Effect of Textile Industry Sludge on River Bed on Under Ground Water near Jojari River

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Abstract- *Jodhpur is one of the most industrialized city of Rajasthan and mainly known for textile industry. This city is situated along the river Jojari in which fresh water flows only in monsoon season and rest of the years only treated and untreated domestic and industrial waste water flows.Effluents from these industries contain lots of heavy metals and salts present in dissolved forms and they are deposited on river bed since many years. And during a course of time, these contaminants infiltrate through the bed to meet with the ground water table. In this study various parameter in water samples sample from various tube-wells located on the bank of the river i.e., pH ,Total Dissolved Solids (TDS), concentration of* Na^+ , Ca^{2+} ,Mg^{2+} ,K^+ ,P^+ *and concentrations of heavy metals like Ni, Pb, Zn, Cr, Cd etc. was determined using Inductive coupled plasma- Optical emission Spectrometer (ICP-OES). Sludge samples from the bed of river Jojari from various places were collected and Ni, Pb, Zn, Cr, Cd were measured. Results indicate that leaching of deposited metals are taking place and is polluting upper level of ground water. Presently leaching effect is not found in deep underground water, it may be because of presence of impermeable layer of soil at certain depth. But if this continues to be same in nearby future then, it may contaminate deep layer of ground water table as well.*

Keywords- CSTR-PID-ZN-Fuzzy-MRAM-MATLAB. Textile industry pollution, Leaching of heavy metals, Ni, Pb, Zn, Cr, Cd, Inductive coupled plasma- Optical emission Spectrometer (ICP-OES), pollution of ground water.

I. INTRODUCTION

Jodhpur district extends between 25° 51' 08" & 27° 37' 09" North latitude and 71° 48' 09" & 73° 52' 06" East longitude covering a geographical area of 22,850 sq km. City of Jodhpur, also known as Suncity or Bluecity of Rajasthan is the third most industrialized city of Rajasthan. Industries in Jodhpur City are mainly located in Industrial Areas developed mainly by RIICO and city is situated on the bank of river Jojari. This river is no more perennial in nature. Fresh water flows into it only in rainy season. In remaining periods, only treated and untreated waste from different textile industries flows. This industrial waste water contains various types of heavy metals and these metals are deposited in the river bed. Heavy metals are important environmental pollutants, particularly in areas with high anthropogenic sources [2]. These pollutants are extremely persistent in the environment, nonbiodegradable nonthermodegradable, therefore could readily accumulate to toxic levels [1,3].Heavy metals contribute to environmental pollution because of their unique properties; heavy metals do not leach from the topsoil and have the potential to accumulate in the different organs (such as the kidneys, bones and liver) leading to unwanted side effects [4,5]. Each heavy metal shows specific signs of its toxicity. Some effects of heavy metals could be toxic (acute, chronic or sub-chronic), neurotoxic, or even carcinogenic, mutagenic or teratogenic [5]. Heavy metals can accumulate in the soil at toxic levels due to long-term application of wastewater. Metals can be transferred from soil to the other ecosystem components, such as underground water or crops, and can affect human health through the water supply and food [1,6]. Soils, as filters of toxic chemicals, may adsorb and retain heavy metals from wastewater. The amount of heavy metals mobilized in the soil is a function of pH, clay content, organic matter content, cation exchange capacity and other soil properties making each soil unique in terms of pollution management [7].

Due to the critical condition of this river it was chosen as the study area. Samples of sludge and ground water were collected from various locations and at various depths. Locations of the sampling point were decided randomly to represent an overall view of the river length. Testing parameters were decided on the basis of textile and steel industries effluent discharge. Effluent from industries specifically the textile cluster contains various heavy metals & salts in dissolved forms which have been deposited on the river bed since past many years. The term heavy metal refers to any metallic element that has a relatively high density and is toxic or poisonous even at low concentration or we define it in a general collective term, which applies to the group of metals and metalloids with atomic density greater than 4 g/cm^3, or 5

times or more, greater than water. Underground water and soil polluted with high concentration of salts & heavy metal is of increasing concern because it is affecting human health and the ecological systems greatly. Effects of these metals on human health are shown in table -1.

