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Spatial and temporal variations of river water quality: A case study of River Kabini at Nanjangud in Karnataka

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Water pollution is alarming all over the globe and necessitates better understanding of spatial and temporal variations of pollutants in the rivers. In this study, the data sets of 8 water quality monitoring stations in River Kabini at Nanjangud which comprised of 10 water quality parameters monitored monthly over 12 years (2000–2011) are used. Temporal variation of the physico-chemical parameters in each station is represented by Box plots. High positive skewness is observed for total dissolved solids (TDS), conductivity, chemical oxygen demand (COD), and chlorides for all stations, showing rampant pollution in the river due to anthropogenic sources. The microbiological parameters in each station shows the river is polluted with total coliform and faecal coliform across baseline, trend and impact stations. The results suggest that the Kabini River is polluted from anthropogenic sources because bathing ghat exists along the river and domestic wastewater is let into the river without treatment. This study provides critical information for river conservation and its protection by suggesting possible treatment of domestic wastewater before letting in the river.

Key words: Box plots, temporal variation, anthropogenic sources, total coliform, faecal coliform.

INTRODUCTION

Rivers are vital freshwater systems of strategic importance across the world, providing main water resources for domestic, industrial, agricultural and recreational purposes. Rivers form the lifeline of human society and play a pivotal role in assimilating or carrying industrial and municipal wastewater and runoff from agricultural fields. In recent years, rivers are amongst the most vulnerable water bodies to pollution as a consequence of unprecedented development. Anthropogenic influences like urbanization, industrialization, agricultural activities as well as natural sources like erosion degrade the surface water (Najafpour et al., 2008; Bu et al., 2010). Thus the water quality of these water resources is a subject of ongoing concern and has resulted in an increasing demand for monitoring river water quality. The quality of water is described by its physical, chemical and microbiological characteristics (Venkatesharaju et al., 2010). Therefore a regular monitoring of river water quality not only prevents outbreak of diseases and checks water from further deterioration, but also provides a scope to assess the current investments for pollution prevention and control. Monitoring programs result in a huge and complex data matrix consisting of a large number of physico-chemical parameters (Alkarkhi et al., 2008). One of the methods in water resources quality assessment is the use of Multivariate statistical techniques to characterize and evaluate freshwater quality and these are useful in verifying temporal and spatial variations caused by anthropogenic factors (Shrestha et al., 2007;

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Venkatesharaju et al., 2010; Ekwere et al., 2011).

In this study, spatial and temporal variations of physicochemical and biological parameters of water quality in Kabini River was assessed in Nanjangud town in Karnataka using multivariate statistical tools like box plots.

MATERIALS AND METHODS

Study area

Nanjangud town is situated 20 km towards the south of Mysore city. River Kabini, a tributary of the River Cauvery, flows along this town. Nanjangud is a pilgrim town attracting crowds on various occasions. Several industries are located in the vicinity of the banks of this river.

There are eight stream monitoring stations in this area, six of which are on River Kabini and two on Hulla Halli Channel. A drain carrying wastewater from Nanjangud town enters the river along this stretch. The stations are shown in Figure 1.

Monitoring stations

The water quality monitoring stations along River Kabini at Nanjangud town are classified as baseline, trend and impact stations. Baseline stations are concerned with natural and unpolluted state of river basin. In these stations, there is no influence of human activities on water quality. Impact stations are used for measuring the quantity of pollutant and extent of pollution due to human interference. Trend stations show how a particular point on a water course varies over time due to influence of human activities. These stations not located on main river systems are sited on major tributaries and points just upstream of the confluence with the main river.

Baseline stations - N2 and N3

Station N2 is located on the river near the waterworks intake of Nanjangud town about 4 km downstream of station N1. Station N3 is located downstream of N2 on the river near the Travelers Bungalow.

Impact stations – N4b and N5

The station N4b is located on a drain which is carrying wastewater from Nanjangud town. The drain enters the river just downstream of the station N4a. Station N5 is a downstream station located near the water intake pump house of Gemini Distilleries Industry. Near this station the river flows at a greater velocity as the river width is small when compared with the width at the upstream station.

Trend stations - N1, N4a, N8 and N9

Station N1 is an upstream river station located near the Karnataka Industrial Area Development Board (KIADB) water intake point. Several industries are located near this station. Station N4a is located near the bathing ghat in Kabini River. Bathing and washing of clothes are very prominent along the right bank in a stretch of about 250 to 300 m length. Station N8 is an upstream station, located near the railway bridge leading towards Chamarajanagar across Hulla Halli Channel. Station N9 is located just downstream of the culvert across the Hulla Halli Channel.

