

Water Pollution and Its Impact in Vicinity of Jaipur Capital City of Rajasthan: A Geographical Analysis

***Dr. Suman Sharma**

Introduction

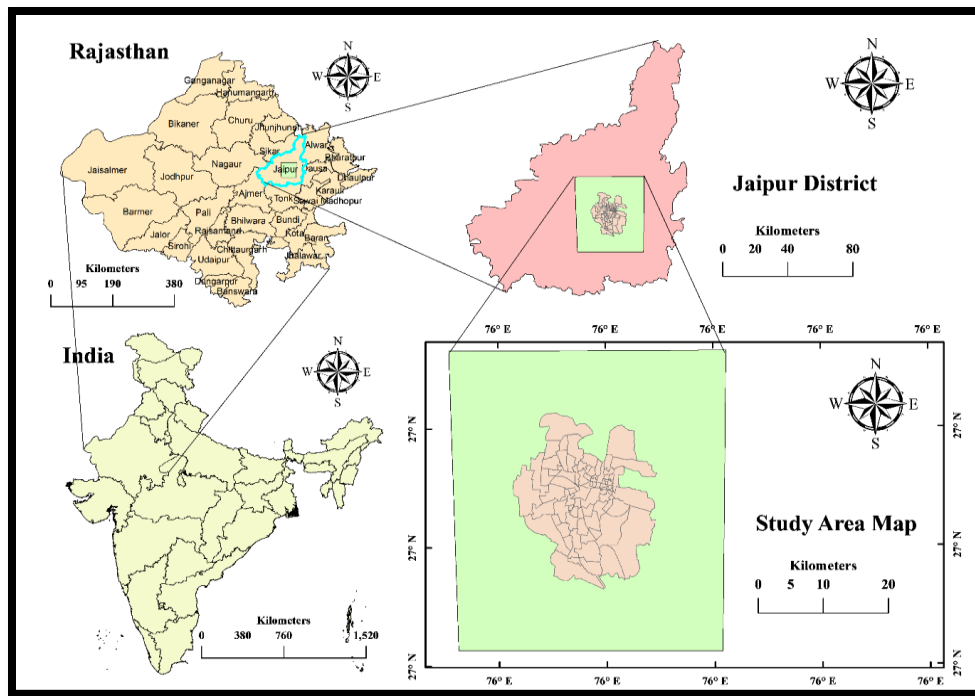
The rapid Industrial and residential progress in and around Jaipur has led to deterioration in the water quality. We considered the relationship between water use and economic growth, typically driven by industrial and urban expansion. A characteristics of this pattern of development is that it is uneven, the process of urbanisation generating contrasting, non-urban areas from which population may migrate to urban centres of economic growth. The pollutants are mainly derived from urban runoff, Storm water drains and municipal waste. The municipal effluents are the most dangerous pollutants as they consist of de-compostable matter of high Biological Oxygen Demand (BOD). The ground water is collected in aquifers at different depths. Which is being polluted due to the influence of polluted water from the surface caused by human and Industrial activities. In Jaipur the commonly used anti pollutant methods are the land file method of solid waste disposals and other low cost sanitation scheme. These methods do not take into account the actual ground water table. The major threat are the accumulated nitrates, phosphates and Heavy metals which remain unused in the ground as they are inorganic substances and thus cannot be used by neither human or the plants.

Study Area

Jaipur is located in the eastern border of Thar Desert, a semi-arid land and lies between 26°23'N to 27°51'N latitudes and 74°55'E to 76°50' E longitudes at an average elevation of 431 m, covering an area of 11151 sq. km. (JDA, 2011). It is located in the foot hills of Aravalli range, surrounded by hillock in northern and eastern sides and vast stretch of planes in western and southern sides. It is because of these topographical constraints; the city is experiencing a growth towards the south (approaching Tonk) and west (towards Ajmer). The hills of the district are the members of North Aravalli ranges.

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Methodology

Two types of data have been collected, (i) Primary data and (ii) Secondary data, Primary data includes- Collection and analysis of water samples and Interaction with local residing people, Field survey for ground truth verification, Secondary data includes – Collateral of data obtained from several Government and Semi. Government organization's, such as Public Health and Engineering Department (P.H.E.D), Rajasthan State Pollution Control Board etc, and Central Groundwater Board.

