International Journal of Lakes and Rivers.
ISSN 0973-4570 Volume 13, Number 1 (2020), pp. 35-42
© Research India Publications
http://www.ripublication.com/ijlr.htm

Statistical Analysis for Urban lakes of Hadoti Region, Rajasthan

Sohil Sisodiya*[1], Renu Kumari Mehar [2a], Anil K. Mathur [2b]

[1] Assistant Professor, Department of Civil Engineering, University Departments, RTU, Kota - 324010, Rajasthan, India.*

[2 a] Graduate Student, Department of Civil Engineering, University Departments, RTU, Kota - 324010, Rajasthan, India.

[2 b] Professor, Department of Civil Engineering, University Departments, RTU, Kota - 324010, Rajasthan, India.

Abstract

This paper undertakes a brief review of all the lakes of the Hadoti region. The area is already semi-arid and thus indicating high regard for the usage of lakes for future generations in concurrence with sustainable development. Statistical analysis proves an important tool in order to address these issues. Water quality being an important parameter influencing the ecological as well as the recharge potential of these sites have found to be impacted with Spatio-temporal variations. The variations have been analyzed over Pre-Monsoon and Post-Monsoon scenarios. Correlation matrix and Analysis of Variance (ANOVA) report significant changes over water quality variables and reinforce the idea of protecting lakes situated in urban environments, so as to make them an ideal recharge potential site. The study will help the stakeholders to properly plan the monitoring variables and also give significant weightage to first showers which may have drastic effects over self-purification aspects of the lakes.

Keywords: Statistical Analysis, Urban lake, Water quality.

1. INTRODUCTION

Water is an important resource and its importance increases significantly especially in semi-arid and arid areas. 'Urban Lakes' are often referred to as small water bodies within the city limits(Sharma, Kanakiya and Singh, 2015) or maybe occurring naturally with certain urban geographic conditions. They serve as principle sites for recreational activities as well as for a groundwater recharge source (Gupta, Jain and Gupta, 1999). Water quality parameters, thus play a significant role (Pradesh, 2014). According to CPCB (cpcb.nic.in), various parameters are to be frequently monitored for having a brief idea considering ecological aspects of the lake under consideration. Independent studies have been carried out for groundwater quality but have been limited or restricted to Kota city(Jain, Mehta and Duggal, 2016), with the present study the area for Hadoti is dealt with, so as to get a better understanding of the urban regions. Statistical analysis proves an important tool for understanding water quality aspects(Bhat et al., 2014). They not only help to have a brief picture of the quality parameters but, help to derive significant important correlations between various important parameters via means of brief statistical tests or methods(Bhat et al., 2014),(Pradesh, 2014). There has been a proven basis of linkage between Spatio-temporal variability and water quality parameters(Bhat et al., 2014). Statistical analysis help to understand the water quality as well as the ecological status of the regime which may be further linked to anthropogenic factors and climatic factors as well(Shrestha and Kazama, 2007). The present study focuses on using correlations between parameters and leading to subsequent identification of variation between the water quality aspects of urban lakes throughout the Hadoti region.

2. MATERIALS AND METHODS

2.1 Materials

2.1.1. Study Area

The study area involves Hadoti region which comprises of Kota, Bundi, Baran and Jhalawar districts. Kota has Kishore Sagar Lake, Jhalawar has Khandiya Lake, Bundi has Jait Sagar Lake and Baran has Dol Lake. All water bodies are situated in city limits and are facing constant human encroachments in their catchments due to increasing urbanization. Figure 1 shows the details of the study area. The current study will help to identify deteriorating conditions of the lakes and will subsequently play an important role in mitigation measures to be adopted for rejuvenation measures in coming future.

