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Water Utilization in the Indapur Tahsil District Pune Maharashtra

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Abstract

Water is life and it is universally acclamation as the most important natural resource. The end use of water is essential for every inhabitant and for a wide range of economic and informal sector activities. It is vital for agriculture, industry, health and hydropower. India accounts for about 17.5 % of the world's population and roughly 4% of the total available fresh water resources. With increasing population and growing demand from industrial and agricultural sectors the water consumption is set to jump up tremendously in the near future. Climate change can severely threat Indapur tahsils water security. Observing these outcomes in the present context, in this paper utilization of water resources and requirement of water resources in the Indapur tahsil. Present study attempts to highlight the utilization of water resources in the Indapur tahsil Pune district of Maharashtra. This paper has been attempt has been made to quantify the water budget of the study area. The proportion of water utilization is in three different activities i.e. domestic purpose, agriculture purpose and industrial purpose in Indapur tahsil are also discussed in the paper. The area being in monsoon climatic conditions it is subject to high variability conditions, it's likely to affect on the availability of water. The outcomes of these studies are briefly presented in the paper. It has been observed that the utilization of water resources are not uniform over the study area.

Key words: domestic, agriculture, industrial, utilization of water.

Introduction

Water is the basic need of life for the human beings and any alteration in its availability is directly going to impact them through various means. India accounts for about 17.5 % of the world's population and roughly 4% of the total available fresh water resources. Most of the rivers are rain-fed and seasonal and only few are perennial. The present study has been taken up to quantify the area being in monsoon climatic conditions it is subject to high variability conditions, it's likely to affect on the availability of water. Water use includes all individual and collective activities of human society which affect water resources and change their quality and quantity. The beneficial utilization of water depends, as does its natural functions, on the water properties. The method of water use and distribution depends especially on the degree of development and organization of the social system. It becomes systematic as a consequence of agricultural, social and industrial development. The end use of water is essential for every inhabitant and for a wide range of economic and informal sector activities. It is vital for agriculture, industry, health and hydropower. Water is also an integral part of the natural environment and the habitat for many forms of life; it may be human, animal and plant (Opoku-Agyemang, 2005). The household wise water utilization statistics has also been worked out through personal interviews conducted during the field visits. For this purpose a questionnaire was framed. Questions are related to domestic, agriculture, livestock and industrial water use and requirement has also been incorporated accordingly.

Objectives

1. To identify present domestic water utilization.
2. To identify present agricultural and livestock industrial water utilization.
3. To identify present industrial water utilization.
4. To make favourable suggestions to appropriate water utilization.

Study area

Indapur tahsil is one of the tahsils in the Pune district consisting of 142 villages along with one urban centre in the study area. There are eight revenue circles in the tahsil. The area extends from 17° 53´ 42" to 18° 19´ 58" North latitudes and 74° 39´ 16" to 75° 09´ 39" East longitudes **(Fig. 1)**. The area is drained by the river Bhima on north and east both sides. Nira River flows south of Indapur tahsil. Total geographical area of the tahsil is 1575.38km^2 (Census 2011), out of which Nira river catchment area compress about 586.8 km^2 and Bhima river catchment covers an area of 902.43km^2. Nira River joins the Bhima River at famous tourist place i.e. Narsinhapur village after travelling a course of 209 Kms. The slope of region is towards east. There are three soil types, namely, coarse shallow, medium black and deep black soils occupying 30, 40 and 30 percent respectively.

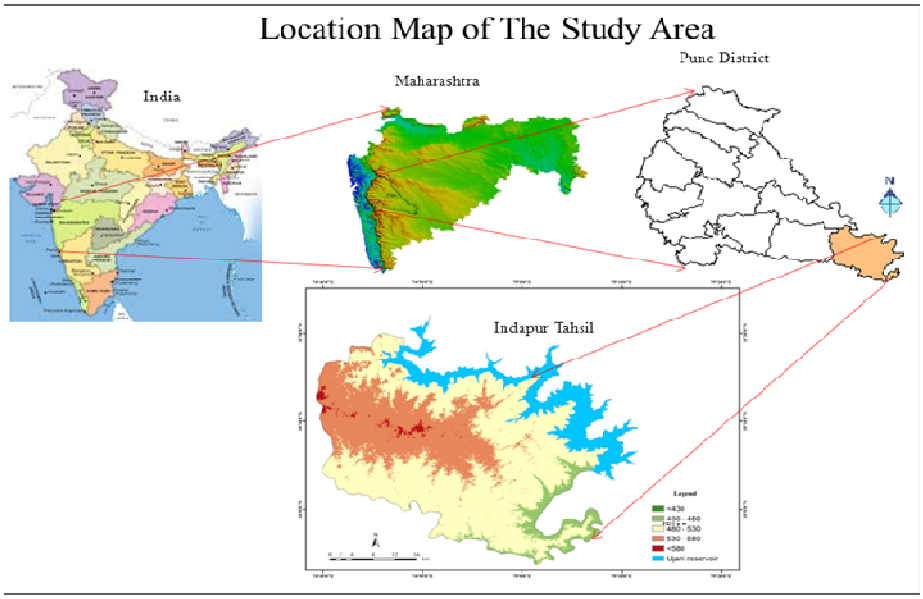


Fig. 1 Location map

Database and methodology

For the present research work secondary data source are used. This work is to develop digital database at large scale using spatial and attribute data. The spatial data comprise of all the thematic and topographic maps and the attribute or non-spatial data is created mainly water details utilities information etc. All the supported data is collected from survey of India, Maharashtra State Gazetteer Pune District, socio economic report of Pune district 2011, 2012 and 2013, economic survey of Maharashtra 2012-13, Maharashtra Governments department of irrigation, department of agriculture, department of water conservation, These data base converted to Microsoft access format to suit to the link up for processing through Arc View 9.3, Surfer version 10, Global Mapper version 11.

Present water utilization of the study area

Water use includes all individual and collective activities of human society which affect water resources and change their quality and quantity. The beneficial utilization of water depends, as does its natural functions, on the water properties. The method of water use and

distribution depends especially on the degree of development and organization of the social system. It becomes systematic as a consequence of agricultural, social and industrial development. From the beginning water has been the basic need and precondition of human existence, but gradually it has also become a raw material which has been turned into a means of development in it.

