P.E.S COLLEGE OF ENGINEERING

MANDYA – 571401, KARNATAKA

(An Autonomous Institute Affiliated to VTU, Belagavi)

SYNOPSIS OF THE PROPOSED PROJECT WORK
ON

Application of Pollution Index and Water Quality Model QUAL2K for Evaluation of Pollutants in Virija Canal, Mandya District, Karnataka.

Submitted by

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ABSTRACT

The present study involves evaluation of pollutants in Virija canal in which the study area comprises of 10km and has 12 sampling sites. During the pre-monsoon season, samples are collected at all sampling points and analyzed for various physicochemical parameters such as pH, TDS, DO, alkalinity, Total Hardness, Calcium Hardness, Chloride, Iron, Fluoride, and Nitrate in the field as well as in the laboratory where pH and TDS are measured using pH meters and DO is fixed on site using necessary chemicals. The study employs the use of a comprehensive pollution index, a water quality index, and a water quality model QUAL2K tomeasure water quality, with a WQI score of 25-50 indicating good quality. Similarly, the computed comprehensive pollution index value of 0.41-1.00 shows that the canal water is slightly contaminated. The overall results of pre-monsoon sampling show that 100% of the water samples are of good quality, so there is no need to protect the study area from contamination, whereas the pollution index shows that the canal water is slightly polluted, so it needs to be treated with respect to parameters that are found to be greater than permissible limits.

KEYWORDS: Physical and Chemical Parameters, Water Quality Index, Comprehensive Pollution Index, Model QUAL2K, Dissolved Ion, DO fixation, APHA Standards, BIS etc.,

INTODUCTION

Water plays an important role in the world economy as it covers about 71% of the Earth's surface, with seas and oceans making up most of the water volume on earth (about 96.5%). Approximately 70% of the freshwater used by humans goes to agriculture in which rivers are the major source of water for agriculture, industries and drinking purpose. But due to urbanization, agriculture, and industrialization, the demand for natural resources has increased dramatically. With increase in population and gap between demand and supply, the canal system has expanded throughout the world to provide maximum access to freshwater. The river Cauvery is the major source of water in Karnataka which is also known as Kodagu’s lifeline with many tributaries. After river leaves Kodagu hills, it forms two islands in Mandya district’s Srirangapatna and Shivanasamudra. The Virija Canal is one of the canal systems of River Cauvery located in Srirangapatna which on the recent studies found to be polluted due to disposal of industrial effluents in a particular canal at Belogola which connects this canal. The river is polluted due to disposal of thousands of gallons of polluted water. This has caused many problems to humans and aquatic life. As there is a need to assess the water quality of Virija Canal, it has to be monitored seasonally. The basic objective of this study is to detect the water quality by determining various parameters which indicates the ions present in the water and thereby comparing them with the standard permissible limit. The main objective of this study is to determine the severity of pollution and source of pollution. The QUAL2k model was utilized to analysis the quality of river water, which aids in the resolution of pollution issues comparable to the water quality index.

OBJECTIVES:

Main objectives:

The primary aim of this study is to analyze the physical and chemical properties of the samples obtained from the Virija Canal study area. The study aims to examine the features of the obtained samples by conducting detailed investigations, giving light on their composition and nature. Additionally, the study aims to compare the test results of the canal water samples with the standards set by the Bureau of Indian Standards (BIS). This comparative analysis will provide valuable insights into the quality of the canal water, enabling researchers and relevant authorities to determine if the water meets the established standards. By evaluating the physical and chemical attributes and comparing them to regulatory guidelines, this study contributes to a better understanding of the overall condition and potential risks associated with the Virija Canal's water quality.

Specific objectives:

- To assess the water quality using the Water Quality Index and the Pollution Index, which represent the ratings for water quality and the range of pollution, respectively.
- To utilize the QUAL2K model to simulate modifications in pollution loads, flow augmentation, and local oxygenation. This will help manage water quality during critical periods, such as low flow, in order to maintain the minimum required concentration of dissolved oxygen in the river.
- To identify potential sources of pollution in the Virija Canal and analyze their impact on water quality.
- To propose recommendations and strategies for improving water quality in the Virija Canal based on the study findings.
- To evaluate the effectiveness of current water management practices in the Virija Canal and suggest potential improvements.

Study Area:

The Kaveri, one of the major Indian rivers flowing through the states of Karnataka and Tamil Nadu which rises at Talakaveri in the Brahmagiri range in the Western Ghats, Kodagu District of Karnataka State at an elevation of 1341m above mean sea level and flows for about800 km before its outfalls into Bay of Bengal. One of the canals that conveys river water fromthe Kaveri, the Virija canal built across Balmuri Falls in Palahalli, near Srirangapatna Taluk, Mandya District, has been chosen as the study area in the present study. The canal was built to facilitate the waters of River Cauvery for irrigational purpose which lies between 12°22'57"Nlatitude and 76°40'1"E longitude.

The Virija canal has been receiving a steady and unbated flow of untreated industrial effluents from Mysore and also sewage, turning the river toxic. During monsoon the problem is not that severe, as the river will be in full spate. But as summer approaches, the problem intensifies and worsens. There is a canal at Belogoala near the Infosys Campus which carries industrial effluents into the river. This particular canal connects the VIrija canal that has manysmaller canals that take the effluents mixed river water to villages and hundreds of acres of agriculture fields. From the Virija Canal, the effluents enter several villages like Karekura, Hosahalli, Palahalli, Naguvanahalli, Chanadagaalu and Srirangapatna at different stages.Several farmers have complained of skin diseases during summer along with itching sensation and deep red rashes after using this water for either washing or drinking while fishes here die in summer.

