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An Assessment of Groundwater Quality (TDS, EC and pH) of Selected Boreholes in Bal'ad District, Middle Shabelle, Somalia: A GIS Based Study

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Abstract: ***Groundwater is almost globally important for human being consumption as well as for the support of habitat and for maintaining the quality of base flow to rivers. GIS helps in better understanding of spatial patterns and relations. The present study represents the spatial variability of ground water quality mapping for Bal'ad district, Lower Shebelle, Somalia. The thematic map of groundwater quality parameters, such as pH, TDS and EC has been tested for all the water samples in order to understand the hydro geochemistry of the groundwater. The results obtained for water quality parameter were compared with standard parameter values suggested by the WHO for drinking water suitability. The spatial contour map of these groundwater quality parameters was derived in Arc Map10.8 software using an Inverse Distance Weighted (IDW) spatial interpolation technique. The study facilitates to understand the existing groundwater quality conditions and to develop appropriate management practices to protect the groundwater sources. The results indicated variations in the groundwater quality parameters, with recommendations for further investigations and management practices.***

Keywords: Groundwater Quality, TDS, EC, pH, GIS, Balad District, Somalia

1. Introduction

On earth, the water is essential for life. The pattern of human settlement throughout history has often been determined by its availability because of its importance (Reda, 2015).

The availability of a water supply adequate in terms of both quantity and quality is essential to human existence. The demand for water has increased over the years and this has led to water scarcity in many parts of the world. The situation is aggravated by the problem of water pollution or contamination. India is heading towards a freshwater crisis mainly due to improper management of water resources and environmental degradation. This leads to lack of access to safe potable water supply to millions of people. This freshwater crisis is already evident in many parts of India, varying in scale and intensity depending mainly on the time of the year.

According to WHO organization, about 80% of all the diseases in human beings are water borne. Further the groundwater, and the pollutants it may carry move with such a low velocity that it may take considerable time for the contaminants to move away from the source of pollution and also degradation in the groundwater quality may remain undetected for years. Once the groundwater is contaminated, its quality cannot be restored by arresting the pollutants from the source.

The purpose of the present study is to estimate the groundwater quality in the Bal ad district and thematically represent it using Geographic Information System (GIS) for understanding of the present scenario at a glance. GIS can be used as a powerful tool for developing solutions for water resources problems for assessing water quality, determining water availability, preventing flooding, understanding the natural environment, and managing water resources on a local or regional scale. [3, 4].

The following table shows list of physical Parameter with corresponding unit, WHO standard (Si):

Table 1: List of physical Parameter with corresponding unit, WHO standard (Si)

Parameters	Units	Standard (SI)
PH	-	6.5 - 9.2
Total Dissolved Solids	mg/L	300 - 1200
Electrical Conductivity	μS/cm	300 - 2000

There are currently no properly defined water quality standards for Somalia. However, the salinity standards for groundwater use are very flexible as it varies from one individual to another.

2. Study Area

Bal'ad district is one of the districts of Middle Shabelle region of Somalia. It is located about 36 kilometers northeast of the capital city of Mogadishu. The district is an area of 4, 400 square kilometers (1, 700 sq. miles) with an estimated population of 642, 000 and 82 villages.

The district passes one of the Somalia's permanent rivers (Shabelle) which passes through the city of Bal - ad, nevertheless neighbors the Indian Ocean and has a long coast of about 70 km. The district is famous for agriculture, livestock and marine resources.

