Hydro-Chemical Facies Analysis and Determination of Dominant Water-Type in District Zhob, Balochistan, Pakistan

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Abstract

Safe drinking water is a fundamental entity to people and other living things. This study investigates the - chemical facies and determination of dominant water-type along with their suitability for drinking purposes. Aqua-Chem software was used for analysis, interpretation, and hydro-chemical facies assessment. In the piper plot prepared by Aqua-Chem, groundwater was divided into six facies and it showed that most of the samples accumulated in the place where required to identify the quality of water. It was found that the dominant water type in district Zhob is the Calcium Magnesium chloride (Ca+Mg+Cl-) type and the second dominant water type was calcium bicarbonate (CaHCO3) type. It was revealed that Sodium Bicarbonate (Na HCO_3) type of water was not present in district Zhob. This study was meant to carry out the detailed hydrochemical facies analysis of drinking water, to help the public and administrations.

Keywords: Zhob Balochistan, Facies Analysis, Aqua-Chem, Water Type

1. Introduction

The chemical impurities present in water are mostly because of the ingredients present in the rock or the soil media that surrounds the water. **House and Newsome (1989)** expressed that the water quality record permits to measured by lessening a vast amount of information on a scope of physio-substance factors to be a solitary number in a basic and target way (**Liou et al., 2004**). The purpose of the calculation of water quality index was to show and simplify the complex water quality data into easily understandable information which can be and used for the betterment of human being and ecosystem. The chemical properties of groundwater, in turn, depends on several features, such as the degree of chemical weathering of the various rock types, contributions from sources other than water-rock contact, overall geology, and quality of recharge water. Such factors and their relations result in a composite groundwater quality (**Al-Khashman and Jaradat 2014**).

With the help of stratigraphy and hydrogeological data, the saturation index of different minerals in water is determined. Variations in saturation state are valuable to differentiate different phases of hydrochemical evolution and help identify which geochemical reactions are important in controlling water chemistry. **Shahab et al. (2018)** investigated Hydrogeological facies and spatial distribution was determined with the help of Aqua-Chem 2010 software. This software was used to develop hydrological facies through a piper plot to reveal the dominant water type and to determine the appropriateness of groundwater for drinking and irrigation.

Up to now very little is known about the water quality of the study area. Ghoraba and Khan (2013) conducted a study about hydrochemistry and groundwater assessment in Balochistan. Five major water types were found in Balochistan which were classified as Mixed CaCl and CaMgCl type however their percentahe was not presented.

In this study, groundwater samples were collected with their spatial location from different schools in district Zhob Balochistan. These samples were tested in the laboratory and all concerned chemical parameters were identified in groundwater. AquaChem software was used for hydro-chemical facies and determination of dominant water-type in the study area. This study will will helpful towards a new horizon of water quality assessment in the adjacent region and will also help the government for short-term and long-term planning.

1.1. Study Area

District Zhob is located, 1408 meter above sea level in northwest Balochistan. Zhob is located between latitude 68° 0′ 0″ to 70o 0′ 0″ and longitudes 30° 0′ 0″ to 32o 0′ 0″ it has its geographical area is 12400 square km with a population of 310544 (Pakistan Statistical Bureau, 2017). It has a semi-arid climate and a low annual rainfall of 11.219 inches. The Map of the study area can be seen in Figure 1. District of Zhob naturally has mineral concessions for Chromite, Coal, and Granite, however, the presence of Glass sand, Copper, Feldspar, Calcite, Fluorite, Ocher, Phosphate Rocks, Limestone, Soapstone, Manganese, and Laterite, are also reported.

