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Research Article

Spatio-Temporal varation Within in pH and TDS in groundwater using Statistics and GIS in Nashik District, Maharashtra India

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Abstract

Measurement of pH and TDS are used to examine the extent of the spatio-temporal variation in groundwater chemistry in Nashik district of Maharashtra. The spatio temporal variations in groundwater broadly reflect flow conditions, soil type, anthropogenic activities and geological factors. In this study three years seasonal data of 2018-19 to 2019-20 including three seasons have examined. pH and TDS have analysed for the groundwater quality using GIS and Analysis of Variance (ANOVA).

Keywords: spatio-temporal variation pH, TDS, Remote sensing, Statistics, GIS.

Introduction

The amount of high-quality groundwater that can be used for agriculture and drinking in the majority of the world is decreasing, and in many dry and semi-arid locations, groundwater is becoming increasingly rare. Geological formation and human activity have a substantial impact on groundwater quality (Zulu et al., 1996)[1]. Groundwater contamination brought on by growing urbanisation can have a negative impact on both the environment and human health. Groundwater contamination is caused by unchecked seepage of wastewater from industrial and agricultural activities as well as infiltration of urban runoff(Dechesne et al., 2004; Nas and Berktay, 2010)[2,3]. The application of different multivariate approaches by researchers, such as principal component analysis and/or factor analysis (PCA/FA), analysis ofvariance (ANOVA) and geostatistics are used to provide an easy way of groundwater classification and revealed a significant relationship and differences between parameters (Ahmadi and Sedghamiz, 2007) [4]

Kerala, India's most southern state, has seen a decline in the quality of its surface water and groundwater as a result of increased industrialisation, urbanisation, and agricultural activity over the past few decades (Nageswara Rao and Ramadurai 1970: laluraj and Gopinath 2006:CGWB2002)[5,6,7].

It will be easier to determine the quality of ground water if you are aware of the unique distribution of pH, electrical conductivity (EC), total suspended solids (TDS), fluoride, and total iron concentration. The health of people can frequently be seriously harmed by groundwater contamination. Low pH levels in groundwater can lead to gastrointestinal problems such hyperacidity, ulcers, stomach pain, and burning sensations. Metal pipes corrode at pH levels below 6.5, releasing hazardous metals as Zn, Pb, Cd, and other metals (Trivedy and Goel 1986)[8]. Local scale management of natural areas necessitates complete spatial coverage of site characteristics such groundwater tables, nutrient levels, and soil acidity (pH). The distributions of plant species and plant communities, for instance, might be inferred from site variables on the assumption that these have particular requirements for things like groundwater regime (Bartholomeus et al., 2012; Runhaar et al., 1997; Tüxen, 1954)[9,10,11]. Remote sensing (RS) is an additional source of site factor estimations due to the increased geographical, spectral, and temporal resolution of earth observation sensors. Examples include hydrochemical parameters and soil moisture content (Bastiaanssen et al., 2005; Panciera et al., 2009; Wigneron et al., 2007)[12,13,14].

Urban wastewater that has been partially or fully treated is often used for industrial and agricultural uses across much of

the nation. The N and P from organic components in the wastewater are liberated and oxidised to high concentrations of NO_3^-, alkalinity, pH, TDS, and other substances when it moves through unsaturated and saturated porous medium. The hydro-geochemistry of groundwater may change due to pH. If used for agriculture, the treated and partially treated wastewater can benefit the environment and society (WHO, 2005)[15]. The Geographic Information System (GIS) can be used to combine geographical data with other types of data. GIS is used to analyse and show spatial data, which helps with resource planning and environmental protection (Assaf and Saadeh, 2008)[16]. Therefore, the objective of this study is to examine the spatial and temporal variation of groundwater using statistics and remote sensing.also this study focus the quality of hydrochemical data for the use of agriculture and drinking water purpose.

