Asian Journal of Water, Environment and Pollution, Vol. 13, No. 1 (2016), pp. 65–71.
DOI 10.3233/AJW-160009

Comparative Analyses of Physico-chemical Characteristics in Surface Water Sources of Shendurney Wildlife Sanctuary, Kerala, India

Smitha Asok V.*, Sobha V.[1] and Navami S.S.

PG Department of Environmental Sciences, All Saints' College, Thiruvananthapuram 695007, Kerala, India
[1]Department of Environmental Sciences, University of Kerala, Kariavattom, Thiruvananthapuram 695581, Kerala, India
✉ smithaasok@gmail.com

Received October 11, 2014; revised and accepted December 17, 2015

Abstract: Water pollution is a major problem worldwide, the management of which requires continuous monitoring and the effective implementation of water resource policy at all levels. The objective of the present study is to evaluate the water quality of three major sub-tributaries of Shendurney river viz. Kallar, Shendurney and Uruliyar which drains through the Shendurney wildlife sanctuary which also forms the catchment of the Kallada reservoir. The reservoir was also brought into the purview of the study and the results revealed a general trend of increasing pollution load from upstream to the downstream. Values of parameters such as pH and DO are higher in samples from the upstream whereas the BOD values which indicate the high concentration of organic matter is higher in the downstream portion of the three streams. The results of the study indicate the deterioration caused due to human interference in the outer and buffer zones of the protected area.

Key words: Water quality, Shendurney wildlife sanctuary, pollution.

Introduction

Water quality is most commonly thought of as the ideal representation of the water's chemical character. As such, it has immense influence on the sustenance of the biotic components in it as well as those supported by it. Variation in the quantity and quality of river water is widely studied in the case of several world rivers. Riedel et al. (2000) examined the spatio-temporal variations in trace elements in Patuent River, Maryland, while Sileika et al. (2006) reported variation in nutrient levels in the Nemunas river of Russia. Among Indian rivers, those flowing through the Gangetic plains are the most studied ones. While Subramanian (1983) documented inconsistent downstream variations in river water chemistry, Mukherjee et al. (1993) and Singh et al. (2002) documented the physical, chemical and biological aspects of river Ganga. Compared to the northern rivers in India, the southern rivers are less studied perhaps due to their smaller size and discharge (Nikhil and Azeez, 2009).

Shendurney Wildlife Sanctuary is a protected area in the Western Ghats, India, extending over an area of 171 sq. km. The objective of the present study is to assess the quality of the existing water resources in the Shendurney Wildlife Sanctuary and also to examine the nutrient availability in these resources with respect to the forest wealth in the study area.

*Corresponding Author

Materials and Methods

Three major sub-tributaries of Shendurney river viz. Kallar, Chendurneyar and Uruliyar were identified for assessing the water quality of the area, since these are the important rivulets draining the sanctuary on the EW, SN and NS directions respectively. Further, to take into account, the spatial variations in each of these river systems, three locations were fixed in the upstream, midstream and downstream sites. Additionally, three samples were also taken from the initial, mid and end points of the reservoir to detect the spatial variations in it. The location map of the study area is given in Figure 1.

The sampling and analysis of various physico-chemical attributes were done following the standard procedures as detailed in APHA (1995) and by Trivedy and Goel (1984). Water quality parameters and analytical methodology are given in Table 1.

