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Inventorization of Water Resources in Solan Block of Himachal Pradesh, India

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Abstract

The present investigations entitled "Inventorization of Water Resources in Solan Block of Himachal Pradesh" was conducted during 2012-13, with the objective to prepare a detailed inventory of water resources in the area, some latest data had also been added. For inventory, a survey was conducted as per prestructured proforma. People's perception was also recorded to verify the inventorization. In Solan Block the total number of water resources recorded in the field were 3218. Out of which 3070 number of water resources are being commercially exploited for use. A total of 412 hand pumps were installed in the area till December 2016. Out of the total water resources in Solan District, 22% ground and 30% surface water resources were in Solan Block. The people's perception indicated that out of 35 panchayats, seven panchayats had water deficiency. In Solan Block 5.29 sq. km of total area was covered under 18 major irrigation schemes till 2016. A total population of 70,643 in rural area of Solan Block had a water requirement of 13,06,189.07 gallons per day whereas, that of urban population (45,845) was 15,13,801.9 gallons per day. The total water requirement of Solan Block calculated was 28,19,990.97 gallons per day for a population of 1,16,488 (Census 2011). The total water storage capacity in Solan Block on an average was 63,07,388.64 gallons to meet the demand of inhabitants along with water requirement for other purposes. But many times this capacity remained unutilized due to less water availability. Periodic water resource management is thus recommended for sustaining quality water availability.

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Inventory, Inventorization, Water Resources and Gallons.

Introduction

Water is one of the most precious resource on earth without which there would be no life on this planet[1]. Inspite of enormous volume of water on the planet, only a small portion is available for use. About 97 per cent of total water is present in oceans and seas which is saline water, and is not useful while fresh water makes up only 2.6 per cent and 4/5 of that is immobilized as ice[2]. This small quantity of fresh water is responsible for sustaining all forms of life on this planet[3].

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Global consumption of water is doubling every 20 years, more than twice the rate of human population growth. At present more than one billion people on earth already lack access to fresh drinking water. By the year 2025 the demand for freshwater is expected to rise to 56% above what currently available water can deliver, if current trends persist[4]. The available water resources in many parts of the country are getting depleted and the water quality has deteriorated. It has been predicted that by 2050 India is going to be water scarce due to the continuous and increasing demand for water[5]. Therefore, a detailed and accurate water resource inventory is deemed necessary to ensure that proper management is executed to promote better sustainability[6].

Distribution of water is highly uneven. The collection of basic data on water balance of the sea and river basins, continents and the planet as a whole is essential for rational utilization and protection of water resources and for understanding the evolution of our planet[7]. Since, water pollution and depletion of water sources due to various anthropogenic causes, as a result of changing climatic situation is increasing therefore documentation (inventorization) of various water bodies, their water yielding potential, availability for use, quality and identifying other related problems is essential for future planning and management. The Water resource inventory (WRI) is a process to identify the availability of water from different sources, water needs of different users, and the tools or facilities to store and/or carry water to the users[8]. There is an urgent need to quantify the fluid inventory and fluid dynamics of the near surface, while understanding volatiles and their deep recycling is fundamental to our understanding of the major dynamic processes of the Earth[9]. The rapid growth of Solan Block has enhanced the use of water and its demand has increased manifold in the recent past. The Solan city of Solan Block is growing rapidly and is generating about 17.51 tonnes of solid waste per day[10]. Information on water availability, quality, requirement, storage and supply

Table 1: Watershed details of the study area

SN.	Name of programe	Name of watershed	Watershed area	Partially or fully covered panchayats of Solan Block
1.	IWDP-II	Dabar Khad Bajrer Khad-I Bajrer Khad-II Bajrer Khad-III Solan Khad-I Solan Khad-II Bhojnagar khad Kaushalya river	39.89 sq. km	Bharti, Kakarhatti, Basal, Dangri, Chamat Bharech, Top ki Ber, Dharot, Sloagra, Parag, Seri, Anji, Shamti Kothon, Bhojnagar, Anhech, Bohli.
2.	IWDP-V	Gamber River east-I, Rao Khad east-I, Rao Khad east-3, Gamber river North-1, Baliani Nala West 1,2, Dabar Khad East-1, Dabar Khad North-1, Ashwani River West-2,3, Dabar Khad south-1	50.00 sq. km	Jadli, Jabal Jamrot, Patta Barauri, Haripur, Bharti, Deothi, Chamat Bharech, Mashiwer, Kakarhatti.

