Spatial Variation of Surface Water Quality of Vrishabhavathi Watershed Using GIS

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Abstract**—**Vrishabhavathi Watershed is a constituent of the Arkavathi River Basin, Bangalore Urban and Ramanagara District and covers an area of 381.465Km^2, representing seasonally dry tropical climate. In Vrishabhavathi watershed Vrishabhavathi River is the main surface water source which is tributary of river Arkavathy, which joins the Cauvery River. It drains a major parts of Bangalore metropolis and is an outlet for domestic and industrial effluent of that area. Earlier this surface water is mainly used for agricultural purposes and drinking purposes. Since this watershed lies in Bangalore urban and Bangalore rural area, today this water is only used for agricultural purposes which are also not safe. In order to assess the surface water quality the present study has been undertaken to map the spatial variability of the surface water quality in the watershed using Geographical Information System. The water qualities of 24 stations were randomly selected in Vrishabhavathi watershed for the present study.GIS is an efficient tool for representation and analysis of spatial information related to water quality analysis. The spatial variation map for sensitive water quality parameters are generated and integrated using Arc GIS10.1. The final integrated map shows 3 priority classes such as Acceptable, Poor and Very poor water quality zones of the study area and provides a guideline for suitability of water for irrigation purpose.

Keywords**---***GIS, and Vrishabhavathi Watershed, Water quality parameters.*

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I. INTRODUCTION

Water is an indispensable resource of the earth. Safe drinking water is the basic need of the every human being. Fresh water has become an insufficient resource due to over exploitation and pollution of water [1]. Many of the rivers and reservoirs are contaminated by the pollutants. These pollutants are directly discharged by industries, municipal sewage treatment plant and polluted runoff from urban and agricultural area. The degree of pollution status is generally assessed by studying physical and chemical characteristics of water bodies in the watershed [2]. Studies related to water pollution in rivers and watersheds like Chambal River [3],Tamirabharani watershed [1], Vrishabhavathi [4], Gomathi River [5], Betwa River [6], SutlejRiver[7], Pamba River[8]and Kosi River [9] have received greater attention from time to time during recent years. Therefore an attempt has been made to study the seasonal spatial variation of surface water quality of vrishabhavathi watershed. In Vrishabhavathi watershed Vrishabhavathi River is the main surface water source which is tributary of river Arkavathy, which joins the Cauvery River. It drains a major parts of Bangalore metropolis and is an outlet for domestic and industrial effluent of that area. Earlier this surface water is mainly used for agricultural purposes and drinking purposes. Since this watershed lies in Bangalore urban and Bangalore rural area, today this water is only used for agricultural purposes which are also not safe. There are so many industries are functioning in the watershed. These industries are classified in to Major and Minor industries. Major industries having their own STP and treated water will pour in to the river. In case of minor industries they do not have STP and directly they will pour water in to the river. This leads increase of pollution level in the Vrishabhavathi River. Degradation of tanks in the urban area is the main factor for the change in the water quality. Due to Urbanization, instead of tanks settlements are built in the watershed. From the settlements watershed is receiving the domestic sewage water. This sewage water finally reached in to the main river Vrishabhavathi. To overcome from this problem we have to analyse the surface water quality in the Vrishabhavthi River. In this case we have analyzed only sensitive parameters such as Flow, PH, SS, Temperature, DO, COD and BOD. From the values of these parameters we can assess the quality of the sewage water.

II. STUDY AREA

Vrishabhavathi Watershed is a constituent of Arkavathi River Basin, Bangalore Urban and Ramanagara District and covers an area of 381.465 Km^2 lying between latitudes 12^0 44^1 37^{11} to 13^0 2^1 31^{11} N and longitudes 77^0 23^1 14^{11} to 77^0 34^1 59^{11} E. Fig 1 shows the Location Map of the Study area.

III. WATER SAMPLING

The water samples collected from 26 sampling stations during pre-monsoon and post monsoon season was tested for major sensitive parameters and compared with prescribed water quality standards for Irrigation by BIS. The location of water quality sites are listed in Table 1 season wise and location of sampling stations are shown in Fig 2. The major parameters namely pH, Suspended solid (mg/l), DO (mg/l), BOD (mg/l) and COD (mg/l) of the samples were analyzed.

