Research Article

A statistical analysis of static water level trend and rainfall data in PTW-1watershed, Buldhana district, INDIA

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Abstract

Groundwater is a dynamic resource and it varies from place to place quantativaly and qualitatively. Its quantity is mostly depends on the rainfall data of that particular region, Geological terrain, Rock type i.e. Aquifer, Geomorphology and drainage pattern. In India especially in Maharashtra state drinking and irrigation water demand is rapidly increases last few years, to cope up this problem, it is necessary to evaluate the existing trend and availability of groundwater in time and space for proper planning in near future. Pre and post monsoon ground water record and its trend, rainfall pattern, and geological especially hydrological study is very useful technique for judicious future planning of groundwater utilization. Proper utilization of available surface water and Ground water quantity it is necessary to manage the watershed concept. For this manners, this paper discuss to analyze the long term (2002-2012) trend of pre- and post-monsoon water level of watershed PTW-1 of Malkapur and Motala Taluka of Buldhana district first time. Trend of Pre and Post Monsoon static Ground water level indicate that there is depletion of static ground water level with the passage of time.

Keywords: Groundwater, static water level, rainfall data, pre and post Monsoon water level,PTW-1 watershed, Statistical analysis, Malkapur, Motala taluka, buldhana district.

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INTRODUCTION

Groundwater is a vital natural resource for the reliable and economic provision of potable water supply in both the urban and rural environment. It thus plays a fundamental role in human well-being, as well as that of some aquatic and terrestrial ecosystems. In the background of preserving this most important natural asset, water utility management is the key area that managers need to focus upon. Fresh and clean water is of fundamental importance to the survival, protection and development of human needs, as well as for the conservation of the environment (Purushtotham et.al, 2011; Deshpande and Aher, 2011). Drinking and irrigation water scarcity is the utmost problem in the country especially in the hard rock terrain. As far as the population has grown its drinking water and food demand rapidly increases. Water is a natural occurring but limiting resource. The rapid development of ground water in the Maharashtra State has boosted agriculture production and plantation crops but decline in ground water level and yield has also been observed particularly in hard-rock regions. In hard-rock regions of the State, the ground water utilization exceeds the ground water replenishment under normal recharge conditions. The situation arises at many places where sustainable management of ground water has become a challenge. Ground water aquifers in these areas are fast depleting leaving the aquifers overexploited. Every year, the list of

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such areas is increasing, forcing the planners and the development agencies to look for the option of artificial ground water recharge. The main source of surface water and Ground water is Rainfall, if the area comes in assured rainfall zone and having a proper percolation of runoff water with manageable exploitation of ground water then water balance is maintain. In the state of Maharashtra, scarcity problem is usual in every summer season, although the area comes in assured rainfall zone but emerging population and irrigation demand may cause an excessive withdrawal of Groundwater thus static water level is surprising decline last four to five years. As per rainfall data of the entire state there is no remarkable change but the time and tempo is not favorable for the recharge the ground water. To arrest the declining trend of ground water level and exponential growth of ground water abstraction structures various centrally sponsored watershed management programmes are being implemented by the State Government with the objectives of conserving soil and water on one hand and augmenting artificial recharge of ground water on other hand.

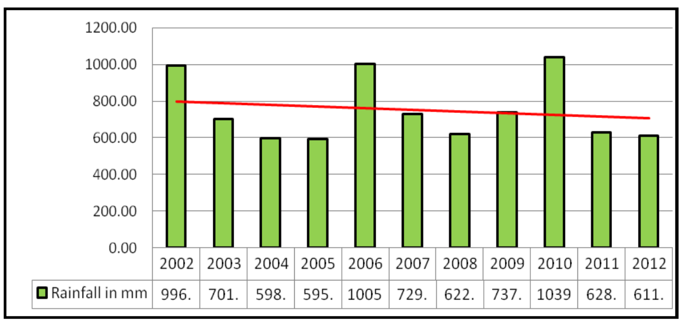

Figure 1: Rainfall Trend in Buldhana district

It is necessary to take curious steps to sustain the ground water and improve the water level by artificial recharge of rain water or surface water. For the planning and management of available water, Watershed management is the best tool. In this Perspective, Government has outlined the watershed boundaries and start to work accordingly, In Maharashtra Total 1531 watershed has been delineate. Buldhana district of Maharashtra is situated at eastern part of vidharbha region, geologically district contain a recent alluvium to Deccan basalt from upper cretaceous to lower Eocene and co ordinates lies between latitude $19^0$51' – $21^0$17' N and longitude $75^0$57' – $76^0$49'E. In the working year 2012 -13, District Buldhana has facing an acute scarcity problem in the entire district, as there is low rainfall in the district i.e. 611.83 mm against the last 10 years average rainfall is 712.96mm (RWSD,2002-2012), The Trend and Graphic Representation is given in Fig 1.

