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Annual Temporal Changes in Concentration of Total Dissolved Solid (TDS), Nitrate and Sulphate in Koyna River water, Maharashtra, India

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Abstract: *The objective of the study is to recognize temporal changes that affect the Koyna River's water quality parameters throughout time. 52 samples of water in total were collected at weekly intervals from March 2018 to March 2019 at the Koyna River in the vicinity of Karad, Maharashtra, India, to determine the concentrations of TDS, sulphate (SO_4^{--}), and nitrate (NO_3^-). The average annual concentration of NO_3^-, SO_4^{--}, and TDS is considerably lower than the values prescribed by WHO and BIS for irrigation and drinking. Timely variations in the parameters have been recorded. Increasing patterns were observed throughout the monsoon season (June to September 2018), followed by a deceased pattern (October to December 2018), and then a remarkably high level of certain variables in January 2019. The outcomes showed that water entering the river from upstream sources, runoff from agriculture, and household and industrial sewage discharges in tributaries and the mainstream are responsible for variations in concentration that occur gradually, suddenly, and in various manners.*

Keywords: Koyna River, Temporal variation, Water quality parameters

I. INTRODUCTION

The Koyna watershed is extensive research in the fields of hydrogeology, hydrogeochemistry, water shade management, and geology (Tarate et al., 2021; Mishra et al., 2017, Sinha et al., 2017, Naik et al., 2001). They also conducted studies on groundwater recharge and regional specific yield (Poonam et. al., 2013; Naik et al., 2009; Raman et al., 2009), as well as hydrogeological, hydrogeochemical, and quality evaluations of surface water, groundwater, and springs. However, some researchers have conducted morphological studies and geological studies on vertical boreholes that are around 1500 meters deep (Karale et al., 2024; Bajirao et. al., 2021; Dhawde et al., 2018). Temporal variations water quality parameters of river watershed level and aquatic surroundings is an important aspect and it is very much depended on land use pattern and runoff discharge (Kadam et al., 2022; Zope et al., 2018; Bu H. et al., 2010; Chattopadhyay et al., 2005). There is no information on the temporal variability of the Koyna River basin and only a limited amount of data regarding surface water quality are accessible.

A study area is part of Peninsular India, which is covered by the Western Ghats hills of the Deccan Basalt. The study area's maximum elevation of the north-south trading Ghats is around 1450 meters. The Koyna river basin flows 65 kilometers in a parallel manner, following the directions of the Western Ghats. The majority of people are employed in agriculture, and most of them reside in villages (Gaikwad et. al., 2020; Lee et al., 2020; Barakade et al., 2011). In the field of agriculture, the most common cash crops that are harvested are sugarcane, rice, wheat, jowar, and pulses. Sugarcane is the main crop grown along riverbanks, and river water is used for necessary irrigation. To maintain and boost crop production, farmers also use chemical and biological fertilizers that contain nitrogen, potassium, phosphorus, and other elements, along with pesticides. We have taken weekly samples near the Tambave-Sakurdi Bridge in Karad, Maharashtra, on the Koyna River in order to quantify the temporal variation of water quality parameters. The sampling point is designated as KYN (Figure No. 1). From March 2018 to March 2019, we took 52 samples from the same site, and we simultaneously measured the pH and temperature. The primary objective of this study is to examine and

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measure the variations in water quality parameters in the Koyna River basin throughout time. Temperature and pH were recorded at sampling site, whereas TDS, nitrate, and sulfate were used as chemical parameters to help us understand the temporal changes of the physical parameters.

Study Area:

The Koyna River, which rises north of Mahabaleshwar in Maharashtra, India, and flows north-south across the Deccan Plateau, is a tributary of the Krishna. The covers approximately 2036 km³ through steep sloppy hills to the moderate plains of Western Ghats. The river runs 140 km south from its source and turns east to meet the Krishna River at Karad. It is located between longitudes (17°7.17'N to 17°58.22'N) and latitudes (73°33.20'E to 74°11.78'E). The Deccan Volcanic Province (DVP), which is composed of thick basaltic lava flows that erupted owing to fissure type volcanic eruptions throughout the late Cretaceous to lower Eocene epoch, covers the Koyna river basin. At heights of around 975–1450 meters above mean sea level (amsl), some of the upper layers of basalt exhibit localized lateralization at their top. The area of the laterite profile varies in thickness from 2 to 30 m. locally, the most recent alluviums are deposited along a riverbank somewhere.