Table-1 : Clinical effects of metals

S.N	Metal	Target open	Clinical effects
1	Lead	Nervous system, Hematopoietic system, Renal	Peripheral Neuropathy, Central Nervous Disorders, Anaemia
2	Chromium	Pulmonary	Ulcer, Perforation of Nasal Septum, Respiratory Cancer
3	Cadmium	Renal, Skeletal Pulmonary	Aminoaciduria, Emphysema

Hence, it is essential to understand the reasons behind this pollution and remediate the contaminated area.Various water samples were collected from underground sources using tube wells situated in those areas along the river Jojari. Many water quality parameters of concern were analysed from those samples like pH ,Total Dissolved Solids (TDS), concentration of Na^+ , Ca^{2+} ,Mg^{2+} ,K^+ ,P^+ and concentrations of heavy metals like Ni, Pb, Zn, Cr, Cd etc. using a technique called Inductive coupled plasma- Optical emission Spectrometer (ICP-OES). Many samples from the bed of river Jojari were also collected for the determination of Ni, Pb, Zn, Cr and Cd.

II. SAMPLING METHOD AND LOCATIONS

Water samples were collected at various depths from investigated sites. 12 samples of underground water from wells (Shown in red colour in figure-1) and 16 samples of sludge from river bed (Shown in blue colour in figure-1) were taken. Before the samples were taken, the water was pumped out for 5-10 minutes until fresh water comes out from deep in the well. Grab samples were collected from the tube well and well near Jojari River at all the sampling locations. The sample bottles were soaked in 10% HNO_3 for 24hr and rinsed several times with double distilled water (DW) prior to use. The samples thus preserved were stored at 40°C in sampling kits and brought to the lab for metal analysis. In the lab, water samples were filtered through 0.45 µm membrane filter. Deionised water was used throughout the study. All glassware and other containers were thoroughly cleaned and finally rinsed with deionised water several times prior to use. Measurements were always carried out during the sampling day in order to keep minimum fluctuations of physical and chemical parameters that are caused by temperature differences.

Table- 2 shows the locations of the samples with their respective names which were taken from upstream to downstream, whereas table-3 shows the location of sludge samples near water sample locations at an average depth of 30 cm from surface.

Table- 2: Water sample locations

S. No.	Sample Nomenclature	Water sample location
1	W-1	Banar village
2	W-2	Ramjanjihattah, railway cantt,Banar road
3	W-3	Nh-65, near Asiyana-Pali road
4	W-4	SalawasJojari river bridge
5	W-5	HP petrol pump (Near Salawas STP)
6	W-6	On road to Salawas railway station
7	W-7	In front of kalpatru warehouse
8	W-8	SalawasNandwan Village
9	W-9	Village Bhandukallaheerkheda
10	W-10	Gelawas Village
11	W-11	Lunawaskhurd Village
12	W-12	Dhundara Village

Table -3: Sludge sample locations

S. No.	Sample Nomenclature	Sludge Sample Location
1	S-1	Near nandri STP
2	S-2	Near kudihodd
3	S-3	100 m upstream to salawas railway bridge
4	S-4	50 m upstream to salawas railway bridge
5	S-5	50 m downstream to salawas railway bridge
6	S-6	250 m downstream to salawas railway bridge
7	S-7	450 m downstream to salawas railway bridge
8	S-8	650 m downstream to salawas railway bridge
9	S-9	850 m downstream to salawas railway bridge
10	S-10	950 m downstream to salawas railway bridge
11	S-11	500 m downstream to salawas railway bridge
12	S-12	Near salawas road bridge
13	S-13	Near nandwan village
14	S-14	Near bhandukallaheerakheda
15	S-15	Near lunawaskhurd
16	S-16	Near dhundhara village