Study Area

Study area is watershed PTW 1 covering the taluka Motala and Malkapur. Watershed area is lies in between $20^0$43' and $21^0$59'N Latitudes and $75^0$56' and $76^0$15'E Longitudes Fig.2. The area is containing hard rock terrain towards the southwest part while alluvium thickness is increasing towards the north. The area is divided into three structural cum physical units i.e. run off Zone (a), Recharge zone (b) and Storage zone(c). These zones indicate the area of recharge i.e. ground water potential. Watershed PTW 1 is further divided into 6 mini watersheds on the basis of drainage in that area. Total area of this watershed is 16293 hectare and total number of village in this watershed is 25.Topographically southeast part is situated on high elevation i.e. 360m from mean sea level at village Sonbardi in taluka Motala while low elevation i.e. 260m is encountered at village Nimbhari of taluka – Malkapur nearer to Jalgaon district of Khandesh area. The area receives rainfall from southwest monsoon. The area falls in assured rain fall zone. The nearest rain gauge station is established at tahsil head quarter and it is maintained by Indian Meteorological Department. This area receives an average annual rainfall of 675 mm. The annual rainfall is distributed in 40 rainy days during June to October. While since last 2 years deficit rainfall has occurred and the deficiency is from 0% to 35% to average annual rain fall. The climate of area is characterized by a hot summer, well-distributed rainfall during the monsoon and generally dry weather during the rest of the year. The rainy season starts in June and lasts till the September. This is followed by sultry weather in October, cold weather from November to February and hot weather from March to May. The mean daily maximum temperature in May in this area is 40.00 C and minimum temperature in December is 10.0 C.

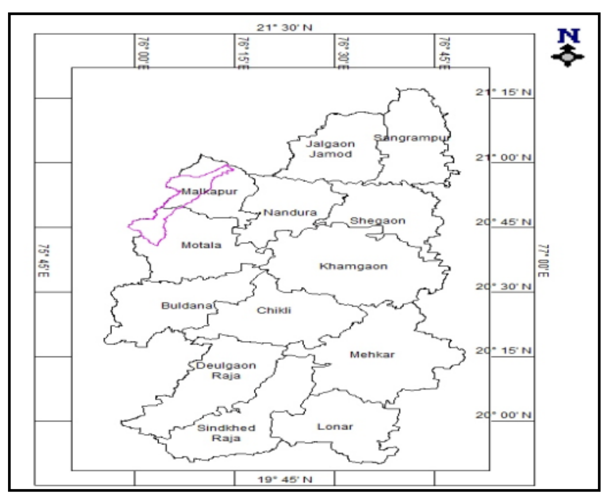

Figure 2: Location map of PTW-1 watershed

Physiography and drainage

Weathered rocks zone forms the most potential ground water reservoir. The depth of weathering is more important for determining the availability and potentials of water resources (Jangle, 2010). In watershed area PTW 1, on the basis of slope range area is distinctly divided into 2 major parts (Fig.3a),

High dissected plateau

This part lies in south east part of watershed, From watershed management point of view, area comes in runoff zone thus less scope to recharge the aquifer i. e. A Zone, Drainage density is more as compare to other parts in watershed and most of the streams are in first order stream, typical dendritic drainage pattern is common in this zone. slope variation observed in this particular part is from 360m to 320m and Total 15 village is included in this zone, to represent the static water level of zone Ground water surveys and development agency, Government of Maharashtra has fix a observation well located at village Pimpalgaon devi of taluka Malkapur.