On the global scale the quantity of water is fixed and sufficiently large, at regional and local scale the water availability becomes a cause of concern and hence it needs to be managed. World Health Organization (WHO) has estimated that about 200 litres / capita / day (lpcd) water is required for these purposes. It is estimated that 200 lpcd would be sufficient for living in towns and only 70 lpcd living in villages without flush latrines. This chapter has been attempt has been made to quantify the water budget of the study area. The proportion of water utilization is in three different activities in the study area **(Table 1 and Fig. 1)**.

Table 1 Proportion of water utilized in three different activities in the study area.

Sr. No.	Water utilization type	Use in MCM	In %
1	Domestic utilization	3.89	0.84
2	Agricultural utilization	451.59	97.01
3	Industrial utilization	10.02	2.15
	Total	465.50	100.00

Source: Nira irrigation office Baramati, Khadakwasala irrigation office Daund, Panchyat Samiti and Agriculture office, Indapur 2012.

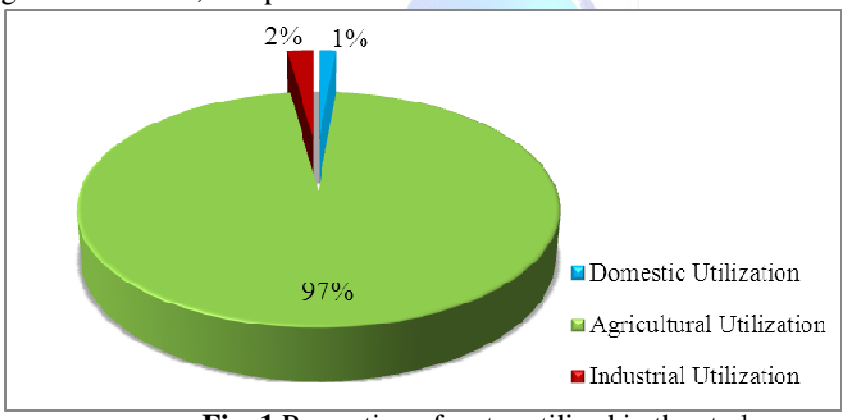


Fig. 1 Proportion of water utilized in the study area.

It is clear from the table that the total water utilization for agriculture claims 451.59 MCM (97.01%), it is large proportion. In the industrial sector 10.02 MCM (2.15%) utilized water, it is considerably low and only 3.89 MCM (0.84%) water utilized for domestic purposes. The water utilization increases in the municipal water requirements.

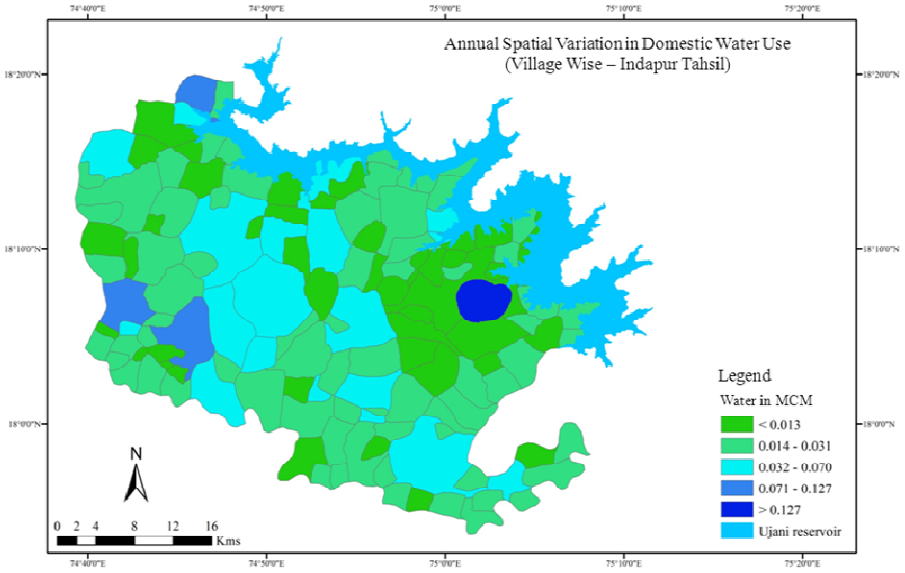
For the present analysis the quantification of the surface water availability has been worked out. Certainly the surface water availability falls short the total water requirements. The area being in monsoon climatic conditions it is subject to high variability conditions hence there is a requirement of supplementing the water from ground water storage for domestic and agricultural requirements. Ground water play important role; however, in the present study only the surface water conditions are being dealt with. The ground water hydrology is separate discipline. So the scope of the present work is confined to surface water conditions as input and water requirement on the demand side.

Present domestic water utilization

For survival of every human life water is an essential element. Man use water for different purposes in which direct consumption of water is of the fore most use. For the present work domestic water utilization pattern is studied on the basis of collected primary data. It was found that in Vaysewadi, Karewadi, Mhasobachiwadi, Lakdi, Nimbodi, Kauthali, Balpudi and Kacharwadi villages people follow the traditional method for water uses i.e. dug wells. It is main source of domestic water supply. In villages contemporary water supply systems are of tap system, hand pumps or dug wells. In case of tap water supply system water is available from the remote source like dam reservoir or from the public dug well in the village area. In most of the system ground water is used as a source for domestic water demand. Expect for on bank of river Bhima villages which use reservoir water and other village's water supply schemes are dependent on canal water and ground water. Ground water is used at a large scale in all the sectors of water use. As discussed by Deolankar (1980) and Sarbhukan (2001) ground water recharge rates are very slow in the basalt rock region of Maharashtra. In such areas further dependence on ground water sources for water supply schemes will be very difficult.

The total water use of Indapur tahsil is 3.894 MCM per year. The major portion of the water use of the study area is consumed by Indapur urban centre, Bhigwan, Palasdev, Lasurne and Kalamb. These five settlements are totally 1.205 MCM (30.95%) water use in the year and another 138 settlement 2.689 MCM (69.05%) water use the in the year. The following **table no. 2 and fig. no. 2** shows the village wise domestic water use in the study area.

