Statistical Interpretation Of Physico-Chemical Parameters Of The Water Of River Chambal At Rangpur, Kota District And River Ujad At Bhimsagar Dam, Jhalawar District, Rajasthan

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ABSTRACT
Water, the elixir of life, is a priceless commodity and should be available to each and every person on this planet. Kota and Jhalawar districts are the fastest developing cities of Hadoti Division of Rajasthan. Though Kota is famous for its quality education and varied industries like cement, textile, fertilizers, limestone & power plants, still this cultural city is facing current trends of urbanization, over-exploitation of resources and exorbitantly increasing population. Therefore, study of physico-chemical parameters of water is considered as an important aspect of pollution studies in the environment.This study is aimed to explore the physico-chemical parameters of water quality standards and their statistical interpretation of the River Chambal at Rangpur, Kota D/S (2 km from City)[21] and U/S Bhimsagar Dam on River Ujad, Jhalawar District [22]of Hadoti Division.In this study, we found that Turbidity andfecal Coliform level are comparatively more than that of permissible limit in months of Monsoon Season. Different Statistical Analyses also explain the suitability of water for agriculture and domestic purposes.Sample S-2 in 2018 has objectionable value of SAR, KR and % Sodium.

Keywords: Jhalawar, Kota,Physico-chemical parameters, Statistical analysis, Water quality,

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1.0 INTRODUCTION

Water, the most essential component, is necessary for sustenance and proliferation of life.All metabolic reactions occur in the water. India has diversified forms of lands in which Rajasthan is situated in North West region as a dry state. The south eastern part of Rajasthan specifically HadotiDivison show the distinctive climatic conditions such as long and extremely hot summer, low rainfall and short mid winter. The Hadoti Division is made up of Kota, Bundi, Baran and Jhalawar, with Kota in the centre, Bundi in the west, Jhalawar in the southeast and Baran in the east.The water quality is affected by geological formations, anthropogenic activities, current trends of urbanization, over-exploitation of resources and exorbitantly increasing population[21][22]. In other words, quality of water is deteriorated by excessive use of fertilizers and industrial discharge [7] [22].

The only perennial river 'Chambal' originating from the hills of Western Madhya Pradesh passes through this area and river Ujad has a stretch of 2 km from Mori (Bhimsagar dam) to Anghora. Owing to human activities, the water in some areas is being unfit for drinking and irrigation purposes.

The selected sites for the present study were the water of River Chambal at Rangpur, D/S (2 km from city) Kota and U/S Bhimsagar Dam on River Ujad, Jhalawar District of Hadoti Division.

2.0 MATERIALS AND METHODS

In this study, the water quality standards of different physico-chemical parameters such as pH, Temperature, Conductivity, Turbidity, Fecal coliform, Total dissolved solids, Biochemical Oxygen Demand, Chemical Oxygen Demand, Total Alkalinity, Total Hardness, Calcium, Potassium, Sodium, Magnesium, Nitrate, Sulphate, Phosphate, Chloride , Fluoride, and Boron dissolved and their statistical interpretation for

domestic and agriculture purpose were evaluated for water of River Chambal at Rangpur, Kota D/S (2 km from City) and U/S Bhimsagar Dam on River Ujad, Jhalawar District of Hadoti Division.

Twelve sample readingswere considered for water of River Chambal at Rangpur, D/S (2 km from city) and U/S Bhimsagar Dam on River Ujad, Jhalawar District collected from Rajasthan Pollution Control Board, Jaipur's Web-Site. Water sample readings were analyzed throughout the consecutive two year for various physico-chemical parameters using standard methods recommended by American Public Health Association [1]. There are various methods to determine different physical and chemical parameters.

National Water Monitoring Programme(NWMP) of Rajasthan State Pollution Control Board, Jaipur produces environmental report of different physico- chemical parameters for different stations of Rajasthan State. All Sample readings for different physico-chemical parameters were reported at Regional Laboratory, Kota.

In this study, twelve sample readings were considered for two consecutive years 2018 and 2019 i.e. six sample readings for each year with even months for water of River Chambal at Rangpur, Kota district D/S (2 km from city) with station Code-1289 [21] and U/S Bhimsagar Dam on River Ujad, Jhalawar District with station code-2946.[22]

3.0 RESULT AND DISCUSSION:

3.1 Water Quality Parameters

Different physico-chemical parameters were reported in 12 samples i.e. 6 samples for 2018 year and 6 samples for 2019 year and were analyzed for the following parameters:

pH, Temperature, Conductivity, Turbidity, Fecal coliform, Total dissolved solids, Biochemical Oxygen Demand, Chemical Oxygen Demand, Total Alkalinity, Total Hardness, Calcium, Potassium, Sodium, Magnesium, Nitrate, Sulphate, Phosphate, Chloride , Fluoride, and Boron dissolved

3.2 Water quality criteria for irrigation

The suitability of water for agricultural use is determined by its quality for irrigation purpose. The quality of water for irrigation purpose is determined by the concentration and composition of dissolved constituents in water. Quality of water is an important aspect in any appraisal of salinity or alkalinity conditions in an irrigated area. Good soil and water management practices result in good quality of water which can promote maximum yield of crop.

