CHAPTER-9

GROUNDWATER ASSESSMENT, DEVELOPMENT AND MANAGEMENT
9.1 Groundwater Assessment

The study area is covered by the hard rock formations, namely Vindhyan, Lametas and Deccan Trap. They become aquifers due to secondary porosity developed by weathering and fracturing. The intensity of Joints and fractures control the groundwater resources in these hard rocks. Generally, for domestic water supply, the weathered zone in these hard rocks assume maximum importance in groundwater development as they are exploited through shallow dug wells since ancient time. The assessment of groundwater resource potential requires the evaluation of annual groundwater recharge and annual groundwater draft.

(a) Annual Groundwater Recharge

There are two methods of calculating the groundwater recharge namely Infiltration Index method and water level fluctuation method. Out of these two methods, the fluctuation method give better results than the Infiltration method. For the fluctuation, groundwater levels are an outcome of additions and subtractions of water by all the parameters, some of which cannot be determined. Further, in groundwater level fluctuation method, the surface area considered for calculation is entirely cultivable area, where most of the farmlands lie. In the Infiltration Index method, the area to be considered for calculating the groundwater recharge represents the total geographical area. Therefore, the author has used the water level fluctuation
method to calculate the groundwater recharge in the study area.

In the fluctuation method, the area of the different aquifers is multiplied by the average fluctuation of that aquifer and it gives the volume of the saturated aquifer. The volume of the each aquifer is multiplied by the specific yield of the aquifer. It means that the equation used in the calculation is as follows:

\[
\text{Annual groundwater} = \text{Area} \times \text{Fluctuation} \times \text{specific yield of water level}
\]

The specific yield values for different aquifers given by A.R.D.C. (1979) and N.A.B.A.R.D. (1984) have been used in the calculation of recharge which are given below:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Lithology</th>
<th>Specific yield (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Basalt</td>
<td>5%</td>
</tr>
<tr>
<td>2.</td>
<td>Lameta</td>
<td>3%</td>
</tr>
<tr>
<td>3.</td>
<td>Vindhyan Shale, sandstone and Limestone</td>
<td>3%</td>
</tr>
</tbody>
</table>

The calculated annual groundwater recharge by using the above equation is given in Table 9.1.
Table 9.1
Annual Groundwater recharge in Sonar river basin (M.P.)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Formation</th>
<th>Area in (Hact.)</th>
<th>Average fluctuation of water level (m)</th>
<th>Annual groundwater recharge (M. h.m.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Basalt</td>
<td>187513.32</td>
<td>4.23</td>
<td>0.039</td>
</tr>
<tr>
<td>2.</td>
<td>Lameta</td>
<td>68186.66</td>
<td>4.08</td>
<td>0.008</td>
</tr>
<tr>
<td>3.</td>
<td>Vindhyan Sandstone</td>
<td>26635.41</td>
<td>4.98</td>
<td>0.003</td>
</tr>
<tr>
<td>4.</td>
<td>Vindhyan Shale</td>
<td>216492.15</td>
<td>5.05</td>
<td>0.032</td>
</tr>
<tr>
<td>5.</td>
<td>Vindhyan Limestone</td>
<td>101214.57</td>
<td>2.78</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>Total</strong></td>
<td><strong>0.090</strong></td>
</tr>
</tbody>
</table>

Thus, the total annual groundwater recharge in the study area is 0.090 m.h.m. Out of this, 25% water losses is due to evaporation, Transpiration, etc, is deducted. Thus, the net annual groundwater recharge is 0.078 m.h.m. in the study area.

(b) Annual groundwater Draft

To determine the annual groundwater draft in the area, the number of different types of existing wells in different formations have been recorded. The number of existing wells have been given in Table 9.2.
Table 9.2
Total number of existing wells in Sonar river basin (M.P.)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Formation</th>
<th>No. of dug well</th>
<th>No. of wells with electric pump</th>
<th>No. of wells with diesel pump</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Basalt</td>
<td>2100</td>
<td>300</td>
<td>272</td>
<td>2,672</td>
</tr>
<tr>
<td>2.</td>
<td>Lameta</td>
<td>327</td>
<td>120</td>
<td>110</td>
<td>557</td>
</tr>
<tr>
<td>3.</td>
<td>Vindhyan Sandstone</td>
<td>210</td>
<td>90</td>
<td>80</td>
<td>380</td>
</tr>
<tr>
<td>4.</td>
<td>Vindhyan Shale</td>
<td>2617</td>
<td>500</td>
<td>300</td>
<td>3,417</td>
</tr>
<tr>
<td>5.</td>
<td>Vindhyan Limestone</td>
<td>850</td>
<td>205</td>
<td>185</td>
<td>1,240</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>6,104</strong></td>
<td><strong>1,215</strong></td>
<td><strong>947</strong></td>
<td><strong>8,268</strong></td>
</tr>
</tbody>
</table>

For the calculation of annual groundwater draft, the average rates of discharge have been determined by the horizontal jet method and the number of pumping hours for different types of wells in a year have been recorded by consulting the users. On the basis of pumping hours and average rates of discharge measured in the field for different types of well, a value of 1.5 hectare/metre per year is used in the draft calculation. The annual groundwater draft has been calculated amount to be 0.012 m.h.m. in the study area.