IV. METHODOLOGY

The water samples collected from 26 sampling stations was tested for physio-chemical parameters and compared with the water standards for Irrigationby Bureau of Indian Standards (BIS, 10500:2010). The locations of the water sampling sites are listed in the table 1. The major parameters namely pH, SS, DO, COD and BOD of the samples were analyzed. The Base map of the Vrishabhavathi watershed is prepared by Survey of India topographical maps 57H/5, 57H/6, 57H/9 and 57G/12 in 1:50000 scale. The Base map was georeferenced and digitized by using ArcGIS 10 for spatial analysis. Spatial interpolation technique through Inverse Distance Weighted (IDW) approach has been used in the present study to delineate the distributions of water pollutants. IDW determines cell values using a linear-weighted combination set of sample points. The weight assigned is a function of the distance of an input point from the output cell location. The greater the distance, the less influence the cell has on the output value. The maps generated through GIS overlay analysis shows spatial variation of sensitive water quality parameters in the watershed.

V. RESULTS AND DISCUSSIONS

The spatial and attribute database generated for the water samples parameters were integrated for the generation of spatial variation of maps of sensitive parameters like P^H, DO, SS, BOD and COD. Based on these spatial variation maps of sensitive water quality parameters, an integrated water quality map of the Vrishabhavthi watershed was prepared using GIS. This integrated water quality maps helps us to know the existing water quality conditions in the watershed.

pH

pH is the one of the important parameters of the water and determines the acidic and alkaline nature of water. The good quality of water having the pH in the range of 7 to 8.3. In the present study during pre monsoon pH is rangingbetween 6.2 to 7.9 and during post monsoon pH is ranging between 6.5 to 8.1. The spatial map of pH was prepared and presented in Fig 3 and Fig 4 for pre monsoon and post monsoon.

Suspended Solids (SS)

The suspended solids was classified in to three ranges (<300 mg/l, 300-425 mg/l and >425 mg/l for pre monsoon and <300 mg/l, 300-500 mg/l and >500 mg/l for post monsoon) and based on these ranges the spatial variation map of Suspended solids has been prepared and presented in Fig 5 and Fig 6. It is clear from the map that except in central part of the watershed has acceptable range of Suspended solids.

Dissolved Oxygen (DO)

DO is the most important sensitive parameter for assessing the water quality and reflects the physical and biological process. Dissolved oxygen is needed for living organism to maintain biological process. The Dissolved oxygen was classified in to three ranges (<1.75 mg/l, 1.75-3.5 mg/l and >3.5 mg/l for pre monsoon and < 2.5 mg/l, 2.5-5 mg/l and > 5 mg/l for post monsoon) and based on these ranges the spatial variation map of Dissolved oxygen has been prepared and presented in Fig 7 and Fig 8. In the present study the rural area of water having acceptable range of DO.

Biochemical Oxygen Demand (BOD)

Biochemical oxygen demand is defined as the amount of oxygen required by bacteria in stabilizing the decomposable organic matter. BOD gives the clear picture about the extent of surface water pollution. In the present study BOD was classified in to three ranges (<100 mg/l, 100-200 mg/l and >200 mg/l for pre monsoon and <75 mg/l, 75-150 mg/l and >150 mg/l for post monsoon) and based on these ranges the spatial variation map of BOD has been prepared and presented in Fig 9 and Fig 10.

Chemical Oxygen Demand (COD)

COD determine the amount of organicpollutants found in surface water (e.g. lakes and rivers) or wastewater, making COD a useful measure of water quality.The COD test is helpful in indicating toxic conditions and the presence of biologically resistant organic particles.In the present study BOD was classified in to three ranges (< 250 mg/l, 250-500 mg/l and >500 mg/l for pre monsoon and <200 mg/l, 200-400 mg/l and >400 mg/l for post monsoon) and based on these ranges the spatial variation map of COD has been prepared and presented in Fig 11 and Fig 12.