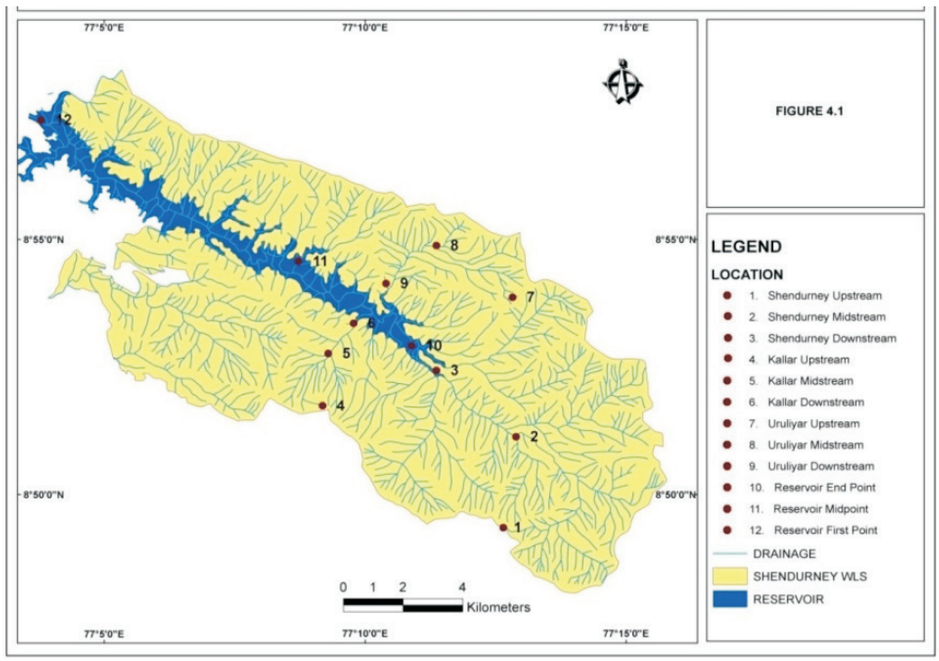

Figure 1: Location map of the study area.

Table 1: Water quality parameters and analytical methodology

Sl. No	*Parameters*	*Methodology adopted*	*Reference*
1.	pH	Electrometric method using	APHA, 1995
2.	EC	Conductivity meter	APHA, 1995
3.	DO	Winkler method	APHA, 1995
4.	BOD	Unseeded dilution technique	APHA, 1995
5.	TSS	Gravimetric method	Trivedy and Goel, 1984
6.	TDS	Gravimetric method	Trivedy and Goel, 1984
7.	Total nitrogen	Spectrophotometric method	Trivedy and Goel, 1984
8.	Total phosphorous	Spectrophotometric method	Trivedy and Goel, 1984
9.	Sulphate	Turbidimetric method	Trivedy and Goel, 1984
10.	Sodium	Flame photometric method	Trivedy and Goel, 1984
11.	Potassium	Flame photometric method	Trivedy and Goel, 1984
12.	Calcium	EDTA titrimetric method	Trivedy and Goel, 1984

Results and Discussion

The results of analysis of various physico-chemical parameters of surface water samples from the Shendurney wildlife sanctuary collected are given in Figures 2 to 13. It is observed that the values are in conformity with the standards specified for surface waters (BIS: 2296, 1992). However there is variability between the sampling sites with respect to certain parameters which can be attributed to the locational aspects and slight human interferences in the enclosure areas inside the sanctuary.

pH

pH, the hydrogen ion (H^+) concentration of a solution, is a measure of the acidity of the solution. Figure 2 shows the variation in values of pH among the upstream, midstream and downstream points of the three rivers and the reservoir. Although the average pH values in the present study confines within the tolerance limit of inland surface waters (BIS: 2296, 1992) it is found that comparatively higher values are found in samples from upstream of all the three streams and the reservoir (6.2, 6.1, 6.2 and 6.2 in the upstreams of Shendurney, Kallar, Uruliyar and reservoir respectively) indicating

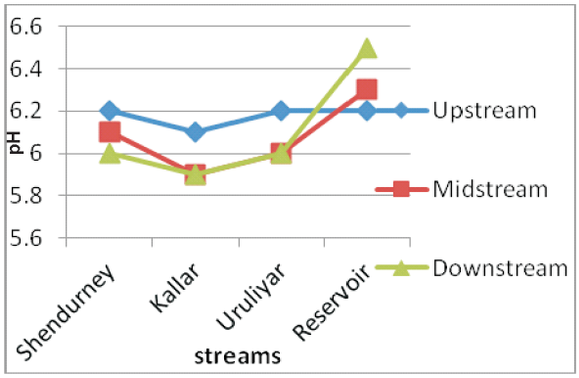

Figure 2: Variation in pH.

