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Application of Geo-Spatial Technologies for Ground Water Quality Mapping of Serchhip District, Mizoram, India

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ABSTRACT

Water is one of the most important natural resources for our day to day life. Erratic and irregular availability of surface water leads to exploration and utilization of ground water for irrigation, industrial and domestic purposes. Therefore, the quality of ground water is equally important as its quantity. The present study utilizes Geographical Information System (GIS) technique to map the spatial variation of ground water quality in Serchhip district, Mizoram. Ground water samples were collected from 83 point sources randomly distributed within the area. The concentration of major water quality parameters namely pH, Electrical Conductivity (EC), Total Dissolved Solids, Total hardness, Iron, Chloride, Nitrate and Fluoride have been estimated for all the samples. The spatial variation maps of these ground water quality parameters were generated and utilize as thematic layers. Different classes within each thematic layer were assigned weightages in numerical rating from 1 to 3 as attribute values in GIS environment. Summation of attributes values of the thematic layers were utilize to generate the final ground water quality map. This final map shows the different classes of ground water quality within the district which can be utilize to provide a guideline for the suitability of ground water uses.
Keywords: GIS, Ground Water, Water Quality, Serchhip District

I. INTRODUCTION

Due to fast expansion of urban areas, population growth and common uses in domestic and agricultural sectors, the demand for water supply increases rapidly [1-3]. Ground water is one of the most vital natural resources and the largest available source of fresh water [4&5]. Therefore, monitoring and conserving ground water have become highly crucial for the present civilization [6 &7].

Geologically, Mizoram state comprises N-S trending ridges with high degree of slopes and narrow intervening synclinal valleys, faulting in many areas has produced steep fault scarps [8]. Therefore, majority of the rainwater available is lost as surface runoff even though the state received high amount of rainfall. Hence, the quality of water from springs, which are the major sources of water in the area, needs to be carefully analysed for generating database of water quality for the entire state [9].

Few efforts were made to study water quality within the state of Mizoram. These include Assessment of the water quality of Tlawng river in Aizawl, Mizoram [10], Seasonal variation in water quality of Tuirial River in vicinity of the hydel project in Mizoram, India [11], Physico-chemical characteristics of Tamdil in Mizoram, northeast India [12].

Advent of geospatial technologies like utilization of Geographical Information System (GIS) and Global Positioning System (GPS) allows fast and cost effective survey and management for natural resources Hence, this technique has wide-range applications including ground water quality mapping [13&14].

Therefore, many researchers have utilized these techniques successfully in ground water studies, both for prospecting and quality mapping [15-20]. 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 [21&22].

II. STUDY AREA

A. Location and extent

Serchhip district is located at the central part of Mizoram, in northeast India. With a total area of 1421.00 sq. km, it is lies between 92° 41′ 05" to 93° 11′ 00" E longitudes and 23° 00′ 23" to 23° 36′ 04" N latitudes. It falls under Survey of India topo sheet No. 84A/11, 84A/12, 84A/14, 84A/15, 84A/16 84E/2, 84E/3 and 84E/4. Location map of the study area is shown in Figure 1.

B. 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 southwest monsoon, with average annual rainfall of 2380.74 mm [23].

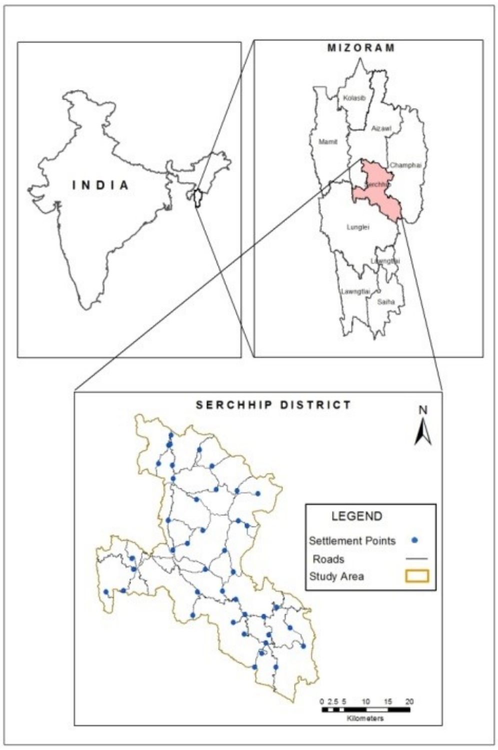


Figure 1. Location map of study area

C. Geology

The study area is underlain by rocks of Bhuban formation which belong to Surma Group of Tertiary age. This formation is sub-divided into Lower, Middle and Upper formations. Lower and Upper formations consist mainly of arenaceous rocks while Middle Bhuban comprises mainly argillaceous rock. The area is characterized mainly by ridgelines and intervening valleys and less prominent ridges. Structural hills are the main geomorphic units. Other geomorphic units like Valley Fill and Flood Plain are characterized by unconsolidated sediments [8].

