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IMPACT OF BILASPUR OPEN DUMPING SITE ON THE QUALITY OF GROUND WATER IN THE VICINITY

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ABSTRACT

This research was carried out to study the impact of an open dumpsite on the quality of shallow underground water in Bilaspur city. The samples of ground water were collected from three wells, located at various distances (100-500m) from the dumping site, and analyzed for various physio-chemical parameters such as temperature, pH, hardness, electrical conductivity, total dissolved solids, total suspended solids, alkalinity, calcium, magnesium, chloride, nitrate, sulphate, phosphate and the metals like sodium, potassium, copper, manganese, lead, cadmium, chromium, nickel. It has been found that most of the parameters of water are not in the acceptable limit in accordance with the IS 10500 Drinking Water Quality Standards. It is concluded that the contamination is due to the solid waste materials that are dumped in the area.

Keywords: groundwater contamination, open dumping site, bilaspur.

I. INTRODUCTION

Open dumpsite approaches as solid waste disposal method is a primitive stage of solid waste management in many parts of the world. It is one of the most poorly rendered services by municipal authorities in developing countries as the systems applied are unscientific, outdated and inefficient. Solid waste disposal sites are found both within and on the outskirts of developing urban cities. With increase in the global population and the rising demand for food and other essentials, there has been a rise in the amount of waste being generated daily by each household. This waste is ultimately thrown into municipal disposal sites and due to poor and ineffective management, the dumpsites turn into sources of environmental and health hazards to people living in the vicinity of such dumps. One of the main aspects of concern is the pollution caused to the earth—be it land, air or water. Open dumps are unsightly, unsanitary, and generally smelly. They attract scavenging animals, rats, insects, pigs and other pests. Surface water percolating through the trash can dissolve out or leach harmful chemicals that are then carried away from the dumpsites in surface or subsurface runoff. Among these chemicals heavy metals are particularly insidious and lead to the phenomenon of bioaccumulation and bio magnifications. These heavy metals may constitute an environmental problem, if the leachate migrates into the ground water. The presence of bore well at the landfill sites to draw ground water threatens to contaminate the ground water.

A water pollutant is a chemical or physical substance present in it at the excessive levels capable of causing harm to living organisms. The physical hazards are the dissolved solids and suspended solids. The chemical hazards are the copper, manganese, lead, cadmium, phosphate, nitrate etc. As the public health concern, the ground water should be free from physical and chemical hazards. The people in and around the dumping site are depending upon the ground water for drinking and other domestic purposes. The soil pollution arises due to the leaching of wastes from landfills and the most common pollutant involved is the metals like copper, lead, cadmium, mercury etc. The Contamination of ground water and soil is the major environmental risk related to unsanitary land filling of solid waste.

IMPACTS OF SOLID WASTE ON HEALTH

The group at risk from this unscientific disposal of solid waste includes-the population in areas where there is no proper waste disposal method, especially the pre-school children, waste workers and workers in facilities producing toxic and infectious mate rials. Other high risk group includes population living close to the waste dump. In particular, organic domestic waste poses a serious threat, since they ferment, creating conditions favorable to the survival and growth of microbial pathogens. Direct handling of solid waste can result in various types of infectious and chronic diseases with the waste workers and rag pickers being the most vulnerable. The exposure to hazardous waste in dumpsites can affect human health, children being the most vulnerable to these pollutants. Direct exposure can lead to diseases through chemical exposure as the release of chemical waste into the environment leads to chemical poisoning.