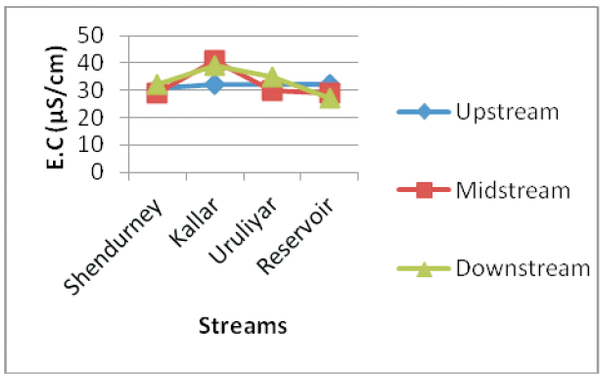

Figure 3: Variations in E.C.

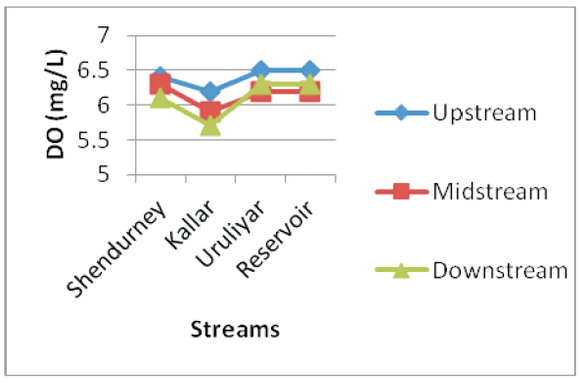

Figure 4: Variation in D.O

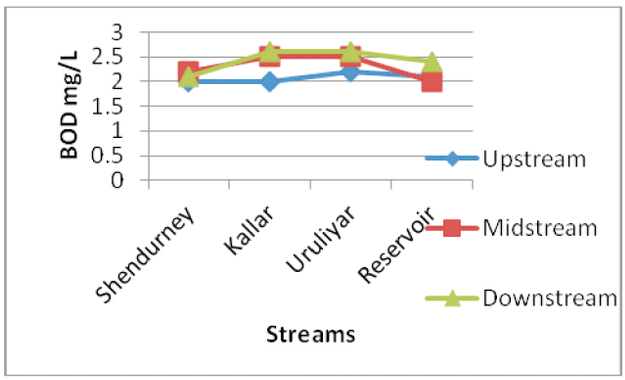

Figure 5: Variation in BOD.

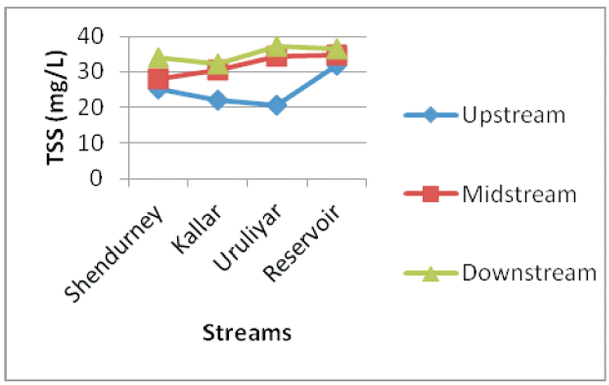

Figure 6: Variation in TSS.

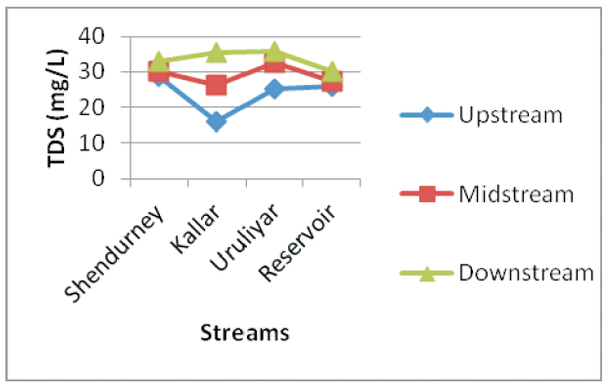

Figure 7: Variation in TDS.

