Ground Water Quality Mapping FOR Mahesh River Basin in Akola and Buldhana District of (MS) India Using Interpolation Methods

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Abstract: The present study was to evaluategroundwater quality inthe Akola and Buldhana district, Maharashtra in India. A detailed hydrochemistry study of groundwater region is described and the origin of the chemical composition of groundwater has been qualitatively evaluated, using observations over a period of premonsoon (June) in the year of 2013.The groundwater quality is equally important as that of quantity. The groundwater quality data was collected in 36 wells sample randomly distributed in Mahesh River Basin. GIS is a powerful tool for representation and analysis of spatial information related to water resources.

To attempt this goal,samples were analysed for various physico-chemical parameterssuch as pH, Electrical Conductivity (EC), Total hardness, Mg and Ca etc. have been estimated for all the sampling locations. The spatial variation maps of these groundwater quality parameters were derived and integrated through GIS. Aninterpolation technique inverse distance weighting was used to obtain the spatial distribution of groundwater quality parameters. The final map classified the groundquality in the study area. The results of this research showthat the development of the management strategies for theaquifer system is vitally necessary.

Key Words: *GIS, Groundwater, GPS, physicochemical parameters, spatial interpolation.*

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I. INTRODUCTION

Groundwater quality is mainly affected by the geologicalformations that the water passes through its course and byanthropogenic activities (Kelepertsis 2000; Siegel 2002;Stamatis 2010;Sullivan et al. 2005). The hydrogeochemical study with GIS reveals the zones where the quality of water is suitable for drinking, agricultural and industrial purposes. In any area around the world, groundwater quality and risk assessment maps are important as precautionary indicators of potential risk environmental health problems. GIS has been widely used in risk mapping (Daniela 1997; Bartels and Beurden 1998; Hong and Chon 1999; Anbazhagan and Nair 2005; Singh and Lawrence 2007; Machiwal et al. 2011).As a result, the naturally existing dynamic equilibrium among the environmental segments get affected leading to the state of polluted rivers. Hence monitoring of surface water quality has become indispensable. On the Surface water quality depends on various parameters such as pH, Electrical Conductivity (EC), Total Dissolved Solids, Ca, Mg, Nitrate etc. A similar approach was adopted by Khadri, ChaitanyaPande and Kanak Moharir (2013) where GIS was used to prepare layers of maps to locate promising well sites based on water quality and availability. Babiker et al. (2007) proposed a GIS-based groundwater quality index method which synthesizes different available water quality data (for example, Cl, Na, SO4) by indexing them numerically relative to the WHO standards. Water quality assessment involves evaluation of the physical, chemical, and biological nature of water in relation to natural quality, human effects, and intended uses, particularly uses which may affect human health and the health of the aquatic system itself (UNESCO/WHO/UNEP, 1996). The use of GIS technology has greatly simplified the assessment of natural resources and environmental concerns, including groundwater. In groundwater studies, GIS is commonly used for site suitability analyses, managing site inventory data, estimation of groundwater vulnerability to contamination, groundwater flow modelling solute transport and leaching, and integrating groundwater quality assessment models with spatial data to create spatial decision support systems (Engel and Navulur, 1999). The present study attempts to the map the spatial variation of surface water quality parameters for Mahesh River Basin using Spatial Interpolation. GIS is an effective tool for water quality mapping and essential for monitoring the environmental change detection. The water samples were collected from 36 locations randomly distributed in the study area. Considering the above aspects of groundwater contamination and use of GIS in groundwater quality mapping, the present study was undertaken to map the groundwater quality in Mahesh River Basin in the Akola district of Maharashtra, India. This study aims to visualize the spatial variation of certain physicochemical parameters through GIS and also GIS is used to assess the existing condition of surface water quality and the contaminated areas can be identified for further monitoring and management.Interpolation is an estimation of Z values of a surface at an unstapled point based on the known Z values of surrounding points. There are two main interpolation techniques: deterministic and geostatistics. Deterministic interpolation techniques create a surface from measured points, based on their extent of similarity [e.g. inverse distance weighted (IDW)] or the degree of smoothing (e.g. radial basis functions). Geostatistical interpolation techniques(e.g. kriging) utilize the statistical properties of the measured points (ESRI 2001).In the present study is based on the analysis of ground water samples collected from different source like open well, tube well, hand pump and water supplied by Agriculture land and drinking purpose.

