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Evaluating Physicochemical Profiles and Algal Indicators of Water Pollution in the Girna River, Maharashtra

Miss. Vaibhavi Bhausaheb Pagar , Dr. K. N. Gaikawad

Department of Botany, K.T.H.M College, Nashik- 422002
(Affiliated to Savitribai Phule Pune University Pune 411007)

Abstract

Ensuring the quality of drinking water is crucial for safeguarding public health and preventing the spread of waterborne diseases. This study evaluates the physicochemical properties and seasonal variations in water quality along the Girna River in Kalwan Taluka, Nashik District, India, over the period 2021–2023. Three major sites—Girna Sampling Site I (GSS-I), Site II (GSS-II), and Site III (GSS-III)—were selected to assess spatial and seasonal changes in water quality. Key parameters including atmospheric temperature, water temperature, and pH were monitored during monsoon, winter, and summer seasons using standard methods prescribed by the American Public Health Association (APHA, 1998) and subsequent modifications. The results indicated clear seasonal patterns, with the highest temperatures recorded during the summer and slight variations in pH across sites and seasons. GSS-III generally exhibited higher average water temperatures, while GSS-II recorded consistently higher atmospheric temperatures. This study also highlights the ecological role of physicochemical characteristics in shaping freshwater algal diversity and water quality. The findings underscore the need for continuous monitoring of aquatic systems, particularly in rural and semi-urban riverine environments, to support sustainable water resource management and public health protection.

Keywords: Water Quality, pH, Water Temperature, Girna River, Kalwan

Introduction

Ensuring the quality of drinking water is paramount for improving public health and preventing disease outbreaks. Contaminated water can lead to various waterborne diseases, emphasizing the necessity of regular monitoring and assessment of water quality (WHO, 2008, 2011; Figueras ; Borrego 2010; Khan ets al., 2023). Water is often referred to as the universal solvent due to its unparalleled ability to dissolve a wide range of substances, including essential chemicals, minerals, and nutrients, which it transports through natural systems and living organisms (Jones *et al.*,2010; Adelodun et al., 2021).

In the 21st century, high-quality freshwater has become an increasingly precious commodity, with its scarcity posing significant challenges globally (Jeba et al., 2023). Freshwater resources are critical for drinking, agriculture, aquaculture, and industrial applications, making their quality a central issue for sustainable development (WHO 2011; Cobbinah et al., 2020). Assessing the physicochemical properties of water is crucial for understanding the aquatic environment and managing these resources effectively (Cobbinah*et al*., 2020, Amanulla et al., 2023). Hydrobiological studies have demonstrated the importance of identifying microalgal indicators and calculating species diversity indices to monitor water pollution (Pradhan et al., 2008; Parmar et al., 2016; Archana et al., 2023). The relationship between microalgae and their nutrient requirements in various aquatic systems has led to strategies for conservation and pollution prevention (Ji et al., 2014; Shahid et al., 2020).

The current research explores the multifaceted aspects of environmental parameters in the Girna River, Kalwan Taluka, Nashik, India. This study uniquely emphasizes the often-overlooked drinkable water, ecology, and freshwater pollution parameters. This study systematically examines three major sampling sites (Girna Sampling Sites I, II, and III) across different seasons over a year, recording variable physicochemical parameters during the different season (APHA 1998, Machender et al., 2013, Afrin et al., 2015; Barakat et al., 2016; Hasan et al., 2019; Radojevic et al., 2019; Shambharkar 2019).

Materials and Methods

Water samples were collected in acid-washed plastic cans with a capacity of two liters from six stations at a depth of approximately one foot below the surface. Sampling was conducted early in the morning between 7:00 and 9:30 a.m. at monthly intervals, by adapted and modified protocols established by APHA 1998, Afrin et al., 2015; Barakat et al., 2016; Hasan et al., 2019 and Radojevic et al., 2019.