Out of 142 villages and 1 urban center, 122 (85.31%) villages have a supply through tap water are the main source of the drinking water and remaining 21 (14.69%) villages supply through another mode. Supply through Nira canal 1.43 MCM, 0.12 MCM through Khadakwasala canal, take from Ujani reservoir 0.949 MCM and 1.395 MCM from groundwater, totally 3.894 MCM water use for domestic purposes in the study area. The villages which have using ground water sources are about 62%. Thus at least 38% are using one or more surface water sources. This clearly indicates that there is heavy dependence on the ground water is main source for domestic use.



Source: Author **Fig. 2**

From the some villages use ground water for manage daily needs. Which water supply use the ground water, these central and western part located villages faces stress or sometimes fail in summer months. The remote water sources supply systems face the problem of water pump, power supply and maintenance of pipeline. These central and western part located villages have difficulties in summer when water is pumped alternate days or totally stop the supply. This is because they cannot afford storage facilities, and supply them by tankers; some poorer households take from their neighbours. However, all agreed this posed no difficulty as neighbours were always willing to assist.

Table 2 Village wise domestic water use

Sr. No.	Name	No. of household	Total Population	Water supply litres / day	Water in MCM	Sr. No.	Name	No. of household	Total Population	Water supply litres / day	Water in MCM
1	Shethphalgadhe	851	4123	144000	0.053	24	Bhawadi	225	907	48000	0.018
2	Pimple	264	1337	20000	0.007	25	Loni	560	2667	48000	0.018
3	Madanwadi	1204	5954	35000	0.013	26	Varkute Bk.	641	2915	80000	0.029
4	Takrarwadi	493	2166	100800	0.037	27	Balpudi	148	743	20000	0.007
5	Bhigvan	1576	7673	300000	0.110	28	Karewadi	302	1466	NA	NA
6	Bhigvanstaion	567	2858	32000	0.012	29	Lakdi	526	2547	20000	0.007
7	Diksal	339	1710	60000	0.022	30	Shindewadi	375	1883	20000	0.007
8	Kumbhargaon	293	1330	76000	0.028	31	Kazad	576	3139	72000	0.026
9	Bandgarwadi	117	622	19200	0.007	32	Nimbodi	383	1922	60000	0.022
10	Poundhawadi	355	1792	85000	0.031	33	Bori	1237	5861	80000	0.029
11	Lamjewadi	142	662	64000	0.023	34	Sansar	1339	6632	144000	0.053
12	Nirgude	433	2095	42400	0.015	35	Bhavaninagar	896	4011	100000	0.037
13	Mhasobachiwadi	397	2000	55000	0.020	36	Jachakvasti	247	1300	52000	0.019
14	Vaysewadi	126	577	NA	NA	37	Kardanwadi	212	917	40000	0.015
15	Akole	678	3273	70000	0.026	38	Jankshan	1081	4855	144000	0.053
16	Bhadalwadi	622	2628	24000	0.009	39	Lasurne	1780	8803	180000	0.066
17	Dalai No.1	262	1204	40000	0.015	40	Pawarwadi	405	2202	48000	0.018
18	Dalai No.2	298	1455	60000	0.022	41	Belwadi	1022	5056	90000	0.03285
19	Dalai No.3	196	895	80000	0.029	42	Sapkalwadi	280	1305	25000	0.009
20	Kalewadi	307	1477	28000	0.010	43	Hingnewadi	243	1218	23000	0.008
21	Bandewadi	72	342	16000	0.006	44	Udhat	428	2023	40000	0.015
22	Palasdeo	793	3621	192000	0.070	45	Paritwadi	260	1245	28000	0.010
23	Malewadi	377	1818	36800	0.013	46	Thoratwadi	156	812	24000	0.009

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Sr. No.	Name	No. of household	Total Population	Water supply litres / day	Water in MCM	Sr. No.	Name	No. of household	Total Population	Water supply litres / day	Water in MCM
47	Chavhanwadi	83	396	16000	0.006	72	Ranmodwadi	725	3468	80000	0.029
48	Bambadwadi	154	688	20000	0.007	73	Kalamb	3576	16338	180000	0.066
49	Mankarwadi	190	986	24000	0.009	74	Nimsakhar	1284	6000	64000	0.023
50	Gholapwadi	322	1407	40000	0.015	75	Nirwangi	753	3601	68000	0.025
51	Tawashi	639	3046	57600	0.021	76	Kauthali	543	2764	40000	0.015
52	Jamb	342	1459	56000	0.020	77	Vyahali	366	1698	33600	0.012
53	Kuravali	535	2925	80000	0.029	78	Kacharewadi	163	829	40000	0.015
54	Chikhali	283	1426	40000	0.015	79	Gotandi	877	4650	80000	0.029
55	Pilewadi	215	1150	40000	0.015	80	Nimgaon Ketki	2450	12397	144000	0.053
56	Maradwadi	139	571	20000	0.007	81	Varkute Kh.	980	4811	44000	0.016
57	Nhavi	695	3222	100000	0.037	82	Kati	1149	5353	144000	0.053
58	Rui	710	3232	95000	0.035	83	Jadhavwadi	101	472	40000	0.0146
59	Gosaviwadi	215	1157	25000	0.009	84	Reda	534	2415	80000	0.029
60	Kalas	855	4141	100000	0.037	85	Redni	795	3938	42400	0.015
61	Thoratwadi	86	473	20000	0.007	86	Khorochi	786	3637	34400	0.013
62	Birgundwadi	162	792	40000	0.015	87	Boratwadi	340	1715	48000	0.018
63	Shelgaon	1825	8215	100000	0.037	88	Chandgaon	185	797	40000	0.015
64	Bharnewadi	847	4358	NA	NA	89	Agoti No.1	282	1261	64000	0.023
65	Anthurne	1245	6100	144000	0.053	90	Agoti No.2	149	719	44800	0.016
66	Kadbanwadi	425	1636	40000	0.015	91	Ganjewalan	193	840	40000	0.015
67	Hangarwadi	376	1807	40000	0.015	92	Kalashi	384	1819	56000	0.020
68	Pitkeshwar	427	2065	68000	0.025	93	Kalthan No.1	483	2135	90000	0.033
69	Sarafwadi	413	2038	120000	0.044	94	Shirsodi	383	1938	34400	0.013
70	Ghorpadwadi	304	1401	16000	0.006	95	Padsthal	291	1405	45000	0.016
71	Sirsatwadi	433	2100	64000	0.023	96	Ajoti	204	864	NA	NA

