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GIS Based Groundwater Quality Assessment and Pollution Index of Bankura District, West Bengal, India

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Objectives

The reliance on groundwater has seen a significant surge in recent times. The worldwide problem of groundwater quality deterioration has arisen due to the acceleration of urbanisation and the subsequent increase in waste discharge. According to the World Health Organisation (WHO), about 80% of health risks are attributed to the intake of contaminated drinking water (Adimalla 2019). The main objectives of this study are:

(a) to figure out the level of pollution and its spatial distribution,

(b) to understand the spatial data structure of the chemical properties.

Study Area

Bankura is situated in the western region of the State of West Bengal. The region referred to as "Rarh" in Bengal is encompassed within the Medinapure Division of the State. The District of Bankura is geographically defined by its boundaries, which lie between 22°38’ N to 23°38’ N latitude and 86°36’ E to 87°47’ E longitude. The River Demodar traverses the northern edge of the district. The neighboring districts include Purba Barddhaman and Paschim Barddhaman to the north, Purulia to the west, and Paschim Medinipur and Jhargram to the south (Figure 1).

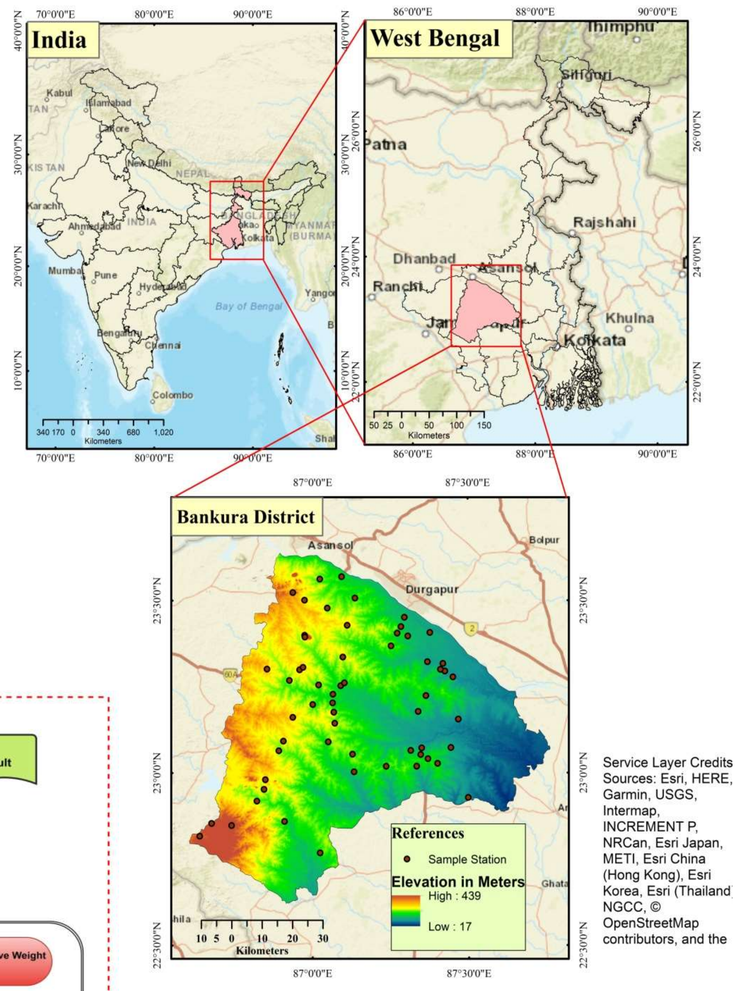

Figure 1. Location Map of the Study Area

Methodology

A total of 59 groundwater samples were collected from the Ground Water Yearbook of West Bengal & Andaman & Nicobar Islands (2021-2022).

Twelve elements, including pH, Total Hardness (TH), Calcium (Ca2+), Magnesium (Mg2+), Sodium (Na+), Potassium (K+), Bicarbonate (HCO_3^-), Chloride (Cl^-), Nitrate (NO_3^-), Sulphate (SO_4 2 $^-$), Total Dissolved Solids (TDS), and Fluoride (F^-), were considered for the study. Figure 3, depicts the correlation among the chemical parameters .

Subba Rao first introduced the pollution index (PI) at the beginning of 2012, it has been extensively utilised to evaluate variations in groundwater quality brought on by different geochemical variables. The estimation of Pollution Index (PI) is determined by employing five fold algorithms. Entire methodology has been represented in the Figure 2.