II.METHODOLOGY AND METHODS

Study Area: Bilaspur is located at 22.05° N and 82.09° E. It has an average elevation of 262m(860 ft). Bilaspur Land filling dumpsite is surrounded by residential areas in which they are heavily affected by both soil and water pollution through the leach out of hazards from the solid waste.The waste dumped at this site includes domestic waste, e.g. kitchen waste, paper, plastic, glass, cardboard, cloths. Construction and demolition waste consisting of sand, bricks and concrete blocks are also dumped. Further waste from the adjacent poultry market, fish market, slaughterhouse, dairy farm and non-infectious hospital waste are also dumped. The site is non-engineered low lying open dump, looks like a huge heap of waste up to a height of 12-20 m. Trucks from different parts of the city collect and bring waste to this site and dump the waste in irregular fashion. The main waste generated in Bilaspur is from the markets of agricultural products, retail and commercial markets, hospital and nursing homes, slaughter houses, industries and construction and demolition activities.

Collection of samples and their analysis: The water samples were collected from various locations at distance100m - 500m. And they were named W1, W2 and W3 samples. Sample Collection, preservation and analysis were done as per the standard methods.The polyethylene sample containers cleaned by 1 mol/L of nitric acid and left it for 2 days followed by thorough rinsing of distilled water. Two litres of samples were collected for the analysis. The generally suitable techniques for the preservation of samples followed as per Indian standard methods. The pH, Electrical conductivity, Total alkanity, hardness and chloride test were done at the site. Total suspended solids. nitrate, phosphate and sulphate were analysed as soon as possible. The samples for trace metal analysis were acidified with concentration HNO_3 to bring pH < 2.

III. RESULTS AND DISCUSSION

pH: pH is most important in determining the corrosive nature of water. Lower the pH value higher is the corrosive nature of water. pH was positively correlated with electrical conductance and total alkalinity(Guptaa 2009). The reduced rate of photosynthetic activity the assimilation of carbon dioxide and bicarbonates which are ultimately responsible for increase in pH, the low oxygen values coincided with high temperature during the summer month. Various factors bring about changes the pH of water. The higher pH values observed suggests that carbon dioxide, carbonate-bicarbonate equilibrium is affected more due to change in physicochemical condition (Karanth

1987). pH of water samples varies from 5.24 to 6.59. The acceptable limit for the drinking water standard is 6.5 – 8.5. Since W2 does not lie in the limit, it is not suitable for drinking.

ALKALINITY: It is Composed primarily of carbonate (CO_3^{2-}) and bicarbonate (HCO_3^-), alkalinity acts as a stabilizer for pH. Alkalinity, pH and hardness affect the toxicity of many substances in the water. It is determined by simple dil HCl titration in presence of phenolphthalein and methyl orange indicators. Alkalinity in boiler water essentially results from the presence of hydroxyl and carbonate ions. Hydroxyl alkalinity (causticity) in boiler water is necessary to protect the boiler against corrosion. Too high a causticity causes other operating problems, such as foaming. Excessively high causticity levels can result in a type of caustic attack of the boiler called "embrittlement" Total alkalinity values vary from 40 mg/L to 260 mg/L. The desirable limit for total alkalinity is 200 mg/L and the permissible limit in the absence of alternate source is 600 mg/L. The total alkalinity value of water sample W2 is very lower as compared to the standard.

CALCIUM: It is measured by complexometric titration with standard solution of ETDA using Patton's and Reeder's indicator under the pH conditions of more than 12.0. These conditions are achieved by adding a fixed volume of 4N Sodium Hydroxide. The volume of titre (EDTA solution) against the known volume of sample gives the concentration of calcium in the sample. The calcium concentration varies from 107 mg/L to 169 mg/L. The desirable limit for calcium is 75 mg/L and the permissible limit in the absence of alternate source is 200 mg/L.

CHLORIDES: It is measured by titrating a known volume of sample with standardized silver nitrate solution using potassium chromate solution in water or eosin/fluorescein solution in alcohol as indicator. The latter indicator is an adsorption indicator while the former makes a red colored compound with silver as soon as the chlorides are precipitated from solution. Chlorides are not usually harmful to people; however, the sodium part of table salt has been linked to heart and kidney disease. Sodium chloride may impart a salty taste at 250 mg/L; however, calcium or magnesium chlorides are not usually detected by taste until levels of 1000 mg/L are reached. The desirable limit for chloride is 250 mg/L and the permissible limit in the absence of alternate source is 1000 mg/L. All the water samples fall within the limit.