Climate:

The Koyna basin has a climate classified as subtropical. Which gets 88% of its rainfall from the Southwest Indian Monsoon from June to October. The basin's rainfall varies from east to west. In the Koyna Basin, the Karad receives the least amount of rainfall whereas the Mahabaleshwar receives exceptionally heavy rainfall. In the basin, the average yearly rainfall is 745 mm at its lowest and 6024 mm at its peak. November to February is the start of the winter season, and March to May is the start of the summer season. January has the lowest recorded daily mean mouth temperature, ranging from 10°C to 14°C, which makes it the coldest month overall. However, May has been the warmest month on record, with daily mean maximum mouth temperatures ranging from 31°C to 37°C.

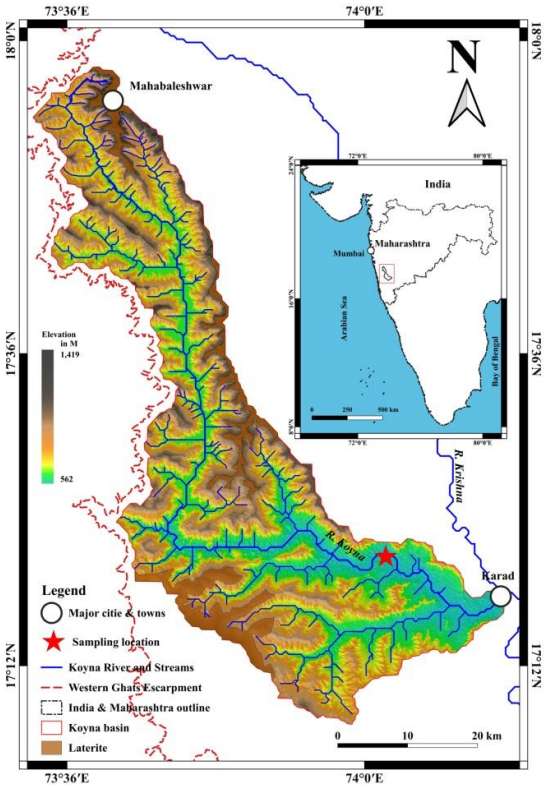

Figure No. 1 Drainage basin and sampling location map of Koyna River

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II. MATERIAL AND METHODS

A weekly representative surface water sample was taken from the Koyna River, a significant Krishna River tributary. For a year, from March 18, 2018, to March 10, 2019, samples were taken on Sundays (except sample no. 7) on the bridge that connected the villages of Sakurdi and Tambave, which is close to Karad city in Maharashtra, India (Latitude 17°18'.686" N, Longitude 74°05'.215" E, Elevation 596 M). The sample was taken from the middle of the river to prevent pollution, human activity, and interference. It was filtered using nylon Whatman membrane filters with pore sizes of 0.22µm. At the sampling location, data on temperature and pH were recorded by using portable Hanna pH and temperature meter during the sampling period. 52 samples in total have been collected during the summer, winter, and monsoon (rainy) seasons. Measurements of the concentrations of major cations and anions have been performed using Ion Chromatography equipment (Metrohm compact IC plus 882, Switzerland). By measuring standards with known concentrations and doing duplicate tests on a small number of samples, the analyses were found to be accurate and precise. Also, Metrohm Eco Titrator is used to analyze alkalinity.

III. RESULTS AND DISCUSSION

The main stream of Koyna has an average yearly temperature of 24.53 °C and pH of 6.86. The lowest recorded temperature of the water was 21.50°C, and the highest was 28.03°C. While the pH varies annually between 6.13 and 7.59. No significant variations in temperature or pH have been noted. As per recommendation of WHO 2011(World Health Organization) and BIS 2012 (Bureau of Indian Standards), the pH natural water should range 6.5-8.5. But some samples from August 2018 to January 2019 shows slightly less pH, it may cause corrosion and metallic taste.

