Ground Water Quality Mapping of Kolasib District, Mizoram, India using Geo-Spatial Technology

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ABSTRACT : *Water is one of the most vital natural resources for our daily life. This essential resource is obtained mainly from surface water and ground water. Inconsistency and unequal availability of surface water leads to the search for ground water. Ground water is profoundly utilized in irrigation, industries and for domestic purposes. Therefore, the quality of ground water is equally important as its quantity. The present study makes use of geo-spatial technology in mapping the spatial variability of ground water quality. Ground water samples were collected from 58 point sources randomly distributed in Kolasib district, Mizoram. The major water quality parameters such namely pH, Electrical Conductivity [EC], Total Dissolved Solids, Total hardness, Iron, Chloride, Nitrate and Fluoride have been estimated for all the sampling locations. The spatial variation maps of these ground water quality parameters were generated and utilize as thematic layers. The thematic layers were given ranks based on their relative importance. Different classes within each thematic layer were assigned weightages in numerical rating from 1 to 3 as attribute values in GIS environment. Summation of these attributes values and the corresponding rank values of the thematic layers were utilize to generate the final ground water quality map. The final map shows the different classes of ground water quality within the district. This can be utilized in giving guideline for the suitability of ground water uses.*

Keywords – *GIS, Ground water, Water quality, Kolasib district*

1. INTRODUCTION

Growth of population, rapid urbanization and increasing uses in domestic and agricultural sectors necessitate the demand for good quality of water supply {[1], [2], [3]}. One of the most vital natural resources and easily accessible source of fresh water is ground water {[4], [5], [6], [7], [8]}. Therefore, finding the potential areas, monitoring and conserving ground water have become extremely important at the present moment {[9], [10]}.

Mizoram comprises high degree of slopes and narrow intervening synclinal valleys. Faulting in many places has produced steep fault scarps [11]. Consequently, majority of the rain water is lost as surface runoff even though the state received high amount of rainfall. Springs are the main sources of water within the state. Hence, the quality of water from such sources needs to be carefully analyzed and represented in a GIS environment [12].

In the field of water quality analysis, few attempts were made within the state of Mizoram. Assessment of the water quality of Tlawng river in Aizawl, Mizoram [[13], Sulphate, phosphate-P and nitrate-N contents of Tlawng river, near Aizawl City, India [14], Seasonal variation in water quality of Tuirial River in vicinity of the hydel project in Mizoram, India [15], Physico-chemical characteristics of Tamdil in Mizoram, northeast India [16] are the few researches previously done.

Advent of geospatial technology permits swift and cost effective survey and management of natural resources [17]. Geographical Information System (GIS), Global Positioning System (GPS) and remote sensing are the major tools in this newly introduced technology. This technique has wide-range applications in geo-scientific researches including ground water quality mapping {[18], [19]}.

For these reasons, many researchers have utilized these techniques successfully in ground water studies, both for prospecting and quality mapping {[20], [21], [22], [23], [24], [25]}. The same techniques have been proved to be of immense value not only in the field of hydrogeology but also for the development of surface water resources as well {[4], [26]}.

2. STUDY AREA

The general information about the study area is described as follows:

2.1 Location and Extent

Kolasib district is located in the northern part of Mizoram, in north-east India. With a total area of 1382.00 sq km., the district is located between 92° 31′ 55" to 92° 54′ 08" E longitudes and 23° 51′ 17" to 24° 31′ 14" N latitudes. It falls under Survey of India topo sheet No. 83D/11, 83D/12, 83D/14, 83D/15, 83D/16, 84A/9 and 84A/13. Location map of the study area is shown in Fig. 1.

