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ASSESSMENT OF GROUND WATER QUALITY USING THE WATER QUALITY INDEX AND CLUSTER ANALYSIS OF VIDISHA AND RAISEN DISTRICTS, MADHYA PRADESH.

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ABSTRACT:
Non-directional anthropogenic activities are to blame for the degradation of subsurface water quality, which is a very worrying issue. This research paper's main goal is to evaluate the subsurface water quality of 25 samples taken in post-monsoon from Madhya Pradesh's Vidisha and Raisen districts. This study recommends using multivariate statistical methods to analyses all 25 water samples, such as cluster analysis and calculating the water quality index (WQI). Standard analytical laboratory techniques were used to compare the quality of post-monsoon samples to pre-monsoon samples for drinking purposes. Parameters like pH, Dissolved Oxygen, Biochemical Oxygen Demand, Total Hardness, Permanent Hardness, Temporary Hardness, Chloride content, and alkalinity were measured. Results obtained were utilized to calculate WQI and CA.

The water quality index assigns numbers to the good, terrible, and medium water quality levels. The majority of the examined samples were of average quality. At several sample points, the impact of anthropogenic activities was determined using cluster analysis. When we wish to condense and simplify multivariate data, this strategy is highly helpful. Twenty-five sampling stations were divided into two groups using a cluster analysis, with one cluster having a smaller population than the other. In order to distinguish between huge groups of observations and a smaller group of observations with similar or close qualities, cluster analysis is used.

Introduction:

Due to the lack of surface water, we use underground water to meet our water needs. Indians use subsurface water for both industrial and agricultural purposes[1]. Yet, the amount of subsurface water is also declining daily, with unrestricted withdrawal being the main cause. When underground water moves slowly and self-purification occurs at a slower rate, it is more hazardous[2]. So, it is crucial to maintain the water's quality and test it for both rural and urban activities, but most importantly for drinking purposes [3,4]. Testing every aspect of water is laborious, and some techniques are also pricey[5].

Statistics can be used to study the temporal and spatial fluctuation of water in addition to analytical methods. In this study, we used the Water Quality Index and Cluster Analysis to evaluate the data we collected from 25 underground water samples using various analytical techniques. The Water Quality Index (WQI) is the most useful tool for assessing the quality of the water [6]. As it is well known, only huge sets of data with little loss are used to use multivariate statistical techniques [7,8,9]. The most often utilized method in research investigations is cluster analysis. It is appropriate when a group of observed or manifest variables exhibits systematic interconnectedness, and the researcher is interested in learning what more underlying or hidden factor underlies this connection [10,11]. The goal of cluster analysis is to break a big collection of items or observations into smaller groups where the observations are similar or nearby while the observations in other groups are dissimilar or distant. Clusters are these more compact groups. As a result, the clusters that are produced have both high internal and high exterior heterogeneity. The interdependence technique of cluster analysis does not distinguish between dependent and independent variables[12,13].

Materials and Methods:

Study Area- East of the Betwa River is where Vidisha is located in Madhya Pradesh, a state in central India[14]. The Vidisha district is located between Latitudes 23 21' and 24 22' North and Longitude 77 15'30" and 78 18' East. It is located in the eastern portion of the fertile Malwa region. It is surrounded

by the districts of Raisen in the south, Sagar in the east, and Guna in the north[15,16]. Its total population is estimated to be 1,55,959 as of the 2011 Census, with an average literacy rate of 86.88% [17]. The Vidisha district has a generally hot climate, with long summer days. The maximum wet season occurs during the southwest monsoon when rainfall is on average 1135.5 mm. There is a lot of water available for groundwater recharges during the southwest monsoon season. In Vidisha, groundwater provides around 75% of the irrigation needs.

The Raisen district is located between latitudes 22 47' and 23 33' north and the longitude 77 21' and 78 49' east. Sehore district is located in the west, Hoshangabad and Sehore districts in the south, Sagar district in the east and south-east, Narsimhapur district in the south-east. 8,395 square kilometres make up its surface area [18].

