ASSESSMENT OF PHYSICO-CHEMICAL CONTAMINANTS IN SURFACE WATERS OF KSHIPRA RIVER AT UJJAIN, M.P

Deependra Singh Raghuwanshi
Department of Chemistry, Government Madhav Science College, Ujjain, M.P. India

Abstract: The entry of toxins and impurities into fresh water ecosystem can start out a series of complex chemical and biological reactions. In order to be aware of how and why these reactions occur and to manage an ecosystem effectively, a thorough knowledge of the structure and basic functioning of that particularecosystem is essential. The present investigation is aimed to study the prevalence of various contaminants of holy River, Kshipra at Ujjain, Madhya Pradesh, India. 18 samples from three different study stations were analyzed for six chemical parameters like pH, DO, TDS, NO_3, SO_4 and PO_4, during summer of 2017. The data points were examined by multiple correlation regression analysis using windows xlstat software to spot the extremely correlated and consistent water quality parameters. The result point out that the mean values of all the estimated parameters are exceeded the acceptable limit set by ICMR/BIS. The results revealed that estimated physico-chemical parameters of all study stations were higher than the standard limits of BIS/WHO, which indicates the poor quality of the river. Overall, the water quality of Kshipra River was relatively poor with respect to its use for domestic purposes.

Keywords: Contaminants, Kshipra River, Ujjain.

Introduction: Water is one of the most crucial resources, which act as a media for both chemical and biochemical reactions. Pollution of fresh water bodies has become a notable and international problem. The major sources of drinking water in India are frequently polluted by the actions of the neighbouring populations and industrial formations [1 [2] [3] [4].

The rapid development of urban zones has further affected the surface water quality The over exploitation, misuse of fresh water and improper waste disposal practices due to rapid increase in industrialization and urban development further affected the surface water quality. The amount of pollution is computable physically, biologically and chemically to identify the responsible parameter in the water quality management programmes [5] [6] [7]8[9]. Hence, a complete river water quality-monitoringagenda is fetching a necessity in order to maintain public health and to protect the valuable biological resources. The Kshipra River is considered as sacred River of Madhya Pradesh as thousands of pilgrims take a holy dip all the year round. However, the dumping of untreated wastes has not only affected the quality of the river water but has intensified the water crisis in the region. This perennial river has lost its glory, like many other rivers in India in the past few decades. The municipal sewage of Ujjain city and the industrial waste around Dewas town find their way into the Kshipra. Its waters, which once satisfied the city's thirst, are not even suitable for bathing no longer. Due to extreme economic activities in and around the Kshipra riverbed, the river flow has been severely affected. Industries, housing colonies and other economic activities have invaded the riverbed [10]. Domestic sewage network of Ujjain city is linked to the sewage pond on Badnagar Road, which then meets the Kshipra. The sewage pond treats only less than 50 percent of waste, and most of the unprocessed waste flows into the Kshipra.

Therefore, the present study is aimed to investigate the water quality of Kshipra River to establish the water quality status of the River, which will offer a base-line data to frame appropriate remedial action plan.

Materials and Methods: ***River***: The Shipra or Kshipra originates from Kokri Bardi hills (747metres high) near Indore. It streams roughly between latitude of 22°40′ and 23°50′as well as longitude of 75°