III. MATERIALS

A. Data used

Base map of the study area was generated from Natural Resources Atlas of Mizoram prepared by Mizoram Remote Sensing Application Centre (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.

B. 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 verification.

IV. METHODOLOGY

The base map was geo-referenced and digitized by using QGIS software and exported to ArcInfo 10.1 software for spatial analysis. The water samples were collected from one hundred and eighty eight locations and were tested for their physico-chemical parameters. 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. This method is one of the most commonly used techniques for interpolation of scatter points and has been used extensively in ground water quality mapping [24-28].

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 limit, Permissible limit and Non-potable classes. All the spatial variation maps/layers were integrated and the final ground water quality map of Serchhip district was then generated.

V. DATA ANALYSIS

All the thematic 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 [13&19].

VI. 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 Aizawl district was prepared using GIS technique. Results and discussion for the major parameters are as follows:

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 divided into two classes. As per BIS guideline, almost the entire area falls within desirable limit (6.5-8.5). Few locations 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.

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 has the first two categories only. These are 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 3.

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

Iron: Iron concentration was divided 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 is divided into Good, and Moderate classes. The spatial variation map for chlorides is presented in Figure 5.

Chlorides: Concentration of Chlorides was categorised in to three ranges (0-250 mg/l, 250-1000 mg/l and >1000 mg/l) by BIS guideline. The entire study area falls within desirable limit and categorised under Good class. The spatial variation map for chlorides has been presented in Figure 6.

Nitrate: Nitrate was divided in to three ranges (<45 mg/l, 45-100 mg/l and >100 mg/l) by BIS guideline. The study area has Good class only. The spatial variation map for Nitrate is presented in Figure 7.

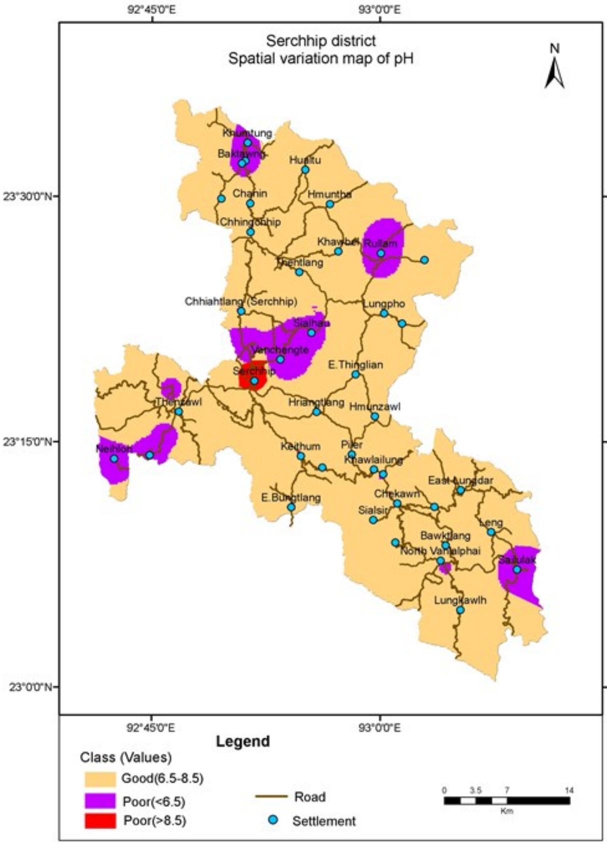
Fluoride: Fluoride concentration was divided in to three ranges (<1.0 mg/l, 1.0-1.5 mg/l and >1.5 mg/l) by BIS guideline. The study area has all the categories which are termed Poor, Good and Moderate classes. The spatial variation map for fluoride has been presented in Figure 8.

Calcium: Calcium concentration was categorised into <75 mg/l, 75-200 and >200 mg/l by BIS guideline. The entire study area falls within desirable limit and categories under Good class. The spatial variation map has been presented in Figure 8.