TABLE-1 WATER SAMPLING SITES OF VIDISHA AND RAISEN DISTRICT

S.No.	Sampling Site	Assigned Symbol
1	Tilak Chowk Vidisha	S1
2	Sindhi Colony Vidisha	S2
3	Pedi School Vidisha	S3
4	Kila Ander Vidisha	S4
5	Baksariya Vidisha	S5
6	Near Rangai Vidisha	S6
7	Gulab Vatika Vidisha	S7
8	Royal City Vidisha	S8
9	Gyaraspur Village	S9
10	Gandhi Chowk GanjBasoda	S10
11	Gulab Ganj Village	S11
12	Banskuli Vidisha	S12
13	Civil Lines Vidisha	S13
14	Lal Bagh GanjBasoda	S14
15	Subhash Nagar Salamatpur	S15
16	Salamatpur Railway Station	S16
17	Dhakna Village	S17
18	Raisen Chouraha	S18
19	Sanchi Green Hotel	S19
20	Sanchi Station	S20
21	Near Anjali Lodge Sanchi	S21
22	Salamatpur Thana	S22
23	Aamkheda Village	S23
24	Mandideep	S24
25	Avantika Colony Raisen	S25

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Analysis Methods:

Water quality index-

This approach offers a single number that can be used to determine the grade. Water quality is assessed using a 100-point scale[19,20]. This method's primary goal is to replicate typical outcomes from complex data. The standard formula for calculating WQI is

$$WQI = Antilog\left[\sum_{n=1}^{n} W \log qn\right]$$

In the provided formula, q stands for quality rating, K for proportionality, n for integer, and W for weightage factor[21].

Cluster Analysis-

The most typical type of clustering used to explain relationships between different samples is agglomerative clustering[22]. Clusters discovered using a dendogram or a tree diagram[23]. A dendogram is a visual representation of different groupings and their surrounding areas. In this study, we used the Ward's approach and the Unweighted Pair Group Method with Arithmetic Averages as two clustering methods (UPGMA).

Results and Discussion:

The majority of the samples are of medium quality, according to the WQI Calculator's calculation of the water quality index. Quite a few samples are poor quality.

TABLE-2 AMALGAMATION STEPS

Step	Number of clusters	Similarity level	Distance level	Clusters joined		New cluster	Number of obs. in new cluster
1	11	99.8276	0.00345	4	10	4	2
2	10	93.2545	0.13491	3	5	3	2
3	9	77.6668	0.44666	6	7	6	2
4	8	73.4298	0.53140	3	9	3	3
5	7	65.6600	0.68680	4	8	4	3
6	6	63.8230	0.72354	3	4	3	6
7	5	61.3569	0.77286	11	12	11	2
8	4	56.2888	0.87422	6	11	6	4
9	3	49.0102	1.01980	3	6	3	10
10	2	47.2657	1.05469	2	3	2	11
11	1	43.2652	1.13470	1	2	1	12

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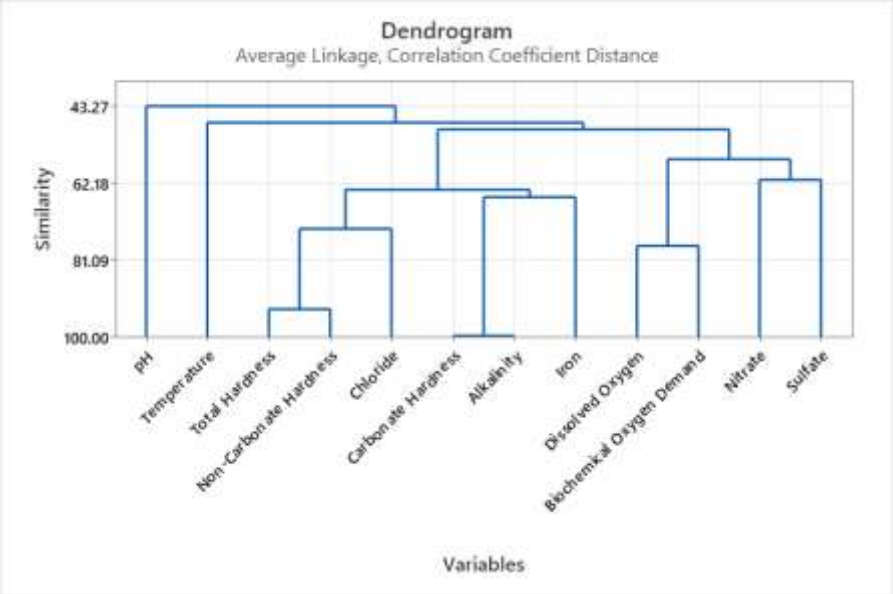
FIG.- 1 CLUSTER ANALYSIS REPRESENTATION WITH THE HELP OF DENDOGRAMS



Conclusion:

The present study demonstrated the importance of multivariate statistical analysis in groundwater studies. Basic statistics showed that most of the parameters were found to exceed the specified desirable limits while few parameters exceeded the permissible limits as well. Water quality index results showed that most of the samples are of medium quality. With the help of above plots and graph we can easily distinct between spatial and temporal variations of all the collected samples. Interesting results are obtained by cluster analysis where one cluster is so small and another is very large. Same variations of clusters are obtained by UPGMA and Ward's method.

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