Fig 4.1 Sampling sites and the effluents from the agriculture field

Fig 4.2 Canal water level and Sampling techniques

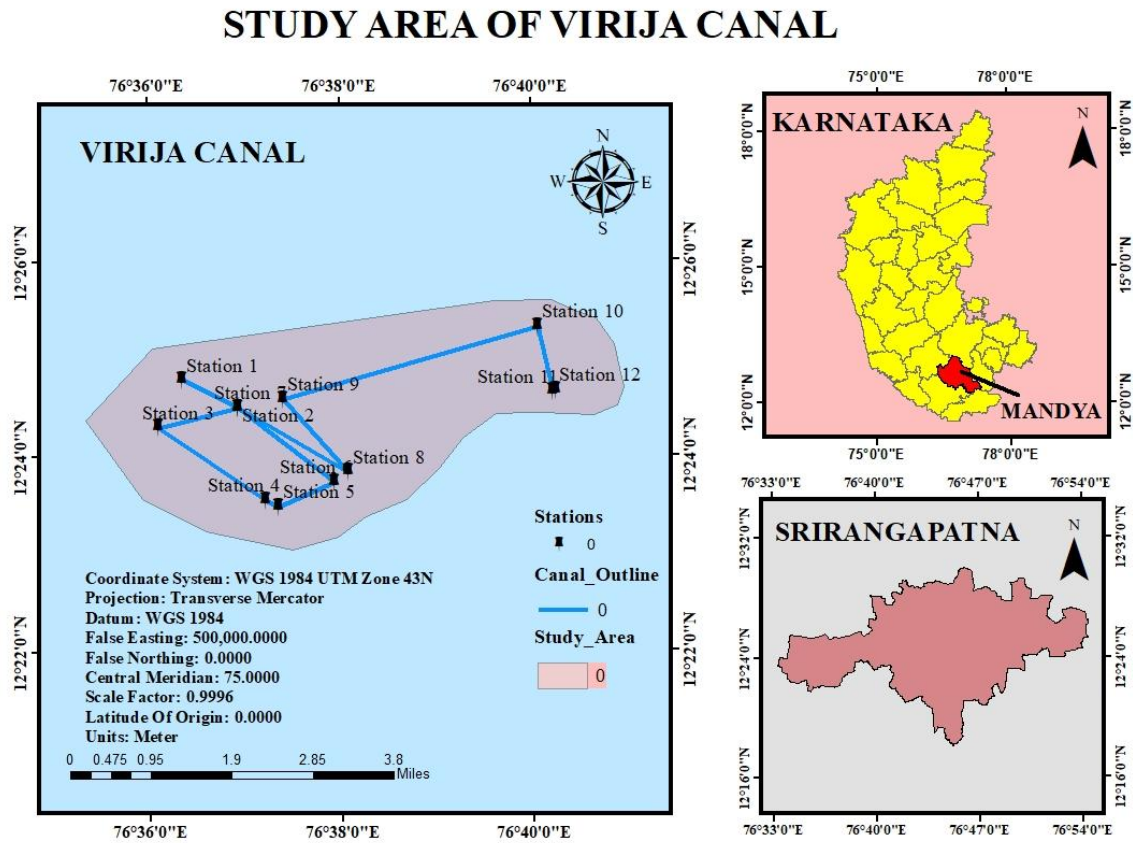


Fig 4.4 Representation of Virija canal and Sampling sites by using ArcGIS

Methodology:

The samples are collected in three different seasons, namely pre-monsoon, monsoon, and post-monsoon, from the Virija Canal where 12 different sampling points are used, and the composite sampling method is employed. The latitude and longitude of each sampling point are recorded, with an approximate distance of 1 km between each point. The sampling procedure follows the standards set by the American Public Health Association (APHA 2017). During the sampling process, 300 ml polythene bottles are used to collect the samples. The bottles are submerged at a depth of approximately 2-3 meters in the canal whereas, BOD bottles are utilized for DO fixation. Several parameters, including temperature, pH, DO, and Total Dissolved Solids (TDS), are measured and recorded on-site and DO fixation is conducted at the sampling location. To maintain the integrity of the samples, they are stored in an iced container, preserving a temperature of 4°C, until they are transported to the laboratory. In the laboratory, various physiochemical parameters, such as total hardness, chloride, alkalinity, fluoride, nitrate, iron, calcium, magnesium, and BOD, are determined through respective experiments. The obtained values are then compared to the standards set by the Bureau of Indian Standards (BIS) (10500:2012).

Methods Used for analyzing parameters

Sl No	PARAMETERS	METHODS
1	pH	pH meter
2	Temperature	Thermometer
3	TDS	TDS meter
4	DO	Winkler Titration
5	Alkalinity	Argentometry(titration)
6	Total Hardness	EDTA Titration method
7	Calcium Hardness	Argentometry(titration)
8	Iron	Spectrophotometer
9	Fluoride	Spectrophotometer
10	Nitrate	Spectrophotometer
11	Chloride	Mohr's Method
12	BOD	Winkler's Method

WATER QUALITY INDEX:

A Water Quality Index is similar as grade, that express the total water quality of a certain areabased on the determined parameters. The index's primary goal is to transform obtained complex data on water quality into information that is easier to apprehend and used by the general public without having to go through the obtained data. A simple indication of water quality can be created using water quality index based on few key parameters. It provides publica rough understanding of potential water challenges in the respective region.

STEPS TO DETERMINE WQI

STEP 1: Determination of unit weight factor for each parameter,

$$W_n = \frac{k}{s_n}$$

Where, k = proportionality constant and s_n= standard values of n^{th} parameter

On summation of unit weight factors of all parameters should be equal to unity ($i.e.,\ w_n = 1$)

STEP 2: Calculation of sub index ( ),

$$Q_n = \frac{[(v_n - v_0)]}{[(S_n - v_0)]}$$

v_n = mean concentration of n^{th} parameter

s_n = standard values of n^{th} parameter

$_0$ = actual value of the parameter in pure water

(Generally, $_0 = 0$ for most of the parameter except for pH (7) and DO (14.6))

STEP 3: STEP 1 and 2 are combined in this step to determine overall WQI of certain area,

$$Overall\ WQI = \frac{\Sigma w_n - Q_n}{\Sigma w_n}$$

Table 1: Classification of water quality depending upon the WQI value:

WQI LEVEL	WATER QUALITY RATING
0-25	EXCELLENT
26-50	GOOD
51-75	POOR
76-100	VERY POOR
>100	UNFIT FOR DRINKING PURPOSE

COMPREHENSIVE POLLUTION INDEX (CPI)

In the present study, Comprehensive Pollution Index (CPI) is adopted in order to classify thewater quality and is evaluated by the following equation as,

$$PI = \frac{\text{Measured concentration of individual parameters}}{\text{Standard permissible concentration of parameters}}$$

$$CPI = \frac{1}{n}\sum_{i=1}^{n} PI$$

PI is the pollution index of individual water quality parameters considered, n is the number ofparameters and CPI is a Comprehensive Pollution Index. The standard permissible concentration of each parameter considered in the study were obtained by Central Pollution Control Board (CPCB) norms of the Indian Government for a general discharge of environmental pollutant.

Table 2: Classification of water quality based on the CPI value

CPI Level	Water Quality Rating
<0.20	Clean
0.21-0.40	Sub-clean
0.41-1.00	Slightly polluted
1.01-2.00	Moderately polluted
≥2.01	Severely polluted

RESULTS:

The present study focuses on the sampling and determination of water quality parameters during the pre-monsoon season and post-monsoon season in the study area, Virija canal. The analytical results for the canal water samples are presented in Table 3 and Table 4. The water quality parameters including pH, TDS, alkalinity, total hardness, calcium hardness, magnesium hardness, iron, fluorides, nitrates, DO, BOD, and chlorides are found to be within the permissible limits set by the Bureau of Indian Standards (BIS).

PRE-MONSOON SEASON:

The water quality index is performed for theVirija canal during the pre-monsoon season to determine the quality of canal water using 12 water quality parameters, The WQI estimated foreach site ranges from 26 to 50, indicating good water quality (Table 1). The CPI plainly shows that the Virija canal was slightly polluted, as the CPI ranges from 0.41 to 1.00 (Table 2).

TABLE 3: Test values of physiochemical parameters in pre-monsoon season.

Sampling sites	Latitude longitude	pH	TDS	DO	Ca^{2+}	Mg^{2+}	TH	Alka linity	F	NO^{3-}	Fe	Cl	BOD
1	12^{0}24’47” 76^{0}36’21”	7.31	98	7.8	5.2	4.8	100	172	0.98	12	Nil	84	Nil
2	12^{0}24’30” 76^{0}36’56”	7.37	100	7.5	5.2	4.6	92	148	0.95	7	Nil	76	Nil
3	12^{0}24’18” 76^{0}36’6”	7.2	102	7.2	5.2	3.6	88	84	0.97	9	Nil	96	Nil
4	12^{0}23’33” 76^{0}37’13”	7.4	99	7.4	6.0	4.0	100	80	1.02	13	Nil	76	Nil
5	12^{0}23’29” 76^{0}37’21”	7.6	100	7.6	4.0	5.6	96	120	0.94	11	Nil	96	Nil
6	12^{0}23’44” 76^{0}37’56”	7.2	119	7.2	4.8	5.6	104	120	0.95	8	Nil	112	Nil
7	12^{0}24’30” 76^{0}36’56”	7.0	118	7.0	5.2	6.0	112	144	0.93	7	Nil	92	Nil
8	12^{0}23’50” 76^{0}38’5”	7.1	119	7.1	5.6	5.2	108	136	0.98	9	Nil	120	Nil
9	12^{0}24’32” 76^{0}37’24”	6.9	119	6.9	5.6	6.0	116	116	1.0	10	Nil	72	Nil
10	12^{0}25’19” 76^{0}40’4”	6.8	120	6.8	4.8	5.2	100	132	0.99	8	Nil	108	Nil
11	12^{0}24’39” 76^{0}40’13”	6.8	120	6.8	6.0	4.8	108	116	0.96	13	Nil	104	Nil
12	12^{0}24’49” 76^{0}40’15”	6.7	121	6.7	6.4	5.2	116	128	0.98	12	Nil	128	Nil