Source: District Watershed Development Agency Office Solan

under present conditions is very scanty. Therefore, information on all these aspect of water is necessary so that appropriate measures can be undertaken for sustainable management of water resources. A comprehensive inventory of the surface and ground water resources was required to be prepared for assessing the potential, as well as for making future plans for this important natural resource. This will also assist in identifying optimum ground-water and surface-water use scenarios, in future.

Objectives

To prepare a detailed inventory of water resources in Solan Block, District Solan of Himachal Pradesh which further includes:

a. Identification of water availability from different sources.
b. Water requirement estimation.
c. Identifying the tools (facilities) to store and/or carry water to the users.

Materials and Methods

The present study was conducted during 2012-2013 in Solan Block, District Solan of Himachal Pradesh, India. The study area is located between 30 ^{0}50'30" to 30^{0}52'00" N latitude and 77 ^{0}08'30" to 77 ^{0}11'30" longitude. This block is spread over an area of 210 sq. km., out of the 1936 sq. km area of the entire district. The average annual rainfall in the district is about 1200 mm which is received mostly during monsoon from July to September. In winters snowfall also occurs at higher reaches with mild winters showers. Figure 1 shows the layout map of the study area and figure 2 shows the map with drainage details of the area.

Collection of Data for Inventory

A detailed survey of Solan Block (35 Panchayat and urban areas) was conducted for documentation (inventorization of water resources in the area) by using pretested proforma and personal interviews. The secondary data was collected from the official certified records maintained by various offices/ departments of Solan namely: Irrigation and Public Health Department (IPH), Deputy Commissioner Office, Office of the Block Development Officer, Office– Project Director & Deputy Director of Agriculture, Office of General Manager District Industries Centre, Mid-Himalayan Watershed Development Division, District Watershed Development Agency, Regional and Ayurvedic Hospital, Tehsil Office, Municipal Cooperation Office, District Water Testing Laboratory, Kandaghat and from each panchayat office. Relevant data was also collected from the HP Government websites and census records.

Estimation of Availability/Status of Water Resources

To assess the availability status of water in different panchayats of Solan Block documentation of various water resources was done. The secondary data was also collected from different offices and the gap was documented. Availability of water for irrigation was determined by summarizing the data

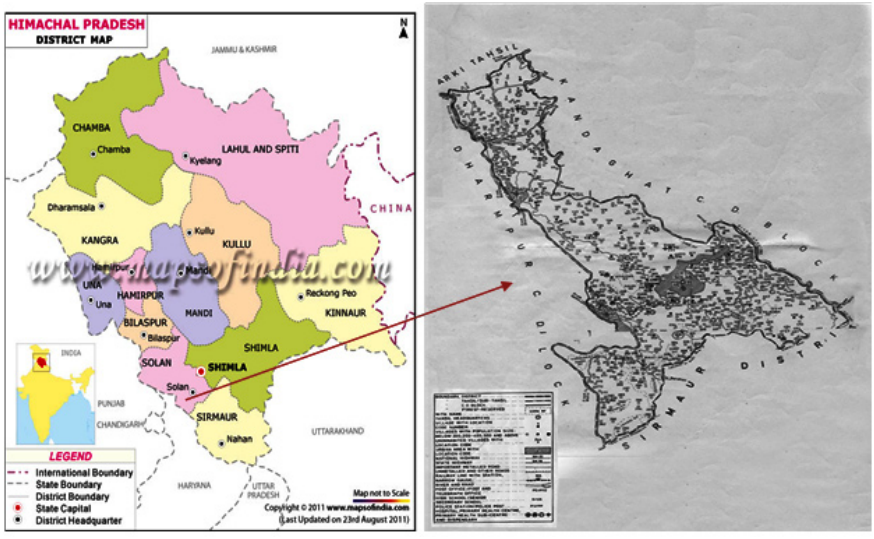

Fig. 1: Maps showing study area (Solan Block)