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Sr. No.	Name	No. of household	Total Population	Water supply litres / day	Water in MCM	Sr. No.	Name	No. of household	Total Population	Water supply litres / day	Water in MCM
97	Sugaon	72	301	17500	0.006	121	Avasari	496	2011	45600	0.017
98	Pimpri Kh.	242	1380	66000	0.024	122	Bhat Nimgaon	337	1547	67200	0.025
99	Malwadi	848	4263	32000	0.012	123	Shetphal Haveli	652	3006	64000	0.023
100	Galandwadi No.1	370	1873	80000	0.029	124	Surwad	587	2639	48000	0.018
101	Narutwadi	224	1331	NA	NA	125	Bhandgaon	632	2993	76000	0.028
102	Kalthan No.2	256	1188	100000	0.037	126	Vakilvasti	435	2144	40000	0.015
103	Gagargaon	152	709	40000	0.015	127	Bawada	2347	10734	144000	0.053
104	Bijwadi	755	3369	60000	0.022	128	Bhodani	545	2488	64000	0.023
105	Rajwadi	104	508	32000	0.012	129	Lakhewadi	946	4540	35600	0.013
106	Vangali	265	1251	32000	0.012	130	Chakati	247	1316	40000	0.015
107	Pondkulwadi	249	1330	17600	0.006	131	Pithewadi	219	1080	56000	0.020
108	Shaha	390	2364	41600	0.015	132	Nirnimgaon	585	2863	60000	0.022
109	Kandalgaon	416	2069	52000	0.019	133	Kacharewadi	219	1141	NA	NA
110	Taratgaon	63	288	40000	0.015	134	Sarati	414	2160	64000	0.023
111	Hingangaon	381	1846	32000	0.012	135	Lumewadi	620	3067	72000	0.026
112	Sardewadi	604	3187	48000	0.018	136	Gondi	232	1116	68000	0.025
113	Galandwadi No.2	470	2299	27200	0.010	137	Ganeshwadi	243	1346	56000	0.020
114	Gokhali	373	1608	NA	NA	138	Pimpri Bk.	463	2251	100000	0.037
115	Tarangwadi	513	2557	33600	0.012	139	Tannu	433	2117	16000	0.006
116	Zagadewadi	231	1193	30000	0.011	140	Narsingpur	468	2231	80000	0.029
117	Pandharwadi	235	1198	72000	0.026	141	Giravi	308	1766	61200	0.022
118	Vadapuri	919	4401	80000	0.029	142	Ozare	124	639	40000	0.015
119	Bedshinge	183	759	32000	0.012	143	Indapur Urban	5228	25515	2450000	0.894
120	Babhulgaon	608	2505	48000	0.018		Total	79683	383183		3.894

Source: Panchyat Samiti Indapur, Municipal Corporation, Indapur 2012 and Census of India 2011.

Drinking water facilities are exists in almost all villages and towns in the study area, but do not supply water through in a year. In the study area not a single village have found dependent on a single source whereas the rest have two sources available in the other 15 (10.49%) villages, 37 (25.87%) and 62 (43.36%) villages available the 3 and 4 sources respectively. More than 5 drinking water sources are available in Palasdeo, Kalas, Kadbanwadi, Kalamb, Vadapuri and Girvi villages **(Table 3)**.

Table 3 Sources of domestic water supply of the study area.

Sr. No.	Source type	No. of water supply sources					
		Single	Two	Three	Four	Five	Six
1	Tap	0	4	24	45	21	6
2	Well	0	14	35	60	22	6
3	Tank	0	0	3	9	8	5
4	Tube well	0	0	9	38	19	6
5	Hand pump	0	10	32	59	20	6
6	River/Canal	0	2	3	27	17	5
7	Spring	0	0	1	3	3	2
No. of village		0	15	37	62	23	6

Source: Census of India 2011

The main source of drinking water in rural area is un-covered well on that source 22645 (30.73%) households depend and in urban area main source is tap water from treated source, on that source 4990 (92.32%) households are depended. Other sources of drinking water of rural and urban households are given in the **Table 4 and Fig.3**. In this figure shows the different drinking water sources of rural and urban households. In rural and urban area found the different main sources. According to above data out of total rural households more than 75% households supply the un-treated drinking water and less than 25% households supply the treated drinking water in rural area. Therefore, in urban area 92.32% households supply treated drinking water only 7.68% households not supply treated drinking water.

Table 4. Distribution of households by main source of drinking water

Sr. No.	Main source of drinking water	Rural	In %	Urban	In %	Total	In %
1	Tap water from treated source	17783	24.13	4990	92.3	22773	28.79
2	Tap water from un-treated source	9768	13.26	24	0.44	9792	12.38
3	Covered well	1287	1.75	18	0.33	1305	1.65
4	Un-covered well	22645	30.73	29	0.54	22674	28.67

5	Hand pump	13069	17.74	32	0.59	13101	16.56
6	Tube well/Bore well	8064	10.94	180	3.33	8244	10.42
7	Spring	62	0.08	1	0.02	63	0.08
8	River/ Canal	540	0.73	16	0.3	556	0.703
9	Tank/Pond/Lake	141	0.19	15	0.28	156	0.197
10	Other sources	325	0.44	100	1.85	425	0.537
	Total	73684	100.00	5405	100	79089	100

Source: Census of India 2011.

