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Study of Ground Water Pollution around an Industry Using GIS

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Abstract: **Water is a basic element of social and economic infrastructure and is essential for healthy society and sustainable development. Due to rapid increase in density of population, fast urbanization, industrialization and agricultural use, the demand of water is increasing day by day. As a result, surface water and ground water level is decreasing. Pollution and increased demand have made good quality water scarcer and expensive. Groundwater is the favourite alternative and is facing threats due to anthropogenic activities, which has lead to deterioration in ground water quality. The possibility of ground water contamination is due to the mixing up of toxic chemicals, fertilizers, waste disposed from industrial sites etc. Hence monitoring of ground water quality has become indispensable. GIS not only facilitates data capture and processing but also serve as powerful computational tools that facilitate multimap integrations. In this project ground water quality analysis was carried out for Chavara Taluk in Kollam District. It was reported that groundwater and surface water around the study area was affected due to effluents from the industry. Water samples were collected from all around the taluk, and the strategically analysed results will be presented in a GIS based water quality mapping suggesting remedial measures for the study area.**

Keywords: **GIS, Ground water, Mapping, Water Quality.**

I. INTRODUCTION

Water is the basic requirements of all life on Earth. Surface water and Groundwater are the major sources of water. Groundwater has become a necessary resource over the past decades due to the increase in its usage for drinking, water supply, irrigation an industrial uses etc. The increase in population and urbanization necessitates growth in the agricultural and industrial sectors which demand for more fresh water. The dependability on ground water has reached an all time high in recent decades due to reasons such as unreliable supplies from surface water due to vagaries of monsoon, increase in demand for domestic, agricultural and industrial purposes. This has resulted in over exploitation all over the country and in certain places it has reached critical levels like drying up of aquifers.

II. STUDY AREA

Fig 1: study area

Water is a precious and most commonly used resource. Water is one of the most abundant chemical substances on earth, as it covers two third of the earth surface. Of the total amount of global water, only 2.4% is distributed on the main land, of which only a small portion can be utilized as fresh water. The available fresh water to man is hardly 0.3-0.5% of the total water available on the earth and therefore, its judicious use is imperative. Contamination of drinking water by human and industrial activities is a serious concern now-a-day. Indiscriminate use of groundwater deteriorates the quality and quantity of water. The quality was assessed in terms of physio-chemical parameters and compared with Bureau of Indian standards. The study area (Fig 1) chosen is nearby KERALA MINERALS AND METALS LTD CHAVARA, KOLLAM. Kerala Minerals and Metals Ltd is an integrated Titanium Dioxide manufacturing public sector undertaking at Kollam, Kerala, India. Its operations comprise mining, mineral separation, and pigment-production plants. It was reported that ground water and surface water around the study area was affected due to the effluents from the industry. Analysis is carried out to check the impacts on water quality which may affect the health of people over there.

III. METHODOLOGY

3.1 WATER QUALITY ANALYSIS

In the present study, water samples were collected from twenty wells in the study area. Analysis of water samples were carried out as per standard methods of water analysis. Alkalinity, chloride and hardness were determined in samples by volumetric titration. Iron and sulphate were determined by colorimetry. According to the Indian Standards and Specifications for Drinking water (IS: 10500) and World Health Organizations (WHO) drinking water limits, above mentioned parameter results are checked. For the analysis water samples were collected in pre cleaned polythene bottles.Water quality standards are depicted in table 1

Table 1: Water Quality Standards (IS: 10500-2004)

Sl.no	Parameter	Permissible Limit
1	pH	6.5
2	Chloride (mg/L)	250
3	Alkalinity(mg/L)	200
4	Hardness(mg/L)	300
5	Sulphate(mg/L)	200
6	Iron (mg/L)	0.3

3.2 GEOGRAPHIC INFORMATION SYSTEM

GIS is a power tool for collecting, storing, transforming the spatial information and arriving decision from the real world for particular set of purpose in real time, where the stored information are geo-references (or) geo- coded. In this project the water quality is analyzed using GIS and mapped. A geographic information system may be defined as an integrated system designed to collect, manage and manipulate information in a spatial context. The geographic component, the various technologies involved and the approach to information modelling set GIS apart from other types of information systems. A geographic information system provides an abstract model of the real world, stored and maintained in a computerized system of files and database in such a way as to facilitate recording, management, analysis and reporting of information. It can be more broadly stated that a geographic information system consists of a set of software, hardware, processes and organization that integrates the value of spatial data.