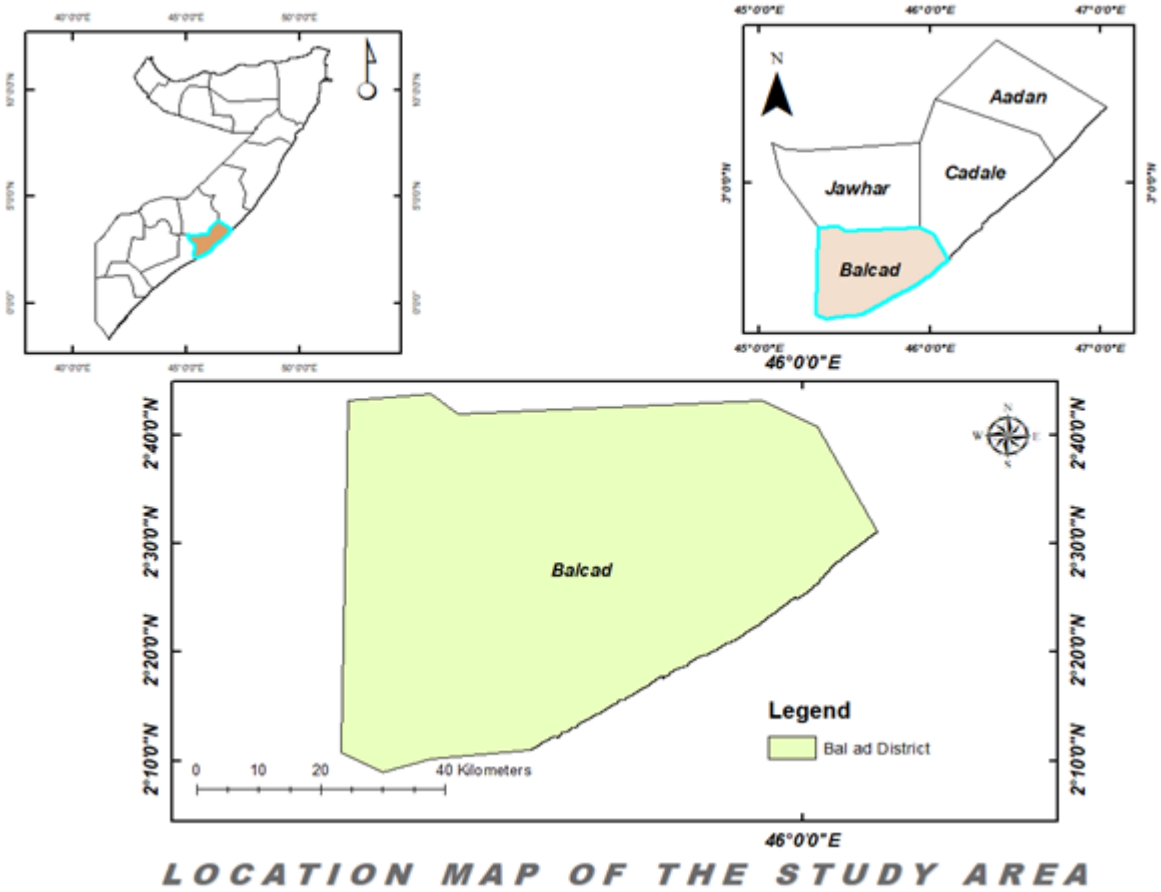

Figure 1: Location map of the study area

3. Methods and Materials

Study Design:

The study's design is a qualitative and quantitative descriptive study that involves diagnosing or testing water samples gathered from 15 wells in Bal'ad district of Lower Shabelle region. The sample was examined using digital tools for water quality chemical testing. TDS and EC Meter Digital Water Tester and Portable PH meter were among the most commonly used instruments.

