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Impact of Solid Waste Disposal on Ground Water Quality in Different Disposal Site at Jaipur, India

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Abstract

This research paper here to present to examine the adverse effect of dumping of solid waste at disposal site on ground water quality at various disposal site at Jaipur city, India. This effect on ground water causes due to the unsystematic or unscientific dumping of solid waste. The water, which already presents in the waste, generates with the biodegradable waste or due to the infiltration of water by rainfall. This water which generates or occurs due to that process pours in the soil and causes contamination with ground water. And that contamination causes the water pollution and changes in the some parameters of the ground water. However, most of the parameters tested fall within WHO recommendation while some are not. The physical and chemical parameters such as temperature, pH, Hardness, Electrical Conductivity, Total Dissolved Solids, Total Suspended Solids were studied using various analytical techniques. To control the further pollution of ground water the open area dumping of the solid waste should be prohibited by the municipals authorities.

Keywords: Leachates, Ground Water, Landfill, Pollution, Water Quality.

Introduction

Rapid industrialization and economic development in India have led to higher urbanization. The proportion of population living in urban areas has been increased from 17.35% in 1951 to 27.8% in 2001 and 31.30 in 2011 and 31.66 in 2012. The avg. Growth of urban population in India is 2.4%.Like many cities in India, Jaipur is undergoing rapid development. The country's GDP has been increasing at 8% per year. In Jaipur, the population was 2.34 million according to the 2001 census, and is now estimated to be over 3.5 million. The process of development involves effects of globalization such as a growing economy, imported resources, information and technology sharing, and more extensive infrastructure.

Jaipur's daily production of solid waste is around 1340 MT/day. Of that amount, 250-270 MT remain on the streets, meaning lifting efficiency is around 80%. The per capita solid waste production per day is 385 g, which with an average family size of five results in 1.92 kg per day. There are no data published on the composition of waste in Jaipur in particular, although the figures for India in general are a fairly accurate representation for Jaipur as well.

It has clearly mentioned that population of the city has increased by 28% in 2001 to 2010 while the total municipal solid waste generated has increased by 16%.

Table 1 and fig 1 shows the trend of waste generation in Jaipur as in Kg per capita per day in 2001, 2004, 2010 and 2013-14(Estimated).

Table 1: Waste Generation Rate (Kg/C/Day)

S. No	Year	Waste generation rate (kg/c/day)	Source
1	2001	0.48	JMC, 2001
2	2004	0.39	CPCB, 2004
3	2010	0.44	JMC, 2011
4	2013-14	0.478	Estimated From Data

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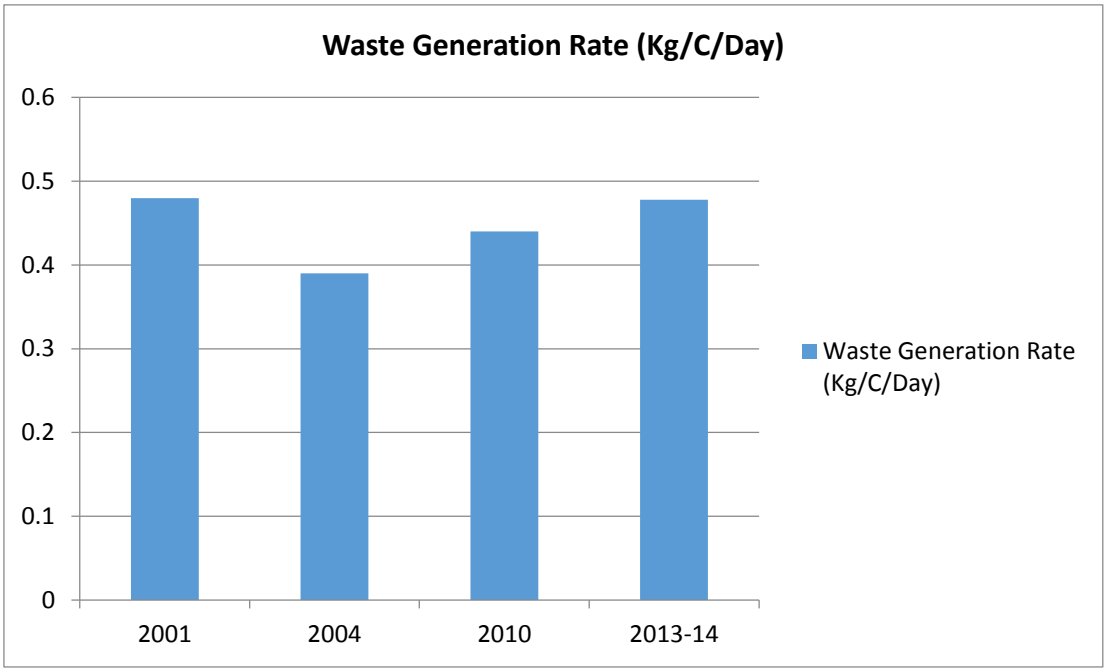