Study Area

In Maharashtra, the third-largest city is Nashik after Pune and Mumbai. Nashik is situated in the North part of Maharashtra state which is 700 meters from the mean sea level (MSL) results in temperature and meteorological variations in the winter season. Nashik has lush mountain terrains from its MSL distance. The Godavari River, Mosam, Girna are flowing through Nashik, Deola, Satana, and Malegaon tehsils. Thus, the Nashik district forms a part of the Western Ghats and Deccan plateau covering an area 3619.44 km^2. Geographically Nashik comprises varied in topography.

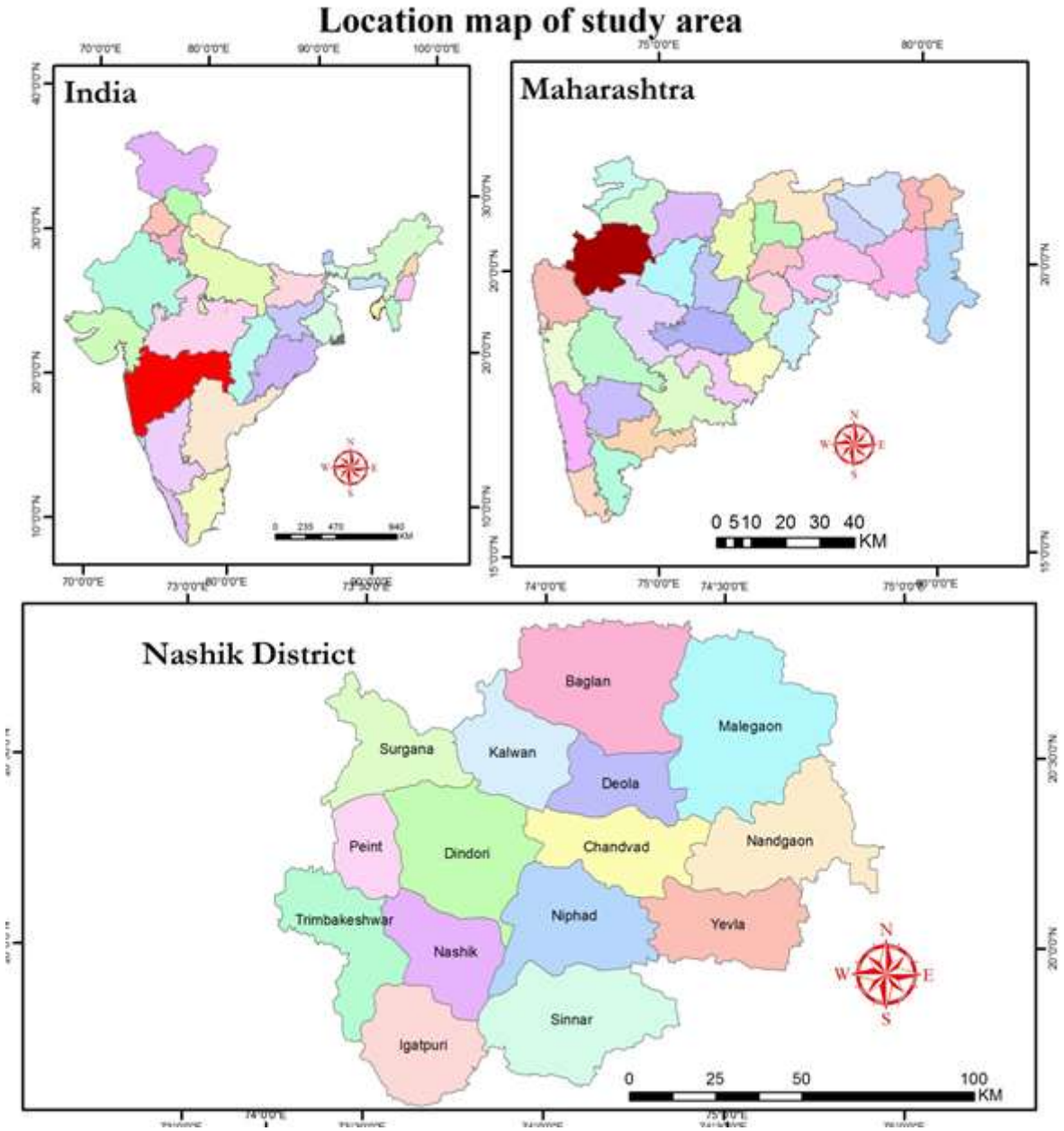

Figure 1: Location map of study area.