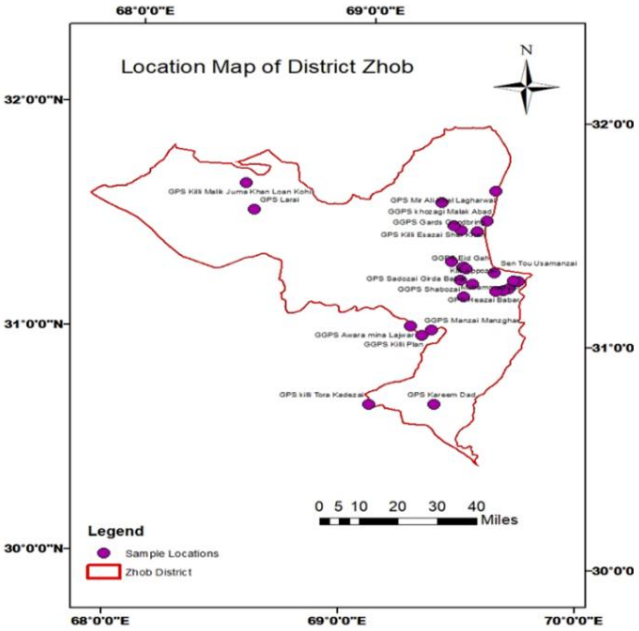

Figure 1. Study Area Map

2. Material and Methods

2.1. Data Collection

For the evaluation of the concentration of cations and anions of different metals in drinking water of the Public Sector Schools of district Zhob Balochistan, a total of 30 samples were collected and preserved in the laboratory by Pakistan Council of Research in Water Resources (PCRWR). Then the sample bottles were sealed out and labeled then taken into the laboratory for the estimation of selective anions and cations by following international standards. The concentration of different elements that are essential for water quality parameterization was tested and data was gathered for further processing.

2.2. Statistical Analysis

The values of the chemical parameters needed to be statistically analyzed. For statistical analysis, the data of the laboratory was used. In the statistical analysis, it was found that, the average values of water quality parameters (Na, K, Ca, Mg, SO_4, HCO_3, NO_3, CO_3, Cl, pH, TDS, and hardness). The standard deviation, variance, skewness, and kurtosis were found to see the diversity of different chemical parameters.

2.3 Hydro-Chemical Facies

Aqua-Chem is very suitable software for analysis and interpretation of water quality, for hydro-chemical facies and Aqua-chem software was used. Piper plot was made which is capable to show a graphical diagram for the classification of water types. In the piper plot prepared for District Zhob through Aqua-Chem, groundwater was divided into six facies based on chemical analysis. The diamond shape in the piper plot showed that most of the samples accumulated in the place where required to identify the quality of water. Results and Discussion

3. Results and discussion

The hydrochemical facies were estimated using Aqua-chem software. The results of the detailed hydro-chemical facies are shown in Figure 2.

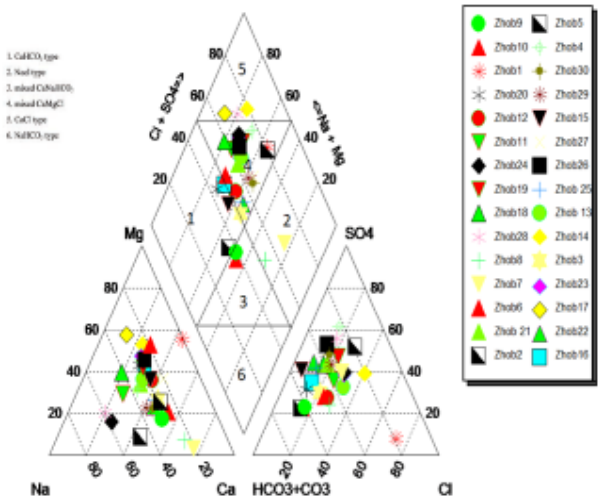

Figure 4: Hydrochemical Facies of District Zhob Balochistan

In the piper plot prepared for District, Zhob completed through Aqua-Chem; groundwater was divided into 6 facies built on the hydrochemical analysis. From the diamond shape in the piper plot reflects that the 19 samples that are 63% of the samples lie in the Calcium Magnesium chloride (Ca+Mg+Cl-) type of water so the dominant water type in District Zhob is Calcium Magnesium chloride (Ca+Mg+Cl-) type. The second major water type is $CaHCO_3$ and four samples lie in these facies, that becomes the 13% of the total samples.