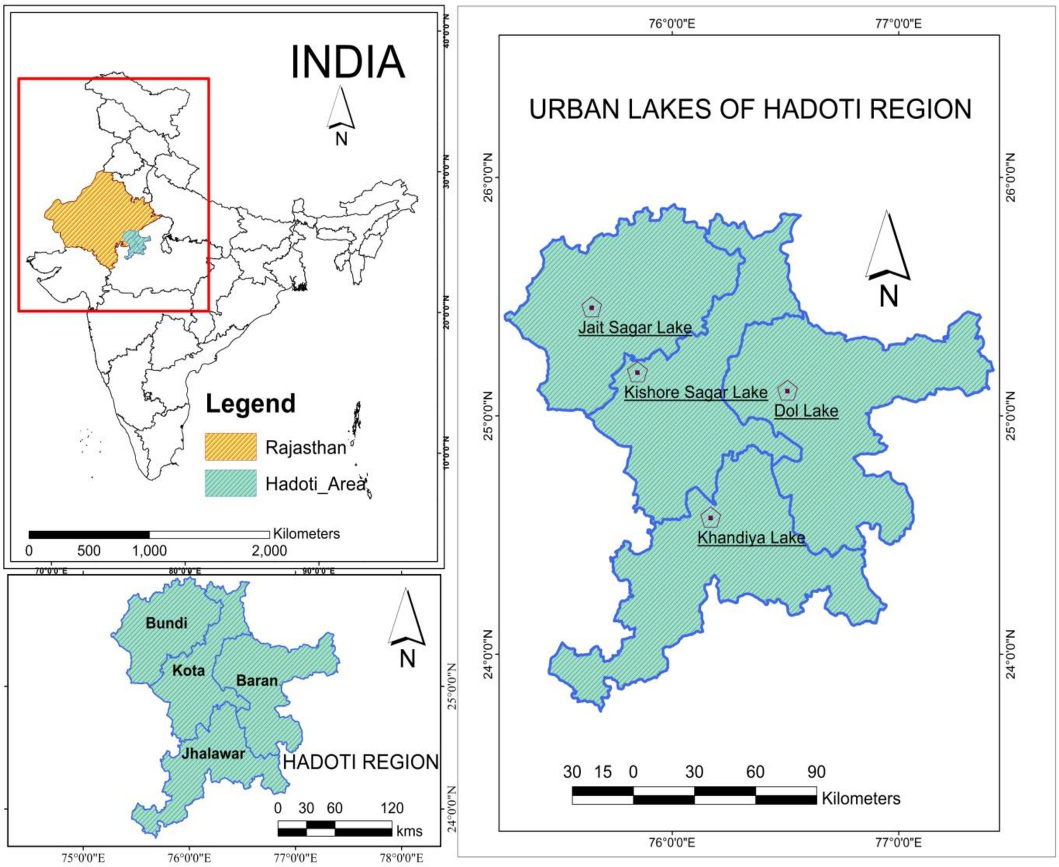

Figure 1: Urban lakes of Hadoti Region

2.2. Methods

2.2.1. Data Collection

All samples were collected and analyzed in the lab and confirm to Standard methods for the examination of water and wastewater by APHA(APHA 1998). Samples for pH, EC, Turbidity, Total Hardness, TDS, Nitrate, Iron, Fluoride, Sodium, Potassium, Calcium, magnesium, and alkalinity samples were collected and analyzed in the lab over a period from April 2019 to February 2020. These parameters are shown in Table 1 and give a brief idea of the physico-chemical characteristics of the lake sites.

2.2.2. Statistical Analysis

With the primary objective of evaluating significant differences among the lakes for the given water quality variables, a two-way Analysis of Variance (ANOVA) at 0.05% level of significance is been adopted (Myers 2010). In order to observe the parameter influence over one another, the correlations matrix is also been worked out. MS-Excel is briefly being used for data analysis. In order to understand temporal effects, analysis is been carried out over pre-monsoon and post-monsoon scenarios which gives a brief picture of the quality aspects for different lake sites.