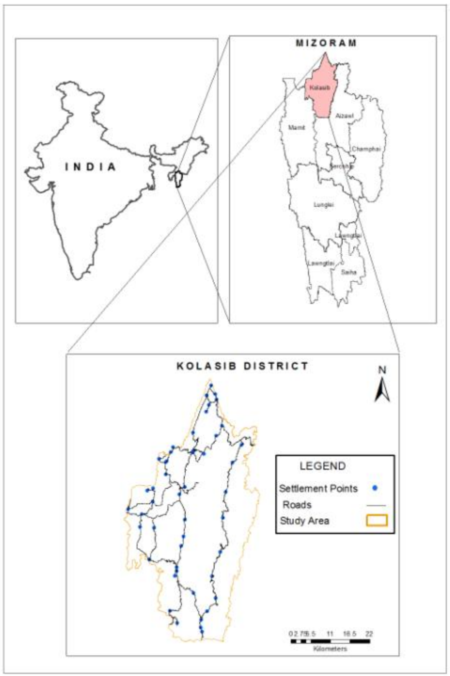

Figure 1: Location map of study area

2.2 Climatic Condition

The climate of the study area ranges from moist tropical to moist sub-tropical. The entire district is under the direct influence of south west monsoon, with average annual rainfall of 2003.30 mm [27].

2.3 Geology

Geologically, the entire state of Mizoram comprises great flysch facies of rocks made up of monotonous sequences of shale and sandstone [28]. The study area lies over Middle Bhuban, Upper Bhuban and Bokabil formations of Surma Group of Tertiary age (GSI, 2011). Middle Bhuban and Bokabil formations consist mainly of argillaceous rocks while Upper Bhuban formation comprises mainly of arenaceous rocks [11]. It was also observed that the rocks exposed within the study area were traversed by several faults and fractures of varying magnitude and length [29].

2.4 Geomorphology

The study area is characterized mainly by ridgelines and intervening valleys and less prominent ridges. Structural hills are the main geomorphic units which were divided as High, Moderate and Low Structural Hills based on their elevation. Other geomorphic units like Valley Fill and Flood Plain are characterized by unconsolidated sediments, and were found along streams and major rivers respectively [30].

3. MATERIALS:

The following materials were utilized in the present study:

3.1 Data Used

Base map of the study area was generated from thematic maps extracted from Natural Resources Atlas of Mizoram prepared by MIRSAC. Satellite data, SOI topographical maps and various ancillary data were also referred in the study. Records of ground water quality prepared by State Referral Institute [SRI], Aizawl were imported and plotted in a GIS environment.

3.2 Software

Prominent GIS softwares like Quantum GIS and ArcInfo 10.1 version were used for analysis and mapping. Hand held GPS device was also utilized in the field for locating sample points and for ground truth verification.

4. METHODOLOGY

The base map was geo-referenced and digitized by using QGIS software and exported to ArcInfo 10.1 software for spatial analysis. Water samples were collected from 58 locations and were tested for their physico-chemical properties. The characteristics of the water were subsequently evaluated using the Indian Drinking Water Standards as per BIS Guideline. The major parameters namely pH, Electrical Conductivity (EC), Total Dissolved Solids, Total hardness, Iron, Chloride, Nitrate and Fluoride of the samples were analyzed.

Spatial interpolation technique through Inverse Distance Weighted (IDW) approach has been used in the present study for generating spatial distribution of the ground water quality. The spatial variation maps of major ground water quality parameters were prepared as thematic layers following BIS Guideline. This Guideline categorized each ground water parameters as Desirable, Permissible and Non-potable classes. The different classes within the BIS Guideline were represented in the present study as Good, Moderate and Poor classes respectively. All the spatial variation maps/layers were integrated and the final ground water quality map of Kolasib district was then generated.

5. DATA ANALYSIS

All the thematic layers were assigned different ranks based on their role in controlling the quality of ground water. All the layers were individually divided into appropriate classes and weightage value is assigned for each class based on their influence on the quality of ground water. This process is done in such a manner that less weightage represents better influence whereas and more weightage represent poorer influence towards the ground water quality. The assignment of weightage values for the different categories within a parameter is done in accordance to their assumed or expected importance in inducing different classes of the ground water quality [18], [24].