TDS: It is generally considered not as a primary pollutant, but it is rather used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator of presence of a broad array of chemical contaminants. The values for the present water samples vary from 1622 mg/L to 1809 mg/L. The desirable limit for TDS is 500 mg/L and the permissible limit in the absence of alternate source is 2000 mg/L. The TDS levels of the water come within the limit. Total Suspended Solids (TSS) (measure of the mass of fine inorganic particles suspended in the water values) are in between 24 and 42 mg/L.

Nitrate: it is one of the most common groundwater contaminant. The excess levels can cause methemoglobinemia, or "blue baby" disease. Although nitrate levels that affect infants do not pose a direct threat to older children and adults, they do indicate the possible presence of other more serious residential or agricultural contaminants, such as bacteria or pesticides. Nitrate in groundwater originates primarily from fertilizers, septic systems, and manure storage or spreading operations. The permissible limit for the nitrate is 45 mg/L.The water samples are in the range of 22.35 to 26.37 mg/L. All the samples are within the permissible range.

Sulphate :It is measured by nephelometric method in which the concentration of turbidity is measured against the known concentration of synthetically prepared sulphate solution. Barium chloride is used for producing turbidity due to barium sulphate and a mixture of organic substance (Glycerol or Gum acetia) and sodium chloride is used to prevent the settling of turbidity. It can be found in almost all natural water. The origin of most sulphate compounds is the oxidation of sulfite ores, the presence of shales, or the industrial wastes. Sulfate is one of the major dissolved components of rain.

High concentrations of sulfate in the water we drink can have a laxative effect when combined with calcium and magnesium, the two most common constituents of hardness. The sample contains the sulphate concentration in the range of 351 to 487 mg/L. The desirable limit for sulphate is 200 mg/L and the permissible limit in the absence of alternate source is 400 mg/L. The samples W2 and W3 are not suitable for drinking.

Phosphorus: it is usually present in natural water as phosphates (orthophosphates, polyphosphates, and organically bound phosphates). Sources of phosphorus include human and animal wastes (i.e., sewage), industrial wastes, soil erosion, and fertilizers. Excess phosphorus causes extensive algal growth called "blooms," which are a classic symptom of cultural eutrophication and lead to decreased oxygen levels in creek water. The water samples contain 0.11 to 0.16 mg/L of phosphate.

Sodium: It is measured with the help of flame photometer. The instrument is standardized with the known concentration of sodium ion (1 to 100 mg/litre). The samples having higher concentration are suitably diluted with distilled water and the dilution factor is applied to the observed values.It is an essential nutrient. The Food and Nutrition Board of the National Research Council recommends that most healthy adults need to consume at least 500 mg/day, and that sodium intake be limited to no more than 2400 mg/day. This low level of concern is compounded by the legitimate criticisms of EPA's 20 mg/L [Drinking Water Equivalency Level (DWEL) or guidance level] for sodium. The maximum permissible level of sodium is 200 mg/L as per WHO guidelines. The present water is having higher concentration as compared to DWEL Level. The sodium level of water is ranging from 449.8 mg/L to 482.2 mg/L.

Metals

Copper: The desirable limit for copper is 0.05 mg/L and the permissible limit in the absence of alternate source is 1.5 mg/L. The undesirable effect beyond the desirable limit is astringent taste, discoloration and corrosion of pipes, fittings and utensils will be caused. The present water samples are having copper ranging from 0.221 mg/L to 0.478 mg/L. Hence, all water samples are contaminated due to copper and not suitable for drinking.

Manganese: The desirable limit for manganese is 0.1 mg/L and the permissible limit in the absence of alternate source is 0.3 mg/L. Beyond this limit taste and appearance are affected and has the adverse effect on domestic uses and water supply structures. The present water samples are ranging from the 0.142 to 2.360 mg/L.