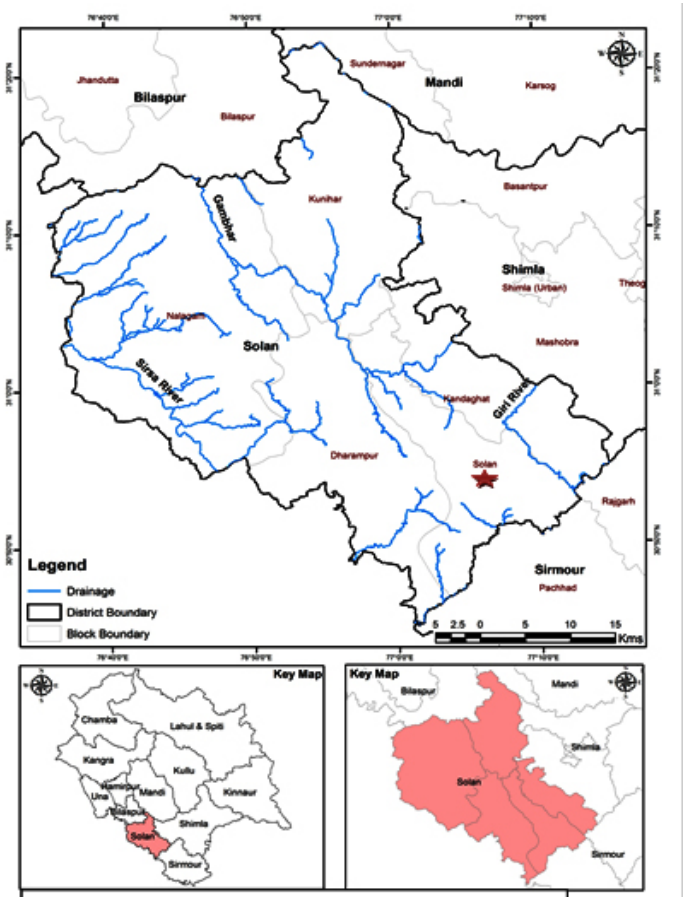

Fig. 2: Map showing ☆ drainage details of the area (Solan Block)

collected from IPH Department regarding different irrigation schemes running in the block. The data regarding types of sources exploited for various schemes was also documented. To record people's perception regarding the availability of water and constraints associated, personal interviews were also conducted. Data regarding watershed division of the area was also collected.

Water Requirement Estimation

Water requirement was calculated by multiplying the respective rural and urban area population (Census 2011) by the standard water requirement values set up by the state government i.e. 18.49 gallons (70 litres) per capita per day for rural area and 33.02 gallons (125 litres) per capita per day for the urban area. To find out the total water requirement of the Block the data obtained was summed up. Rural area population was obtained from panchayat offices and urban population (Solan, Subathu and Dagshai) from the municipal cooperation office and census records 2011.

Storage and Supply

To find out the number of storage structures and total storage capacity in the Block, data was collected from various departments and field observations. Water storage capacity of both rural and urban area was calculated separately. Documentation of various water harvesting structures constructed under various projects and their storage capacity was also recorded. The data regarding various water management and quality check practices followed in the study area was analysed. Documentation of lift, gravity feed and combined water supply schemes in the Block was done.