Parameter	Ranking	Range	Weight
pH	15	<6.5	3
		6.5-8.5	1
		>8.5	3
Electrical conductivity (umhos/cm)	15	0-2250	1
		2250-3000	2
Total Dissolved Solids (mg/l)	15	0-500	1
		500-2000	2
Total Hardness (mg/l)	15	0-300	1
		300-600	2
Iron (mg/l)	10	<0.3	1
		0.3-1.0	2
		>1.0	3
Chlorides (mg/l)	10	<250	1
		250-1000	2
Nitrate (mg/l)	10	<45	1
		45-100	2
Fluoride (mg/l)	10	<1.0	1
		1.0-1.5	2

Table No.1: Rankings and weightages of parameters

6. RESULTS AND DISCUSSION:

The spatial and the attribute database generated are integrated for the generation of spatial variation layers of major water quality parameters. Based on these spatial variation layers of major water quality parameters, an integrated ground water quality map of Kolasib district was prepared using GIS technique. Results and discussion for the major parameters are as follows:

6.1 pH

pH is one of the important parameters of water which determines the acidic and alkaline nature of water. The pH value of water ranged between 6 and 9. The pH values of the samples were classified into two classes. As per BIS guideline, majority of the area falls within desirable limit (6.5-8.5). Few areas were below 6.5 and above 8.5. Area with desirable limit were categorized as Good class while those areas with pH value less than 6.5 or more than 8.5 were categorized as Poor class. The spatial variation map for pH was prepared and presented in Figure 2.

6.2 Electrical Conductivity (EC)

The Electrical Conductivity (EC) of water was classified in to three ranges (0-2250 µmhos/cm, 2250-3000 µmhos/cm and >3000 µmhos/cm) by BIS guideline. Areas which have Electrical Conductivity values between 0-2250 µmhos/cm were categorized as Good class; those which are having the values ranging between 2250-3000 µmhos/cm were categorized as Moderate class while those area having values greater than >3000 µmhos/cm were categorized as Poor class. The spatial variation map for Electrical Conductivity (EC) were prepared and presented in Figure 3.

6.3 Total Dissolved Solids (TDS)

The Total Dissolved Solids (TDS) of water is classified in to three ranges (0-500 mg/l, 500-2000 mg/l and >2000 mg/l) by BIS guideline. The present study area has only two categories which are termed as Good class and Moderate class respectively. The spatial variation map for TDS was prepared based on these ranges and presented in Figure 4.

6.4 Total Hardness

The Total hardness is classified in to three ranges (0-300 mg/l, 300-600 mg/l and >600 mg/l) by BIS guideline. The present study area was categorized as Good class and Moderate class. Based on these ranges the spatial variation map for total hardness has been obtained and presented in Figure 5.

6.5 Iron

Iron was classified in to three ranges (<0.3 mg/l, 0.3-1.0 mg/l and >1.0 mg/l) by BIS guideline. Based on these ranges, the study area was divided into Good, Moderate and Poor classes. The spatial variation map for iron is presented in Figure 7.

6.6 Chlorides

Chlorides was classified in to three ranges (0-250 mg/l, 250-1000 mg/l and >1000 mg/l) by BIS guideline. The study area has the first two categories only which are termed Good and Moderate classes. The spatial variation map for chlorides has been presented in Figure 8.

6.7 Nitrate

Nitrate was classified in to three ranges (<45 mg/l, 45-100 mg/l and >100 mg/l) by BIS guideline. The study area has only to ranges which were categorized as Good and Moderate classes. The spatial variation map for Nitrate is presented in Figure 9.

6.8 Fluoride

Fluoride was classified in to three ranges (<1.0 mg/l, 1.0-1.5 mg/l and >1.5 mg/l) by BIS guideline. The study area has only two categories, viz., Good and Moderate. The spatial variation map for fluoride has been presented in Figure 10.