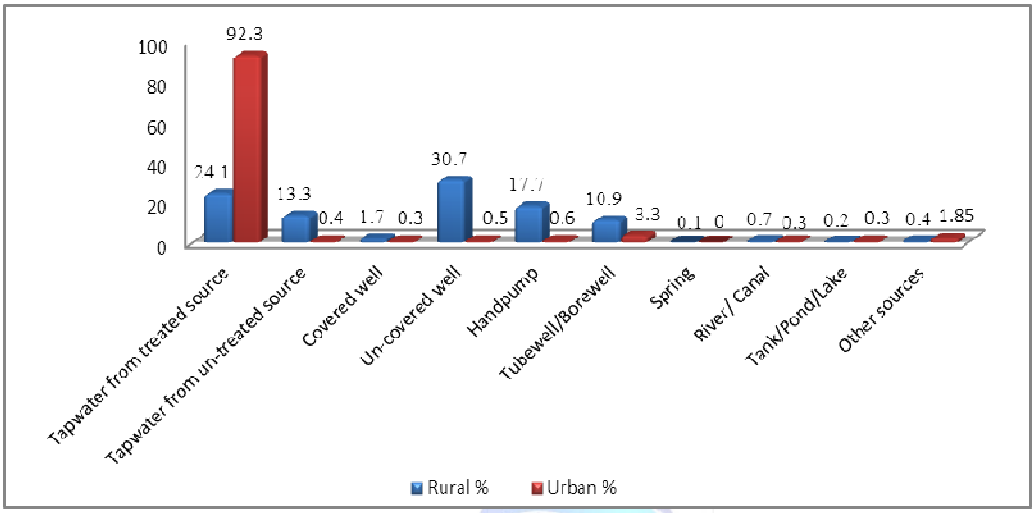


Fig. 3 Major sources of drinking water of rural and urban households

Present agricultural water utilization

The existing policy of water management therefore requires modifications and changes. The traditional system of irrigation results in mass wastage of water. Some amount of this water drains out as surface run-off, some increases the moisture level of the soil thus rendering it too wet and considerable amount is evaporated and returned to the atmosphere. The efficiency of the irrigation water use in farming still remains at the level of 35-40%.

The existing system of flooding the fields results in large scale wastage of water, without ensuring increase in agricultural productivity. Uses of sprinklers and drip irrigation have demonstrated on farm water efficiencies up to the range of 80-90% with concomitant increase in crop productivity to the tune of 20 to 100% depending on the crop. It is therefore necessary to adopt area specific, season specific, crop specific and source specific water resources management to ensure long term sustainability.

In the study area, under irrigated land by the different ways water sources are around 83067 ha (55.78%) **(Table 5, Fig. 4 and Fig. 5)**. The main source of irrigation water is farmer-owned wells, from that source 46.86% volume of water available in the study area. Out of total irrigated area, 42.45% area under irrigation with the help of Nira and Khadakwasala canals. Nira left canal was constructed in the year 1882, whose length was 60 Kms. in Indapur tahsil. Total irrigated area under Nira left canal area of Indapur tahsil is 18049 ha area. Khadakwasala Canal

was constructed in the year 1956. The length of this canal is 61 Kms in Indapur tahsil. Total irrigated area under Khadakwasala canal of Indapur tahsil is 17209 ha and under small project 1036 ha, well irrigation 26469 (31.86%) ha.

Table 5 Area under different modes of irrigation

Sr. No.	Mode of irrigation	Area under irrigation in		Volume of water in	
		Hectares	%	MCM	%
1	Nira canal	18049	21.73	51.50	11.53
2	Khadakwasala canal	17209	20.72	35.94	8.05
3	Well	26469	31.86	209.13	46.84
4	Ujani reservoir	10052	12.10	120.62	27.02
5	K. T. weir	10252	12.34	24.97	5.59
6	PT and other	1036	1.25	4.31	0.97
	Total	83067	100.00	446.47	100.00

Source: Irrigation offices, Baramati and Daund, GSDA office, Pune and Socio-Economic Report, Pune 2012.

For the above area supply the water for irrigation by the different ways. Groundwater is a major source of irrigation through this way 209.13 MCM utilize water. The southern part of Indapur tahsil comes under plane area due to which it benefits from Nira left canal supply 51.5 MCM water 35.94 MCM through Khadakwasala canal.

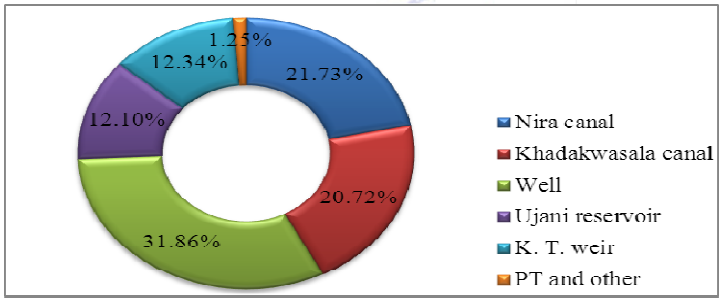


Fig. 4 Area under different modes of irrigation in the study area

Similarly, Ujani reservoir and K. T. Weir provide water respectively 120.62 MCM and 24.89 MCM, through percolation tank and other modes only 4.16 MCM supply water. There are 446.47 MCM water use for agriculture purposes (**Table No. 5 and Fig. 5**)

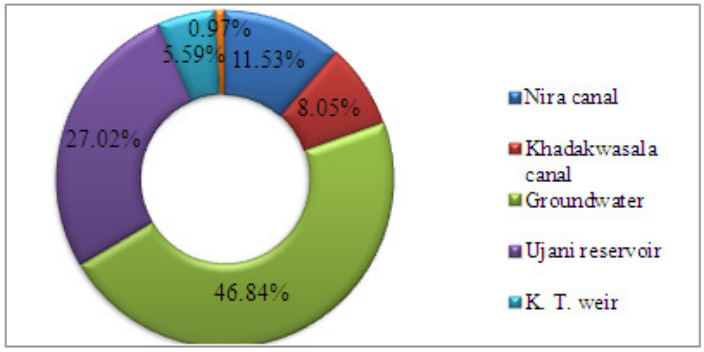


Fig. 5 Irrigation types volume of water utilized in the study area

Source: Irrigation office, Baramati and Daund and GSDA, Pune 2012

Agriculture water use estimation

Total water use of Indapur tahsil is approximately about 446.473 MCM per year. Estimation of total agriculture water use calculated as discussed in the methodology. The major portion of the water use of the Indapur tahsil is consumed by rabbi crop cultivation followed by kharif crop cultivation. The water utilized for each village for kharif and rabbi agriculture is shown in **table 6 and fig 6**. The total cultivable land in the study area is 1,26,325 ha (84.82%) out of this kharif and rabbi crop cultivated area is only 23,391.94 ha (18.52%) and 47,995.6 ha (37.99%) of the total study area respectively in 2012-13.

