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Research Article

HYDROGEOLOGICAL APPRAISAL OF WATER STRESSED MANSING TANDA VILLAGE, MUKHED TALUKA, NANDED DISTRICT, CENTRAL INDIA

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ABSTRACT
It has been noted that there was only one hand pump available to cater the need of drinking water for the villagers in Mansing Tanda. The yield of the hand pump decreases after February and goes dry after March and other private and irrigation sources of the studied area also go dry. The pipe water supply source also goes dry in April. After the month of April people have to depend on water tankers only. Therefore, the feasibility of all technical options under JSP-II were verified. In monsoon, after the month of August till November the PWS well has good yield of 44 klpd with 3 to 5 pumping hours per day. Recuperation rate was also good during this period and the dugwell attains water level within overnight. Similarly, the water-balance computation brought out that the month July to November has higher surplus water balance. Hence the month from July to November is suitable for the storage of water tank in monsoon for scarcity month from April to June. Therefore, a storage tank of 2.25 lac liters capacity was recommended to fulfill the drinking water need in scarcity period.

Keywords: *Hydrogeological Appraisal, Water Stressed, Mansing Tanda Village, Mukhed Taluka, Nanded District, Central India*

INTRODUCTION
Water is a natural but limited resource having the vital importance for sustaining life, food, health, economic development, and integrity; however it is impossible to find any substitute for most if its uses (Rakesh Kumar *et al.*, 2005). National Water Policy (NWP, 2002) has set the water allocation priorities in planning and operation of systems. As per the NWP (NWP, 2002) the priority should be i) drinking water, ii) irrigation, iii) hydropower, iv) ecology and v) navigation. National Commission for Integrated Water Resources Development (NCIWRD, 1999) has emphasized on interrelationship of Indian River systems with utilizable annual surface water and precipitation percentage. The concept of watershed as a planning unit for development of land and water resources gained importance in 1973 (WDG, 2003). Todd (1995) considers the augmenting the natural movement of surface water into underground formations by any way of construction as artificial recharge in watershed area (Gray, 1961; Todd, 1995; Karanth, 1999; GSDA, 2007). Such studies on watershed management for recharge of groundwater are being emphasized from past couple of decades (Murkute and Joshi, 2011; 2018).
According to the 2011 census of India, 70% population, reside in rural areas and about 85% of population depends upon groundwater as source of drinking water. With the growing population, it is getting difficult to provide adequate drinking water. India has been one of the fastest growing economies in the last decade. Maharashtra stands amongst top states in the country. Maharashtra being agriculture based economy; most of the population is living in rural areas. Geologically almost 82% of the state of Maharashtra is covered by hard massive Deccan trap basalt (GSDA, 2005; 2009), having rainfall infiltration factor 2 to 3%. Maharashtra receives rainfall from southwest monsoon. Western Maharashtra receives highest rainfall where as the areas at foothills of western ghat to the east and middle Maharashtra receives least rainfall. Vidarbha region receives well to average rainfall. Marathwada in the middle and due east receives average to poor rainfall.

Jalswarajya-II project is being implemented by water supply and sanitation department government of Maharashtra. It is World Bank aided programme, for six years period (2014 to 2020), mainly for institutional capacity building and implementation of water supply schemes in water stress, water quality and peri-urban areas. The main aim is to provide a sustainable drinking water supply for the water stress villages having less than 500 population, water quality affected villages, and peri urban villages for 365 days. Government of Maharashtra, in collaboration with world bank introduced Jalswarajya-II in state of Maharashtra with the support of government organizations like Groundwater Surveys And Development Agencies (GSDA), Maharashtra Jeevan Pradhikaran (MJP), Executive Engineer Rural Water supply Division of respective district.