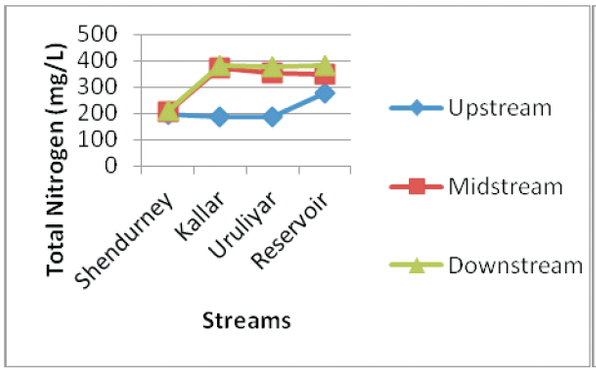

Figure 8: Variation in total nitrogen.

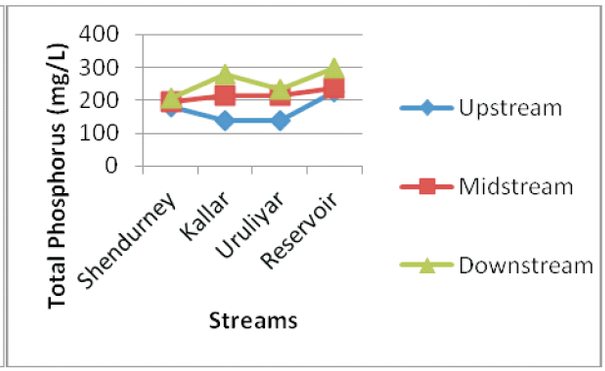

Figure 9: Variation in total phosphorus.

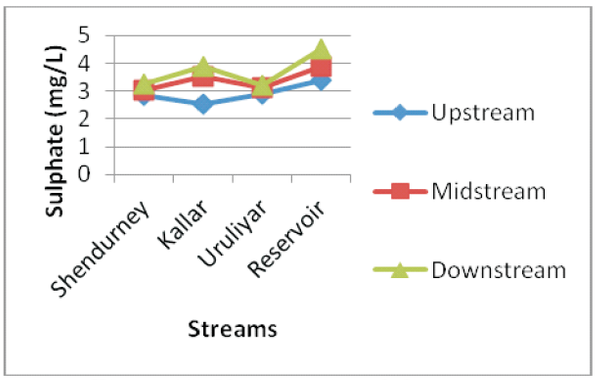

Figure 10: Variation in sulphate.

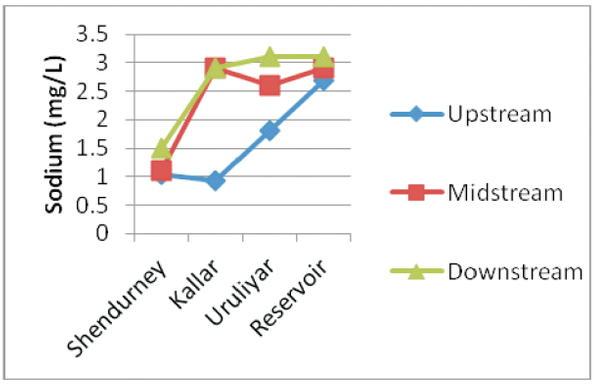

Figure 11: Variation in sodium.

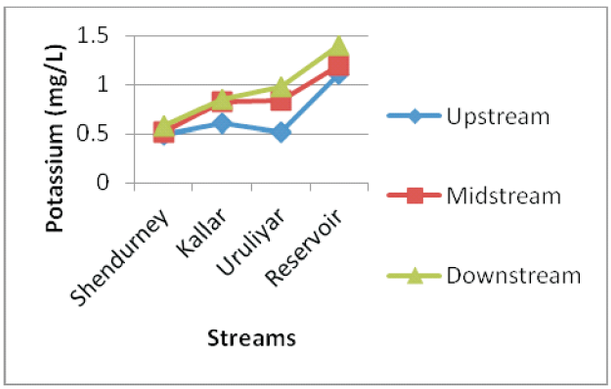

Figure 12: Variation in potassium.

