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Hydrochemical Characteristics and Ion Sources in Mann River Basin, Maharashtra, India

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Abstract: As the environmental problems are getting more serious day by day in different parts of the world, now a days, the problems of water quality have become more serious than the quantity. Many actors like soil, sewage disposal, effluents, geology and other environmental conditions in which the water tends to stay or move and interact with ground and biological characteristics greatly affects the groundwater quality of an area. The Mann river falls in Buldana and Akola district of Maharashtra, India. The study area falls under the tropical climate. It has high temperature in summer and very cold in winter. The mean annual rainfall is 625 mm. The major sources of water supply in the study area for drinking and industrial uses are surface water bodies and groundwater. In present situation, groundwater (wells and hand pumps) is the major source of irrigation. In present study, assessment of groundwater quality and hydro chemical evolution with respect to ion sources of groundwater has been taken into consideration. Using samples collected in this basin, the water chemical composition and ion source characteristics of river were studied. The results show that the river is weakly alkaline, the average pH is 8.2 and the TDS is 169.29 $mg \cdot L^{-1}$. With the elevation decreasing along the river, the TDS of main stream tend to increase firstly and then decrease, but those of TDS of each tributary decrease, and latter is lower than the former. Affected significantly by the flow, the lowest value of ion concentration in river occurs in summer, and the highest occurs in winter. The hydrochemical type of river is CaMg-HCO_3. In the river, the order of cation mass concentration is $NH4^{+}<K^{+}<Na^{+}<Mg^{2+}<Ca^{2+}$, and that of anion is $F^{-}<NO^{3-}<Cl^{-}<SO4^{2-}<HCO3^{-}$. The sources of ions in river are mainly from the weathering of Silicates and Carbonates.

Keywords: Inland River Basin, Mann River, Hydrochemistry, Ion Sources, Silicates.

Introduction:

Earth is called as blue planet as it contains about 79% of water. Out of these resources much of water is saline and locked into huge glaciers. Therefore less than 1% water is only available to meet the agricultural, industrial and household requirements. Therefore it become quite eventual to preserve the quality and quantity of the valuable natural resource.[1-4] Groundwater is the main source of water which generally utilized to fulfill the said requirements.[5] The nature of rocks and their water preserving properties decides the availability of ground water. Worldwide, many workers have concentrated over

groundwater and drainage morphometric analysis.[6-9] Groundwater is supposed to be a supportive function of human health, socio-economic development and positive growth of ecosystems.[10,11] In order to disclose the hydrochemistry of ground water, relevant factors such as mapping and structural interpretation,[12-14] lithostratigraphical study,[15] identification of unstable zone,[16] tectonics net erosion rate, land use/land cover change detection, etc are at the shoot end of geoscientists.[7] Anthropogenic activities are responsible for small to large scale changes on the hydrological cycle.[5] Agricultural production and standard of human health are the promoted factors by the importance of quality of water. The overexploitation of ground water is reflected through the detrimental affection of quality and quantity of the valuable universal solvent. Residential, municipal, commercial, industrial and agricultural activities are also responsible to play the role in affecting the groundwater quality.[9] Water quality data is utilized in the present study to analyze the chemistry of ground water. Hydro geochemical data are used in the analysis of Electrical Conductivity (EC), Total Dissolved Solids (TDS), Total Hardness (TH) and Sodium Adsorption Ratio (SAR), Percent sodium and Permeability Index (PI).

Water resource is the basis for human survival, especially in arid regions where it is scarce and the quality of it become responsible to affect the ecological environment and the regional economies. As an important part of water resource research, the chemical characteristics of water can reflect the type of water and determine the source of ions, which is the prerequisite for studying water quality. The research on the surface water quality began as early as the end of the 19th century. In 1970, Gibbs proposed the Boomerang Envelope model based on the research of anions and cations in surface water, and divided the ion sources in surface water into rock weathering type, precipitation control type and evaporation concentration type[7]. The research on hydro geochemistry has also made significant progress. The Mann River Basin is located in the Vidarbha region of the India. As one of the most densely populated areas in inland river basin of India, water resource has become the core of the contradiction between people and the ecological environment.

Its hydrochemical characteristics are mainly determined by the geochemical process of rocks in the area, and are affected by climate, precipitation, soil, vegetation and human activities. This study aims to understand the hydrochemical characteristics of the basin and explore its chemical composition and ion sources. Furthermore, it can provide a basis for the sustainable development, the protection of water resource and the governance of the ecological environment of Mann River Basin.

