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GROUNDWATER IN RAJASTHAN WITH SPECIAL REFERENCE TO AJMER DISTRICT

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ABSTRACT

***The high level of attention being given to water harvesting and groundwater recharge in Rajasthan** reflects both the aridity of the state and increasing concerns regarding groundwater overdraft. Rajasthan's economic growth is largely dependent on water, more specifically on groundwater. 71% of the irrigation and 90% of the drinking water supply source is groundwater . Presently, there is tremendous pressure to exploit groundwater by State and private users, i.e. by those who have access and control over this limited resource. The resulting consequences are also well known - in 2019, out of 236 groundwater zones, only 20.8% were categorized as safe. The rest reached the stage of being categorized as semi-critical (8.9%), critical (33.9%) and over-exploited (36.4%). The causes of groundwater depletion and pollution are rooted in population growth, economic expansion, decline in groundwater recharge and over-abstraction caused by the rapid increase in the number of wells and tubewells and the progress in pumping technology.*

*Besides rainfall and lithological characteristics, the development of groundwater aquifers and recharge to such aquifers is largely determined by the geomorphic properties of the land, especially slope, drainage patterns and the nature and thickness of the unconsolidated/semiconsolidated layers over the bedrock formations. A good correlation exists between the hydrogeological properties of non-hard rock areas and the geomorphic properties of the land. Since geomorphic features can easily be identified through visual interpretation of remote sensing products and field traverses, it is possible to identify potential aquifers and to locating areas suitable for groundwater recharge . **However, very few studies on the relationship between geomorphic properties and groundwater characteristics have been done in Rajasthan**, and most of these have been carried out in universities in the arid western part of the State.*

*One of the largest challenges in evaluating the viability of groundwater harvesting for recharge is the lack of accessible technical information on the overall groundwater context in Rajasthan. As a result, the first step in planning and the development of groundwater resources in the State should be detailed mapping of the resource base. In addition, to asses and plan optimum utilization of groundwater resources, precise determination of all the hydrological parameters under different geomorphic and rainfall conditions for the same lithological unit is required. Even the river basin boundaries should be demarcated more precisely – something that can be achieved with the help of advanced remote sensing techniques. **In areas where basin boundaries cannot be identified, we suggest that the area of the basin be classified into "Donor" and "Receptor" zones or as "Index Catchment".***

INTRODUCTION

In general Salinity, alkalinity, fluoride, nitrate and TDS are the major factors, which affect the water quality most.

pH: the pH of ground water in this area varies within minimum 7.5 to maximum 8.5 in both seasons. Almost all the water samples in this area are alkaline in nature though the values of pH of all water samples were found to be within the permissible limits in both seasons. The standard limits prescribed by WHO and IS 10500:2012 are 6.5- 8.5.

Electrical Conductivity (EC): E.C. depends on the concentration of dissolved mineral matter content. The salt concentration is generally measured by detecting EC. In the present study area the EC has been observed from 942 to 9771 µS.cm-1 . About 60 % water samples have EC more than permissible limit. If the TDS is high then EC will be high .[1]

Total Dissolved Solids(TDS): The value of T.D.S. is very important for the assessment of water quality . High TDS value of water indicates the higher mineralization of water. The desirable limit for TDS is 500 mg/L and maximum permissible limit is 2000 mg/L .As the result of analysis the values of total dissolved solid ranges from 660 to 6840 mg/L during pre-monsoon and 780 to 6280 mg/L in Post-monsoon season. Maximum TDS has been observed at handpump of villages. About 46% samples have TDS beyond permissible limit of 2000 mg/L. It concludes that mostly water is saline in a certain block. This shows that anthropogenic impact which can be due to agricultural activity leading to local spatial and temporal variability of runoff Away from the permissible level, palatability decreases and may cause gastrointestinal irritation.