Material and Methods

One hundred and eighty groundwater samples were collected from fifteen tehsil in Nashik in Summer, Rainy and winter Season. Each tehsil contributes 1 sample of groundwater (openwell). The collected from year 2018-19 to 2020-21 sample collected in pre-cleaned polyethylene containers of two-liter capacity, and their hydrochemical parameters were analyzed. These field samples were analyzed immediately for the water quality parameters given in table 1.

Analysis of the hydrochemical parameters has been done statistically each hydrochemical parameter is compared with standards of water quality given by WHO and BIS 10500: 2012

Table 1: Water quality parameters and their method of analysis.

Sr. No.	Parameters	Method
1.	pH	pH meter
2.	TDS	Gravimetric analysis by oven drying method

Statistical Analysis of Hydrochemical Parameters

Table 2 and Table 3 give information of the average of pH and TDS for all 15 tehsils of each season. We have performed ANOVA to test whether average of pH and TDS differ significantly for each season. Average readings are in Table 4 and Table 5 are obtained by performing ANOVA.

Table 2: Average of pH and TDS in 2018-19

Sr. No.	Name of Tehsil	Parameters					
		pH			TDS (mg/lit)		
		Rainy	Winter	Summer	Rainy	Winter	Summer
	Nashik	7.2	7.8	7.9	502.01	525.02	625.25
	Dindori	7.2	7.2	7.9	505.88	505.88	525.88
	Kalwan	7.2	7.4	8.1	302.22	306.2	356.2
	Niphad	7.5	7.5	8	321.15	338.12	348.12
	Nandgaon	7.4	7.6	7.6	401.45	411.45	520.45
	Yeola	7.2	7.3	7.6	498.1	500.1	520.45
	Sinnar	7.5	7.8	7.9	305.49	345.49	545.49
	Peinth	7.4	7.5	7.6	401.1	501.1	508.8
	Surgana	7.4	7.5	7.6	401.8	408.8	508.8
	Satana	7.8	7.9	7.8	311.65	318.8	568.8
	Igatpuri	8.1	8.1	8.4	582.25	585.25	625.25
	Baglan	8.1	8	8.1	611.25	620.25	630.25
	Deola	8	8.1	8.3	511.2	521.25	528.25
	Kalwan	8.1	8	8.1	430.49	440.49	445.49
	Trimbakeshwar	8.3	8.2	8.3	430.49	432.49	445.49

Table 3: analysis of pH and TDS in 2019-20

Sr. No.	Name of Tehsil	Parameters					
		pH			TDS (mg/lit)		
		Rainy	Winter	Summer	Rainy	Winter	Summer
	Nashik	7.4	7.2	7.8	501.01	525.02	625.25
	Dindori	7.2	7.2	7.9	505.88	505.88	525.88
	Kalwan	7.2	7.4	7.8	302.22	306.2	625.25
	Niphad	7.5	7.2	8	321.15	525.02	348.12
	Nandgaon	7.4	7.6	7.6	401.45	411.45	520.45
	Yeola	7.6	7.3	7.8	605.28	500.1	625.25
	Sinnar	7.5	7.8	7.9	305.49	345.49	545.49
	Peinth	7.4	7.2	7.6	401.1	525.02	508.8
	Surgana	7.4	7.5	7.6	401.8	408.8	508.8
	Satana	7.8	7.2	7.6	311.65	525.02	508.8
	Igatpuri	8.1	8.1	8.4	512.25	525.25	615.25
	Baglan	8.1	7.9	7.8	611.25	525.02	508.8
	Deola	8	8.1	8.3	511.2	501.25	528.25
	Kalwan	8.1	8	7.9	420.49	440.49	508.8
	Trimbakeshwar	8.3	8.1	8.3	400.49	505.02	415.49