Table 3.1: Water Quality Index

Sampling Points	Water Quality Index	Water Quality
1	28.476	GOOD
2	27.478	GOOD
3	27.531	GOOD
4	28.919	GOOD
5	27.678	GOOD
6	28.268	GOOD
7	27.114	GOOD
8	28.19	GOOD
9	28.555	GOOD
10	28.355	GOOD
11	27.19	GOOD
12	27.961	GOOD

Table 3.2: Comprehensive Pollution Index

Sampling Points	CPI	Polluted
1	0.68	Slightly
2	0.625	Slightly
3	0.585	Slightly
4	0.62	Slightly
5	0.662	Slightly
6	0.673	Slightly
7	0.684	Slightly
8	0.683	Slightly
9	0.681	Slightly
10	0.675	Slightly
11	0.652	Slightly
12	0.693	Slightly

MONSOON SEASON:

The water quality index is performed for the Virija canal during the monsoon season to determine the quality of canal water using 12 water quality parameters. The WQI estimated for each site ranges from 0 to 25, indicating maximum excellent water quality (Table 1). The CPI is computed for each sample point and the values falls between 0.41-1.00, indicating the water quality of the Virija Canal is slightly polluted (Table 2).

Table 4: Test values of physiochemical parameters in Mansoon season.

Sampling sites	Latitude longitude	pH	TDS	DO	Ca^{2+}	Mg^{2+}	TH	Alkal-inity	F	NO^{3-}	Fe	Cl	BOD
1	12^{0}24’47” 76^{0}36’21”	8	56	7.2	36	12	48	80	0.63	11	0	150	Nil
2	12^{0}24’30” 76^{0}36’56”	7.49	53	8.3	40	8	32	88	0.67	8	0	470	Nil
3	12^{0}24’18” 76^{0}36’6”	7.6	53	7.9	28	12	40	72	0.65	9	0	390	Nil
4	12^{0}23’33” 76^{0}37’13”	7.3	55	7.7	29	28	32	64	0.74	11	0	550	Nil
5	12^{0}23’29” 76^{0}37’21”	7.4	55	7.6	40	24	16	64	0.49	13	0	190	Nil
6	12^{0}23’44” 76^{0}37’56”	7.3	68	7.5	28	4	24	80	0.72	8	0	750	Nil
7	12^{0}24’30” 76^{0}36’56”	7.3	59	7.3	24	12	36	80	0.74	13	0	390	Nil
8	12^{0}23’50” 76^{0}38’5”	6.9	67	7.5	28	4	36	80	0.71	11	0	42	Nil
9	12^{0}24’32” 76^{0}37’24”	6.8	73	7.3	24	0	24	80	0.78	12	0	670	Nil
10	12^{0}25’19” 76^{0}40’4”	6.3	72	7.4	32	16	16	76	0.58	9	0	630	Nil
11	12^{0}24’39” 76^{0}40’13”	7.1	76	7.8	32	8	40	68	0.63	11	0	790	Nil
12	12^{0}24’49” 76^{0}40’15”	7.3	69	8.1	36	4	32	80	0.73	8	0	950	Nil

Table 4.1: Water Quality Index

Sampling Points	Water Quality Index	Water Quality
1	20.048	EXCELLENT
2	21.148	EXCELLENT
3	20.629	EXCELLENT
4	22.803	EXCELLENT
5	17.306	EXCELLENT
6	21.765	EXCELLENT
7	22.221	EXCELLENT
8	21.197	EXCELLENT
9	22.68	EXCELLENT
10	18.623	EXCELLENT
11	20.05	EXCELLENT
12	26.457	GOOD

Table 4.2: Comprehensive Pollution Index

Sampling points	CPI	Polluted
1	0.771	Slightly
2	0.64	Slightly
3	0.739	Slightly
4	0.707	Slightly
5	0.7744	Slightly
6	0.813	Slightly
7	0.860	Slightly
8	0.861	Slightly
9	0.82	Slightly
10	0.768	Slightly
11	0.893	Slightly
12	0.861	Slightly

POST-MONSOON SEASON:

The water quality index is performed for the Virija canal during the post-monsoon season to determine the quality of canal water using 12 water quality parameters. The WQI estimated for each site ranges from 26 to 50, indicating good water quality (Table 1). The CPI is computed for each sample point and the values falls between 0.41-1.00, indicating the water quality of the Virija Canal is slightly polluted (Table 2).

Table 4: Test values of physiochemical parameters in post-monsoon season.

Sampling sites	Latitude longitude	pH	TDS	DO	Ca^{2+}	Mg^{2+}	TH	Alkal-inity	F	NO^{3-}	Fe	Cl	BOD
1	12^{0}24’47” 76^{0}36’21”	6.85	162	6.7	72	53	125	193	0.90	23	Nil	110	Nil
2	12^{0}24’30” 76^{0}36’56”	6.91	160	6.6	78	23	101	153	0.88	20	Nil	124	Nil
3	12^{0}24’18” 76^{0}36’6”	7.1	161	6.8	77	56	133	111	0.92	18	Nil	124	Nil
4	12^{0}23’33” 76^{0}37’13”	7.13	161	6.9	84	39	123	106	0.89	25	Nil	136	Nil
5	12^{0}23’29” 76^{0}37’21”	7.21	166	6.9	73	47	120	134	1.00	21	0.16	115	Nil
6	12^{0}23’44” 76^{0}37’56”	7.28	171	6.8	82	51	133	150	0.90	2	0.18	136	Nil
7	12^{0}24’30” 76^{0}36’56”	7.05	169	7.1	88	78	146	155	0.96	18	0	142	Nil
8	12^{0}23’50” 76^{0}38’5”	6.92	173	7.3	84	79	163	141	0.98	15	0	153	Nil
9	12^{0}24’32” 76^{0}37’24”	7.12	169	7.2	80	65	145	147	1.01	22	0	137	Nil
10	12^{0}25’19” 76^{0}40’4”	7.42	170	6.8	87	51	138	123	1.00	21	0	139	Nil
11	12^{0}24’39” 76^{0}40’13”	7.31	160	6.7	83	89	172	138	0.95	20	Nil	147	Nil
12	12^{0}24’49” 76^{0}40’15”	7.28	162	6.5	88	81	169	126	0.93	22	0	129	Nil

Table 4.1: Water Quality Index

Sampling points	Water Quality Index	Water Quality
1	26.498	GOOD
2	25.305	GOOD
3	27.063	GOOD
4	26.168	GOOD
5	66.567	POOR
6	69.3	POOR
7	28.618	GOOD
8	29.059	GOOD
9	29.449	GOOD
10	28.856	GOOD
11	28.61	GOOD