The village Mansing Tanda, Mukhed taluka, Nanded district of Maharashtra faces regular shortage of drinking water during summer conditions. The average annual rainfall of the study area is 955 mm. From the year 2009 to year 2016, Mansing tanda village was continuously tanker fed for 60 to 100 of summer days every year. The hydrogeological appraisal of this water stressed study area is presented in present paper. The studies on groundwater quality and groundwater pollution in around Nanded city have already been conducted by Panaskar *et al*., (2007) and Kaplay and Patode (2007), and hence groundwater quality issues are not discussed in the present paper.

MATERIALS AND METHODS

The detailed survey of the study area was carried out, where in four main parameters were primarily considered, which are, i) drinking water status of study area, ii) rainy days and rainfall and its temporal and spatial variation, iii) static water level condition of study area and iv) feasibility of technical options as per the norms of Jalswarajya-II. The water requirement for existing population of village as per the Government norm of 20 lpcd for scarcity period of 90 days was calculated and the feasible technical option of storage tank was recommended. The estimate of scheme was prepared by Executive Engineer, Rural Water Supply Division, Zilha Parishad (ZP), Nanded. The all essential documents and formats of grampanchayat were collected by concerned NGO. After that a consolidated detailed project report of each village was prepared by GSDA and submitted by Dy. CEO Water supply and sanitation, ZP to WASSO, Mumbai for technical and administrative approval.

Figure 1: Location map of village Mansing Tanda from Google Earth

Study Area

Mansing tanda is located due south of Taluka headquarter Mukhed at a distance of about 20 kilometer (Fig.1). It is bounded by Latitude $18^0$35'42" North and Longitude $77^0$23'53" East. The geographical area of village is 7.91 sq km and comes under toposheet nuumber 56 F/7 of SOI. The village can be accessed in all seasons by tar road. Average annual rainfall of the taluka is 820.20 mm. Almost 90% of the rainfall is received from southwest monsoon. Maximum rainy days of study area are from month July and August in the year. The maximum temperature of study is is about 45^0 c in summer and it lowers down to 10^0 c in winter.

Hydrogeology and Water Issues of Study Area

Mansing tanda is small habitation having population of 123 souls located in remote area of Mukhed taluka District Nanded. The Tanda is situated on plateau top and geomorphologically it is undisected plateau that comes under runoff zone therefore the amount of rainfall received during monsoon season contributes more to runoff than recharge. Geologically the area is covered with hard massive basalt which is moderately weathered fine-grained, yellowish to black in color, fractured, in nature (GSI, 2008). Jointing is moderate in these rocks having infiltration factor less than 2% (GSDA, 2009, 2017). In study area, there is only single hand pump which is seasonal in nature and unable to cater the drinking water needs of the habitation. This hand pump goes dry in the summers i.e. from April onwards. The study area has permanent piped water supply having dug well as source. This dug well in summer goes dry. The private sources in the surrounding area also goes dry, therefore villagers has to depend on tanker during summer.

The requirement of water for existing population of 123 souls of area as per 40 lpcd is 4920 l/day in winter and availability of water from existing pipe water supply scheme and from hand pump is 2000 to 3000 l/day in winter. Whereas this water availability in summer decreases up to 500 lit/day in early April and then source goes dry. As per the government norm of 20 lpcd for scarcity area the water requirement of the study area is 2460 lit/day and the sources of study area fail to cater this need of village and eventually the village become fully dependent on tanker until the next monsoon cycles starts.

Table 1: Month wise rainfall of study area for 20 years (in mm)

Sr. No.	Year/ Month	June	July	August	September	Total Rainfall	Percent (%)
1	1998	209.1	205	296	153	863.1	105
2	1999	102	281	184	112	679	83
3	2000	138	180	422	64	804	98
4	2001	236	88	362	3	689	84
5	2002	214	52	237	127	630	77
6	2003	135	284	171	75	665	81
7	2004	81	350	114	299	844	103
8	2005	77	302	153	279	811	99
9	2006	119	11	274	252	656	80
10	2007	154	130	103	253	640	78
11	2008	90	126	125	237	578	70
12	2009	29	86	140	85	340	41
13	2010	43	254	262	191	750	91
14	2011	82	251	333	68	734	89
15	2012	154	190	149	88	581	71
16	2013	141.6	482.6	173.9	116.1	914.2	111
17	2014	47.2	89.9	245.9	26.9	409.9	50
18	2015	90.6	49.7	140.5	103.3	384.1	47