Data preparation

The data sets of 4 water quality monitoring stations which comprised of 10 water quality parameters monitored monthly over 12 years (2000-2011) are used for this study. The data is obtained from the Water Quality Monitoring work of Cauvery River Basin in Mysore District, Karnataka State assigned to Sri Jayachamarajendra
College of Engineering, Mysore under a nationwide River Water Quality Monitoring Project of the National River Conservation Directorate (NRCD), Ministry of Environment and Forests, Government of India, under its National River Conservation Project (NRCP). Although there are more water quality parameters in these stations, only 10 most important parameters are chosen because of their continuity in measurement through the 12 years. The 10 selected water quality parameters include dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), chlorides (Cl), total dissolved solids (TDS), conductivity, total coliform (TC), faecal coliform (FC), temperature and pH.

Statistical analysis

The data for spatial and temporal variation of physico-chemical parameters of baseline, impact and trend stations was analyzed using Paleontological Statistics (PAST) version 2.15 Software Package. The 12 year annual average is taken for each parameter at each station for the plot. The spatial and temporal variations are represented by box plots for various physico-chemical parameters. Box-plot provides a visual impression of the location and shape of the underlying distributions. The line across the box represents the median, whereas the bottom and top of the box show the location of the first and third quartiles. The whiskers are the lines that extend from the bottom and top of the box to the lowest and highest observations inside the region (Razmkhah et al., 2010). Several researchers (Pejman et al., 2009; Bu et al., 2010; Razmkhah et al., 2010; Garizi et al., 2011) have used box plots to assess seasonal and other water quality variations along rivers.

RESULTS AND DISCUSSION

The spatial and temporal variations for physico-chemical parameters of baseline, impact and trend stations are shown in Figures 2 to 4, respectively.
As shown in Figure 2a and b, the values of TDS and conductivity show asymmetric plots and are skewed with high positive values. This is because of wide variety of inorganic salts and organic matter due to natural conditions and agricultural runoff. A high value of TDS indicates effects of anthropogenic sources along the river (Charkhabi et al., 2006) and in this case also the station N3 is located near Travelers Bungalow. Conductivity variation reflects the status of inorganic pollution and is a measure of TDS in water (Garizi et al., 2011). High conductivity value observed is a result of increased agricultural land use and runoff in the river. COD and chlorides are also present in this part of the river indicating pollution. This study indicates that the baseline stations in the river are getting polluted.

Figures 3a and b show the physicochemical parameters of the impact station. It is seen that that station N4b is highly polluted with positive skewness observed for BOD, COD, Cl, TDS and conductivity. The DO value in station N4b is less. This is because TDS affect the depletion of DO in water and similar trend was observed by Charkhabi et al. (2006). The station N4b is located on the drain carrying wastewater from Nanjangud town and enters the river. In station N5 the skewness observed in all parameters is less than that at station N4b. This is because dilution is occurring near this station as the river flows at a greater velocity since the river width is small when compared with the width at the upstream station.

The physicochemical parameters of trend stations are given in Figure 4a to d. COD, chlorides, TDS and conductivity are high in these stations. Compared to station N1, N4a shows high positive skewness for COD and Cl, showing pollution from anthropogenic sources. This is because station N4a is located near the bathing ghat in Kabini River.
The data for spatial and temporal variation of microbiological parameters of baseline, impact and trend stations was analyzed using Microsoft Office Excel 2007. The 12 year annual average is taken for each parameter at each station for the plot. The microbiological parameters of water quality data of baseline, impact and trend stations are shown in Figures 5 to 7, respectively.

It is seen from Figure 5a and b that TC is high in stations N2 and N3, indicating pollution of the river in baseline stations. Station N2 is located on the river near the waterworks intake of Nanjangud town and this is a matter of concern. Station N3 is located downstream of N2 on the river near the Travelers Bungalow and shows a high value for TC.

As shown in Figure 6a and b, the station N4b is located on the drain carrying wastewater from Nanjangud town and enters the river and TC value is high. In station N5 also the TC value is high the river flows at a greater velocity since the river width is small when compared with the width at the upstream station. Similar trend is observed in trend stations shown in Figure 7a to d.

**Conclusion**

It is alarming that the pollution in river Kabini is escalating over the years in this stretch at Nanjangud town due to indiscriminate human activities and agricultural uses along the river. The pollution level of the river is on the rise and can cause serious problem in near future. From this study of the surface water quality of the river, it can be concluded that the water of this river may represent serious threat to the ecosystem due to anthropogenic pollution. Although, some parameters may not be at critical pollution level, but high levels of COD, TDS, conductivity, total coliform and faecal coliform clearly
indicates severe water pollution and there is a need for wastewater treatment plant to prevent further river water pollution.

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**REFERENCES**