Manganese: The concentration of manganese is categorised in to three ranges (<0.1 mg/l, 0.1-0.3 and >0.3 mg/l) by BIS guideline. The present study area has all categories that are named as Good class, Moderate class and Poor class respectively. The spatial variation map for concentration of manganese was prepared based on these ranges and presented in Figure 10.

Alkalinity: It is a measure of the capacity of water to neutralize acids. The concentration of manganese is divided in to three ranges (<200mg/l, 200-600mg/l and >600mg/l) by BIS guideline. The present study area has only the first two categories that are termed

Good class and Moderate class respectively. The spatial variation map for Alkalinity was prepared based on these ranges and presented in Figure 11.



igure 2. Spatial variation map of pH

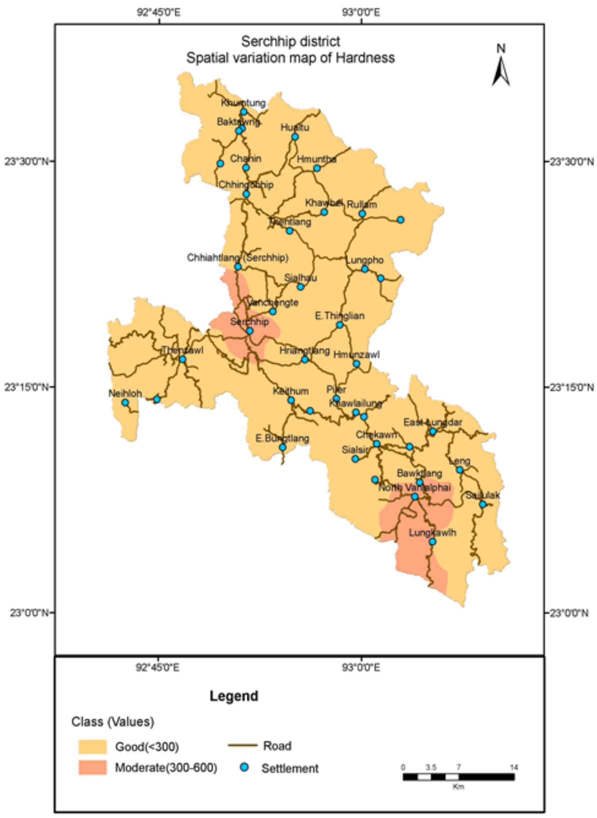


Figure 3: Spatial variation map of total hardness

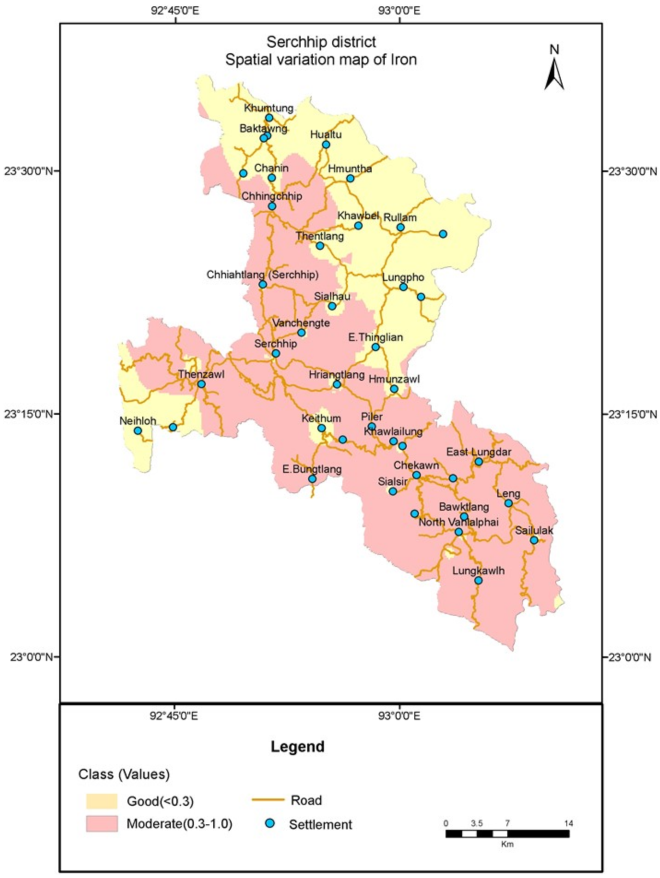


Figure 4: Spatial variation map of iron