Table 6 Village wise use of agriculture water for Kharif and Rabbi Season

Sr. No.	Name of village	Agricultural water use in MCM		
		Kharif season	Rabbi season	Total
1	Shetphalgadhe	1.204	4.512	5.716
2	Pimple	0.184	1.673	1.857
3	Madanwadi	0.343	3.843	4.186
4	Takrarwadi	0.094	0.358	0.452
5	Bhigvan	0.913	1.636	2.549
6	Bhigvanstaion	NA	NA	NA
7	Diksal	0.643	2.530	3.173
8	Kumbhargaon	0.117	1.412	1.529
9	Bandgarwadi	0.122	1.097	1.219
10	Poundhawadi	0.091	2.246	2.337
11	Lamjewadi	0.393	1.768	2.161
12	Nirgude	1.444	5.333	6.777
13	Mhasobachiwadi	0.566	4.556	5.122
14	Vaysewadi	0.487	1.226	1.713
15	Akole	4.694	5.049	9.743
16	Bhadalwadi	0.313	2.833	3.146
17	Dalaj No.1	0.239	0.927	1.166
18	Dalaj No.2	0.379	1.848	2.227
19	Dalaj No.3	0.194	1.169	1.363
20	Kalewadi	0.293	3.556	3.849
21	Bandewadi	0.198	3.180	3.378
22	Palasdeo	0.151	0.685	0.836
23	Malewadi	0.418	3.646	4.064
24	Bhawadi	0.915	1.323	2.238
25	Loni	1.159	1.868	3.027
26	Varkute Bk.	1.963	2.802	4.765
27	Balpudi	0.773	1.148	1.921
28	Karewadi	0.447	1.426	1.873
29	Lakdi	1.565	4.114	5.679
30	Shindewadi	2.054	3.049	5.103
31	Kazad	1.854	4.602	6.456
32	Nimbodi	1.512	1.995	3.507
33	Bori	3.117	5.537	8.654
34	Sansar	2.341	2.544	4.885
35	Bhavaninagar	1.171	1.383	2.554
36	Jachakvasti	1.848	2.007	3.855

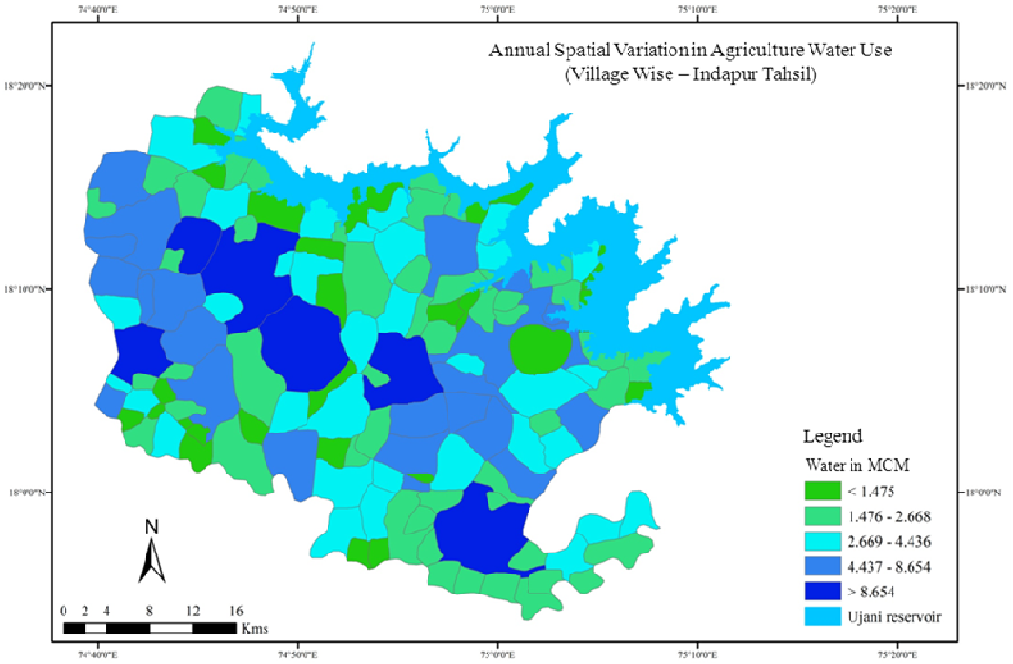
37	Kardanwadi	0.725	0.929	1.654
38	Jankshan	0.183	0.675	0.858
39	Lasurne	0.995	2.688	3.683
40	Pawarwadi	0.516	0.700	1.216
41	Belwadi	0.800	1.790	2.590
42	Sapkalwadi	0.936	1.112	2.048
43	Hingnewadi	1.989	1.343	3.332
44	Udhat	1.365	1.698	3.063
45	Paritwadi	0.434	1.352	1.786
46	Thoratwadi	0.390	0.820	1.210
47	Chavhanwadi	0.804	0.464	1.268
48	Bambadwadi	0.312	0.561	0.873
49	Mankarwadi	0.336	0.525	0.861
50	Gholapwadi	0.557	0.707	1.264
51	Tawashi	2.118	2.853	4.971
52	Jamb	0.659	0.897	1.556
53	Kurwali	1.872	2.256	4.128
54	Chikhali	0.344	0.647	0.991
55	Pilewadi	0.397	1.669	2.066
56	Maradwadi	0.300	0.929	1.229
57	Nhavi	0.684	1.966	2.650
58	Rui	0.979	1.945	2.924
59	Gosaviwadi	0.511	3.015	3.526
60	Kalas	0.816	13.399	14.215
61	Thoratwadi	0.422	0.964	1.386
62	Birgundwadi	0.159	2.941	3.100
63	Shelgaon	6.430	3.871	10.301
64	Bharnewadi	2.649	3.900	6.549
65	Anthurne	0.554	1.397	1.951
66	Kadbanwadi	1.887	1.237	3.124
67	Hangarwadi	0.301	0.719	1.020
68	Pitkeshwar	1.268	1.351	2.619
69	Sarafwadi	0.849	1.051	1.900
70	Ghorpadwadi	0.468	0.816	1.284
71	Sirsatwadi	0.323	0.872	1.195
72	Ranmodwadi	0.243	0.512	0.755
73	Kalamb	0.979	1.407	2.386
74	Nimsakhar	1.553	4.044	5.597
75	Nirwangi	1.248	2.007	3.255
76	Kauthali	0.453	3.309	3.762
77	Vyahali	1.111	3.325	4.436
78	Kacharwadi	0.252	1.322	1.574
79	Gotandi	2.302	2.007	4.309
80	Nimgaon Ketki	3.192	9.868	13.060
81	Varkute Kh.	3.816	3.828	7.644
82	Kati	2.571	2.941	5.512
83	Jadhavwadi	0.337	0.873	1.210
84	Reda	0.616	2.262	2.878
85	Redni	1.504	1.589	3.093

