Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; 6(4): 2034-2039
Received: 12-05-2017
Accepted: 13-06-2017

Shamsul Haq
Sher-e-Kashmir University of Agricultural Science and Technology, Jammu Kashmir. India

Shoukat Ara
Sher-e-Kashmir University of Agricultural Science and Technology, Jammu Kashmir. India

Asma Absar Bhatti
Sher-e-Kashmir University of Agricultural Science and Technology, Jammu Kashmir. India

Faizan Jalal
Department of Earth Sciences, University of Kashmir, Jammu Kashmir. India

Mohd Shafi Bhat
Department of Zoology, University of Kashmir, Jammu Kashmir. India

Correspondence
Shamsul Haq
Sher-e-Kashmir University of Agricultural Science and Technology, Jammu Kashmir. India

Determination of water quality of surface water resources of central Kashmir, Jammu and Kashmir, India

Shamsul Haq, Shoukat Ara, Asma Absar Bhatti, Faizan Jalal and Mohd Shafi Bhat

Abstract
The present work aims at assessing the water quality index (WQI) in the surface water bodies of Noorbagh (Srinagar) and Narkara (Budgam) situated in central Kashmir of Jammu and Kashmir by monitoring fifteen sampling points within each location. The surface water samples were subjected to comprehensive physico-chemical analysis involving major cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+},), anions (HCO^{3-}, CO_3^-, Cl^-, SO_4^{2-}, NO_3^-, PO_4^{3-}, B^-) besides general parameters (pH, EC and TDS). For calculating the WQI, nine parameters namely, pH, electrical conductivity, total dissolved solids, sodium, calcium, magnesium, chloride, sulphate, and nitrate nitrogen were considered. SAR and boron values indicated that both Noorbagh and Narkara surface water bodies are excellent (S1) for irrigation, while electrical conductivity values classified that waters of both the locations fall under medium salinity (C2) category. Further, it is apparent from WQI values that surface water bodies of Noorbagh and Narkara belong to excellent water class with WQI values of 22.9 and 15.0 respectively.

Keywords: water quality index, SAR, boron, cations, anions

Introduction
Our environment has witnessed a continuous and rapid deterioration which cause pollution in all its abiotic and biotic components. Now-a-days water pollution is burning issue all over the world. Like other developing countries water pollution in India also reach in alarming situation due to lack of proper management policies. Hence the quality and quantity of utilizable surface water decreases which ultimately results in water crisis. So there is need for continuous evaluation of water quality and pollution level in order to promote better living condition around the reservoirs and to save the reservoirs before their extreme worst condition of eutrophication (Anu *et al*., 2011) [1]. The physico-chemical parameters of water and the dependence of all life process of these factors make it desirable to take as an environ (Manjare *et al*., 2010) [11]. The quality of surface water is largely affected by natural processes (weathering and soil erosion) as well as anthropogenic inputs (municipal and industrial waste water discharge). The anthropogenic discharge represents a constant polluting source; whereas surface runoff is a seasonal phenomenon, largely affected by climatic conditions.

Developmental pressures and increasing human population has made the water bodies of the study area vulnerable to sewage flow, solid waste dumping, etc., in turn exerting pressure on the percolation and infiltration processes responsible for the groundwater recharge (Ravikumar *et al*. 2011) [19]. The municipal effluents from such natural drains deteriorated the quality of these water bodies. Sedimentation of the pollutants has not only reduced the surface area of the water which in turn has increased evaporation rate, but also reduced ground water levels on account of poor permeability with more and more silt, clay deposits, trash and toxic waste accumulation in them year after year. In spite of the fact that nutrient enrichment stimulates the growth of plants (algae as well as higher plants), nutrient enrichment in water bodies is considered as one of the major environmental problems in many countries (Oczkowski and Nixon 2008) [15], ultimately leading to deterioration of water quality and degradation of entire ecosystems (Yu *et al*. 2010) [23]. Hence, periodic monitoring and assessment of water quality helps to develop management strategies to control surface water pollution (Shuchun *et al*. 2010) [21] in spite of increasing urbanization and anthropogenic pressure on them. Water quality index (WQI) is one of the most effective tools (Mishra and Patel 2001; Naik and Purohit 2001) [12, 13] to communicate information on the quality of water to the concerned citizens and policy makers as it is an important parameter for the assessment and management of surface/ground waters.