Table 1: Parameters for Urban lakes of Hadoti Region

Parameters	pH	Turbidity	EC	Total Hardness	T.D.S.	Nitrate	Iron	Na^+	K^+	$HCO3^-$	Ca^{2+}	Mg^{2+}	F^-	
MAX	8.2	15.6	450	175	772	5	0	28	3.3	137	80	50	1.5	**Kishore Sagar Lake, Kota**
MIN	7.6	13	343	100	234	1	0	21	2.79	110	26	27	0.13	
MEAN	7.89	14.40	389.75	143.25	389.75	3.25	0.00	23.75	3.04	126.50	56.25	34.00	0.55	
SD	0.25	1.14	54.14	31.34	257.35	1.71	0.00	3.10	0.22	11.56	23.95	10.74	0.64	
MAX	7.95	14.4	323	110	1584	25	0.1	39	3.9	152	80	20	0.18	**Dol Lake, Baran**
MIN	6.6	9.2	189	75	144	10	0	31	2.7	70	8	18	0	
MEAN	7.19	11.40	233.00	92.00	527.75	19.50	0.05	35.00	3.15	125.00	46.75	19.25	0.11	
SD	0.58	2.32	62.03	14.58	705.09	6.86	0.04	3.65	0.53	37.89	29.57	0.96	0.08	
MAX	7.7	11.7	505	145	698	15	0.1	29	2.8	198	120	70	0.75	**Khandya Lake, Jhalawar**
MIN	7.3	10	386	70	289	10	0	21	1.9	148	34	15	0.15	
MEAN	7.55	11.05	428.25	116.25	438.25	12.50	0.03	25.25	2.38	174.00	97.75	33.00	0.32	
SD	0.19	0.76	52.51	34.49	180.31	2.08	0.05	3.30	0.40	20.85	42.52	25.02	0.29	
MAX	7.41	10	394	145	674	5	0.3	23	2.1	172	125	40	0.7	**Jait Sagar Lake, Bundi**
MIN	7.2	3.7	368	128	258	2	0	17	1.5	125	105	19	0.18	
MEAN	7.35	7.43	380.25	137.00	369.00	3.50	0.13	20.00	1.78	156.25	115.50	29.25	0.34	
SD	0.10	2.78	13.18	7.26	203.47	1.29	0.13	2.58	0.28	21.42	9.54	9.18	0.24	

Table 2: Correlation Matrix Parameters for Pre-Monsoon Seasons

	pH	*Turbidity*	*EC*	*Total Hardness*	*T.D.S.*	*Nitrate*	*Iron*	*Na^+*	*K^+*	*$HCO3^-$*	*Ca^{2+}*	*Mg^{2+}*	*F^-*
pH	1												
Turbidity	**0.868**	1											
EC	0.640	0.296	1										
Total Hardness	0.763	0.573	**0.932**	1									
T.D.S.	-0.304	0.035	-0.925	-0.799	1								
Nitrate	-0.510	-0.311	-0.925	-0.945	**0.919**	1							
Iron	-0.903	-0.878	-0.263	-0.416	-0.123	0.095	1						
Na+	-0.103	0.182	-0.819	-0.693	**0.974**	**0.878**	-0.330	1					
K+	0.427	0.761	-0.389	-0.093	0.673	0.356	-0.706	0.757	1				
HCO3-	-0.249	-0.599	-0.084	-0.415	0.043	0.401	0.145	0.090	-0.452	1			
Ca2+	-0.423	-0.704	0.422	0.172	-0.723	-0.455	0.741	-0.826	-0.983	0.279	1		
Mg2+	0.446	0.445	0.723	0.871	-0.721	-0.923	-0.084	-0.720	-0.114	-0.720	0.264	1	
F-	**0.803**	0.625	**0.915**	**0.998**	-0.758	-0.921	-0.475	-0.643	-0.029	-0.427	0.106	**0.855**	1

Table 3: Correlation Matrix Parameters for Post-Monsoon Seasons

	pH	*Turbidity*	*EC*	*Total Hardness*	*T.D.S.*	*Nitrate*	*Iron*	*Na^+*	*K^+*	*$HCO3^-$*	*Ca^{2+}*	*Mg^{2+}*	*F^-*
pH	1												
Turbidity	0.490	1											
EC	0.358	-0.204	1										
Total Hardness	0.420	-0.536	0.265	1									
T.D.S.	0.325	-0.227	**0.999**	0.255	1								
Nitrate	-0.561	0.347	-0.165	-0.975	-0.148	1							
Iron	-0.417	-0.942	-0.055	0.649	-0.038	-0.510	1						
Na^+	-0.656	0.333	-0.631	-0.889	-0.616	**0.868**	-0.334	1					
K^+	0.063	**0.887**	-0.550	-0.757	-0.561	0.593	-0.800	0.711	1				
$HCO3^-$	0.145	-0.544	**0.932**	0.446	**0.939**	-0.293	0.306	-0.683	-0.805	1			
Ca^{2+}	0.049	-0.626	**0.891**	0.450	**0.901**	-0.281	0.391	-0.648	-0.846	**0.994**	1		
Mg^{2+}	0.757	0.206	**0.870**	0.284	**0.853**	-0.296	-0.363	-0.690	-0.247	0.677	0.594	1	
F^-	0.742	-0.066	0.107	0.874	0.082	-0.959	0.259	-0.819	-0.360	0.142	0.105	0.372	1

Table 4: ANOVA Test for Pre-Monsoon Seasons

ANOVA: Two-Factor

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
pH	4	30.185	7.546	0.030
Turbidity	4	45	11.250	3.750
EC	4	1405	351.250	11814.083
Total Hardness	4	512	128.000	822.333
T.D.S.	4	2432.5	608.125	30468.063
Nitrate	4	39.5	9.875	79.729
Iron	4	0.275	0.069	0.004
Na+	4	96.5	24.125	33.729
K+	4	9.52	2.380	0.361
HCO3-	4	602.5	150.625	276.229
Ca2+	4	255	63.750	1514.917
Mg2+	4	92.5	23.125	21.063
F-	4	1.945	0.486	0.112
KST	13	1388.535	106.810	31868.038
Dol Lake	13	1419.975	109.229	55164.756
Khandya Lake	13	1404.175	108.013	30657.526
Jait Sagar Lake	13	1309.740	100.749	23892.587

ANOVA SUMMARY

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Parameters	1564444.778	12	130370.398	34.882	3.42102E-16	2.033
Lakes	553.098	3	184.366	0.049	0.985267656	2.866
Error	134550.109	36	3737.503			
Total	1699547.99	51				

Table 5: ANOVA Test for Post-Monsoon Seasons

ANOVA: Two-Factor

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
pH	4	29.75	7.4375	0.192291667
Turbidity	4	43.55	10.8875	15.770625
EC	4	1457.5	364.375	5906.229167
Total Hardness	4	465	116.25	485.4166667
T.D.S.	4	1017	254.25	2973.416667
Nitrate	4	38	9.5	50.16666667
Iron	4	0.125	0.03125	0.002239583
Na+	4	111.5	27.875	49.72916667
K+	4	11.15	2.7875	0.477291667
HCO3-	4	561	140.25	1300.25
Ca2+	4	377.5	94.375	809.8958333
Mg2+	4	138.5	34.625	125.5625
F-	4	0.7	0.175	0.000566667
KST	13	996.2	76.63076923	11360.77064
Dol Lake	13	820.325	63.10192308	7091.461715
Khandya Lake	13	1288.96	99.15076923	20422.68751
Jait Sagar Lake	13	1145.79	88.13769231	14896.92455

ANOVA SUMMARY

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Parameters	619438.9	12	51619.90911	71.96300323	1.92E-21	2.032703
Lakes	9328.105	3	3109.368459	4.334751772	0.010446	2.866266
Error	25823.22	36	717.3117685			
Total	654590.2	51				

3. RESULTS AND DISCUSSION

Parameters responsible for the change in water quality have been easily identified due to the correlation matrix (Shrestha and Kazama, 2007). Correlation matrix reveals that for pre-monsoon seasons, parameters like pH, Turbidity, EC, TDS, nitrate, fluoride, and magnesium have strong correlations whereas for post-monsoon parameters change to calcium, magnesium, potassium, alkalinity with EC and Total Hardness indicating the increase of inflow due to runoff generated in the catchment.

ANOVA helps to identify the trend with respect to location and its influence among the parameters.(Pradesh, 2014) Thus, resulting in the identification of differences and the associated water quality variables. Pre-Monsoon test indicates that there is a strong effect over parameters indicating a strong Spatio-temporal variation, however, for a given lake, the relation reveals that the parameters do not show huge variations.

However, this trend changes significantly in the post-monsoon scenario, where the effect almost doubles for the lakes and shows a relation amongst the parameters indicating a change in water quality due to the inflow of runoff during post-monsoon periods.

These results cumulatively indicate that the lakes although being in almost identical urban environments show a significant change in water quality which may affect the recharge potential as well as ecological aspects of the lake.

4. CONCLUSION

Anthropogenic impacts play a major role in the water quality aspects of the lakes. (Bhat et al., 2014) They indicate that catchment treatments have a direct bearing on the aquatic nature of the lakes. Thus, in today's scenario for the urban situations where the lakes face a constant threat against encroachments and runoff playing an important parameter for inflow in the lake. With the current research, It becomes quite evident, that proper water quality monitoring studies should be conducted so as to ensure proper sustainable development for the urban environments under consideration. First showers need to be checked so that the self-purification potential of the lake is not disturbed and the quality aspects are maintained.

CONFLICT OF INTERESTS

The authors declare no conflict of interests regarding the publication of this study.

ACKNOWLEDGMENTS

The authors are grateful to Rajasthan Technical University for providing laboratory facilities required for the analysis of the samples.

REFERENCES

[1] Bhat, S. A. *et al.* (2014) 'Statistical Assessment of Water Quality Parameters for Pollution Source Identification in Sukhnag Stream: An Inflow Stream of Lake Wular (Ramsar Site), Kashmir Himalaya', *Journal of Ecosystems*, 2014, pp. 1–18. doi: 10.1155/2014/898054.

[2] Gupta, A. B., Jain, R. and Gupta, K. (1999) 'Water quality management for the Talkatora Lake, Jaipur - A case study', *Water Science and Technology*. International Association on Water Quality, 40(2), pp. 29–33. doi: 10.1016/S0273-1223(99)00427-8.

[3] Jain, N., Mehta, A. and Duggal, R. (2016) 'Groundwater quality and its suitability for DCM Industrial', 3(2), pp. 392–398.

[4] Pradesh, M. (2014) 'Physico-chemical analysis of upper lake water in Bhopal region of', 5(5), pp. 165–169.

[5] Sharma, J. N., Kanakiya, R. S. and Singh, S. K. (2015) 'Limnological Study of Water Quality Parameters of Dal Lake, India', *International Journal of Innovative Research in Science, Engineering and Technology*, 4(2), pp. 380–386. doi: 10.15680/IJIRSET.2015.0402078.

[6] Shrestha, S. and Kazama, F. (2007) 'Assessment of surface water quality using multivariate statistical techniques: A case study of the Fuji river basin, Japan', *Environmental Modelling and Software*, 22(4), pp. 464–475. doi: 10.1016/j.envsoft.2006.02.001.

[7] American Public Health Association (1998). Andrew D. Eaton et al., Standard Methods for the Examination of Water and Wastewater. Washington, DC: American Public Health Association.

[8] Introduction to Statistics and Data Analysis, Myers, R.(9780840068415), 2010, BROOKS COLE Publishing Company.

[9] http://www.cpcb.nic.in/ accessed on 05 July 2020.