Integration of Data Using GIS

In the integrated GIS analysis, all the spatial variation maps of sensitive water quality parameters such as pH, Suspended Solids, DO, COD and BOD were integrated into a weighted index overlay process. In the present study, the criterion table with suitable ranks and weightages adopted for the sensitive water quality parameters map. The integrated water quality map of Vrishabhavathi Watershed was prepared for premonsoon and postmonsoonare shown in Fig

13 and Fig 14. The integrated map shows the clearpicture about Acceptable, Poor and Very poor zones in the study area. From the integrated analysis, acceptable range of water quality prevails over the rural area of the watershed and the rest of the area has Poor and Very poor condition.

Conclusions

Vrishabhavathi River regime is affected due to urbanization and industrial activities. Industrial effluents and wastes from urban infrastructure, agriculture, horticulture, mines, all eventually affect the river water quality. The present study has been undertaken to analyze the spatial variation of major water quality parameters such as pH, SS, DO, COD and BOD using GIS approach. The spatial variation maps of sensitive water quality parameters were prepared and finally all these maps were integrated. The water quality has been classified as acceptable, poor and very poor using weighted index overlay method in GIS. The integrated map shows the broad idea about acceptable, poor and very poor water quality zones in the study area. This study helps us to understand the water quality at various points and suggest suitable remedial measures to achieve clean and clear water in the river course. Also to develop suitable management practices to protect the water resources for domestic, industrial or irrigation purpose.

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Table 1: Location-wise Sampling Stations and Water quality parameters

Sampling Period		Pre-Monsoon (April 2013)					Post-Monsoon (September 2013)				
Sl. No.	Station Name/Parameters	p^H	SS mg/l	DO mg/l	COD mg/l	BOD mg/l	p^H	SS mg/l	DO mg/l	COD mg/l	BOD mg/l
1	Near Nandini Layout	6.4	496	0.3	682	268	6.7	554	0.8	592	196
2	Near Magadi Road- Outer Ring Road Jn	6.5	510	0.3	712	278	6.8	589	0.8	604	211
3	Ramachandrapura	6.6	526	0.4	725	284	6.9	591	0.9	608	216
4	Near Chord Road -Magadi Road Jn	6.2	560	0.5	746	293	6.5	625	1.1	618	221
5	Near Vijayanagar	6.4	587	0.6	778	312	6.8	645	1.1	636	226
6	Near Bapujinagar	6.7	598	0.4	797	317	6.8	657	1	652	236
7	Inlet of BWSSB Treatment Plant V	6.9	683	1	832	322	7.1	664	1.9	632	265

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	Valley										
8	Outlet of BWSSB Treatment Plant Valley	7.6	67	4.3	263	53	7.5	85	6.3	212	56
9	Outlet of Hosakerehalli Tank	6.7	546	0.7	812	309	6.8	634	1.3	694	264
10	Near Nice Road	7.1	220	1.9	134	49	7.3	354	2.8	96	25
11	TagachaguppeKumbalagoduIndl Area	7.2	236	0.8	145	53	7.4	338	1.3	124	28
12	Near Hampapura	7.2	246	0.8	157	58	7.4	357	1.3	129	31
13	Near Shanumangala	7.4	258	0.9	164	65	7.5	376	1.6	117	33
14	Inlet of Mylasandra STP	6.8	466	0.9	424	165	7.1	597	1.8	296	135
15	Outlet of Mylasandra STP	7.8	96	3.2	106	41	7.9	96	3.9	101	21
16	Tyagarajanagara Lake	6.6	518	0.6	687	269	6.8	687	1.1	496	184
17	Yelachenahallikere	6.7	523	0.3	674	263	6.9	674	0.9	487	168
18	Byramangala Tank	7.8	310	1.3	118	48	8.1	456	1.6	74	23
19	Near Outlet of Byramangala Tank	7.9	322	1.4	121	52	8	467	1.5	77	28
20	GanapathihalliKere	7.2	168	4.6	64	26	7.3	340	6.8	32	16
21	Hosahalli Tank	7.2	188	5.2	68	29	7.3	364	7.1	34	19
22	Starting Point of Sewage Goraguntepalya	6.2	486	0.3	667	261	6.5	546	0.8	491	184
23	Pipeline Road- Jalahalli West	6.2	489	0.3	687	271	6.5	597	0.8	554	164
24	BelaluKere- outside of Ridge	7.1	154	7.6	58	21	7.4	334	7.9	29	12
25	Kodihallikere-Near byramangala village	7.9	331	1.5	146	58	7.8	437	2.8	96	24
26	Jagarnahalli lake-outside ridge line	6.6	528	0.4	681	267	6.9	647	0.9	563	196