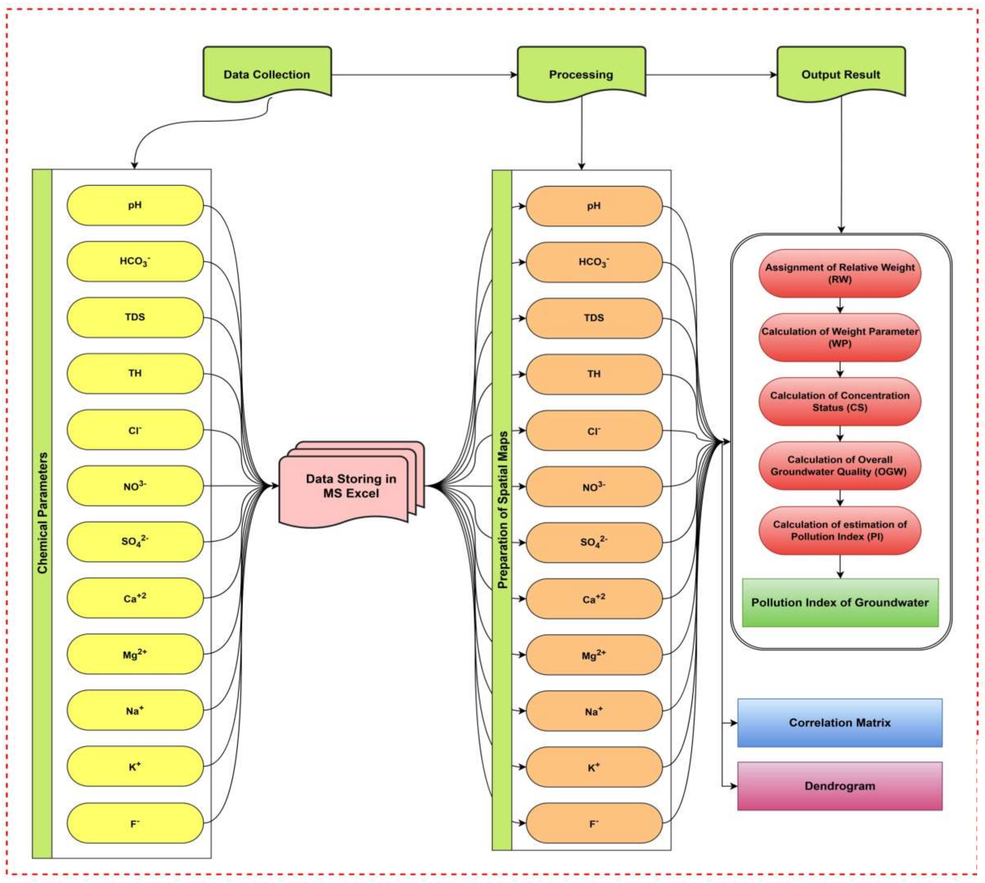

Figure 2. Flowchart of the Methodology

Figure 3. Correlation Matrix

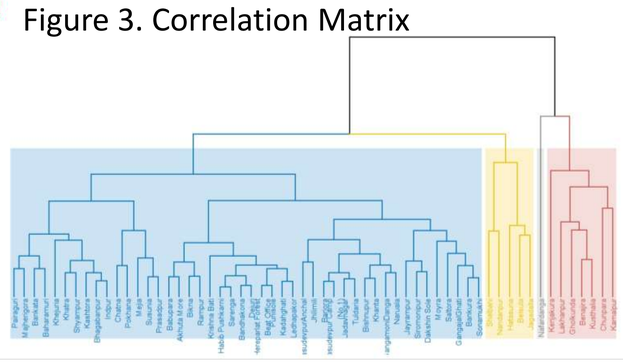

Figure 6. Dendrogram of Chemical Parameters

Results

Concentration of twelve chemical parameters have been mapped using IDW (Inverse Distance Weighted) tool in ArcGIS (Figure 4). Table 1 represents that more than 30% area of the district crossed the standard limit for TDS, pH, TH, Ca^{2+}, Mg^{2+}, K^+. However, Figure 5 shows insignificant pollution has been noticed in the district.

Figure 6, depicts the similar type of water quality. Here, four distinct type of water quality have been noticed.