Alkalinity: Alkalinity of the water is due to presence of carbonates, bicarbonates and hydroxide salts. The alkalinity values in the study area were recorded between 260 to 1220 mg/L in pre monsoon season and 220 to 1220 mg/L during Post-monsoon season. The hydroxide, carbonates and bicarbonate probably released from limestone sedimentary rocks, carbonate rich soils, cleaning agents etc.The Maximum value (1220 mg/l) is observed . The Maximum permissible level of alkalinity is 600 mg/L (BIS Standard). About 83 %of water samples tested were found to be within permissible limits. High amount of alkalinity in water is harmful for irrigation which leads to soil damage and reduces crop yields.

Chloride (Cl-): All the natural types of water contain chlorides. Chloride is added to water due to the agricultural activities, industries and chloride rich rocks. itis a widely distributed element in all types of rocks in one or the other form. Its affinity towardssodium is high. High concentration of chloride is due to the invasion of domestic wastes and disposals by human activities . Soil porosity and permeability also play a key role in building up the chlorides concentration .

According to IS:10500:2012the desirable limit of chloride is 250 mg/Land the permissible limit is 1000mg/l. In the present analysis, chloride concentration lies between the range of 90 mg/L to 2370 mg/L in pre-monsoon season and Minimum and Maximum values are decreasing in post monsoon seasons.(120 to 2270 mg/l.). The highest value of 2370 mg/l is observed at Handpump area. Excessive chloride in water is particularly not harmful but increase of chloride level in water is injurious to People suffering from heart and kidney diseases.

Hardness: The total hardness is the measure of the capacity of water to precipitate soap. Hardness of the water is due to presence of Ca and Mg salts. Usually the hardness is not harmful to health but it has been suspected to play some role in heart diseases . In this study area, the range of total hardness was found to be from 260 mg/L to maximum 3880mg/L in Pre-monsoon season and 320mg/L to 3050mg/L in Post-monsoon season in more than 50% of samples hardness as crossed permissible limit. The hardness of the water is due to dissolved minerals from sedimentary rocks through seepage and runoff ,Detergents and soaps also aggravate the situations. The standard limits of total hardness are 200 to 600 mg/l. as per IS 10500:2012.

Sulphate (SO4): In Present study area the sulphate values exhibited between 16 to 660 mg/l in pre monsoon season, and 16 mg/l to 555 mg/l. in Post-monsoon season Sulphate occurs naturally in water as a result of leaching from gypsum and other common minerals.Discharge of industrial wastes and domestic sewage tends to increase concentration of sulphate in water. Only 3 samples have concentration beyond the permissible limit as prescribed by IS 10500:2012 (400 mg/l.).High concentration of sulphate may cause gastro intestinal irritation particularly when concentration of magnesium and sodium is high. [2]

Nitrate(NO3): The values of nitrates in the study area were recorded between 30 mg/L and 860 mg/L.About 75% of samples exceed the desirable limit of 45 mg/L. If the concentration of nitrate is higher than 45 mg/L, it will cause a disease called blue baby disease or methaemoglobinaemia in infants .The high level of nitrate in study area has reported that nitrate contamination of water is due to increasing use of nitrogenous fertilizers and nitrites can cause depletion of dissolve oxygen content of water . NAEP have concluded that residual nitrate in the soil in the major cause of nitrate contamination in ground water. The appreciable quantities of nitrates and nitrites found in these investigations have some public health implications.

Calcium: The Calcium in the sampling sources ranges from 48 to 808 mg/L during pre-monsoon season and 48 to 660 mg/L during Post-monsoon season of 2013. In most of the samples it falls above the desirable limit of 75 mg/ L(IS:10500:2012), and only 30% samples have calcium concentration above the permissible limit of 200 mg/L. The higher value is mainly attributed due to the abundant availability of lime stone in the area. Consequently more solubility of calcium ions is present. Magnesium: In these samples, the minimum concentration of magnesium has been increased from 26 mg/L in Pre-monsoon to 36 mg/L in Post- monsoon season. But the maximum value decrees from 446 mg/L to 336 mg/L in post-monsoon season 2013.In all most of all the samples magnesium falls above the standard desirable limit 30 mg/L in both seasons. The concentration of magnesium may be due the dissolution of magnesium calcite, gypsum and dolomite .All the major parameters in both seasons were found to be in excess of the desirable limit given by WHO / ICMR / IS (10500:2012) standards, so that water quality of the study areas of poor quality.[3]

