CHAPTER - IX

HYDROGEOLOGICAL AREA CATEGORISATION

CONCEPT

It has been observed that groundwater occurrence shows a wide range of variation in the Heran basin, the minimum yield being less than 100 lpm and the maximum being more than 2000 lpm. The various controlling factors responsible for such groundwater conditions have already been discussed in the earlier chapters. Each controlling factor, either of lithology, or structure or geomorphology, shows a variety of characters that influence the groundwater recharge, storage and flow. It is thus seen that at any

given location in the area the groundwater conditions have been rendered very complex. In the light of the hydrogeological evaluation made in the previous chapter, here, the author has attempted to construct a model giving hydrogeological categorisation of the basin area. The area category gives a rating of groundwater yield, depending upon the integrated assessment of all the variables of different controlling factors.

Occurrence of groundwater is a function of several variables related to hydrometeorological and hydrogeological set up of a region. The hydrometeorological parameters contribute water input, while the hydrogeological parameters form the groundwater storage and outputs. The influence of the hydrometeorological factors are generally appreciated on a regional scale. In the present case, the E-W aligned Heran basin shows an increasing trend of rainfall towards north east, while the trend of evaporation and evapotranspiration is on decrease. Thus the influence of each other is balanced and the basin area as a whole can be regarded as isotropic to the hydrometeorological contribution to groundwater.

In the Heran river basin which is comparatively a small area, the complexities of hydrogeological characters are however many, mainly due to the three controlling factors of varying lithology, structural complexity and geomorphic diversity. With the given uniform conditions of inputs for

groundwater recharge, the differential response of the surface and subsurface terrain conditions have governed the present pattern of the groundwater occurrence and distribution. Groundwater recharge, storage, movement, aquifer formation, chemical quality etc. have are all related to the above three important controlling factors. Taking into account the due role played by the various parameters of the three controls, a model has been devised for the basin, which provides an area categorisation basis for the groundwater occurrence.

APPROACH AND METHODOLOGY

The methodology aims to classify the area relatively favourable and unfavourable for the groundwater occurrence and development. Groundwater potential at any given location in the basin area has been worked out by assessing the contribution from the various controlling factors which on the basis of their water yielding capacities have been described as hydro-lithological, hydro-structural and hydro-morphological factors. The scheme of rating these factors into three yield classes, each are discussed as under.

HYDRO-LITHOLOGICAL CLASSES

The large variety of rock types of the area belong to two main hydrogeological categories : consolidated formations and unconsolidated formations. The major part of the basin is covered by the consolidated formations which show great

diversity of mineralogical and textural characters. Field observations have indicated that they have remarkable differences in water bearing capabilities. Keeping this in view, the consolidated formations have been separated into two classes, (L_1 and L_2). The unconsolidated formation comprising the third class (L_3).

The characteristics of each class could be summarised as under:

Class	Formations
L_{-1}	Massive basalts, gabbroas, dolerites trachytes, andesites, granites, quartzites, shale and indurated sandstones.
L_{-2}	Sandstones, limestones, carbonatites, phyllites, mica-schists, biotite gneiss, vesicular and amygdaloidal basalts, inter-trappeans, breccias and conglomerates.
L_{-3}	All unconsolidated formations including colluvium and alluvium materials, comprising gravel, sands, kankars and silts etc.

HYDRO-STRUCTURAL CLASSES

The structural and tectonic features have subjected the rocks to mechanical failures giving rise to major and minor rupture planes, viz. fracture zones, shear zones, fault etc.

Other structural characteristics include folds, unconformities, igneous intrusives and lava flow contacts etc. These features have played important role towards producing zones of secondary porosity in the consolidated rocks. The porous and permeable zones of varying intensity that have been produced in an otherwise unproductive consolidated rocks in the vicinity of the structural features have given rise to local aquifers. These structurally controlled aquifers have varying capacities of groundwater yield. Depending upon their role in the development of groundwater aquifers, three hydro-structural classes have been worked out and are tabulated as under:

Class	Structures
S-1	Minor joints, major joints filled with secondary material, tight contacts of lava flows, bedding planes, metamorphic foliations parallel to stream flow, dyke intrusions parallel to stream flow etc.
S-2	Master joints, minor shear zones, fracture joints, local faults, open contacts of lava flows, metamorphic foliations across the stream flow etc.
S-3	Major zones of shearing and faulting, dyke intrusives across the stream flow and intersections of linear zones.