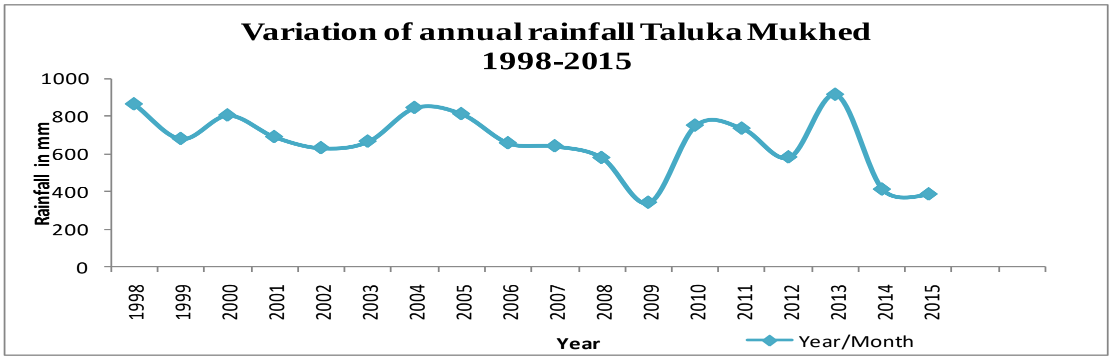

Figure 2: Graph showing rainfall trend of last 18 years for study area

Computation of Rainfall Distribution And Temporal/ Spatial Variation

The study area experiences tropical climate. The rainfall distribution is erratic in nature, where in monsoon rain starts generally from last week of June and ends in middle of September. The study area receives maximum rainfall in July-August. On the basis of computational values of rainfall distribution of last 18 years in study area, it was observed that relatively least monsoon rainfall was noted in year 2009 where the study area received only 340 mm rainfall, which is 41%, compared to normal rainfall. Contrary, in year 2013 the study area received highest rainfall of 914.20 mm (Table 1). The average rainfall for the last 18 years is 665 mm. It is observed that in last 18 years, the study area received < 50 % rainfall 3 times and > 100% rainfall 3 times (1998, 2004 and 2013). On the basis of fig 2, it was observed that there was declining trend in the annual rainfall of study area and the rainfall dependability is 630 mm of the study area.

On the basis of computation of rainy days, from June to September for the study area (Table 2) it is observed that the month of August has higher number of the rainy days during the monsoon season.

Table 2: Particulars of daily rainfall analysis for the last 18 years from study area

Sr.No	Year	June	July	August	September	Total rainy days
1	1998	11	10	17	12	50
2	1999	9	16	14	8	47
3	2000	11	10	15	5	41
4	2001	9	4	15	1	29
5	2002	10	5	9	8	32
6	2003	9	14	11	3	37
7	2004	5	12	7	9	33
8	2005	5	12	9	9	35
9	2006	5	9	7	13	34
10	2007	11	8	10	12	41
11	2008	9	7	9	7	32
12	2009	5	9	10	6	30
13	2010	7	15	12	13	47
14	2011	6	14	17	4	41
15	2012	11	17	14	8	50
16	2013	11	20	8	7	46
17	2014	5	8	12	3	28
18	2015	7	8	11	10	36

The interrelationship of rainfall is copared with the rainy days for months fromJune to September seperately interms of scatter diagram (Fig 4, 5, 6 and 7). The subtle observations of rainfall as well as rainy days computations are presented in Table 3.

