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Research Article

Assessment of Physico-Chemical Parameters of Water at Selected Stations of Krishna River, Kolhapur District, Maharashtra, India

Sadiya T. Patel[1,2], Sachinkumar R. Patil[1], Surat A. Manjare[1,*]

[1]Department of Zoology, Jaysingpur College, Jaysingpur, Maharashtra, INDIA.
[2]Department of Zoology, Shivaji University, Kolhapur, Maharashtra, INDIA.

ABSTRACT

Background: Water is an essential natural resource for all forms of life, and its quality plays a crucial role in maintaining public health, preventing diseases, and improving the quality of life. Monitoring physicochemical parameters of river water is necessary to assess its suitability for various uses. **Objectives:** The present study aimed to evaluate the water quality status of the Krishna River at selected stations in Kolhapur district by analyzing key physicochemical parameters over a one-year period. **Materials and Methods:** Water samples were collected monthly from February 2023 to January 2024 at five selected stations of the Krishna River: Kanwad, Hasur, Ghalwad, Nrusinhawadi, and Bubnal. The collected samples were analyzed for various physicochemical parameters, including water temperature, transparency, turbidity, total solids, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), electrical conductivity, pH, dissolved oxygen, free CO_2, hardness, chlorides, alkalinity, phosphate, and nitrate. **Results:** The study revealed noticeable seasonal and spatial variations in the physicochemical characteristics of water, influenced by environmental and climatic changes. However, most of the analyzed parameters were found to be within the permissible limits for potable water quality. **Conclusion:** The findings indicate that the water quality of the Krishna River at the selected stations is generally suitable for drinking purposes and can also be used for domestic and commercial applications. Continuous monitoring is recommended to ensure the maintenance of water quality and to detect any future changes.

Keywords: Kolhapur District, Krishna River, Physicochemical Parameters, Water Quality.

Correspondence:
Dr. Surat A. Manjare
Department of Zoology, Jaysingpur College, Jaysingpur, Maharashtra, INDIA.
Email: sadiyapatel97@gmail.com

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INTRODUCTION

Water is a vital natural resource and a fundamental requirement for the survival of living organisms. It has been instrumental in the evolution and maintenance of life on Earth. Water is extensively used for domestic consumption, agricultural irrigation, and industrial activities. Rivers and streams constitute important components of the natural environment and support human populations, aquatic life, wildlife, and vegetation (Hasse and Blodgett, 2009).

Rivers play a crucial role in sustaining life by providing water for drinking, irrigation, fisheries, and industrial purposes. There is major seven rivers in India, the Brahmaputra, Indus Tapi, Godavari, Mahanadi, Krishna and Narmada, along with their numerous tributaries (Balasubramanian, 2013). The Krishna River is among the longest rivers of India with length is about 1400 km (Sutar *et al.*, 2025). It originates near Mahabaleshwar in the Western Ghats and flows through Maharashtra, Karnataka, Telangana, and Andhra Pradesh before draining into the Bay of Bengal. In Maharashtra, the river flows through Kolhapur, Sangli and Satara districts and is extensively used by the local population (Comprehensive study report on Krishna River stretch, 2014).

Water quality represents the ability of water bodies to support biological life and meet human needs. Maintaining good water quality is necessary to ensure safe drinking water, recreational use, and the protection of aquatic ecosystems. Water pollution occurs when human activities cause changes in the physical, chemical, or biological properties of water, rendering it unsuitable for its intended uses (Jyoti, 2021).

In recent years, increasing population pressure, agricultural practices, discharge of municipal sewage, and industrial effluents have deteriorated river water quality (Singh *et al.*, 2004). Physico-chemical analysis is a fundamental tool for evaluating the health of aquatic ecosystems and determining the suitability

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of water for various purposes. Several studies have emphasized the need for continuous monitoring of the Krishna River to prevent further degradation.