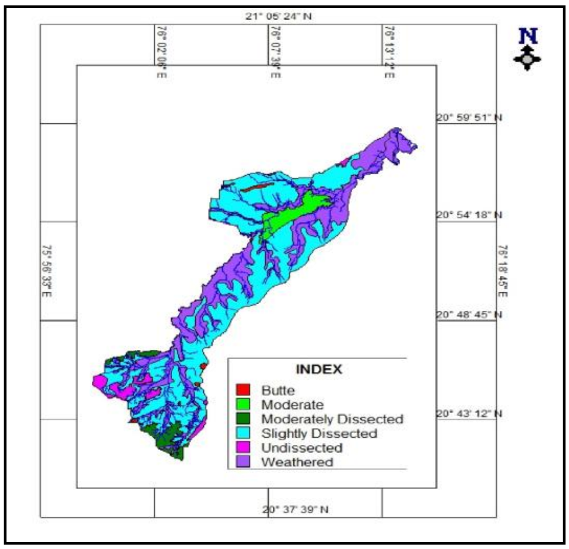

Figure 3a: Geomorphological map of PTW-1 watershed

Figure 3b: Map of PTW-1 watershed showing observation well

Moderately Dissected Plateau

Rest of part of the area in this watershed belongs in undissected plateu and drainage density is less as compare to Zone A, This area is called a recharge and storage zone i.e. B and having a scope to recharge aquifer in some extent. Elevation difference in this area is varies from 320m to 280m. Slope towards the north direction with the angle of 2^0 - 5^0, area is having a scope to augmentation of runoff water. Total 5 villages are situated in this recharge zone and for ground water monitoring and study one observation well is fixed at village Urha of taluka Motala. Drainage of this region is converted into 3^{rd} to 4^{th} order stream. This is plateau plain area and northern part of watershade PTW 1. Drainages are in mature stage and become flat towards the north. Total 5 villages is situated in this zone and for ground water monitoring and study one observation well is fixed at village Hingana Kazi of taluka Malkapur. Soil thickness is comparatively more in this part and reaches up to 7 m to 12 m. along the bank of Wyaghra its thickness is high. Aquifer potential is good (Pathrikar *et al*,1987). The watershed PTW 1 is drained by the major river Wyaghra and its tributary. Wyaghra River is flowing from southwest to northeast direction. It is in mature stage. The main drainage is topographically controlled which exhibits meandering in various places like nearby the bridge on Malkapur – Devdabha road and due west corner of village Hingana Kazi. Various 2^{nd} to 3^{rd} order stream flowing from northwest to southeast direction. Most of it originates at high elevation part towards south east of studied area. Widths of the nallas are approx 10 – 15 m. while depth is around 2 – 3.5 m. All the drainages in the area are flowing along the principle slope direction. The drainage exhibits typical Deccan trap pattern i.e. dendritic drainage pattern. Width of river in study area is varies from 30 -35 m. and depth range is about 3.0 to 5.0 m. The width of Wyaghra river is increasing from South to North while its depth is decrease in same direction. Depending on width and depth of river, the southern area in the village is more favorable to recharge rather than the northern area. Sand thickness in river bed is about 1.5 – 2.00 m. Watershed PTW 1 is further divided into 5 miniwatershed on the basis topography, slope variation and drainage density, i.e. Bld /PTW 1 (1/6),(2/6),(3/6),(4/6),(5/6) and (6/6). Total villages in this watershed are divided into these six miniwatersheds. In miniwatershed 1/6 containing 3 villages i.e. Wadgaon, Pimpalgaon Devi and Mahalungi, Miniwateshed 2/6 containing 4 villages Sonbarad, Lapali, Sindhkhed and Liha Bk, Miniwatershed 3/6 containing 5 villages Ridhora Kh, Gugli, Kolhi Golar, Urha and Dahigaon, Miniwatershed 4/6 containing 4 villages i.e. Chinchkhed, Malegaon, Wadaji and Harankhed. All above mentioned miniwatershed area comes in run off zone, during field survey hard compact massive trap is encountered on the surface thus there is no scope to recharge the surface water. Miniwatershed 5/6 containing Aland, Jambuldabha, Gaulkhed, Khamkhed and Hingana Kazi and Miniwatershed 6/6 contain 4 villages Jalalabad, Wajirabad, Bhalegaon and Nimboli. Miniwatershed 5/6 and 6/6 are more or less flat topography, weathered formation encountered along the cross section of Nallas, irrigation well thus there is scope to recharge the surface water into Ground water.