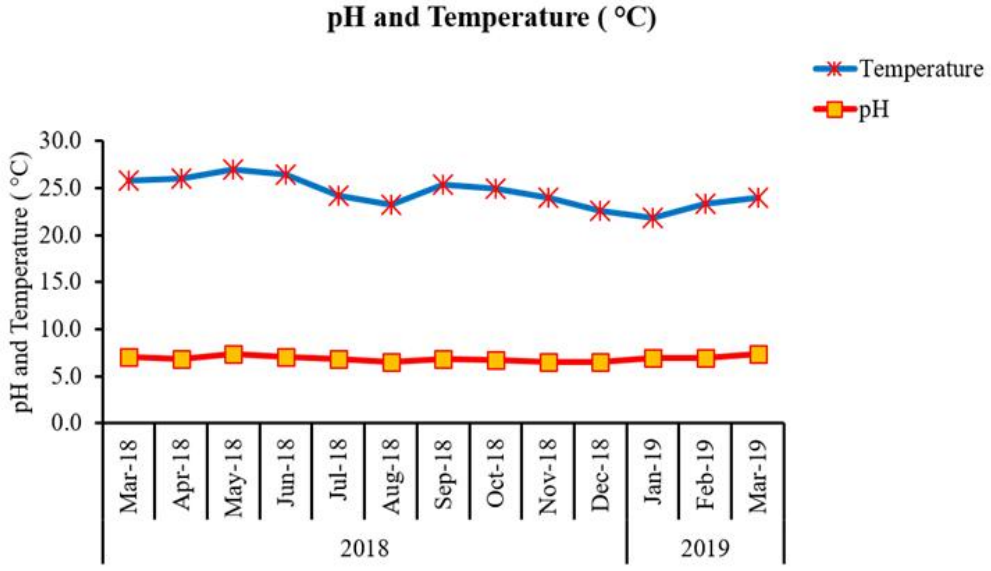

Figure No. 2 Average monthly variation in Temperature and pH

As shown in Figure No. 3, the nitrate (NO_3^-) and sulphate (SO_4^{--}) are showing dramatic variance. The average yearly concentration of nitrate is 0.95±0.95. An average that is almost 53 times lower than the 50 mg/l recommendation value (WHO 2011) and higher than the 0.84 reported during the peak monsoon seasons in 2001 and 2002. July, May, and June of 2018 had the lowest nitrate concentration of 0.04 throughout the year, while January of 2019 had the highest concentration of 6.11, which is 6-7 times higher than the yearly average.

The yearly average sulphate concentration is 1.91± 0.67 which is higher (1.49) than reported in monsoon seasons in 2001 and 2002 (Das et al., 2005) and it is 100 times lower than desirable value of BIS (BIS 2012). The minimum and maximum concentration of sulphate is 1.34 and 5.97 throughout the sampling period. The unusual high concentration observed in Jan 2019 is maximum which is ~6-7 times higher than yearly average concentration.

The variation of nitrate and sulphate with respect season is very significant. Which is lower in summer and gradually increase in monsoon. It is abruptly changed in winter season and showing different pattern than normal. The

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concentration of nitrate in summer season is half than yearly average and it doubled in monsoon and winter season. A Sulphate concentration is approximately same as yearly average in monsoon and winter season but in summer season less than yearly average.