Table 4: Analysis of Variance for pH, using Adjusted SS for Tests

Sources of Variation	DF	Sum of Squares	Mean Sum of Squares	F	P
Source of water	1	50.657	50.657	957.31	0.000*
Season	2	7.954	3.977	75.16	0.000*
Error	746	39.475	0.053		
Total	749				

Table 5: Analysis of Variance for TDS, using Adjusted SS for Tests

Sources of Variation	DF	Sum of Squares	Mean Sum of Squares	F	P
Source of water	1	105	105	0.01	0.913
Season	2	294417	147209	16.57	0.000*
Error	746	6625859	8882		
Total	749	6920382			

*: significant at 5% level of significance

Since *p*-value is less than 0.05, we can say that there is a significant difference between the average of pH and TDS for three seasons viz, rainy, summer and winter.

Spatial and temporal variation of pH and TDS using GIS

In order to analyse groundwater sensitivity to contamination, manage water resources on an appropriate scale, and comprehend the natural environment, GIS is utilised as an useful tool for creating solutions to problems with water resources. The spatial distribution maps of all groundwater quality metrics for drinking purposes in accordance with the BIS (2012) criteria were created using the spatio-temporal interpolation methodology and arc GIS 10.5 software. For the creation of the spatial distribution maps of all water quality measures, including the WQI map, the spatial and non-spatial (attribute) data bases were merged. To create various thematic maps, the water quality data (non geographical data) is connected to the sample place (spatial data). the spatio-temporal maps are interpolate with individual sample readings. The spatio-temporal change of pH and TDS in groundwater is depicted in the following figures.