Source of Pollution

There are two source of water pollution that is:

1. Industrial Source
2. Municipal/Sewerage

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(i) Industrial Sources

There has been a rapid industrial transformation in Jaipur since 1961 period. This has resulted in growth of different kinds of small and medium scale industries around Jaipur. There are about 2400 registered small scale industries in Jaipur city alone. These are mainly house-hold industries manufacturing goods on house-hold basis, such as stone cutting, polishing, lakh work, gota, sculpture etc. the share of workforce population in the walled city is around 334 units. Suggesting a high degree of concentration in the walled city.

Table 1: Industry at a Glance

Sr. No.	Head	Unit	Particulars
1.	Registered Industrial Unit	No.	2369
2.	Total Industrial Unit	No.	25935
3.	Nos. Of Medium & Large Unit	No.	34
4.	Employment Generated In MSMEs	No.	188680
5.	Employment In Large and Medium Industrial Area	No.	--
6.	No. Of Industrial Area	No.	35

Source: Ministry of MSME, Government of India, 2015-16

The magnitude and characteristics of industrial solid waste are extremely complex. In general there are Industries generating large quantities of solid waste containing relatively less concentration of hazardous constituents i.e. is traces (e.g. metallurgical, Iron & Steel, fertilizers). On other hand there are other groups of industries such as chlor-alkali, pesticides, dyestuffs, electro planting, photographic chemical, fine chemicals etc. which generate comparatively less quantity of solid wastes but highly toxic and hazardous.

From Table-1 it is seen that there are 133 industries dealing with chemicals, and 165 industries dealing with dye or painting out of a total of 702 medium and large scale Industries. Most of these are likely to cause water pollution alone, whereas other may cause both water & air pollution. The water which is drained out of these factories is a source of pollution. This water is disposed off in three ways viz, through well cemented laid out drains, spilling on the roads or spreading it out in open vacant lands. The records of Rajasthan State Investment Corporation, Jaipur reveal that each water polluting industry is having an area of about 143 acres. The effluent water from various industries in the source of soil and water pollution. Those industrial units which discharge their effluent in open areas create maximum water pollution. The effluent waters from these industrial units mix in fresh water of Dravyavati River.

Jalmahal Lake and in small ditches, These effluents have poisonous elements like mercury and other

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toxic substances. Three types of industries are the most water polluting industries and they are chemical, non-ferrous metals and agro based.

Table 2: Details of Existing Micro & Small Enterprises and Artisan Units

NIC Code No.	Type of Industry	Number of Units
1.	Food based Industries	586
2.	Beverage & Tobacco based Industry	52
3.	Cotton based	5192
4.	Wooden based	2599
5.	Paper based	1003
6.	Leather based	4630
7.	Rubber, Plastic/Petro based	2429
8.	Mineral based	3433
9.	Metal based	2924
10.	Engineer Units	586
11.	Electrical Industry/Machinery & Appliances	1125
12.	Service & Repairing	2508
13.	Misc. Mfg. Industries	4658

Source: Ministry of MSME, Government of India, 2015-16

(ii) Municipal/Sewerage Sources

The City has only a partial sewerage system Which was developed in 1934 However with rapid expansion of the city as well as growth of population, the old sewerage system became quite inadequate and very little expansion was done till 1975. It is at that time a decision to expand the sewerage in phases was taken up as well as treatment plant of 6 M.G.D.-27 MLD capacity was installed. During 1980 under IDA assisted programmes provision for laying of sewerage from 22 godam to Delas near Sheopur Visu Village was taken up. Only the unit of O.S. 09 was taken up in this package a length of 600 mtr. Of 1000 mm dia R.C.C. sewer line was laid. A sewerage treatment plant was installed at Jalmahal lake a decade ago which provided partial treatment of the sewage brought into the lake.

The sewerage disposal system in the region varies from open disposal to sewer line and sewerage treatment plant for a part of Jaipur. Jaipur city has sewerage system limited to walled city, RHB colonies and some colonies of JDA. Laying of sewerage lines in the outer colonies is in process at present. Most of the areas resort to direct disposal to pits (Kui) many of which are even taken to sub-soil water level. Limited use of septic tanks and soak pits is also in use. The system of disposal is of an

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alarming magnitude in terms of pollution threat to ground water and increasing incidence of water borne diseases, such as Cholera, Hepatitis, Dysentery etc.

The disposal and treatment system of human excreta is subject of major concern for the environmentally safe development of the city. Most of the water discharged from house-holds and small scale industries within the city flows through various drains and is collected outside the city limits in low lying areas. The sewerage disposal of Jaipur city is divided in two directions mainly north and south. Sewerage from the northern part along with surface drains carrying sludge and industrial wastes of the small scale industries situated in residential areas fall in JalMahal Lake where a sewerage treatment plant of 6 MGD capacity was installed in 1980-81 for treating a part of the sewerage effluents in the northern region. However the sewerage of the southern part is discharged south of 22 godam and is being partially used for sewerage farming. Lack of any sewerage system over the past 40 years has resulted in Nitrate contamination even in deep aquifers as evident from the analytical results of a number of samples specially collected from Bani Park, C-Scheme, Adarsh Nagar, Ghat Gate etc. Nitrate values as high as 875 Ppm, (max. permissible 50 ppm) has been reported from the water samples from a dug cum bore well near Jai Club in C-Scheme area in Jaipur. The sewerage farming near Ram Nagar Ext. causes severe threat of Nitrate contamination to the potential groundwater zone south and west of Gopalpura.

Physico-Chemical Characteristics of the Sewage Effluents

A study conducted by University Rajasthan suggests very high concentration of non-degradable pollutants in the JalMahal lake water which are slowly percolating towards water table. Table-3 shows the characteristics of sewerage effluents of northern fall of Jaipur city.

Table 3: Physico-chemical Characteristics of the Sewage Effluents of Northern fall of Jaipur City and Jalmahal Lake

S.No.	Characteristics	Sewage	Lake water
1	PH	7.1-8.2	7.5±0.1
2	Conductivity	628-1170	800±200
3	Dissolved solids	454-835	375±80
4	Suspended solids	470-780	330±20
5	Carbonates and Bicarbonates	125-242	170±35
6	Biological oxygen demand	60-144	72±32
7	Chemical oxygen demand	6.2-34±.6	15.4±6.4
8	Ammonical-nitrogen	5.7-26.6	13.2±3.5
9	Nitrate-nitrogen	3.1-6.3	5.7±2
10	Total nitrogen	42±5	70±3

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11	Chlorides	71.2-249.5	110±25
12	Sulphates	37.6±165.7	72±30
13	Phosphates	6.2-18.5	12±3
14	Sodium	65.7-177.0	71±10
15	Calcium	21.8-57.6	41±10.5
16	Magnesium	6.2-24.3	13.5±4.6
17	Potassium	3.4-21.6	11.5±4.3
18	Lead	0.02-0.14	0.45±0.08
19	Zinc	0.08-0.25	0.46±0.05
20	Iron	0.02-0.07	1.50±0.10
21	Copper	0.01-0.26	0.38±0.04
22	Cadmium	0.09-0.10	0.108±0.01

Concentration of all the parameter are in mg/lit. except of PH and conductivity (mhos/cm.)

Source: Research study on physico chemical investigations on sewage effluents and sludges of Jaipur city - University of Rajasthan, Jaipur, 2015-16

Table 4: Some Physico-Chemical Parameters in Water Samples of Jaipur Region, 2015-16

S. No.	Parameter	Lake Water	Well Water	Municipal Water
1	pH	9.2	8.0	7.2
2	Conductivity (m mhos cm ⁻¹)	8600	7400	1300
3	TDS	1548	15191	858
4	Chlorides	425	1333	227
5	Bicarbonate	647	436	285
6	Sulphates	240	190	150
7	Chemical	1100	680	520
8	Total-N	76	28	19
9	NH ₄ ⁺ -N (Ammonium + Nitrogen)	16	0.38	0.27
10	NO ₃ ⁻ -N (Nitrate - Nitrogen)	45	20	8
11	Phosphorus (Inorganic)	13	0.41	0.32

Source: Research study in Physicochemical investigations on sewage effluents and sludges of

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*Jaipur city- University of Rajasthan, Jaipur, 2015-16***Water scarcity is determined by demand and supply**

The Water of Jawaharnala is also polluted by the waste waters in the form of sullage and sewage of the adjacent residential colonies. The underground sewer line of Jawaharnagar and the effluents of Jaipur Dairy Plant find their exit into this nala. Due to slope gradients at some point along the nala course, water collects and stagnates in the pools which became breeding site of dangerous mosquitoes and several other anthropodes besides harbouring rich form of dangerous microbes. There is also a long term danger of seepage of trace elements and other toxic compounds in the deeper aquifers. The water also is a potent source of infection in the form of viruses, bacteria and helminth parasites which are present in the human excreta. Table 5 gives the values of indicative parameters from Jawaharnala water.

Table 5: Values of Some of the Significant Parameters of JawaharNala, 2015-16

Component	Test Result	Normal Value
PH	8.2	6.5-8.0
Conductivity	1089.2 us/cm	200-800 us/cm
Colour	Muddy	Clear/Transparent
TDS	565mg/1	300-600 mg/1
COD	1050.0 mg/1	<bellow 20mg/L
Total Nitrogen	69.44 mg/1	0.12 to 2.2 mg/L
Hardness	312 mg/1	60-120 mg/L
Chloride	724 mg/1	Bellow 10mg/L
Sodium	114.0 mg/1	20 mg/L
Potassium	62 mg/1	3.5-5.0 mmol/L
Calcium	60 mg/1	1 to 135 mg/L

Source: Research study in Physicochemical investigations on sewage effluents and sludges of Jaipur city- University of Rajasthan, Jaipur, 2015-16

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High COD values, indicates presence of high concentration of degradable organic pollutants also slow degradation of oxidizable pollutant.

It is generally found that the tubewells, Pumping deeper aquifers potable water and in most cases better than those tapping shallow aquifers. In general quality of groundwater is not good for drinking. Water quality is also an important factor in agricultural and industrial sectors.

Impact of Water Pollution

Urban areas have been thirsty for much of the 20th century. Their growing demand has outstripped supply and fuelled technological development but at considerable financial and environmental cost.

All actions taken for development seek essentially to modify the human environment towards more desirable state, and all natural phenomena. In this perspective, are assessed in terms of their utility and influence on human life. The water pollution, not only affects the human health either by direct intake or through food-chain, but also affects the vegetation.

Impact on Human Health

The abiotic and biotic contaminations in the waters of Jaipur and its environment. which have been dealt with, show that the water of Jaipur city is not of ambient quality and is reflected in the health of the people. The effect of biotic contaminations, though not methodically studied and no specific data is available. are sometime reflected by the outbreaks of diseases in the epidemic forms in the past. However, the slow and gradual effects of abiotic contamination on health have been reported at various health centers.

The major water-borne diseases common in the city of Jaipur are related to geogenic causes besides the pathogens which become active in time and space. There are many chemical compounds whose presence in drinking water could be harmful or even fatal to human and vegetable life. Some of these compounds arise from natural sources and are inherent to the area specifics, whereas others are induced by human activity such as use of insecticides in agriculture farms and mixing of industrial pollutants in the form of solid or liquid wastes.

The diseases caused by contaminated water may be either water-borne, water washed, water-based or from water related vectors. Most of the disease, as per the records of the Directorate of Medical & Health, Govt. of Rajasthan, fall under the first category. i.e. water-borne. A recent UNESCO survey in the developing and under-developed countries has revealed that about 80% of all diseases in these countries are water related. In India about 4 million children die annually due to water-borne diseases, At any given time 400 million people may be suffering from gastroenteritis, in all the developing or under-developing countries.

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The disease organisms are most commonly transmitted to water supplies by human fecal contaminations and industrial effluents. The most common water born disease in Jaipur city are typhoid para-typhoid fevers, bacillary dysentery, diarrhoea, gastroenteritis and cholera. Table 6 gives the average incidence rate of these disease in the city as whole.

Table 6: Average Incidence Rate of Major Water Borne Diseases, 2015-16

Sr. No.	Diseases	Male	Female	Total
1.	Typhoid & paratyphoid Fever and Salmonella Infections	19	13	32
2.	Bacillary dysentery and Amiebiasis	72	06	78
3.	Enteritis and otherdiarrhoeal diseases	137	93	230
4.	Gastritis & duodenities	36	33	69
	City Total	264	145	409

Source: Directorate of Medicals & Health Department Government of Rajasthan, 2015-16.

There are other aspects relating to the impurity of water, other than the water-borne pathogens which affects the human healthy adversely. They are pesticides, herbicides, and trace elements like lead, zink, cadmiuns, barium, molybdenum, arsenic etc., besides nitrates, fluorides & chlorides. In this respect the reported presence of high concentration of lead & cadmium metal in the Jhalana area deserves special mention. Similarly the water in the Jawaharnala are found polluted with such toxic elements like lead, cadmium, zinc and mercury. High concentration of nitrate is both injurious to man and animals.

Impact on Vegetation

Agriculture is being practiced in the outskirts of Jaipur urban complex even today. It is now on records that there is a high incidence of diseases and poor crop production, some of which could be related to impurities of water. The most important factors which affect water quality for agriculture are (i) Silt, (ii) Total Concentration of Salts, (iii) Proportion of sodium to other cautions and (iv) Special toxic ions like boron, chloride, sodium or bicarbonate. The toxicity of ions largely depends

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upon the type of crop. The suitability of water for irrigation, depends upon the Sodium Absorption Ratio (SAR), which is a function of ratio of sodium (Na) to calcium (Ca) and magnesium (Mg) and has been proposed by the U.S. Salinity Laboratory (U.S. Deptt. of agriculture, 1953). as:-

A part from the yield, which is generally a primary consideration, the quality of the produce obtained under saline condition is also important.

Saline groundwater in irrigation has its adverse effect due maximum to (i) increase soil salinity (ii) change its drainage and texture (iii) Induce development of kankar pan at shallow.

Over 60 common plant diseases are recorded from different parts of Jaipur. Some of them could be due to high values of chemical or biological contaminants in the groundwater. Essentially the main pollutants in the agricultural field are the agricultural wastes which include pesticides that are sprayed on crops as well as sediments. Fertilizers and plant that are carried downwards during irrigation as well as into waterways during periods of rainfall. Since these wastes are also organic they increase the BOD of the receiving waters. Addition of excess plant nutrients by adding inorganic fertilizers, can disturb the nitrogen-phosphorus balance in these systems, as well as excessive plant growth. When the plants die, they settle to the bottom and since they are organic, they increase the BOD of the system during decomposition. Many pesticide compounds which are used are non-biodegradable as well as slightly soluble in water. Consequently when sprayed on crop land, they remain in the soil for long period of time. During periods of heavy rainfall or when the crops are irrigated, they tend to be carried as suspended particles into surface or underground systems. This way, they enter the food-chain, undergo concentration in non-target organisms and increase in animal tissue to alarming levels. They may also enter the drinking water by entering into surface or groundwater systems. Thus a careful and judicious use of pesticides and fertilizers is warranted to minimize water pollution in this sector.

Conclusions and suggestion

This suggests more attention should be paid to conservative and demand management.

- i. Streams and groundwater are being polluted by municipal and industrial wastes. The main danger of water pollution in the industrial sector is from chemical, agro based and dye industries, the waste waters of which are either directly thrown into the streams or gradually seep into the groundwater through cesspools.
- ii. Lack of sewerage system in the past, has resulted in the contamination of even deeper aquifers.

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- iii. Water samples collected from different parts of the area show high values of nitrates and TDS, high conductivity (salinity), from the city area, and high fluoride values in the southern parts, including Sanganer area. About 78% of the water supply to Jaipur City contains high nitrate values. Some concentration of trace elements (lead & cadmium) are also recorded from Jhalana area.
- iv. Growth of slums is due to rapid urbanisation and industrialisation along with population explosion, About 30% of the population is residing in slum conditions.
- v. The pollution of groundwater is due to both biotic and abiotic contaminations.
- vi. Whereas the abiotic contamination (high nitrate, TDS, Salinity etc) have a slow and gradual effect on human health the biotic contamination gives rise to waterborne diseases.
- vii. Growing of vegetables in the polluted water of Dravyavati River and sewage farming in the Baisgodam area, may induce harmful elements in the human bodies through the food chain.

Suggestion

- i. Discourage drinking of waters rich in fluorides and nitrate contents. This can be done only when alternative and assured water supply suitable for drinking can be provided to people.
- ii. Since the Dravyavati River is an influent between Sanganer and Ramsagar branch, the effluents from Sanganer dyeing industry need to be treated before being discharged into it. Similarly, Jhalana Nadi is an influent between Jagatpura & Khatipura. In view of this, the municipal waste, which is dumped in the river bed, near Jagatpura needs to be shifted to alternative sites in the gully erosion area south of Langriyawas on Ramgarh road.
- iii. Recently taken up sewer line work should be continued faster, covering all parts of the urban area as well as new colonies being developed.
- iv. The pollution control authorities, industries and academicians should share responsibility for providing a pollution-free situation. Guidance is particularly required by small and even medium units who often find the problems beyond their ability.
- v. Combined treatment plants may be the best situation for small & medium units.
- vi. Recycling of industrial waste water after proper treatment, as well as proper treatment of industrial wastes from the industrial areas before their disposal, should be made mandatory.

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- vii. The entire industrial waste should be classified into hazardous and non-hazardous category. The hazardous wastes can be subjected to special holding, treatment and disposal techniques.
- viii. The need to improve infrastructure available with the pollution control Board should attract priority.

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