Chapter 10

Study of Hydro-chemical Properties of Neyyar River, Kerala: An Attempt to Estimate Pollution Status

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The present study objectively analyzed the hydrochemistry of Neyyar River, Kerala. Water samples were collected from six different locations from Neyyar River starting from reservoir to Poovar during the period of 2015 to 2016. Total twelve hydro chemical parameters were analyzed using standard methods. The analyzed parameters were hydrogen ion concentration, salinity, dissolved oxygen, biological oxygen demand, cadmium, chromium, copper, iron, manganese, nickel, lead, and zinc. This study revealed that the water quality problems are very high at downstream stretches of the river. Apart from the lowering of water quality, the estuarine contact may also adversely impact the concentrations of hydrogen ion and salinity at Poovar. The contents of dissolved oxygen and biological oxygen demand at downstream stretches indicated the intensity of pollution exists there. Among the metals studied, the maximum concentration was shown by iron. The values of manganese, zinc, lead and copper have shown trivial removal from the overlying waters at elevated salinity conditions, even though the substantial quantities of anthropogenic pollutants exist there. The correlation study indicated that the dissolved oxygen is the odd parameter showed negative correlation with all others. All the metals except zinc showed higher concentrations above the permissible limit for drinking water prescribed by Bureau of Indian Standards. The escalated heavy metal contaminations at the downstream of the river have indicated a polluted environment. Therefore, the conservation and management of this water body is very much required.

Introduction

Rivers are very important in human progress by providing drinking water, making the earth fertile and serving as a medium for transportation. For centuries, humans have been enjoying the ecosystem services provided by rivers without understanding how the river ecosystem functions and maintains its vitality (Naiman, 1992). Man has changed the nature of rivers by controlling their floods, by constructing large impoundments, by overexploiting their living and non-living resources and by using rivers for disposal of wastes. Neyyar River is one of the important small catchment rivers in the south-western coast of India, where the demand of water is increasing exponentially over the years in tune with increase in population and economic development. The River is extensively used for domestic, recreational, drinking and irrigation purposes in the area. But different municipal, chemical and domestic wastes are being disposed in to the river and people use this river for extensive sand mining without any concern for the life of the river. Hence, there is an urgent need for continuous monitoring of the river water quality so as to safeguard public health threats from using this water. In this perspective, the present study tries to focus on the chemical characteristics of Neyyar River for its complete stretch.

Materials and Methods

Water samples were collected from six sampling stations of the Neyyar River (Figure 10.1) monthly for 12 months from June 2015 to May 2016. All the analyses were carried out following standard methods (APHA, 2005).

Results and Discussion

In the present study, 12 chemical parameters were analyzed in the surface waters of Neyyar River. Hydrogen ion concentration is an important parameter for determining the quality of water in an aquatic environment. Hydrogen ion concentration generally varied between 6.6 and 7.9, the minimum value at the reservoir in June, July, October and November of 2015 and the maximum at Poovar in March 2016. Seasonal influence was considerable and it was observed that during monsoon and post-monsoon, lower values of pH were noted. Salinity plays a major role in controlling various physical, chemical and biological processes occurring in the aquatic environment. In the present study, the salinity varied broadly between 0.002 ppt in November 2015 to 11.26 ppt in March 2016. The salinity has been gradually increasing towards the downstream reaches. This is due to the ingression of saline water with freshwater. Seasonal influence was also marginal in the distribution of salinity in Neyyar River. Dissolved oxygen (DO) is a major constituent of interest among the water quality parameters of standard categories. In Neyyar River, DO was ranging from 3.84 mg/l at S6 in March 2016 to 6.56 mg/l at S1 in October 2015. Higher values of DO were observed in post-monsoon followed by monsoon. Inverse to the distribution of DO, the values biochemical oxygen demand (BOD) fluctuated between 0.34 mg/l (at S1) in June 2015 to 5.89 mg/l (at S6) in March 2016. The biological oxygen demand seemed to be high during pre-monsoon season and is probably due to stagnation of contaminants, which showed the degradation of the river system from the highland portion onwards.

