CHAPTER-4

OCURRENCE AND MOVEMENT
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An understanding about the occurrence and movement of groundwater as well as availability of surface water is essential to initiate the plan for development of water resources of a region. Water in any region occurs under two conditions, surface water and ground water. Surface water bodies can be classified as river, ponds, reservoirs etc. The groundwater occurs in confined or unconfined condition. The occurrence and movement of groundwater depend upon porosity and permeability of the water-bearing rock formations and is further affected by the topography, geomorphology and structure of the area.

For Rajnandgoan Block, with an area about 480 sq. km, recharge through surface runoff during monsoon and non-monsoon period is estimated as 89.24 Mcm and 9.86 Mcm respectively with total yield of about 96 Mcm, and average surface water potential yield of 0.344 Mcm/sq. km. (Groundwater Recharge project, Rajnandgaon, C.G. W.B.). The recharge through seepage from canals and from existing tanks 1.63 Mcm and 3.14 Mcm respectively, with net recharge (85% of total of recharge) is estimated as 86.91 Mcm. There are several ponds, tanks, reservoirs ranging from 2 acre. to 10 acre. in area out of which few are lined, store water throughout the year. Surface water is a fluctuating resource; although reservoir storage can stabilize the supply. It can be shown that complete stabilization and utilization is not attainable. Therefore, groundwater has attained considerable importance, to supplement the sustainable supply of water.

4.1 HYDROLOGICAL PROPERTIES OF LITHOUNITS: The groundwater resources of the region are evaluated lithologically. The main lithounits of the area are Gunderdehi shale, sandstone and stromatolitic limestone of Chandi formation. At places, these are capped by thick laterite cover (2 to 8 meter).

The Gunderdehi shale is fine-grained, compact and becomes splintery. The bedding plane and interconnected vertical joints extending up to a depth of 4 to 6 meters, provide limited scope for percolation of groundwater and consequently have limited scope for groundwater occurrence. The shale horizon functions
primarily as an aquiclude for underlying aquifer and restrict the percolation of surface water to deeper zones, however, where calcareous shale is exposed, it acts as a fairly good aquifer.

The sandstones are medium-grained, compact, purple to raddish brown in colour. It is interbedded with shales and occupy the elevated ground. The sandstones of the area are non permeable or possess very low permeability. They yield small quantities of water. The movement of groundwater in sandstone is controlled by secondary porosity present in the form of joints (Plate-16 ). The zone of weathering is shallow, and fissures extend up to shallow depths 9 meter. The water table in areas occupied by sandstone fluctuates from 5 metre to 8 meters between post-monsoon and pre-monsoon period.

The limestone is the principal aquifer of the study area. It is dense, compact and possesses no primary porosity. However, these rocks contain low to high secondary permeability due to the presence of karstification, fracture, joints and chemical weathering (Plate-17 ). Groundwater present in the secondary openings, solution channels and sink holes of variable dimensions are found to occur in these rocks. Karstic features like grike and clients (Plate-13 ) are also observed. The occurrence of solution cavities, ranging in length from few cm. to as much as 2 meters with wide extension are also recorded in the area. They extend down upto depth of 30 meters and above as observed in some bore wells. The solution cavities are interconnected and sometimes are found filled with loose clayey material. Cavity formation is also observed along the contact between limestone and intercalated thin shale bands. The interconnected cavities and fracture zones act as conduits for infiltration and movement of groundwater. The discharge of the wells in limestone terrain is more than 7500 gph. (Hasda, Parsada village).

The elevated area of Sonbarsa catchment is capped by laterite with thickness gradually decreasing from 8 meter (west) to 2 meter (east). These cappings comprise highly porous top with underlying impermeable lithomargic clays. Laterite is coarse textured, porous and highly permeable but because of its limited thickness, it dries out during summer, hence, does not constitute a lasting source of groundwater. It acts as an unconfined aquifer.
Plate 16. Groundwater seepage, through inherent joints in sandstone near Salebharri village.