Hence, the present work has been carried out with a focus to evaluate the prevailing water quality and portability of surface water resources for consumption and irrigational purposes of central Kashmir by analyzing physico-chemical parameters and by estimating water quality index.

Material and Methods

Surface water samples were collected from the irrigation channels of major vegetable belts of central Kashmir Noorbagh (Srinagar) and Narkara (Budgam). Water from these irrigation channels is also used for other domestic purposes besides irrigation. The surface water samples were collected from fifteen sites from each location in pre acid washed plastic bottles after rinsing them with the same water 3-4 times and were brought to laboratory immediately for analysis of parameters *viz.* pH, electrical conductivity, total dissolved solids, sodium, calcium, magnesium, carbonates, bicarbonates, chloride, sulphate, boron, nitrate nitrogen, potassium and phosphorus, The standard analytical procedures as recommended by the American Public Health Association (2005) [2] were employed in the present study (Table 1). Sample from each location were analyzed thrice for each parameters (i.e., triplicate results) to obtain concordant values. Based on the results of physicochemical analyses, irrigation quality parameter i.e., sodium absorption ratio (SAR) was also calculated. The suitability of the surface water from these two locations for drinking, domestic, and irrigation purposes was evaluated by comparing the values of different water quality parameters with those of the Bureau of Indian standards (BIS 1998) [4] guideline values for drinking water.