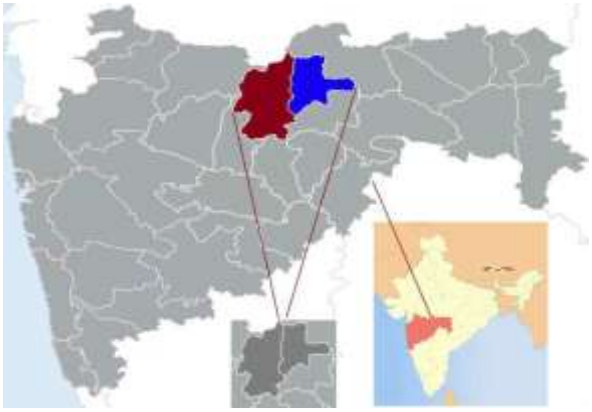

Figure 1. Location map of the study area

Sample collection and testing

Sampling points for river were set along the River, and samples were collected once a month (some samples were not collected on few months because of weather and road impacts). Use ArcGIS 10.2 to process the Dem of the watershed and extract the river network (Set flow accumulation and extract data larger than 800). When collecting river samples, use a simple sling tool to collect samples in the middle of the river, and collect samples 10 cm below the surface of the river. The polyethylene sample bottle was rinsed three times with river samples, then put the sample into the bottle and seal well, and store the sample in the refrigerator. During the sampling period, a total of 214 samples were collected.

All samples were carried to the Laboratory and stored in a low temperature laboratory (about -15℃). To avoid the influence of CO_2 and H_2O in the air, the samples were kept in a sealed state from sampling to the experiment. 48 hours before the test, the samples were taken out and melt naturally at room temperature (about 21°C) without opening. Thereafter pH, EC and main ion concentration were detected. TDS, EC and pH were determined. The measurement range of TDS is between 0.001 and 1000 mg· L^{-1}, with an accuracy of ±0.5%, the measurement range of EC is between 0.001 and 2000μs·cm^{-1}, with an accuracy of ±0.5%, and that of pH is from 0.000 to 14.000, with an accuracy of ±0.05%. Before measuring ion concentration, all samples were filtered using filter membrane of 0.45μm. The concentrations of Na^+, K^+, Mg^{2+}, Ca^{2+}, NH_4^+, Cl^-, F^-, NO_3^- and SO_4^{2-} were determined by means of the ion chromatograph. The error of test data does not exceed 5%. The ultrapure water used in the blank sample and the standard sample is 18.2 MΩ (Millipore Company, USA).

Results and Discussion

The runoff changes of the Mann River have obvious seasonal characteristics. The flow rate is higher from June to September. The highest daily flow rate occurs in July, which it is up to 47.9 m^3· s^{-1}. The value of TDS in the Mann River ranges from 353 mg· L^{-1} to 735 mg· L^{-1} and the average value is 544 mg· L^{-1}. The TDS of river has a negative correlation with the flow. When the runoff is larger, the TDS is lower.

In turn, when the runoff is smaller, the TDS is higher. At the same time, the value of TDS in the river shows a downward trend, and it reaches the lowest value in July. After September, the runoff decreases gradually, while the value of TDS in the river rises gradually, and it reaches the highest value in winter to summer. The value of pH in the Mann River varies from 7.15 to 9.42, and the average value is 8.28, which indicate the river belongs to alkaline water. The difference is not obvious in different seasons.

The sequence of mass concentration of main cation in the Mann River is $NH_4^+ < K^+ < Na^+ < Mg^{2+} < Ca^{2+}$, and their mass concentrations are 0.19, 0.68, 7.12, 11.97, 31.38 mg· L^{-1}, respectively. The sequence of mass concentration of main anion is $F^- < NO_3^- < Cl^- < SO_4^{2-} < HCO_3^-$, and their mass concentrations are 0.05, 1.14, 1.28, 33.54, 131.06 mg· L^{-1}, respectively.

The lowest value of each ion concentration occurs generally in mid December, which is mainly affected by runoff and climate. Because the temperature is the lowest at this time, the rocks are weakly weathered, so the ion concentration in river is the lowest. The highest

values of Ca^{2+} and HCO_3^- appear in May, and the remaining ions also show an upward trend at the same time. Except for Ca^{2+} and HCO_3^-, the highest values of other anions occur in October, and the concentrations of other cations are also higher at the same time, which is affected by climate factors. After September the amount of precipitation and the runoff of the river also decrease gradually, so the concentration of various ions increase correspondingly. On the middle and late November, the weathering products of the rock weakens, so the concentrations of most ions in the river appear the lowest values.

Conclusions

In the Mann River Basin, the water is weakly alkaline, and the seasonal changes are not obvious. TDS of the Mann River is 544 mg· L-1. The seasonal difference of ion concentration is obvious, that is lowest in winter and highest in summer. The cation concentration in river is NH4+<K+<Na+<Mg2+<Ca2+, and the anion concentration is F-<NO3-<Cl-<SO42-<HCO3-.

The type of water chemistry in study area is CaMg-HCO3. The sources of ions in the Mann River and its tributaries are controlled significantly by the weathering of rocks, which is mainly weathering products of silicates, but they are more affected relatively by human activities.

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