II. STUDY AREA

The Mahesh River basin is situated in Akola and Buldhana Districts of Maharashtra which is located between 76° 46’11’’E and longitude 20°40′ 36” N latitude covered by survey of India toposheets no. 55 D/9, 55 D/7, 55D/11,55D/13,55D/14 and 55 D/15on 1:50,000 scale. It can be approached from Amravati by road transport which is about 120 Km. The Mahesh River basin which is a major tributary of Mun River lies towards the western and southern part of Akola and Buldhana district. The total area covered by Mahesh River Basin is 328.25 Sq. Kms. the study area is occupied by alluvium and Deccan basalts which are horizontally disposed and is traversed by well-developed sets of joints. The Ajanta hill ranges are bordering the district in the Southern with their slope towards Western. The starting part of Akola district is plain whereas the Western part is again elevated with its general slope towards Sothern. The Mahesh River Basin flows in the Southern to Western direction having western slope and meets the Mun River near Balapur village in Akola district. Purna is the major river of the Akola and Buldhana district. The important tributaries of Purna River are Katepurna, Morna, Man, Vidrupa, Shahanur, Van and Nirguna. Most of the watershed area was covered by unconsolidated sediments, black cotton soil, Red soils and basaltic rocks of Deccan Traps. The study area was drained by Mahesh River flowing south to western with almost dendritic to sub-dendritic drainage pattern.

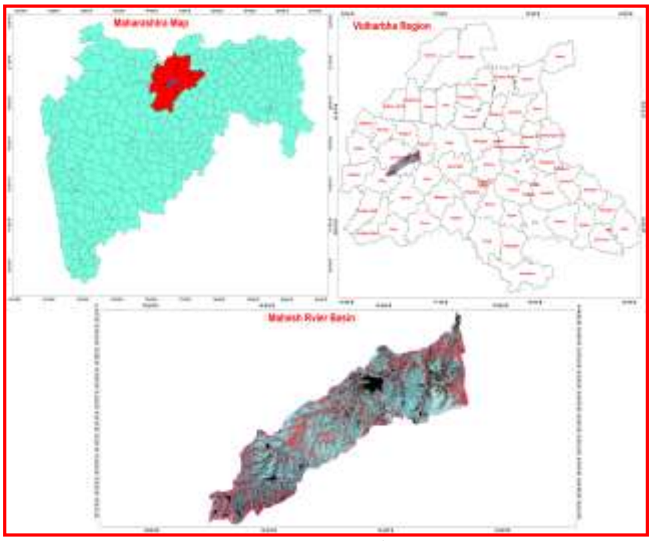

Figure 1. Location Map of the Study Area

III. METHODOLOGY

Total of 36 water samples are collected from underground water table from hand pumps, tube well and open wells these samples were collected during the Pre-2013 year out of which 36 samples are collected in pre monsoon and another 36 samples are collected in post monsoon respectively the physic-chemical properties like conductivity, Ec, pH, Th, Ca and Mg are analyses in the chemical laboratory. The examination of water samples are performed within 24h from water collection. Water samples are collected in white can before collection it is rinsed thoroughly. The study area map is digitized from SOI toposheets then latitude and longitude of the sampling stations are taken from the hand held GPS. These latitude and longitude are converted into shape files in ARCGIS 10.1. The shape files are added to ARC map by using KML to layer tool then raster files are created by using the Geostatistical analysis tool. In the present study, the base map was prepared using Survey of India Toposheet nos. 58N/13, 14, and 15 on 1:50,000 scale. Geographical information system (GIS) software utilities are used to spatially represent data sets for the purpose of generating maps and making spatial comparisons of data. Arc GIS spatial analyst was the primary tool used to produce maps that aided analysis. The maps spatially integrated and the analytical results of hydrological parameters show the study area water quality. The spatial analysis of various physico-chemical parameters was carried out using the Arc GIS 10.1 software.

Table 1.Showing Values of Various Physic-Chemical Parameters.