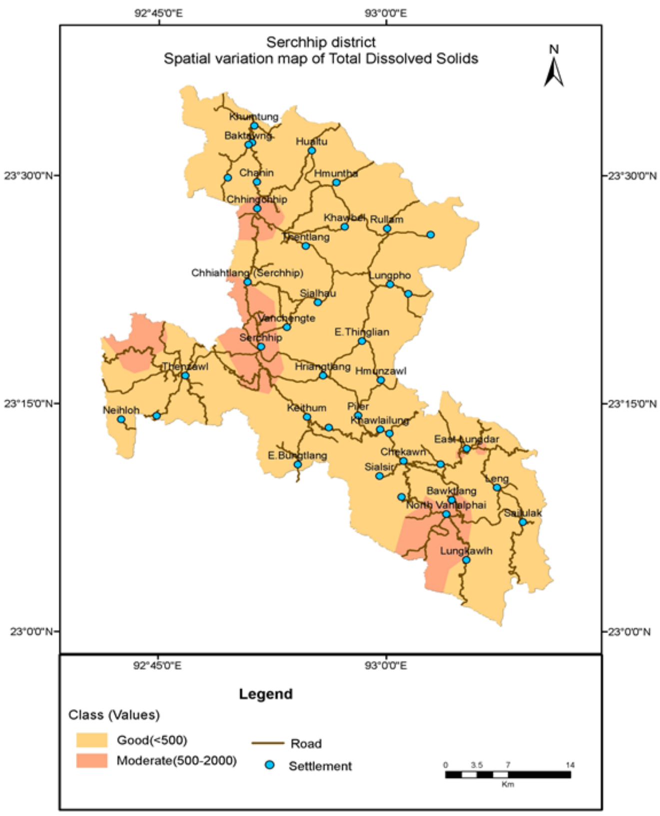


Figure 5: Spatial variation map of TDS

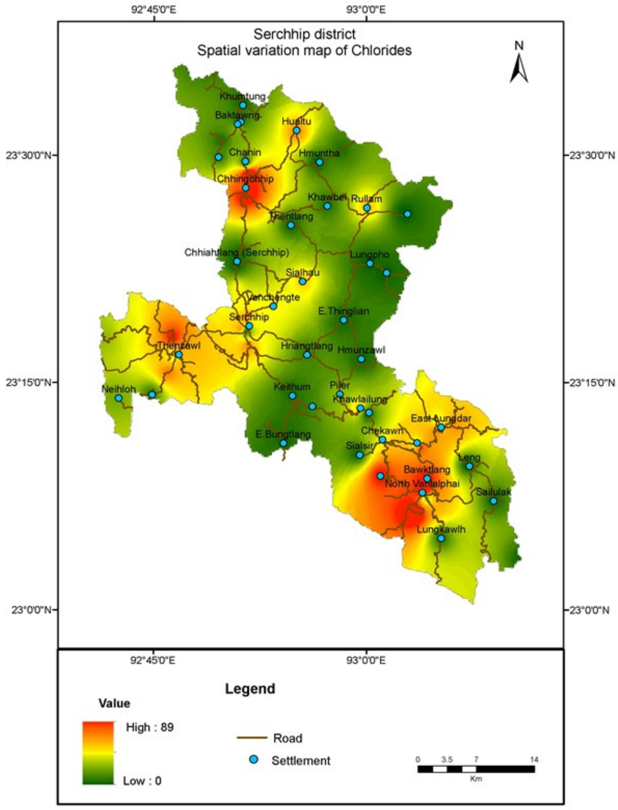


Figure 6: Spatial variation map of chlorides

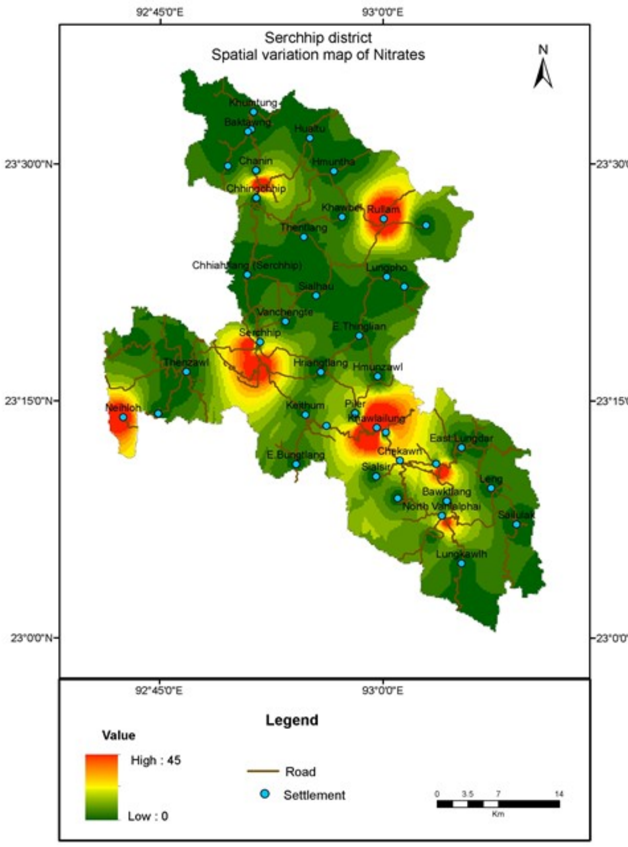


Figure 7: Spatial variation map of nitrates

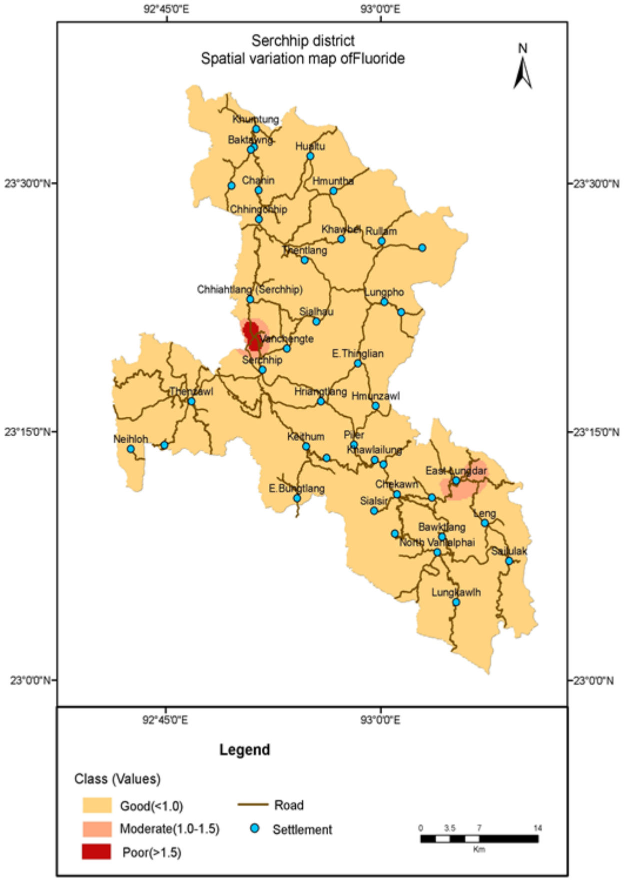


Figure 8: Spatial variation map of fluoride

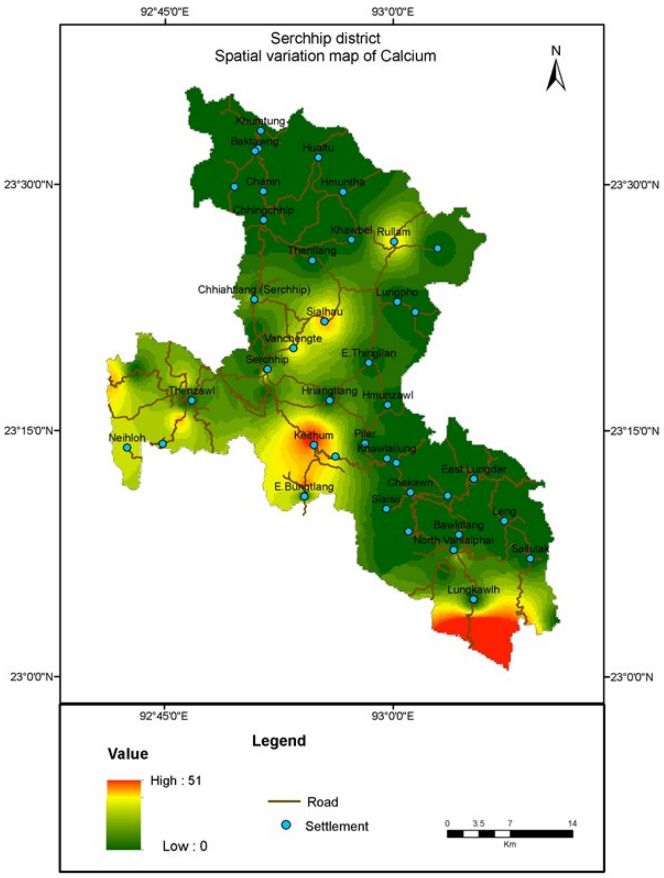


Figure 9: Spatial variation map of calcium

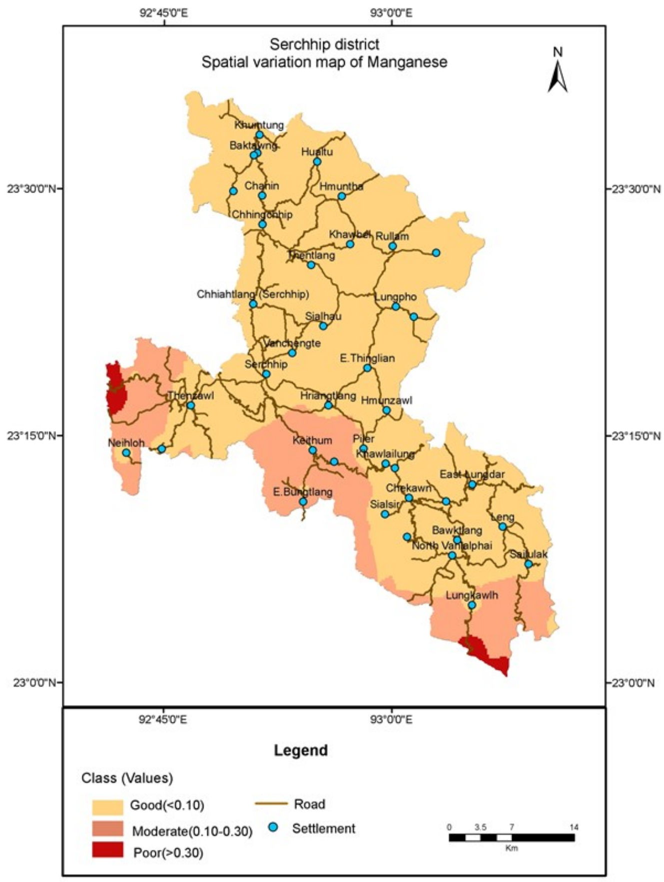


Figure 10: Spatial variation map of manganese

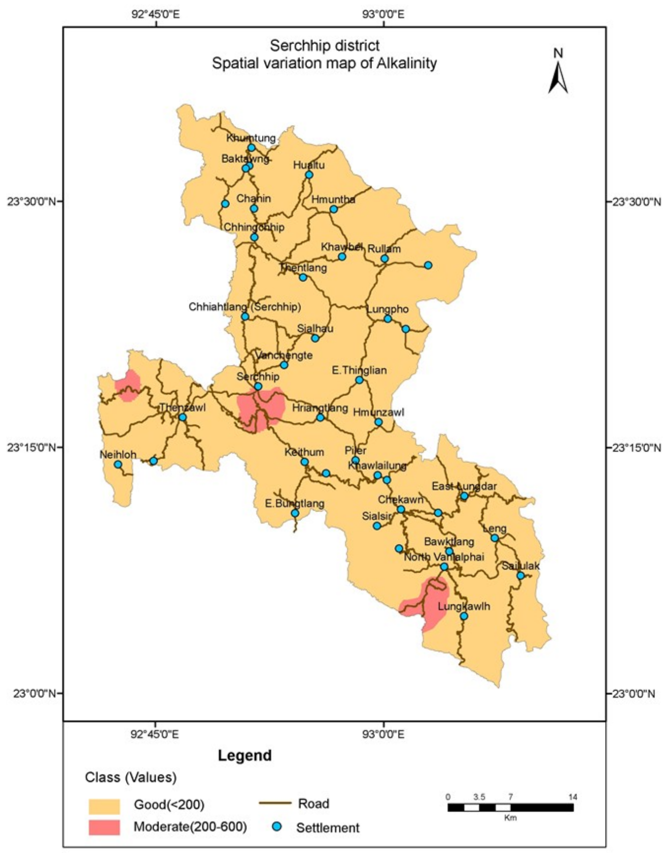


Figure 11: Spatial variation map of Alkalinity

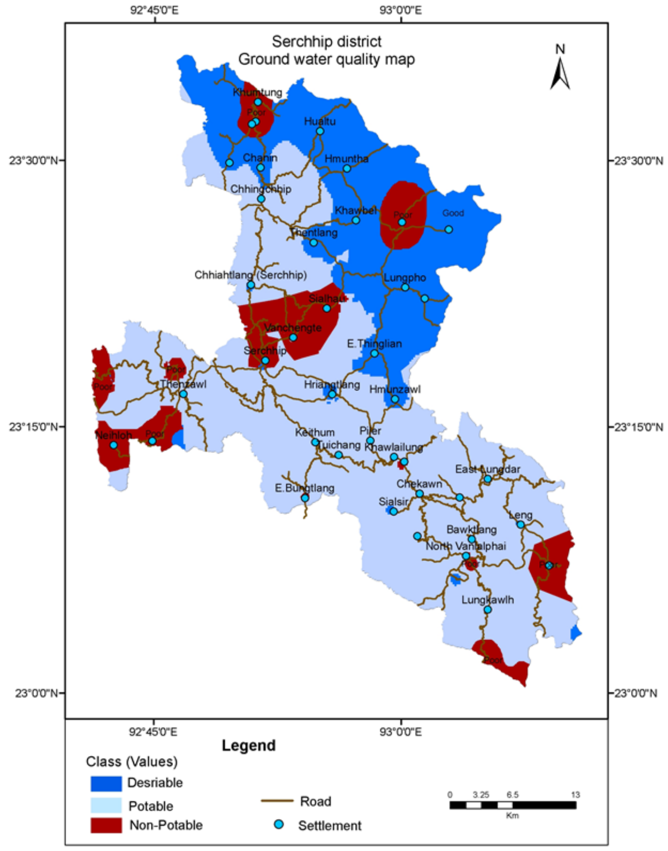


Figure 12 : Ground water quality map of study area

The final map shows broad idea about good, moderate and poor ground water quality zones in the study area. The ground water quality has been classified quantitatively as good (26.02%), moderate (61.25%) and poor (12.74%) depending on the final weight values assigned to polygons in the final layer. Spatial variation of ground water quality is shown in figure 12.