Table.1 Statistical Variation of Chemical Parameters in District Zhob Balochistan

Parameter	Mean	Standard Deviation	Maximum Value	Minimum Value	Variance	Skewness	Kurtosis
pH	7.641	0.284	8.400	6.900	0.081	0.031	2.482
EC	827.83	356.513	1703.000	390.000	127101.42	0.993	0.385
TDS	550.04	325.260	1719.000	5.300	105793.87	1.586	4.156
Na	61.355	37.625	190.000	3.000	1415.648	1.532	3.359
K	3.548	2.077	6.000	0.000	4.312	-0.101	-1.634
Mg	34.091	24.766	120.000	2.000	613.358	1.592	3.417
Ca	64.968	37.776	178.000	28.000	1427.063	1.734	2.888
F	0.581	0.449	2.000	0.000	0.202	1.639	2.875
Cl	80.290	111.426	650.000	10.000	12415.690	4.317	22.813
SO4	158.387	92.326	426.000	48.000	8524.173	1.346	2.430
HCO_3	182.581	45.576	310.000	100.000	2077.211	0.642	1.083
CO_3	0.181	0.989	5.600	0.000	0.979	5.295	31.000
NO_3	2.610	2.243	9.700	0.000	5.033	1.544	3.523
Hardness	283.03	121.864	500.000	58.000	14850.805	0.486	-0.868
Turbidity	8.355	3.566	19.300	1.800	12.716	0.909	1.944

Three samples that become 10% of the total samples lie in CaCl type. Two samples lie in Mixed $CaNaHCO_3$ type and Two samples in NaCl type both. That becomes 7% in each category. There are no samples that lie in the Sodium Bicarbonate ($NaHCO_3$) type. So, we can conclude that based on the hydrochemical facies the dominant water type in district Zhob is Calcium Magnesium chloride (Ca+Mg+Cl-) and we don't have Sodium Bicarbonate (Na HCO_3) type in District Zhob. The previous study by **Ghoraba and Khan** (2013) also indicated the same water type in this study area. The Ca+ Mg+ dominance indicates the abundance of sedimentary rock and limestone as assessed by **Umar et al. (2013)**.

Statistical Analysis as can be seen in Table 1 shows that maximum parameters are symmetric, and no great variations are observed in the samples except for carbonates (CO_3) and chloride (Cl). The average value of pH is 7.6 that indicates the safe alkaline nature of water in the study area which is good in boosting the immune system of the human being. The alkaline nature of water is due to the limestone in the area. The average value of turbidity is 8.355, standards deviation is 3.566 the turbidity values are too high in the region which can be removed by coagulation process and Simple reverse osmosis process.

4. Conclusion

Geologically, the study area is rich in minerals and sedimentary rocks which will result in a high concentration of hardness. From the piper plot prepared for District Zhob it was found that 63% of the samples lies in Calcium Magnesium chloride (Ca+Mg+Cl-) type of water so the dominant water type in District Zhob is Calcium Magnesium chloride (Ca+Mg+Cl-) type. The 13% of the total samples lie in second major water type ($CaHCO_3$) and 10% of the total samples lie in CaCl type. Two samples lie in Mixed $CaNaHCO_3$ type and Two samples in NaCl type. There are no samples that lie in the Sodium Bicarbonate (NaHCO3) type. The Ca+ Mg+ Dominance indicates the abundance of sedimentary rock and limestone as the area is chiefly composed of sedimentary rocks of limestone, the dolomite, the argillites (mudstone, clay, shale), a sandstone, and soil cover.

As the turbidity in 87% samples is exceeding the safe limit and 10% samples of TDS and Fluoride (F)exceed the safe limit, that will have negative implication on the health of the population. Simple reverse osmosis filter is recommended at household level to decrease the turbidity before using this water for drinking purposes.

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