S.No	Ec µS/cm	pH	TDS mg/l	Ca mg/l	Mg mg/I
0	986	7.6	407.56	2.79	5.36
1	693	6.3	471.92	5.49	3.95
2	1200	7.6	544.72	4.44	6.45
3	987	7.8	399.46	4.24	3.75
4	1414	7.9	451.96	5.09	3.95
5	890	7.5	343.36	3.94	2.93
6	870	7.2	415.55	3.94	4.37
7	879	6.8	557.77	4.24	6.91
8	704	7.6	428.05	3.94	4.62
9	945	6.8	441.67	5.69	3.14
10	785	6.8	292.28	1.9	3.95
11	879	6.1	500.17	6.24	3.77
12	805	6.7	444.45	5.56	3.3
13	875	7.1	325.75	2.79	3.72
14	905	6.8	380.64	3.89	3.72
15	905	6.3	465.47	5.59	3.72
16	768	6.5	417.03	4.39	3.95
17	879	6.9	346.47	2.4	4.53
18	987	6.9	450.27	5.24	3.77
19	1002	7.3	408.09	4.44	3.72
20	945	6.3	344.36	3.74	3.14
21	812	7.2	559.69	4.74	6.45
22	987	7.1	411.59	4.84	3.39
23	687	6.3	481.9	5.69	3.95
24	658	6.9	476.91	5.59	3.95
25	782	7.1	415.34	4.54	3.77
26	546	7	657.65	5.09	8.06
27	512	7.1	515.43	2.25	8.06
28	356	6.3	485.55	5.99	3.72
29	355	6.4	272.01	2.3	3.14
30	345	7	476.42	6.14	3.39
31	645	6.7	469.93	4.04	5.36
32	358	6.3	338.35	3.04	3.72
33	389	6.5	383.54	3.54	4.13
34	489	7	338.35	3.04	3.72
35	348	6.3	415.55	3.94	4.37
36	648	6.2	417.83	4.59	3.77

IV. GENERATING GROUNDWATER QUALITY MAP

The base map was georeferenced and digitized by using ARC GIS-10.1 software and exported to Arc view software for spatial analysis. Spatial interpolation technique through Inverse Distance Weighted (IDW) approach has been used in the present study to delineate the distribution of water pollutants. The Inverse Distance Weighted (IDW) referred to as deterministic interpolation methods because they assign values to locations based on the surrounding measured values and on specified mathematical formulas that determine the smoothness of the resulting surface. This method uses a defined or selected set of sample points for estimating the output grid cell value.

V. RESULTS AND DISCUSSION

The spatial and the attribute database generated are integrated for the generation of spatial variation maps of major water quality parameters Ec, pH, Th, Ca and Mg. Based on these spatial variation maps of major water quality parameters, an Integrated Groundwater quality map of Mahesh River Basin was prepared using Arc GIS 10.1. This integrated Groundwater quality maps helps us to know the existing groundwater condition of the study area.

A. pH

pH is one of the important parameters of water and determines the acidic and alkaline nature of water. The pH of the good quality water ranges from 7.5 to 7.9. The pH of the samples was well within the prescribed standards for drinking water. The spatial variation map for pH was prepared and presented the pH of analysed sample varies from 6.1 to 6.4 for pre monsoon of 2013.