Plate 17. Bedding joints in limestone facilitates groundwater movement near village Basula.
4.2 OCCURRENCE AND MOVEMENT OF GROUNDWATER

The primary watershed areas are the primary recharge regions located at higher elevations. Sloping lands have several intermittent nalas and perennial streams. The rain water is the main source of groundwater recharge in the area.

Groundwater infiltrates and gets stored in weathered, jointed and fractured zones which is extending down to deeper depth. Groundwater in the area usually occurs under the semiconfined conditions. The water level as observed recedes upto 20 mts. in shale and limestone and 14 mts. in sandstone. During summer the depth to water as observed during premonsoon period ranges between 3.5 mts. to 8 mts. b.g.l. in shale, 4 to 12 mts in sandstone 4.5 mts. to 13.5 mts. b.g.l. in limestone.

The zone of fractured and weathered mantle is a regional feature; it is common to all formations of the study area. So, at shallower depth all rock types act as homogenous one but at deeper zones, fissures and solution cavities get widened while porosity of shale and sandstone reduces considerably due to load of overlying rocks. The highly impermeable lithomargic clays below laterite do not allow circulation of groundwater between the underlying formations resulting in perched water table conditions.

The occurrence and circulation of water at shallow depth is confined to sheet and other minor partings in shale, jointed and fractured zones in sandstone and cavernous zones in limestone, both in water table and semi-confined conditions (Plate-18). In the areas where shale is underlain by limestone, groundwater occurs under semi-confined condition with shale beds acting as confining beds.

From the data presented above, it is observed that in post-monsoon period water table conditions vary in depth from 3.5 m to 15 meters during summer and in winter it is 2.5 to 9.5 meters. Water table at maximum depth during post-monsoon period is observed at village Jogi gupha i.e. 12.70 meters. Water table is at the maximum depth in areas occupied by sandstone and shale overlying the stromatolitic limestone but where laterite caps these formations, shallow water conditions have developed due to perched water bodies.
Plate 18. Auto flow well near village Bhalukona.
Fig. 4.1 LOCATION OF DUG-WELL (WELL INVENTORY) IN SONBARSAR BASIN.
4.3 WELL INVENTORY: In Sonbarsa river basin, 62 dug wells were inventoried and data regarding the diameter, total depth, depth to water level, etc., were collected to understand the nature of occurrence and movement of groundwater (APPENDIX-I Well inventory data, Table - 4.1 and Table - 4.2). The depth to water level was collected during premonsoon (April-May, 1999) and postmonsoon (Oct.-November, 1998) periods to determine the direction of groundwater movement and fluctuation of water levels in various lithounits (Fig. 4.1). The data collected were processed to prepare water level contour maps for premonsoon (Fig. 4.2) and postmonsoon seasons (Fig. 4.3) and also for groundwater fluctuation map (Fig. 4.4). The reduced levels of the observation wells were calculated through R.L. given in toposheet and also obtained from the office of the Ground Water Survey & Irrigation Department.

4.4 GROUNDWATER LEVEL MAPS: The groundwater level maps for premonsoon and postmonsoon periods and water level fluctuation map were prepared on 1:50000 scale. The contour interval is 3 meters and for fluctuation it is 1 meter interval to avoid the grouping of large number of contours lines in small scale.

Water table configuration reflects the topography and flow condition in an aquifer. Elevation in water table tends to become parallel to the land surface. The groundwater body often comprises system of flow, regional and local. The overall characteristics of water table elevation are considered in regional flow, while local flow is generated by the effects of local features of topography and geology in the zone of saturation.

These maps express the equilibrium relation between flow velocities, hydrologic properties of water-bearing material and topography of the region. These maps are helpful in determining the flow direction, gradient and groundwater occurrence with relation to topography. Further, these maps can also be utilized in recommendation of sites for ground water exploration and development.

