CHAPTER - 7

OCCURRENCE AND MOVEMENT OF GROUNDWATER

7.1 Hydrogeological Units:

The occurrence and movement of groundwater depend upon the rock formations present in the area. It also depends upon the topography, structure, and geomorphology, as well as hydrogeological properties of the water-bearing materials. The first three aspects of the area have been dealt with in the preceding chapters. This chapter therefore presents an insight into the general hydrogeological properties of water-bearing formation with a view to throw light on any possibility of inflow of ground waters from the hard rock as well as unconsolidated hydrolitho units into the aquifers of the study area.

7.1.1 Alluvium:

Alluvium comprises of silt, sand, gravel, and clay particles. It is an excellent aquifer in the study area. It covers an area of 869.04 Sq. Kms (7.67% of the total area of the study region). 3 key wells ground water level was monitored at in this formation. The depth to water level ranges from 4.50 bgl in village Garautha to 8.0 m bgl in village Dhanaura during pre-monsoon period – 1993 and 2002, whereas it ranges from 3.10 m to 5.05 m bgl in villages Siya & Dhanaura respectively during post-monsoon period 1993 and 2002. The water table ranges from 158.82 m to 165.94 m amsl in village Dhanaura and Garautha respectively during pre-monsoon period 1993 and 2002, and it ranges from 162.77 m to 166.84 m amsl in the same two villages respectively during post-monsoon – 1993 & 2002. The fluctuation between pre & post monsoon water levels ranges from 0.80 to 3.80 m in villages Garautha and Siya respectively during the year 1993 & 2002.

7.1.2 Basalt :

Basalt belongs to Deccan Traps. It covers an area of 1635 sq. kms (14.43% of the total area of the study region). 21 key wells have been selected for measurements of water level during pre-monsoon and post monsoon periods in the years 1993 and 2002. The depth to water level ranges between 4.20 m bgl and 17.40 m bgl in villages Dhamoni and
Jalandhar respectively during pre monsoon period of the year 1993 & 2002, whereas it ranges between 1.65 m & 10.3 m bgl in villages Berkheri & Jalandhar respectively during post-monsoon – 1993 and 2002. The water table ranges from 368.27 m to 587.57 m amsl in villages Barattiha & Bhainsa respectively during pre-monsoon period – 1993 and 2002, whereas it ranges between 369.02 m to 591.77 m amsl in villages Barattiha and Bhainsa respectively during post-monsoon period 1993 and 2002. The fluctuation between pre and post-monsoon water levels ranges from 0.30 m to 8.65 m in village Dhamoni and Jaisinagar respectively during 1993 & 2002.

7.1.3 Sandstone:

Sandstone belongs to Vindhyan supergroup. It covers an area of 1051.47 sq kms (9.28% of the total area of the study region). 13 key wells have been selected for measurements of water level during pre monsoon & post-monsoon periods in the years 1993 and 2002. The depth to water level ranges between 4.25 m and 16.40 m bgl in villages Bamhauri and Karrapur respectively during pre-monsoon period, whereas it ranges between 1.60 m & 9.20 m amsl in village Baxwaha during post-monsoon period – 1993 & 2002. The same parameter ranges from 436.64 m and 513.25 m amsl in villages Pedarwa and Sunwaha respectively during pre-monsoon period – 1993 and 2002, whereas it ranges between 440.19 m and 515.3 m amsl in the same two villages respectively during post-monsoon period 1993 and 2002. The fluctuation between pre-monsoon and post monsoon water levels ranges from 0.60 to 9.80 in villages Sunwaha and Baxwaha respectively during 1993 & 2002.