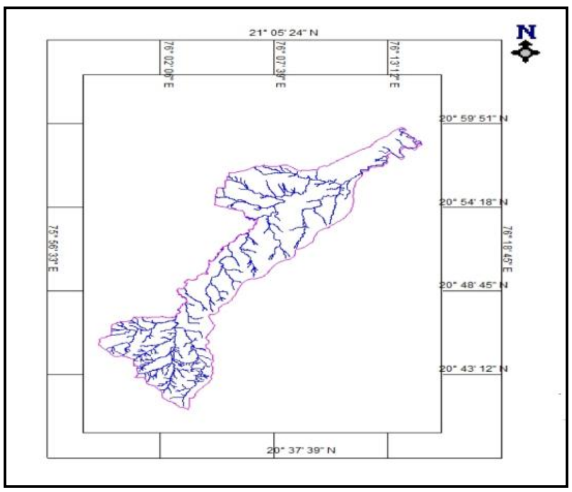

Figure 4: Drainage map of PTW-1 watershed

In watershed PTW 1, Vyaghra is major drainage flowing from southwest to northeast, in some patches along the bank of Vyaghra river local alluvium formation is observed, total thickness of local alluvium varies from 2.5 m to 7.5m. this alluvium contain Sand, pebbles and sandy loam which is followed by tiny yellow color clay or mud upghto the depth of 8 m to 12 m and its thickness is goes on increases towards north where Vyaghra meets the Purna river (Fig.4.).

Geological setting

Major part is covered by basaltic lava flows of upper Cretaceous to lower Eocene age, while the deposition of alluvial sediment is observed on both bank of River. Deccan Trap Basalt forms an important water bearing formation. The disposition of vesicular unit and massive unit of different lava flows has given rise to multi layered aquifer system. The water bearing capacity of Vesicular Basalt largely depends upon size and shape of vesicles, density of vesicles and the degree of inter connection of vesicles. Massive Basalt generally does not possess primary porosity. However, Massive Basalt, which is fractured, jointed and weathered posses' water bearing capacity. Degree of weathering and topographic setting also plays a major role in respect of productivity. In Basalt, ground water occurs both in Vesicular and Massive Basalt as well as inter flow zones in weathered mantle, fractured zones. In general ground water occurs under water table conditions in shallow aquifer and semi-confined to confined conditions in deeper aquifer (Agashe,1994;CGWB,2007).

The local alluvium consists of clay, sand, gravel, pebbles, and boulders. It occurs in one or more beds having thickness of 1.5m to 3.0m (Table.1). The local alluvium is underlined by grayish colored highly to moderately weathered massive basalt. It shows various cracks and fractures which are filled with quartz veins. The thickness of weathered basalt ranges from 7.5m to 9.00m. It is acting as aquifer. The geological section in this area on the basis of lithologs of wells is as under,

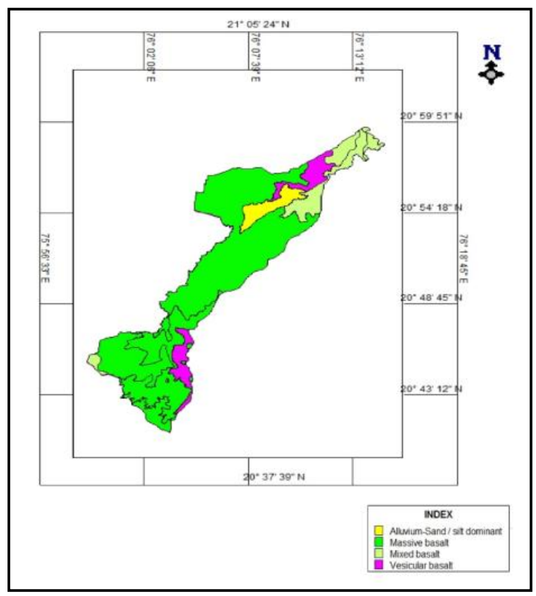

Figure 5: Geological map of PTW-1 watershed (after GSI, 1990)

Simple Lava flow is observed during the field survey around Watershed PTW 1 shivar as there are no internal flow lobes is observed. Flow thickness is found on an average 2 – 10 mtr, its thickness is goes on increases towards the north and clearly visible along the traverse course of Wyaghra River. Extensive flow that appear to be a single unit without being internally divided into flow lobes, columner jointing is common and somewhere occur in multiple tier i.e. layer (Fig.5).