Total dissolved Solids and the sodium content in relation to the amounts of calcium and magnesium or SAR [2] determines the suitability of water for irrigation. The suitability of groundwater for irrigation use was evaluated in the form of salinity by different statistical calculations such as (Sodium absorption ratio (SAR), soluble sodium percentage (SSP) and Chloro alkaline indices(CAI).

Statistical Representation of Water Parameters

3.2.1 Sodium Absorption Ratio(SAR):SAR is an vital parameter given by Richard in 1954[19]. The basic concept behind the sodium absorption is to find out the soil alkalinity of water used for irrigation purposes[12].

SAR (Sodium Absorption Ratio) = $\frac{Na}{\sqrt{\frac{Ca+Mg}{2}}}$

Note: Ca^{2+}, Mg^{2+} and Na^{+} are expressed in mg/l.

3.2.2 Chloro Alkaline Indices (CAI): Chloro alkaline indices is used to calculate the base exchange proposed by Schoeller[20]. Chloro alkaline indices are used to calculate ion exchange between the water and its surrounded area.

It is measured by following equation CAI = $[Cl^- - (Na^+ + K^+)/Cl^-$

Note: all ionic concentrations are measured in mg/l.

- CAI >0 : No Base Exchange reaction i.e. there is any existence of anion cation exchange type of reactions.
- CAI <0 : Exchange between sodium and potassium in water with calcium and magnesium in the rocks by a type of Base Exchange Reactions[17]

3.2.3 Percentage Sodium (%Na) = A method used for rating the irrigation waters which is utilized on the basis of percentage and electrical conductivitygiven by Wilcox[24].

It is calculated by the formula:- %Na = $\frac{(Na+K)}{Na+K+Mg+Ca} \times 100$

Note: All ionic concentrations are expressed in mg/l.

3.2.4 Kelly's ratio (KR) :Kelly ratio represents the assessment ratio for calculating the suitability

of water for agriculture purpose. The suitability and unsuitability of water for agricultural purpose on basis of KR is due to alkali hazards [9].

Kelly's ratio was calculated by using the following expression

Kelly Ratio(KR) = $\frac{Na}{(Ca+Mg)}$

KR ≤1 : Appropriate for irrigation and shows good quality

KR>1 : Unappropriate for irrigation purposes

Note: All ionic concentrations are reported in mg/l.

3.3.5 Calculation of Indices: Langelier Saturation Index (LSI)

LSI is an equilibrium index that indicates the corrosivity of water. The measure of the ability of a solution to deposit or dissolve calcium carbonate is expressed as the Langelier saturation index and given by Langelier. It is explained with the use of pH [13].

- LSI <0 : No potential scale develops andwater will dissolve $CaCO_3$.
- LSI >0 : Scale formation occurs in $CaCO_3$ precipitate form.
- LSI = 0 : Border line scale potential develops.

To calculate LSI, value of total alkalinity (as $CaCO_3$), Calcium hardness as $CaCO_3$), total dissolved solids (TDS) and value of pH and temperature of water (°C) required.

Note: All ionic concentration are expressed in mg/l.

LSI = pH – pHs

pHs is defined as the pH at saturation in calcite or calcium carbonate.

It is calculated by following formula

pHs = (9.3 + P + Q) – (R + S)

where $P = (\log_{10}[TDS] - 1)/10$

$Q = -13.12 \times \log_{10}(°C + 273) + 34.55$

$R = \log_{10}[\text{CaHardness as } CaCO_3] - 0.4$

$S = \log_{10}[\text{Total alkalinity as } CaCO_3]$

We can calculate LSI by help of these equations.

LSI is helpful in predicting the scaling or corrosive tendencies of the water.

- Negative value of LSI indicates water dissolves $CaCO_3$and shows corrosiveness.
- Positive value of LSI indicatesscaling propensity and water deposits calcium carbonate.