Results and Discussions

Water Resource Inventory (WRI)

Availability of Water Resources

Survey study conducted revealed that out of the total water resources in Solan District 22% ground and 30% surface water resources were present in Solan Block. On an average Solan Block had 3184 resources of water as per official records whereas, field data revealed that Solan Block contained 3218 number of water resources. This gap may be due to the non-inclusion of relatively small scale resources of water which are contributing less to water availability for utilization, in the official records.

Out of total water resources, 3070 number of resources had been exploited for various uses and requirements of people. The availability of water resources varied from 5 to 262 in different panchayats. Personal interviews conducted in the area, revealed that out of total 35 panchayats in the Block there were a few panchayats that faced water scarcity for most part of the year and some panchayats faced deficiency in summers. A change in availability and utilization status scenario of various water resources was also recorded while interviewing the people. According to the people many perennial sources had changed to seasonal water source, many sources that were earlier used to fetch water for drinking were used for domestic and irrigation purposes only and some sources were not used at all. Occurrence of available and exploited water resources and variation in use, may be attributed to the topography, slope, terrain, rainfall, total area of panchayat, land use, water resource management, aquifer system, surface and ground water system, population, level of exploitation and pollution, extend of various constructions, developmental activities and area under forest.

A total of 412 hand pumps had been installed in the Block. According to IPH department the number of installation had decreased in the past few years and nearly 18 hand pumps were found non-functional. The reason can be reduction in the ground water level, over exploitation, quality deterioration and disturbance in the aquifer system of the area. It has also been reported that water table had declined due to over exploitation to meet the increased demand of water for irrigation, drinking and other purposes[11].

Solan Block had been divided into 17 watershed

Table 2: Status of various irrigation schemes running in Solan Block

SN.	Name of scheme	Type of source	Discharge in LPS*	Area covered sq. km
1.	LIS Garkhola	Stream	9.91	0.14
2.	LIS Patti Kolian	Stream	9.91	0.24
3.	LIS Goura	River	1,72,200	0.13
4.	LIS Sawan Gaon	River	1,01,000	0.28
5.	LIS Gamjhoon	Ravine	75.59	0.47
6.	LIS Patta Brouri	Ravine	84.36	0.91
7.	LIS Sultanpur	Ravine	9.06	0.12
8.	FIS Dharot Kuhl	Stream	113.24	0.56
9.	FIS Nouni	Stream	7.93	0.08
10.	FIS Reh Katal	Ravine	692.00	0.07
11 .	FIS Upper dhillon	Stream	6.10	0.04
Status of various irrigation schemes started in Solan Block after 2013				
12.	FIS Sheel	Stream	28.31	0.46
13.	FIS Raipurrano	Stream	12.51	0.12
14.	LIS Haripur	Ravine	2.50	0.54
15.	LIS Gan ki Ser	Stream	8.37	0.26
16.	LIS Oily Majholi	Stream	-	0.30
17.	LIS Faskna	Ravine	-	0.31
18.	LIS Kohari	Ravine	-	0.27
	Total		274259.7	5.29

Source: Irrigation and Public Health Department Office Solan * LPS: Litre Per Second

areas (Table 1) under Integrated Watershed Development Projects (IWDP) covering an area of around 89.89 sq.km as per official records of District Watershed Development Agency till December 2016. In Solan Block 11 irrigation schemes were running covering an area of 3.034 sq. km which is 1.41% of total irrigated area in the Solan District. 7 Lift Irrigation Schemes (LIS) and 4 Flow Irrigation Schemes (FIS) were running in the Block. Streams, ravines and rivers were the water sources exploited for irrigation purpose (Table 2). The number had increased to 18 (2 FIS and 5 LIS) till December 2016 with area coverage of around 2.26 sq.km. The total area under different schemes thus came out to be 5.29 sq.km During interview it was also found that in addition to these major schemes, irrigation was also done by fetching water from other water sources like step wells, springs, rainwater harvesting tanks, etc. The use of a source for irrigation may be attributed to the type of source, availability of water in the source, alternative use of the source other than irrigation and to the total water discharge of the source.