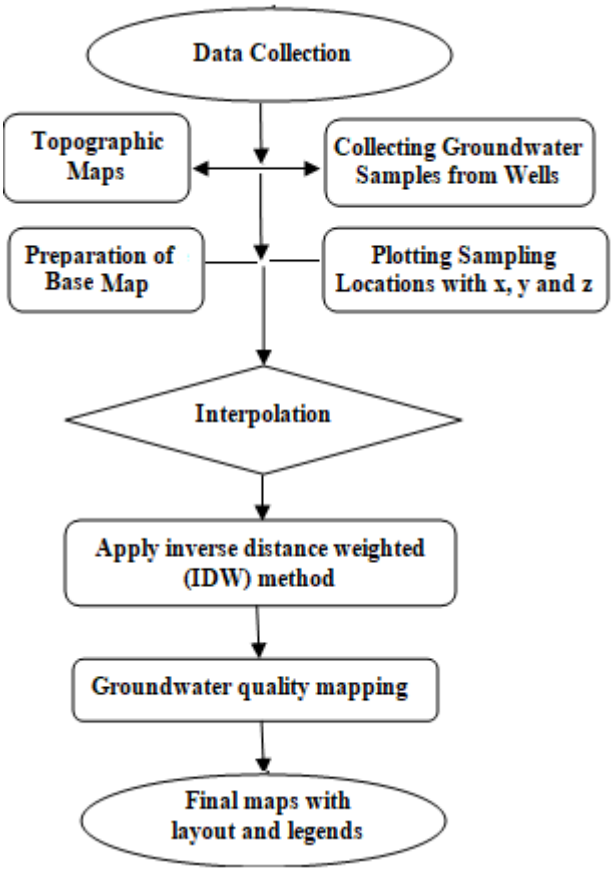

Figure 2: Methodology

Sample collection

During the months of October to December 2022, 15 samples from Bal'ad district of Lower Shabelle region were gathered and tested. So, using pre - washed and sterilized 500 ML plastic containers. All of the samples were registered, labeled, and physical tests of water quality were performed quickly. The instruments were portable measurements that provided immediate results, and samples were chosen using non - randomized methods, which resulted in collecting samples for various wells in the district. The following are the 15 sample collected from Bal'ad district of Lower Shabelle region, Somalia, having distinct wells that provide residents with a continuous water delivery system.

Table 2: Source and location of samples

S_NO	*Well Name*	*Longtitude*	*Latitude*	*TDS*	*EC*	*PH*
1	CEELKA CALI MUDEY	45.41	2.38305556	1049	2098	7
2	EELKA XAADOLE	45.40833333	2.385	806	1612	6.7
3	EELKA ISBTALKA	45.38805556	2.35888889	1508	3016	7.6
4	CEELKA SOLARKA	45.38166667	2.35333333	891	1782	6.6
5	CEELKA ISKUULKA	45.38722222	2.35583333	1501	3002	7.2
6	CEELKA WAKALADA	45.38972222	2.35722222	1621	3242	6.8
7	CEELKA JIMCAALE	45.39916667	2.35138889	1171	2342	7.4
8	CEELKA SHIINE	45.40833333	2.34277778	1281	2562	7
9	CEELKA CABAAS	45.39277778	2.33888889	819	1638	6.9
10	CEELKA GARASDELE	45.39222222	2.31861111	899	1798	7
11	CEELKA CARAFAAG	45.395	2.27888889	721	1442	6.8
12	CEELKA HARERI CAADLE	45.39611111	2.24916667	1060	2120	6.5
13	CEELKA HAREERI MADOBE	45.39611111	2.23305556	689	1378	7.5
14	GARAS BINTOW	45.39722222	2.21722222	1053	2106	6.9
15	CEELKA SUUDI	45.39833333	2.18916667	1263	2526	7.2

Data analysis

The thematic map of groundwater quality parameters, such as pH, TDS, and EC has been tested for all the water samples in order to understand the hydro geochemistry of the groundwater. The results obtained for water quality parameter were compared with standard parameter values suggested by the WHO for drinking water suitability. The spatial contour map of these groundwater quality parameters was derived in Arc Map10.5 software using an Inverse Distance Weighted (IDW) spatial interpolation technique.

4. Result and Discussion

The spatial and the attribute database generated are integrated for the generation of spatial variation maps of major water quality parameters pH, TDS, AND EC. Groundwater quality maps have been showed below for each parameter. In this study groundwater quality data were prepared using Arc Map 10.8 software. This integration of the groundwater quality maps helps us to know the existing groundwater condition in the area.