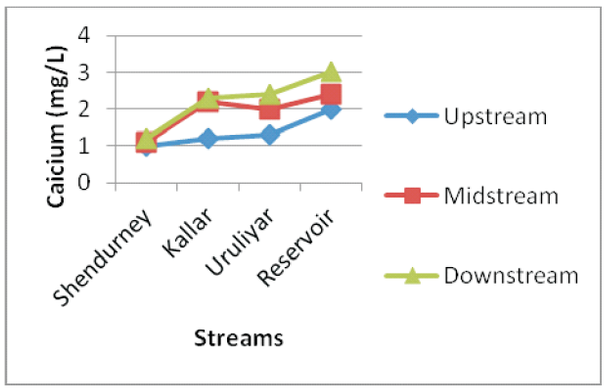

Figure 13: Variation in calcium.

near neutral conditions due to lesser disturbances. The lowest value is observed in the case of Kallar stream (5.9). The samples exhibit neutral or close to neutral pH similar to the one reported by earlier studies with similar geological set up (Babu et al., 2003; Mathukumalli and Ramanathan, 2003). Lianthuamluaia et al. (2013) opined that pH had no strong positive correlation with most of the observed water quality parameters, whereas it showed a strong negative correlation with ammonia.

Electrical Conductivity (EC)

The electrical conductivity (EC) is an index to represent the concentration of soluble salts in water (Avasn et al., 2010). Figure 3 shows the EC values in Shendurney and it can be seen that the values are progressively increasing downstream. The highest EC value is observed in samples from Kallar stream (32 mg/l, 41 mg/l and 39 mg/l respectively in the upstream, midstream and downstream points respectively) which is, however, much below the average surface water samples. Similar distribution of low values was noticed by Abbasi et al. (1999) and Mini et al. (2003) from the surface waters of Kerala.

Dissolved Oxygen (DO)

Optimum concentration of DO is essential for maintaining aesthetic qualities of water as well as

for supporting aquatic life. The variation in DO is represented in Figure 4 and it can be seen that comparatively higher DO values are noted in samples both from the upstream of the streams (6.4 mg/l, 6.2 mg/l and 6.5 mg/l) and from the upstreams of the reservoir (6.5 mg/l). Similar values (6.11 mg/l) were observed from Sasthamkotta fresh water lake (Prakasam, 2003) and from Valliyar river in Tamil Nadu (6.21 mg/l) by Salini (2009). Distribution of DO values in the sanctuary generally implies the serene nature of the water resources of the study area.

Biological Oxygen Demand (BOD)

Variation of BOD values is given in Figure 5. BOD measurement is used as the index of organic pollution under anaerobic conditions. High BOD values in the mid (2.5 mg/l) and downstream (2.6 mg/l) portions of Kallar and Uruliyar clearly reveal the influence of organic contamination from anthropogenic activities, since these two rivulets are draining through inhabited areas such as private enclosures falling within the sanctuary boundary.

Total Suspended Solids (TSS)

From Figure 6 it is clear that the TSS values are higher in the downstream samples of the streams and the reservoir. Highest TSS values are noted in the downstream sample of Uruliyar (37.3 mg/l). High values noticed in the mid and down streams of Kallar (32.4 mg/l and 30.5 mg/l) and Uruliyar (37.3 mg/l and 34.4 mg/l) is a clear case of surface run off induced by rain and an evidence of soil erosion caused by human intervention. Current distribution of TSS is similar to those reported by Babu et al. (2000) from Peppara wild life sanctuary and Bijukumar et al. (2010) from Lakkidi.

Total Dissolved Solids (TDS)

TDS in water is contributed largely by the presence of dissolved minerals like iron or manganese. TDS in natural waters fluctuates depending on the weathering characteristics and the degree of anthropogenic pollution. In the present study, TDS values are comparatively higher (32.8 mg/l in Shendurney, 35.5 mg/l in Kallar and 35.9 mg/l in Uruliyar) in samples from the downstream region of the three streams (Figure. 7). Kataria et al. (1996) reported that increase in TDS indicates pollution by extraneous sources. In the current study, average TDS values are indicative of the general absence of pollution by dissolved salts. This is in contrast with the values obtained from the rivers of polluted zones where high values were noticed during pre-monsoon period (Sujitha et al., 2011).