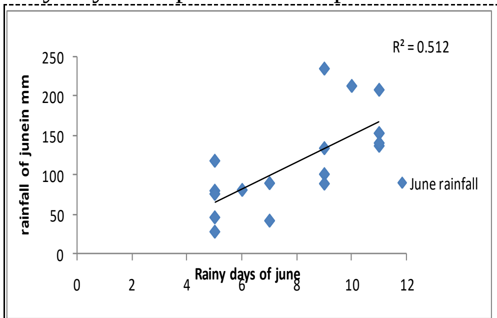

Fig. 4. Scatter diagram of rainfall and rainy days in June

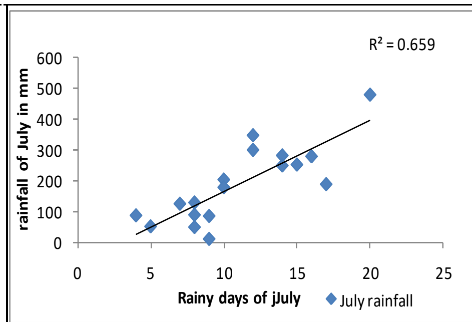

Fig. 5. Scatter diagram of rainfall and rainy days in July

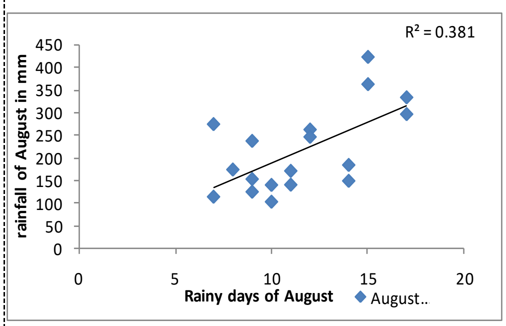

Fig. 6. Scatter diagram of rainfall and rainy days in August

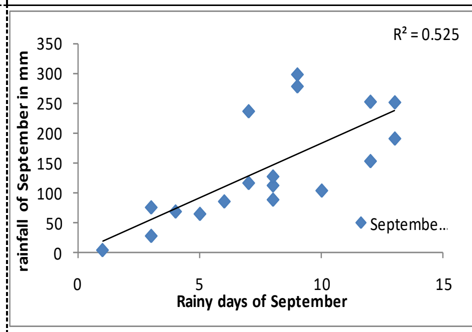

Fig. 7. Scatter diagram of rainfall and rainy days in September

The figure 4 to 7 clearly bring out that the interrelationship between rainfall and rainy days, where in data depict positive co relationship, however R^2 values range from 0.381 to 0.659, from June to September with higher value for July and lower for August month. It is observed that, for the rainfall, coefficient of variation during monsoon ranges from 7.32 to 11.73 with higher value for September and lower for June (Table 3). It is, therefore this interrelation between number of rainy days and the rainfall is weaker to propose any distinct pumping period for the water supply. On the basis of study of rainfall and rainy days from June to September of last 18 years it is observed that the months July and August would be the most assuring month for excess pumping of water to store storage tank for scarcity period.

Table 3: Monthwise statistical data of study area

Sr. No	Month	Rainfall In mm			Rainy Days			Standard Deviation	R^2	Coefficient of Variation (CV)
1	June	236	29	119.3	11	5	8	59.39	0.512	7.32
2	July	482	11	189	20	4	11	123.36	0.659	11.21
3	August	422	103	215	17	7	11	92.95	0.381	8.08
4	September	299	03	140	13	1	7	89.91	0.525	11.73

Static water level condition of study area:

The data of nearest observation well related to the study area was utilized to ascertain details of water level in the area. The average post monsoon static water level of last 15 years was 5.3 m while the pre monsoon static water level was 9.9 m. The average water level fluctuation over the last 15 years was 4.7 m. The maximum rise in groundwater level was seen in the year 2003 (1.30 m below ground level) and during this year rainfall was 99% of normal (Fig.8). Whereas most of the years the observation well goes dry in pre monsoon.