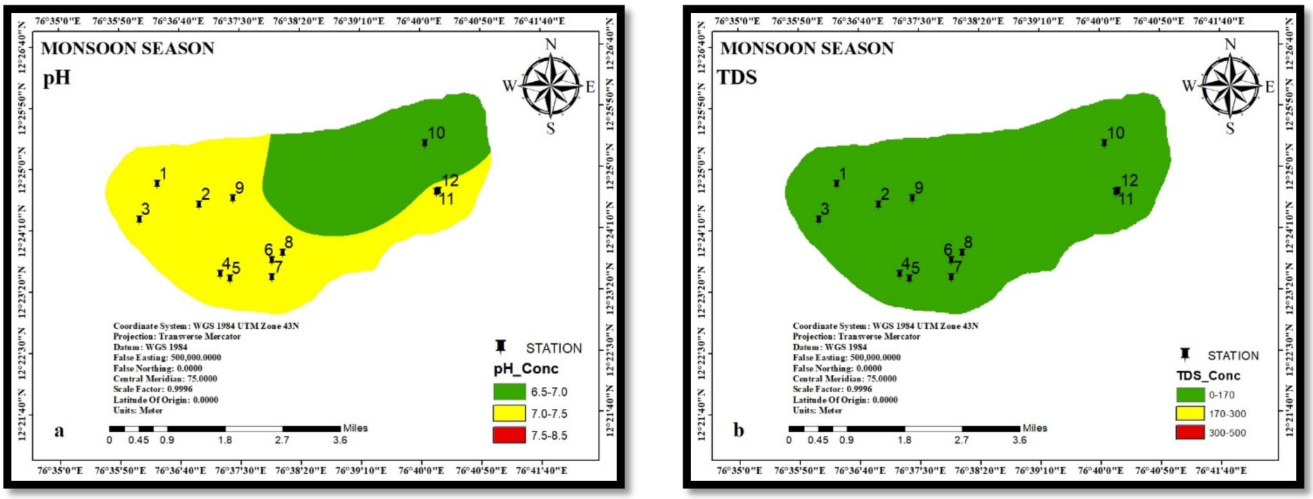
Table 4.2: Comprehensive Pollution Index

Sampling points	CPI	Polluted
1	0.771	Slightly
2	0.64	Slightly
3	0.739	Slightly
4	0.707	Slightly
5	0.7744	Slightly
6	0.813	Slightly
7	0.860	Slightly
8	0.861	Slightly
9	0.82	Slightly
10	0.768	Slightly
11	0.893	Slightly
12	0.861	Slightly

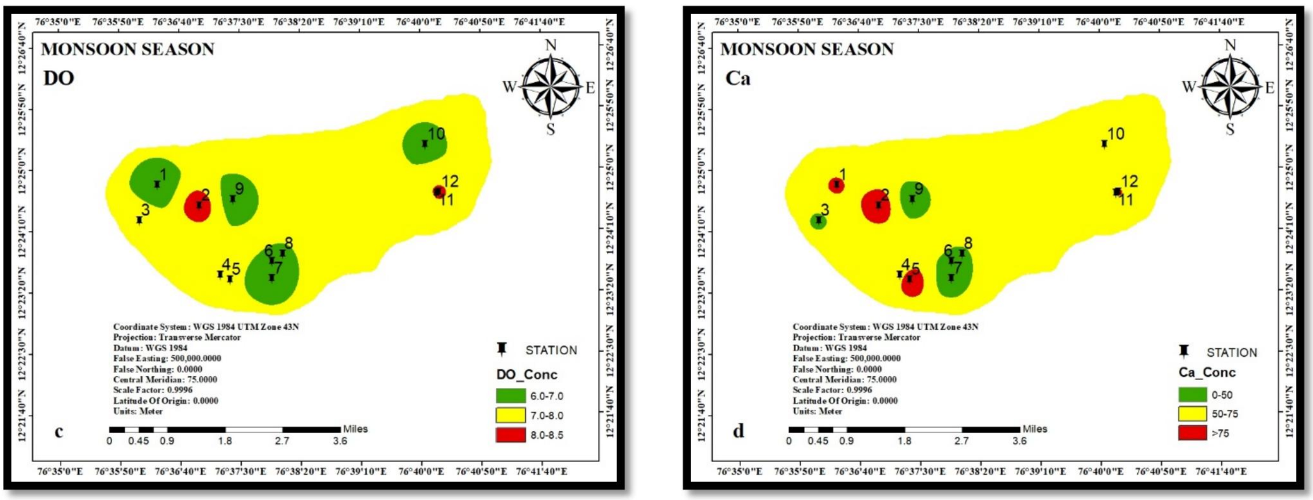
Spatial Distribution:

The Kriging interpolation technique was used in this study as an effective tool for spatial interpolation of groundwater quality parameters leading to the generation of the spatial distribution maps. Kriging is based on the regionalized variable theory that assumes that the spatial variation in the phenomenon represented by the z-values is statistically homogeneous throughout the surface. The distribution of each groundwater quality parameters has been demarcated in different zones on spatial distribution map viz. acceptable /desirable and permissible limits according to BIS (2012,2015) and WHO (2017) for drinking purpose (Arjun Ram et al. 2021). The below maps represents the spatial distribution of determined parameters of three seasons such as monsoon, pre-monsoon, post-monsoon season.

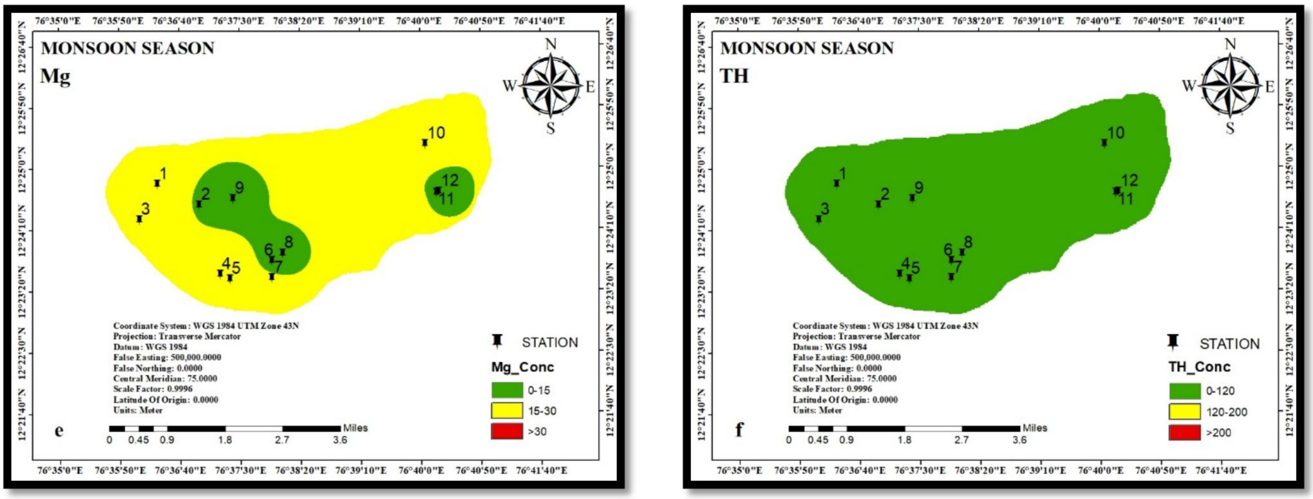
Monsoon Seasons:



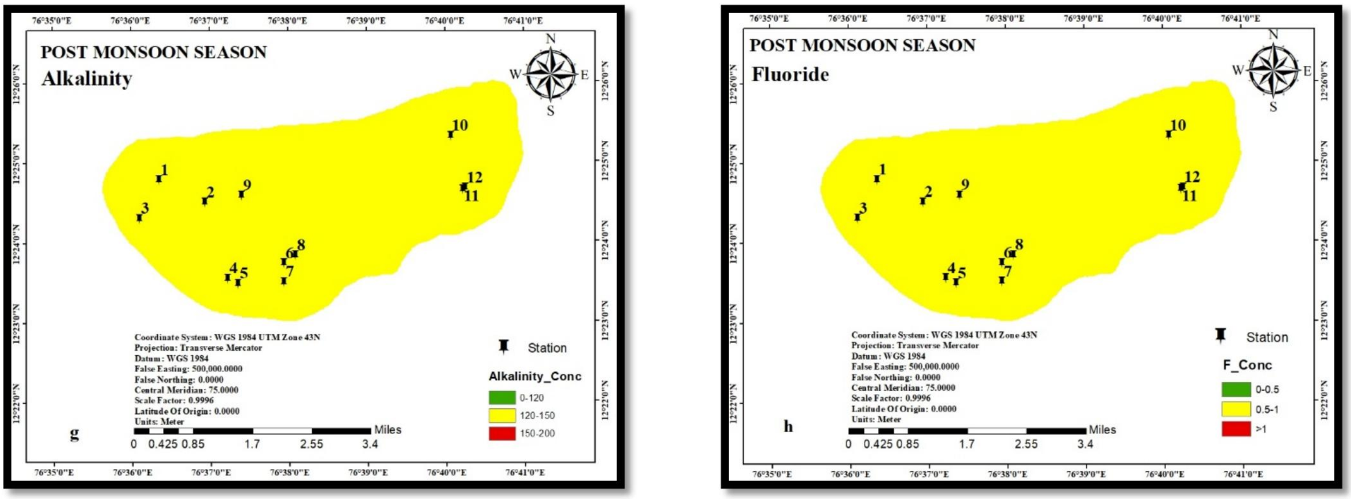
(a-b) Spatial distribution map of pH and TDS



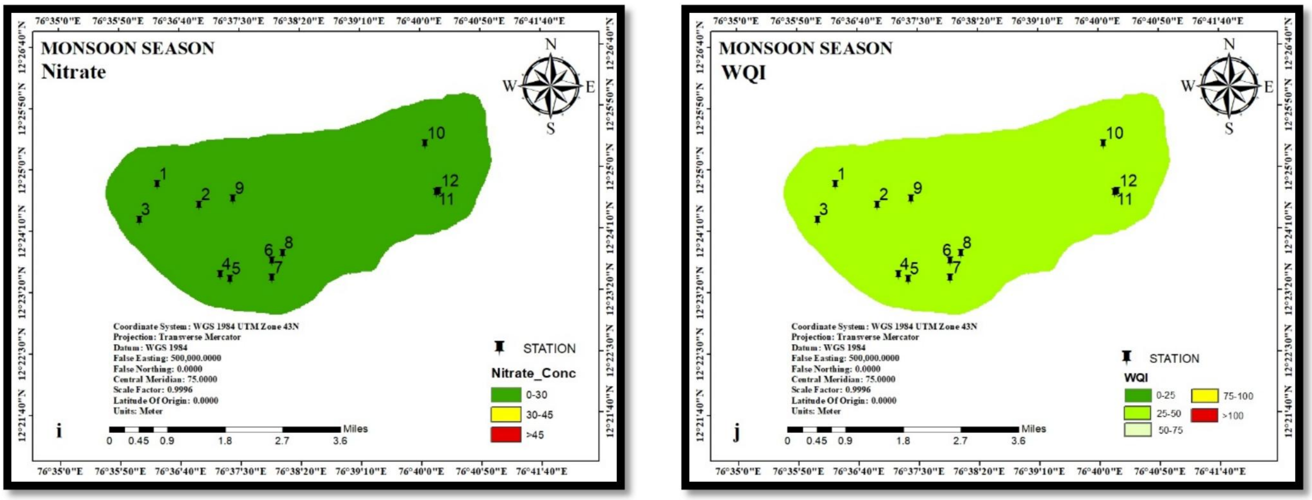
(c-d) Spatial distribution map of DO and Ca



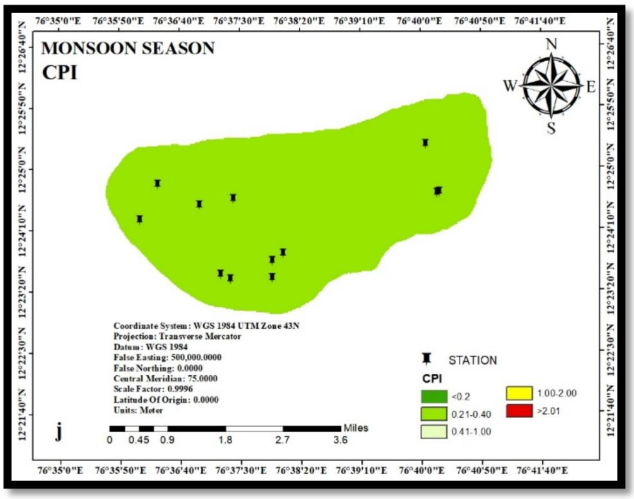
(e-f) Spatial distribution map of Magnesium and TH