Central Ground Water Board (CGWB) regularly monitors ground water quality of shallow aquifers on a regional scale, once every year. Ground water quality data generated during various scientific studies and ground water quality monitoring indicate that the ground water in major part of the country is potable. However, some parts of various states are contaminated by Salinity, Arsenic, Fluoride, Iron, Nitrate and Heavy metals beyond the permissible limits of BIS. State-wise details are given below.

The possible sources of contamination of ground water are either geogenic or anthropogenic in nature. Anthropogenic contamination of ground water is due to industrial discharges, landfills, diffused sources of pollution like fertilizers and pesticides from agricultural fields etc.

Steps taken to check the ground water pollution are –

- Control of industrial pollution under the provision of Water (Prevention and Control of Pollution) Act, 1974 by consent mechanism being applied by SPCBs/ PCCs.
- A mutually agreed time targeted programme is implemented under Corporate Responsibility on Environment Protection (CREP).
- Establishment of Common Effluent Treatment Plants (CETPs) for cluster of Small Scale Industrial units.
- Continuous water quality monitoring systems are being established on industrial units in the country, through the directives issued by CPCB, for getting real time information on the effluent quality.[4]For improving the coverage of safe drinking water to rural population, the Ministry of Drinking Water and Sanitation supplements the efforts of the states by providing them with technical and financial assistance through the centrally sponsored **National Rural Drinking Water Programme (NRDWP).** It is the State Governments who plan, design, approve, execute and operate & maintain the schemes for providing safe drinking water to rural population.