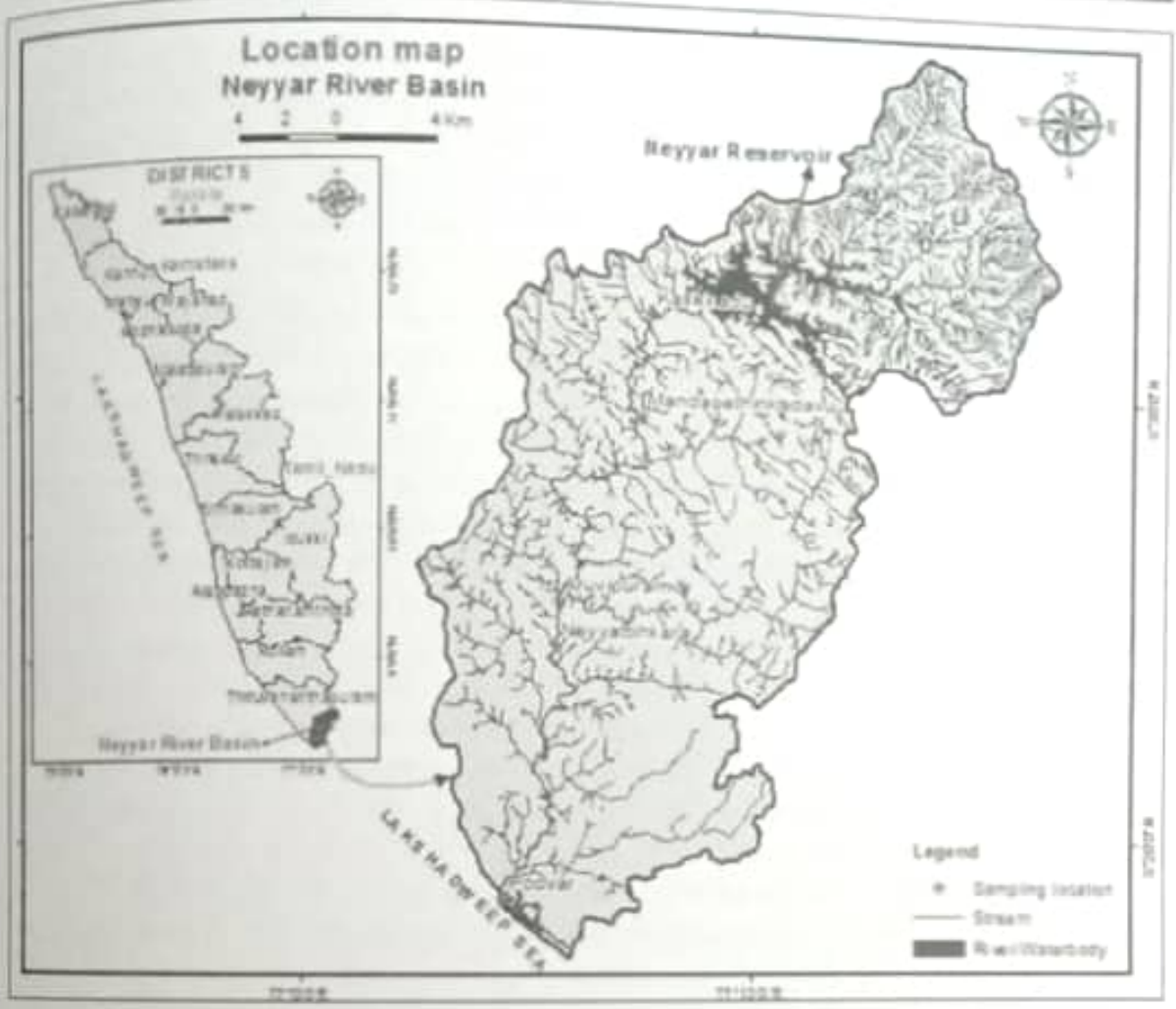

Figure 10.1: Sampling Locations of Neyyar River.