Water Requirement of Rural and Urban Population

There were 26,172 households over an area of 210 sq. km in Block. The total population of rural area in Solan Block according to 2011 census was 70,643 with 14,937 households (Table 3). Water requirement of rural area was calculated 13,06,189.07 gallons per day. Water requirement of urban area differed significantly from that of rural area which came to be 15,13,801.9 gallons per day for a population of 45,845. Thus, average total water requirement of Solan block came out to be 28,19,990.97 gallons per day for a population of 1,16,488. According to the people and IPH officials and officials of other departments this water requirement is increasing at a very fast rate. Reason for this significant difference in the requirement of water in different areas could be due to difference in population, dependency of the people on supplied water, extend of development activities in the area and state standard supply rate that vary for rural [18.49 gallons (70 litre)/capita/day] and urban population [33.02 gallons (125 litres)/ capita/day].

Table 3: Water requirement status of Solan Block

Sr. No.		Area (sq. km)	Households (no.)	Population (no.)	Water Requirement (in Gallons)
1.	**Rural**	197.41	14,937	70,643	13,06,189.07
a.	Solan	6.18	9,803	39,256	12,96,233.12
b.	Subathu	2.40	855	3,685	1,21,678.7
c.	Dagshai	3.31	577	2,904	95,890.08
2.	**Total Urban**	11.89	11,235	45,845	15,13,801.9
	z	210	26,172	1,16,488	28,19,990.97

*1 Gallon = 3.79 litres

Storage and Supply of Water

Water storage system was found to be different for rural and urban area. For storage of water from different sources, various Lift Water Supply Scheme (LWSS), Gravity Water Supply Scheme (GWSS) and combined had been used. In the Block springs, ravines, stream, Giri river, Ghamber river and other sources were used for extracting water. For rural area water was stored and supplied by the IPH Department under various water supply schemes. As documented in table 3 storage for rural supplies was done in three different divisions i.e. Jaunaji, Chambaghat and Kumarhatti. Total storage capacity of all the three divisions was 8,89,229.55 gallons. Storage tanks in all the divisions were cleaned twice a year and water was supplied to the users after testing and treatment. The samples were tested at District Water Testing Laboratory, Kandaghat.

Water for urban area was stored by the Municipal Cooperation. There were nine storage tanks that

received water from various water supply schemes (Table 4). The total water storage of these tanks was 54,18,158.79 gallons. These tanks receive water from various IPH schemes. Two major schemes, Lift Water Supply Scheme (LWSS) Ashwani ravine and Drinking Water Supply Scheme (DWSS) Giri River supplied water to Solan town and surrounding 114 villages. Water supplied to the users was tested weekly at Central Research Institute, Kasauli.

It was not possible for a single department to look into the matters related to water storage and supply to such a large area and big population and also water is to be supplied according to different standards and norms on periodic basis. The storage structures were to be checked and cleaned periodically and water was to be analysed for various parameters and treated properly before supply to the users. So, storage divisions had to be separate and looked before by different departments for effective management.

Table 4 reveals that during 2008-2011 many water harvesting structures had been constructed that further created and enhanced the total water storage capacity in the area under various government schemes and projects. More than 510 water storage tanks, 132 farm ponds, 95 check dams and 33 rooftop water harvesting structures had been constructed on community as well as individual land in the study area. This has created a total water storage capacity of 237.37 lakh gallons. Government had introduced and funded various projects and schemes under various plans like watershed management in order to improve the water quality and availability, to check soil erosion, to meet the water requirements and to reduce the pressure on large perennial water sources that are facing threat and pollution. So, various departments undertook construction of different water harvesting structures to meet the objectives under government projects.