Sampling Sites:The fieldwork focused on three main sampling sites along the Girna River in Kalwan City:

I. Girna Sampling Site I (GSS-I):Located at the entry point to the city.
II. Girna Sampling Site II (GSS-II): Situated at the midpoint of the city.
III. Girna Sampling Site III (GSS-III): Positioned at the endpoint of the city.

Each site was further divided into ten different sampling positions to ensure comprehensive data collection.

Seasonal Variation Record Charts: Sampling was conducted across three seasons—monsoon, winter, and summer to account for seasonal fluctuations in water levels and corresponding changes in physicochemical parameters and algal biodiversity.

Physicochemical Analysis:

1. **Atmospheric Temperature (AT):** Recorded using a Mercuric Celsius thermometer with 0.1% accuracy at about one foot depth from the surface layer of water.
2. **Water Temperature (WT):** Measured using the same method as atmospheric temperature.
3. **pH:** Assessed at the sampling stations using a digital pen pH meter and later confirmed in the laboratory.

Laboratory Analysis: Upon collection, water samples were transported to the laboratory for further physicochemical analysis using the standard methods outlined by the American Public Health Association (APHA 1998, Machender et al., 2013, Afrin et al., 2015; Barakat et al., 2016; Hasan et al., 2019; Radojevic et al., 2019; Shambharkar 2019).

Data Analysis:Data on atmospheric temperature, water temperature, and pH were systematically recorded and analyzed. Seasonal variations and their impacts on the physicochemical properties and algal biodiversity were documented, with results presented in tables and graphs.

Results and Discussion

The study was conducted across three distinct sites along the Girna River, designated as Girna Sampling Site I (GSS-I), Girna Sampling Site II (GSS-II), and Girna Sampling Site III (GSS-III). These sites were carefully chosen to represent different environmental conditions and physicochemical parameters for a comprehensive analysis over the period of 2021-2023.

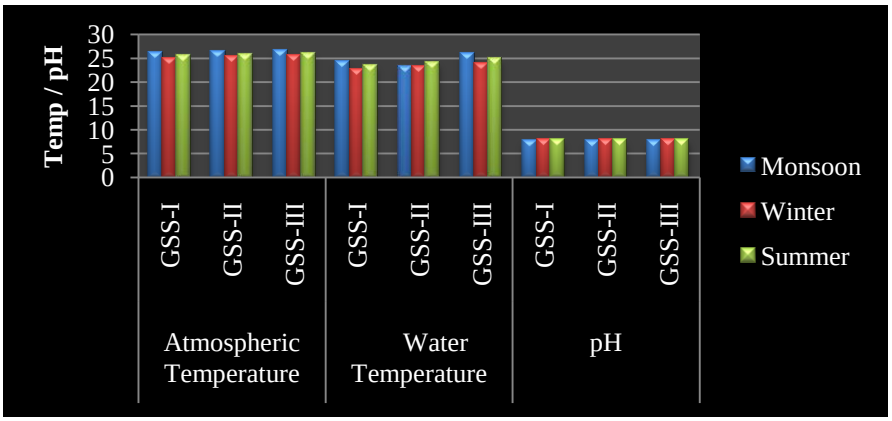
Water samples were systematically collected from each of these sites following the standardized methodology to ensure consistency and accuracy in data collection.

a. Physico-chemical Parameters (2021-2022):

i. Atmospheric Temperature:Comparing the atmospheric temperatures at the three Girna River sampling sites reveals distinct seasonal patterns. At GSS-I, the monsoon temperatures ranged from 21.4°C to 31.5°C with an average of 26.283°C, winter temperatures varied from 18.0°C to 31.8°C with an average of 24.958°C, and summer temperatures averaged slightly higher at 25.620°C. GSS-II exhibited a monsoon range of 23.4°C to 32.4°C with an average of 26.591°C, winter temperatures spanned 16.2°C to 32.2°C averaging 25.316°C, and the summer average was 25.953°C. For GSS-III, monsoon temperatures ranged from 22.7°C to 30.9°C with an average of 26.667°C, winter temperatures varied between 14.6°C and 32.0°C averaging 25.683°C, and summer temperatures averaged 26.175°C. Overall, GSS-II consistently showed the highest average temperatures across all seasons *of sampling period 2021-2022*, while GSS-I and GSS-III exhibited similar trends but with slightly lower averages.