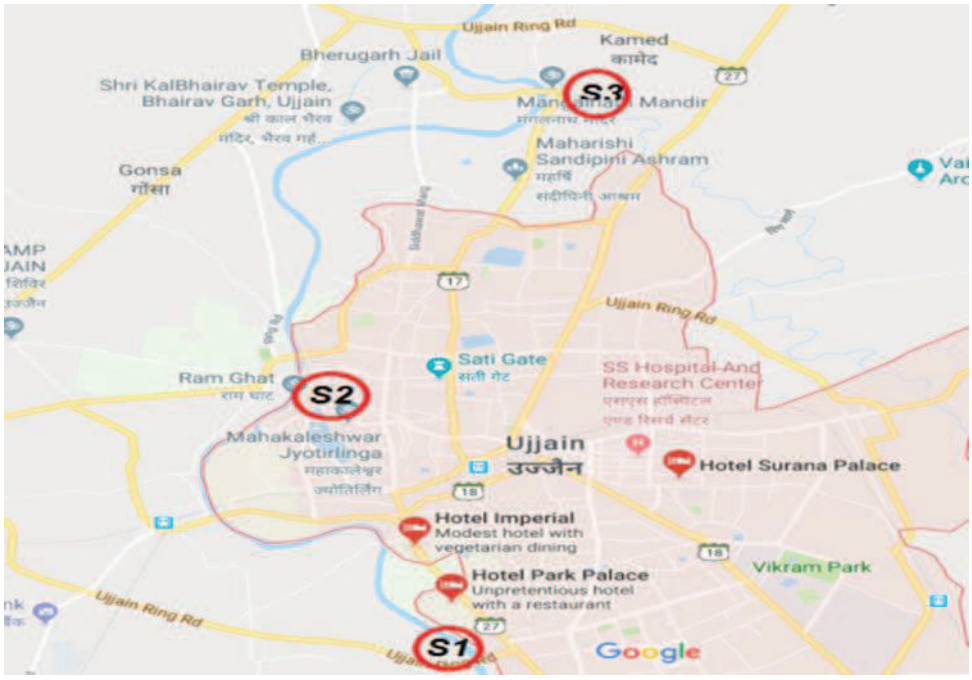
45′and 75°35′, north across the Malwa platue (Fig.1). It receives a tributary river Khan just upstream of Ujjain and river Gambhir near Mehidpur before merging with river Chambal. Total length of the river is about 195 kms [11]. River Khan coming from Indore city merges with it at Triveni Sangam. River Khan is the biggest source of contamination to River Kshipra carrying high organic content, chemicals and heavy metals.

Sampling stations: Sampling stationsare selected in such a way to cover major points of River so that results acquired will represent the true status of the river.

Station A: ***Triveni Sangam***: This is the place where River Khan combines with Kshipra River. River Khan is the major source of contamination to River Kshipra carrying high organic content, chemicals and heavy metals. It is also a major site for bathing. Dumping of flowers, coconuts and performance of rituals by dippers is also evident on this site due to presence of Shani mandir.

Station B: Ramghat: It is the ancient bathing ghat and located near Mahakaleswar temple. Thousands of citizens take a holy dip daily and dump a mixture of puja materials like flowers, and coconuts. Performance of rituals by dippers is also evident in this site. It is around 10 km away from the station A.

Station C. Mangalnath Ghat: It is situated in the north of Ujjain on the banks of river Kshipra near the auspicious mangalnath temple, around 6 km away from station B. The main livelihood of people in this province is printing and dyeing cotton textiles. Many used chemicals, dyes, detergents, waxes, starch and cellulose and its effluent is directly thrown into the river without treatment.



The surface water samples were collected at about 10 cm below the surface in summer months of 2017 in airtight glass bottles. They are immediately transported to the laboratory, and stored at 4 º C. Samples were analysed for various water quality parameters like temperature, pH, dissolved oxygen (DO), transparency, nitrate, phosphate and sulphate by means of the standard method of APHA (1998) [12] within 24 hours of sample collection. pH of the water samples was measured at the site during sampling. Other samples like DO, TDS, NO_3, SO_4 and PO_4 content were determined using the standard method of APHA [12]. Numerical computations like arithmetic mean, standard deviation and standard error, correlation and regression analysis were calculated by using XLSTAT 2010 Excel add-in Window software [13]. The natures of correlations between parameters were determined based on the correlation

coefficient obtained. Data obtained from chemical analysis compared with WHO/ICMR/BIS [14] [15] [16] procedure.

Results: The numerical analysis with respect to range, mean, SD and SE values for surface water quality parameters of Kshipra River are summarized in Table.1. Significant variations in water quality parameters were observed among three study stations due to variation in pollution load and different hydrographic environment. River water quality parameters (Table 1) were evaluated through a correlation matrix, which shows that all the measured parameters were found to be significantly ($p < 0.01$) correlated with the other samples except pH. The correlation matrix analysis reveals that pH has shown positive correlation with all parameters except DO (-0.90293). It is exhibited highly positive correlation with nitrate (0.951613), phosphate (0.764265), sulphate (0.633519) and TDS (0.147301). DO shown negative correlation with all studied parameters (Table.2) while Nitrate exhibited positive correlation with sulphate and phosphate.