Table 2 Showing Weightages and Ranking assigned for different Water Quality parameters

Sl. No	Parameters	Parameters Range		Ranking	Weightages
		Premonsoon	Postmonsoon		
1	pH	7-7.5	7-7.5	1	20%
		>7.5	>7.5	2	
		<7.0	<7.0	3	
2	SS (mg/l)	<300	<300	1	20%
		300-425	300-500	2	
		>425	>500	3	
3	DO(mg/l)	>3.5	>5	1	20%
		1.75-3.5	2.5-5.0	2	
		<1.75	<2.5	3	
4	BOD(mg/l)	<100	<75	1	20%
		100-200	75-150	2	
		>200	>150	3	
5	COD(mg/l)	<250	<200	1	20%
		250-500	200-400	2	
		>500	>400	3	

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Fig 1 Location Map of the Study area.

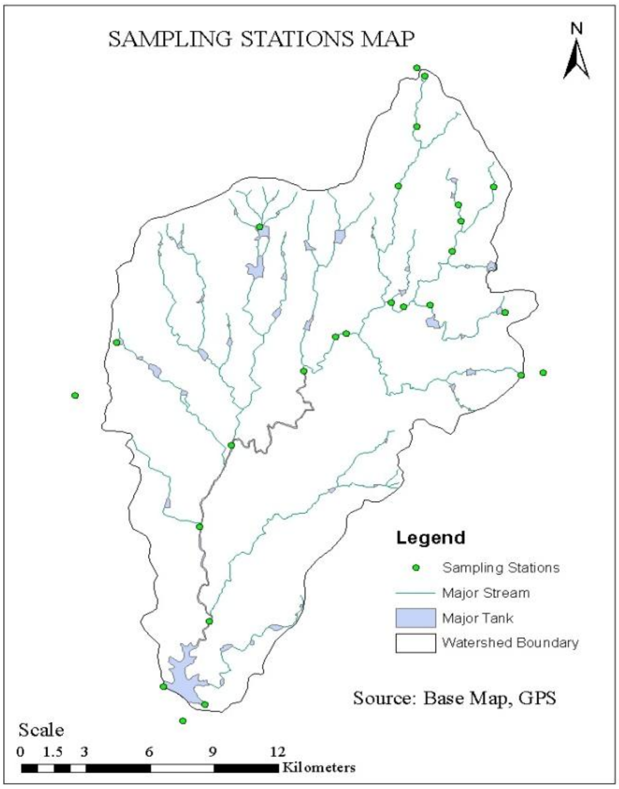

Fig 2 Sampling Stations Map

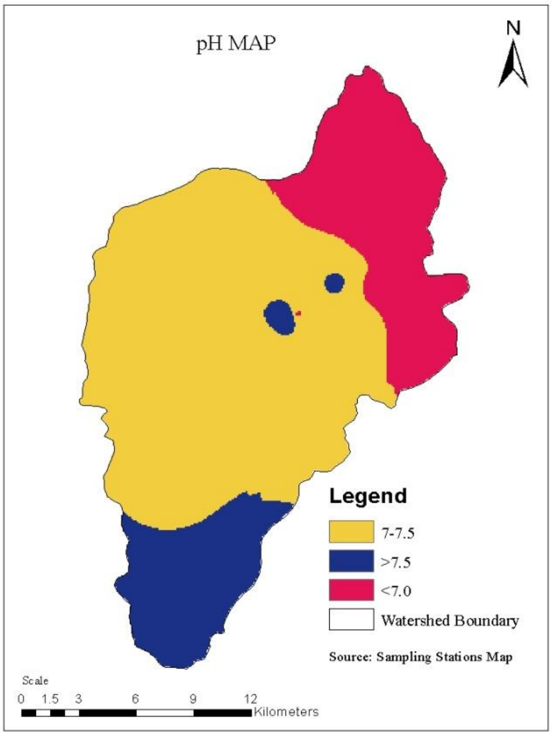

Fig 3: Spatial Variation Map of pH during Pre monsoon

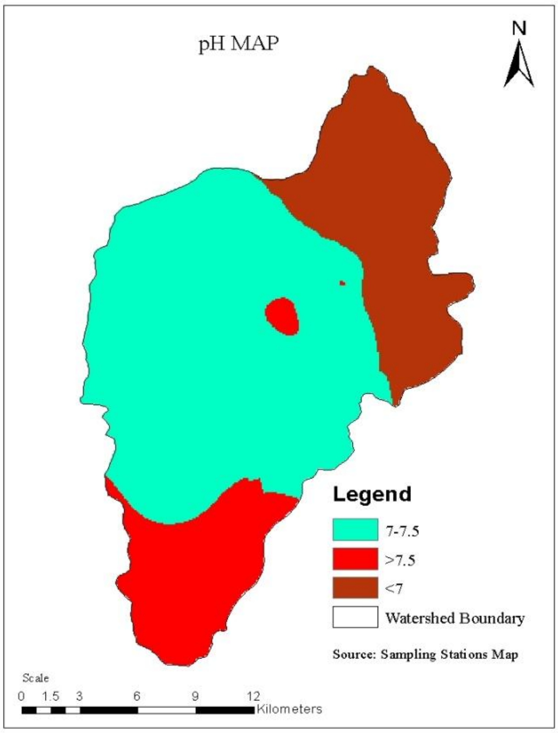

Fig 4: Spatial Variation Map of pH during Post monsoon

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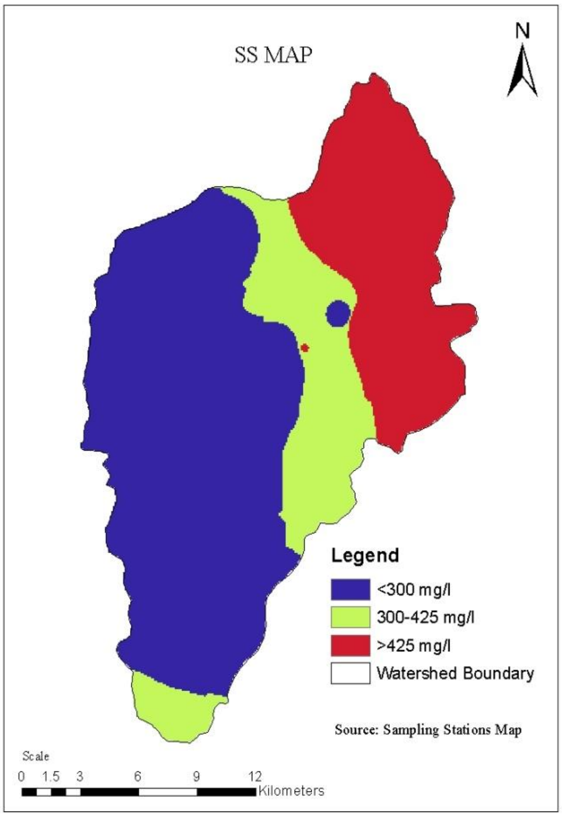

