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ASSESSMENT OF OHAR WATERSHED BASED ON BIO-PHYSICAL AND SOCIO-ECONOMICAL INDICATORS

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ABSTRACT

In present study, for the assessment of the watershed some indicators are selected such as water quality, ground water table, soil quality, soil and water conservation structures evaluation and resident's questionnaire survey. These indicators were evaluated by field survey, observations, sampling and testing of parameters. For the evaluation of the watershed, general data was acquired from Soil and Water Conservation Department, Maharashtra. The results of the water quality analysis when compared with the limits prescribed by the IS 10500, 2012 shows that the total dissolved solids, electrical conductivity, pH and hardness are in permissible limits whereas the fluoride and nitrate are low and high respectively. The ground water level ranges from 1.5 to 12.4 meters in selected wells when measured in June 2020. The average ground water table increased from 18.29 to 9.15 meters in last five years. The evaluated soil and water conservation structures in the watershed are overall in good condition with water storage but needs minor repairs. The outcomes of the residents survey shows that measures implemented in the watershed are beneficial in overall development of the watershed by improving the agricultural productivity and thereby elevating income.

Keywords *– Watershed, Soil and water conservation, ground water table, water quality*

INTRODUCTION

India has 16% of world population and only 4% of world water resource. The state of Maharashtra has more than 9% population of the country. Due to unevenness in rainfall in the state, some of its regions are subjected to frequent droughts. The areas which are drought affected primarily depend on ground water as its source and the ever increasing demand of ground water is leading to drop in the ground water level (Singh et al., 2017).

Watershed development is the strategy of protecting the livelihood of the people and the ecosystem from excessive soil erosion and moisture loss. The main purpose of watershed development is to enhance the water availability, fodder and elevate the income of the farmers by increasing the agricultural productivity. There has been a significant positive impact of these watershed development projects in the drought prone areas by improvement in water availability and crop yield (Rao, 2016). The soil and water conservation measures are divided into ridge line treatment and drainage line treatment. In the portion of the watershed with steep slopes where the velocity of flow is high ridge line treatment is done whereas in the portion of the land with relatively flat slopes where velocity of flow is low drainage line treatment is done. Some of the important ridge line treatments include contour trenches and earthen contour bunds and the drainage line treatment includes Loose Boulder checks, Gabion structure, Earthen bunds and Cement bund (National Rural Employment Guarantee Act, 2007) (CTARA IITB, 2019).

The impact assessment of the watershed is carried out using the indicators based on the bio-physical, socio-economical and sustainability aspects of the watershed. The evaluated indicators are thus beneficial in assessing the watershed for the impact of agronomical, biological and engineering measures and also help in justifying economical expenses on various activities involved in watershed development. These indicators also add to the transparency and accountability towards the stakeholders and will increase confidence among the agencies involved in the implementation (Sharda et al., 2012). These indicators play a crucial role in assessing the watershed development works. The assessment of the watershed is carried out using semi structured interviews, transect walks, measurements and field observation (Mekonen & Tesfahunegn, 2011). In context of assessing the watershed some of the objectives are derived for the assessment of the impacts due to watershed development works as soil erosion rate, sediment yield, water supply, habitat enhancement, flood protection, recreation, public involvement and water quality (Ridolfi et al., 2010), (Diyabalanage et al., 2017).

The percentage coverage of the soil and water conservation measures in a watershed is vital factor as the 100% coverage would definitely derive maximum socio-economical benefits but on the contrary it will lead to negative effects in the natural system and landscape. Therefore a coverage of about 85% of soil and water conservation measures in a watershed found more effective (König et al., 2012)

STUDY AREA

Ohar watershed is the part of Kham river catchment in Aurangabad District, Maharashtra. Harsul Lake is on the downstream reach of this study area. The population of the