Many times the water storage capacity created in the area remained unutilised due to less availability of water in the sources this may be attributed to the drastic change in the rainfall pattern experienced during the last few decades in the area. In the region, decade 2001-2010 experienced decrease in rainfall during different seasons, maximum decrease of 115.73 mm was noticed in summer and winter season over the base period followed by 88.31 mm in spring and 25 mm in winter season. Whereas, in the decade of 2001-2010 an increase in rainfall to the tune of 53.37 mm was noticed in autumn season over the base period (Figure 3). This decrease in rains during winter, summer and spring months had resulted in water scarcity which was affecting the recharge of water resources. Reduced number of rainy days and increased intensity of rainfall had led to less time for percolation of water into the soil. Change in rainfall pattern had also led to increased runoff and soil erosion, thus, increasing the extend of silt accumulation in the downstream water resources that further reduced the water holding capacity of those resources and deterioration of water quality because the runoff water not only brings silt but also many organic and inorganic pollutants. The removal of top fertile loose soil during high intensity rainfall had resulted in the low rate of plant growth in the area. All these factors had resulted in reduction of ground water recharge, less availability of water in the small water resources like step wells and springs and more pressure on the large perennial resources for water supply.

Table 4: Status of water storage divisions for Solan Block

Sr. No.	Storage Division	No. of Tanks	Storage Capacity (gallons*)
1.	Jaunaji	45	3,58,322.97
2.	Chambaghat	23	3,21,338.88
3.	Kumarhatti	48	2,09,567.69
	Total Rural	116	8,89, 229.85
4.	Solan Urban	9	54,18,158.79
	Total	125	63,07, 388.64

Source: Irrigation and Public Health Department and Municipal cooperation Office Solan *1 Gallon = 3.79 litres

Water Supply Status in Solan Block

Water supply was done through personnel connections and community taps periodically under various piped water supply (PWS) schemes. Water distribution system was different for rural (IPH Department) and urban areas (IPH and Municipal Corporation). The distribution system varied with the

Table 5: Year-wise details of work executed under different projects and storage capacity created

Sr. No.	Name of Work	No. of Completed structures			Storage Capacity created (lakh gallons)		
A. Work done on community land		**2008-09**	**2009-10**	**2010-11**	**2008-09**	**2009-10**	**2010-11**
1.	Water storage tanks	21	59	47	2.02	10.91	10.46
2.	Farm ponds	37	63	32	3.79	9.28	6.45
3.	Check dam	28	47	20	29.25	67.22	60.35
B. Work done on individual land		**2008-09**	**2009-10**	**2010-11**	**2008-09**	**2009-10**	**2010-11**
1.	Water storage tanks	0	61	322	0.00	4.24	30.62
2.	Roof top harvesting structures	0	9	24	0.00	0.86	1.92