PH

PH is a significant parameter in evaluating acidity or alkalinity of water. The computation of pH is to determine the intensity or alkalinity and measures the concentration of hydrogen ions. The study area pH value ranges from 6.5 to 7.6 with an intermediate value of 7. As per World Health Organization the study area pH value map shows the major part of the study area is good to moderate.

Total Dissolved Solids (TDS)

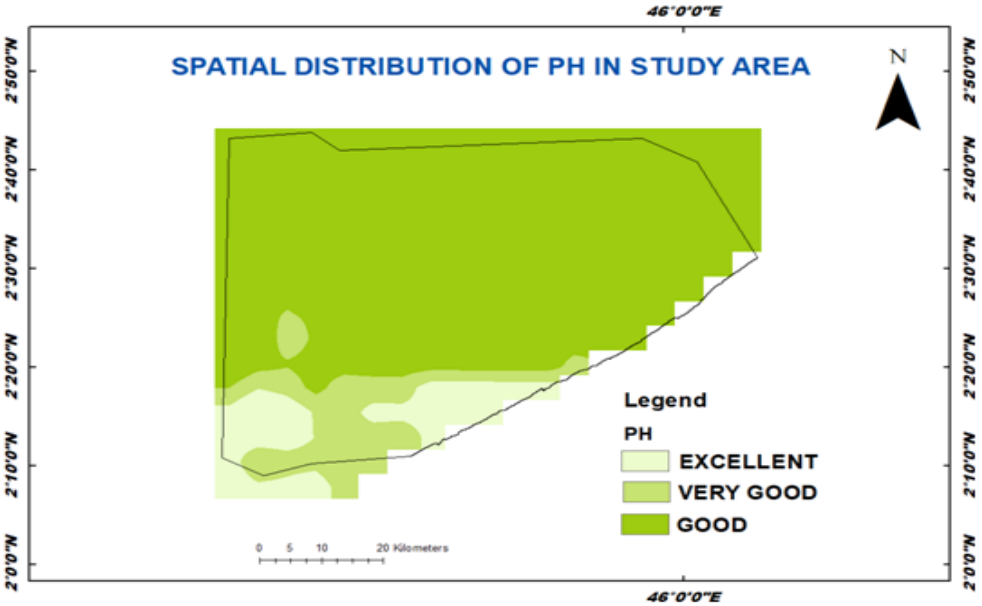

Figure 3: Spatial Distribution of PH in study area

The Second parameter researchers used was Total dissolved solids which abbreviated (TDS) is the word used to define all dissolved matters of inorganic minerals and some organic chemicals present in water is known as Total dissolved solid.

The analysis of TDS for study area shows the minimum 689 mg/l and the maximum of 1621 mg/l. Further, the understanding of the spatial distribution of interpolation was carried out. The value of TDS divided into 3 major categories namely fair (600 - 900mg/l), poor (900 - 1200mg/l) and unacceptable (above 1200mg/l) as shown in fig.4. The spatial distribution map shows the major part of the study area is fair to unacceptable.