86	Khorochi	1.447	2.006	3.453
87	Boratwadi	0.378	1.076	1.454
88	Chandgaon	0.934	1.165	2.099
89	Agoti No.1	0.795	0.933	1.728
90	Agoti No.2	0.645	0.790	1.435
91	Ganjewalan	0.609	0.736	1.345
92	Kalashi	1.280	1.747	3.027
93	Kalthan No.1	0.974	2.427	3.401
94	Shirsodi	0.440	2.216	2.656
95	Padsthal	1.091	2.409	3.500
96	Ajoti	0.085	0.146	0.231
97	Sugaon	0.054	0.163	0.217
98	Pimpri Kh.	0.709	1.625	2.334
99	Malwadi	0.958	4.813	5.771
100	Galandwadi No.1	0.562	1.700	2.262
101	Narutwadi	0.448	2.111	2.559
102	Kalthan No.2	0.533	1.517	2.050
103	Gagargaon	1.030	1.337	2.367
104	Bijwadi	0.364	1.111	1.475
105	Rajwadi	0.493	0.630	1.123
106	Vangali	0.662	0.940	1.602
107	Pondkulwadi	0.874	1.360	2.234
108	Shaha	0.799	1.272	2.071
109	Kandalgaon	0.598	1.270	1.868
110	Taratgaon	0.129	0.370	0.499
111	Hingangaon	0.852	1.816	2.668
112	Sardewadi	2.529	1.712	4.241
113	Galandwadi No.2	1.533	2.588	4.121
114	Gokhali	0.517	2.482	2.999
115	Tarangwadi	0.630	4.726	5.356
116	Zagadewadi	6.151	1.906	8.057
117	Pandharwadi	0.933	1.026	1.959
118	Vadapuri	1.499	1.768	3.267
119	Bedshinge	0.541	1.165	1.706
120	Babhulgaon	2.091	3.440	5.531
121	Avasari	1.579	2.132	3.711
122	Bhat Nimgaon	1.593	2.574	4.167
123	Shetphal Haveli	1.503	1.827	3.330
124	Surwad	0.785	1.505	2.290
125	Bhandgaon	2.076	3.012	5.088
126	Vakilvasti	0.525	1.242	1.767
127	Bawada	2.895	10.040	12.935
128	Bhodani	0.718	1.473	2.191
129	Lakhewadi	0.963	1.456	2.419
130	Chakati	0.610	1.046	1.656
131	Pithewadi	0.558	1.427	1.985
132	Nirnimgaon	0.547	1.176	1.723
133	Kacharewadi	0.589	1.577	2.166
134	Sarati	0.335	1.435	1.770

135	Lumewadi	0.690	1.402	2.092
136	Gondi	0.769	1.339	2.108
137	Ganeshwadi	1.042	1.519	2.561
138	Pimpri Bk.	1.501	1.821	3.322
139	Tannu	1.474	2.086	3.560
140	Narsingpur	1.329	1.976	3.305
141	Giravi	0.617	0.946	1.563
142	Ozare	0.659	1.156	1.815
143	Indapur	0.546	4.796	5.342
Total water use		146.778	299.695	446.473

Source: Agriculture office, Indapur 2012 and Author

NA: Not available



Source: Author **Fig. 6**

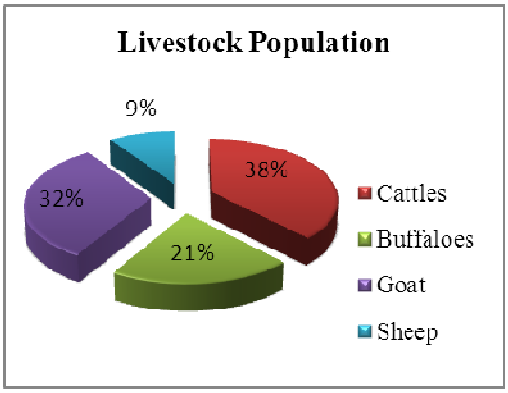
Livestock water use

Animals are important part of agriculture in the study area. Total animal population was 259980. Thus, total use of water for animal 5.11 MCM per annum. This estimate is presented in **table 7 and fig 7a and Fig. 7b**.

Table 7 and fig.7a shows population **and 7b** Shows water utilization of animal.

Sr. No.	Animal	Water use lpcd	Population	Total water use in	
				Litres per day	MCM per Year
1	Cattles	85	98357	8360345	3.05
2	Buffaloes	85	53962	4586770	1.67
3	Goat	10	83191	831910	0.30
4	Sheep	10	24470	244700	0.09
	Total	190	259980	14023725	5.11

Source: Frasier and Hyers, 1983 and Panchyat Samiti, Indapur 2012.



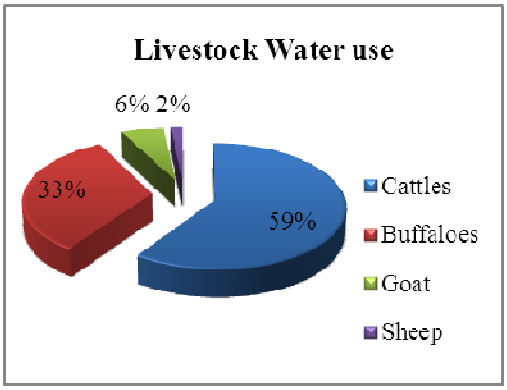
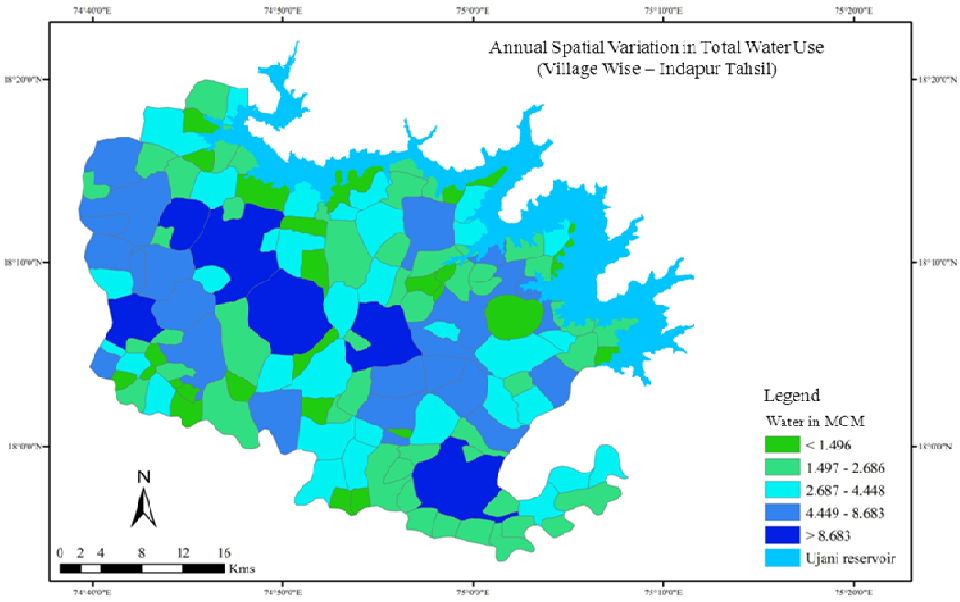