7.1.4 Granite:

It is the most extensive aquifer in the study area. It covers an area of 7206.19 sq. kms (63.6%). As this formation covers major part of the study area, 80 key wells have been selected in this aquifer for measurements of water level during pre-monsoon & post-monsoon period in the years 1993 & 2002. The depth to water level ranges between 3 m to 16.17 m bgl in villages Bandha & Bamhorikala respectively during pre-monsoon period, whereas it ranges between 1.20 m and 16.10 m bgl in villages Dargawan &
Harapalpur during post-monsoon period – 1993 & 2002. The water table ranges from 182.76 and 490.4 m amsl in villages Gursarai and Kenwar respectively during pre-monsoon period 1993 and 2002, whereas it ranges between 185.46 to 493.5 m amsl in the same two villages respectively during post-monsoon period 1993 & 2002. The fluctuation between pre-monsoon and post-monsoon water levels ranges from 0.15 to 8.10 m in villages Matgown and Majna respectively during 1993 and 2002.

7.2 Well Inventory:

The well inventory data of 121 dug wells were collected from State Groundwater Survey. Water Resources Department, Sagar (M.P.) and Jhansi (U.P.) for 1993 to 2002. These data relate to different rock formations occurring in the region, viz., Alluvium, Basalt, Sandstone, Limestone, granite etc. The location of inventoried wells is shown in Fig. 7.1, and the well inventory data are given in Appendix – 6. These data pertain to their following aspects:


On the basis of these data two sets of maps are prepared: maps of depth to water table Pre and Post-monsoon 1993, and water level Fluctuation map for 1993, maps of water table at the pre and Post-monsoon 1993; and a similar set of maps for the year 2002. A comparative interpretation of these map provides an insight into water below ground level and water table above sea level at pre and post-monsoon seasons as well as the fluctuation between there water extreme seasons comparison between two years – 1993 and 2002 leads to the trends of change in these parameters during the decade.
Dhasan River Basin, India
Location of Inventoried Wells

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- Location of Wells
26  Well Number in Dhasan Basin

Fig. 7.1
7.3 Depth to Water Level:

Depth to water level represents the position of water table with reference to ground surface. This data was collected from the office of the Senior Hydrogeologist, Groundwater survey, Water Resources Department, at Sagar (M.P.) and at Jhansi (U.P.). The maps of depth to water level were prepared for Pre-monsoon and Post-monsoon, 2002 by using 121 dug wells data. Similarly, maps were prepared for Pre-monsoon and Post-monsoon, 1993. The depths to water level maps are useful to delineate the areas of recharge, discharge, and water logging conditions.

7.3.1 Pre-monsoon Depth to Water Level-2002:

A pre-monsoon depth to water level map on scale of 1 cm = 10 kms at a contour (i.e. isopleths of depth to water level below ground level) at the interval of 3 m and shown in Fig. 7.2. A glance at depth to water level map indicates that the depth ranges between 3 and more than 15 m b.g.l. in Dhasan river basin. The area can be divided into four zones viz, shallow (3-6m), moderate (6-9m), deep (9-12m) and very deep (more than 12 m). It is evident that depth to water level is mostly deep to moderate in the major part of the Dhasan river basin except a small area in the south-east, south-west and some are middle basins, and north-east part where it is very deep. About 80% area of the basin shows the deep to moderate water level (6-12 m), and about 15% shows the very deep water level (more than 12 m) which indicate heavy pumping of ground water through dug wells and tube wells.

Browsing the map of depth to water level in pre-monsoon 2002, it can be generalised that shallow depth to less than 3 m bgl occurs in the lower most part of the Dhasan river and in a few very small patches on the flanks, except one east-west patch in the central basin. Similarly, very deep level conditions (> 12 m bgl) prevail over several small patches on either flanks of the basin, except one notable patch in lower central basin most; other area fall in the moderate depth to water level (i.e. 6-12 m bgl.) Thus only one notable and fairly extensive patch of deep or very deep water level in the lower mid basin calls attention, as does the one narrow east west patch of very shallow depth of water level in the central part of the basin in pre-monsoon season of 2002.
7.3.2 Pre-monsoon Depth to Water Level – 1993:

A pre-monsoon depth to water level map was similarly prepared for the Pre-Monsoon 1993 (Fig. 7.3). It is clear from the map that the depth to water level ranges between 3 m and more than 15 m b.g.l in Dhasan river basin. The area can be divided into four zones viz. shallow (3-6m), moderate (6-9m), deep (9-12m) and very deep (more than 12m). The major part of the area shows moderate depth to water level except small pockets around Jalandhar, Baxwaha, Ranital, Mau, Bamhorikala, and Bijora where it is very deep which might be due to withdrawal of groundwater in the summer season.