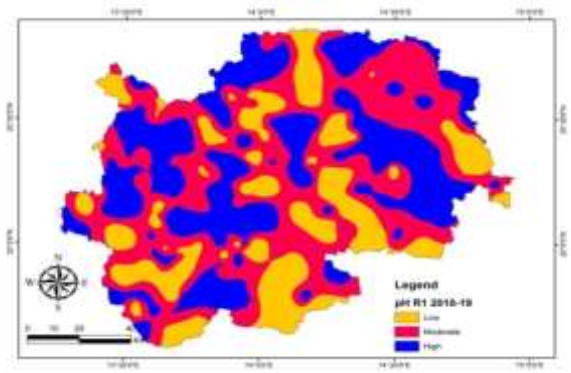

Figure 2: pH S1 2018-19

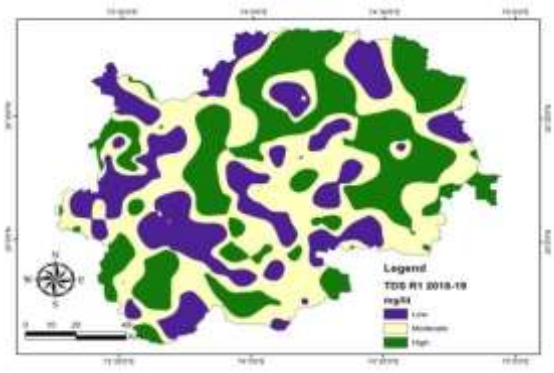

Figure 3: pH W1 2018-19

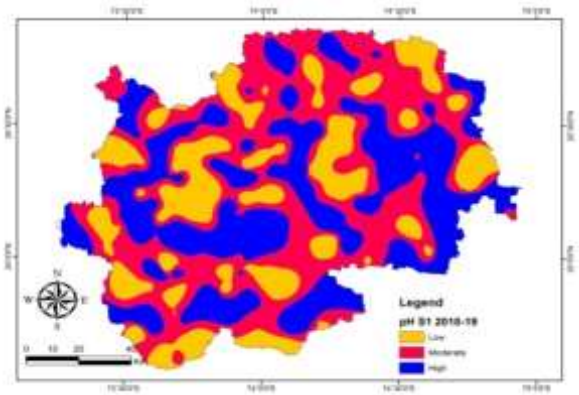

Figure 4: pH R1 2018-19

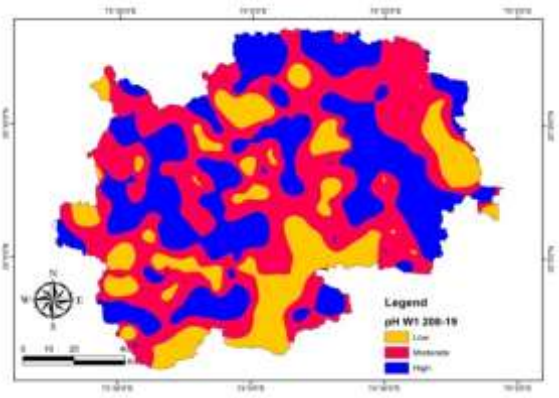

Figure 5: TDS R1 2018-19

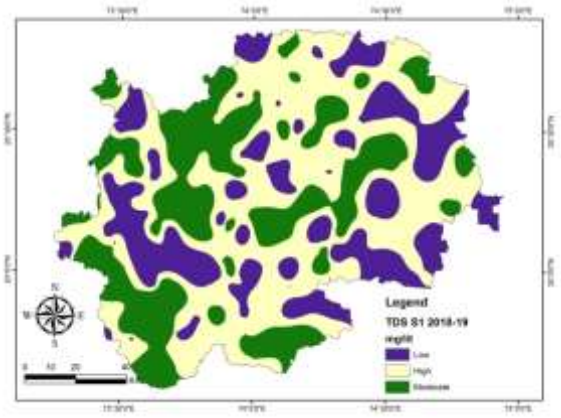

Figure 6: TDS S1 2018-19

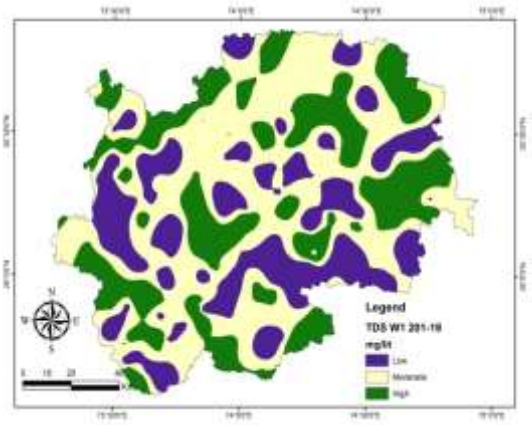

Figure 7: TDS W1 2018-19

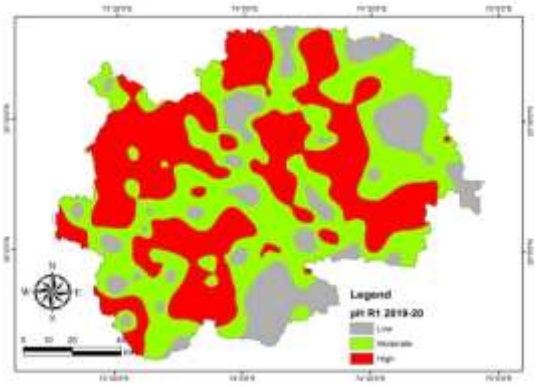

Figure 8: pHR1 2019-20

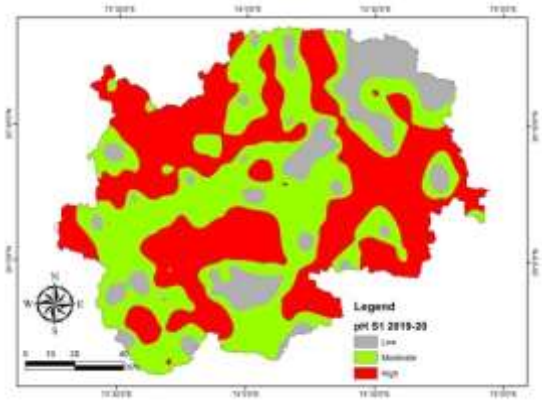

Figure 9: pH S1 2019-20

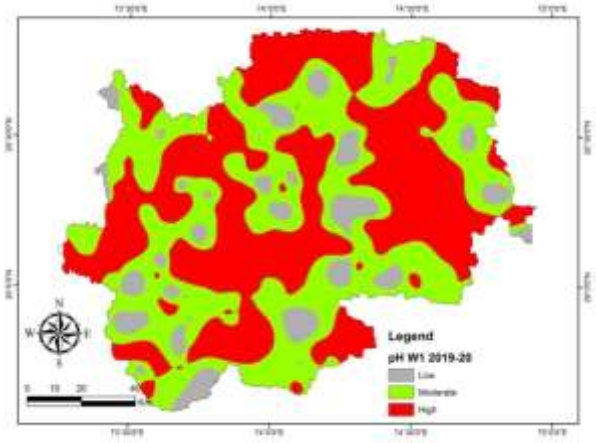

Figure 10: pH W1 2019-20

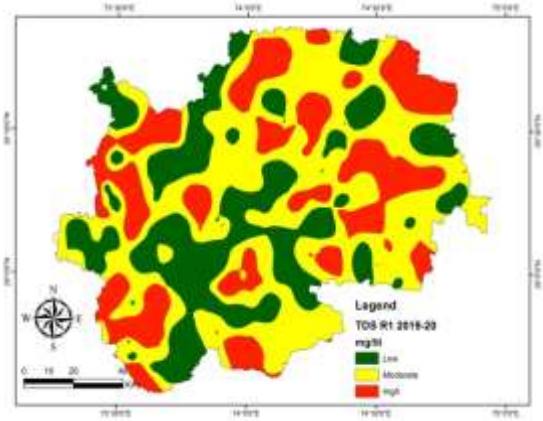

Figure 11: TDS R1 2019-20

Result and discussion

Maps of ground water quality are crucial and useful in determining the suitability of water for various uses, mostly in agriculture and drinking. Variations were reported in the physicochemical properties of ground water in the various tehsils and regions. Groundwater quality varies from location to location and over time. This indicates that even at the same location, the quality of the ground water changes with the season. It depends on the kind of soil, human activity, and geographical elements. Numerous factors, including the presence of landfills, open dumps, the use of fertilisers, the disposal of industrial waste, mining activities, the lack of an underground drainage system, the continual burning of municipal solid waste, etc., affect the quality of ground water. The greatest variance is primarily seen during the summers of 2018–19 and 2019–20 due to interactions between water and rock, soil, and depth of groundwater. One of the most important operating water quality parameters is pH, with the ideal range between 6.5 to 8.5. The BIS has set an upper limit of 8.5 for the pH of drinking water. The data on the pH of groundwater collected ranged from 7.0 to 8.4; the