Table-1: Physico-chemical parameters for Sampling Period 2021-2022

Sr. no.	Parameters	Sampling Stations	Sampling Period 2021-2022					
			Monsoon		Winter		Summer	
			Range	Average	Range	Average	Range	Average
1	Atmospheric Temperature	GSS-I	21.4-31.5	26.283	18.0-31.8	24.958	18.0-31.8	25.620
		GSS-II	23.4-32.4	26.591	16.2-32.2	25.316	16.2-32.4	25.953
		GSS-III	22.7-30.9	26.667	14.6-32.0	25.683	14.6-32.0	26.175
2	Water Temperature	GSS-I	20.6-28.2	24.283	15.2-27.0	22.716	15.2-28.2	23.499
		GSS-II	22.5-28.8	23.25	16.2-29.4	23.2	16.2-29.4	24.129
		GSS-III	22.0-29.8	26.125	15.4-28.3	23.8	15.4-29.8	24.962
3	pH	GSS-I	7.2-8.6	7.75	7.5-8.7	8.05	7.2-8.7	7.9
		GSS-II	7.1-8.7	7.75	7.6-8.7	8.075	7.1-8.7	7.912
		GSS-III	7.1-8.6	7.808	7.2-8.8	8.033	7.1-8.8	7.920



Graph 01. Sampling Period 2021-2022

ii. Water Temperature: Comparing water temperatures at the three Girna River sampling sites for the period 2021-2022 highlights seasonal variations. At GSS-I, monsoon water temperatures ranged from 20.6°C to 28.2°C with an average of 24.283°C, winter temperatures varied from 15.2°C to 27.0°C with an average of 22.716°C, and summer temperatures averaged slightly higher at 23.499°C. GSS-II recorded monsoon temperatures between 22.5°C and 28.8°C with an average of 23.25°C, winter temperatures ranged from 16.2°C to 29.4°C averaging 23.2°C, and the summer average was 24.129°C. For GSS-III, monsoon water temperatures ranged from 22.0°C to 29.8°C with an average of 26.125°C, winter temperatures varied between 15.4°C and 28.3°C averaging 23.8°C, and summer temperatures reached up to 29.8°C, averaging 24.962°C. Overall, GSS-III exhibited the highest average temperatures across all seasons, while GSS-I and GSS-II showed similar trends but with slightly lower averages.

iii. pH Levels : Comparing the pH levels at the three Girna River sampling sites for the period 2021-2022 reveals slight variations across seasons. At GSS-I, pH levels ranged from 7.2 to 8.6 during the monsoon with an average of 7.75, in winter the range was 7.5 to 8.7 with an average of 8.05, and in summer the range was 7.2 to 8.7 with an average of 7.9. GSS-II exhibited pH levels from 7.1 to 8.7 during the monsoon, averaging 7.75, winter levels ranged from 7.6 to 8.7 with an average of 8.075, and summer pH averaged 7.912. At GSS-III, monsoon pH levels ranged from 7.1 to 8.6 with an average of 7.808, winter levels ranged from 7.2 to 8.8 with an average of 8.033, and summer pH levels ranged up to 8.8, averaging 7.92. The pH levels at all sites remained within a neutral to slightly alkaline range, with GSS-II showing the highest winter average, while GSS-III demonstrated the highest variability across the seasons in sampling year 2021-2022.

b. Physico-chemical Parameters (2022-2023)