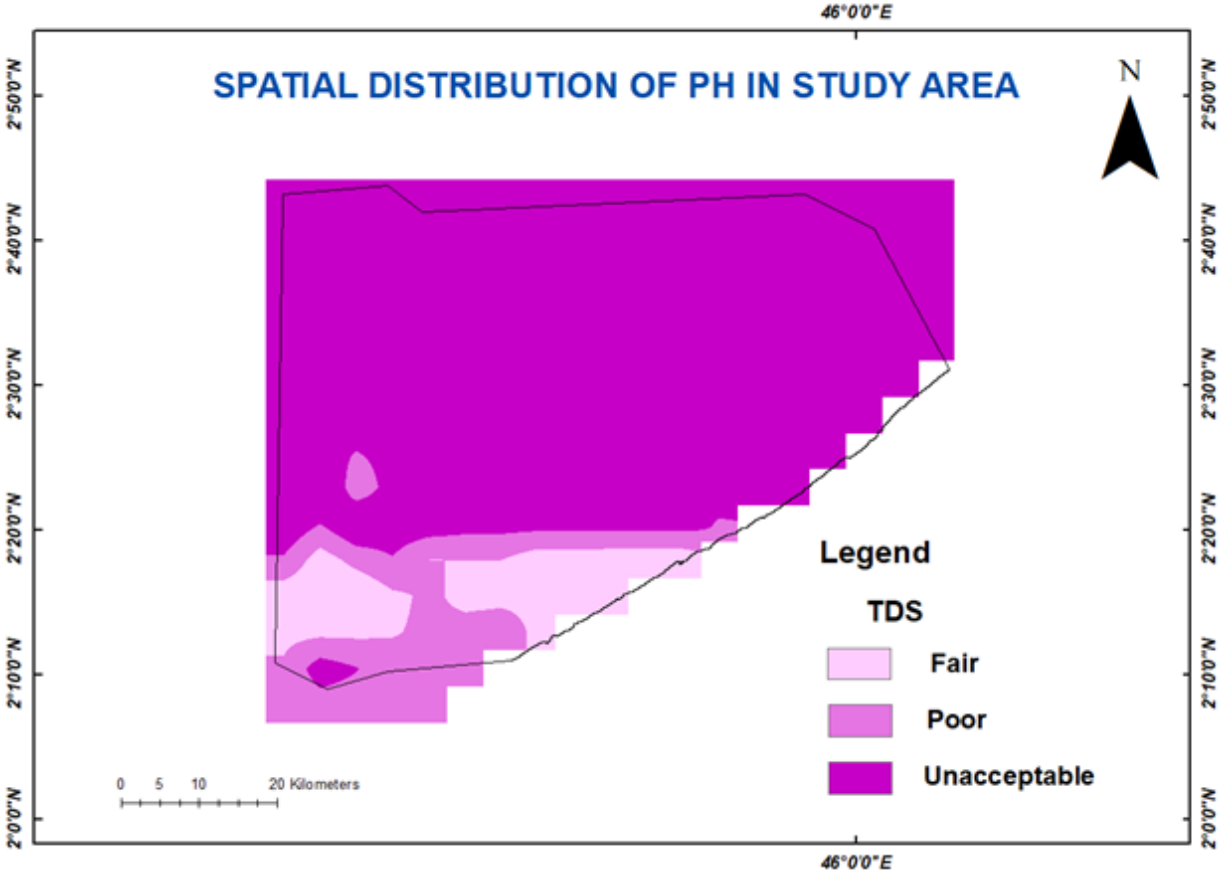

Figure 4: Spatial Distribution of TDS in study area

Electrical conductivity (EC)

Electrical Conductivity is the ability to conduct electricity. Electrical conductivity refers to a medium's capacity to convey an electric current, in this instance water. The electric current is carried through water by the presence of dissolved minerals such as calcium, chloride, and magnesium. The capacity of a substance to transport an electrical current is measured by its electrical conductivity (EC).

The analysis of EC for study area shows the minimum 1378 µs/cm and the maximum of 3242 µs/cm. Further, the understanding of the spatial distribution of interpolation was carried out. The value of divided into 3 major categories namely good (1378 µs/cm), moderate (1378 - 2000 µs/cm l) and poor (2000 µs/cm) as shown in fig.5. The spatial distribution map shows the major part of the study area is good to poor.