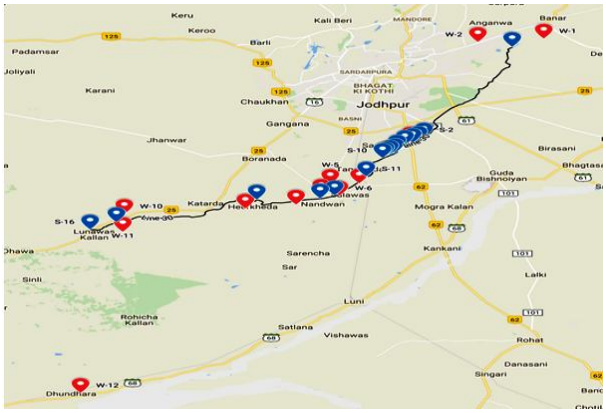

Figure-1: Map of Study Area(Location of sludge & water sampling stations)

III. OBSERVATIONS AND ANALYSIS

Concentration of various parameters in ground water sample and sludge from river bed is presented here in the table-4 and concentration of heavy metals are shown in table-5. Concentration of heavy metals in deposited sludge in Jojari river bed is shown in table-6.

Table -4: Concentration of various parameters in Ground Water Samples

Sample Nomenclature	Location	pH	TDS (mg/l)	K (mg/l)	Na (mg/l)	Ca (mg/l)	B (mg/l)	Si (mg/l)	Mg (mg/l)	P (mg/l)
W-1	**Banar Village**	7.8	10205	92.6	3143	32.7	2.4	3.58	17.9	1
W-2	**RamjanjiHatta**	7.84	7280	21.3	3679	19.7	2.6	5.7	11.6	0.2
W-3	**Ashiyana-Pali road**	8	7605	87.9	4573	49.6	1.3	5.02	23	0
W-4	**Salawas-Jojri river bridge**	7.24	60450	188	32864	283	12.6	1.22	285	0
W-5	**Hp petrol pump**	7.51	1495	12.2	1392	6.3	0.48	6.22	2.69	0.1
W-6	**Near railway line**	7.85	3835	13.1	3268	26	1.69	6.3	4.45	0
W-7	**Kalpatru warehouse**	7.03	7020	29.9	4444	79.8	1.5	7.9	22.3	0
W-8	**Salawas-nandwan village**	7.07	6565	93.4	4455	48.6	0.5	29.49	9.15	1.4
W-9	**Bhandu village**	7.85	5915	19.2	5804	26.6	1.03	5.9	13.1	0
W-10	**Gelawas**	6.86	5005	82.2	2719	121	0.56	1.4	31.3	0
W-11	**Lunawas-khurd**	7.23	14300	39.3	4618	98.2	2.17	5.08	66.4	0
W-12	**Dhundhara**	7.53	6695	60.9	3624	59.9	0.54	4.33	19.9	0.1

Table -5: Concentration of Heavy Metals in Ground Water Samples

Sample Nomenclature	Location	Pb mg/l	Zn Mg/l	Cd Mg/l	Ni Mg/l	Cr(VI) Mg/l
W-1	**Banar Village**	0	0	ND	ND	ND
W-2	**RamjanjiHatta**	0.04	0	ND	ND	ND
W-3	**Ashiyanapali road**	0.02	0	ND	ND	ND
W-4	**Salawas-jojri river bridge**	0	0	ND	ND	ND
W-5	**Hp petrol pump**	0.08	0	ND	ND	ND
W-6	**Near railway line**	0.07	0	ND	ND	ND
W-7	**Kalpatruwherehouse**	0.11	0	ND	ND	ND
W-8	**salawasnandwan village**	0.53	0	ND	ND	ND
W-9	**Bhandu village**	0.05	0	ND	ND	ND
W-10	**Gelawas**	0	0	ND	ND	ND
W-11	**Lunawaskhurd**	0.03	0.86	ND	ND	ND
W-12	**Dhundhara**	0.007	0	ND	ND	ND