Figure 1: Trend of Waste Generation Rate in Kg/C/Day (C = Capita)

The population of Jaipur city in increasing every year and due to the population growth the amount of solid waste generation is increasing every day. The solid waste is a heterogeneous mixture of various kinds of solid waste, and may include biodegradable food waste called garbage, and the solid waste like paper, glass, metal items, rags, etc., called rubbish. The garbage includes all sorts of putrescible organic waste obtained from kitchens, hotels, restaurants, etc. All waste food articles, vegetable peelings, fruit peelings, etc., are thus includes in this term. These wastes are organic in nature, and thus, likely to decompose quickly, producing foul odours and health hazards. The density of garbage usually varies between 450 to 900 kg/m^3.

Table 2 shows the physical characteristics of the MSW in Jaipur city as per the report of CPCB, 2000.

Table 2: Physical Characteristics of MSW in Jaipur (% by Weight) (CPCB, 2000)

City	Paper	Textile	Plastic	Glass	Ash, Fine Earth and Others	Compostable Matter
Jaipur	6.0	2.0	1.0	2.0	47.0	42.0

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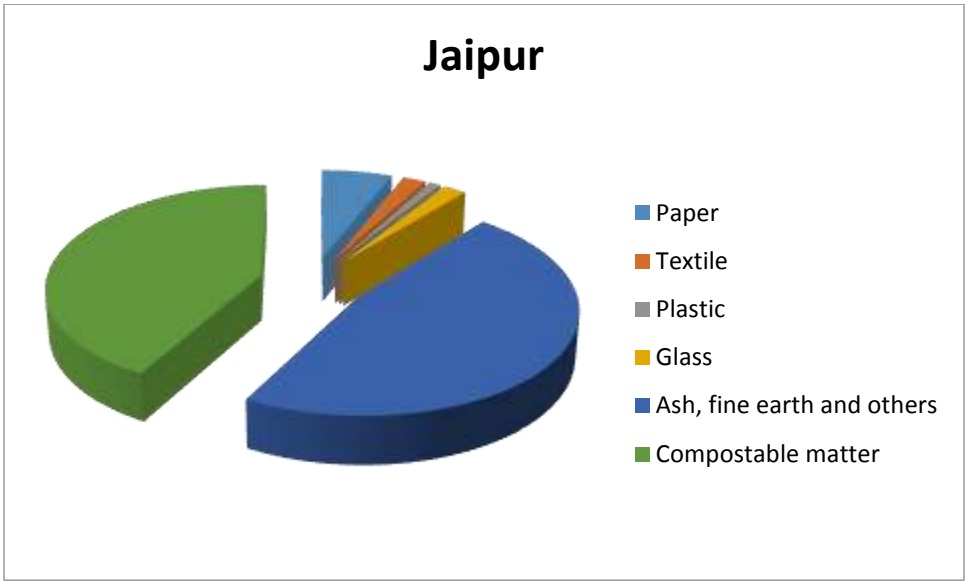