From the map, it is evident that the ground water quality in the northern part of the study area is in the good condition while the Central part of the study area is in the moderate condition. There are few pockets within the district where the ground water quality is in poor condition.

VII. CONCLUSION

The Ground water quality map helps us to comprehend the existing ground water condition of the study area. The present study indicated that groundwater qualities in some urban areas are poor as per BSI guidelines.

The integrated map shows the broad idea about good, moderate and poor ground water quality zones in the study area. The prediction of ground water quality zones can be used for ground water exploration, development and management programme. GIS technique 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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VIII. REFERENCES

[1]. Choudhary BS, Manoj Kumar, Roy AK & Ruhal DS (1996). Application of remote sensing and Geographic Iinformation Systems in ground water investigations in Sohna block, Gurgaon district, Haryana (India). International Archive of Photogrammetry and remote Sensing, XXXI (B6), p. 21.

[2]. Majumder A and Sivaramakrishnan L (2014). Ground water budgeting in alluvial Damodar fan delta: A study in semi-critical Pandua block of West Bengal, India. International Journal of Geology, Earth & Environmental Sciences, 4(3), p. 23-37.

[3]. Benibo Tekena, Abayomi Alaga, Henry U. Okeke, Ebikare I . Benibo and Kappo Ayorinde (2016) Assessment of Groundwater Recharge Potential in the Northern Parts of Auchi and Environs, Edo State, Nigeria, Using Geospatial Techniques. International Journal of Scientific Research in Computer Science, Engineering and Information Technology, 1(2), p. 57.

[4]. Sharma MP and Kujur A (2012). Application of Remote Sensing and GIS for ground water recharge zone in and around Gola Block, Ramgargh district, Jharkhand, India. International Journal of Scientific and Research Publications, 2(2), p. 1.

[5]. Neelakantan R and Yuvaraj S (2012). Evaluation of ground water using geospatial data – A case study from Salem taluk, Tamil Nadu, India. International Journal of Remote Sensing & Geoscience, 1(2), p. 7.

[6]. Kumar CP (2013). Assessment and strategies for development potential of deeper confined aquifers in India. Asian Academic Research Journal of Multidisciplinary 1(8), p. 1.

[7]. Kumar B and Kumar U (2011). Ground water recharge zonation mapping and modeling using Geomatics techniques. International Journal of Environmental Sciences 1 (7), p. 1671.

[8]. GSI (2011). Geology and Mineral resources Of Manipur,Mizoram, Nagaland and Tripura. Geological Survey of India, Miscellaneous Publication No. 30 Part IV, 1(2), p. 36-39.

[9]. CGWB (2007). Manual on artificial recharge of ground water. Central Ground Water Board, Ministry of Water Resources, p. 13.