Table -6: Concentration Of Heavy Metals in Deposited Sludge on Bed of River Jojari

Sample Nomenclature	Ni (mg/l)	Cd (mg/l)	Zn (mg/l)	Pb (mg/l)	Cr (mg/l)	Cr+6 (mg/l)
S1	8.752	1.438	6.999	8.465	2.069	0.083
S2	3.481	3.186	8.624	8.992	0.981	0
S3	8.138	2.759	9.123	3.654	0.771	0
S4	58.613	69.882	89.104	81.936	53.007	22.504
S5	80.413	70.933	65.031	77.203	68.095	34.097
S6	81.632	70.318	79.728	55.632	62.114	31.109
S7	60.434	73.638	64.652	59.541	60.602	30.514
S8	73.814	75.552	53.217	60.014	67.842	33.989
S9	77.321	60.138	63.217	74.234	60.602	30.362
S10	16.311	6.699	17.56	19.63	16.354	8.193
S11	10.909	14.533	13.449	11.297	10.575	5.443
S12	12.231	10.587	11.234	9.633	14.223	7.191
S13	12.541	8.998	14.012	14.274	11.391	5.701
S14	1.923	4.017	5.928	3.505	2.359	1.22
S15	3.668	7.291	5.892	8.567	3.643	1.884
S16	8.464	6.511	4.143	5.556	4.884	1.628

Sludge and groundwater analysis of jojari river and nearby areas throughout the length of the river was carried out. Table-4-7 indicates the measured values of various parameters. Major aim of the study was to analyse the impact industrial waste water has on a river body and the amount of salts & heavy metals deposited on the surface have leached the groundwater in due course of time.Groundwater samples showed an optimum pH range of 7-8, whereas TDS was very high throughout the river and nearby catchment areas making it unsuitable for drinking and agricultural practices. Maximum TDS was found at the sample W-4 (Salawas-jojari River bridge) which is a site for direct discharge of industrial effluent in the river and is thus most severely affected. Associated salts like Na, Ca, K, Mg showed similar trends as TDS which make it highly saline and cannot be used any sort of human activity.Boron was found maximum at sample W-4 with a concentration of around 12 mg/l. According to the Environmental Protection Agency (EPA), If boron levels are over the long-term health advisory and lifetime health advisory for adults (5 mg/l), there is a risk to testicles and unborn babies. Silica was found maximum concentration 29.5 mg/l in sample W-8 (Salawas-Nandvan village), other samples had silica concentration in optimum range.Phosphorus and zinc levels in water were found to be within limits. Heavy metals such as Iron, Chromium, Nickel, and Cadmium were also tested from ICP but they were not in detectable concentrations. This suggest that the majority of heavy metals remained in the sludge and were found absent in the groundwater, it may be because of presence of impermeable layer of soil at certain depth.Sludge sample analysis showed heavy metal concentration (Cobalt, Zinc, Lead, Chromium VI,

nickel) maximum within area S4 to S9 which is downstream to the direct contamination area mentioned with sample W-4 of groundwater. it indicates that leaching is up to a certain depth only. Observation clearly points out to the fact that the most affected zone in the river is Salawas railway bridge to Salawasroad bridge. Hence it is this belt where direct discharge of textile industries takes place and heavy metals have mobilised to approximately 3.0 km downstream along the surface. Ground water is unsuitable for consumption or for agricultural practice due to very high dissolved solid, cations (Na, K, P, Ca, Mg) and only lead (0.53 mg/l in W-8) were found to be higher than permissible limit.

IV. CONCLUSIONS:

It is clear from the measured values of heavy metals concentration in the river bed that , increase in concentration of heavy metals is due to discharge of textile waste water either treated or untreated. Similarly presence of these heavy metals in upper layer of underground water in the tube well situated near the river indicates that leaching of these heavy metals from deposited sludge have been started and is polluting the underground water. Hence it is the time to take preventative action in this matter to save the river and underground water.

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