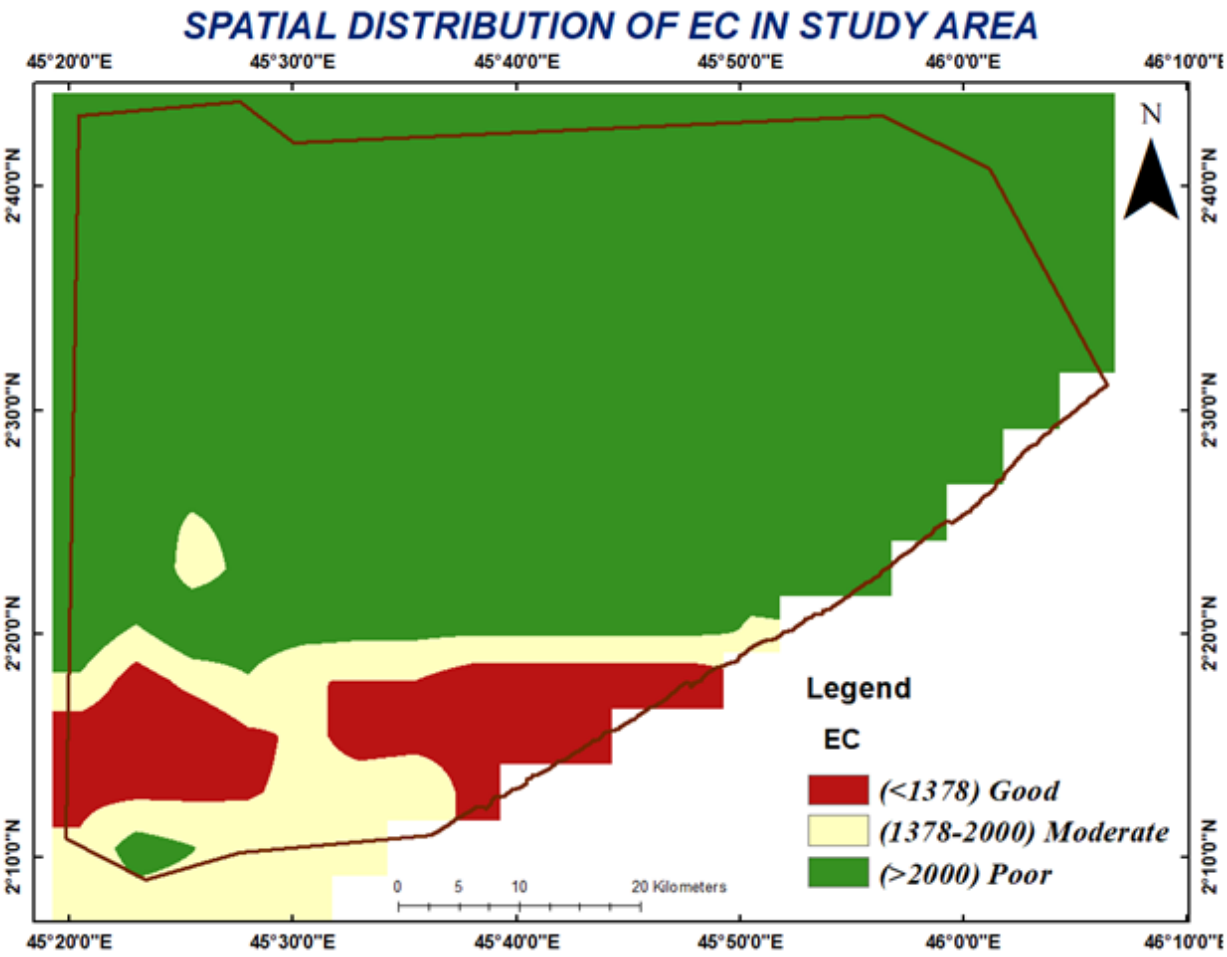

Figure 5: Spatial distribution of EC in study area

5. Conclusions

The study found variations in the groundwater quality parameters of TDS, EC, and pH in the selected boreholes in the Balad district. The highest variation was observed in some domestic wells. The pH value of the study area was found to be good to moderate as per WHO standards. The study recommends further investigations into other potential water contaminants and the implementation of guidelines for the use of domestic wells for drinking water.

6. Recommendations

- The present study recommended investigate other potential water contaminations such as chemicals, microbial and radiological materials for a longer period of time, in order to assess the domestic wells water for drinking.
- Guideline for use the domestic wells for drinking water and educate the people in the different region about harmful on health.

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