majority of tehsils near agricultural and industrial areas have pH levels higher than 8.0, which may be caused by excessive fertiliser use and untreated industrial water. This demonstrates that the research area's ground water is marginally saline. In figures 2,3,4,8,9, and 10, pH concentrations are distributed spatially and temporally. TDS stands for Total Dissolved Solids, which is a concentration of mineral compounds dissolved in water. Reverse osmosis, electrodialysis, exchange, and solar distillation are methods for removing high TDS concentrations. The BIS 2012's definition of the permissible

limit of TDS 2000 mg/lit is present when the alternative source is absent. The largest TDS content is present in tehsils like Sinnar, Nashik, Kalwan, Baglan, and Niphad, however it is still within acceptable limits. Figures 5, 6, 7, 11, 12, and 13 display the spatial distribution of TDS.

Conclusions

In the present work, an attempt was made to evaluate and to map groundwater quality surrounding in Nashik district. The estimated analysis provides an easy way of understanding the overall potability of water quality. The integration of various thematic layers with the help of ArcGIS 10.5 is of immense help in determining suitability of ground water quality for drinking and agricultural purpose. The highly affected parameters are pH and TDS. It is observed that the groundwater quality of pH And TDS is within the permissible limit (At the time of alternative source is absent). All tehsils are found to be having concentration within desirable limit. Also our study concludes that the groundwater quality with respect to pH and TDS is slightly saline. Since *p*-value is less than 0.05, we can say that there is a significant difference between the average of pH and TDS for three seasons viz, rainy, summer and winter.

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