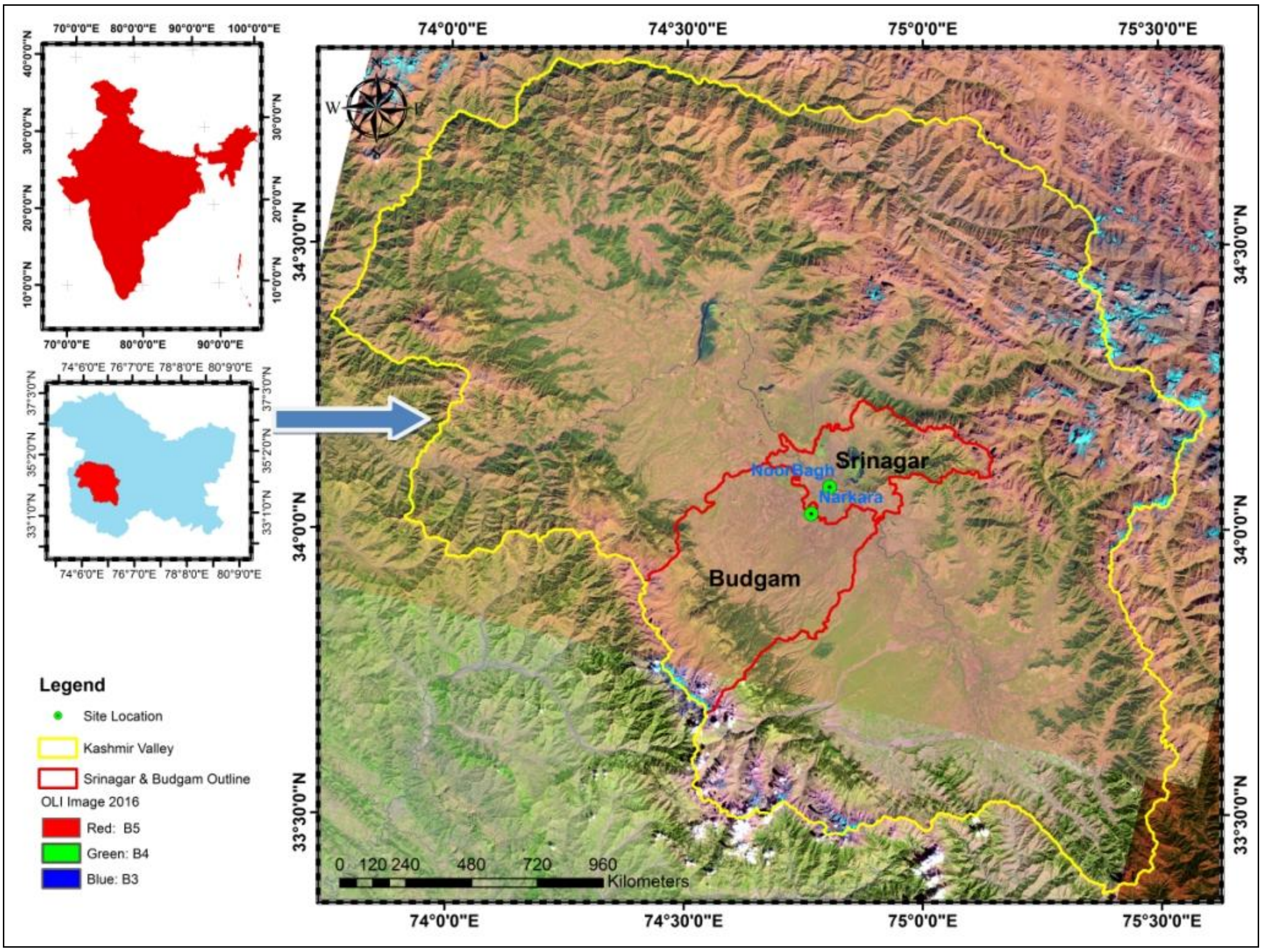

Fig 1: GPS sampling points of the study area

Water Quality Index

fThe WQI provides a comprehensive picture of the quality of surface/ground water for most domestic uses. WQI is defined as a rating that reflects the composite influence of different water quality parameters (Sahu and Sikdar 2008) [20]. For calculating the WQI in the present study, parameters namely, pH, electrical conductivity, total dissolved solids, calcium, magnesium, sodium, chloride, sulphate and nitrate have been considered (Table 2).

Water Quality Index was calculated by the following formula:

Water Quality Index (WQI) = $\Sigma Q_i W_i$

Where Q_i (water quality rating) = $100 \times (V_a - V_i) / (V_s - V_i)$

Where,

V_a = Actual value present in the water sample

V_i = Ideal value (0 for all parameters except pH which is 7.0)

V_s = Standard value.

If quality rating $Q_i = 0$ means complete absence of pollutants,

While $0 < Q_i < 100$ implies that, the pollutants are within the prescribed standard

When $Q_i > 100$ implies that, the pollutants are above the standards.

W_i = Unit weight

Table 1: Analytical methods adopted along with BIS desirable limits

S. No.	Parameters	Analytical method	Unit	Desirable limit (BIS 1998) [4]
1.	pH	Electrode		8.5
2.	Electrical Conductivity (EC)	Conductivity-TDS meter	dSm^{-1}	2
3.	Total dissolved solids (TDS)		mgl^{-1}	1000
4.	Sodium (as Na^{2+})	Flame photometric	mgl^{-1}	100
5.	Calcium (as Ca^{2+})	EDTA titrimetric	mgl^{-1}	75
6.	Magnesium (as Mg^{2+})	Photometric	mgl^{-1}	30
7.	Carbonates (as CO_3^{2-})	Titrimetric	mgl^{-1}	250
8.	Bicarbonates (as HCO_3^-)	Titrimetric	mgl^{-1}	NA
9.	Chloride (as cl^-)	Silver nitrate	mgl^{-1}	1000
10.	Sulphate (as SO_4^{2-})	Turbidimetric	mgl^{-1}	200
11.	Boron (B)	Curcumin method	mgl^{-1}	NA
12.	Nitrate (as NO_3^{2-})	Salicylate method	mgl^{-1}	45
13.	Potassium (as K^+)	Flame photometric	mgl^{-1}	10
14.	Phosphorus (as PO_4^{3-})	Stannous chloride	mgl^{-1}	0.3

Result Discussion

The samples were collected from the fifteen different sites within the surface water bodies of Noorbagh and Narkara and each sample was analyzed for various physicochemical parameters. The range and mean analytical results for each parameter for both the locations are summarized in Table 2.

pH is a numerical expression that indicates the degree to which water is acidic or alkaline, with the lower pH value tends to make water corrosive and higher pH provides taste complaint and negative impact on skin and eyes (Rao and Rao 2010). The mean pH of Noorbagh was 7.73±0.035 while the mean pH of Narakara was 7.34±0.088 Garg *et al*. (2010) is of the opinion that that pH range between 6.0 and 8.5 indicates the productive nature of any water body. Thus, pH of both the locations in the present study are within the permissible limit of 6.5–8.5 (BIS 1998) [4].