Table.1. Water Quality Data at three Sampling Stations of Kshipra River at Ujjain

	Study stations		
Parameter	A	B	C
pH	7.3± 0.31	7.8± 0.31	8.4 ± 0. 71
DO	5.4± 0.11	4.44± 0.4	4.5± 0.3
TDS	2124.2± 5.2	1924.2± 5.2	2318.7± 5.5
Nitrate	96.3± 1.8	99.3± 1.6	98.8± 1.4
Sulphate	228.2± 6.4	238.2± 9.4	231.4± 8.7
Phosphate	0.7±.0.001	0.74±.0.001	0.9±.0.001

Table 2: Correlation Matrix Analysis

	pH	Do	TDS	Nitrate	Sulphate	Phosphate
pH	1					
DO	-0.90293	1				
TDS	0.147301	-0.5581	1			
Nitrate	0.951613	-0.72717	-0.16377	1		
Sulphate	0.633519	-0.23949	-0.67197	0.84063	1	
Phosphate	0.764265	-0.96725	0.750445	0.529107	-0.0148	1

pH: According to ICMR and BIS standards the range of pH should lie between 6.5 to 8.5. If the pH is less than 6.5, it ceases the building of vitamins and minerals in the human body. In excess of 8.5 pH values cause the taste of water more salty and causes eye irritation and skin disorder for pH. The rainwater has no minerals useful for human body and has a pH of 5.5–6 and not harmful on used as drinking purpose. pH in the range 3.5–4.5 affects the aquatic life. From Table 1, it was clear that the range of the pH lies between 7.3 to 8.1, which follow the permissible standards specified by WHO, ICMR, and BIS. In the present study, a slight variation of pH is observed for all sampling stations (A-C) may be due to low annual variation in free CO_2. Our studies are in agreement with studies of physico chemical parameters of Chambal River at Nagda [17] [18] [19] [20].

Dissolved Oxygen (DO): The dissolved oxygen (DO) reveals the alterations happen in the biological parameters due to aerobic or anaerobic phenomenon and signifies the condition of the river/streams water for the purpose of the aquatic as well as human life [17] [18]. The aquatic life disturbed due to low values of DO [15] [16]. The range of 5–14.5 mg O_2/L was found to be suitable for the natural waters. The range of DO lies between 4 to 6 mg/L ensures better aquatic life in the water body [14] [15 [16]. In the present study, the DO values are found to be less than the standard limits of BIS/ICMR at station B and C (4.44 and 4.5mg/L). The low DO concentration in these sites was due to higher waste discharges and nutrient near by the river site, which enhanced the microbial activity occurring during the degradation of the organic matter. .This indicates that the effluent and domestic sewage containing high organic pollutants have invaded the groundwater, which decreases the dissolved oxygen content because of microbial activities.

Total Dissolved Solids (TDS): TDS is estimated for measuring the amount of solid materials dissolved in the water. High TDS values causes harmful effect to the public health such as the central nervous system, provoking paralysis of the tongue, lips, and, face, irritability, dizziness. The range of TDS falls between 500–1500 mg /L [14] [15 [16]. In the present study, the TDS values exceeded the standards of ICMR/BIS in all study stations and in both the seasons.

Nitrate-Nitrogen (NO_3-N): Different agricultural activities yield in the increase of nitrate concentration in ground and surface water [21]. Increase in the amounts of Nitrate-Nitrogen in surface water causes different problems such as level of oxygen in the water-decreased results in effects on the aquatic life, plants and algae [22]. Blue baby syndrome disease in human body occurred due to reaction of nitrite and iron in with red blood cell create methemoglobin that stops oxygen level. The children under age of 1 year suffered most due to consumption water contaminated with nitrate. The range of Nitrate-Nitrogen prescribed by ICMR, WHO, BIS are 20, 45, 45 mg/ L, respectively. In the present, study the nitrate values significantly higher than the standard limits.

Sulphate: Sulfates occur naturally in numerous minerals, including barite ($BaSO_4$), epsomite ($MgSO_4{\cdot}7H_2O$) and gypsum ($CaSO_4{\cdot}2H_2O$) [14]. These dissolved minerals contribute to the mineral content of many drinking waters. Sulfates are discharged into water from mines and smelters and from kraft pulp and paper mills, textile mills and tanneries. Atmospheric sulfur dioxide, formed by the combustion of fossil fuels and in metallurgical roasting processes, may contribute to the sulfate content of surface waters. Sulfur trioxide, produced by the photolytic or catalytic oxidation of sulfur dioxide, combines with water vapour to form dilute sulfuric acid, which falls as acid rain. The Sulphate content of natural waters is an important consideration in determining their suitability for public and industrial supplies. All the natural water contains sulphate ion. Maximum sulphate is recorded during the Monsoon season at the site where agriculture runoff merged to the river from nearby area. The upper limit for sulphate is 200mg/L (BIS). Beyond this causes gastro intestinal irritation. Sulphate values in the present study were much higher in all study stations than standards given by BIS/ICMR. Sulphurdioxide is used as a bleaching agent in textile industry acts as a pollution source for sulphate content. The effluent on percolation pollutes the ground water by increasing the sulphate level. This effluent during its flow may also carry the agricultural runoff containing sulphate fertilizers, which in turn increases the sulphate concentration in ground water [23].