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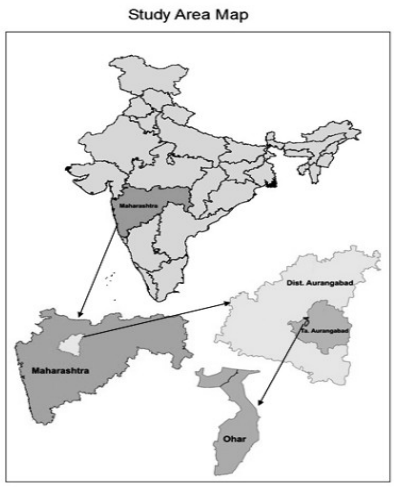
watershed as per the census survey, 2011 is 2,032. The study area is in the North western part of Aurangabad taluka. The geographical area of the watershed is 1478 hectors and located at 11 kms from Aurangabad city. This study area is under the toposheet no. 47 M/5 of Survey of India. The average annual rainfall in the watershed is 625 millimeters. The location of the study area is shown in Figure 1.

Fig. 1:- Location of Study area

METHODOLOGY

The indicators involved the assessment of the watershed are stated in Figure 2.

For the analysis of the ground water quality and ground water level, nine wells were selected in the watershed in such a way that entire watershed is covered from upstream to downstream along the main stream in the watershed, nine wells are so located that four on upstream, two on mid-stream and three on the downstream of the watershed.



The methodology adopted for sampling and testing of water is as stated in the surveyed literature and guidelines of Central pollution control board (CPCB, 2007). Samples were collected from the running motor on the well for about ten minutes (Susan Varughese and Devi Prasad.K.V, 2012). The samples were collected in the plastic bottle of 1000 ml. The parameter tested were Total dissolved solids, Electrical conductivity, pH, Temperature, Hardness, Fluoride and Nitrate. Total dissolved solids, Electrical conductivity, pH and Temperature were tested on field using portable testing meters and Hardness, Fluoride and nitrate were tested in the lab using colorimetric comparison method using kits. The obtained results are then statistically and graphically interpreted with reference to IS 10500, 2012.

The sample for analyzing the surface water quality was collected on the main stream (Kham River) near well no 1. The sample was collected in the plastic bottle of 1000 ml.

The ground water level monitoring was done in June, 2020 in the nine selected open wells by lowering the tape in the well and measuring the depth of water. Along with the field observations, data was also collected for the ground water table from soil and water conservation department.

Soil samples were collected at two points where visual variation in the physical features of the soil is observed. The samples collected are as per the method prescribed by the Agriculture department of Tamil Nadu state (http://agritech.tnau.ac.in). The sampling process includes cleaning the surface litter at the location, collect five samples from selected field as four at corners and one centre, place the sample in the tray and mix thoroughly, discard half sample and again mix it, quartering is done by dividing the mixed sample into four parts and discarding two quarters, repeat the procedure till the desired sample size is obtained and collect the sample in a polythene or cloth bag and label the bag.

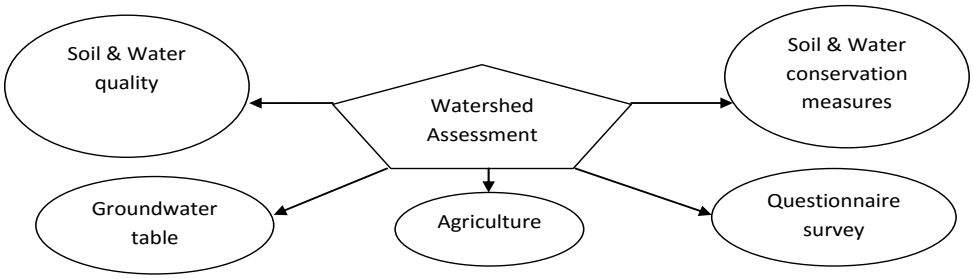


Fig. 2 - Methodology for the watershed assessment

The soil and water conservation structures were evaluated based on visual references and rebound hammer testing. In this evaluation 4 Cement bunds, 2 earthen bunds, 1 Kolhapuri type (KT) weir and 1 percolation tank in the watershed were selected.

The detailed questionnaire covering all the objectives of the assessment as Bio-physical and socio-economical aspect is used for surveying the beneficiaries in the vicinity of the soil and water conservation structure. The detailed questionnaire is stated in Appendix I.