Figure: 2 Trend of MSW in Jaipur (% by weight) (CPCB, 2000)

Solid waste land filling and open area dumping are the most common method of disposal of the solid waste. There are three dumped site nearer to the Jaipur city, where the all Jaipur city solid waste dumped are Mathura das pura, Langadiyawas and Sewapura. These three dumped sites are open dumpsites. In open dumped site no need of equipment or machineries required, are of less operating cost and lack of expertise for leachate collections. Open dumps are generally smelly and unsightly. These dump sites attracts the animals, rats, pigs, insects and other pests. In the solid waste many different type of chemicals are presents like detergents, inorganic chemicals, toxics, 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. During the season of rainfall the infiltration of water slightly occurs, and the water also available in waste and that water find its way to the ground water and causes the contamination. In India more than 60 million population suffer from fluoridise by drinking fluoride contaminated water. Therefore the present study was done for the investigation of the impact on ground water quality due to the different-different dumping site of solid waste at Jaipur.

Impact of Solid Waste on Health

Due to the unscientific or unsystematic disposal of solid waste include the population areas where there is no proper disposal method is used, especially pre-schools children; waste workers; and workers in facilities producing toxic and infectious material. Increases in risk of injuries, infections are also due to the uncontrolled solid waste. Various types of the infections and chronic disease also causes due to the direct handling of solid waste. Waste from agriculture and industries can also cause serious health risks. Candid dumping of untreated sludge in rivulets, briny's, moreover ponds consequences in the gathering of harmful spirits in the grub cable washed-up the annuals also carnals that meal on it. Disposal of clinic also different medicinal consumption exacts particular complaisance subsequently this can make primary well-being dangers. This sewage produced from the infirmaries, shape heed centres, medicinal laboratories, moreover study centres such as discarded syringe taunts, swathes, scrubs, smears, plus further varieties of infectious chaff are frequent disposed beside the typical stop-infectious dross.

Disease

Exact chemicals if released untreated, e.g. cyanides, mercury, further polychlorinated biphenyls are highly poisonous moreover revelation can escort to ill or dissolution. Any studies hold detected excesses of tumour in habitants vulnerable to hazardous destroy. Numerous studies enjoy been carried external in various members of the macrocosm to originate a association among shape moreover hazardous ravage.

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Experimental

Study Area

Jaipur is located at the latitude 26° 55' N and longitude 75° 49' E. The city had disposal sites at Sewage farm and Jagatpura, which has been abandoned now. And now the disposal is done at three major disposal site which is located outside the Jaipur city are as follows:

1. Mathura-Das-Pura – Area: 176 Bigha – 17 km
2. Sewapura Site – Areas: 200 Bigha – 20 km
3. Langadiyawas – Area: 483 Bigha – 21 km

1. Mathura-Das-Pura: This site is located in the east direction of the city. Total area for the site was 176 Bighas. This is the oldest site and about 17 Km from the main city. Approximately, 300 to 400 TPD of garbage is being dumped every day at this site.
2. Langadiyawas: This site is located in the east direction of the city, 3 to 4 Km from the Mathura-Das-Pura. The total area of this landfill site is 483-bigha
3. Sewapura: This site is located at 20 Km from the main city in North direction on Jaipur-Delhi road. Its total area is 200-bigha. MSW of 17 wards of the Vidyadhar Nagar zone and 5 to 6 wards of Civil Line zone which comprised of half of the total Civil Line zone dumped to this site. Approximately, 200 to 300 TPD of garbage was being gone every day to this site.