Phosphate ($PO_43–$): Industrial and sewage waste create the pollution due to the presence of phosphates, which caused growth of nuisance for microorganisms. The maximum use of fertilizer is the main source of phosphate, which comes from agricultural or residential cultivated land into surface waters with storm runoff. High phosphate level causes muscle damage, problem with breathing and kidney failure [16]. The increase in phosphorus concentrations in the rivers leads to eutrophication and depletion of dissolved oxygen concentrations [24] The limit for phosphate phosphorus is 0.1 mg /L. The phosphate values in the present study also exceeded the standard limits of BIS/ICMR. The higher values may be due to the soil erosion from nearby area that also includes phosphates.

Ganasan, V. and Hughes, R.M [24] studied water quality in relation to fish assemblage in Shipra and Khan Rivers. Ahmad, et al [25] performed studies on the influence of dye industrial effluent on physico chemical characteristics properties of soil at Bhairavgarh near Ujjain. Manderia, S. and Manderia, K.H [26] conducted Qualitative studies on surface waters of Holy Kshipra River at Ujjain City (MP). Kumawat, D.M. and Sharma, M.K [27]. studied the quality Status of river Kshipra at Ujjain before its linkage with Narmada water. Bhasin, S., et al [28] studied deterioration in water quality of river Kshipra at Ramghat, of Ujjain during mass bath. Recently, Gangwar et al [29] also studied the changes in Physico-chemical Characteristic of River Kshipra during the Simhasth Festival. Our results are in accord with all the above workers.

Discussion:

Conclusions: The results of correlation analysis reveal the negative relationship of DO with other parameters, which implies high organic pollution with anthropogenic activities in the river basin.

Outcomes of this study revealed that point (municipal and industrial effluents) and nonpoint sources (agricultural runoff) are the chief contributors to organic and nutrient pollution in this River. Thus it can be concluded that the water of the Kshipra River at sampling sites pose serious threat to the ecosystem due to anthropogenic pollution. The correlation matrix analysis is supportive to regulatory agencies to spot individual factors responsible for deteriorating water quality. From this study, it is evident that Kshipra River is highly polluted due to discharge of industrial and domestic wastes at different spots during its flow from the origin. The results of present study Is useful to policy makers to prepare an action plan to prevent the pollution load of this sacred River. The results of the present study obtained in summer months but the values of water parameters may differ for other seasons. Hence, the outcome of this study could not be generalized. It just exhibits the conflicting tendency of the studied model. It is anticipated that our outcomes could be very useful to the local authorities for effective management of water quality of the River. Hence, there is an imperative need to implement suitable control measures to prevent and reduce the pollution to restore its old age glory.

References:

1. Reddy, P.B. and Baghel, B.S., 2010. Impact of Industrial Wastewaters on the Physicochemical Characteristics of Chambal River at Nagda, M. P., India. *Nature, Environment and Pollution Technology*, *9*(3), pp.519-526.
2. Reddy, P.B. and Baghel, B.S., 2012. Impact of Industrial wastewater on the Chambal River and Biomarker responses in fish due to pollution at Nagda. MP India. *DAV Int. J. Sci*, *1*(1), pp.86-91.
3. Reddy, P.B., 2012a. Histopathogical studies as potential and direct biomarkers of pollution. *Trends in Life sciences*, *1*(1), pp.27-31.
4. Reddy, P.B., 2012b. Evaluation of potential biomarkers for effluent induced hepatotoxicity. *International Journal on Applied Bioengineering*, *6*(2).
5. Gupta, R.C. and Ajay, K., 2012. Assessment of water quality status of holy river Kshipra using water quality index. *Journal of Indian Water Resources Society*, *32*(1-2), pp.1-7.
6. Sahu, G., Satpathy, K.K., Mohanty, A.K. and Sarkar, S.K., 2012. Variations in community structure of phytoplankton in relation to physicochemical properties of coastal waters, southeast coast of India.
7. Vajravelu, M., Martin, Y., Ayyappan, S. and Mayakrishnan, M., 2017. Seasonal influence of physico-chemical parameters on phytoplankton diversity, community structure and abundance at Parangipettai coastal waters, Bay of Bengal, South East Coast of India. *Oceanologia*.
8. Reddy, P.B.2017. Statistical approach for the assessment of water quality parameters of Chambal River at Nagda. Life Sciences International Research Journal, 4, Spl Issue, pp. 38-41.
9. Parmar, R.K. and Reddy, P.B., 2014. Assessment of surface water quality of Chambal River: A multiple linear regression analysis. *Periodic research, I, (3)*, pp.69-73.
10. https://scroll.in/article/746509.
11. Tyagi Aditya, Sharma M.K. and Bhatia K.K.S., 2003. "The study of temporal and spatial trends of water quality of river Kshipra using Water Quality Index", Environ. Hlth, 45, 1, 15-20.
12. APHA.1998.American Public Health Association Standard Methods for the Examination of Water and Wastewater. 20th. Ed. Washington, D.C.: APHA/AWWA/WPCF.
13. https://www.xlstat.com/.
14. WHO. 2006. Guidelines for drinking water quality, Reccomendations.Vol.1. 3rd Edn. pp. 491-493.
15. ICMR. 2000. http://icmr.nic.in/ethical_guidelines.pdf.
16. BIS. 2014. www.**bis**.org.in/qazwsx/cmd/Circular_14543_1408. **2014**.
17. Reddy, P.B.2017.Staistical approach for the assessment of water quality parameters of Chambal River at Nagda, Life Sciences International Research Journal Vol 4 Spl Issue, 38-41.
18. Reddy, P.B., 2016. Assessment of seasonal and anthropogenic impact on the surface water quality and health status of fish in Chambal River at Nagda, MP India. Shodsarita, 2016.
19. Reddy, P.B. and Rawat, S.S., 2013.Assessment of aquatic pollution using histopathology in fish as a protocol. *International Research Journal of Environment Sciences*, *2,* (8), pp.79-82.
20. Reddy, P.B. and Baghel, B.S., 2012. Impact of Industrial wastewater on the Chambal River and Biomarker responses in fish due to pollution at Nagda. MP India. *DAV International Journal of Science*, *1*(1), pp.86-91.

21. Nas and Berktay, 2006.Groundwater contamination by nitrates in the city of Konya (turkey). A GIS perceptive. J.Env.Mange.79, 30-37.
22. Davie, T.2003. Fundamental of hydrology, Routledge, Taylor &Francis group London/New York.
23. Pawar, N.J. and Shaikh, I.J. 1995, 'Nitrate pollution of ground waters from basaltic aquifers, Deccan trap hydrological province', Env. Geol. 25, 197–204.
24. Ganasan, V. and Hughes, R.M., 1998. Application of an index of biological integrity (IBI) to fish assemblages of the rivers Khan and Kshipra (Madhya Pradesh), India. *Freshwater Biology*, *40*(2), pp.367-383.
25. Ahmad, M.T., Sushil, M. and Krishna, M., 2012. Influence of dye industrial effluent on physico chemical characteristics properties of soil at Bhairavgarh, Ujjain, MP, India. *J. Environment Sci*, *1*(1), pp.50-53.
26. Manderia, S. and Manderia, K.H., 2014. Monitoring & Analysis of Qualitative Characteristics of Holy Kshipra River at Ujjain City (MP). *The International Journal of Science and Technoledge*, *2*(11), p.174.
27. Kumawat, D.M. and Sharma, M.K., 2015. Quality Status Study of river Kshipra at Ujjain before its linkage with Narmada water. *J Global Biosci*, *4*(2), pp.1508-1516.
28. Bhasin, S., Shukla, A.N. and Shrivastava, S., 2015. Deterioration in water quality of river Kshipra at Ramghat, during mass bath, Ujjain. MP, India.
29. Gangwar, S., Meena, S., Dave, K. and Wanganeo, A., 2017. Change in Physico-chemical Characteristic of River Kshipra during the Simhasth Festival. *Int. J. Curr. Microbiol. App. Sci*, *6*(5), pp.1331-1336.

***