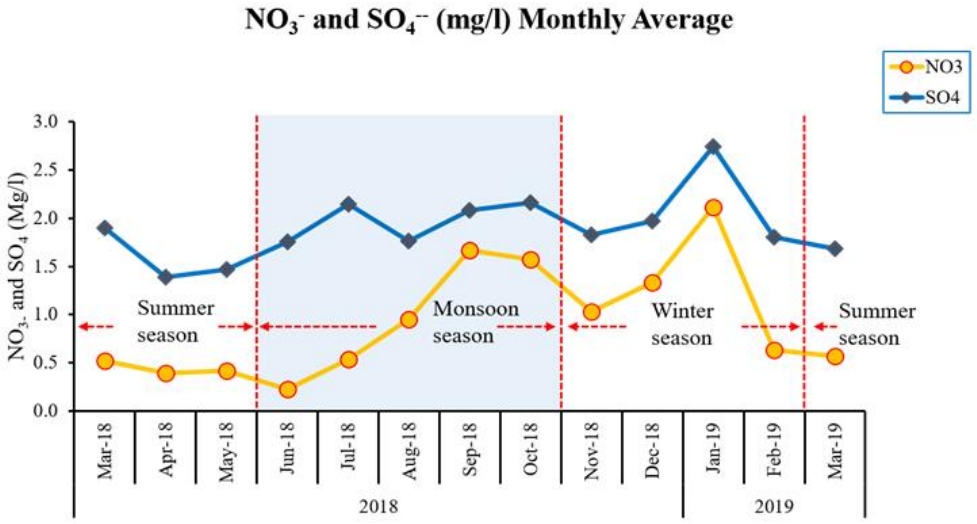

Figure No. 3 Average monthly variation in Nitrate (NO_3^-) and Sulphate (SO_4^{--}) concentration from the Koyna River Surface water

The TDS concertation is ranges from 51.23 to 218.91 mg/l and yearly average is 69.21. It is abruptly increased at some samples in March 2018, September 2018 and January 2019. The Desirable limit of TDS in drinking water is 500mg/l (BIS 2012) and permissible limit is 1500 mg/L (WHO 2011) which is 7 times and 22 times lower than desirable and permissible value respectively.

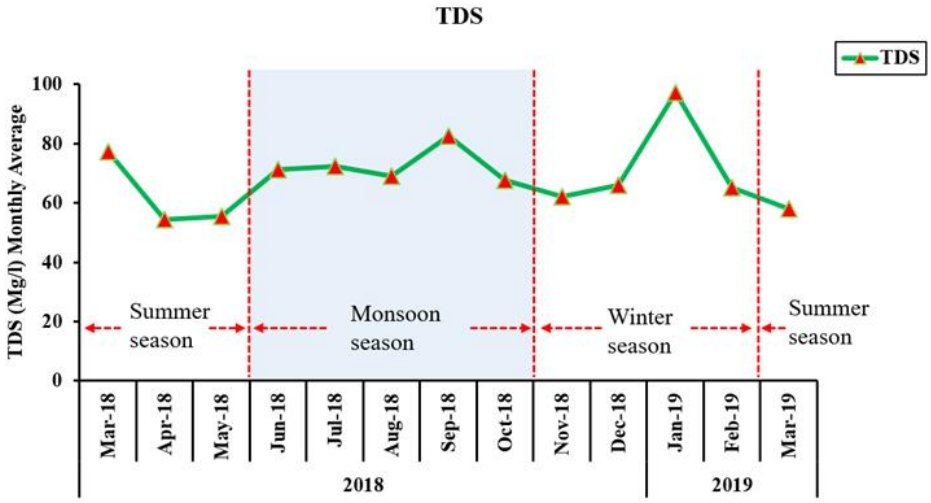

Figure No. 4 Average monthly variation in TDS concentration from the Koyna River Surface water

IV. CONCLUSION

In this study, we investigate weekly temporal changes occurs in five water quality parameters trends at the Koyna river in March 2018 to March 2019. Results are showing normal trends of nitrate and sulphate till July 2018 and after that concertation of gradually increased and decreased in monsoon season and but it abruptly increased in January 2019. TDS is higher in March 2018 and deceased till June and gradually increased throughout monsoon. After moon is showing decrease tread but sharply increased in January 2019. This sharp and abrupt peaks are indicating the

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anthropogony activity and pollution from agriculture and domestic sewage discharge in stream. So, we should identify this type of events, monitor and mitigate for sustainable development of the study area.

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