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title: **Quality of shallow groundwaters of Hoshangabad city, Madhya Pradesh, India and its suitability for domestic and irrigational purposes, an rural environment appraisal**

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Water is a precious gift of nature to human beings. Water is needed not only for domestic use but also for the growing needs of any nation for its better agricultural growth.

Hoshangabad is a holy city, situated near the river Narmada. Residents living near the river, use shallow groundwater for drinking as well as for irrigation purposes.

The main objective of the present study is to assess and evaluate the water quality of shallow groundwater of Hoshangabad city and its suitability for domestic and irrigation purposes. In the present study, the hydrochemical investigation is restricted to the major ions' concentration like Ca, Mg, Na–K–CO_3, HCO_3, Cl, NO_3 etc. In order to assess the water quality, 18 (Eighteen) shallow groundwater samples were collected from the different shallow aquifers of the Hoshangabad city and analyzed by using the methods as proposed by APHA (1995).

The experimental values of water samples suggested that most of the waters are slightly alkaline due to the presence of Carbonates and Bicarbonates. The pH values of water samples varied between 7.5–7.9. EC values were in the range of 650–2200 micromohs/cm at 25°C. The calcium hardness and magnesium hardness values ranged from 84 to 210 mg/l and 52 to 203 mg/l respectively. Total dissolved solids and total hardness values of water samples are well within the permissible limit as per the guidelines proposed by WHO, ICMR and BIS. Calcium and Magnesium are the two major constituents amongst the cations and it varies from 28 to 72 mg/l and 5 to 30 mg/l respectively. The conc. of sodium and potassium varies from 36 to 62 mg/l and 1.6 to 5.4 mg/l respectively. The carbonate is absent or present in traces. Bicarbonate is the important anion and it varies from 80 to178 mg/l. Chloride and Sulphate, conc. varies from 28 to 148 mg/l and 10 to 41 mg/l respectively. The Nitrate and Phosphate conc. varies from 10 to 41 mg/l and 0.07 to 0.42 mg/l respectively.

A variety of graphical representation methods are used to classify water. In the present study, Piper Trilinear Diagram (1944) and Modified Trilinear Diagram by Romani (1981) are used to classify the shallow groundwater. The concentration of major cations and anions has been converted to me/l and percentage reacting values of each ion have been computed and plotted in Pipers Trilinear Diagram and Modified Trilinear Diagram. The presentations of chemical analysis data in Pipers Trilinear Diagram reveal that the hydrochemistry of majority of shallow groundwaters are dominated by alkaline earth, weak acids and carbonate hardness, over 50% of which is temporary in nature. The chemical analysis data plotted in modified Trilinear diagram reveals that the majority of shallow groundwaters fall in the field C-1 and A-1, which shows that the shallow groundwater belongs to calcium-bicarbonate type.

In order to evaluate the agricultural water quality, various irrigational specifications have been suggested by various workers. In the present study, irrigational specifications as proposed by Asgar et al. (1936), Kelley et al. (1940), Eaton (1950), U.S. Soil Salinity Staff Diagram (1954), Wilcox (1955), Paliwal (1972), and Ayers and Westcot (1985) have been used to assess the suitability of shallow groundwaters for irrigational purposes.

Asgar et al. (1936) has suggested the salt index as a parameter for evaluating the quality of irrigation water. Salt index is negative for all good waters and positive for suitable waters. In the present study, the values of all the shallow groundwater samples are negative indicating the suitability of water for irrigation purposes.

Sodium problem in irrigation water can be evaluated on the basis of Kelly's ratio. If this ratio is below one, water is suitable. If this limit is in between one and two, the water is marginally suitable and if this ratio is beyond two, water is unsuitable. In the present study, the majority of shallow groundwater sa mples have less than one Kelly's ratio, indicating the suitability of water.

Eaton (1950) proposed that the indirect effect of carbonate and bicarbonate on water quality and it is expressed in terms of Residual Sodium Carbonate (R.S.C.). As per the guidelines of US Soil Salinity Laboratory Staff (1956), the majority of shallow groundwater samples have RSC more than 1.25 which clearly suggests that the water is safe for irrigational purposes.

When the EC and SAR values of shallow groundwater samples of the area were plotted in the US Soil Salinity diagram, it clearly indicate that the shallow ground waters showing no sodium hazard and the water belongs to good category.

As per Wilcox classification diagram based on EC and Soluble Sodium Percentage (SSP), the shallow ground waters fall in "Good to Permissible" class.

As per Paliwal (1972), the magnesium hazard is likely to be developed in soil when this ratio exceeds 50%. In the present study the value of index of magnesium hazard is less than 50% which clearly indicates that the shallow groundwater samples can be profitably applied for irrigation.

Ayers and Westcot (1995) proposed modified water quality guide lines based on Sodicity, Toxicity and Salinity. A comparison of EC, SAR, TDS, Cl, and NO_3, values of shallow groundwaters with the values of the parameters as proposed by Ayers and Westcot, reveals that the majority of shallow groundwaters belongs to "Slight to Moderate Restriction" category.

On the basis of various water quality guidelines proposed by BIS, WHO and ICMR, it is suggested that the majority of shallow groundwaters are found suitable for drinking purposes. On the basis of the various irrigational specifications such as Salt index, Kelly's Ratio, Residual Sodium Carbonate, Sodium Adsorption Ratio and Magnesium ratio it can be concluded that the majority of shallow groundwater samples are quite suitable for irrigational purposes. However, marginal and "slight to moderate restriction" water can be used for irrigation after proper management and selection of crops.

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