Table 2: Physico-chemical characteristics of surface water

	Noorbagh (Srinagar)		Narkara (Budgam)	
	Mean±S.E	**Range**	**Mean±S.E**	**Range**
pH	7.73±0.035	7.53-7.94	7.34±0.088	6.95-7.89
EC($dS\ m^{-1}$)	0.40±0.018	0.29-0.52	0.32±0.012	0.25-0.42
TDS ($mg\ l^{-1}$)	130.87±1.867	115.0-140.0	120.73±2.279	100.0-130.0
Na ($mg\ l^{-1}$)	14.59±0.540	10.50-18.10	11.00±0.578	8.63-15.90
Ca ($mg\ l^{-1}$)	33.92±1.202	28.13-42.81	26.96±1.189	19.10-35.69
Mg ($mg\ l^{-1}$)	13.57±0.591	9.47-17.28	11.37±0.767	7.83-18.75
CO_3^{2-}($mg\ l^{-1}$)	1.41±0.084	1.00-2.12	1.00±0.082	0.52-1.47
HCO_3^-($mg\ l^{-1}$)	51.11±1.603	40.07-62.13	40.73±2.220	30.13-60.39
Cl ($mg\ l^{-1}$)	26.68±1.912	16.12-38.06	19.78±1.166	12.12-29.23
SO_4^{2-} ($mg\ l^{-1}$)	0.89±0.101	0.42-1.56	0.54±0.091	0.21-1.56
B ($mg\ l^{-1}$)	0.09±0.008	0.05-0.14	0.064±0.007	0.01-0.09
SAR	1.06±0.042	0.76-1.40	0.90±0.051	0.68-1.37
NO_3-N ($mg\ l^{-1}$)	0.30±0.052	0.10-0.96	0.24±0.038	0.10-0.70
K ($mg\ l^{-1}$)	1.08±0.043	0.82-1.36	0.89±0.046	0.69-1.20
P ($mg\ l^{-1}$)	0.25±0.013	0.17-0.35	0.16±0.014	0.08-0.27

Table 3: Classification of irrigation water based on electrical conductivity

S. No.	Type of water	Suitability for irrigation
1.	Low salinity water (C1) conductivity between 0.1 and 0.25 $dS\ m^{-1}$	Suitable for all types of crops and all kinds of soil. Permissible under normal irrigation practices except in soils of extremely low permeability
2.	Medium salinity water (C2) conductivity between 0.25 and 0.75 $dS\ m^{-1}$	Can be used, if a moderate amount of leaching occurs. Normal salt tolerant plants can be grown without much salinity control
3.	High salinity water (C3) conductivity between 0.75 and 2.25 $dS\ m^{-1}$	Unsuitable for soil with restricted drainage. Only highsalt tolerant plants can be grown
4.	Very high salinity (C4) conductivity more than 2.25 $dS\ m^{-1}$	Unsuitable for irrigation

Electrical conductivity of water is a function of its total dissolved salts (Harilal *et al*. 2004) [7] and it is an index which represent the total concentration of soluble salts in water (Purandara *et al*. 2003; Gupta *et al.* 2008) [17, 6]. The mean conductivity values were 0.40±0.018 $dS\ m^{-1}$ in Noorbagh waters and 0.32±0.012 $dS\ m^{-1}$ in Narkara area. Conductivity values of both the locations were well below the permissible limits of 2 $dS\ m^{-1}$. Furthermore, relatively higher EC values were recorded in the Noorbagh water, which is attributed to the high degree of anthropogenic activities such as waste disposal, sewage inflow and agricultural runoff (Pandit 2002) [16]. Classification of water based on Electrical conductivity (Table 3) illustrates that the waters of both the locations belong to medium salinity class (C2).

Total dissolved solids (TDS) mainly consists of inorganic salts such as carbonates, bicarbonates, chlorides, sulphates, phosphates and nitrates of calcium, magnesium, sodium, potassium, iron etc. and small amount of organic matter. The mean concentration of TDS in Noorbagh was 130.87±1.867 mg l^{-1} while in Narkara it was 120.73±2.279 mg l^{-1}. TDS values of Noorbagh and Narkara were well below the permissible limits of 1,000 mg l^{-1}.