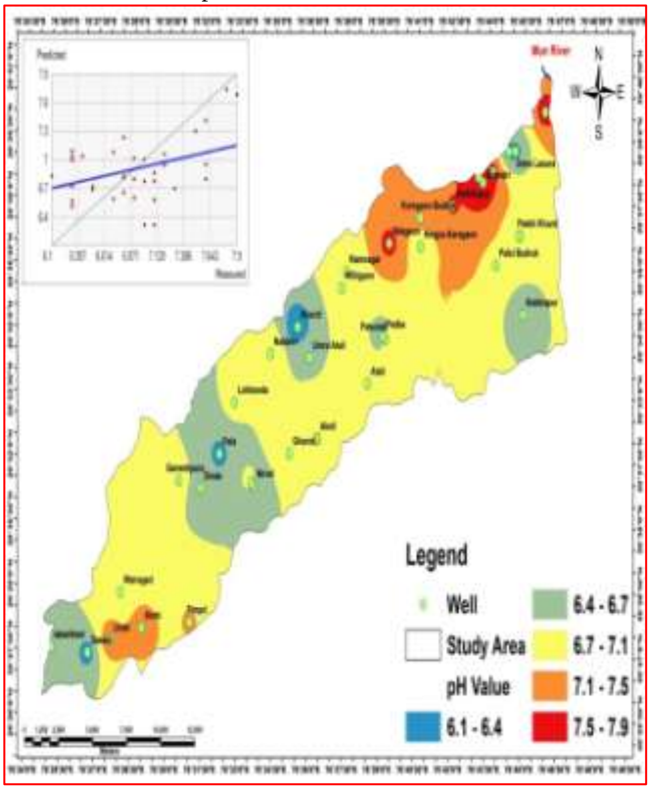

Figure2. Ph Spatial Distribution Map of Mahesh River Basin

B. Electrical Conductivity (EC)

Electrical conductivityis the ability of a substance to conduct an electrical current, measured in microsiemensper centimeter (mS/cm). Ionssuch as sodium, potassium, chloride give water its ability to conduct electricity. Conductivity is an indicator of the amount of dissolved salts in a stream often is used to estimate the amount of total dissolved solids (TDS) rather than measuring each dissolved constituent separately. The ability of a cube 1 cm. on a side to conduct an electrical current is called electrical conductivity; this is the reciprocal of resistivity and is measured in mhos. Since, mho is too large a unit for fresh water, micromho is used. This is a function of temperature and the kind of ions present and the concentration of other ions. These readings are adjusted to 25^0c so that variation in conductivity is a function only of the dissolved ions in water. Hence, the unit in micromhos/cm at 25^0c. The range of electrical conductivity (EC) in the area is 1109.06 to 1414 for pre monsoon of 2013.

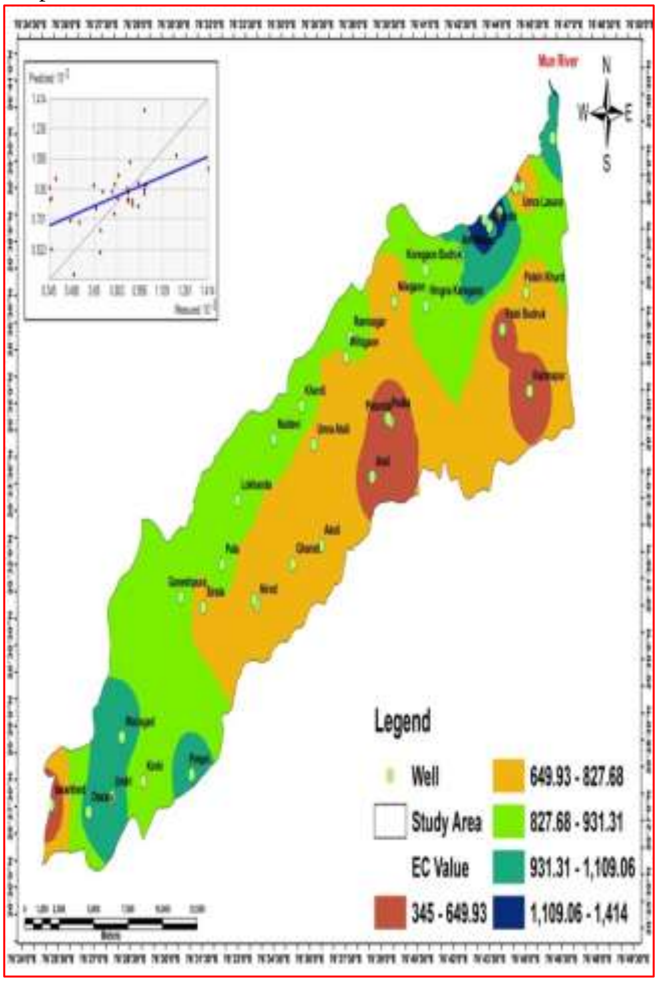

Figure. 3 Spatial Distribution Map of EC Pre 2013

C. Calcium (Ca)

It is one of the alkaline earth metals and widely distributed in earth crust and all way abundant present as a cation in ground water. In the presence of CO_2, Calcium bicarbonates can normally be dissolved up to 20 ppm at atmospheric pressure and up to 100 ppm at higher pressure. The concentration may higher in water coming from limestone zone. The values of calcium in water sample of study area are equalized by chemical analysis. The

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observation 2013 pre monsoon of Ca value in Mahesh river basin minimum ranges 1.9 to 3.10 and maximum ranges value is 5.65-6.24.