HYDRO-MORPHOLOGICAL CLASSES

The surficial characters of the terrain considerably affect the groundwater recharge, thereby contribute to the groundwater resources. Several features like landforms, drainage, ground slope, weathering etc. have their specific influence towards the contribution of groundwater occurrence. Depending upon the evaluation of their characters, and related level of groundwater yield, these geomorphic features have been grouped into three hydro-morphic classes as under:

Class	Characteristic features
M-1	Ground slope more than 4%, steep hilly terrain, barren stoney waste areas, radial drainage pattern, shallow weathered zone with thin soil cover, poor vegetation cover, affluent river channels, rocky river bed.
M-2	Ground slope 2 to 4%, local depression, trellis, pinnate and rectangular drainage patterns, rugged terrain, moderate soil and vegetation cover and weathered zone of moderate soil cover.
M-3	Slopes less than 2% flat and/or gentley undulatory terrain, low lying plains, large surficial depressions, flood plains and river terraces, broad valley bottoms, thick

vegetation and soil cover, sandy and influent river bed, buried river channels, centripetal and annular drainage pattern, thick weathering profile.

AREA-CATEGORISATION

RATING CONCEPT

Groundwater potential at any part of the basin is regarded as the combined influence of different classes of the above three major controlling factors of hydrolithology (L), hydrostructure (S) and hydromorphology (M).

Depending upon the class rating final assessment has been made. Considering the ratings 1, 2 and 3 as score numbers for the particular classes, the sum total of the three sets of score values would provide a number having minimum to maximum value ranging between 3 to 9 as under:

Category	L	S	M	Score
I	1 (L_1)	1 (S_1)	1 (M_1)	03
II	2 (L_2)	2 (S_2)	2 (M_2)	06
III	3 (L_3)	3 (S_3)	3 (M_3)	09

Taking into account the above rated scores for any given location of the area, the area categorisation can be made as

Category - I : Score 3 & 4, low potential.

Category - II: Score 5, 6 and 7 medium potential.

Category- III: Score 8-9 high potential.

This type of categorisation I, II & III with relative potentials gives a broad and qualitative evaluation of the area. Of course, this categorisation has been supported with geophysical survey results and geohydrological parameters of the aquifers, which have been highlighted in the chapter on Groundwater Hydrology, for obtaining a precise picture; based on the geohydrological field studies and their evaluation these proposed categories for any given location in the study area should have the following characteristics.

Category	Geohydrological characteristics
I	Porosity - Less than 3% Yield - less than 300 lpm Transmissibility - Less than 50 m^2/day Permeability - Less than 1 m /day
II	Porosity - 3 to 6 % Yield - Between 300 to 1000 lpm Transmissibility - Between 50 - 200 m^2/day Permeability - Between 1-10 m/day
III	Porosity - More than 10% Yield - More than 1000 lpm Transmissibility - More than 200 m^2/day Permeability - More than 10 m/day.

Considering the influence of these geohydrological parameters on these categories, a groundwater potential map of the basin area has been prepared (Fig.9.1). It is seen in the map that areas of the low groundwater potential i.e. category I have extensive spread in the eastern, northeastern and southeastern parts of the basin area. Here the hydrogeological classes are of L_1, S_1, and M_1 category having an aggregate score of 3. Some local patches fall under category II & III, the category III comprises L_1, S_3, M_3 having an aggregate score of 7.

The category III dominantly occupies the middle and lower reaches of the basin where all the hydrogeological classes are of higher order i.e. L_3, S_3, M_3 & L_3, S_2 & M_3 with an aggregate score of 9 & 8.

The above scheme of categorisation as applied to the Heran river basin provides a good example of a reasonably dependable approach and technique to evaluate groundwater potential for any area, which could be categorised on the pattern evolved by the present author in this study. The approach and methodology does not involve large inputs in terms of money and personnel, but provide a reasonably dependable information at least as a starting point.