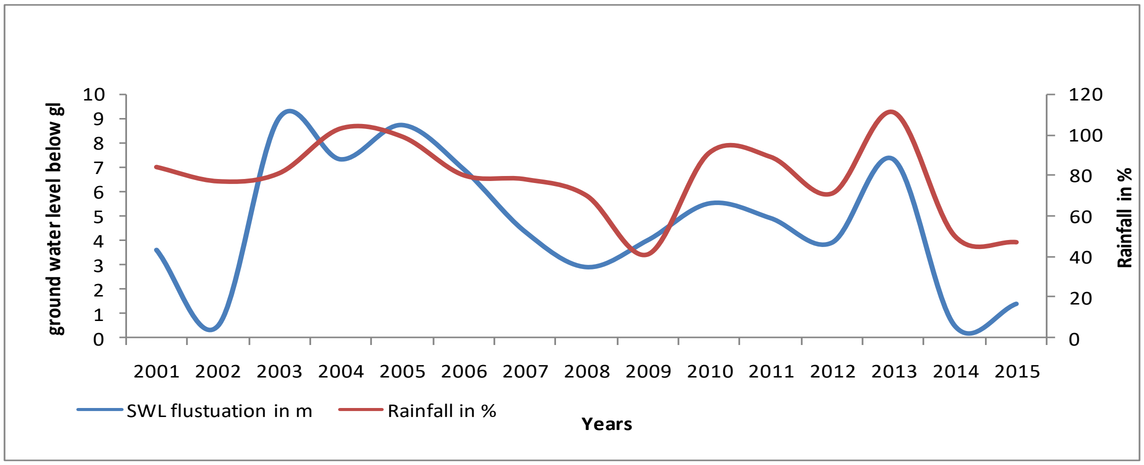

Figure 8: Rainfall and static water level trend for last 15 years

From the figure 8 it is observed that the static water level after 2009 was completely dependent on the rainfall showing direct relationship.

DISCUSSION

Discussion and Conclusions On Feasibility of Technical Options

It has been observed that there was only one hand pump available to cater the need of drinking water for the villagers in Mansing Tanda. Its yield decreases after month February and goes dry after March and other private and irrigation sources of study area also go dry. The pipe water supply source also goes dry in April. After the month of April people have to depend on tanker only. It is, therefore, the feasibility of all technical options under JSP-II were verified. The verification was done using inventory of field-based options, viz., i) the piped water supply scheme was available for the tanda and the dugwell source was located near village tank, hence for the strengthening of source was recommended with the help of deepening of well and horizontal bores, ii) it was observed that there were no feasible roofs available to recommend roof top rainwater harvesting, iii) as there was no spring available in the study area, spring based scheme was not possible, iv) renovation of existing water supply scheme was not needed and v) providing a storage tank for 90 days and filling it from adjacent pipe water supply source well of Mansing Tanda was the only solution

As per the feasibility of technical option in JSP-II project discussed above option fifth was feasible for the scarcity affected village. It was observed that, there was the pipe water supply scheme of Mansing Tanda, based on source dugwell at a distance of 500 m due east of tanda. This pws well was located in low-lying valley portion. The depth of dug well was 10 m and the diameter was 8 m. This well was seasonal in nature and during summer after March, the well goes dry. In monsoon, after month August up to November the pws well has good yield of 44 klpd with 3 to 5 pumping hours per day. Recuperation rate was also good during this period and the source dugwell attains water level in overnight. Similarly, the water-balance computation brought out that the month July to November has higher surplus water balance. Hence the month from July to November is suitable for the storage of water tank in monsoon for scarcity month from April to June. It is, therefore, technically recommended to construct a storage tank for storing water in monsoon period for scarcity period in summer (Todd, 1995). The total requirement of water for the 90 days from month April to June as per the Government norm of 20 LPCD for scarcity period was about 221400 liters. Therefore, a storage tank of 2.25 lac liters capacity was recommended to fulfill the drinking water need in scarcity period.

The tank would be filled from a pipe water supply dugwell as a source during peak monsoon period or high intensity rainy days period from July-August for water requirement of present souls of Mansing Tanda. Similarly, the daily distribution tank of 5000 liters was also recommended with stand post for equal distribution of water as per 20 lpcd.

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