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SUSTAINABLE ENVIRONMENTAL SANITATION AND WATER SERVICES

Planning for groundwater utilisation: case study Maharashtra

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Maharashtra state often comes under the grip of water scarcity, due to the vagaries of monsoon. Fourteen districts, in the Central part of the state have been identified as chronically drought affected and due to repeated failure of monsoon in this part of the state, scarcity relief measures and works under Drought Prone Area Programme (DPAP) have been implemented for past twenty five years. Water shortage in these districts is felt to such a critical extent that, even the drinking water has to be made available through tankers from the sources located at a very long distances. Under such a severe situation, information on the availability of both groundwater and surface water forms the basis for planning and management of water supply.

Groundwater moves away from its in-situ recharge location, towards storage zone, or towards gravitational lows. Hence the information about the rate at which groundwater moves away from the location of its recharge viz. information on the dynamics of the groundwater, becomes vital for planning of water supply during periods of crisis. Further, during the period of normal / excess rainfall years, caution taken to keep the excess groundwater reserved for drinking water purposes will unnecessarily obstruct the utilization of this resource for improving crop productivity.

Construction of Piezometers and installation of DWLRs on them in Maharashtra state has opened a new vision, in data collection on groundwater levels, since 1999. This data has been used to develop relations between depth to water level, the quantity of water available in the aquifers and duration of availability of groundwater. Data collected at two Piezometers located at villages Kolgaon and Mahim, in watershed WF-19, Taluka Palghar have been used for this analysis.

Details of piezometers

Villages Kolgaon and Mahim are located in Palghar taluka of Thane District, Maharashtra. These villages are included in watershed WF-19. This watershed is a part of westerly flowing river basin. This is an under developed water shed and is designated as white with respect to its stage of ground water development / utilization.

Kolgaon (730 45' 52"; 190 43' 25") is located at A1 quadrant of Topo-sheet No. 47 A/14. The area around this village is having plane land gently sloping towards western direction. Formation around this village is feebly fractured and moderately weathered Massive Basalt, belonging to Deccan Traps. Weathered zone extends up to 5 meters below ground level. 83 % of the watershed's assessment worthy area, is occupied by this hard rock aquifer. During January 1998, one Piezometer of 30 meters depth has been constructed at Kolgaon village. Due to the limited irrigation activity around the location of Piezometer, this Piezometer represents a non- interference (minimum disturbed) hard rock aquifer conditions, within the watershed WF-19. This Piezometer is at an elevation of 11.89 meters above mean sea level.

Western most part of the watershed WF 19 is occupied by the Coastal Alluvium formation. This formation is made up of sand, gravel, clay and seashells. Groundwater potential in this formation is very good. Ground water in this area is used for both irrigation and drinking water purposes on a large scale. This part of the watershed is under intense cultivation for raising cash crops and as a result, the area has become over exploited from groundwater development point of view. The impact of this development is visible in terms of

- Reduction in duration of groundwater availability and
- Seawater encroachment in certain parts of the watershed affecting the groundwater quality and creating irreversible changes in the environmental conditions.

WF-19 watershed has 17% of its assessment worthy area occupied by this Coastal Alluvium aquifer. With a view to monitor the ground water levels of this aquifer, one Piezometer at village Mahim (72 44' 19"; 19 30'37') was constructed, to a depth of 20 meter during January 1998.

This Piezometer is at an altitude of 8.1 meters above mean sea level. On this Piezometer DWLR was installed on 3-1-2000. Initially DWLR has recorded data for a partial water table recession season, and later it has started malfunctioning. Hence, the DWLR recorded data, along with manually collected data (after October 1999), have been used for interpretation purposes.

Type of DWLR records

The data generated through DWLRs installed on two Piezometers along with the data collected manually, have been used for undertaking this analytical work. However, this data covers only three recession seasons in case of Kolgaon and only one partial recession season in case of Mahim Piezometer. With a view to work out the rate of water table recession and residual ground water balance (in quantity), DWLR data has been filtered and data for every change in water level, from its peak, by 0.5 meter has been compiled. Cumulative time taken in days for such a change for Kolgaon Piezometer has been calculated. Change in

water level after every seven days recorded at Mahim Piezometer have been worked out.

Water table at Kolgaon had receded from its peak level of 1.12 meters below ground level (bgl) on 13/9/1999 to 9.29 meters bgl on 26/3/2000, in 4656 hours (i.e. 194 days). During the record of first recession season though the water levels have receded up to 9.29 meters bgl, due to heavy disturbances in water levels, the compilation of data up to 7.62 meters was undertaken. Furthermore there exist gaps in the filtered data. By using the data, that is going to be generated in future, scope for filling the data gaps exists.

Water table in Mahim Piezometer had reached its peak at 2.67 meters on 25th Aug 2000 and recedes to its trough at 7.85 meters on 19th May 2001. This depletion takes place during a period of 264 days. There exist data record gap from 13th December 2000 up to 7th January 2001. This data gap will be filled from the data that is going to be generated in future. It has been observed that the rate of recession of water table, at shallow depth is having a faster recession rate, compared to its recession rate at increased depths.

Groundwater balance

A ground water assessment has been recently completed for Thane district. As per the recommendation of the Groundwater Estimation Committee Viz. GEC-97, considerations for the micro variables, such as groundwater storage worthy area, groundwater potentials in irrigation command area and non-command area, non-monsoon rain fall recharge, normalization of rainfall recharge, etc. have been given. According to this assessment watershed WF-19 has an annual ground water recharge of 5188.22 hectare metres, annual ground water withdrawal of 523.61 hectare metres and annual ground water balance of 4664.61 hectare metres'.