7.3.3 Comparison between Pre-monsoon Depth to Water Level – 2002 and 1993:

The comparison between the depth to water level maps for 2002 and 1993 reveals that the deep depth to water level has increased in upper and lower Dhasan river basin this 10-year period. The areas of depth range 6-9 m during 1993 have changed to the depth range 9-12 m during 2002 in upper and lower Dhasan basin. Some pockets of more than 12 m depth to water level have developed around Jaisinagar, Pedarwa, Jaruakheda, Karrapur, Hirapur, Bada Melhora, Naigawan & Berorakhet during 2002 as compared to comparison of 1993. This condition is ascribable to heavy pumping of groundwater through the dug wells and tube wells. The southern and north-eastern part of the Dhasan basin therefore becomes dry in summer season.

7.3.4 Post-monsoon Depth to Water Level – 2002:

A post-monsoon depth to water level map on scale of 1cm = 10kms at a contour interval of 3 meters is shown in Fig. 7.4. A glance at depth to water level map indicates that depth to water level ranges between less than 3 m to more than 12 m b.g.l in Dhasan river basin. The area can be divided into five zones viz., very shallow (less than 3m), shallow (3-6 m), moderate (6-9m), deep (9-12m), and very deep (more than 12m). The major part of the area shows shallow moderate depth to water level except in the pockets around Sarkhadi, Jalandhar, Baxwaha, Bada Melhora, Matgawn,
Dhasan River Basin, India
Pre-Monsoon Depth to Water Level
(May-1993)
Mau, Nowgown, BamhoriKala, Harpalpur, Tori-Fatehpur, where it is deep
to very deep (more than 9 m) and also except the areas around Bamhauri,
Lahargown, Ratausa, Dhawari, and Jigni, where it is very shallow (less
than 3m).

7.3.5 Post-monsoon Depth to Water Level – 1993 :

Post-monsoon depth to water level is mapped on scale of 1 cm =
10kms at a contour interval of 3 meters (Fig. 7.5). It is clear from the depth
to water level map that the depth to water level ranges between less than
3m and more than 12 m below ground level in Dhasan river basin. The
area can be divided into five zones viz. very shallow (0-3m), shallow (3-6m),
moderate (6-9m), and deep (9-12m), and very deep (more than 12m). The
major part of the area shows shallow depth to water level and some part of
the area shows moderate depth to water level. Nevertheless, some small
pockets show definably greater depth to water level (i.e. more 9 m b.g.l)
particularly on the margin of the basin, or even in lower central basin and
small one in upper most basins.

Comparing with the pre-monsoon condition, it may be noticed the
low water level pockets are the scares one as appeared on pre-monsoon
map, except for a secondary low area in lower central basin. One small
pockets of pre-monsoon low around wells Nos. 32 and 33 have however
changed radically into a shallow depth in the monsoon period.

7.3.6 Comparison between Post-monsoon Depth to water level –
2002 and 1993 :

The comparison between the depth to water level maps for 2002 and
1993 reveals that the moderate depth to water level developed in south-
western, middle and north-eastern basin during 2002. The depth range 3-
6 m during 1993 has changed to the depth range 6-9m during 2002, in NE,
middle & SW Dhasan basin. Some pockets of more than 9 m depth to
water level have developed around Sarkhadi, Jalandhar, Baxwaha,
Matgown, BamhoriKala and ToriFatehpur during 2002 as compared to
1993. These conditions appear related to heavy pumping of ground water
through the dug wells and tube wells. Some pockets of more than 9m
depth to water level in 1993 have disappeared around Ghaura, Bhagwan,
and Ranital during 2002.
Dhasan River Basin, India
Post-Monsoon Depth to Water Level
(Nov. 2002)
Dhasan River Basin, India
Post-Monsoon Depth to Water Level
(Nov.-1993)