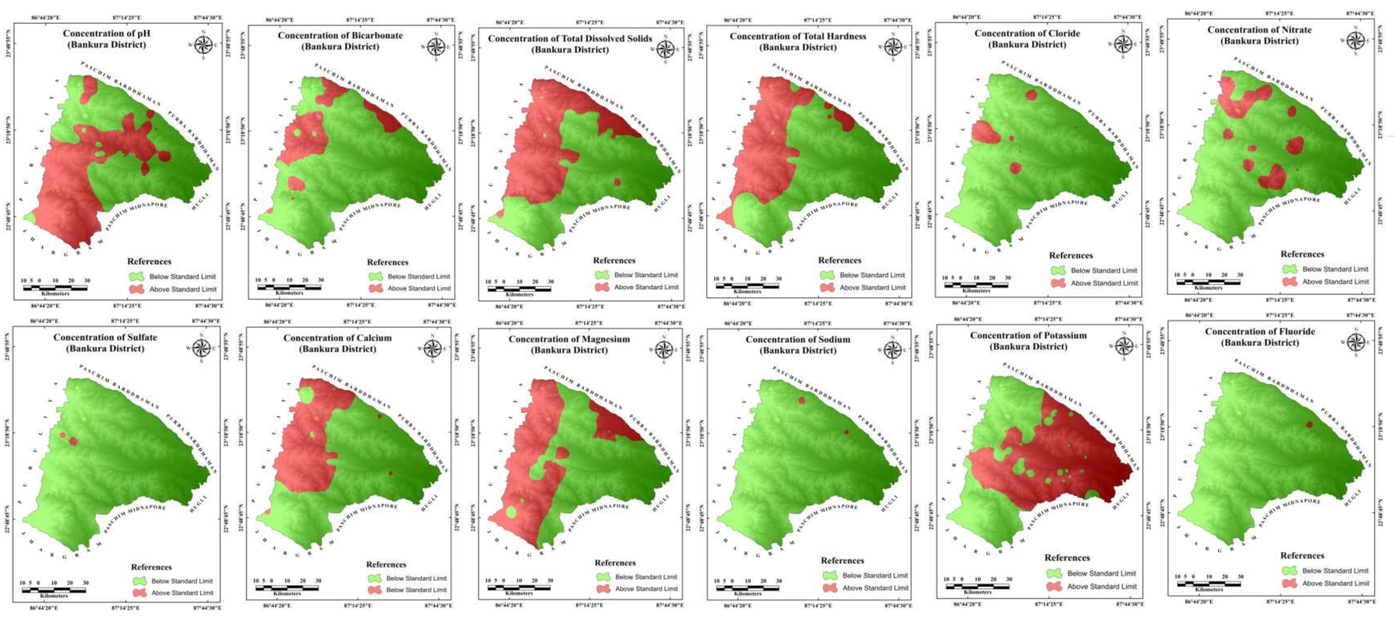

Figure 4. Spatial Concentration of Chemical Parameters

Table 1. Areal Coverage of Chemical Parameters

Chemical Parameters	TDS	pH	TH	Ca2+	Mg2+	Na+	K+	HCO3-	Cl-	SO42-	NO3-	F-
Below Standard Limit	57.85	54.32	62.17	69.43	55.88	99.69	42.97	83.18	95.73	99.51	87.43	99.81
Above Standard Limit	42.15	45.68	37.83	30.57	44.12	0.31	57.03	16.82	4.27	0.49	12.57	0.19

Figure 5. Pollution Index of Bankura District

Table 2. Areal Coverage of Pollution Index

Range of PI	Classification	Percent of Area
<1.0	Insignificant pollution	94.88
1.0 to 1.5	Low pollution	5.01
1.5 to 2.0	Moderate pollution	0.11
2.0 to 2.5	High pollution	0.00
>2.5	Very high pollution	0.00

Conclusions

In this work, both the Pollution Index and geographical maps of quality metrics have been used, with an analysis of the relationships between these factors. However, till now condition of the water quality of the district is under control, but some of the chemical parameters like, TDS, pH, TH, Ca^{2+}, Mg^{2+}, K^+ have crossed their limit in significant parts of the district. This research has potential benefits for the local community, as it could be used as an important asset for informing the polluted areas of the district. Subject matter may be made more accessible to those without specialised knowledge by the use of visual aids and maps.