Table -1Statistical Analysis of Various Water Sample Readings of Chambal River, Kota

Statistical Parameters	2018						2019					
	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11	S-12
	Feb	April	June	Aug	Oct	Dec.	Feb	April	June	Aug	Oct	Dec.
SAR	15.62	29.7	15.61	8.57	9.77	13.45	12.4	11.9	13.4	10.60	7.75	11.3
CAI	0.67	0.36	0.66	0.54	0.60	0.33	0.59	0.19	0.332	0.14	0.40	0.36
%Na	60.9	73.5	59.6	49.7	50.6	55.2	55.4	54.7	59.2	61.5	52.6	60.4
KR	1.4	2.7	1.4	0.94	0.99	1.2	1.21	1.13	1.34	1.47	1.03	1.42
LSI	0.67	0.95	0.99	-1.32	0.44	1.01	0.61	0.87	1.015	-0.26	-0.37	0.06

Note: All ionic concentrations are expressed in mg/l.

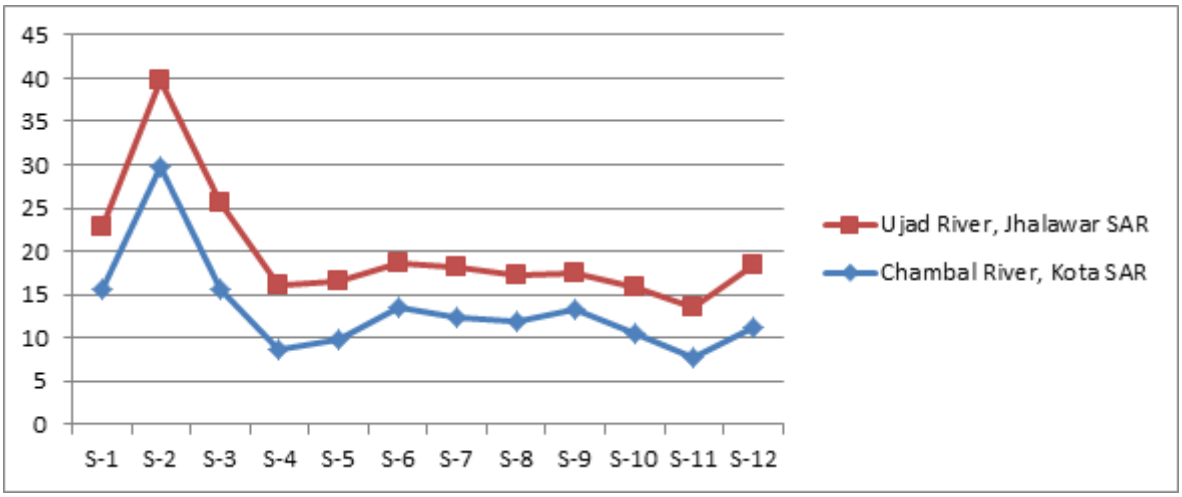
Table-2Statistical Analysis of Various Water Sample Readings of Ujad River, Jhalawar

Statistical Para	2018						2019					
	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11	S-12
	Feb	Apr	Jun	Aug	Oct	Dec.	Feb	Ap	Jun	Aug	Oct	Dec

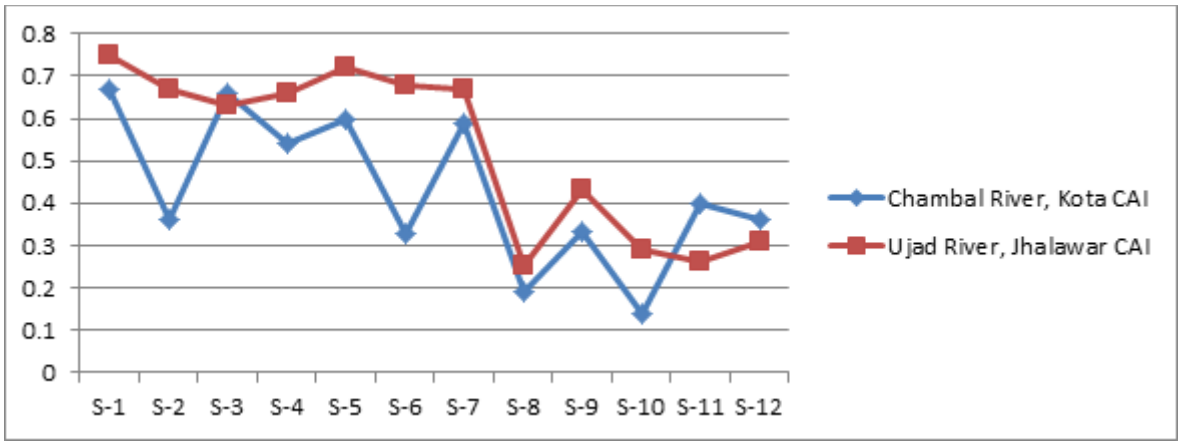
meters								r				
SAR	7.26	10.09	10.08	7.44	6.79	5.16	5.71	5.42	4.16	5.22	5.82	7.15
CAI	0.75	0.67	0.63	0.66	0.72	0.68	0.67	0.25	0.43	0.29	0.26	0.31
%Na	47.5	53.0	52.9	51.3	37.2	39.9	40.0	38.8	34.0	44.1	45.3	51.8
KR	0.88	1.11	1.08	0.99	0.55	0.63	0.64	0.59	0.48	0.74	0.77	1.00
LSI	-0.05	0.50	0.74	-0.52	-0.26	-0.23	0.00	0.27	0.63	-0.64	-0.24	-0.08