Table 1: Geological sequence in PTW-1 Watershed

Formation	R.L BMSL	Thickness in m	
Alluvium deposits	265 to 245	20.0 m	Recent
Greenish coloured highly weathered vesicular basalt	245 to 235	10.0 m	
Greyish black coloured moderately weathered jointed massive basalt	235 to 227	8.0m	Upper Cretaceous to Lower Eocene
Highly weathered greenish coloures vesicular basalt	227 to 220	7.0m	

MATERIAL AND METHODS

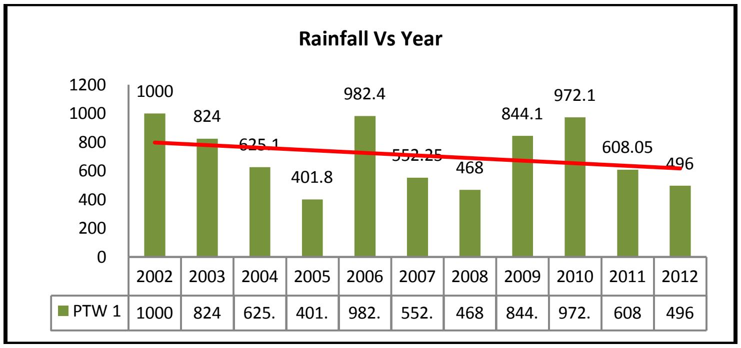

Figure 6: Rainfall Vs Year in PTW-1 watershed

The database for this watershed is derived from 3 observation well who represent the three basic morphozone i.e. runoff zone, recharge zone and storage zone. These observation wells indicate the periodic and routine monitoring of depth to water level. After a careful study of the different metrological parameter and static ground water level of the study area, two seasons have been taken in this study.

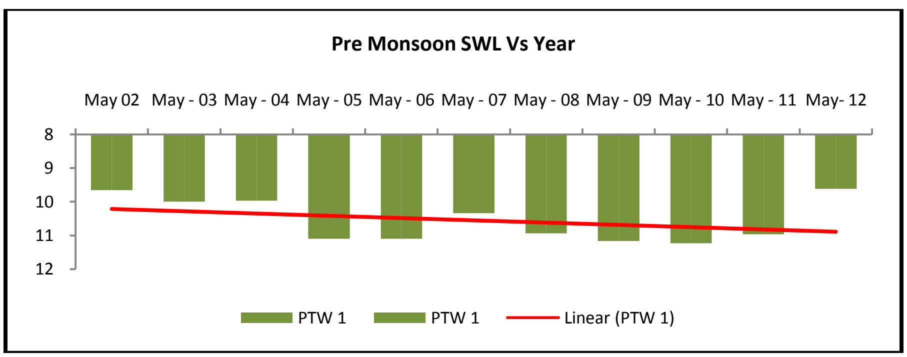

Figure 7: Pre-monsoon SWL Vs Year in PTW-1 watershed

1. Rainfall data (Fig.6)
2. Pre Monsoon static water level (Fig.7)
3. Post monsoon static water level (Fig.8)

Rainfall data is taken from last 10 year to analyze the trend and pattern. It reveals that in the monsoon year 2002 area received a maximum rainfall i.e. 1000mm while in the year 2005 received a minimum rainfall i.e. 401.8mm. Last 10 year Pre and post Monsoon static water level record of GSDA is consider for analysis of spatial and temporal trend of water level (Fig.9).Morphological area indicate the different geological formations have a different aquifer thickness. Towards the south part nearer to mahalungi, Pimpalgaon Devi aquifer thickness is low while its water holding capacity is more towards the north.

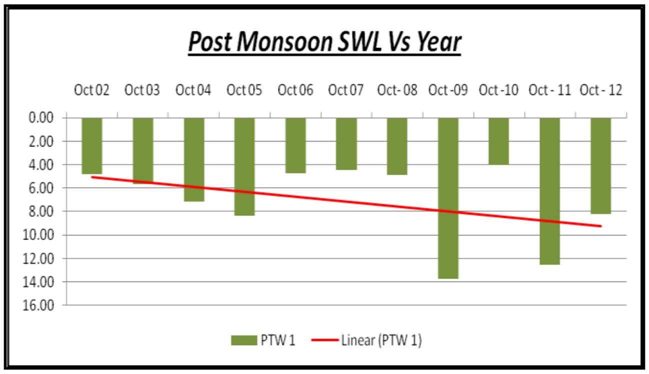

Figure 8: Post-monsoon SWL Vs Year in PTW-1 watershed

The database of the depth to water level of each of the stations for the considered period has been reduced to water table level by subtracting each of the depth to water level reading (measured from bgl) from Reduced Level (actual elevation from mean sea level) of that station. Thus each of the water table value represents the respective elevation or height from the mean sea level (msl). To determine the groundwater flow direction of Buldhana district, pre- monsoon water table data (i.e. April) for the year 2012 has been considered since draught like situation prevailed during summer months of that year. As the annual replenishment of the aquifer primarily depends on rainfall, a study on yearly rainfall for the considered period is imperative in analyzing the water level trend and fluctuation.