Index
Depth To Water Level (m.b.g.l.)
- 0 – 3
- 3 – 6
- 6 – 9
- 9 – 12
- More than 12

Kilometres

78°30'E

25°N

24°N
7.4 Water Table (amsl):

Water levels of 121 dug wells were collected from the office of the Senior Hydrogeologist, Groundwater Survey, Water Resources Department, Sagar (M.P.) and Jhansi (U.P.) during pre monsoon and post monsoon, 2002 & 1993, and the heights of respective water level above mean sea level were determined from the reduced levels of the wells (presented in Appendix – 6).

The water table contour maps have been prepared by drawing contours through points of same water table value at 20m interval for pre-monsoon and post-monsoon 2002-1993. Flow lines have been drawn perpendicular to water table contours, which represent the direction of movement of water through the aquifer, to the direction of decreasing head.

7.4.1 Pre-monsoon Water Table – 2002:

A pre-monsoon water table map on scale of 1cm=10 kms at 20 m contour interval has been prepared and shown in Fig. 7.6. From this map it is clear that the general trend of ground water flow is towards the main drainage and its major tributaries. Arrows on the map indicate the movement of ground water. It represents the true ground water conditions of the water-bearing formations. The highest water table contour is 580 meters with reference to mean sea level, whereas the lowest is 160 meters with reference to msl. The maximum height of water table is 587.17 m above msl, whereas the minimum height is 158.82 meters above msl. Widely spaced contour indicates more permeable water-bearing formation and the closely spaced contour shows less permeable aquifer. In general, the map shows that the study area has good aquifer.

7.4.2 Pre-monsoon Water Table – 1993:

A pre-monsoon water table map on scale 1cm=10kms at 20m contour interval has been prepared and shown in Fig. 7.7. From this map it is clear that the general trend of groundwater flow is towards the main drainage and its major tributaries. The movement of ground water is indicated by arrows on the map. It represents the true ground water condition of the water-bearing formations. The most of the area is characterised by the widely spaced water table contours in the almost plain
Dhasan River Basin, India
Pre-Monsoon Water Table Contours
(May-2002)

INDEX
Flow Line
Water Table Contour
(in metre amsl)
Contour Interval 20 m
Dhasan River Basin, India
Pre-Monsoon Water Table Contours
(May-1993)

INDEX
Flow Line
Water Table Contour
(in metre amsl)
Contour Interval 20 m
topography represents the area of more permeability than the hilly area with closely spaced water table contours in the middle basin of Dhasan river, which is relatively less permeable area. The altitude of water table ranges between 580 m amsl near Bhainsa village in the southern part of Dhasan river and 160 m amsl near Dhanaura village in the northern part of Dhasan river. The maximum difference in water table contour is 420 m.

7.4.3 Comparison between Pre-monsoon Water Table – 2002 and 1993:

The comparison between the water table maps for 2002 and 1993 reveals that the nature and behaviour of water table is almost similar to the pre monsoon water table contour in Dhasan river basin. Some pockets are developed for water rich around Kakarwaha, Burena, Mankari, Kachhora and Kaneyra during 2002 as comparison to 1993. Some water-rich pockets developed around Baldevgarh, Sejora and Harpalpur during 2002 in comparison to 1993.

7.4.4 Post-monsoon Water Table – 2002:

A post monsoon water table map on scale of 1cm=10kms at 20m contour interval has been prepared and shown in Fig. 7.8. It becomes clear from this map that the trend of groundwater flow is towards the main drainage and its major tributary. The movement of groundwater is indicated by arrows on the map. It represents the true groundwater conditions of the water bearing formations. The highest water table contour is 580 m amsl, whereas the lowest is 160 m amsl. The maximum height of water table is 590.62 m amsl near Bhainsa village in the southern part of Dhasan river and the minimum height of water table is 162.77m amsl near Dhanaura village in the northern part of Dhasan river basin. The maximum difference in water table contour is 420m. Widely spaced contour indicates more permeable and water bearing formation and the closely spaced contour shows less permeable aquifer. In general, the map shows that the study area has good aquifer.