(c) Groundwater Balance

The annual groundwater draft calculated for different wells in the study area is 0.020 m.h.m. The draft may be more because the effluent seepage losses are not included in this amount. The net annual groundwater recharge determined
amounts to be 0.078 m.h.m. Therefore, the balance of groundwater available for future development in a year works out to be 0.058 m.h.m. It means that huge quantity of groundwater is available for pumping in the study area.

9.2 Groundwater Development

The available groundwater in the area should be utilized by constructing the more dug wells, shallow tube wells, dug-cum-bore wells, etc., in the area. Thus, the scarcity of the water problems of the people of the area can be sloved by proper development of groundwater resources.

To identify the groundwater favourable zones, the hydrogeomorphological map is very helpful which is prepared by using the Remote Sensing Techniques. Among the various hydrogeomorphic units, some are grouped as favourable zones, some as moderately favourable zones and some are poor zones. The Alluvial plain and buried pediplain, etc., are marked as favourable zone for groundwater development. The buried pediplain and lineaments are marked as moderately favourable zones. By considering the favourable zones for the development of available groundwater map (Fig.9.1) has been prepared which shows the favourable areas for the construction of different type of new wells. Thus, by digging these wells in the area, the development of groundwater resource can be done.

9.3 Groundwater Management

It is noticed that in many cases, the principle of balance between recharge and draft is ignored in groundwater
development schemes. The development and management of groundwater resource have to be carried out in a scientific way to avert possible adverse effects resulting from over exploitation of groundwater. It is observed that due to improper use of groundwater, the groundwater levels have been depleting in some parts of the study area. The situation becomes very serious in summer when most of the shallow dug wells dry up and yield of the hand pump/tube well or dug-cum-bore wells reduce considerably resulting the drinking water crisis in most of the village in the study area. Therefore, the management of groundwater becomes essential in the area. It can be done by augmenting the groundwater resource of the area. For this purpose, the author has adopted the concept of 'watershed management' in the study area.

9.3.1 Artificial Recharge Techniques

The mechanism of the artificial recharge depends on the local topography, geology, soil conditions and method of recharge (Sharma, 1992; Reddy, et al., 1994). There are numerous methods but all are not suitable for a particular area. The selection of a artificial recharge methods depend on the following factors:

a. Hydrologic properties of the aquifers.
b. Hydrogeologic set up.
c. Infiltration/percolation characteristics of vadose zone.
d. Water availability and
e. Economic constrains.
Thus, looking to the above characteristics and financial constraints, the following methods are suggested for artificial recharge of groundwater in the study area. These are given below:

(a) By obstructing the flow

In this method, water barriers will be constructed in the shape of:

(i) Boulder check dam/stop dam and

(ii) Soil check/boulder checks

(i) Boulder check dam/stop dam

The Boulder check dam/stop dam will be constructed along the main nala or tributaries to arrest all the subsurface flow passing through the nala bed or through underground dyke. It should be constructed just downstream of the village. This way, the water pool will be available in the village during and after rainy season for various uses. The height of the Boulder check dam/stop dam over the dykes should be selected in this way that the water stretch of the downstream structure just touches the toe of the upstream structure. The depth of the underground dyke which should be complete barrier for subsurface flow is so decided that it goes upto 0.5 metre deep inside the impervious rocky layer. The underground dyke at various location should be fixed according to the nature of substructure. It is rectangular in cross-section and dug across the width of the tributary which is generally 1.5 to 2.0 metres. The depth of excavation also should be 1.0 to 1.5 metres.
(ii) Soil check/boulder checks

These are constructed in series as the narrow section of the small streams in the watershed and farmlands to detain rainwater for a longer period of time throughout the monsoon season. The period of contact of surface run-off allows it to percolate down the surface, which will augment the groundwater resource. These structures can be constructed easily by the farmers with a little guidance about the location and method of construction.

Thus, the above mentioned structures not only recharge the groundwater but also help in curbing top soil erosion and providing soil moisture in the farmlands to enable to farmers to take the second crop. The site of these structure are shown in Fig.9.2.

(b) By storing the water

In this method, the water is obstructed and stored in trenches, contour bunded area and in percolation tank. The percolation tanks are most suitable and effective in the study area. The groundwater mound areas are suitable site for the percolation tank, the site of these tanks are given in Fig.9.2.

9.4 Some important features of hydrogeological interest

During the field investigations some important features of hydrogeological interests are found in the Sonar river basin. These are given below:
FIG. 9.2—LOCATION MAP OF ARTIFICIAL RECHARGE STRUCTURES IN SONAR RIVER BASIN, (M.P.)

INDEX

- Boulder/Soil check
- Stop Dams/Check Dams
- Percolation Tank
a. Cavities in limestone

These are found in Mirjapur village of pathariya block and Kabirpur village of Batiagarh block of Damoh district.

b. Underground water pools

These are present along Sonar river in Batiagarh block. It seems due to the presence of cavernous limestone.

c. Very good groundwater potential zone

The vicinity of the village Futera of Batiagrah block is a very good area of groundwater potential for tube wells.

d. Spring

These are found near Narsingarh in patharia block of Damoh district.

e. Artesian flowing well

These are found in Ghughas village of Batiagarh in Damoh district and Nayagaon village near Parsoria village of Sagar District.

f. Bad quality of groundwater

In Bakeni village of Pathariya block near Aslana railway station in Damoh district, a tube well of Shri Jagdish Singh has bad chemical quality of groundwater. The groundwater is very hard and the concentration of sodium and chloride are very high, when this groundwater applies to crop, it becomes black and the growth of crop is very less.