(g-h) Spatial distribution map of alkalinity and fluoride

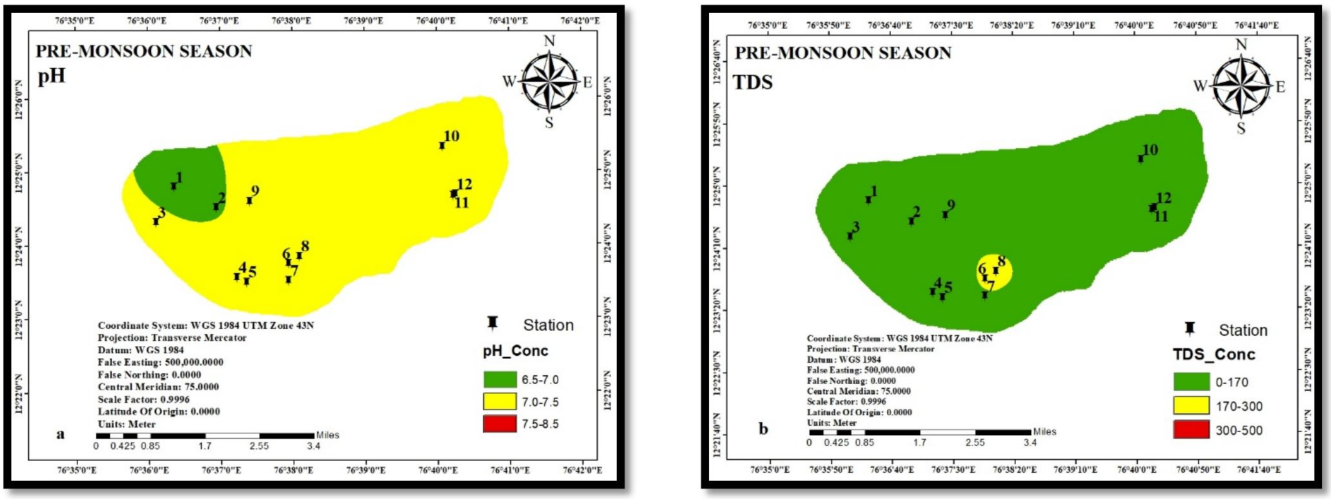


(i-j) Spatial distribution map of Nitrate and WQI

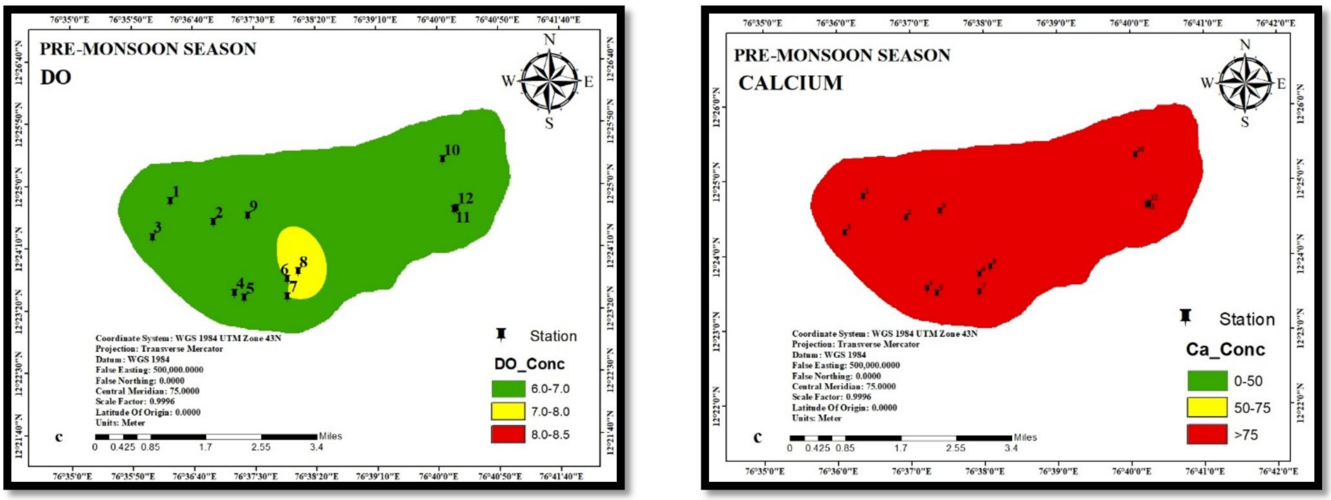


Spatial distribution map of CPI

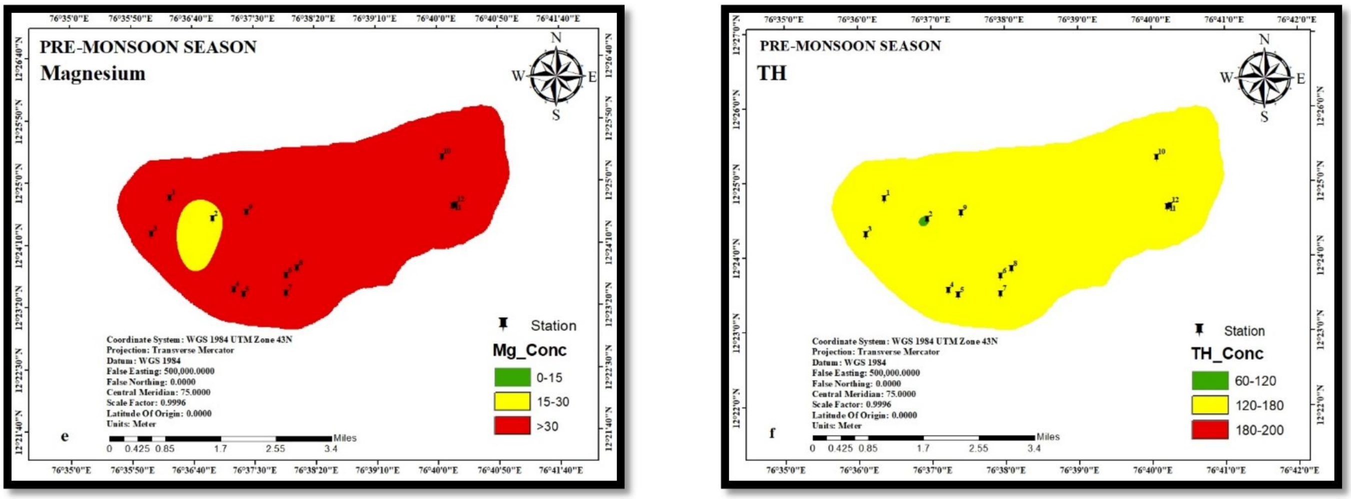
Pre-monsoon Season:



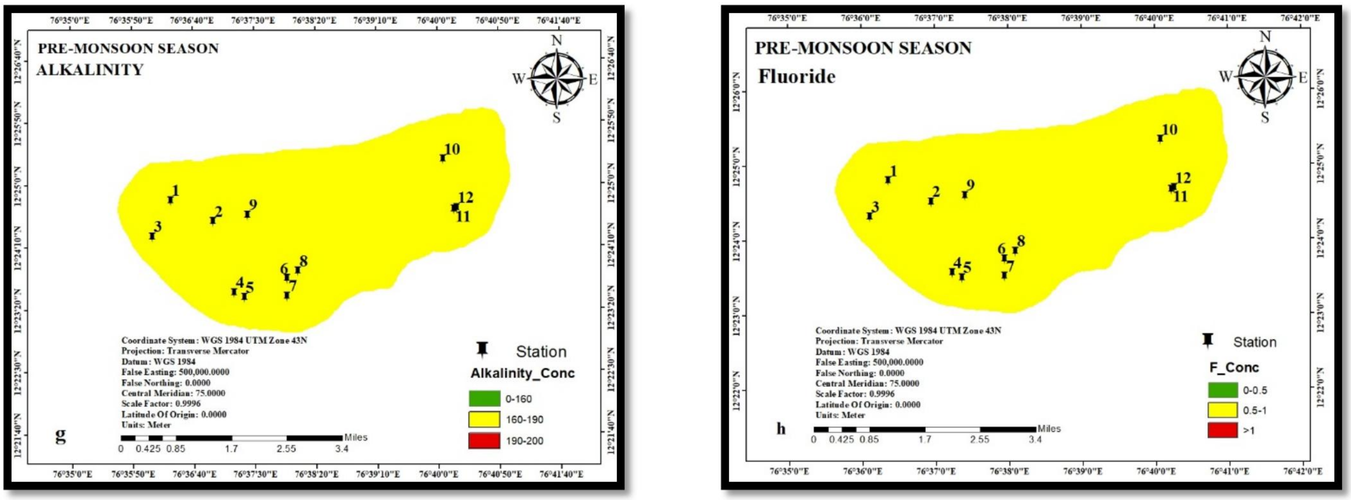
(a-b) Spatial distribution map of pH and TDS