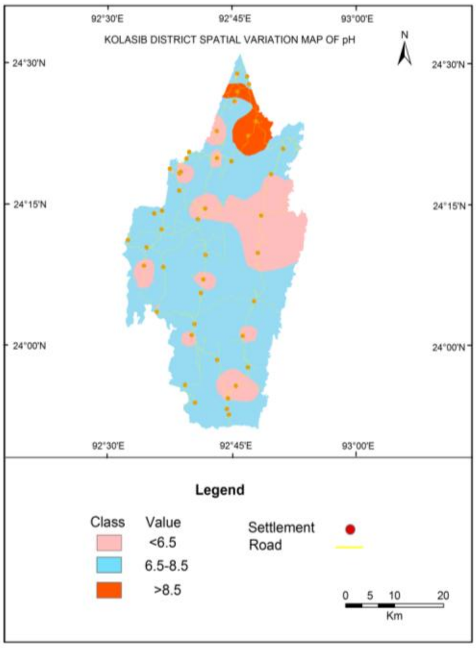

Figure 2: Spatial variation map of pH

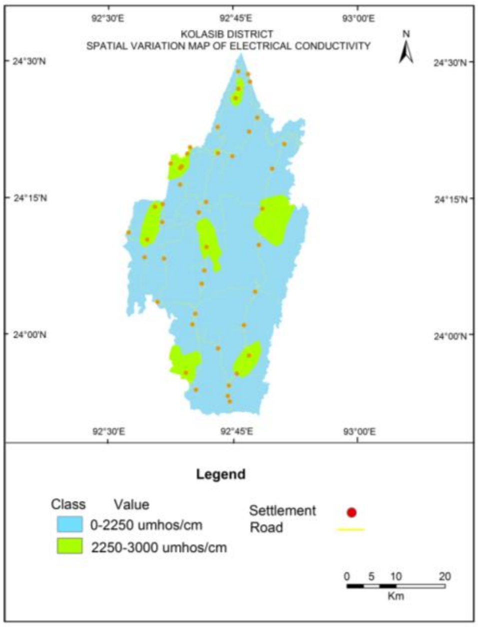

Figure 3: Spatial variation map of EC

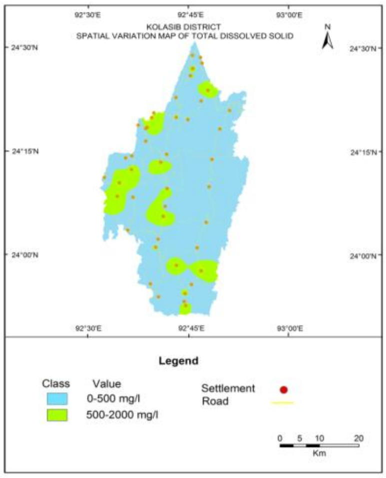

Figure 4: Spatial variation map of TDS

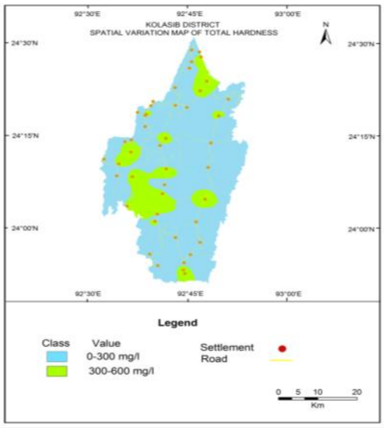

Figure 5: Spatial variation map of Total

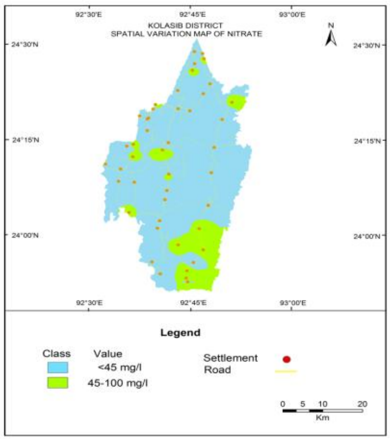

Figure 8: Spatial variation map of

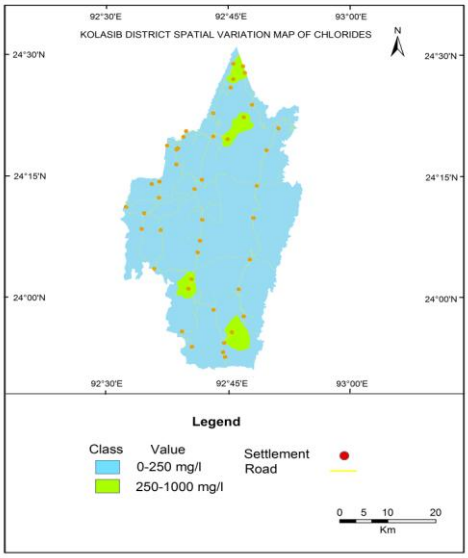

Figure 7: Spatial variation map of Chloride

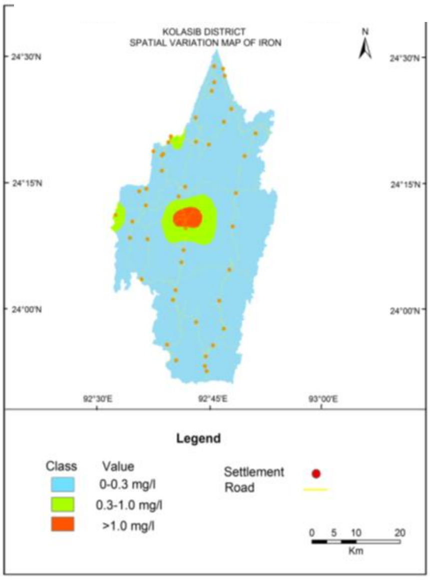

Figure 6: Spatial variation map of Iron

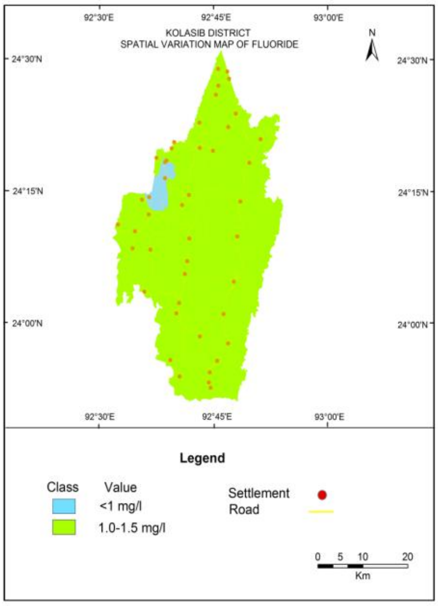

Figure 9: Spatial variation map of Fluoride

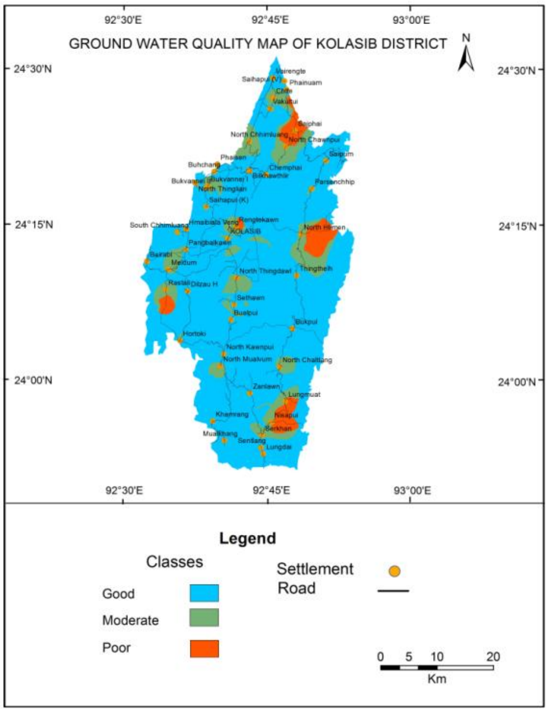

Figure 10: Ground water quality map of Kolasib district

The final map shows the broad idea about good, moderate and poor ground water quality zones of the study area. The ground water quality has been classified quantitatively as good (83.12%), moderate (12.24%) and poor (4.62%) depending on the final weight values assigned to polygons in the final layer. In terms of areal coverage, the good water quality zone covers 83.12%, moderate quality zone occupies 12.24% while the poor water quality zone takes up 4.62% of the total area

7. CONCLUSION

The Ground water quality map helps us to know the existing ground water condition of the study area. The calculation of ground water quality zones can be used for ground water exploration, development and management programme.

The main alarming chemical characteristic of the water quality is pH value at few paces. Fluoride content of the water needs to be monitored regularly as the map shows that the value is above desirable limits in almost the entire district.

It can be concluded that the quality of ground water need to be monitored on regular basis with the growing population and urbanization.

Geo-spatial technology has been proven to be useful tools for mapping ground water quality. The ground water quality map prepared through this study will be useful for planning future ground water developmental programme.

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