The sample of water collected from the various area of these site. The sample which was collected is mentioned as S-1, and S-2, etc., the water sample site details are as follows:

Table 3: Location of Sites

Site No	Site Location and their Description
S 1	Tube well of Shri Ram Sahay Sharma, At Langadiyawas, within 500 metres, in East direction from Landfill site
S 2	Tube well of Shri Raghunath Meena in west direction from the Mathuradaspura Landfill Site
S 3	Surface water, Mathuradaspura, Tehsil- Jamwa Ramgarh, Distt- Jaipur
S 4	Tube well of Shri Mangal Ram Meena in south direction from Mathuradaspura Landfill site
S 5	Tube well of Shri Chotu Meena in south direction from Mathuradaspura Landfill Site
S 6	Tube well of Shri Ram Kotwala Ji, Dwarka Farm, Roop ki Nangal
S 7	Hand pump, Dhani Nimba Wali, Mathuradaspura
S 8	Open well of Sh. Chhaju Ram Saini, Dhani Nimba Wali, Mathuradaspura
S 9	Surface Water, Sewapura
S 10	Tube well of Shri Gopal Yadav at Sewapura

Preparation of Water Sample

The water samples were collected from 10 different locations of the namely S-1 to S-10 (Table-3) surrounding the MSW dumping area. The water samples were collected in well cleaned autoclaved bottles. The sample bottles brought to the lab and analysed with standard methods.

Analysis

The samples were then later analysed for physicochemical parameters and heavy metal content. pH determination was carried out by using digital pH meter. Temperature(°C), Total Dissolved Solid(mg/L), Total Hardness(mg/L), Electrical Conductivity (µS/cm). The physiochemical analysis of

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water samples were carried out as per to standard methods.

pH

pH is measured by a pH meter using glass electrode which generates a potential varying linearly with the pH of solution in which it is immersed. The pH value of water indicates the negative log of hydrogen ion concentration present in water.

$pH = -\log H^+$; or $H^+ = (10)^{-pH}$ ..... (i)

Electrical Conductivity

A simple conductivity meter with dip-type cell is used for this purpose. The instrument and cell are calibrated using 0.005M KCl solution (conductivity = 654 µmho cm^{-1}).

Electrical Conductivity (specific conductance), $k = \frac{1}{R} . \frac{A}{l}$ ..... (ii)

TDS

Total dissolved solids (TDS) is a measure of the combined content of all inorganic and organic substances contained in a liquid in molecular, ionized or micro-granular suspended form. Generally the operational definition is that the solids must be small enough to survive filtration through a filter with two-micrometer (nominal size, or smaller) pores. The two principal methods of measuring total dissolved solids are gravimetric and conductivity.

Electrical conductivity of water is directly related to the concentration of dissolved ionized solids in the water. Ions from the dissolved solids in water create the ability for that water to conduct an electrical current, which can be measured using a conventional conductivity meter or TDS meter.

The relationship of TDS and specific conductance of groundwater can be approximated by the following equation:

$TDS = k_e EC$ ..... (iii)

Where TDS is expressed in mg/L and EC is the electrical conductivity in µS/cm at 25° C. The correlation factor k_e varies between 0.55 and 0.8.

Hardness

Hardness results from the presence of divalent metallic actions, of which calcium and magnesium are the most abundant in ground water. These ions react with soap to form precipitates and with certain anions present in the water to form scale. Because of their adverse action with soap, hard waters are unsatisfactory for household cleansing purpose; hence, water-softening processes for removal of hardness are needed.

The hardness in the water is derived from the solution of carbon-di-oxide, released by bacterial action in the soil, in percolating rain water. Low pH conditions develop and lead to the solution of insoluble carbonates. Impurities in limestone, such as sulphates, chlorides and silicates, become exposed to the solvent action of water as the carbonates are dissolved so that they also pass into solution. Thus, hard water tends to originate in areas where thick topsoils overlie limestone formations.