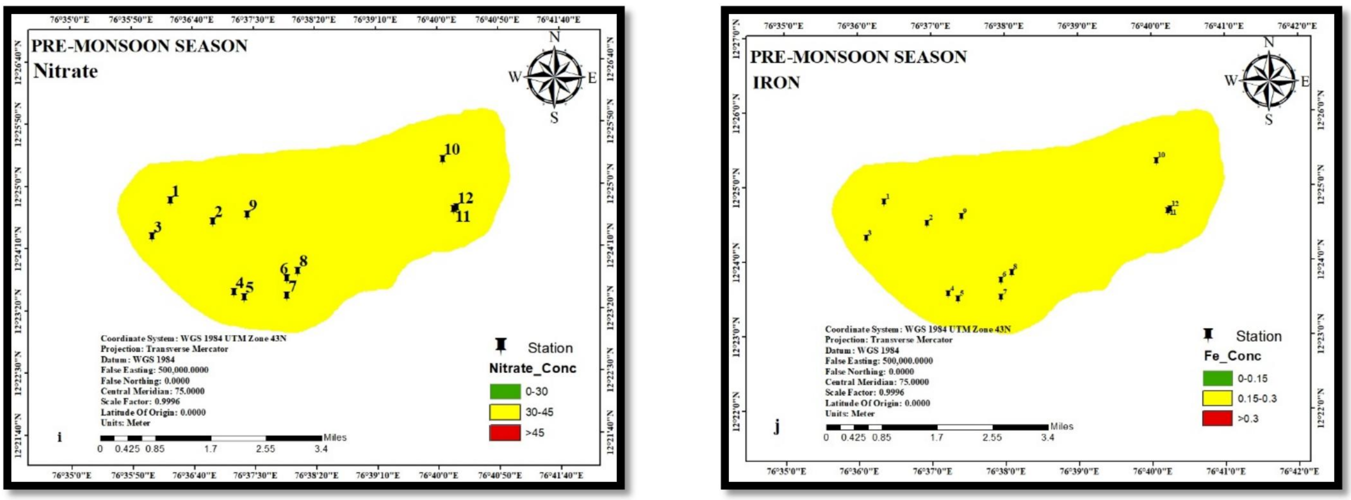
(c-d) Spatial distribution map of DO and Ca



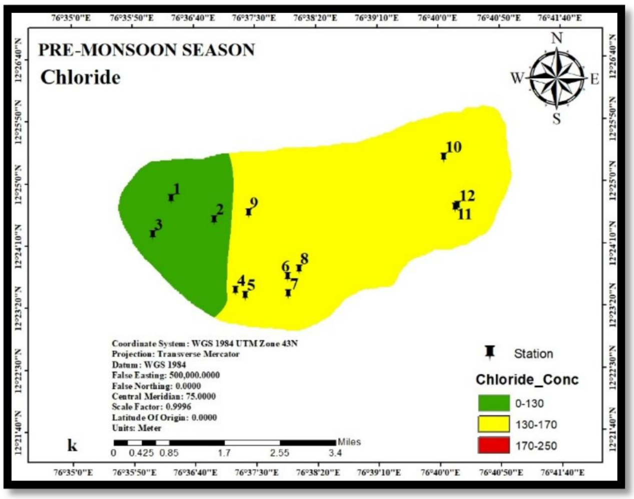
(e-f) Spatial distribution map of Magnesium and TH

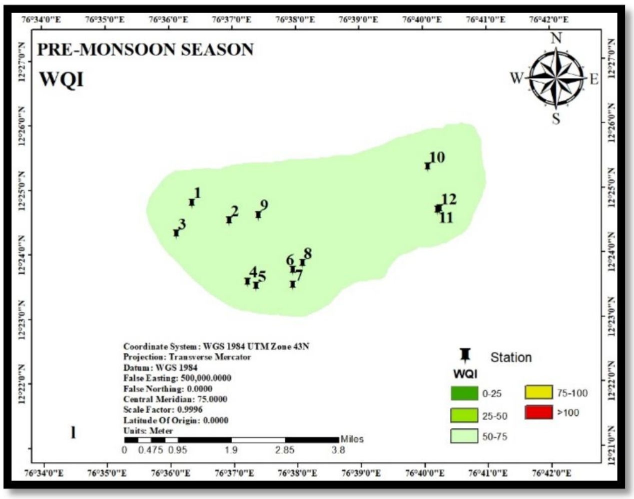


(g-h) Spatial distribution map of alkalinity and fluoride

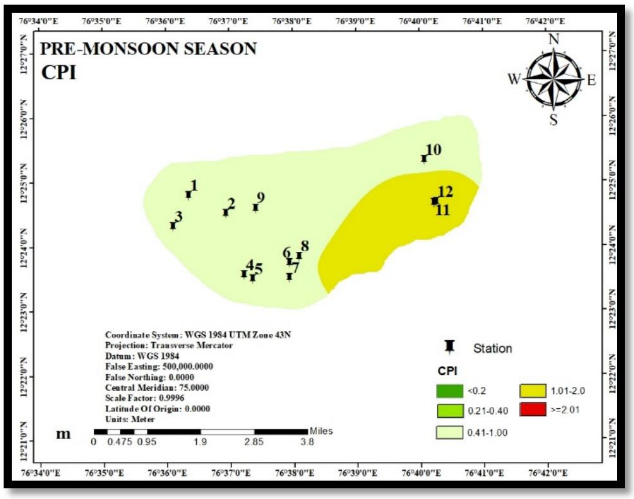


(i-j) Spatial distribution map of Nitrate and Iron



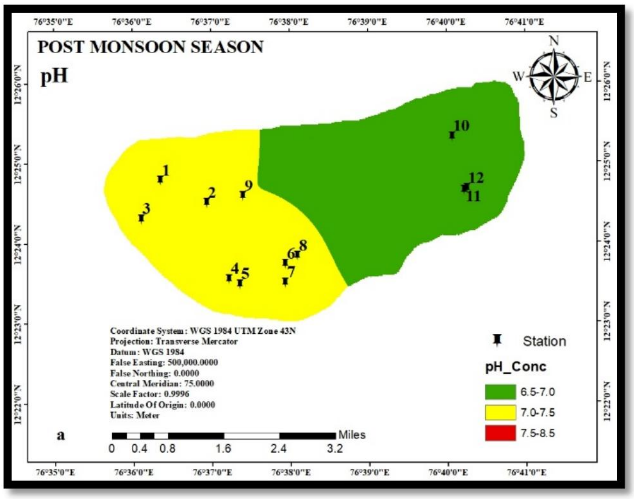


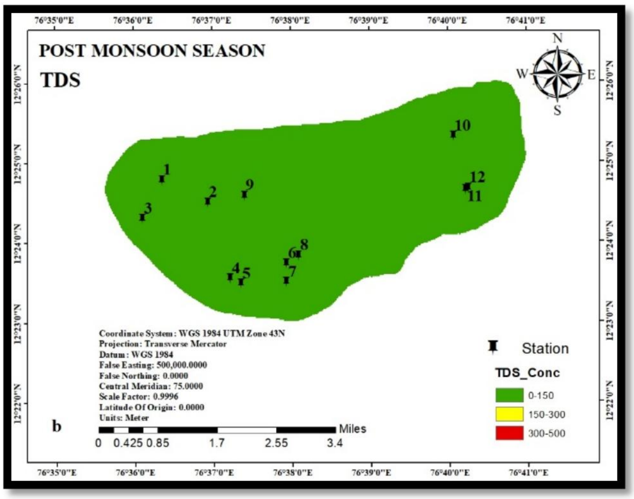
(k-l) Spatial distribution map of Chloride and WQI