In the present study, the spatial and temporal fluctuations in the concentration of various heavy metals were obtained. The cadmium (Cd) content in Neyyar River was observed to vary from 0.004 ppm (at S1) in August 2015 and March 2016 to 0.044 ppm (at S6) in November 2015. The ranges of cadmium during monsoon, post-monsoon and pre-monsoon seasons were 0.005 ppm (at S1) to 0.033 ppm (at S6), 0.007 ppm (at S1) to 0.040 ppm (at S6), and 0.005 ppm (at S1) to 0.033 ppm (at S6), respectively. The observed limit of Cd in river water was higher than desirable limit of 0.003 mg/l (IS 10500, 2012) for all the three seasons. The chromium (Cr) content in Neyyar River was noticed to vary from 0.034 ppm (at S1) in April 2016 to 0.180 ppm (at S6) in November 2015. The ranges of chromium during monsoon, post-monsoon and pre-monsoon seasons were 0.051 ppm (at S1) to 0.150 ppm (at S6), 0.063 ppm (at S1) to 0.170 ppm (at S6), and 0.040 ppm (at S1) to 0.152 ppm (at S5), respectively. Seasonal influence was less in the distribution of chromium in Neyyar River. A marginal decrease in concentration of Chromium was observed in the estuarine region during pre-monsoon. Like Cadmium, chromium was also above the desirable limit of 0.05 mg/l (IS 10500, 2012) for three seasons except at reservoir station. The Copper (Cu) concentrations in Neyyar River have varied from 0.056 ppm (at S1) in March 2016 to 0.147 ppm (at S6) in July 2015. The ranges

of copper during monsoon, post-monsoon and pre-monsoon seasons were 0.070 ppm (at S1) to 0.140 ppm (at S5), 0.070 ppm (at S1) to 0.130 ppm (at S5 and S6), and 0.060 ppm (at S1) to 0.140 ppm (at S5), respectively. Seasonal influence was less in the distribution of Cu in Neyyar River. The estuarine zone of Neyyar River has shown marginal decrease in the Cu content. Analyses show that the Cu content was higher than the desirable limit of 0.05 mg/l at all the stations. During monsoon season, the Cu values were slightly high in Neyyar river water.

The Iron (Fe) concentration in the waters of the Neyyar River has varied from 0.217 ppm (at S1) in November 2015 to 0.739 ppm (at S6) in November 2015. The ranges of Fe during monsoon, post-monsoon, and pre-monsoon seasons were 0.301 ppm (at S1) to 0.681 ppm (at S6), 0.240 ppm (at S1) to 0.720 ppm (at S6), and 0.351 ppm (at S1) to 0.654 ppm (at S6), respectively. Seasonal influence was marginal in the distribution of Fe in Neyyar River. The estuarine region was noted for the increase in concentration of iron. The analytical data of Fe was above the desirable limit of 0.3 mg/l (IS 10500, 2012) for the three seasons except at Neyyar dam. The sources of Fe include leaching of cast iron pipes in water distribution systems and iron sulfate is also used as fertilizer and herbicide (Reimann *et al.*, 2003). The Manganese (Mn) content in Neyyar River has varied from 0.065 ppm (at S6) to 0.147 ppm (at S5) in the study period. The ranges of manganese during monsoon, post-monsoon, and pre-monsoon seasons were 0.092 ppm (at S1) to 0.121 ppm (at S5), 0.110 ppm (at S1) to 0.132 ppm (at S5) and 0.080 ppm (at S6) to 0.140 ppm (at S5), respectively. The distribution of Mn in the Neyyar River was less affected by the change in season. The estuarine region has shown the decrease in concentration of Mn. The Mn content in the river was also higher than permissible limit of 0.1 mg/l except at S6 in during pre-monsoon and S1 during monsoon.