MATERIALS AND METHODS

Study Area

Kolhapur district lies between 15°43′ to 17°17′ N latitude and 73°40′ to 74°42′ E longitude. The Krishna River flows through the eastern part of the district, receiving water from tributaries such as Panchganga, Dudhganga and Warna. The region experiences a tropical monsoon climate with heavy rainfall during June to September and influences river water quality. After intensive survey 5 sampling stations (Kanwad, Ghalwad, Hasur, Nrusinhawadi, and Bubnal) were selected at approximate distance. Water samples were collected monthly from selected locations along the river.

Sample Collection

Water samples were collected from five selected sampling stations over a period of one year, from February 2023 to January 2024. Standard procedures recommended in limnological literature were followed for the analysis of physico-chemical characteristics of water (APHA-2017, Workbook on Limnology by Adoni *et al.*, and Chemical and Biological methods for water pollution studies by Trivedy and Goel). Parameters such as water temperature, pH, transparency, Dissolved Oxygen (DO), and free CO_2, were measured directly at the sampling sites. Laboratory analyses were carried out to determine total hardness, Electrical Conductivity (EC), Turbidity, Total solids, Total dissolved solids, Total suspended solids, alkalinity, chloride, nitrate, and phosphate. At each sampling station, water samples were collected in clean 1-litre polythene bottles. Necessary precautions were taken during sampling, handling, and transportation to avoid contamination.

Laboratory Analysis

The collected water samples were examined in the laboratory to assess their physico-chemical properties. All glassware used during the analysis was pre-treated with dilute nitric acid and rinsed with distilled water to prevent possible contamination. Details of parameters, their units, and methodology with their brief description is given in Table 1.

RESULTS

Monthly variations in the physico-chemical characteristics of surface water from the selected stations were evaluated to understand the hydrological status of all the stations (Tables 2-6).

Temperature

Temperature is a primary factor controlling chemical reactions and biological processes in aquatic systems. During the study period, water temperature varied between 20 and 26°C. Similar range have been noted by various workers. Khan *et al.* (2017) have reported range between 19 to 26°C of the Narmada River, El Morhit *et al.* (2014) observed temperature variation between 19.2 to 29.2°C of the Loukkos River, Islam *et al.* (2015) recorded 22 to 30°C of the Karnaphuli River, Sahoor *et al.* (2016) documented range 22 to 28°C. Highest temperature was noted during April 2023 of Ghalwad station and lowest was noted during October 2023 of Bubnal, Nrusinhawadi and Kanwad stations and January 2024 of Bubnal.

pH

The pH values ranged from 6.2 to 8.9, indicating slightly acidic to moderately alkaline conditions. Highest pH was noted during May 2023 at Hasur and lowest during December 2023 at Bubnal station. Many workers found maximum pH in summer and minimum in winter Bera *et al.* (2023), Snyder *et al.* (2021), Zhang *et al.* (2025).

Electrical Conductivity

Electrical conductivity varied from 116 to 672 µS/cm, reflecting changes in dissolved ionic content. Highest conductivity was recorded during December 2023 at Nrusinhawadi and lowest during July 2023 at the same station.

Transparency

Transparency showed pronounced seasonal variability, ranging from 20.3 to 99.06 cm. Maximum was observed at Hasur during April 2023 and Minimum was observed during July 2023 at Kanwad station.

TDS (Total Dissolved Solids)

TDS ranges from 0.08 mg/L to 0.368 mg/L. Highest TDS was noted during January 2024 at Nrusinhawadi while lower were noted during May 2023 at Ghalwad.

Total Hardness

Total hardness values ranged from 60 to 302 mg/L, classifying the water as soft to hard. Maximum value of hardness was noted during February 2023 at Kanwad and minimum was noted December 2023 at Hasur station.

Alkalinity

Alkalinity values ranged from 22 to 102 mg/L, indicating moderate buffering capacity of the river. Maximum alkalinity was noted during February 2023 at Nrusinhawadi and minimum was during August 2023 at Bubnal.

Chlorides

Chloride concentrations varied from 25.52 to 68.06 mg/L, Highest concentration of chlorides was observed during January 2024 at Bubnal and Ghalwad stations where as lowest was recorded during September 2023 of Bubnal.

Table 1: Physico-chemical Parameters, Methods, and Units Used for Water Analysis.

Sl. No.	Parameter	Method Used / Instrument	Principle / Brief Description	Unit
1.	Transparency	Secchi Disc Method	Average depth at which disc disappears and reappears	cm
2.	Turbidity	Nephelometric Method (Digital Turbidity Meter)	Measurement of light scattered by suspended particles	NTU
3.	pH	Digital pH Meter	Measurement of hydrogen ion concentration	-
4.	Alkalinity	Acidimetric Titration	Titration with N/50 H_2SO_4 using phenolphthalein and methyl orange indicators	mg/L as $CaCO_3$
5.	Total Hardness	EDTA Titrimetric Method	Complexometric titration using Eriochrome Black-T indicator	mg/L as $CaCO_3$
6.	Free Carbon Dioxide	Titration Method (APHA, 2005)	Neutralization of CO_2 using NaOH with phenolphthalein	mg/L
7.	Dissolved Oxygen (DO)	Winkler's Iodometric Method	Oxidation-reduction titration using sodium thiosulphate	mg/L
8.	Chloride	Argentometric Titration	Precipitation of AgCl using $AgNO_3$ and potassium chromate indicator	mg/L
9.	Total Dissolved Solids (TDS)	Gravimetric Method	Residue after evaporation of sample	mg/L
10.	Nitrate	Phenol Disulphonic Acid Method	Formation of yellow colour measured at 410 nm	mg/L
11.	Phosphate	Stannous Chloride Method	Formation of molybdenum blue complex measured at 690 nm	mg/L
12.	Electrical Conductivity (EC)	Conductivity Meter	Measurement of ionic strength of water	µS/cm

Table 2: Physico - Chemical Parameters of Bubnal (February 2023-January 2024).

Parameter / Month	Temperature (°C)	pH	Elec. Conductivity	Transparency (cm)	Total Dissolved Solids	Hardness	Alkalinity	Chloride	Phosphate	Nitrate	Dissolved Oxygen	Free CO_2
February	21	8.8	402	63.5	0.24	186	100	56.72	0.1362	0.495	5.6	4.4
March	21	8.4	322	76.2	0.1608	146	40	42.54	0.1473	1.087	4.8	Ab
April	25	7.3	360	81.28	0.2208	114	38	34.03	0.138	2.304	4.4	4.4
May	24	8.6	410	81.28	0.3292	132	36	51.04	0.02712	2.1158	3.6	Ab
June	24	8.6	204	63.5	0.192	94	24	36.87	0.02364	0.96	3.6	4.4
July	22	7	220	24.8	0.3424	98	36	51.04	0.102	1.634	6	35.2
August	22	6.9	164	26.3	0.0832	74	22	56.72	0.107	0.854	5.6	8.8
September	21	7.1	230	25.4	0.0742	96	50	25.52	0.04465	0.782	4.8	13.2
October	20	7.1	246	86.36	0.122	74	40	59.95	0.101	0.724	4.8	4.4
November	21	6.8	227	67.31	0.1626	72	60	62.39	0.0704	0.694	5.2	8.8
December	21	6.2	176	53.34	0.2808	76	64	56.72	0.0836	0.768	5.6	8.8
January	20	7.9	610	69.7	0.351	134	72	68.06	0.117	0.599	5.2	66
Average	21.83	7.56	297.58	59.91	0.2132	108	48.5	50.1	0.0914	1.0847	4.93	15.84
Standard Deviation	1.642245322	0.8628	129.7728493	22.6658528	0.0976	35.5323	22.25677	12.787	0.042445	0.6014	0.7691	19.916

Table 3: Physico-chemical Parameters of Nrusinhawadi (February 2023 - January 2024).

Parameter / Month	Temperature (°C)	pH	Elec. Conductivity	Tranparency (cm)	Total Dissolved Solids	Hardness	Alkalinity	Chloride	Phosphate	Nitrate	Dissolved Oxygen	Free CO_2
February	21	8.8	462	71.12	0.276	174	102	56.72	0.1473	0.576	6.4	4.4
March	21	8.4	306	63.5	0.1888	140	34	45.37	0.15382	0.742	5.2	26.4
April	25	7.7	364	64.58	0.2248	136	40	31.19	0.168	0.879	4.8	30.8
May	24	8.4	426	88.9	0.358	136	36	56.72	0.03077	0.4828	4	Ab
June	24	8.7	400	66.04	0.2976	132	42	53.89	0.02234	0.466	4	4.4
July	22	6.5	116	26.8	0.1416	90	24	39.7	0.173	1.989	8	8.8
August	22	6.4	322	28.5	0.184	100	38	53.89	0.052	1.272	7.2	13.2
September	21	7.3	374	26.3	0.163	108	52	56.72	0.0573	0.824	6.8	17.6
October	20	8.3	448	78.74	0.212	62	36	59.55	0.094	0.803	4.8	13.2
November	21	7.4	408	63.5	0.1733	68	64	53.89	0.0942	0.973	5.6	8.8
December	21	6.9	672	50.8	0.2668	76	66	51.04	0.0718	0.781	4	17.6
January	22	7.7	532	51.2	0.3686	129	70	65.22	0.1228	1.024	6	8.8
Average	22	7.7	402.5	56.66	0.2378	112.58	50.33	51.99	0.098	0.9	5.57	14
Standard Deviation	1.54	0.83	133.41	20.56	0.08	34.17	21.72	9.24	0.05	0.41	1.34	8.536

Table 4: Physico-chemical Parameters of Hasur (February 2023 - January 2024).

Parameter / Month	Temperature (°C)	pH	Elec. Conductivity (µS/cm)	Transparency (cm)	Total Dissolved Solids (mg/L)	Hardness	Alkalinity	Chloride	Phosphate	Nitrate	Dissolved Oxygen	Free CO^2
February	22	8.6	410	76.2	0.1876	164	88	48.21	0.1326	0.879	2.4	8.8
March	22	8.2	396	86.36	0.2056	166	44	51.04	0.13562	1.307	5.2	79.2
April	26	8.2	316	99.06	0.1632	108	44	51.04	0.144	1.606	4.4	22
May	25	8.9	362	73.66	0.3624	100	30	53.89	0.03604	0.4542	3.6	Ab
June	25	8.8	522	68.58	0.4268	162	42	56.72	0.0364	0.818	4	8.8
July	23	6.6	206	22.4	0.194	84	28	39.7	0.129	2.245	7.2	8.8
August	23	6.7	306	23.6	0.1636	106	30	51.04	0.112	0.784	6.8	4.4
September	22	7.8	270	23.4	0.1552	116	50	53.89	0.08503	0.982	6.4	13.2
October	21	7	412	73.66	0.226	68	38	56.72	0.094	0.822	4	Ab
November	22	7.3	346	58.42	0.1822	64	70	59.55	0.099	0.995	5.2	4.4
December	22	7.1	528	39.37	0.3284	60	70	65.22	0.0837	1.19	6	22
January	23	7	418	49.1	0.3194	120	62	56.72	0.1184	1.012	4.8	Ab
Average	23	7.67	374.33	57.81	0.243	109.83	49.67	53.64	0.1	1.09	5	19.07
Standard Deviation	1.54	0.84	94.74	26.11	0.09	38.22	18.95	6.34	0.04	0.46	1.42	23.49

Nutrients (Nitrate and Phosphate)

Nitrate concentrations ranged from 0.348 to 2.597 mg/L while phosphate values varied between 0.0223 and 0.2334 mg/L. Higher nutrient levels during summer may be linked to increased microbial activity and internal nutrient recycling, whereas lower concentrations during the monsoon are attributed to dilution. Although nutrient levels were generally low, occasional increases in phosphate may enhance the risk of eutrophication under favourable conditions.

Free Carbon Dioxide

Free carbon dioxide concentrations ranged between 4.4 and 35.2 mg/L and did not exhibit a consistent seasonal pattern. Fluctuations in CO_2 levels may be influenced by respiration, decomposition of organic matter, and photosynthetic uptake. Occasional higher concentrations could indicate increased biological activity or organic load in water.

Dissolved Oxygen

Dissolved oxygen values ranged from 2.4 to 7.2 mg/L. Maximum value was noted during August 2023 at Nrusinhawadi, July 2023 at Hasur, Kanwad and Ghalwad whereas minimum value was recorded during Feb'23 of Hasur.

DISCUSSION

During the entire study period, all the stations exhibited distinct seasonal variations in water temperature, comparatively lower values recorded during the winter months and higher values during the summer season. Similar trend of declined temperature in winter and inclined in summer was recorded by Muhammad *et al.* (2020), Shaktawat and Rathore (2026), Kumar (2025), Gebrehiwot *et al.* (2018) Singh *et al.* (2018). The decline in water temperature during winter can be attributed to reduced ambient temperatures, which may further be influenced by increased wind velocity and higher water levels. In contrast, the elevated water temperature observed during the summer season is mainly due to increased ambient temperature resulting from high intensity of light and reduced water levels (Patil, 2014).

Higher pH values observed during summer may be associated with enhanced photosynthetic activity, leading to reduced carbon dioxide levels in water. Lower pH during winter could be linked to organic matter decomposition and increased respiration (APHA, 2017). Overall, pH values remained within acceptable limits, suggesting favourable conditions for aquatic life.

Higher value of electrical conductivity in winter might result from evaporation and concentration of dissolved salts, while lower values during the monsoon are attributed to dilution by rainwater. Seasonal fluctuations in conductivity indicate the influence of hydrological processes on ionic composition.

Higher transparency during Summer indicates effective settling of suspended particles, while reduced transparency during the monsoon reflects increased turbidity caused by surface runoff carrying silt and organic matter from the catchment area. Such seasonal variation in transparency directly influences light penetration and primary productivity. TDS is important as it reflects salinity, these dissolved mineral content in water affects water quality used for drinking, agriculture, aquatic life, and ecosystem health.

Lower hardness during the monsoon season may be due to dilution effects, whereas higher values during winter are likely caused by leaching of calcium and magnesium salts from surrounding soils and rocks. Seasonal variation in hardness reflects the influence of catchment geology and hydrological conditions.

Higher alkalinity during winter may be related to reduced biological utilization of bicarbonates, while lower values during monsoon due to dilution of river water by heavy rainfall which reduces concentration of carbonates and bicarbonates.

Elevated levels of chloride during winter may be due to evaporation and agricultural practices, whereas reduced concentrations during the monsoon are likely the result of dilution. Chloride levels remained within permissible limits, suggesting minimal pollution impact.

Higher concentrations of Dissolved oxygen during monsoon may be attributed to lower water temperature and increased physical aeration of water due to heavy rainfall which increases oxygen solubility, while reduced levels during summer are associated with elevated temperature and increased biological oxygen demand. Overall DO levels indicate good aeration and favourable ecological conditions.

Table 5: Physico-chemical Parameters of Kanwad (February 2023 - January 2024).

Parameter Month	Temperature (°C) image1	pH	Elec. Conductivity	Transparency (cm)	Total Dissolved Solids	Hardness	Alkalinity	Chloride	Phosphate	Nitrate	Dissolved Oxygen	Free CO_2
February	21	8.8	360	62.48	0.2344	302	88	39.7	0.1374	0.997	4.8	22
March	22	8.3	262	60.96	0.1484	116	30	39.7	0.14721	1.118	5.2	Ab
April	25	7.2	374	86.36	0.1876	124	28	53.88	0.159	1.429	4.4	8.8
May	25	8.2	200	71.12	0.1208	74	34	31.19	0.05913	2.5975	6.4	4.4
June	25	8.7	326	60.96	0.0373	138	42	48.21	0.04368	0.348	4.8	4.4
July	23	6.3	210	20.3	0.2864	120	28	42.54	0.135	1.835	7.2	4.4
August	22	6.5	296	22.4	0.1152	104	36	56.72	0.11	1.28	6.8	8.8
September	22	7.8	264	21.3	0.1036	110	60	59.55	0.0841	1.002	6.4	8.8
October	20	7.2	464	76.2	0.1756	68	46	62.39	0.135	0.991	4.4	Ab
November	21	7.5	364	55.88	0.1117	64	58	65.22	0.0992	0.869	5.2	4.4
December	22	7.1	582	48.26	0.3424	62	64	56.72	0.117	0.701	6	8.8
January	21	8.4	547	76	0.3078	108	60	62.39	0.1283	0.687	4.8	4.4
Average	22.42	7.67	354.08	55.18	0.18	115.83	47.83	51.51	0.112	1.154	5.53	7.92
Standard Deviation	1.73	0.83	123.23	22.78	0.09	64.03	18.46	11.01	0.04	0.59	0.98	5.4088

Table 6: Physico-chemical Parameters of Ghalwad (February 2023 - January 2024).

Parameter Month	Temperature (°C) image1	pH	Elec. Conductivity	Transparency (cm)	Total Dissolved Solids	Hardness	Alkalinity	Chloride	Phosphate	Nitrate	Dissolved Oxygen	Free CO_2
February	22	8.4	370	50.8	0.1496	142	84	42.54	0.1421	0.806	4.8	13.2
March	22	8.4	276	58.42	0.1296	112	34	36.86	0.14521	1.683	5.2	17.6
April	26	7.7	284	58.43	0.1692	106	36	34.03	0.125	2.202	4.4	4.4
May	25	8.4	210	68.58	0.08	66	24	34.03	0.03348	1.6749	6.4	4.4
June	25	8.6	278	63.5	0.3568	110	32	39.7	0.2334	0.56	4.8	4.4
July	23	6.4	180	24.4	0.1424	100	28	42.54	0.094	1.578	7.2	8.8
August	22	6.6	290	27.4	0.1704	98	34	53.89	0.348	0.74	6.8	4.4
September	22	7.9	284	26.4	0.1634	116	52	65.22	0.0377	0.651	6.4	8.8
October	21	7.6	498	73.66	0.244	84	56	62.39	0.1	0.541	4.4	4.4
November	21	7.9	408	65.02	0.135	72	56	53.88	0.0961	1.017	5.2	13.2
December	22	6.7	588	60.96	0.3188	76	66	51.04	0.126	0.927	6	17.6
January	22	7.2	403	69.8	0.3142	125	64	68.06	0.1292	0.602	4.8	4.4
Average	22.83	7.65	339.08	53.95	0.1977	100.58	47.17	48.68	0.1341	1.0818	5.53	8.8
Standard Deviation	1.66	0.77	118.77	17.85	0.09	22.76	18.54	12.14	0.09	0.56	0.98	5.3066

CONCLUSION

The physico-chemical assessment of the Krishna River at selected stations in Kolhapur district revealed that all parameters were within the permissible limits prescribed by the World Health Organization (WHO). However, elevated free CO_2 concentrations at certain stations reflect localized anthropogenic influences, primarily due to increased carbon load from domestic wastewater discharge and surface runoff.

To sustain the existing water quality, regular monitoring should be continued, with particular attention to carbon-related parameters. Effective treatment of wastewater, control of runoff, and strict enforcement of environmental regulations are recommended to minimize anthropogenic impacts and ensure long-term ecological sustainability of the Krishna River.

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ABBREVIATIONS

TDS: Total Dissolved Solids; **DO:** Dissolved Oxygen; **EC:** Electrical Conductivity; **CO_2:** Carbon Dioxide; **WHO:** World Health Organization; **APHA:** American Public Health Association; **NTU:** Nephelometric Turbidity Units; **Ab:** Absent/ Not Available (as indicated in tables).

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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