Total Nitrogen (TN)

TN is the sum of nitrate-nitrogen, nitrite-nitrogen, ammoniacal nitrogen and organically bound nitrogen. The down and mid streams of the three streams showed high TN values, especially that of Kallar stream (383 mg/l and 374 mg/l). In the case of the reservoir, the downstream region (382 mg/l) shows high concentration of TN (Figure 8). Possibility of fertilizer-borne nitrogen reaching the rivers by surface run off is evident here. In contrast to the study area, values as high as 756 mg/l (Nair and Chattopadhyaya, 2005) and as low as 3.5 mg/l (Krishnan, 2008) were noticed from Periyar.

Total Phosphorous (TP)

Highest TP values are noted in sample from the downstream (28 mg/l) point of the reservoir (Figure 9). Comparatively lower P values in the upstream locations (179 mg/l at Shendurney upstream, 138 mg/l at Kallar upstream and 138 mg/l at Uruliyar upstream) indicate that the riparian vegetation can be very important P filters that reduce nutrient input into streams. The marginal increase downstream indicates its anthropogenic origin which reaches the aquatic flow through surface drain. Organic P at the range of 66 µg/l was noticed from Bharathapuzha River (Babu et al., 2003). Padma and Nair (2010) opined that P exhibits strong concentration with increasing river flow indicating the dominance of point sources.

Sulphate

Sulphate occurs naturally in water and may be present in natural waters in concentrations ranging from a few to several thousand milligrams per litre. The variation in sulphate concentration in different samples is given in Figure 10. Maximum value is noted in sample from the downstream of the reservoir (4.5 mg/l). This can be correlated to the region which is a confluence of three rivers viz. Kulathupuzha, Shendurney and Kazhuthurutty after flowing through human inhabited areas. In fresh water Lake Vellayani, anthropogenic input of sulphate (8.1 mg/l) was visible compared to that (0.11 mg/l) of Sasthamkotta (Krishnakumar and Sobha, 2002).

Sodium

Weathering of salt deposits and contact of water with igneous rock provide natural sources of sodium. There is an increased concentration of sodium in samples of

inhabited areas of Kallar (2.9 mg/l in midstream and downstream) and Uruliyar (2.6 mg/l and 3.1 mg/l in midstream and downstream respectively) may possibly be due to the anthropogenic contribution. Figure 11 shows the variation in sodium concentration in three streams and the reservoir. Three samples from the reservoir also show high concentration of sodium (2.7 mg/l, 2.9 mg/l and 3.1 mg/l in the upstream, midstream and downstream points). Relatively higher concentration was reported in Ganges (18.4 ppm) by Subramanian (1979), in Brahmaputra (6.3ppm) by Raymahasay (1970) and in Krishna (34.4 ppm) by CSMRS (1973). Monsoonal leaching of Na similar to the current distribution was however noticed by Babu et al. (2003) from Bharathapuzha River.

Potassium

Potassium ranks seventh among the elements in order of abundance, yet its concentration in most drinking waters seldom reaches 20 mg/l. In this study, potassium content in waters exhibits a remarkable increase in the reservoir portion (1.1 mg/l, 1.2 mg/l and 1.4 mg/l in the upstream, midstream and downstream) of the study area (Figure 12). This indicates a depthwise increase in K possibly attributed to contribution from litter addition and recycling as reported by Nandakumar et al. (2004) in Idukki reservoir. The concentration is low in the upstream water samples.

Calcium

Calcium contributes to the total hardness of water. The distribution of Ca in the study area is represented in Figure 13. Calcium concentration is higher in samples from the downstream of Kallar (2.3 mg/l) and Uruliyar (2.4 mg/l) and in downstream sample of the reservoir (3 mg/l). The lowest values are noted in samples from the Shendurney stream (0.98 mg/l, 1.1 mg/l and 1.2 mg/l in the upstream, midstream and downstream). A sharp increase in the upstream reservoir (2 mg/l) is visible indicating its probable recycling from the deeper layers by plants as reported in the case of Idukki reservoir (Nandakumar, 2004). Ca and Mg dissolve out of rocks and consequently are detected in many lakes and stream water (Gajananda et al., 2003), together with this, high aeration might have added to the rise in values in the reservoir region in the present study.