Cadmium: The permissible limit for cadmium is 0.01 mg/L. Beyond this the water becomes toxic. The samples are in the range 0.010 to 0.014 mg/L, slightly more to the permissible limit.

Nickel: The desirable limit for nickel is 0.07 mg/L as per the WHO guidelines for drinking water quality, 2006. The samples are in between 0.029 to 0.154 mg/L. S2 is beyond the limit.

Lead: The permissible limit for lead is 0.05 mg/L. The water sample has no appreciable concentration of lead and it is found to be below the detection level. The detection level is 0.01 mg/L.

Chromium: The permissible limit for chromium is 0.05 mg/L. The water sample has no appreciable concentration of chromium and it is found to be below detection level. The detection level is 0.03 mg/L.

Mercury: The permissible limit for mercury is 0.001 mg/L. The water sample W1 has the concentration of 0.00087 mg/L and the other two water samples have no mercury content.

TABLE-I: WATER QUALITY PARAMETERS AT BILASPUR SOLID WASTE DUMPING AREA.

Parameters	Ground water W1	Ground water W2	Ground water W3	Requireme nt (Desirable Limit)	Permissible limit in the absence of alternative source	Undesirable effect outside the Desirable Limit
Colour, Hazen units, Max	2	1	3	5	25	Above 5, consumer acceptance decreases

Odour	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	--	--
Taste	Agreeable	Agreeable	Agreeable	Agreeable	--	--
Turbidity, NTU,Max	1.4	0.8	1.1	5	10	Above 5, consumer acceptance decreases
pH value	6.59	5.24	6.56	6.5-8.5	No relaxation	--
Electrical Conductivity@ 25°C, µmhos/cm	2950	3290	3180	--	--	--
Total alkanity as CaCO3,mg/L	260	40	236	200	600	Beyond this limit taste becomes unpleasant
Total Hardness (as CaCO3) mg/L, Max	515	450	669	300	600	Encrustation in water supply structure and adverse effects on domestic use
Calcium mg/L, Max	144	107	169	75	200	Encrustation in water supply structure and adverse effects on domestic use
Magnesium, mg/L,Max	37.6	22.5	60.1	30	100	Encrustation in water supply structure and adverse effects on domestic use
Chloride, mg/L,Max	729	877	795	250	1000	Beyond this Limit,test,corrosion and palatability are affected
Nitrate, mg/L,Max	22.35	26.37	23.41	45	No relaxation	Beyond this methaemoglobinemia takes place
Sulphate, mg/L,Max	351	487	441	200	400	Beyond this causes gastro intenstinal irritation when magnesium or sodium present
Total Dissolved solids, mg/L	1622	1809	1749	500	2000	Beyond this palatability decreases and may cause gastro intestinal irritation
Total Suspended solids, mg/L	24	38	42	--	--	--
Sodium, mg/L	449.8	482.2	451.5	--	--	--
Potassium, mg/L	22.4	8	21.1	--	--	--
Copper, mg/L	0.478	0.388	0.221	0.05	1.5	Astringent taste, discoloration and corrosion of pipes, fitting and utensils will be caused beyond this

Manganese, mg/L	2.360	1.410	0.142	0.1	0.3	Beyond this limit taste/appearance are affected, has adverse effect on domestic uses and water supply structures
Lead, mg/L	BDL	BDL	BDL	0.05	No relaxation	Beyond this limit the water becomes toxic
Cadmium, mg/L	0.010	0.014	0.012	0.01	No relaxation	Beyond this limit the water becomes toxic
Chromium (as Cr6+), mg/l	BDL	BDL	BDL	0.05	No relaxation	May be carcinogenic above this limit
Nickel, mg/L	0.041	0.154	0.029	--	--	--
Phosphate, mg/L	0.16	0.11	0.11	--	--	--
Mercury, µg/L	0.87	BDL	BDL	1	No relaxation	Beyond this limit the water becomes toxic

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