Thus, $H_T = Ca \times \frac{CaCO3}{Ca} + \frac{CaCO3}{Mg} \times Mg$ ..... (iv)

Where H_T, Ca and Mg are measured in milligrams per lit. and the ratios of equivalent weights. Eq. (iii) reduces to

$H_T = 2.5\ Ca + 4.1\ Mg$ ..... (v)

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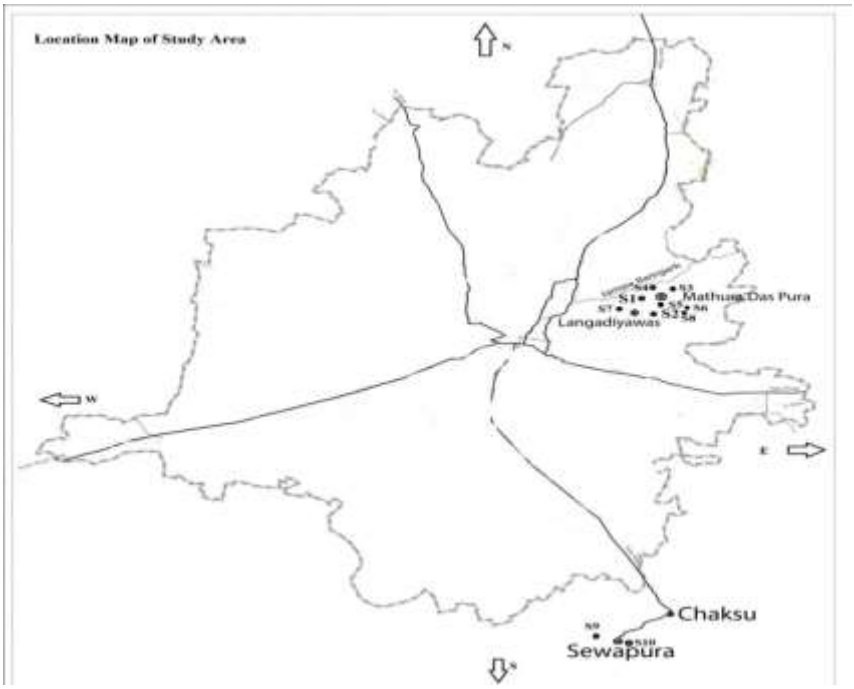

Fig: 3 Map Showing the Location of Sample Area of Jaipur

Results and discussion

The results shows the pH ranges from 7 to 8.7 (Table 5). The total dissolved solids were high in range from 24 to 1828.4 mg/l. Total Hardness from 37 to 828 mg/l. Heavy metals were analysed and their presence was found in traces. The physicochemical analysis of water samples give varied results. The pH was found in normal limits of W.H.O. and other organisations. The above results are higher than acceptable limits of monitory organisation and indicate the effect of dumping of municipal solid waste in the study area as the ground water quality is slowly deteriorating. The study reveals that the ground water may become completely unfit for the purpose of drinking and irrigation. it can easily be observed that pH value is higher at S-3 only and at others are under acceptable places, pH value beyond the set norm in the water will affect the mucous membrane and water supply system. While on the other hand total dissolve solid is higher at all the 9 sites from the standard set maximum limit, beyond this limit palatability decreases and may cause gastro intestinal irritation. Total hardness as $CaCO_3$ is higher at S-8 encrustation in water supply structure and adverse effected on domestic uses.

The standard values of ground water quality recommended by various organisations are given in Table 4.

Constituents	**BIS 1991**		**WHO 1984**	
	HDL	**MPL**	**HDL**	**MPL**
pH	6.5-8.5	8.5-9.2	7.0-8.5	6.5-9.2
EC				1400
TDS	500	1500	500	1500

(All the parameters are expressed in mg/l except pH)
Abbreviations: HDL: High Desirable Limit, MPL: Maximum Permissible Limit

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Results Table

Table 5: Comparison of components level in ground water collected from different sites with the Standard Measure