Conclusion

Values of parameters such as pH and DO are higher in samples from the upstream of the three streams viz., Shendurney, Kallar and Uruliyar indicating a serene ecosystem with lesser human interventions. The other parameters such as EC, BOD, TSS, TDS, total nitrogen, total phosphorus, sulphate, sodium, potassium and calcium showed higher concentration in the lower reaches of the three streams. The BOD values which indicate the high concentration of organic matter is higher in the downstream portion of the three streams. The values indicate that the pollution load is increasing from the upstream to the downstream since the river reaches the area of more human interference. Anukool and Shivani (2011) also reported the increasing nature of pollution from upstream to downstream of a river. In the case of reservoir, values of pH, BOD, TSS, TDS, total nitrogen, total phosphorus, sulphate, sodium, potassium and calcium are higher in the samples from first station which is near the buffer zone. The values of EC and DO are higher in the lower reaches of the reservoir. Among the three streams analyzed, the Shendurney stream shows less pollution status than other two streams viz. Kallar and Uruliyar. The study revealed that increased pollution status in the downstream than the upstream may be due to the entry of pollutants to the streams by way of various anthropogenic activities in the two private enclosures coming inside the sanctuary boundary.

References

Abbasi, S.A., Khan, F.J., Sentilevelan, K. and A. Shabuden (1999). *Indian J. of Env. Health*, **41(3):** 176-183.

Anukool, S. and S. Shivani (2011). Assessment of Physico-Chemical properties and sewage pollution indicator bacteria in surface water of River Gomti in Uttar Pradesh. *International Journal of Environmental Sciences*, **2(1):** 325-336.

APHA (1995). Standard methods for the examination of water and waste water. 20th ed. American Public Health Association, Washington DC.

Avasn Maruthi, Y., Ramakrishna Rao, S., Apta Chaitanya, D., Kaizar Hossain, Santhosh Kumar, R., Sitaratnam, M. and R. Tulasi Rao (2010). Evaluation of Water Quality in the Vicinity of Some Saltpans, Visakhapatnam District, Andhra Pradesh. *The Bioscan* Special issue, **3:** 665-672.

Babu, K.N., Padmalal, D., Sreeja, R. and P. Sreebha (2003). Water quality variation of Bharathapuzha River, south west coast of India: Problems and solutions. *In:* Environmental Pollution, Vijay P. Singh and Ramanathan Yadava (Eds). Allied Publishers, New Delhi.

Babu Suresh, D.S., Bijumon, M.T., Latheesh Kumar, Manoj, A.K. and M.V. Vinod (2000). Terrain evaluation for

integrated watershed development in Peppara wildlife sanctuary. Technical Report. Centre for Earth Science Studies.

Bijukumar, A., Kurian, Mathew Abraham and Raj Smrithy (2010). Spatio-temporal shift of nutrients due to Lakkidi Check Dam in Bharathapuzha River. Proceedings of 22nd Kerala Science Congress, KFRI, Peechi.

BIS (1992). Indian Standard specifications for surface water, IS: 2296. Bureau of Indian Standards, New Delhi.

CSMRS (1973). Chemical composition of river waters in India. Cent. Soil. Mater. Res. Stn., New Delhi.

Gajananda, K.H., Kaushik, A., Bhupendar Singh, Gupta, V., Gera, N. and H.N. Dutta (2003). Drinking water quality assessment over the Schirmacher oasis, east Antarctica. *In:* Environmental Pollution. Vijay P. Singh and Ramanathan Yadava (Eds). Allied Publishers, New Delhi.

Kataria, H.C., Quereshi, H.A., Iqbal, S.A. and A.K. Shandilya (1996). Assessment of water quality of Kolar Reservoir in Bhopal (MP). *Pollution Research,* **15:** 191-193.