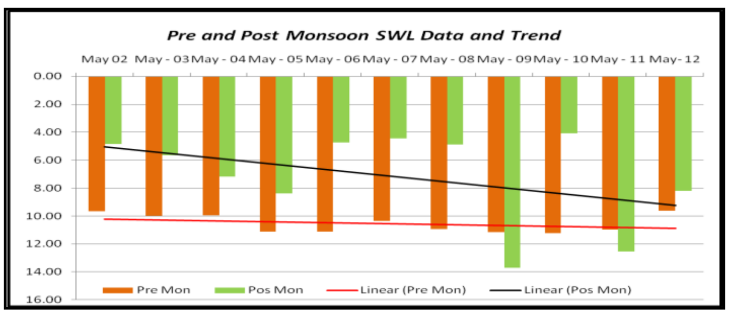

Figure 9: Pre and Post-monsoon SWL data and trend in PTW-1 watershed

The Watershed enjoys tropical monsoon climate with an average 706 mm annual rainfall (2002- 2012). Figure 6 shows the plot of annual rainfall *versus* year. A best-fit trend line is drawn within the graph to determine the annual rainfall trend for the specified period. Analysis of the trend of the water table during the considered span of 10 years shown in fig. 9. On an above Geological set up of the studied area, From Hydrological point of view following tables shown relationship between the parameters studied with ground water potential zones.

Table 1: Relationship between the parameters studied with ground water potential zones

GW Potential Zone Map	Very Low	Low	Moderate	High	Very High
Geology	Hard Compact - Bassalt	Compact with weathered basalt	Highly weathered with alluvium formation	Alluvium	Alluvium with Boulder zone
Drainage Density	Very high	Moderately – high	Very low - moderately	Very low - Moderately	Very Low
Topography	High – very high	Moderate - high	Very low – high	Very low	Very low
Slope steepness	High – very high	Moderate - high	Very low – high	Very low	Very low
Rainfall	Moderate, very high	Moderate, very high	Moderate – very high	Moderate - high	Moderate
Sand and Clay ratio	Very low	Very low - Low	Very low – Low	Very low - Low	Moderate – very High
Lineament Density	Very Low	Very low - Moderate	Very low - Moderate	high – very High	Very High

DISCUSSION AND CONCLUSION

It is concluded that, Static Ground water level of Pre monsoon trend since last 10 year is slightly decreases while post monsoon water level is tremendously goes on decreases. On carefully study of Geological set up of the entire watershed, its exhibit high topography, compact massive basalt formation and high ranges of slope variation resulting to low waterbearing capacity of aquifer and scanty rainfall is the main cause of Scarcity. Total 4 miniwatershed 1/6,2/6,3/6,4/6 area covering this non worthy area. i.e. run off zone, this area always comes in scarcity zone. Total 16 villages sitated in miniwatershed 1/6,2/6,3/6,4/6 and 9 villages comes in watershed 5/6 and 6/6. Out of total 25 vilages, most of the villages are common for applied tanker or temporary pipe water supply scheme in summer season to cope up the required drinking water demand, villages i.e. Wadgaon, Pimpalgaon devi, Mahalungi and Sonbarad, lapali, Sindhkhed and Liha Bk, Ridhora Kh, Gugli, kolhi Golar, Urha and Dahigaon facing scarcity from October onwards. As per the last 5 years scarcity reports it is exhibited that villages Liha Bk, Pimpalgaon Devi, Lapali, Mahalungi and urha provide tanker for drinkng water purose in rainy season in the month of June and July.All above villages comes in miniwatershed 1/6,2/6,3/6. Remaining villages are also facing the drinking and irrigation water problem from January onwards.

RECOMMENDATIONS

- To relief from the scarcity of all above villages, Awareness training with basic fact for villagers should be conduct;
- Annual water budget programme implemented in entire watershed with cropping pattern should be change as per budget availability;
- Scientific ground water recharge method of Government schemes i.e. National Drinking water programme, Hariyali and Mahatma Gandhi Rural Employment Gurranty scheme implemented in a area for long term basis (minimum 3 years monitoring);
- Drip irrigation should be adopted for more effective irrigation without excessive evaporation and also for preventing weathering and leaching;
- Crop selection should be dependent on water quality, water availability and water needs;
- Rainwater harvesting techniques should be implemented to augment the groundwater resources.

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