The four functions of GIS are:

1. Data acquisition and pre-processing
2. Data management, storage and retrieval
3. Manipulation and analysis
4. Product generation

GIS has the power of organizing effective Social Information System (SIS) towards decision- making or resource management. The spatial information system comprises synthesis of spatial formation and non- spatial data within GIS framework. The GIS aims and works at bringing together, the diverse information, which are gathered from various different sources. Hence, this is also known as integrated analysis. Similar studies were conducted using GIS for Coonoor Taluk in Nilgiri District as per the journal "Study of Ground water Quality with GIS Application for Coonoor Taluk in Nlgiri District".

Quantum GIS (QGIS) is one of the widely used open Geographic Information System across the world. It was developed in the year 2002 with an objective to make the GIS software viable for anyone which is traditionally expensive. QGIS aim to an easy use of GIS, providing common functions and features that are available in the most proprietary GIS software. QGIS supports a number of GIS vector and raster data formats.

IV. RESULTS AND DISCUSSION

In table 2 chemical analysis and stability parameters are tabulated.

Table 2: chemical analysis and statistical parameters of groundwater samples collected from the study area

SAMPLE NO	DISTANCE FROM SOURCE	ALKALINITY (mg/L)	HARDNESS (mg/L)	CHLORIDE (mg/L)	IRON (mg/L)	pH	SULPHATE (mg/L)
1	500 m, E	30	438	84.97	BDL	8	85.82
2	750 m, E	10	106	119.96	BDL	8	85.42
3	500 m, N	10	94	70.478	.205	8	134
4	200 m, N	10	50	21	BDL	8	93
5	50 m, W	8	556	282.91	BDL	8	38.8
6	70 m, W	12	500	216.93	5.862	2	206
7	200 m, W	18	128	119	0.221	8	346
8	500 m, W	10	40	41	0.23	8	68.3
9	400 m, W	34	325	42.98	0.25	8	112.8
10	500 m, W	42	320	47.48	0.329	8	86.8
11	600 m, W	60	334	50.48	0.898	8.5	84.6
12	750 m, W	38	326	31	0.578	8	78.8
13	750 m, W	8	74	40.98	0.339	7	35.8
14	289 m, SE	214	212	35.5	BDL	7.5	85.3
15	159 m, SE	168	236	42.6	0.35	7	86.7
16	319 m, NW	16	72	60.4	0.03	5	89
17	53 m, NE	160	236	49.7	0.06	7	114.4
18	98 m, NW	54	400	159	0.05	7	143
19	885 m, SW	246	350	213	0.010	7	133
20	887 m,W	210	250	32	0.03	7	35.8

4.1 ALKALINITY

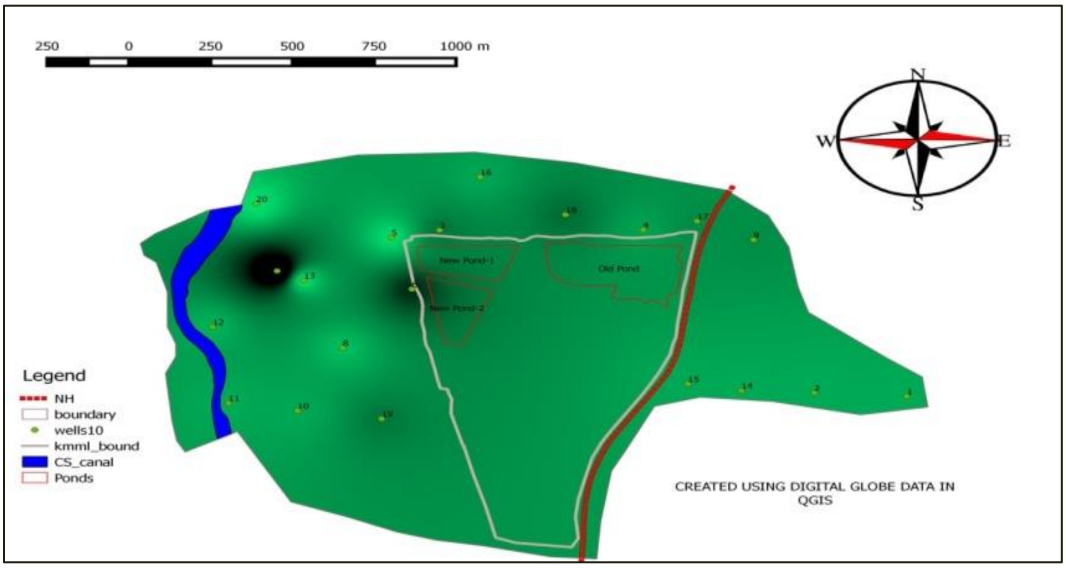

Fig. 2: Spatial variation map of Alkalinity.