Fig 5: Spatial Variation Map of SS during Pre monsoon

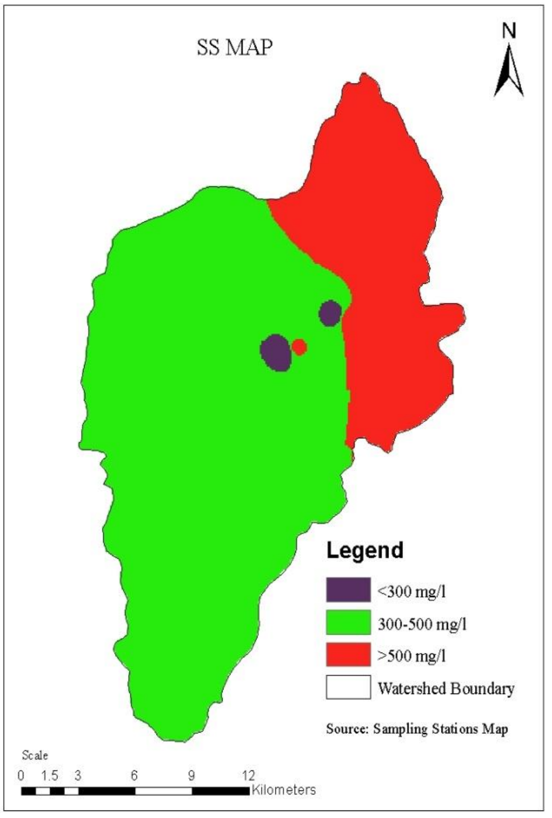

Fig 6: Spatial Variation Map of SS during Post monsoon

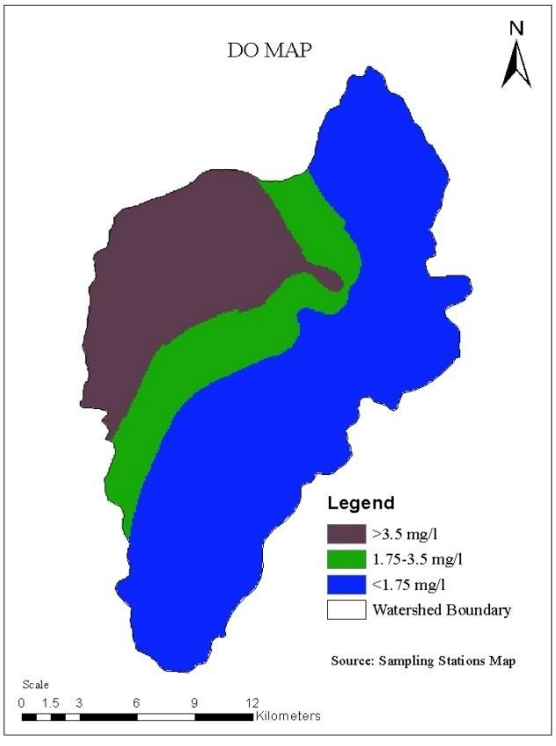

Fig 7: Spatial Variation Map of DO during Pre monsoon

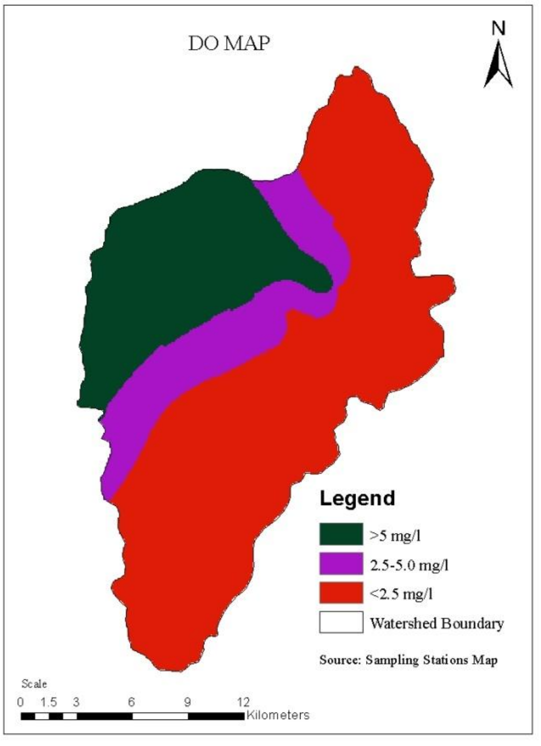

Fig 8: Spatial Variation Map of DO during Post monsoon

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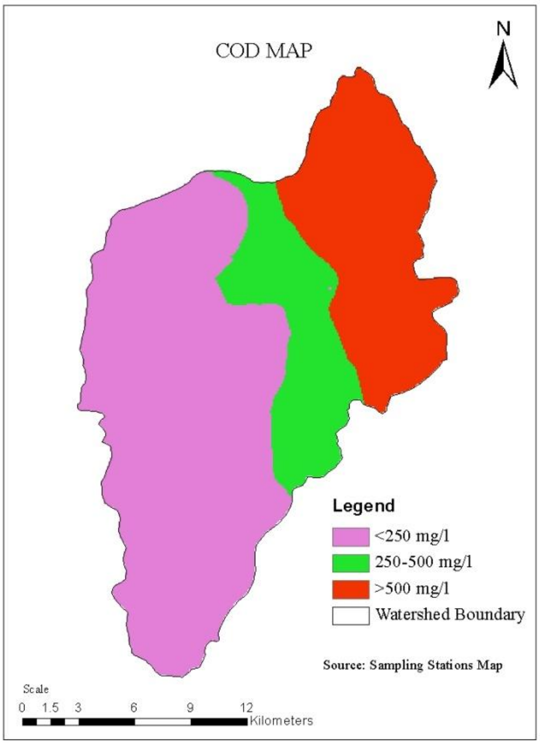