OBSERVATION

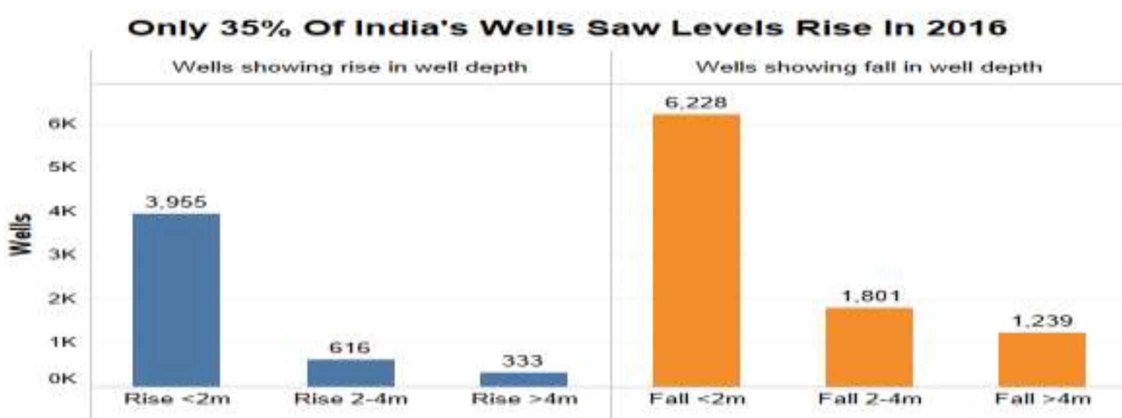

Figure 1: Grounwater Crisis

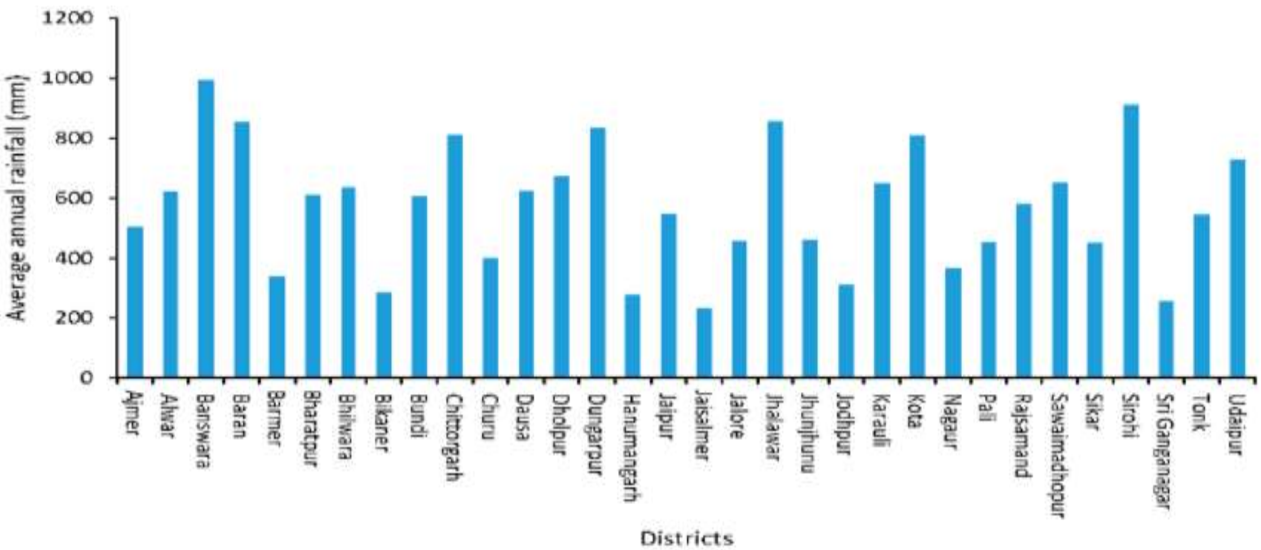

Figure 2: Districtwise Average Annual Rainfall In Rajasthan

Table-1 : Details Of Affected Districts With Ground Water Contamination By Different Chemical Constituents In Rajasthan

State/UT	Salinity (ECabove3000μS/cm) (EC :Electrical Conductivity	Fluoride (above 1.5 mg/l)	Nitrate (above 45mg/l	Arsenic (above0.01mg/l)	Iron (above1mg/l)	Heavy metals :Lead (above0.01 mg/l) Cadmium (above 0.003mg/l) Chromium (above 0.05 mg/l)
Rajasthan	Ajmer, Alwar, Baran, Barmer, Bharatpur, Bhilwara, Bikaner, Bundi, Chittorgarh, Churu, Dausa, Dhaulpur, Ganganagar, Hanumangarh, Jaipur, Jaisalmer, Jalore, Jhalawar, Jhunjhunu, Jodhpur, Karauli, Kota, Nagaur, Pali, Rajasamand, Sawai-Madhopur, Sikar,	Ajmer, Alwar, Banswara, Barmer, Bharatpur, Baran, Bhilwara, Bikaner, Bundi, Chittaurgarh, Churu, Dausa, Dhaulpur, Dungarpur, Ganganagar, Hanumangarh, Jaipur, Jaisalmer, Jalore, Jhalawar , Jhunjhunu, Jodhpur, Karauli, Kota, Nagaur, Pali, Pratapgarh, Rajsamand, Sirohi, Sikar, Sawai	Ajmer, Alwar, Banswara, Baran, Barmer, Bundi, Bharatpur, Bhilwara, Bikaner, Chittaurgarh, Churu, Dausa, Dhaulpur, Dungarpur, Ganganagar, Hanumangarh, Jaipur, Jaisalmer, Jalore, Jhalawar, Jhunjhunu, Jodhpur, Karauli, Kota, Nagaur, Pali, Partapgarh, Rajasamand, Sirohi, Sikar, Sawai	Ganganagar	Ajmer, Alwar, Banswara, Baran, Barmer, Bharatpur, Bhilwara, Bikaner, Bundi, Chittaurgarh, Churu, Dausa, Dhaulpur, Dungarpur, Ganganagar, Hanumanga	Lead: Jhunjhunu Dist (Khetri Copper Deposit), Pali, Jaipur (Sambhar Lake, Sa nganer