Alkalinity is the measure of capacity of the water to neutralize a strong acid. Permissible limit of alkalinity is 200 mg/L as per WHO standards. In most of the wells the alkalinity is less than 200 mg/L. High alkalinity in water bodies leads to sour taste and salinity. Spatial variation map for alkalinity has been obtained by QGIS and presented in Fig. 2.

4.2 CHLORIDE

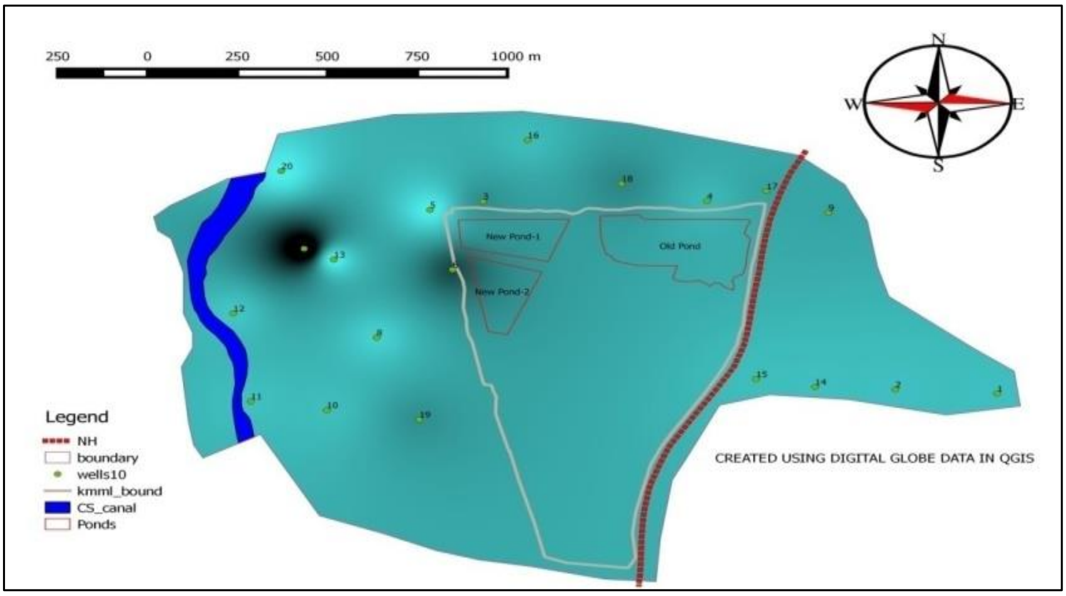

Fig. 3: Spatial variation map of Chloride

Chloride occurs naturally in all types of water. Chloride in natural water may results from agricultural activities, industries and chloride rich rocks. The results obtained shows that all the sampling stations are well within the permissible limit of 250 mg/l as per WHO guidelines for drinking water quality. The spatial variation map for chlorides has been obtained by QGIS and presented in fig. 3.