RESULTS

Water quality assessment

The results of the water sampling are as stated in Table 1 The ground water quality for Total dissolved solids, Electrical conductivity and pH found to be in range of actual limit and permissible limits prescribed by the IS

Table 1 – Results of water quality sampling (June, 2020)

Well No. / Parameters	IS 10500, 2012		Well 1	Well 2	Well 3	Well 4	Well 5	Well 6	Well 7	Well 8	Well 9	Surface Sample
	AL	PL										
Limits for Drinking												
TDS (mg/l)	500	2000	324	460	446	694	337	320	396	419	393	123
pH	6.5-8.5	NR	7.2	7.2	6.8	6.9	7.0	7.6	7.4	7.7	7.2	8.2
Temperature ^{o}c	-	-	31.8	31.9	31.8	31.5	31.3	31.2	31.1	31.0	31.2	31.2
Nitrate (mg/l)	45	NR	**50**	**50**	**50**	**48**	**47**	**46**	**50**	**48**	**50**	**-**
Fluoride (mg/l)	1	1.5	**0.75**	**0.75**	**0.75**	**0.75**	**0.75**	**0.25**	**0.75**	**0.50**	**0.75**	**-**
Hardness (mg/l)	200	600	300	450	475	**675**	275	300	275	350	400	-
Limits for Irrigation												
EC (µS/cm)	0-1500	50000	648	921	892	1389	674	634	792	839	786	249

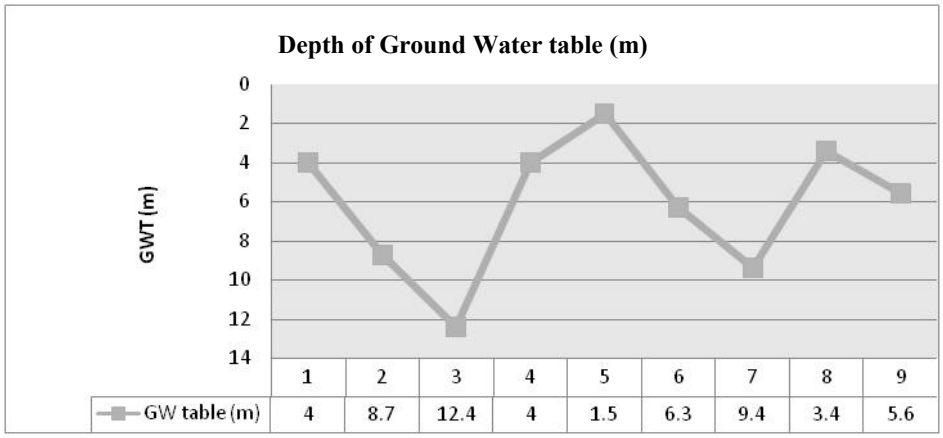


Fig. 3 – Ground water table variation graph

10500, 2012. The hardness of the ground water sample found to be in limit prescribed by IS code except in well no. 4. The level of fluoride found to be lower in the water sample when tested with the colorimetric comparison method and the level of nitrate is higher in the water samples. The nitrate levels can be correlated with the use of chemical fertilizers. The surface water quality for the total dissolved solids, electrical conductivity and pH found to be in range of limits prescribed by IS 10500, 2012.

Ground water level monitoring

The graphical representation of the variation in the ground water table is as shown in Figure 3.
Out of the four wells on the upstream the first well is nearer to the main stream of the watershed whereas fourth well is distant apart, in the mid stream area sixth well is nearer compared to fifth well and in the downstream area eighth well is nearer to stream than other two. In this graph no particular trend in ground water variation is observed, this may be due to local geological aquifer condition along with it no past ground water level data pertaining to these well is available.

Soil quality assessment

The obtained results of the testing for Nitrogen, Phosphorous, Potassium and pH for soil samples are as shown in Table 2.

Evaluation of soil and water conservation structures

The cement nala bunds (CNB), kolhapuri type (KT) weir, percolation tank (PT) and earthen bund (EB) were evaluated based on visual inferences and rebound hammer testing to assess the strength and efficiency of the structure. The data obtained by testing is stated in Table 3.

