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Assessment of Spatial Distribution of Chemical Characterization of Darna River Water, Nashik, India

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ABSTRACT

The current research paper has been carried out to assess the spatial distribution of chemical characterization of Darna River water in Nashik. To fulfil the objective of the present study, total 11 sites and 10 parameters have been chosen and water samples have been collected from these sites of the river dated on 12th May 2024. A random purposive sampling method has been implemented to collect the samples to assess the chemical characteristics of 10 parameters such as TDS (mg/l), Calcium (mg/l), Fluoride (mg/l), Chloride (mg/l), Iron (mg/l), Total Alkalinity (mg/l), Nitrogen-nitrate (mg/l), pH, Electrical Conductivity (EC) and Total Hardness (mg/l). All collected samples have been analysed using standard water analysis methods in laboratory. The outcome of the sample analysis has been represented in the form of thematic maps. The readings of chemical parameters demonstrate the increasing pollution downstream due to human activities like as domestic wastewater, cremation sites, urbanization, etc. The agricultural runoff is also promoting the pollution due to intensive use of agrochemicals and fertilizers. The result thoroughly indicate heterogeneous chemical quantity and declining water quality downstream. This research provide a valuable baseline for agriculture department for setting the ideal guidelines of the future perspective for the farmers as well as the municipal councils for sustain the river water quality.

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Introduction

Rivers are the significant freshwater resources that support ecosystems, sustain biodiversity, and fulfil a wide range of human needs, including drinking water, agriculture, industry, and recreation. However, rapid urbanization, industrial development, agricultural runoff, and inadequate waste management have led to significant deterioration in river water quality across the globe. The decline in water quality of river systems not only affects aquatic life but also poses serious risks to public health and socio-economic development (Meenakshi et al. 2002). The water quality can be defined as the chemical, physical and biological characteristics of water, usually in respect to its suitability for a designated use. Water can be used for recreation, drinking, fisheries, agriculture or industry. Each of these designated uses has different defined chemical, physical and biological standards necessary to fulfil the respective purpose. After many years of research, water quality standards are fixed to ensure the suitability of efficient use of water for a designated purpose. Water quality analysis is to measure the required parameters of water, following standard methods, to check whether they are in accordance with the standard (Makwana et al. 2012).

Numerous studies and outbreak investigations globally have found a direct association between poor water quality and human health. Agricultural runoff, cremation sites, industrial waste and the municipal solid waste have emerged as one of the leading cause of pollution of surface water. (Kaur H. et al. 2001, Adefemi et. al. 2010, Rim-Rukeh 2013). Venkatesharaju et al. (2010) has been studied seasonal and special variation in surface water quality of Cauvery river stretch in Karnataka. This study was concluded that river water of the study area was not polluted in respect to physico- chemical assessment. Agarkar (2003) has been highlighted that fluoride content in drinking water badly affected the human health in Buldhana. In the same way, Nashik's rapid urbanization and industrial growth have led to increased pollution, threatening the quality of its drinking water sources. The estimation of chemical parameters is required mainly for water quality analysis. Therefore for current research work has been designated to study the chemical parameters of water in Darna River and its surroundings. Hence, the objective of the current research has been set as to assess the spatial distribution of chemical characterization of Darna River water in Nashik.

Study Area

The Darna is tributary of the Godavari River, located in the Nashik district of Maharashtra, India which rises at elevation of 1040 m on the northern side of Kulung hill in the Sahyadri ranges, with covering 1316 km^2 area. The basin is extended between 19^0 35' 00" N to 19^0 59’ 13" N latitudes and 73^0 31’ 31" E to 73^0 58’ 46" E longitudes (Fig.1). It has long and meandering course and its bed is wide and sandy (Pathare, 2018). The river meets to Godavari River at Darnasangavi.