4.3 HARDNESS

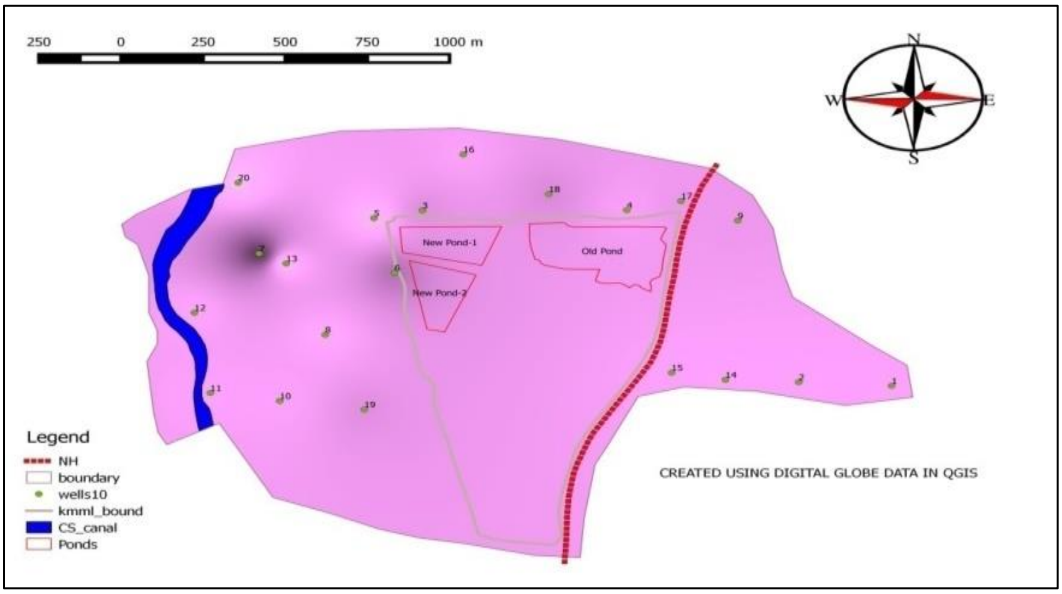

Fig. 4: Spatial variation map of Hardness

Total hardness is considered as the major character of drinking water. Hardness is defined as the concentration of calcium and magnesium ions. Permissible limit of hardness is 300 mg/L as per WHO. The samples collected near pond have high hardness. Hardness prevents soap from lathering and increases the time for boiling the water. Spatial variation map for total hardness has been obtained QGIS and presented in Fig. 4.

4.4 IRON

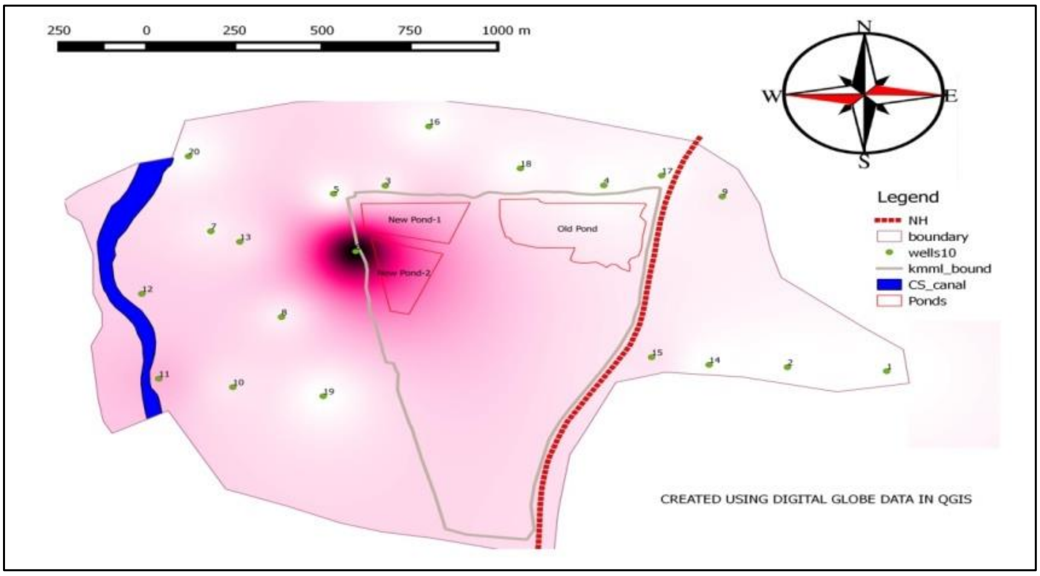

Fig. 5: Spatial variation map of Iron

As per WHO the permissible limit of iron is 0.3 mg/L. But the samples analyzed near the pond have high Fe content. The irony smell of the water is noted in most of the places. The shortage of iron causes a disease called "anaemia and prolonged consumption of drinking water with high concentration of iron may lead to liver disease called as haermosiderosis. The spatial variation map iron was prepared by QGIS and presented in fig. 5.