Fig 9: Spatial Variation Map of COD during Pre monsoon

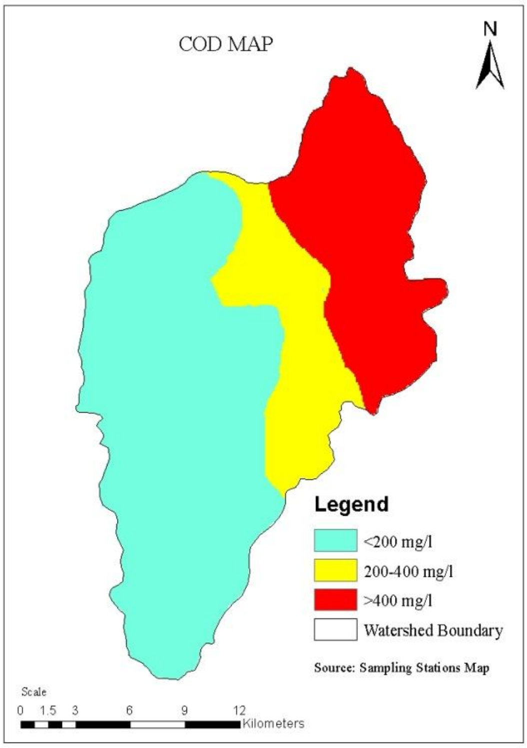

Fig 10: Spatial Variation Map of COD during Post monsoon

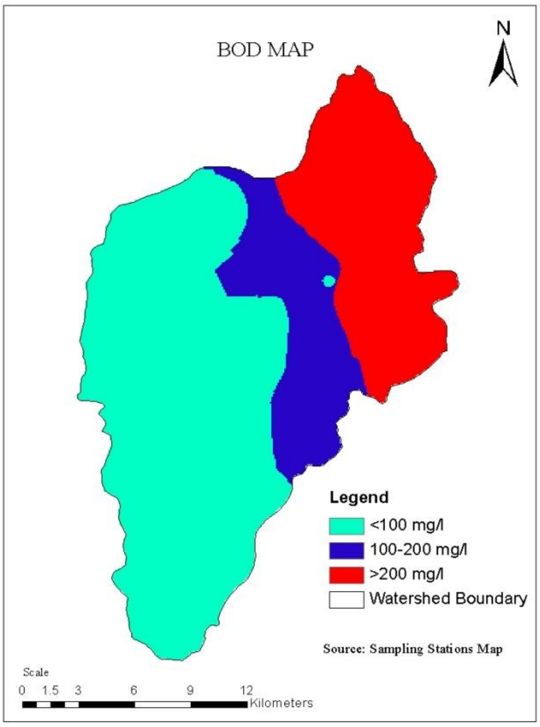

Fig 11: Spatial Variation Map of BOD during Pre monsoon

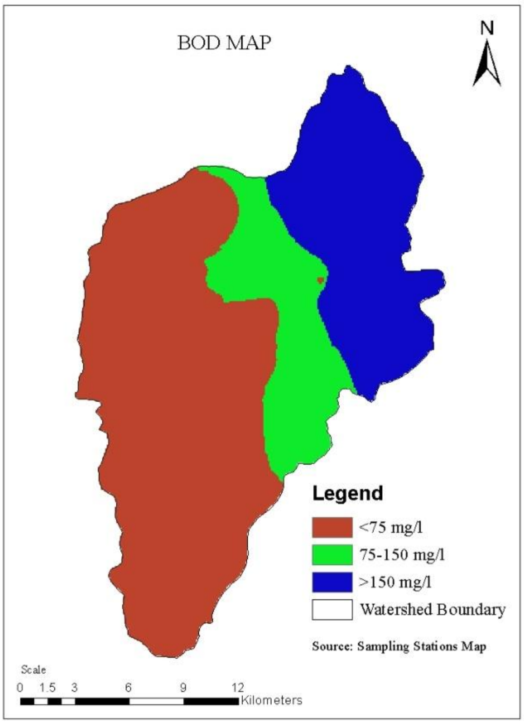

Fig 12: Spatial Variation Map of BOD during Post monsoon

