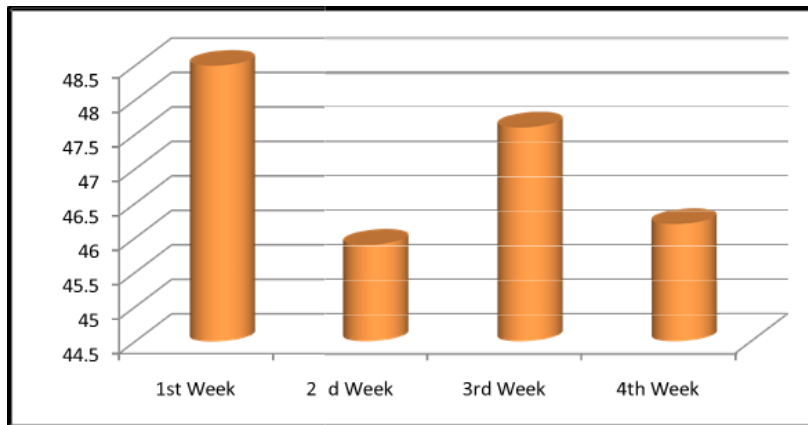
Graph 1.8 : showing the annual means of Concentrations of Chlorides (mg/l) in the ground water at the outskirts of Gorai (Station I) during the study period



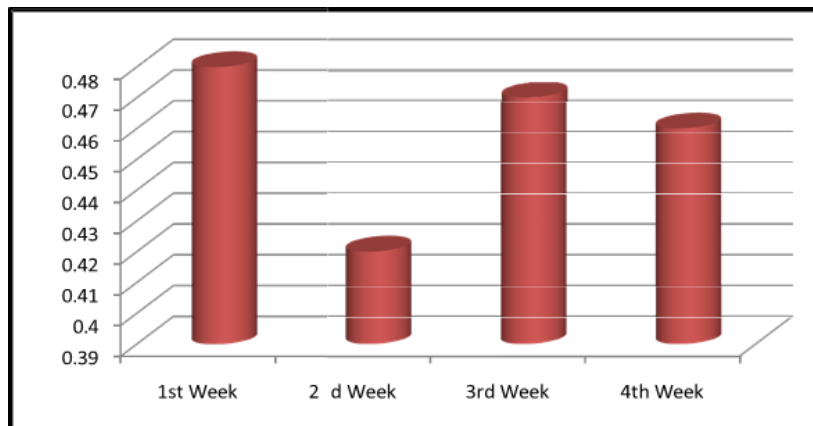
Graph 1.9: showing the annual means of Concentrations of Nitrate Nitrogen (mg/l) ground water at the outskirts of Gorai (Station I) during the study period



Graph 1.10: showing the annual means concentration of Sulphates (mg/l) in the groundwater at the outskirts of Gorai (Station I) during the study period



Graph 1.11: showing the annual means of Concentrations of Iron (mg/l) in the ground water at the outskirts of Gorai (Station I) during the study period



(Station I) during the study period

Graph 1.12: showing the annual means of Concentrations of Zinc (mg/l) in the ground water at the outskirts of Gorai(Station I) during the study period

V. CONCLUSION

The investigation of groundwater around MSW dumpsite of Mumbai reveals that 100% of samples during post-monsoon were unfit for drinking and other domestic purposes on the basis of TDS and other parameters. During post-monsoon period all physical and chemical parameters of all ground water samples were abnormally increased which could be due to the leaching of MSW from the open landfills. This indicates that domestic waste leads to more critical problem to the peoples who are living nearby the dumpsite and suggests lack of sufficient sanitary facilities due to uncontrolled urbanization. The highest correlation was found between EC and chloride. The high content of chloride comes mainly from paint and chemical industries. Trace metal study indicates that during both pre and post-monsoon, concentration of Fe was high in many stations. Pb, Mn and Cr were found to be high in all samples. The findings clearly indicate that the ground water and soil of the study area is heavily polluted especially with toxic heavy metals besides high TDS and other inorganic major constituents. The findings of the study also indicate that there is a need for proper industrial planning and the safe disposal of industrial and urban waste which would otherwise lead to severe environmental degradation.

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