Note: All ionic concentrations are expressed in mg/l

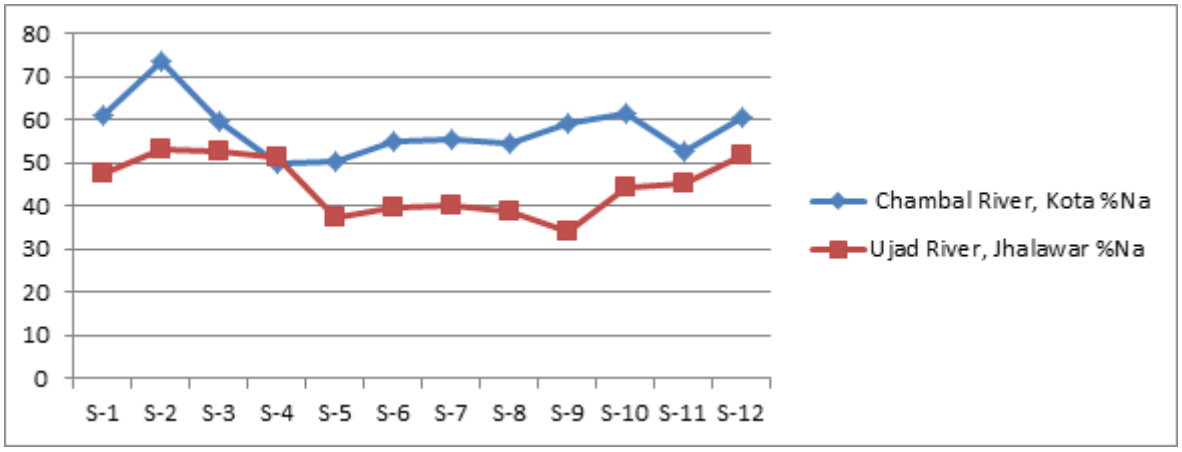
Graph-1 Statistical analysis SAR of various water samples S-1 to S-12 of Kota and Jhalawar Districts



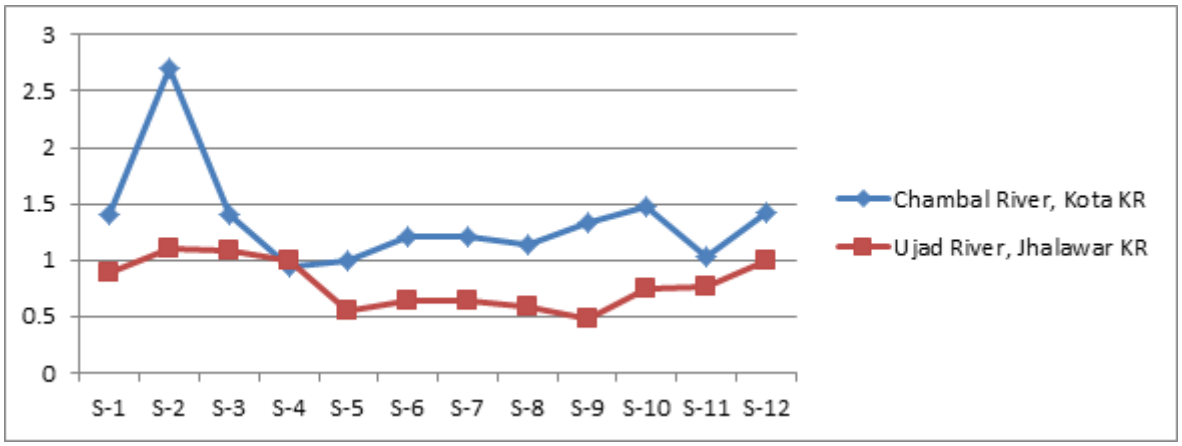
Graph-2 Statistical analysis CAI of various water samples S-1 to S-12 of Kota and Jhalawar Districts