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State/UT	Salinity (ECabove3000µS/cm) (EC :Electrical Conductivity	Fluoride (above 1.5 mg/l)	Nitrate (above 45mg/l	Arsenic (above0.01mg/l)	Iron (above1mg/l)	Heavy metals :Lead (above0.01 mg/l) Cadmium (above 0.003mg/l) Chromium (above 0.05 mg/l)
	Sirohi, Tonk, Udaipur	Madhopur, Tonk, Udaipur	Madhopur, Tonk, Udaipur		rh, Jaipur, Jaisalmer, Jalore, Jhalawar, Jhunjhunu, Jodhpur, Karauli, Kota, Nagaur, Pali, Pratapgarh, Rajsamand, Sikar, Sawai Madhopur, Sirohi, Tonk, Udaipur	

DISCUSSION-GROUNDWATER IN AJMER (ESPECIALLY)

Groundwater aquifer vulnerability has been assessed by incorporating the major geological and hydrogeological factors that affect and control the groundwater contamination using GIS-based DRASTIC model along with solute transport modeling. This work demonstrates the potential of GIS to derive a vulnerability map by overlying various spatially referenced digital data layers (i.e., depth to water, net recharge, aquifer media, soil media, topography, the impact of vadose zone and hydraulic conductivity) that portrays cumulative aquifer sensitivity ratings in Ajmer. It provides a relative indication of groundwater aquifer vulnerability to contamination. The soil moisture flow and solute transport regimes of the vadose zone associated with specific hydrogeological conditions play a crucial role in pollution risk assessment of the underlying groundwater resources. An effort has been made to map the vulnerability of shallow groundwater to surface pollutants of thestudy area, using soil moisture flow and contaminant transport modeling. The classical advection-dispersion equation coupled with Richard's equation is numerically simulated at different point locations for assessing the intrinsic vulnerability of the valley. The role of soil type, slope, and the land-use cover is considered for estimating the transient flux at the top boundary from daily precipitation and evapotranspiration data of the study area. The time required by the solute peak to travel from the surface to the groundwater table at the bottom of the soil profile is considered as an indicator of avulnerability index. Results show a high vulnerability in the southern region, whereas low vulnerability is observed in the northeast and northern parts. The results have recognized four aquifer vulnerability zones based on DRASTIC vulnerability index (DVI), which ranged from 45 to 178. It has been deduced that approximately 18, 25, 34, and 23% of the area lies in negligible, low, medium and high vulnerability zones, respectively. The study may assist in decision making related to theplanning of industrial locations and the sustainable water resources development of the selected semi-arid area. [5]