*1 Gallon = 3.79 litres

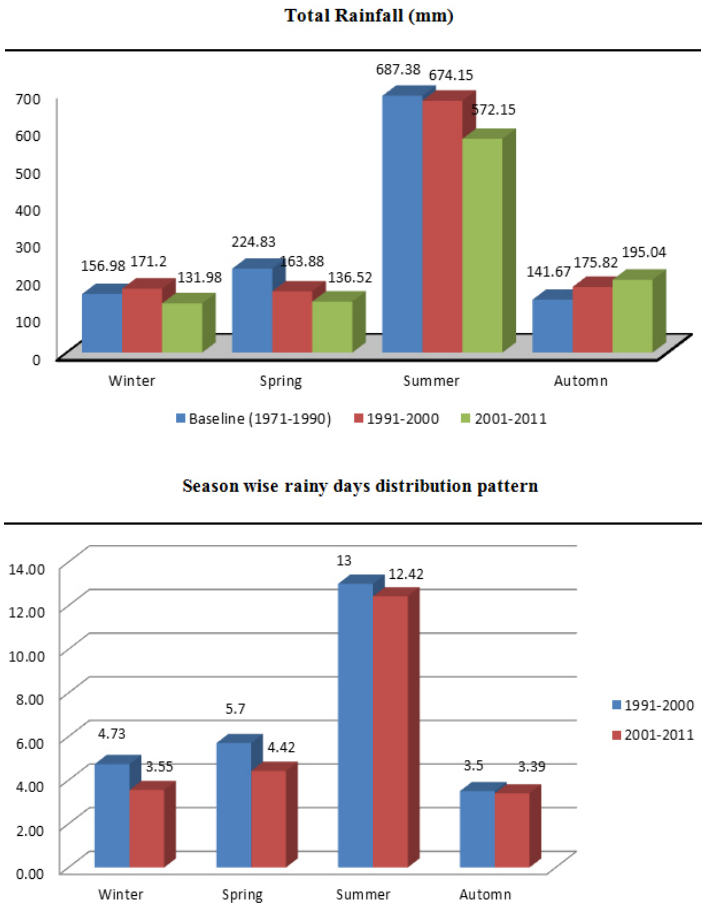

Fig. 3: Total Rainfall (mm) and Season wise rainy days distribution pattern in Solan Block

Table 6: Number and percentage of households by main source of drinking water

Block	Total/ Rural/ Urban	Total no. of Households	Tap water from treated source	Tap water from untreated source	Covered well	Un-covered	Handpump well	Tubewell/ borehole	Spring canal	River/	Tank/ pond /lake	Other Sources
Solan	Total	26,308	22,114	1314	313	137	448	16	499	75	185	1207
			84.06%	4.99%	1.19%	-0.52%	-1.70%	-0.06%	-1.90%	-0.29%	-0.70%	-4.59%
	Rural	15,082	11,191	1228	283	120	394	12	423	75	182	1174
			74.20%	8.14%	1.88%	-0.80%	-2.61%	-0.08%	-2.80%	-0.50%	-1.21%	-7.78%
	Urban	11,226	10,923	86	30	17	54	4	76	0	3	33
			97.30%	0.77%	0.27%	-0.15%	-0.48%	-0.04%	-0.68%	0%	-0.03%	-0.29%

Source: Directorate of Census Operations, 2011[12]

area and the distributing department. Supply to the urban area was more than that to the rural area that may be attributed to the difference in the dependency of people on the supplied water, standard of living, more number of commercial set ups in the urban area and supply rate. Another reason was that in rural areas traditional water resources were also utilised by the people to meet out small scale water requirements.

There were 121 Water Supply Schemes running in 28 panchayats of the Block out of which there were 57 lift, 58 gravity and 6 combined water supply schemes The difference in water supply schemes in various panchayats may be ascribed to the occurrence of water resources, type of resources, availability of water in the resources and economic feasibility to extract water from the resources in the panchayat.

As on 1/4/2011 (according to the official records of IPH Department, Solan) out of total 35 panchayats 13 panchayats were fully covered and 22 were partially covered under water supply. However, on an average the extend of coverage was more than 70% in almost all the panchayats. There were 572 piped water supplies in the block. Reason for partial coverage may be the tough topography due to which it was not feasible to install the piped water supplies and also because people were using traditional water sources to meet their small water requirements. Another reason being that the IPH department was still under progress to install piped water supplies to the left out areas. The data in table 6 shows the number and percentage of households with different sources of drinking water.

Conclusion

It was inferred from the study that people's perception indicated reduction in total water availability during summers due to less rains being experienced in the region during the last two decades. Out of the total water resources in Solan District, 22% ground and 30% surface water sources were present in Solan Block. In rural and urban areas of Solan Block total 1,16,488 inhabitants require 24,13,102.07 gallons of water per day. On an average, the extend of water supply coverage was more than 70% in almost

all the panchayats. 84.06% of total households received water from treated water source. The total water storage capacity in the area was nearly 63,07,388.34 gallons, which however generally remained unutilized due to less availability of water. Hence, water availability needs to be increased for supplying water as per requirement of the block.

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