7.4.5 Post-monsoon Water Table – 1993:

A post-monsoon water table map has been prepared on the scale of 1cm=10kms at 20m contour interval water table above mean sea level and shown in Fig. 7.9. From this map it is clear that the general trend of
Dhasan River Basin, India
Post-Monsoon Water Table Contours
(Oct.-2002)

INDEX

Flow Line
Water Table Contour
(in metre amsl)
Contour Interval 20 m

10 20 30 Kilometres
Dhasan River Basin, India
Post-Monsoon Water Table Contours
(Nov.-1993)

INDEX
Flow Line
Water Table Contour
(in metre amsl)
Contour Interval 20 m

Kilometre
groundwater flow is towards the main drainage and its major tributary. Arrows on the map indicate the movement of groundwater. The most of the area is characterised by the widely spaced water table contours in the almost plain topography represents the area of more permeability than the hilly area with closely spaced water table contours in the middle basin of Dhasan river, which is relatively less permeable area. The highest water table contour is 580 m amsl, whereas the lowest is 160m amsl. The maximum height of water table is 591.77 m amsl near Bhainsa village and minimum height of water table is 164.12 m amsl near Dhanaura village.

7.4.6 Comparison Between Post-monsoon Water Table – 2002 and 1993:

The comparison between the water table maps for 2002 and 1993 reveals that the configuration of water table is almost similar. Some pockets are developed for water rich around Mehar, Rurawan, Mankari, Mauvaripur during 2002 comparison of 1993. Some water rich pockets are disappeared around Kakarwaha, Burena, Dargawan, Kachhora & Jever during 2002 in comparison to 1993.

7.5 Topography and Water Table Along Dhasan Basin:

A ground surface contour map (Fig. 7.10) has been prepared by considering the reduced level of ground surface at each dug well occurring in the Dhasan basin area. A glance at this map shows that the highest elevation is 596.47 m amsl near Bhainsa village and lowest elevation is 167.82 m amsl near Dhanaura village.

A cross section along line A-B has been drawn in SW-NE direction and topographic profile has been also prepared along the same cross section line. The profiles of static water level for pre-monsoon and post-monsoon periods have been drawn in Fig. 7.11. These profiles show that they are not parallel to the topographic profile, because the basin is covered by different type of rocks, so the water table is different in different rock formation.
Topography & Water Table Along Dhasan Basin

- Ground Surface
- Post-monsoon
- Pre-monsoon

2002

1993

Vertical Exaggeration 87.50 Times
7.6 Water Level Fluctuation:

The water level fluctuation was determined by deducting post-monsoon water level from the respective pre-monsoon water level for all the inventoried wells and given in Appendix-6. The water level fluctuation map for the year of 2002 has been prepared by using water level fluctuation observed in the wells and shown in Fig. 7.12. Similarly, the water level fluctuation map (Fig. 7.13) for the year of 1993 has also been prepared. The water level fluctuation map is useful to evacuate the ground water recharge in the area.

7.6.1 Water Level Fluctuation – 2002:

A glance at water level fluctuation map (Fig.7.12) indicates that the water level fluctuation ranges between less than 2m & 8m in Dhasan river basin. The low fluctuation was found in mostly middle basin around Barattiha, Sunwaha, Ghaura, Bandha, Makari, Chandpura, Matgaon, Sihora, Baroda-Sagar etc. and northern part around Harapalpur, Tori Fatehpur, Garautha etc. The high fluctuation more than 6m was found in the north-west around Jeoramora, middle basin around Kakarwaha, Hirapur & south-east around Karrapur, south-west around Jalandhar, and south basin around Karhad, Jaisinagar.