4.4.1. Premonsoon Water Table Map: The Premonsoon water table map is
Fig. 4.2 PRE-MONSOON WATER LEVEL CONTOUR MAP OF SONBARSAR (April-May 1999)

LEGEND

1. WATER LEVEL
2. R.L. IN METERS
3. BOUNDARY
4. FLOW LINE
5. WATER LEVEL CONTOUR

Fig. 4.3 PRE-MONSOON WATER LEVEL CONTOUR MAP OF SONBARSAR (April-May 1999)
Fig. 4.3 POST-Monsoon Water Table Contour Map of Sonbarsa (Oct-November, 1998)
presented in (Fig 4.2). In this map, water table follows the trend of topographic contours. The premonsoon depth to water level below the ground surface varies between 346 m to 265 m contours. The hydraulic gradient is towards east i.e. along the Sonbarsa river. The average hydraulic gradient in Gunderdehi shale is 3m/km whereas it is 5.5m/km in Chandi limestone.

The variation in hydraulic gradient in limestone might have been due to non-uniform development of karsts and/or due to filling of cavities.

The pattern of water table contours exhibits that it is has influent (Village Jarahi, Temri) and effluent (village Gopalpur) nature of the Sonbarsa river which is due to occurrence of respective recharge and discharge zones along the river valley.

4.4.2 Post monsoon Water Table Map: The post-monsoon water table map (Fig.4.3) illustrates broadly similar pattern to that of pre-monsoon period. The water level below the ground surface varies between 362 to 269m contours. The post-monsoon water elevations indicate more or less uniform rise (3.5 m to 6 m) due to monsoon recharge of the water table throughout the region. In the post-monsoon period, the convergence of contours indicates higher transmissivity and occurrence of hydraulic trough as seen near village Nawgaon. The mounds near village Temri during premonsoon period disappear and a new mound develops around Thelkadih and Eraikala villages due to saturation of aquifer compared to surrounding region.

4.4.3 Water Level Fluctuation Map: Water level fluctuation is caused by difference in supply and withdrawal of groundwater. The main source of groundwater recharge is rainfall. It affects the rise and fall of water table in a particular area. From the critical evaluation of water level fluctuation map of Sonbarsa river basin (Fig. 4.4, Table 4.2), it is observed that minimum fluctuation (1.5 meter) occur near the mouth of the Sonbarsa river. However, most of the western part of the basin shows higher fluctuation. This high fluctuation in water table is possibly due to the occurrence of shale/shale limestone lithology. The central and eastern parts show water level fluctuation from 3 to 6m along with some pockets having more fluctuation.
Figure 4.4 WATER LEVEL FLUCTUATION IN SONBARSA RIVER BASIN.
### Table 4.1: Salient Features of Well Inventory

<table>
<thead>
<tr>
<th>Range</th>
<th>Well Diameter</th>
<th>Depth below ground level (meters)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Below 2m</td>
<td>4-6</td>
</tr>
<tr>
<td>No. of wells</td>
<td>15</td>
<td>49</td>
</tr>
<tr>
<td>%</td>
<td>22.95</td>
<td>74.97</td>
</tr>
</tbody>
</table>

### Table 4.2: Salient Features of Pre-Monsoon, Post-Monsoon & Water Level Fluctuation in Sonbarsa River Basin

<table>
<thead>
<tr>
<th>Pre-Monsoon</th>
<th>Post-Monsoon</th>
<th>Fluctuation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth range of water level b.g.l in m</td>
<td>Depth range of water level b.g.l in m</td>
<td>Fluctuation in Water Level in m</td>
</tr>
<tr>
<td>Range Less than</td>
<td>4-6</td>
<td>6-8</td>
</tr>
<tr>
<td>No. of Wells</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>%</td>
<td>12</td>
<td>24</td>
</tr>
</tbody>
</table>


The salient features of above studies are summarized as follows -

1. The Sonbarsa river is mainly of effluent nature.
2. There is minor variation in flow direction during premonsoon and post-monsoon periods.
3. The convergent nature of flow lines towards the Sheonath River indicates groundwater discharge to the river.
4. High fluctuation is observed in limestone with huge interconnected solution cavities.
5. A high permeability aided by water table gradient as evident in western pocket.