Component as mg/l	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**	**S 6**	**S 7**	**S 8**	**S 9**	**S 10**
pH	7.98	7.07	8.66	7.02	7.14	7.36	8.12	7.73	7.21	7.3
Electrical Conductivity (µs/cm)	1.34	1.44	1.6	1.9	2.1	1.5	1.8	1.54	2.2	3.5
Temp. in °C	28	30	27	28	30	26	29	28	25	27
Total Suspended Solids(mg/L)	75	69	53	36	47	42	71	31	65	41
Hardness (total) as CaCO3	372	364	280	784	364	160	140	828	600	330
Total Dissolved Solids (mg/L)	2493	1307	1351	1258	1289	901	576	316	1828.4	1240.2

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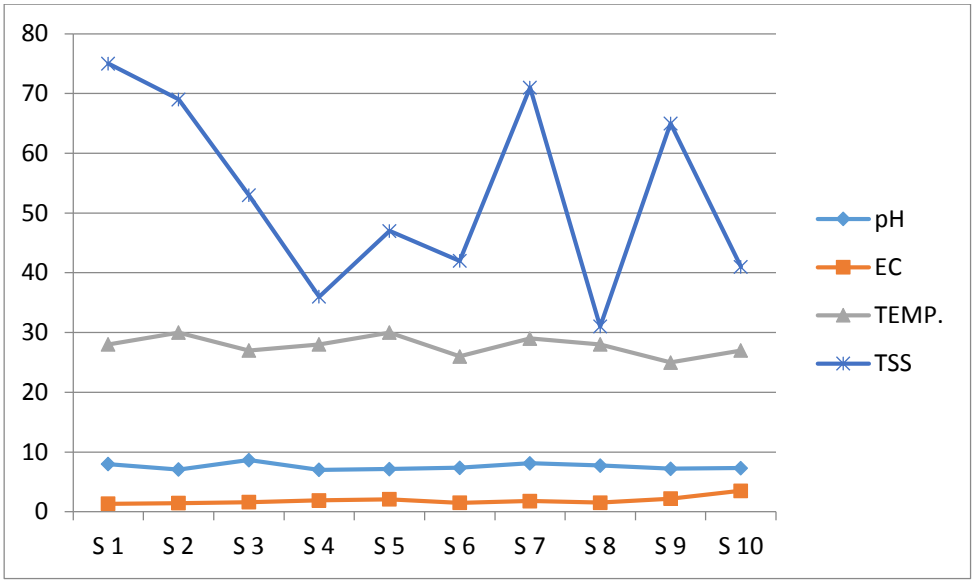

Fig: 4 Showing Analysis of Ground Water at Different-Different Sites

Table: 6 shows the Characteristics for Drinking Water & Health Hazards on Human Health and the consequences if the substance goes beyond the permissible level.

Table: 6 Characteristics for Drinking Water & Health Hazards on Human Health

S. No	Substance or Characteristic	Requirement (Desirable level)	Undesirable Effect Outside the Desirable Limit
1	pH value	6.5 to 8.5	The water will affect the mucous membrane and/or water supply system
2	Hardness (total) as $CaCO_3$ (mg/l)	300	Encrustation in water supply structure and adverse effects on domestic use
3	Total Dissolved Solids mg/l	500	Beyond this palatability decreases and may causes gastro intestinal irritation

Conclusion

It can be thus concluded readily that the dumping of town strong dwindle should entirely be stopped in the peruse environs as it is slowly harmful the world. The leachates formed slowly seep in the bottom moisten index plus might finally dirty the earth beverage. Intoxicated Chloride moreover fluoride appreciates in the stream try's hardly solitary fabricate it sick for drinking only further crusade numerous debilities. The towering weights of chloride further fluoride might be fitting to leaching of harmful bodies of urban strong fritter in to the estate irrigate appendix. Chloride conc. if more than 250 mg/l, causes salty taste. Fluoride concentration more 1.5 mg/l if consumed for long period causes dental and skeletal fluorosis. The disease causes complete damage of bones and teeth. The nitrate values are very low. High conc. of nitrate i.e. above 45 mg/l results in "Methmoglobinemia" in infants. Thus the need of the hour is to save water from being polluted by moving away the municipal solid waste dumpsite from the area and develop a properly managed landfill site.

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