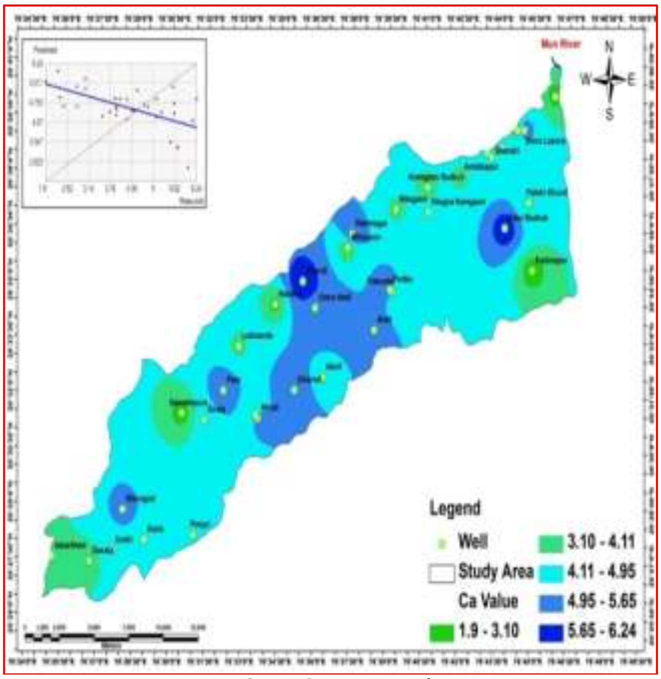

Figure 4. Spatial Distribution Map of Ca Pre 2013

D. Magnesium (Mg)

Magnesium and calcium are the two elements mainly responsible for hardness water. Olivine, biotite, horn blend, serpentine is the some major magnesium bearing minerals. The presence of carbon dioxide influences the solubility of magnesium. The desirable limit of magnesium in natural water is 30 mg/Lit. The observation of the Mg value in study area ranges between 2.93 to 3.48 and 5.49 to 8.06 for Pre-monsoon 2013.

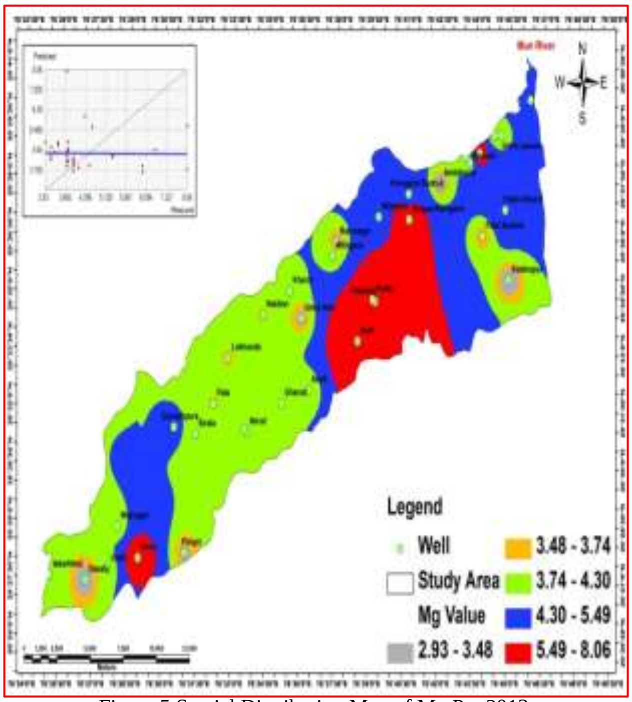

Figure 5 Spatial Distribution Map of Mg Pre 2013

E. Total Dissolved Solids

The mineral constituents dissolved in water constitute dissolved solids. The concentration of dissolved solids in natural water is usually less than 500 mg/L, while water with more than 500 mg/L is undesirable for drinking and many industrial uses. Water with TDS less than 300 mg/L is desirable for dyeing of cloths and the manufacture of plastics, pulp paper, etc. (Durfer and Baker, 1964). The total concentration of dissolved minerals in water is a general indication of the over-all suitability of water for many types of uses. Subba Rao et al. (1988) and Deepali et al. (2001) reported that TDS concentration was high due to the presence of bicarbonates, carbonates, sulphates, chlorides and calcium. TDS can be removed by reverse osmosis, electro dialysis, exchange and solar distillation process. It is the concentration of non-volatile substances present in the water in molecular dispersed and colloidal state. Due to surface & subsurface movement of water, it contains a wide variety of dissolved inorganic chemical constituent in various amounts. Fundamentally, it is based on concentration of NaCl, which in turn determine the conductivity which has a bearing on TDS. Conversion between TDS and conductivity in micro siemens or micromho's/cm. at 25^0, TDS in ppm. and varies between 0.55 – 0.75.A value of 0.90 has been arrived at Sawayer and McCarthy, (1978); Walton, (1970) gave a relation that for groundwater in the range of 100 – 5000 micromoho's / cm at 25^0c. In the study area minimum ranges 272.01 to 356.16 and maximum ranges between 573.49 to 657.56for pre monsoon of 2013.

Table2. Range of TDS With Reference To Water Quality

T D S	Water Quality
< 1000	Fresh
1000-10000	Brackish
10,000 – 1,00,000	Saline
> 1,00,000	Brine

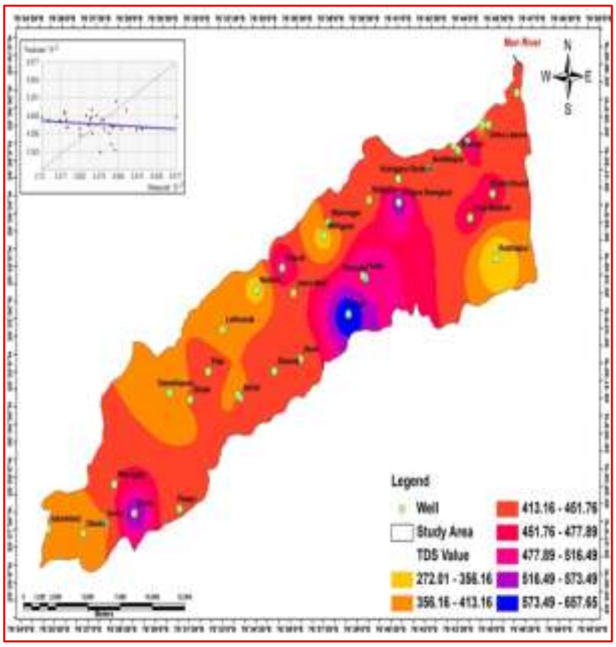

Figure 6 Spatial Distribution Map of TDS Pre 2013

VI. CONCLUSIONS

It provides freshwater for domestic, agriculture, industrial and ecological purpose. However, due to the rapid economic development and population growth, the pressure imposed on ground water is alarmingly increasing. Also heavy ground water extraction has caused many problems such as decline in ground water level, salt water intrusion, ground water pollution etc. among these problems ground water survival. Therefore the identification, assessment and remediation of ground water pollution have attracted the researcher and academician these days. In the present study the ground water quality of Mahesh river basin for the year 2013 pre monsoon has been evaluated. The values of water quality parameters for pre-monsoon have been compared with the standards to identify the areas of concern. The scale and degree of degradation varies significantly with the susceptibility of local aquifers to exploitation related deterioration and their vulnerability to pollution. Over 50% of the world's population is estimated to be residing in urban areas, and almost 50% of the mega-cities having populations over 10 million are heavily dependent on ground water, and all are in the developing world. In India, there are over 20 million private wells, in addition to the government tube wells Datta, (2005). This study aims to visualize the spatial variation of certain physico-chemical parameters through GIS. The main objective of the research work is to make a groundwater quality assessment using GIS, based on the available physico-chemical data from 36 Well locations in Mahesh River Basin watershed in the Akola and Buldhana district of Maharashtra. The purposes of this assessment are (1) to provide an overview of present groundwater quality, (2) to determine spatial distribution of groundwater quality parameters such as Hardness, Ec, pH, TH, Ca and Mg. The spatial distribution analysis of groundwater quality in the study area indicated that many of the samples collected are not satisfying the drinking water quality standards prescribed by the WHO and ISI. The government needs to make a scientific and feasible planning for identifying an effective groundwater quality management system and for its implementation. Since, in future the groundwater will have the major share of water supply schemes, plans for the protection of groundwater quality is needed. Present status of groundwater necessitates for the continuous monitoring and necessary groundwater quality improvement methodologies implementation.

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