Fig. 7a **Fig. 7b**

Agricultural water utilization is 446.473MCM and animal water utilization is 5.118 MCM totally 451.591 MCM (**Fig. 8**) water utilized for agriculture purpose in the study area.

Present Industrial water utilization

Industrial growth is a key driver of water demand both from industrial production perspective as well as the stimulation of service sectors. Water utilization for industries although insignificant compared for the demand for the agricultural uses. Industrial use is enabled by industrial water use and disposal systems, i.e. sets of structures, technological equipment such as measuring and controlling devices as well as waste water treatment and recycling, sludge disposal and the harmless discharge of polluted water into appropriate recipients. Sugar factory is the most successful.



Source: Author **Fig. 8**

industries in the study area. There is 1 Ballarpur Industries Limited (BILT) paper mill are situated in the study area. It is an important activity using lot of water in Indapur tahsil. This BILT paper industry use the 8.6 MCM (85.83%) water and other industries use the only 1.42 MCM (14.17%) water. Other industrial activities that have implications for water demand include 4 sugar factories, 1 Jaggery factory and 1 milk product industries. These industries serve the needs of water through Nira canal 0.657 MCM, Khadakwasala canal 0.763 MCM and 8.6 MCM (23,571 m^3/day) fulfil by Ujani reservoir. There are total 10.02 MCM used in the industrial section. **(Table 8 and Fig. 9)**.

Table 8 Industrial water use by different industrial units

Sr. No.	Name of industry	Crushing capacity in MT	Daily use of water in M^3	Daily demand of water in M^3	Total use in season M^3	Use in %
1	Ballarpur Industries Ltd (BILT)	0	23571	23571.0	8603415	85.9
2	Chhatrapati Sahkari Sakhar Karkhana	3500	1750	1312.5	196875	1.97
3	Nira-Bhima Sahkari Sakhar Karkhana	3500	1750	1312.5	196875	1.97
4	Karmyogi Shankarrao Patil Sahkari Sakhar Karkhana	8000	4000	3000.0	450000	4.49
5	Baramati Agro Sakhar Karkhana	3500	1750	1312.5	196875	1.97
6	Sonaie Jaggery Industry	500	20	20.00	3000	0.03
7	Sonaie dairy	0	1300	600.0	219000	2.19
8	Other industrious	0	410.96	410.96	150000	1.50
	Total	19000	34552	31539.5	10016040	100.00

Source: Pune District Socio-Economic Report 2012 and 2013

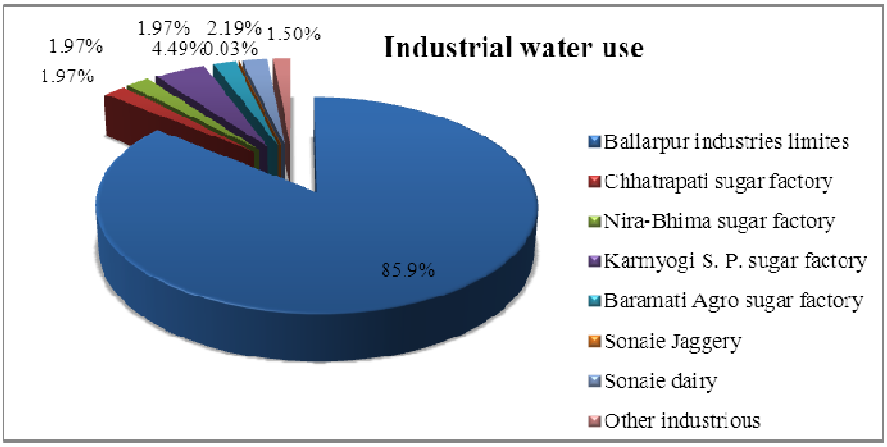


Fig. 9 Schematic diagram of use of industrial water by different industrial units

Conclusions

It has been one of the challenging studies for quantifying the climate change impact wherein the water balance simulation modelling approach has been used to maintain the dynamics of hydrology and thereby make assessments of vulnerability which are more authentic and reliable. The average annual volume of rainfall is 1052.46 MCM. The very low rainfall volume is observed to the northern side sub basin of the tahsil (BM-61) accounts 16.43 MCM i.e. 1.56% and very high rainfall volume is observed to the eastern side sub basins of Indapur tahsil (BM-78) accounts 247.95 MCM which covers around 23.56% of the total study area. According to Thornthwaite's method, it can be noticed that, around 49.08 % area (65 villages) facing very high water scarcity and rest of the villages (78 villages), 50.92% area comparatively show low degree of water scarcity. In an attempt to find out the present villages which are dependent on water supply through water tankers especially in summer months. This overall statistics generated from the raster analysis through the principles of map algebra, clearly indicates that entire tahsil is in water deficit zone, within which different levels of priority have been delineated.

The strategies may range from change in land use, cropping pattern to water conservation etc. and need rigorous integrated analysis before paving way into policy decisions. The research works done on water utilization of the study area. Some of the affects of climate change on water resources. Agriculture cannot sustain without adequate water available for its consumption. With increasing population and demands from various sectors including industry and agriculture the consumption of water is going to jump up in the coming decades.

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