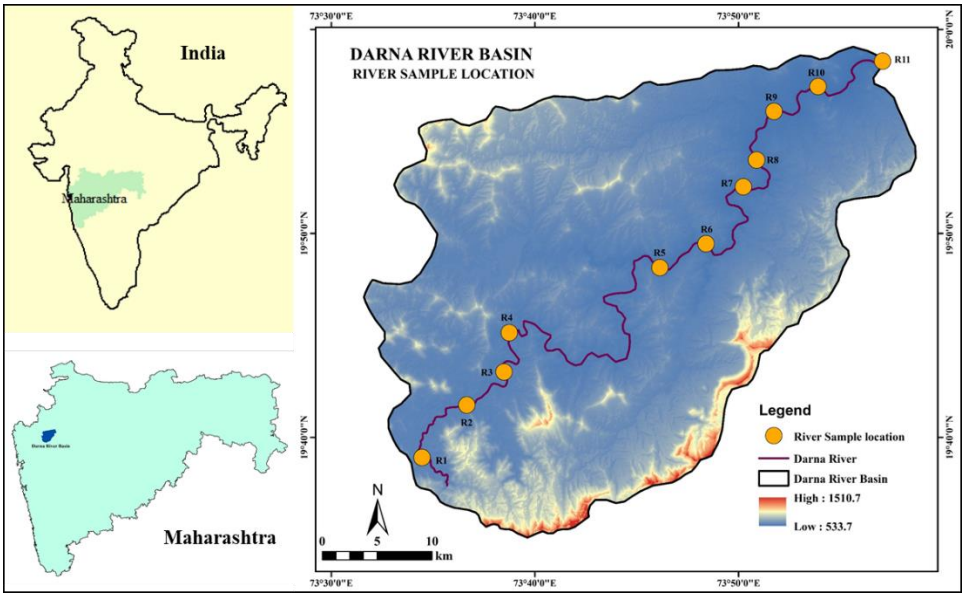

Fig 1. Location map of the Darna River Basin

Data Collection and Methodology

The primary and secondary data sources have been used for the current study. To fulfil the objective, the river water samples have been collected from the Darna River, Nashik. Total of 11 sites and 10 parameters have been chosen (Fig. 2), and water samples have been collected from these sites of the river on the 12th May 2024. The samples have been coded as R1 to 11 and the details of all sample sites have been mentioned in Table 1. A random purposive sampling method has been adopted to collect the samples. Samples have been collected (Photo plate 1) in clean plastic bottles of 1 litre capacity to study the chemical characteristics of 10 parameters such as TDS (mg/l), Calcium (mg/l), Fluoride (mg/l), Chloride (mg/l), Iron (mg/l), Total Alkalinity (mg/l), Nitrogen-nitrate (mg/l), pH (temperature @25ºC), Electrical Conductivity (EC) and Total Hardness (mg/l). All collected samples have been analysed using various standard water analysis methods in the Regional Water Testing Laboratory, Nashik (Water Supply and Sanitization Department, Government of Maharashtra). The results of the Darna River water's chemical properties have been finally shown in a table, and various thematic maps have been prepared.

Table 1: Details of the Darna River Sample Locations

Sample Name	Sample location	Latitude	Longitude
R1	Nandgoan Sado	$19^0$39'0.97''N	$73^0$34'27.24''E
R2	Ghoti BK.Taloshi	$19^0$41'34.94''N	$73^0$36'39.23E
R3	Devle	$19^0$43'12.44''N	$73^0$38'28.85''E
R4	Manikkhamb	$19^0$45'6.45''N	$73^0$38'44.49''E
R5	Sakur	$19^0$48'19.53''N	$73^0$46'8.10''E
R6	Shenit	$19^0$49'29.46''N	$73^0$48'24.14''E
R7	Bhagur	$19^0$52'17.09''N	$73^0$50'13.90''E
R8	Nanegoan	$19^0$53'35.55''N	$73^0$50'52.93''E
R9	Palse	$19^0$55'57.70''N	$73^0$51'44.13''E
R10	Kotamgoan	$19^0$57'11.82''N	$73^0$53'54.19''E
R11	Darnasangvi	$19^0$58'26.56''N	$73^0$57'4.29''E

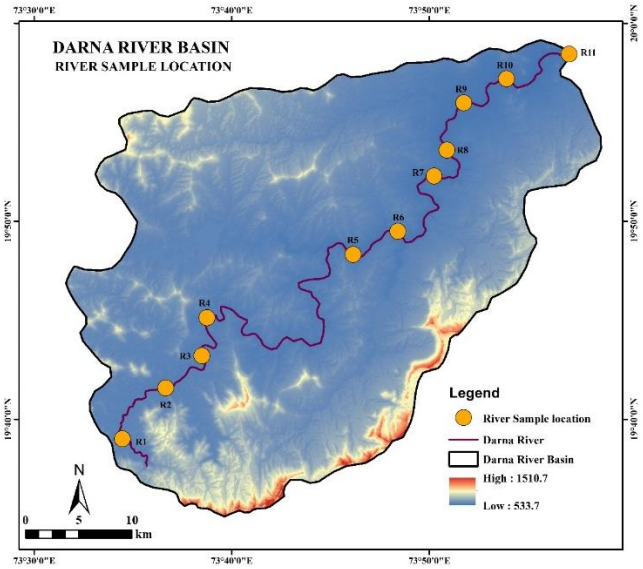

Fig 2. River Sample Location of the Darna River Basin

Result and Discussion

The human factors influencing river water chemistry are agricultural runoff, industrial discharge, urbanization, etc., which mainly affect river water quality. The excessive use of fertilizers and pesticides introduces high concentrations of nitrates and phosphates, which can cause eutrophication (Chandra et al. 2018; Bhutekar et al. 2018). The change in the chemical properties can affect public health. From this point of view, to study the chemical characteristics of Darna River water samples have been used to analyse.