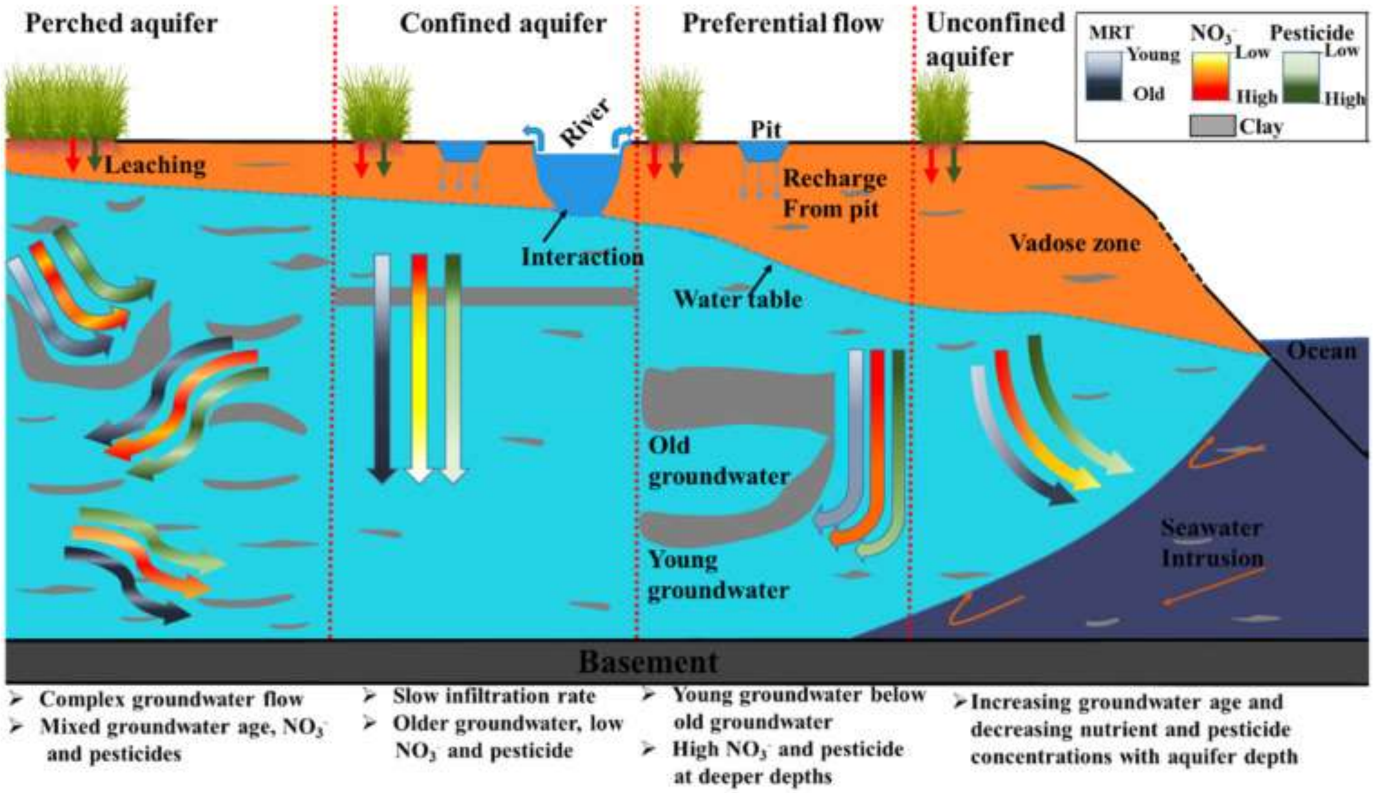

Figure 3: Groundwater Ajmer District

Figure 4: Water Testing Services Ajmer District

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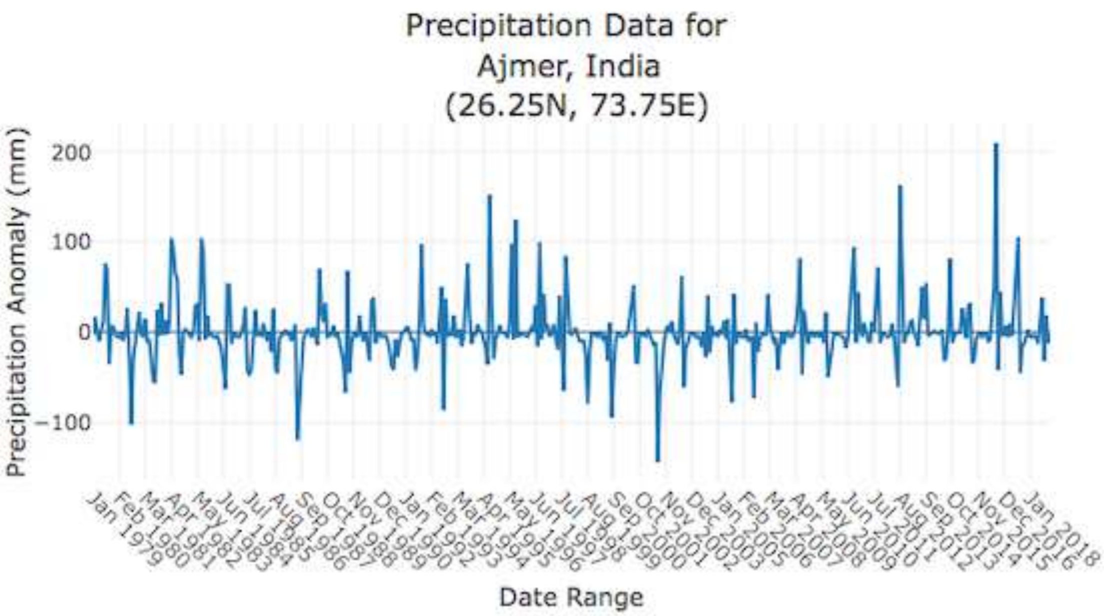