The nickel (Ni) content in Neyyar River has varied from 0.016 ppm (at S1) in March 2016 to 0.133 ppm (at S6) in November 2015. Its content has ranged from 0.020 ppm (at S1) to 0.102 ppm (at S6) in monsoon, 0.030 ppm (at S1) to 0.120 ppm (at S6) in post-monsoon, and from 0.020 ppm (at S1) to 0.110 ppm (at S5) in pre-monsoon. Seasonal influence was less in the distribution of Ni in Neyyar River. It was observed that the concentration of Ni was increasing downstream. The Poovar region is noted for the marginal decrease in concentration of Ni during pre-monsoon. Observations have shown that the Ni content was above the desirable limit of 0.02 mg/l for all the three seasons except at S1 during pre-monsoon and monsoon.

The lead (Pb) concentration in the Neyyar River was varying from 0.056 ppm (at S2) in September 2015 and at S4 in April 2016 to 0.105 ppm (at S5) in March 2016. During monsoon, post-monsoon, and pre-monsoon seasons it was ranging from 0.060 ppm (at S2) to 0.090 ppm (at S5), 0.060 ppm (at S1) to 0.090 ppm (at S5), and 0.060 ppm (at S1 and S4) to 0.100 ppm (at S5), respectively. Lead exhibits only a marginal variation spatially and temporally in Neyyar River. The estuarine region has shown lower values of Pb compared to the upper and middle reaches of Neyyar River.

During the study period, zinc (Zn) content in Neyyar River was varying from 0.090 ppm (at S1) in June 2015 to 0.215 ppm (at S5) in March 2016. The ranges of Zn during monsoon, post-monsoon, and pre-monsoon seasons were 0.100 ppm (at S1)

Table 10.1: Correlation between Various Hydro-chemical Parameters

	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn	Salinity	pH	DO	BOD
Cd	1.000											
Cr	0.886	1.000										
Cu	0.780	0.92	1.000									
Fe	0.894	0.896	0.859	1.000								
Mn	0.100	0.378	0.438	0.137	1.000							
Ni	0.933	0.931	0.836	0.879	0.276	1.000						
Pb	0.481	0.688	0.770	0.541	0.626	0.618	1.000					
Zn	0.621	0.821	0.799	0.640	0.677	0.742	0.705	1.000				
Salinity	0.596	0.343	0.202	0.525	0.579	0.477	-0.042	-0.086	1.000			
pH	0.724	0.595	0.464	0.766	-0.169	0.696	0.220	0.232	0.800	1.000		
DO	-0.640	-0.652	-0.720	-0.765	-0.218	-0.668	-0.564	-0.400	-0.470	-0.696	1.000	
BOD	0.793	0.779	0.814	0.873	0.153	0.825	0.591	0.494	0.567	0.775	-0.930	1.000

to 0.180 ppm (at S5), 0.136 ppm (at S1) to 0.195 ppm (at S5), and 0.115 ppm (at S1) to 0.210 ppm (at S5), respectively. Seasonal influence was less in the distribution of Zn in Neyyar River. The estuarine region was noted for a marginal decrease in concentration of Zn. The analytical data of Zn content showed that all the stations recorded lower values than the permissible limit of 5 mg/l in all seasons. The relationship between the concentrations of various chemical parameters of water samples have been analyzed statistically by using correlation matrix for the entire study area (Table 10.1).

Conclusions

This study revealed that deterioration in quality of water is very high at downstream stretches of the river. This is due to high anthropogenic disturbances associated with the region. It is evident that water quality problems prevalent in the region are due to improper disposal of refuse, contamination of water by sewage, and surface runoff. Apart from the lowering of water quality, the estuarine contact may also adversely impact the freshwater system at Poovar. In the Neyyar River although the heavy metals like Mn, Zn, Pb and Cu exhibits removal from overlying waters at elevated salinity conditions, the metal Fe exhibits increase towards high saline zone. This might be due to addition of iron rich finer particulates from the mining centers to the overlying waters, along with the geochemical peculiarities of this element under natural waters. For Mn, Zn, Pb and Cu, the values have shown a decrease in trend towards the estuarine side. The higher concentration of metals in the lower stretches of Neyyar River clearly indicates the substantial quantities of anthropogenic pollutants exist there. In addition, this region also receives toxic contaminants from various sources.

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Impact of Climate Change Biodiversity and Environment

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