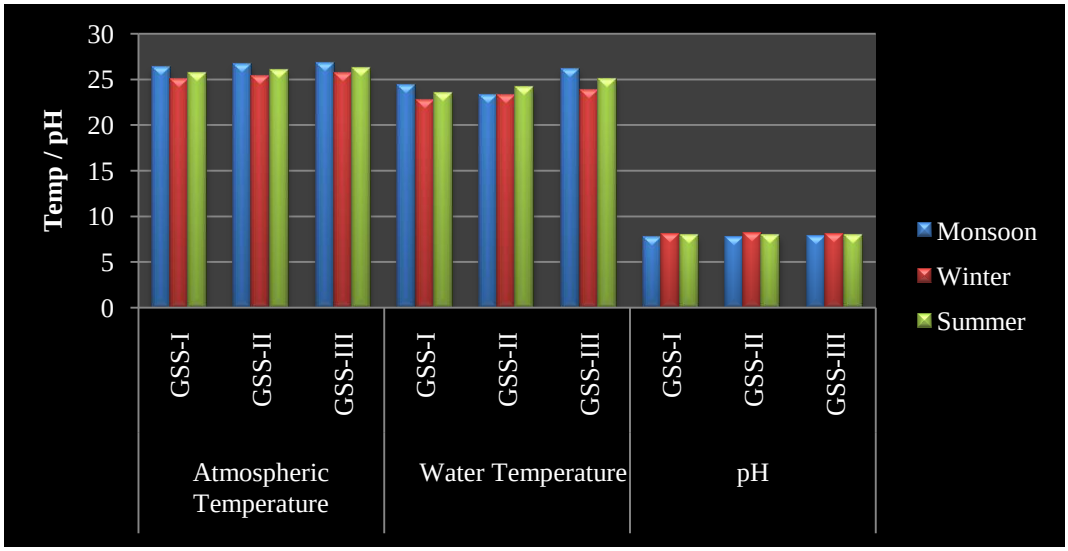
i. Atmospheric Temperature : At GSS-I, during the monsoon, temperatures ranged from 23.8°C to 33.6°C, averaging 27.841°C. In winter, the range was 19.0°C to 33.4°C with an average of 26.808°C, while in summer, the average temperature was 27.324°C. At GSS-II, monsoon temperatures varied from 22.9°C to 31.2°C, with an average of 27.166°C. Winter temperatures ranged from 20.2°C to 33.2°C, averaging 27.433°C, and in summer, the average was 27.3°C. For GSS-III, the atmospheric temperature during the monsoon ranged from 23.3°C to 32.4°C, averaging 27.758°C. Winter temperatures varied between 16.4°C and 33.6°C, with an average of 26.775°C, and summer temperatures averaged 27.266°C. The data indicate that atmospheric temperatures at all three sites were highest during the monsoon and summer seasons, with slight differences in the ranges and averages, highlighting the influence of seasonal climatic changes on the region.

ii. Water Temperature : The water temperature at the three sampling sites along the Girna River showed notable seasonal and spatial differences. At GSS-I, the monsoon water temperatures ranged from 20.6°C to 28.6°C, with an average of 25.058°C. Winter temperatures were slightly cooler, ranging from 16.1°C to 27.4°C, with an average of 23.316°C. In summer, the water temperature averaged 23.283°C. At GSS-II, monsoon water temperatures varied from 20.8°C to 29.2°C, averaging 23.958°C. During winter, temperatures ranged from 16.6°C to 28.0°C, with an average of 23.816°C, and in summer, the average was 23.887°C. At GSS-III, water temperatures during the monsoon ranged from 22.7°C to 29.9°C, with an average of 26.033°C. Winter temperatures were between 17.1°C and 28.2°C, averaging 24.158°C, and in summer, the average temperature was 25.095°C. These variations reflect the impact of seasonal changes on water temperature, with the highest averages typically observed during the monsoon and the lowest during winter.