7.6.2 Water Level Fluctuation – 1993:

It is apparent from the map (Fig. 7.13) that the water level fluctuation ranges between less 2m and 10m in Dhasan river basin. The low fluctuation (less than 2m) was found around Rajauwa, Mehar, Dhamoni, Bamhauri, Baraj, Sendhpa, Bharatpur, Jatara, Tori Fatehpur & Garautha etc. and the high fluctuation (more than 8m) was found around Jaisinghnagar, Jalandhar, Karrapur, Pedarwa, Baxwaha, Kharoo, Dhajraj, Chendeyra, Siaori, etc. The fluctuation of water level of this area was uncertain due to dry wells during pre-monsoon.

7.6.3 Comparison between Water Level Fluctuation 2002 and 1993:

The comparison between the water level fluctuation maps for 2002 and 1993 reveals that there is no major change in the ranges of fluctuation. Some pockets disappeared for high fluctuation around Jaisinghnagar, Jalandhar, Baxwaha, Jaiharpura, Kharoo, Majna, Siaori, Tori Fatehpur seen in 1993 look mitigated in 2002, and some pockets of high fluctuation look to have appeared around Karhad, Jeoramora.
Dhasan River Basin, India
Water Level Fluctuation
(From May through November 2002)

Index
Water Level Fluctuation in Metres

- 0 – 2
- 2 – 4
- 4 – 6
- 6 – 8

78°30'E
79°30'E
10 0 10 20 30 Kilometres
Dhasan River Basin, India
Water Level Fluctuation
(From May through November 1993)
7.7 Water Level Change:

This section considers the change of water level (bgl) between pre-monsoon seasons as well as between the post-monsoon seasons of the reference years. The water level change was determined by deducting Pre-monsoon depth to water level: 1993 from the respective Pre-monsoon depth to water level: 2002; and similarly for the post-monsoon periods.

7.7.1 Water Level Change: Pre-monsoon: 2002, in comparison to 1993:

A glance at Pre-monsoon level change: 2002, in comparison to 1993 (Fig. 7.14) indicates that the water level change ranges between more than +1m and more than −4 metres in Dhasan river basin. The high water level change (water level fall more than 4m) was found in south part around Bandri, Karrapur, Rajauwa and some part of middle basin around Berethi, Hirapur, Kakarwaha. The low water level change was found in middle & upper basin except some pockets. The water level rise in 2002 in comparison to 1993 was found in some part of north basin and some part of middle basin around Sunwaha, Mardewra, Bamnorakala, Bhagwan, Ranital, Sarkar, Chendeyra, Jevar, Muraunipur, Siya. Only one pocket was found in middle basin (around Ranital) where water level rise more than 1 metre.

7.7.2 Water Level Change: Post-monsoon: 2002, in comparison to 1993:

A glance at Post-monsoon water level change: 2002, in comparison to 1993, (Fig. 7.15) indicates that the water level change ranges between more than +1 metre to more than −4 metre in Dhasan river basin. The high water level change (water level fall more than 4 metre) was found in some part of south basin around Sarkhadi, Sihora, Mehar, Karrapur and some part of middle east basin around Baxwaha, Gulganj, Panagar, Kharoo, Deori, Lugase. The low water level change was found in some pockets over whole basin. The water level rise in 2002, in comparison to 1993, was found mostly in middle basin around Mardewra, Ramtoriya, Bamnorakala, Ghaura, Bhagwan, Ranital, Berethi, Bharatpur, and in two part of south basin around Sagar and Karhad, and over one pocket of north basin around Ratausa. Five pockets were found in the basin (around Sagar, Mardewra, Ranital, Berethi, and Bharatpur) where water level rise more than 1 metre.
Dhasan River Basin, India
Pre-Monsoon Water Level Change: 2002
(In Comparison to 1993)
Dhasan River Basin, India
Post-Monsoon Water Level Change: 2002
(In Comparison to 1993)
REFERENCES:


