CHAPTER 8

MODEL FORECAST

8.1 GENERAL

The model developed for the lower Palar River basin was used to predict the response of the aquifer system to the anticipated changes in hydrological stresses. The aquifer response for different input and output fluxes was studied in order to understand behaviour of this aquifer system. The model forecast was carried out until the year 2010. For this simulation, monthly average rainfall recharge, ponds/river recharge and abstraction were used. On the analysis of the last ten year river flow data, it is found that the Palar River flowed only once in three years. Hence, the Palar River flow was considered once in three years that is during 2003, 2006 and 2009.

8.2 MODEL FORECAST

8.2.1 Normal rainfall condition

The model was run to predict the regional groundwater head in this area until the year 2010. For these runs, the monthly average rainfall calculated from 70 years rainfall data was used. The present level of groundwater abstraction was considered for this simulation. The simulated regional groundwater head for September 2010 is shown in Figure 8.1. There is not much increase or decrease in water level (Figure 8.2). A similar observation is
made in most of the locations. In the years when the flow in the Palar River was considered, there is an increase in groundwater level by about 0.5 m in the wells located near the rivers. The solute concentrations such as chloride, bicarbonate, sodium and calcium (Figure 8.3) does not increase or decrease indicating that they are stable under the present condition.

Figure 8.1 Predicted regional groundwater head (m above msl) in May 2010

8.2.2 Drought year once in four years

Analysis of the 70 years rainfall data indicate that in 33 years, the rainfall was less than the annual average of 1167 mm. The average of these low rainfall years (drought period) was found to be 882.43 mm/year. In order to study the effect of drought years in this area, the model was run by assuming deficit of rainfall once in four years until 2010. The monthly average of deficit rainfall years was calculated and used for this purpose. The groundwater level declined by about 0.6 to 1.2 m during the assumed drought years (Figure 8.4).
Figure 8.2 Observed and predicted groundwater head until 2010
Figure 8.3 Predicted solute concentration until 2010 in Well No. 8.
However, the groundwater level recovered to the level observed during the normal rainfall within the next year. Even under the normal rainfall years the water level was from -0.4 to -1.8 m in the wells located up to 800 m from the coast. The groundwater head was lowered from 1 to 2.4 m below the sea level during drought years in the coastal region. During these drought periods, there would be an increase in pumping, which was not considered in this simulation. In case of excessive pumping during such periods, it could only possibly cause seawater intrusion along the coastal areas. Solute concentration also follows the similar trend as that of groundwater level.
Figure 8.4  Predicted groundwater head with decrease in rainfall once in four years
8.2.3 Increase in pumping

As groundwater is the major source of water for the industries located in this region, there has been an increase in pumping over the years. Hence, it is essential to know the behaviour of the system under increased hydrological stress. There are two major anticipated changes in the pumping pattern in future, the first being the possible increase in pumping at MAPS station to meet the increasing demand for the expansion of its activities, and the second being the increase in pumping for various uses over the entire area. These two situations are discussed below:

8.2.3.1 Increase in pumping by 15% at the MAPS pumping station

It is anticipated that pumping will be increased by 2 MGD for supply to PFBR near MAPS. Hence, the model was run with an increase of 2 MGD (15% increase) pumping at its pumping station. For these runs, the monthly average rainfall calculated from the 70 year rainfall data was used. The predicted regional groundwater head with increase in pumping is shown in Figure 8.5. In well no. 33 located in Pandur village (located on the western side of the pumping station), the groundwater head was lowered by 0.4 to 0.6 m due to increase in pumping (Figure 8.6). In well no. 35 located in Lathur village (located on the eastern side of the pumping station), the groundwater head was lowered by 0.6 to 0.8 m due to increase in pumping (Figure 8.7). The comparison between the wells located on the western and eastern parts of the MAPS site indicates that the groundwater level decreases more on the eastern side. Even under normal rate of pumping, the groundwater head is lowered below the sea level during the dry seasons as discussed earlier, where as due to
the increase in pumping at the MAPS pumping station, the groundwater water head would decline much lower than the sea level. The flow vectors also indicate that about 2 – 2.5 km inland from the coast would get affected by saline intrusion, resulting in contamination of the groundwater resources. So, if the pumping is increased by 2 MGD at MAPS pumping station, the villages in the eastern part will get affected. A 2 MGD increase in pumping at the MAPS pumping station, however, does not have any major effect in the solute concentration.

8.2.3.2 Increase of pumping by 15% in the entire study area

The groundwater pumping rate for the entire study area was increased by an additional 2 MGD (i.e. 15% increase). For these runs, the monthly average rainfall calculated from the 70 year rainfall data was used. The forecasted model indicates that this aquifer system is stable and suffers no adverse effect due to increase in pumping. The groundwater head values are found to be lowered by 0.1 to 0.3 m (Figure 8.8). This clearly indicates that the aquifer is stable and increase in 2 MGD pumping uniformly distributed over the entire area does affect this aquifer system.

The chloride and sodium concentration marginally increase by about 5 mg/l when the pumping was increased by 15% for the entire area. However, there is no major change in the concentration of bicarbonate and calcium (Figure 8.9).
Figure 8.5 Predicted groundwater head for September 2010 with increase in pumping by 2 MGD at MAPS site and under normal pumping conditions
Figure 8.6 Groundwater head with present pumping conditions and with an increase in pumping by 2 MGD (15% at MAPS) western side of the MAPS site.
Figure 8.7  Groundwater head with present pumping conditions and with an increase in pumping by 2 MGD (15% at MAPS) eastern side of the MAPS site.
Figure 8.8  Groundwater head with present pumping conditions and with an increase in pumping by 2 MGD (15% overall).
Figure 8.9  Predicted solute concentration with 2 MGD increase in pumping.
8.2.4 Effect of construction of subsurface barrier

The expansion of the atomic power station at Kalpakkam will require pumping of 2 MGD in addition to the present level of pumping. As the model prediction of this additional pumping indicated decline in the groundwater table by 0.6 - 0.8 m (explained in section 8.2.3.1), a proposal was made to construct a subsurface barrier across the Palar River to augment the groundwater resources. Hence, the three-dimensional mathematical model of this area developed was used to predict the impact of the subsurface barrier located near Ayapakkam village on the groundwater head. The proposed dimension of the subsurface barrier to stretch across the Palar River is about 1362 m in length and extends to a depth ranging from 3.66 - 6.90 m. The presence of this subsurface barrier was simulated in the model by assigning zero hydraulic conductivity values to the cells near the village of Ayapakkam. The model predicted an increase in the groundwater head adjoining the barrier (Figure 8.10). The impact of the barrier is clearly seen by the increase in the groundwater head by 0.1 to 0.3 m (Figure 8.11a) along the upstream side of the barrier, while on the downstream side the groundwater head is lowered by 0.1 to 0.2 m (Figure 8.11b).

Further, the effect of the subsurface barrier on the spatial variation of solute concentration is also similar to that of groundwater level.
Figure 8.10 Predicted regional groundwater head with impact of subsurface barrier on September 2003
Figure 8.11a Effect on the groundwater head with the construction of subsurface Barrier along the upstream side

Figure 8.11b Effect on the groundwater head with the construction of subsurface barrier along the downstream side