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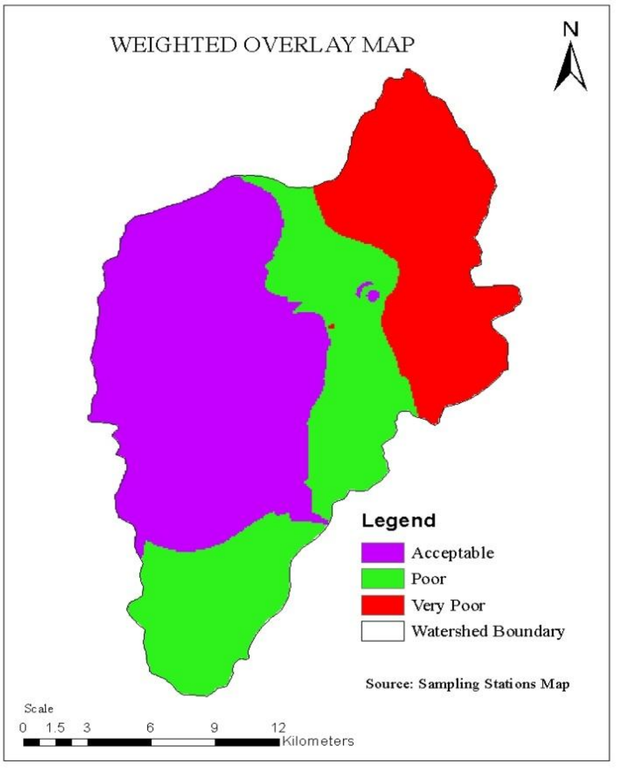

Fig13: Integrated Spatial Variation map of Surface Water quality during Premonsoon

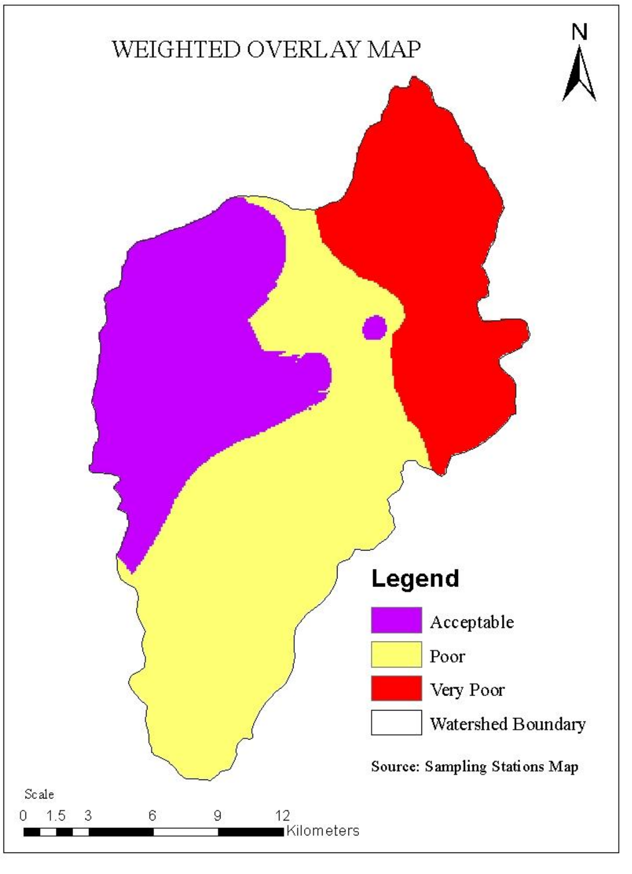

Fig14: Integrated Spatial Variation map of Surface Water quality during Postmonsoon