Figure 5: Rainfall in Ajmer District

Mean value of total dissolved solids in the roof water is 10.5mg/L with other constituents present in very low concentration. Bacteriologically, it is also free from harmful microorganisms and is harmless. It can be stated that the roof water is almost analogous to distilled water. Mean values of physico-chemical and bacteriological characteristics of the pond water are given . Average value of turbidity in pond water is 68.88 JTU against a permissible values of 10 JTU for drinking purpose whereas the roof water is clean with 1 JTU. So the turbidity pick up from the soil by the rain water on the way to the pond is 58.88 JTU. Generally, surface water has always higher turbidity than the groundwater and subsurface water. Contrary to the roof water pond water is highly polluted by bacteriological parameters. [6]

The pH is almost neutral in both the cases. Naturally, mineral acids resulting from oxidation of SO2 and organic acids are also found to contribute acidity to the precipitation (Chan et al. 1987, Ayer 1990). Pure water is in equilibrium with global atmospheric CO2 and yield the natural acidity to the rain water with pH 5.6. So, pH value of 5.6 is considered as the demarcation line for acidic precipitation. Moreover, in the absence of CaCO3 the rain water pH would be expected to be around 5 due to natural sulphur compounds .

Roof water is found to be very soft and free from bacteriological pollution. Roof water collection system at household level for drinking purpose seems to be encouraging. Pond water is objectionable due to presence of TDS, turbidity and bacteriological pollution. For pond water sand filter may be used for clarifying the water. On the other hand, water from built up area may be routed through a separate channel for household use .[7]

The study showed that wastewater used for irrigation in Ajmer city was highly contaminated with cadmium. Observed concentrations of Cd ranged between 0.011 ppm (S-1) and 0.085 ppm (S-6). The average value of Cu was 0.042±0.031 ppm. Although the concentration of Cd was higher than standard limit, but the Cd level at various sites did not show significant differences. It was reported that samples collected from S-6 and S-10 had high level of Cd in comparison to samples taken from other sites. **Sources of Cd include wastes from Cd-based batteries and runoff from agricultural soil where phosphatic fertilizers are used. Cd is a common impurity in phosphatic fertilizers** [8]

The concentration of lead at various sampling sites was in the range of 0.187 ppm (S-1) to 0.386 ppm (S-10). The average level of Pb at various sampling sites was 0.239±0.038 ppm. Resultsshowed that the concentration of lead at all the sites had higher than the safe limit prescribed for irrigation water. The higher concentration of lead at S-10 sampling sites might be due to heavy traffic on nearby highway (NH-8). **It is also reported that Pb along with traces of Fe and Zn arrives from urban runoff .** The level of Ni in wastewater, at various sampling sites was in the range of 0.004 ppm (S-1, S-4, S-9) to 0.010 ppm (S-3). The average concentration of nickel at different sites was 0.006±0.002 ppm, which was within the recommended maximum level, thus, the wastewater for irrigation is quite safe from Ni contamination point of view. The concentration of Cr at various sampling sites was below detectable limit of 0.02 mg/L. Correlation test was carried out on the data of wastewater samples between the heavy metals .The values of correlation coefficients (r) were calculated among all the possible sets of parameters of heavy metals. The correlation matrix showed a positive correlation between all the variables. **Pb, Ni or Cu correlated positively with Cd, and Fe strongly correlated with Pb. Also Pb correlated with Ni.** The positive relationship existing between the heavy metals shows their origin from the same source. [9,10]

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