Major Ion Chemistry

In Noorbagh surface waters the predominant cation trend was in the order of $Ca^{2+} > Na^{+} > Mg^{2+} > K^{+}$ and in Narkara waters the predominant cation trend was in the order of $Ca^{2+} > Mg^{2+} > Na^{+} > K^{+}$ with calcium being the dominant cation at both the locations. The predominant anion trend was in the order of $HCO_3^- > Cl^- > CO_3^{2-} > SO_4^{2-} > NO_3^{2-} > PO_4^{3-} > B^-$ at both the locations with bicarbonate being the predominant anion.

Chemistry of Cations

The mean concentration of calcium in Noorbagh surface waters was 33.92±1.202 and in Narkara it was 26.96±1.189. It is evident that Noorbagh water showed higher calcium content compared to Narkara water which is attributed to the increased concentration of waste materials discharged into the Noorbagh water (Khan *et al*., (2012) [9]. However, in both the locations the calcium content was found below the prermissible limits of 75 mgl^{-1}. The average magnesium values in Noorbagh was 13.57±0.591 and in Narkara it was 11.37±0.767 mgl^{-1}. It is evident that the magnesium values in waters of both the locations are below the permissible limits of 30 mgl^{-1}.

The mean sodium concentration in waters of Noorbagh was 14.59±0.540 mgl^{-1} and in Narkara the mean concentration of sodium was 11.00±0.578 mgl^{-1}. The concentration of sodium in the waters of Noorbagh and Narkara were below the permissible limits of 100 mgl^{-1}. The average potassium concentration ion Noorbagh water was 1.08±0.043 mgl^{-1} and in Narkara water the mean concentration of potassium was 0.89±0.046 mgl^{-1}. Both the locations showed potassium concentration below the permissible limits of 10 mgl^{-1} (BIS 1998) [4]. Higher concentration of sodium and potassium in Noorbagh compared to Narkara is due to domestic sewage contamination of Noorbagh waters (Bhat *et al*. 2001) [3].

Chemistry of anions

The mean bicarbonate concentration in Noorbagh was 51.11±1.603 mgl^{-1} which is higher than that of Narkara where the mean concentarion of bicarbonate was recorded as 40.73±2.220 mgl^{-1}. In Noorbagh the average chloride concentrion was 26.68±1.912 mgl^{-1} and in Narkara it was 19.78±1.166 mgl^{-1}. Noorbagh showed higher chloride concentration than Narkara is due to the fact that human excreta increases the chloride concentration (Hassan *et al*., 2013) [8], but both the locations chloride values well below the permissible limits of 1,000 mgl^{-1}.

The mean sulphate concentration in Noorbagh was 0.89±0.101 mgl^{-1} and in Narkara the mean concentration of sulphate was 0.54±0.091 mgl^{-1}. Both the locations showed the sulphate values within the permissible limits of 200 mgl^{-1}.

The concentration of nitrate in groundwater and surface water is usually low but gets increased because of agricultural runoff, refuge dump runoffs, or contamination with human or animal wastes (Nas and Berktay 2006) [14]. The mean concentration of nitrate in Noorbagh was 0.30±0.052 mgl^{-1} and in Narkara it was 0.24±0.038 mgl^{-1}. The increased nitrate concentration in Noorbagh could be due to allochthonous supply of nitrate rich materials and enhanced decomposition rate (Lone *et al*., 2013) [10]. Both Noorbagh and Narkara showed nitrate values within permissible limits of 45 mgl^{-1}.

The mean carbonate concentration in Noorbagh was 1.41±0.084 mgl^{-1} and in Narkara it was 1.00±0.082 mgl^{-1}.

The mean phosphate concentration in Noorbagh was 0.25±0.013 mgl^{-1} and in Narkara it was 0.16±0.014 mgl^{-1}. The concentration of phosphorus in both the locations was below the permissible limits of 0.3 mgl^{-1}. However higher concentration of phosphorus in Noorbagh compared to Narkara is due to the fact that PO_4^{3-} enters the lakes through domestic wastewater (Vyas *et al*. 2006) [22].