Graph-3 Statistical analysis of % Na of various water samples S-1 to S-12 of Kota and Jhalawar Districts



Graph-4 Statistical analysis KR of various water samples S-1 to S-12 of Kota and Jhalawar Districts



Graph-5 Statistical analysis LSI of various water samples S-1 to S-12 of Kota and Jhalawar Districts

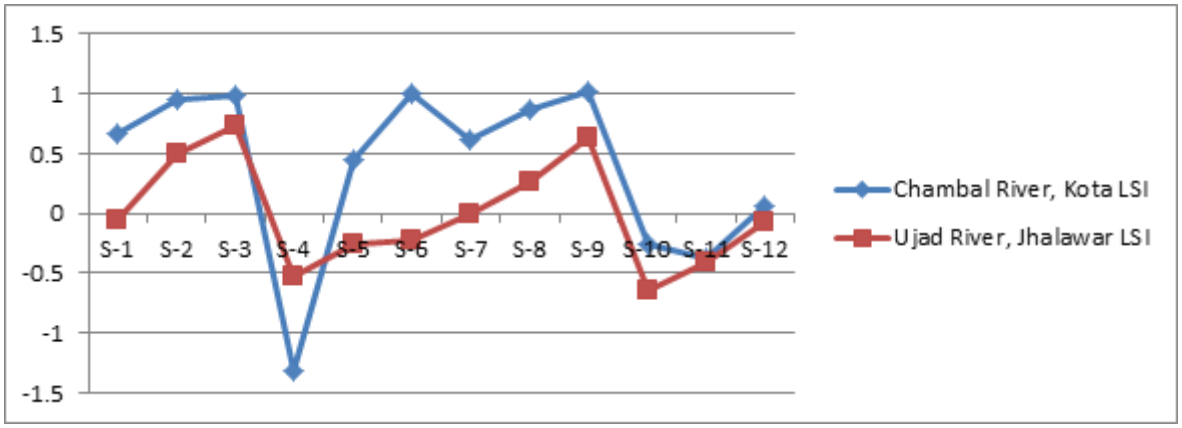


Table-3Comparison of Water Samples on the basis Statistical Analyses Parameters

Statistical Analysis Parameters	Categories	Range	No. of Samples Chambal River, Kota		No. of Samples Ujad River, Jhalawar	
			2018	2019	2018	2019
Sodium Absorption Ratio(SAR)	Excellent Good Fair Poor	0-10 10-18 18-26 >26	2 3 1`	1 5 	4 2 `	All
ChloroAlkanineIndices(CAI)	Base Exchange Reaction Cation Exchange Reaction	Negative Value Positive Value	NIL All	NIL All	NIL All	NIL All
Sodium Percentage(%Na)	Excellent Good Permissible Doubtful Unsuitable	0-20 20-40 40-60 60-80 >80	 4 2	 4 2	 2 4 	 3 3
Kelly Ratio(KR)	Suitable Marginal Suitable Unsuitable	<1 1-2 >2	2 3 1	 All 	4 2 	5 1

4.0 CONCLUSION

From the observations made in the study, the following conclusions are drawn:

- All the samples readings come near to the permissible range for drinking and irrigation use apart few samples which are exceeding the limit due to anthropogenic activities. In some cases, there was increase or decrease shown in readings which was due to change in weather.
- On the basis of statistical analysis, that all samples are alkaline in nature and are present in permissible range and it shows requirement of mild conditioning agents for drinking and industrial purposes.
- With the exception of some samples, the concentrations of cations and anions are within the permitted limits for drinking water guidelines.
- The suitability of water for irrigation is evaluated based on SAR, CAI, % Na,KR and salinity hazards. Most of the samples fall in the suitable range for irrigation purpose based on SAR, CAI, % Na and KRvalues, but very few samples that are exceeding the permissible limits like Kota in April'2018, S-2 sample had high value of SAR, KR % sodium. In 2019 also, Sodium percentage of sample S-10 and S-12 were in doubtful category but under control. Samples of River Chambal showed more deviation from standard values than River Ujad. These variations are observed to be in different kind of geological areas and different anthropogenic activities were carried in the study area.

This study will be helpful in sustainable development of water sources in Rangpur area of district Kota and Bhimsagar dam at Ujad River, Jhalawar, Rajasthan.

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