Outcomes of questionnaire survey and data collection

The questionnaire survey of the residents was carried out along with the data collection from the soil and water conservation department. The outcome of the questionnaire survey and the data collected from the concerned authorities for the pre and post watershed development phase is stated in Table 4

CONCLUSIONS

There is significant improvement in the ground water level, the observed water level ranges from 1.5 meters to 12.4 meters in June 2020. The average water level in last five years increased from 18.29 meters to 9.15 meters. The water quality analysis shows that the total dissolved solids, pH, electrical conductivity and hardness are in the

Table 2 – Soil sample testing results

Sample/Parameter	Sample 1	Sample 2
Nitrogen (N)	10 kg/acre	10 kg/acre
Phosphorous (P)	(0-5) kg/acre	(0-5) kg/acre
Potassium (K)	150 kg/acre	150 kg/acre
pH	8.0	8.0

Table 3 – Soil sample testing results

Structures	CNB 1	CNB 2	CNB 3	CNB 4	KT weir	EB	PT
Strength of concrete in (N/mm^2) by rebound hammer.	17	20	16	16	17	-	-
Visual inferences	Good	Good	Good	Good	Good	Good	Good
Water storage	Yes	Yes	Yes	Yes	Yes	No	Yes
Erosion in sill/bucket	Yes	No	No	No	Yes	No	No
Leakages	-	-	-	-	Yes	No	No
Embankment	-	-	-	-	-	Good	Good
Remark ; if any	Erosion in the bucket	-	-	-	Leakage between gate and rubber seal	Constructed by the farmer on own	Repaired In past 3 years

Table 4 – Pre and Post project scenarios for the Ohar watershed

Sr.No	Aspect		Pre project	Post project
01	Cultivable land (Ha)		1032	1248
02	No. of Cattles (Cow/goat/sheep/buffalo)		787	850
03	Poultry (No. of birds)		250	306
04	No. of Wells		154	164
05	No. of Cement Nala bunds		6	7
06	No. of Cement Nala bund repair		2	3
07	Percolation tank repair		0	4
08	Earthen Nala bund		42	45
09	Well recharge		0	0
10	Stream (Nala) widening & deeping		0	3
11	Well deepening & recharge shaft		0	3
12	Farm Ponds		0	2
13	Area under crop and productivity			
		Bajari (Ha)	144	183
		Tur (Ha)	110	124
	Kharif	Moong/Udit (Ha)	21	26
		Soyabean (Ha)	6	8
		Makka {corn} (Ha)	264	305
		Wheat (Ha)	38	46
	Rabi	Jowar (Ha)	184	192
		Harbhara/Grams (Ha)	56	86
	Cash	Cotton (Ha)	309	325
	crops			

	Vegetables	Tomato	2		3	
		Chilli	28		32	
	Fruits	Sweet lime	4		6	
		Mango	3		4	
		Pomegranate	5		6	
14	Average water level (in meters)		Pre monsoon	Post monsoon	Pre monsoon	Post monsoon
	Bore well (meters)		54.87	33.54	36.59	24.39
	Wells (meters)		5.49	1.83	3.66	0.91
Average water level in last 5 years (meters)			18.29		9.15	

permissible limit prescribed by the IS 10500, 2012, whereas the nitrate and the fluoride are on high and low side respectively. The quality of the evaluated soil and water conservation structures are overall in good condition with the water storage.

The outcome of the questionnaire survey suggests that the residents are satisfied with the watershed development works. It is well admitted that there is improved agricultural productivity and income due to availability of water. There is significant improvement in the ground water level of the wells in the watershed. There is growth in the businesses associated with the agriculture. The residents are satisfied with the village run water supply scheme. The samruddhi expressway passes through the watershed, thus the residents admit that the economy of the watershed also enhanced due to the compensation of the land acquired for the project and this will be boosting other economic activities in the watershed in coming years but on the other hand this project may change the ecological aspects and the agro driven economy to other urbanized businesses.

It is recommended that, there is need of minor repair of KT weir and certain bunds, there is scope in increasing the density of the soil and water conservation structures in the watershed and the use of organic fertilizers should be increased to reduce the nitrate levels in the ground water.

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