Irrigation Quality parameters

Sodium Adsorption ratio

If the SAR ratio of the water samples in the study area is less than 10, it is excellent for irrigation purposes. The SAR values for each water sample was calculated using the following equation (Richards 1954).

$$SAR = \frac{Na^{+}}{\frac{\sqrt{Ca^{2+} + Mg^{2+}}}{2}}$$

The mean SAR concentration in Noorbagh was 1.06±0.042 and in Narkara it was 0.90±0.051. According to the classification given in table 4 both Noorbagh and Narkara waters showed SAR values below 10 indicating that these surface water bodies are excellent (S1) for irrigation.

Table 4: Classification of irrigation water based on SAR

S. No	Types of water and SAR value	Quality	Suitability for irrigation
1.	Low sodium water (S1) SAR value: 0–10	Excellent	Suitable for all types of crops and all types of soils, except for those crops, which are sensitive to sodium
2.	Medium sodium water (S2) SAR value: 10–18	Good	Suitable for coarse textured or organic soil with good permeability. Relatively unsuitable in fine textured soils
3.	High sodium water (S3) SAR value: 18–26	Fair	Harmful for almost all types of soil; Requires good drainage, high leaching gypsum addition
4.	Very high sodium water (S4) SAR value: above 26	Poor	Unsuitable for irrigation

Boron

If the water has boron concentration < 1.0 then the water is excellent for irrigation purposes, if its values falls in between 1.0-2.0 then the water is good for irrigation, 2.0-4.0 is medium and >4 is bad for irrigation purposes. The mean concentration of boron in Noorbagh water was 0.09±0.008 mgl^{-1} and in Narkara the average concentration of boron was 0.064±0.007 mgl^{-1}. The boron values in waters of both Noorbagh and Narkara are < 1.0 and hence both the waters are excellent for irrigation purposes.

Table 5: Water Quality Index (WQI) of surface water of selected locations

Parameters	BIS desirable limit (1998) [4]	Unit Weight (W_i)	WiQi	
			Noorbagh	Narkara
pH	8.5	0.219	10.534	4.945
EC	2	0.371	7.371	5.948
TDS	1000	0.0037	0.048	0.045
Na	100	0.0698	1.018	0.768
Ca	75	0.025	1.131	0.899
Mg	30	0.061	2.759	2.312
Cl^-	250	0.0074	0.079	0.059
SO_4^{-2}	200	0.01236	0.006	0.003
NO_3-N	45	0.0412	0.028	0.022
Water Quality Index ($\sum W_iQ_i$)			22.973	15.000

Water quality index value	Water quality status
0-25	Excellent water quality
26-50	Good water quality
51-75	Poor water quality
76-100	Very poor water quality
>100	Unsuitable for drinking

(Chatterji and Raziuddin 2002) [5]

Water quality index

The computed WQI values are classified into five types namely, excellent water (WQI < 25), good water (26 > WQI < 50), poor water (51 > WQI < 75), very poor water (76 > WQI < 100), and water unsuitable for drinking (WQI > 100). In the present study, the computed WQI values in Noorbagh water was 22.9 while in Narkara water, it was 15.0 (table 5). Higher value of WQI in Noorbagh were mainly due to the presence of higher concentration of total dissolved solids, electrical conductivity, sodium, calcium, magnesium, chloride and sulphates (Ravikumar *et al*. 2013) [18]. However, it is evident from the results that surface water bodies of Noorbagh and Narkara fall under excellent water category.

Conclusion

Water quality index technique used to assess the suitability of surface water Noorbagh (Srinagar) and Narkara (Budgam) for domestic and irrigation purposes illustrated that both the locations belong to the excellent water category. However, higher values of water quality index was obtained for Noorbagh surface water bodies which needs to be continuously evaluated and addressed on priority basis. Electrical conductivity classified Noorbagh and Narkara surface waters, to medium (C2) salinity class. All the ions are well below the permissible limits of Indian Standards and water bodies of both the locations belong to excellent (S1) class based on SAR values, indicating their suitability for irrigation.

Acknowledgement

The author is highly thankful to Ministry of Minority Affairs and University Grants Commission for funding research work and Division of Environmental Sciences (SKUAST-K) for providing support and laboratory facilities.

References

1. Anu, Upadhyaya SK, Avinash B. Heavy metal analysis of various water bodies located in and around Bhopal, M.P. (India). International journal of Environmental Science and Development. 2011; 2(1):27-29.
2. APHA. Standard Methods for the Examination of Water and Wastewater. American Public Health Association, Washington, USA, 2005.
3. Bhat SA, Rather SA, Pandit AK. Impact of effluent from Sheri Kashmir institute of medical sciences (SKIMS), Soura on Anchar Lake. J Res Dev. 2001; 1:30-37.
4. Bureau of Indian Standards BIS. Drinking water specifications revised. 1998, 2003. IS: 10500.
5. Chatterji C, Raziuddin M. Determination of water quality index (WQI) of a degraded river in Asanol industrial area, Raniganj, Burdwan, West Bengal. Nature, Environment and Pollution Technology. 2002; 1:181-189.
6. Gupta S, Maheto A, Roy P, Datta JK, Saha RN. Geochemistry of groundwater Burdwan district, West Bengal India. Environv Geol. 2008; 53:1271-1282.
7. Harilal CC, Hashim A, Arun PR, Baji S. Hydro geochemistry of two rivers of Kerala with special reference to drinking water quality. J Ecol Environ Conserv. 2004; 10(2):187-192.
8. Hassan K, Yosuf AR, Balkhi MH, Jamila I, Dar SA. Seasonal assessment of physico-chemical characteristics of water in river Jhelum of Kashmir. Journal of Himalayan Ecology and Sustainability Development. 2013; 7:1-5.
9. Khan MY, Shabeer M, Imtiyaz AR, Nazir AW. Physico-chemical analysis of river Jhelum (Kashmir). Global Journal of Science Frontier Research. 2012; 12:1-3.
10. Lone SA, Farid A, Lori SM, Zuber SM. Physicochemical characterization of lotic systems of Kashmir: A case study of river Jhelum. International Journal of Science and Nature. 2013; 4:579-582.
11. Manjare AS, Vhanalakar, Muley VD. Analysis of water quality using physico-chemical parameters Tamdalge tank in Kolharpur district Maharastra. International journal of Advanced Biotechnology and Research. 2010; 1(2):115-119.
12. Mishra PC, Patel RK. Study of pollution load in the drinking water of Rairangpur: a small tribal dominated town of North Orissa. Indian J Environ Ecoplan. 2001; 5(2):293-298.
13. Naiz S, Purohit KM. Studies on water quality of river Brahmani in Sundargarh district, Orissa. Indian J Environ Ecoplan. 2001; 5(2):397-402.
14. Nas B, Berktay A. Groundwater contamination by nitrates in the city of Konya, (Turkey): a GIS perspective. J Environ Manage. 2006; 79:30-37.
15. Oczkowski A, Nixon S. Increasing nutrient concentrations

and the rise and fall of a coastal fishery, a review of data from the Nile Delta, Egypt. Estuar Coast Shelf Sci. 2008; 77:309-319.

16. Pandit AK, Yousuf AR. Trophic status of Kashmir Himalayan lakes as depicted by water chemistry. J Res Dev. 2002; 2:1-12.
17. Purandara BK, Varadarajan N, Jayashree K. Impact of sewage on ground water: a case study. *Poll Res* 2003; 22(2):189-197.
18. Ravi kumar P, Mehmood AM, Somashekar KR. Water quality index to determine the surface water quality of Sankey tank and Mallathahalli lake, Bangalore urban district, Karnataka, India. Journal of Appl Water Sci. 2013; 3:247-261.
19. Ravi kumar P, Venkatesharaju K, Prakash KL, Somashekar RK. Geochemistry of groundwater and groundwater prospects evaluation, Anekal Taluk, Bangalore Urban District, Karnataka, India. Environ Monit Assess. 2011; 179:93-112.
20. Sahu P, Sikdar PK. Hydrochemical framework of the aquifer in and around East Kolkata wetlands, West Bengal. India Environ Geol. 2008; 55:823-835.
21. Shuchun Y, Bin X, Deyang K. Chronology and nutrzents change in recent sediment of Taihu Lake, lower Changjiang River Basin, East China. Chin Geogr Sci. 2010; 20(3):202-208.
22. Vyas A, Mishra DD, Bajapai A, Dixit S, Verma N. Environment impact of idol immersion activity lakes of Bhopal, India. Asian J Exp Sci. 2006; 20(2):289-296.
23. Yu FC, Fang GH, Ru XW. Eutrophication, health risk assessment and spatial analysis of water quality in Gucheng Lake, China. Environ Earth Sci. 2010; 59:1741-1748.