4.5 pH

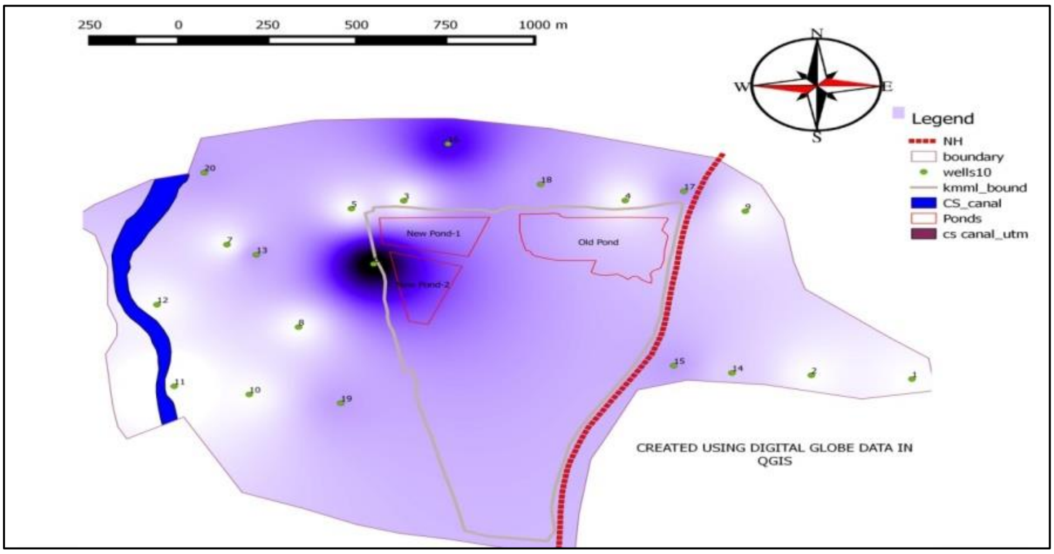

Fig. 6: Spatial variation map of pH

pH is one of the important parameters of water and determines the acidic and alkaline nature of water. The pH value of water ranged between 2 and 8.5. The pH of the samples was not within the prescribed standards for drinking water. The spatial variation map for pH was prepared by QGIS and presented in fig. 6. A low value of pH was recorded in the well no.6 which is nearest to the pond.

4.6 SULPHATE

Sulphate is found in small quantities in ground water. Sulphate may come into groundwater by industrial or anthropogenic additions in the form of Sulphate fertilizers. The values of sulphate from the study area are all within the permissible limit of 250 mg/L as per WHO for drinking water purpose. The spatial variation map for pH was prepared by QGIS and presented in fig. 7. A high value of sulphate was recorded in the well no.6 which is nearest to the pond.

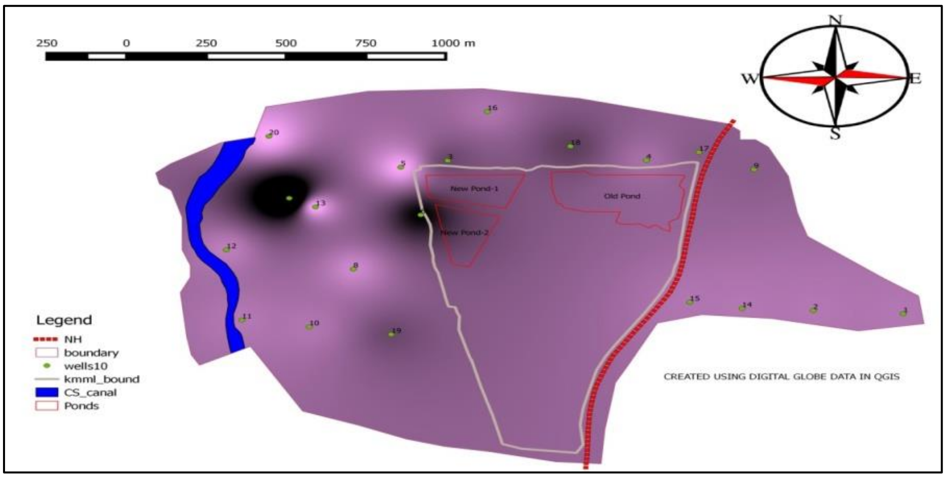

Fig. 7: Spatial variation map of Sulphate

V. DATA INTEGRATION USING GIS

The spatial variation map of major groundwater quality parameters such as pH, Total hardness, Sulphates, alkalinity, Iron and Chlorides were integrated and the final integrated groundwater quality map of the area nearby KMML, Chavara was prepared using GIS. The integrated map shows the broad idea about good, moderate and poor groundwater quality zones in the study area. This map provides more realistic status of the quality of available groundwater in the study area and can be used for any groundwater development programme.

VI. CONCLUSION

Water is the prime requirement for the existence of life and groundwater is a precious resource of finite extent. Over the years, increasing population, urbanization and expansion in agriculture has lead in the scientific exploitation of ground water creating a water stress condition. It was reported that the groundwater quality in Chavara Taluk has been reduced due to pollution. Hence monitoring the groundwater quality is indispensable. The study was carried out in a small area. The results of water samples were analyzed. The affected areas are marked using GIS technique. The area of impact shows wider effect adjacent to the new concrete pond indicating likely leak through the concrete pores, further spread can be prevented by designing impermeable clay lining around the pond. GIS technologies can provide appropriate platform for convergent analysis of large volume of multi-disciplinary data and decision making for ground water studies can be effectively done. This study demonstrates that the use of GIS could provide useful information for groundwater quality assessment. The present study provides a guideline for solving water quality problem in Chavara Taluk.

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