Krishnakumar and V. Sobha (2002). Sediment Geochemistry and water quality assessments of two freshwater lakes of southern Kerala: Its implications in environmental conservation and management. Proceedings of the fourteenth Kerala Science Congress. STEC.

Lianthuamluaia, Asha, Landge, T., Purushothaman, C.S., Deshmukhe, Geetanjali and Karankumar K. Ramteke (2013). Assessment of Seasonal Variations of Water Quality Parameters of Savitri Reservoir, Poladpur, Raigad District, Maharashtra. *The Bioscan*, **8(4):** 1337-1342.

Mathukumalli, B.K.P. and AL. Ramanathan (2003). Water quality of Achankovil River, Western Ghats, South India. *In:* Environmental Pollution. Vijay P. Singh and Ramanathan Yadava (Eds). Allied Publishers, New Delhi.

Mini, I., Radhika, C.G. and T. Gangadevi (2003). Hydrological studies on a lotic ecosystem, Vamanapuram river, Thiruvananthapuram, Kerala, South India. *Poll Res*., **22(4):** 617-626.

Mukherjee, D., Chattopadhyaya, M. and S.C. Lahiri (1993). Water quality of the river Ganga and some of its physico-chemical properties. *Environmentalist*, **13:** 199-210.

Nair, K.N. and Srikumar Chattopadhyay (2005). Water resources of Kerala – Issues and case studies.

Nandakumar, V. (2004). Terrain characteristics and soil degradation studies in the forest ecosystem adjoining Idukki reservoir. Technical Report No. CESS-PR-17-2004. Centre for Earth Science Studies, Akkulam.

Nikhil Raj and P.A. Azeez (2009). Spatial and temporal variation in surface waterchemistry of a tropical river, the river Bharathapuzha, India. *Current Science*, **96(2):** 245-251.

Padma P. and S.M. Nair (2010). Assessing the P fractionation in a tropical river estuarine system of south India. *Chemistry and Ecology*. Taylor and Francis. **26(6):** 453-466.

Prakasam, V.R. (2003). Limnological studies on Sasthamkotta lake, a freshwater Ramsar site. *Indian J. Environ. & Ecoplan*, **7(2):** 239-242.

Raymahasay, B. (1970). Stream erosion in Himalayas. *In:* Hydrogeochemistry. Clarke, N.Y.

Riedel, G.F., Williams, S.A., Riedel, G.S., Gilmour, C.C. and J.G. Sanders (2000). Temporal and spatial patterns of trace elements in the Patuxent River: A whole watershed approach. *Estuaries*, **23:** 521-535.

Salini, G.T. (2009). A study on the pollution of Valliyar River in terms of bacteriological and physico-chemical parameters. M Phil thesis, M.S. University, Tirunelveli.

Singh, M., Muller, G. and I.B. Singh (2002). Heavy metals in freshly deposited stream sediments of rivers associated with urbanisation of the Ganga plain, India. *Water, Air, Soil Pollut*., **141:** 35-54.

Sileika, A., Lnacke, P., Kutra, S., Gaigals, K. and L. Berankiene (2006). Temporal and spatial variation of nutrient levels in the Nemunas River (Lithuania and Belarus). *Environ. Monit. Assess*., **122:** 335-354.

Subramanian, V. (1979). Chemical and suspended sediment characteristics of rivers of India. *Jour. Hydrology*, **44:** 37-55.

Subramanian, V. (1983). Factors controlling the chemical composition of river waters in India. *In:* Proceedings of the Hamburg Symposium, August, 1983.

Sujitha, P.C., Mitra Dev, D., Sowmya, P.K. and R. Mini Priya (2011). PhysicoChemical parameters of Karamana River Water in Trivandrum District, Kerala, India. *International Journal of Environmental Sciences*, **2(2):** 472-490.

Trivedi, R.K. and P.K. Goel (1984). Chemical and biological methods for water pollution studies. Environmental Publication, India.

Venkatesharaju, K., Ravikumar, P., Somashekar, R.K. and K.L. Prakash (2010). Physico-Chemical and Bacteriological Investigation on the river Cauvery of Kollegal Stretch in Karnataka. *Journal of Science, Engineering and Technology*, **6(1):** 50-59.