Analysis of the data

Relation between depth to water levels (measured through DWLRs installed on Piezometers) and ground water balance in the water shed have been developed based on following assumptions:

- Groundwater recharge in the watershed is having direct reflection in the form of water levels in Piezometer.
- Total annual groundwater recharge i.e. 5188.22 hect. meters in water shed WF-19, is being represented as the shallowest water level, at a depth of 1.12 meters bgl, in Kolgaon Piezometer and 2.67 meters bgl, in Mahim Piezometer, respectively.
- Groundwater storage distribution, within the watershed is directly proportional to the area occupied by Coastal Alluvium and Basalt formations and further to Specific yield of the above-mentioned formations.
- Vertical variations in **T** and **S** values of the aquifers have been presumed to be nil. But in field, conditions they are found to be otherwise. Hence, in future data on vertical changes in T & S values will be collected (by adopting inverse well technique), and by introducing this additional control in to the mathematical relations, further improvement will be achieved.

Based on the above three understandings ground water recharge distribution in Coastal alluvium and Basalt has been worked out. Ground water assessment worthy area of the watershed WF-19, has been occupied in the proportion of 17: 83, by Coastal alluvium and hard rock aquifers, respectively. Similarly, for all calculation purposes specific yields of these aquifers have been considered as 3.5% and 1.5%, respectively. By giving the effects of the above factors, groundwater distribution in coastal alluvium and hard rock aquifers have been calculated to be in the proportion of 129: 249, with in the watershed WF-19. Based on this ratio, total groundwater recharge of 5188.22 hectare meters distribution works out for the water shed as 1770.58: 3417.64 hectare meters.

Depth to water level, recession duration and ground water balance

Data filtered from raw data, for Piezometer at village Kolgaon is shown at statement no. K. Similarly data for the Piezometer at village Mahim is shown at M. Graphical relation developed for hard rock aquifers represented by Kolgaon Piezometer between

i. Depth to water level and recession duration in days
ii. Depth to water level and Ground water balance in Hectare Meters and
iii. Ground water balance and recession period in days

are shown at plate no. K-2, K-3 and K-4, respectively. Similar relation developed for Coastal Alluvium aquifer in watershed WF-19 is shown at plate no. M-2, M-3 and M-4, respectively.

By referring the water levels recorded / measured at Piezometer centers, the groundwater availability on that day with in the watershed and duration for which the available balance will be available can be worked out by using the graphs K-2 and M-2. By referring the water levels recorded by DWLRs, balance of ground water resource available on any day can be worked out, by using graph number K-3 & M-3, with respect water levels recorded at two Piezometers.

Further, the information about the duration during which groundwater balance gets reduced to its minimum quantity, can be worked out by referring to graph number K-4 & M-4. Based on these information and data on population of the area, planning for reservation of ground water for drinking water purpose can be worked out and the rest of available ground water storage can be planned for irrigation activity. By referring to graph number K-4 & M-4, at the end of monsoon period, future of water table recession trend can be predicted and total planning for optimum utilization of Groundwater can be achieved.

Word of caution

It is very important to understand that, the present analysis of data has been undertaken by using DWLR recorded data for one monsoon cycle only along with manually collected water levels. This analysis, if based on the water table data in-puts of longer duration, then by normalizing the water table recession curves (by using best-fit line technique), the improvement in the quality of forecasting, can be achieved. Further, necessity to introduce the additional controls like vertical variations in T and S values of the aquifers have been felt.

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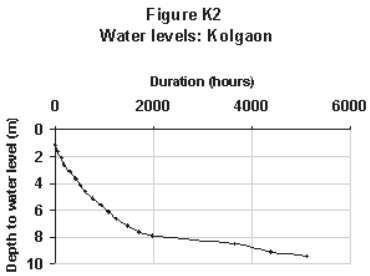
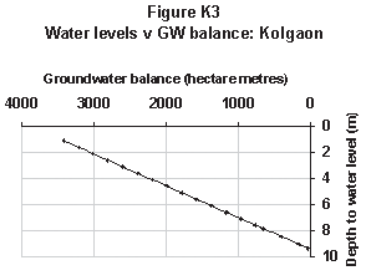
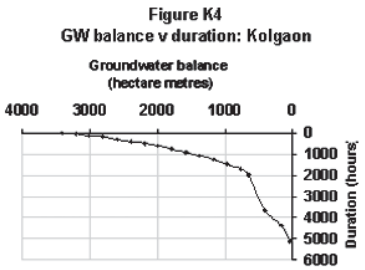
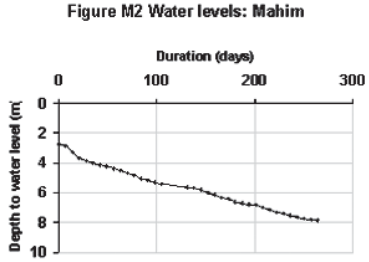
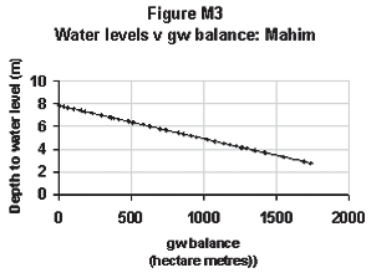


Figure K2.









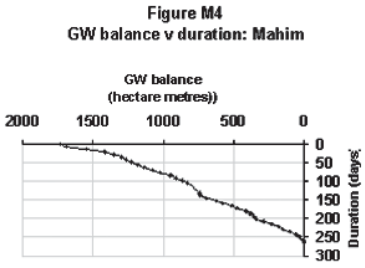


Figure K3 to M4