Analysis of Chemical Characteristics

The pH of Darna River water ranges in 7.1 to 7.51 indicates mildly alkaline condition which indicates acceptable pH range (Fig.3a and Table 2). EC reflects the concentration of dissolved ions/salts in water. Nanegoan, Palse, Kotamgoan, and Darnasangvi (R9-R11) represent high EC levels, indicating significant ionic concentration. The trend shows a progressive increase in EC levels from upstream to downstream, reflecting how water quality deteriorates in the Darna river course. The result highlights that human influence and land-use changes likely contribute to declining water quality downstream (Fig.3b). Nitrate is a key water quality parameter due to its widespread occurrence and health impacts. The Kotamgoan (R10) and Darnasangvi (R11) highlight locations where nitrate levels are poor and unsafe for drinking. These areas show poor nitrate concentrations that may be linked to intensive agricultural practices, fertilizer runoff, or improper waste disposal (Fig.3c). Elevated chloride can indicate pollution and increase salinity, harming aquatic life. Kotamgoan and Darnasangvi (R10, R11) fall into the polluted category, which indicates chloride levels are relatively high. This indicates possible contamination from human activities such as urbanization, agricultural runoff, sewage disposal, or industrial discharge (Fig.3d). Total hardness represents the concentration of calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions dissolved in water. Indicates water solubility for drinking, domestic, and industrial uses. All river water samples total hardness ranges from 20-100 mg/L, in which R1-R8 sites are mostly in the soft water category, whereas R9-R11 sample sites are depicted in the moderately hard

category. It is generally well-balanced, tastes good, and can still be used without significant issues (Fig.3e). TDS represents the total concentration of dissolved inorganic salts and organic matter in water. The TDS of the current study ranges from 57-258 for the river water, which indicates that it falls under the good to excellent category. TDS increases at Palse (R9), Kotamgaon (R10), and Darnasangvi (R11) sites due to the river entering the urban area and subsequently is responsible for the release of large amounts of solid waste, discharge of domestic wastewater, encroachment, and sewage at Darnasangvi as the river meets the Godavari River (Fig.3f). Calcium is a key element influencing water hardness, pH, and alkalinity. All sample sites of the Darna River water range from 3-5 mg/L, which indicates the soft to moderate water hardness, and it also negatively affects the growth of calcium-demanding organisms (Fig.3g). High concentration of fluoride (> 1.5 mg/L) exceeding the WHO limit suggests significant natural or anthropogenic sources of contamination. In the study area, Darna River water ranges from 0.03 - 0.15 mg/L, indicating that all sample sites show a low fluoride level concentration, interpreting the water as safe for aquatic life and drinking (Fig.3h). Iron concentration helps determine water suitability for drinking, agriculture, and aquatic life. In this study, R9, R10, and R11 sample sites show high concentrations of iron which may change the physical and chemical properties of the riverbed, further impacting the environment as well as disrupting the overall ecological balance of aquatic ecosystems (Fig.3i). Alkalinity is the capacity of water to neutralize acids and resist pH changes. All sample sites alkalinity ranges from 16 – 64 mg/L which increases from (R1 to R11) upstream to downstream direction, may be due to the agricultural runoff, urbanization, etc. R1-R4 samples shows low, R5-R11 samples show average alkalinity, indicating that the Darna river water is generally considered safe for drinking purposes (Fig.3j).

Table 2: Result of Chemical Parameters of Darna River Water

Sample Name	pH	EC	TDS	Total Hardness	Fluoride	Nitrogen-Nitrate	Iron	Chloride	Total Alkalinity	Calcium
R1	7.1	112	72	24	0.04	2	0.05	6	16	3
R2	7.11	89	57	20	0.03	1	0.04	4	16	3
R3	7.16	109	70	28	0.04	2	0.05	6	16	3
R4	7.17	126	81	32	0.04	2	0.06	10	16	5
R5	7.21	176	114	52	0.06	3	0.09	14	36	5
R6	7.23	183	118	56	0.07	4	0.09	14	36	5
R7	7.27	184	119	56	0.07	4	0.09	14	32	5
R8	7.32	190	123	64	0.07	4	0.09	16	44	5
R9	7.35	260	169	80	0.1	5	0.13	20	52	5
R10	7.39	398	258	100	0.15	8	0.2	26	64	5
R11	7.51	279	181	92	0.1	6	0.14	24	64	5
Desirable limit	6.5-8.5	–	500	200	1	45	1	250	200	75
Permissible limit	no relaxation	–	2000	600	1.5	no relaxation	no relaxation	1000	600	200
Test method	MET-4500-H*(B)	MET-2510(B)	MET-2540 (C)	MET-2340(C)	MET-4500-F^-(D)	MET-4500-$NO3^-$ (B)	MET-3500-Fe-(B)	MET-4500-CL–(B)	IS 3025 (PART 23):2000/MET-2320(B)	MET-3500-Ca (B)
Unit	-	µs/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L

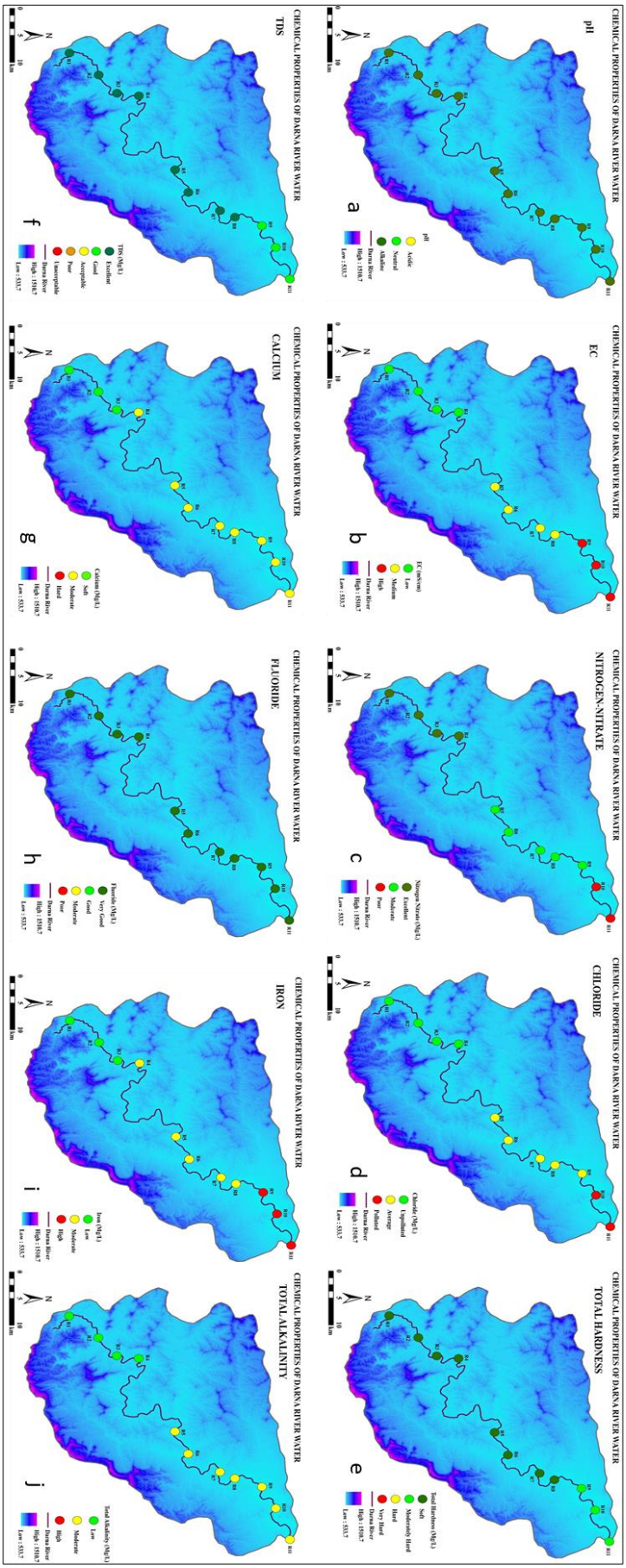

Fig 3. Spatial Distribution of Chemical Characteristics of the Darna River Water

Photo plate 1: Snaps of Sample Collection in the Study Area

Conclusion

The present research work highlights the chemical characteristics of Darna River water. The results interpret that pollution is increasing downstream due to human activities like as domestic wastewater, cremation sites, and urbanization similarly; the agricultural runoff is also promoting the pollution due to intensive use of agrochemicals and fertilizers especially in rice field area. The result thoroughly indicate heterogeneous chemical quantity and declining water quality downstream. This research provide a valuable baseline for agriculture department for setting the ideal guidelines of the future perspective for the farmers as well as the municipal councils for sustain the river water quality.

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