Table-2: Physico-chemical parameters for Sampling Period 2022-2023

Sr. no.	Parameters	Sampling Stations	Sampling Period 2022-2023					
			Monsoon		Winter		Summer	
			Range	Average	Range	Average	Range	Average
1	Atmospheric Temperature	GSS-I	23.8-33.6	27.841	19.0-33.4	26.808	19.0-33.6	27.324
		GSS-II	22.9-31.2	27.166	20.2-33.2	27.433	20.2-33.2	27.3
		GSS-III	23.3-32.4	27.758	16.4-33.6	26.775	16.4-33.6	27.266
2	Water Temperature	GSS-I	20.6-28.6	25.058	16.1-27.4	23.316	16.1-28.6	23.283
		GSS-II	20.8-29.2	23.958	16.6-28.0	23.816	16.6-29.2	23.887
		GSS-III	22.7-29.9	26.033	17.1-28.2	24.158	17.1-29.9	25.095
3	pH	GSS-I	7.3-8.6	7.833	7.2-8.8	7.966	7.2-8.8	7.899
		GSS-II	7.2-8.5	7.841	7.4-8.8	7.983	7.2-8.8	7.912
		GSS-III	7.2-8.5	7.758	7.4-8.9	8.041	7.2-8.9	7.899

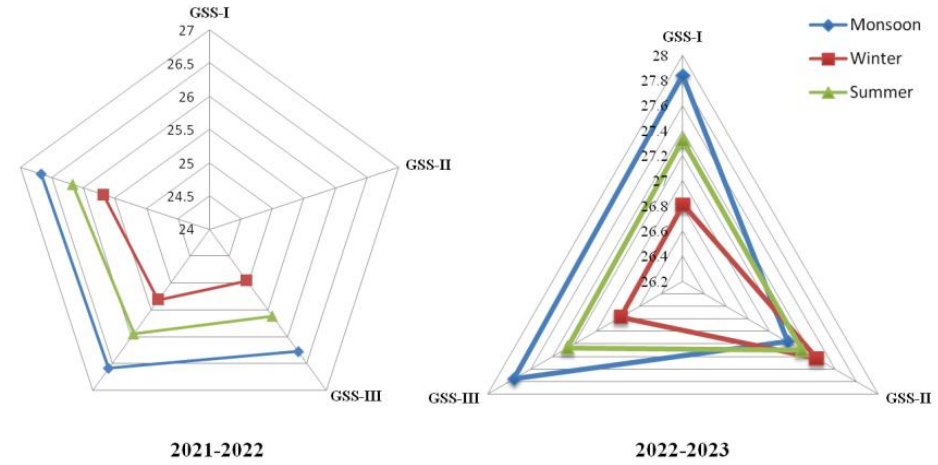
iii. pH Levels : At GSS-I, the monsoon pH levels ranged from 7.3 to 8.6, with an average of 7.833. During winter, the pH varied from 7.2 to 8.8, averaging 7.966, while in summer, the pH range and average were 7.899. At GSS-II, the monsoon pH levels varied from 7.2 to 8.5, with an average of 7.841. In winter, the pH ranged from 7.4 to 8.8, with an average of 7.983, and during summer, the average pH was 7.912. At GSS-III, the pH levels during the monsoon ranged from 7.2 to 8.5, with an average of 7.758. Winter pH levels varied from 7.4 to 8.9, with an average of 8.041, and in summer, the average was 7.899. These fluctuations indicate that pH levels are relatively stable across seasons, with minor variations between sites and slightly higher pH values typically observed in winter.



Graph 02. Sampling Period 2022-2023

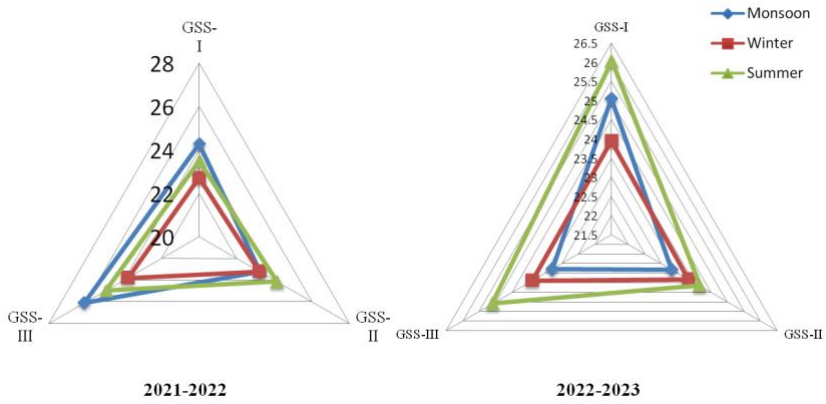
Discussion:

This study examines the atmospheric temperature variations at three sampling sites (GSS-I, GSS-II, and GSS-III) along the Girna River over two consecutive years (2021-2022 and 2022-2023). The data collected during the monsoon and winter seasons provide insights into the climatic changes and environmental conditions of the region.During the monsoon season, a noticeable increase in atmospheric temperatures was observed across all three sampling sites from 2021-2022 to 2022-2023.The winter season also exhibited a notable increase in atmospheric temperatures across all three sampling sites between the two years.



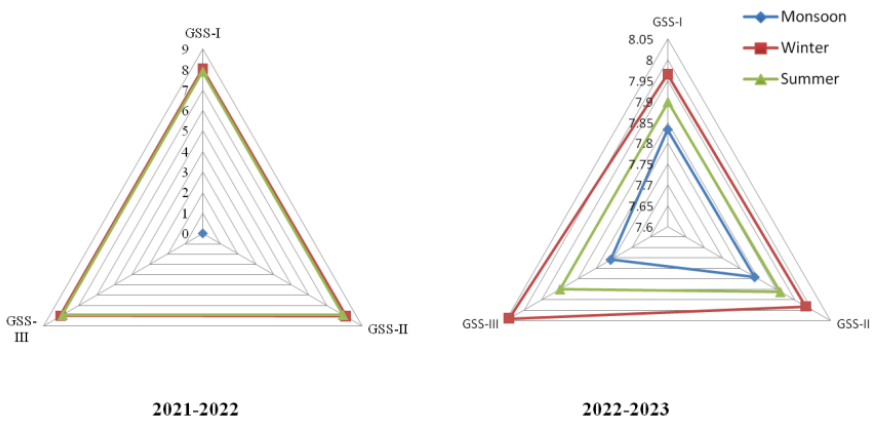
Graph 03. Atmospheric Temperatures

The data indicate that water temperatures at all sites showed an upward trend from 2021-2022 to 2022-2023. This rise in water temperatures, particularly during the monsoon and winter seasons, may suggest ongoing climatic changes impacting the Girna River.



Graph 04. Water Temperatures

The warmer water conditions could influence the aquatic ecosystem, affecting species distribution, metabolic rates, and ecological interactions. These trends highlight the need for continuous monitoring to understand the long-term implications of temperature changes on the river's health and biodiversity. pH levels at all sites showed minor variations between 2021-2022 and 2022-2023. Despite slight fluctuations, the pH remained within a neutral to slightly alkaline range across all seasons. These stable pH levels suggest consistent water quality in the Girna River, which is crucial for maintaining the health of aquatic ecosystems. Continuous monitoring is essential to detect any future changes that could impact the river's biotic communities and water chemistry.



Graph 05. pH

Conclusion

The study conducted a comprehensive analysis of the physicochemical parameters of water at three sampling sites along the Girna River in Kalwan Taluka, Nashik, India, over the period of 2021-2023. The parameters assessed included atmospheric temperature, water temperature, and pH levels across different seasons—monsoon, winter, and summer. The results revealed notable seasonal variations and provided valuable insights into the environmental conditions and water quality of the Girna River.The data indicated an upward trend in both atmospheric and water temperatures from 2021-2022 to 2022-2023, particularly during the monsoon and winter seasons. This suggests ongoing climatic changes that could have significant impacts on the river's aquatic ecosystem, affecting species distribution, metabolic rates, and ecological interactions. Despite these temperature changes, the pH levels at all sites showed only minor variations, remaining within a neutral to slightly alkaline range. This stability in pH suggests consistent water quality, which is crucial for maintaining the health of aquatic ecosystems.

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