[10]. Lalchhingpuii, Lalramnghinglova H and Mishra BP (2011). Assessment of the water quality of Tlawng river in Aizawl, Mizoram. Sci Vis 11 (2), p. 72-76.

[11]. Lalparmawii S and Mishra BP (2012). Seasonal variation in water quality of Tuirial River in vicinity of the hydel project in Mizoram, India. Sci Vis 12(4), p. 159-163.

[12]. Mishra BP and Lalzahawmi Chenkual (2014). Physico-chemical characteristics of Tamdil in Mizoram, northeast India. Sci Vis 14(4), p. 200-206.

[13]. Ganesh Babu O and Sashikkumar MC (2013). Application of GIS for ground water quality mapping of Tiruppur block, Tamil Nadu. International Journal of Remote Sensing & Geoscience, 2(5), p. 18-25.

[14]. Ramakrishna, Nagaraju D, Mohammad Suban Lone, Siddalingamurthy S and Sumithra S (2013). Ground water prospectus studies of Tattekere watershed, Mysore district, Karnataka, India using Remote Sensing and GIS. International Journal of Remote Sensing & Geoscience, 3(1), p. 6-10.

[15]. Gustafsson P (1993). High-resolution satellite data and GIS as a tool for assessment of ground water potential of semi-arid area. IXth Thematic Conference on Geologic Remote Sensing. 8-11 February, 1993, Pasadena, California, USA.

[16]. Saraf AK and Jain SK (1994). Integrated use of remote sensing and GIS methods for ground water exploration in parts of Lalitpur District, U.P. India: International Conference on Hydrology and Water Resources. 20-22 December, 1993 at New Delhi, India.

[17]. Krishnamurthy J and Srinivas G (1995). Role of geological and geomorphological factors in ground water exploration: A study using IRS-LISS-II data. International Journal of Remote Sensing, 16, p. 2595-2618.

[18]. Krishnamurthy J, Mani A, Jayaraman V and Manivel M (2000). Ground water resources development in hard rock terrain – an approach using remote sensing and GIS techniques. International Journal of Applied Earth Observation and Geoinformation, 2(34), p. 204-215.

[19]. Karthikeyan N, Saranya A, and Sashikkumar MC (2013). Spatial analysis of ground water quality for Virudhunagar district, Tamil Nadu using GIS. International Journal of Remote Sensing & Geoscience, 2(4), p. 23-30.

[20]. Soumen Dey (2014). Delineation of Ground Water Prospect Zones using Remote Sensing, GIS Techniques - A Case Study of Baghmundi development Block of Puruliya District,West Bengal. International Journal of Geology, Earth & Environmental Sciences, 4(2), 62-72.

[21]. Saraf AK and Choudhury PR (1998). Integrated remote sensing and GIS for ground water exploration and identification of artificial recharge site. International Journal of Remote Sensing, 19(10), p.825–1841.

[22]. Sharma MP and Kujur A (2012). Application of Remote Sensing and GIS for ground water recharge zone in and around Gola block, Ramgarh district, Jharkhand, India. International Journal of Scientifc and Research Publictions, 2(2), p. 1-6.

[23]. Lalzarliana C (2016). Rainfall records of Mizoram. Directorate of Agriculture, Government of Mizoram, p. 1.

[24]. Ambica, A., Sartiha,B. and Anbarasan, R. (2017). Groundwater quality assessment using water quality index and GIS, Maduravoyal, Chennai, India. International Journal of Civil Engineering and Technology, 8(8) 1375–1381.

[25]. Khadri, S.F.R and Pande, C.B. (2015). Ground Water Quality Mapping FOR Mahesh River Basin in Akola and Buldhana District of (MS) India Using Interpolation Methods. International Journal on Recent and Innovation Trends in Computing and Communication. 3(2), 113 – 117.

[26]. Kumar, A., Goel, A., Goyal, A. and Hooda, R.S.(2015). Groundwater quality study in Farrukhnagar block, Gurgaon district, Haryana using GIS. Journal of Indian Water Resources Society, 35(1), 22-32.

[27]. Mahalingam, B., Ramu, Bhauso, M.D. and Jayashree, P.(2014).Assessment of Groundwater Quality Using GIS Techniques: A Case Study of Mysore City. International Journal of Engineering and Innovative Technology. 3(8), 117-122.

[28]. Shyamala, G. and Jeyanthi, J. (2017). Integrated Weighted Overlay Model Using Inverse Distance Weightage for Assessing Groundwater Quality. Journal of Environmental Science and Management, 20(1), 26-32.