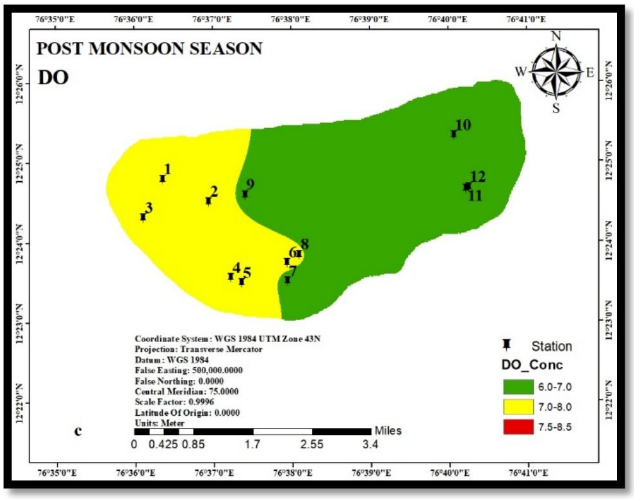
(m) Spatial distribution map of CPI

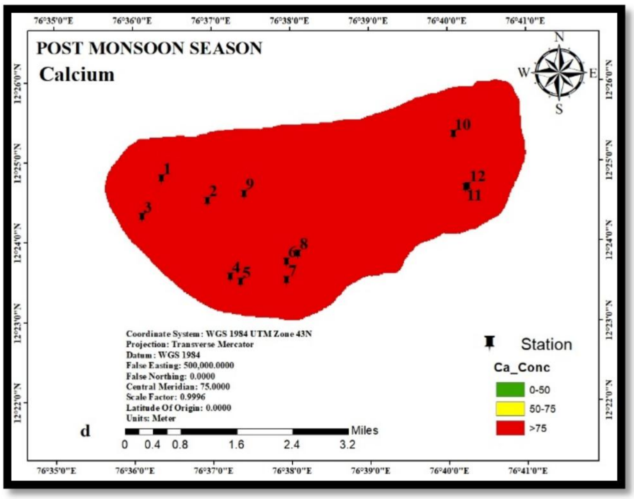
Post-Monsoon Season:



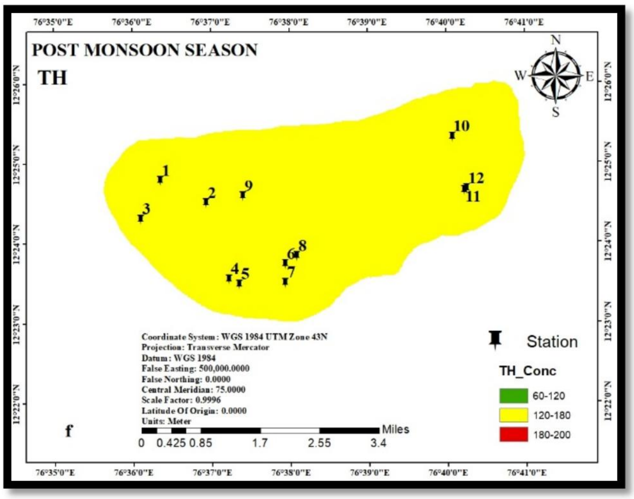


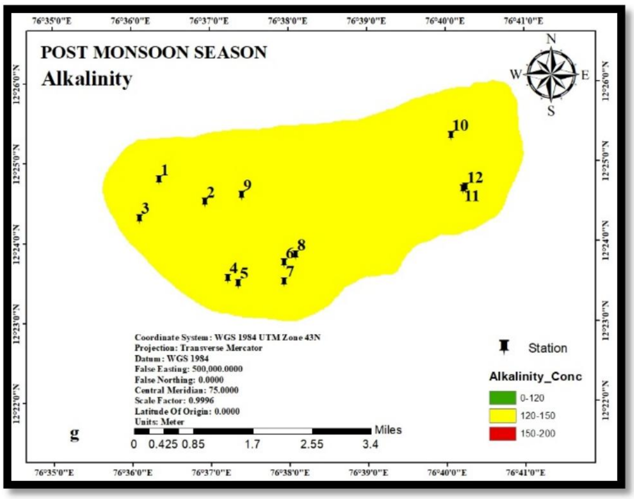
(a-b) Spatial distribution map of pH and TDS



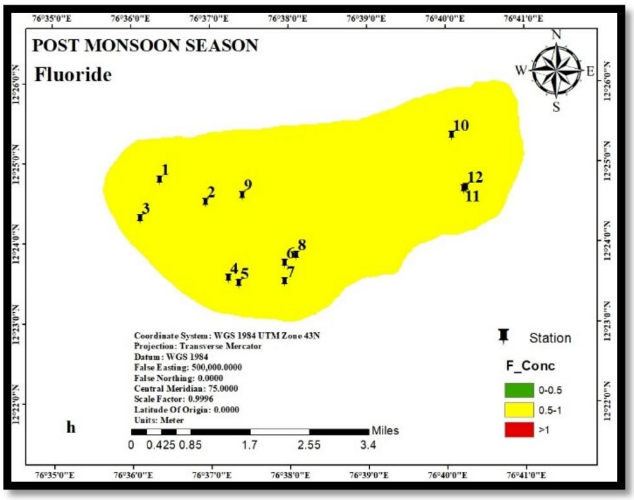


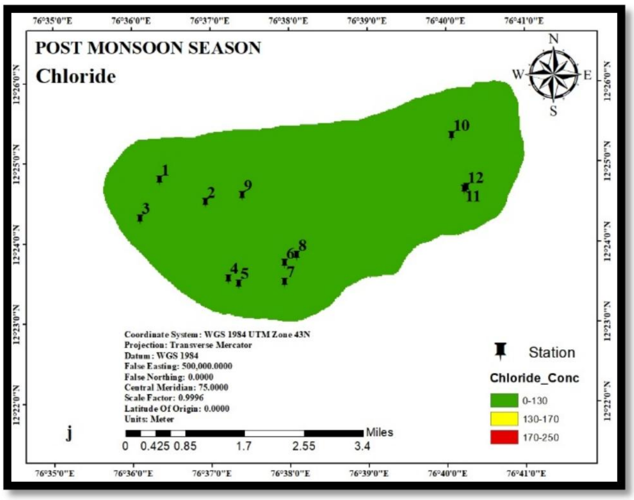
(c-d) Spatial distribution map of DO and Ca



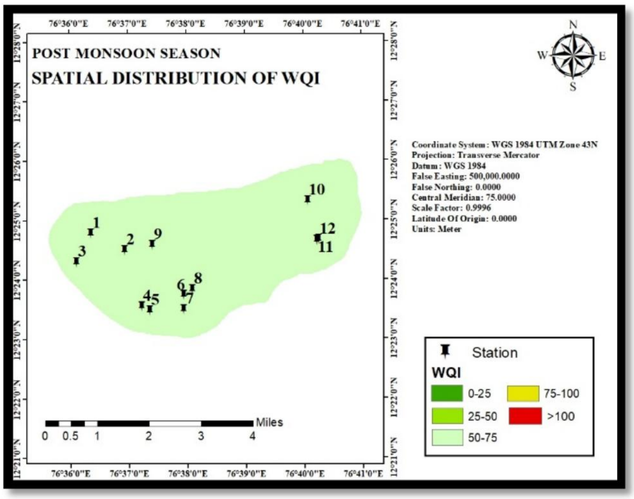


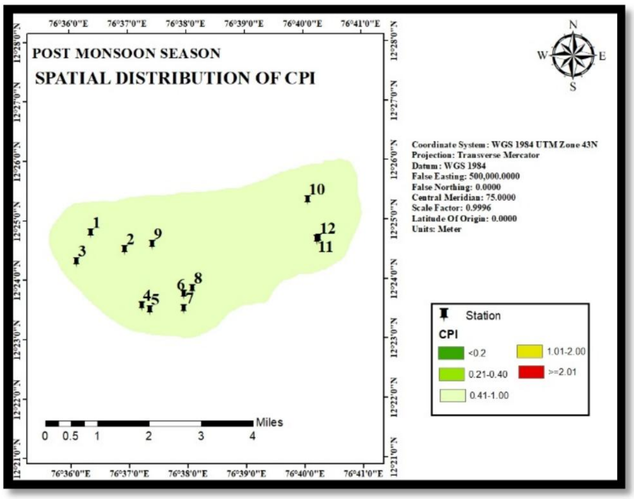
(e-f) Spatial distribution map of Magnesium and TH





(g-h) Spatial distribution map of alkalinity and fluoride





Spatial distribution map of WQI and CPI