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RESEARCH ARTICLE

SPATIAL DISTRIBUTION OF DRINKING WATER COVERAGE IN THE RURAL AREAS OF UTTARAKHAND HIMALAYA: A GEOGRAPHICAL ANALYSIS

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Abstract

Uttarakhand government has made a good effort towards covering rural areas in meeting basic water requirements. There are various natural water sources such as spring, river, glacier, groundwater, well etc which play a significant role in the supply of water in the villages of Uttarakhand state. The fundamental objective of this research paper is to study the basic water facility in the villages of Uttarakhand state. For this purpose, the piped water supply (PWS) and functional household tap connection (FHTC) are analyzed. There are total 16919 villages in the study area. Out of the total villages, 16568 villages have PWS facility and about 47% households are connected with PWS facility. There are about 38% villages have more than 70% FHTC coverage. The study reveals that unbalanced development of FHTC and PWS facility among the different districts, i.e., some districts such as U.S. Nagar, Champawat, Almora, Haridwar etc have poor development of FHTC and PWS facility whereas some districts such as Dehradun, Chamoli, Bageshwar etc have good facility. The study suggests that all the villages and households should be covered equally under PWS and FHTC facilities to ensure basic water security.

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Introduction:-

Water is a finite, renewable and vital natural resource on the Earth that is essential for the existence of life. The fundamental objective of this research paper is to analyze the coverage of basic water facilities in the villages of the Uttarakhand state. Out of the total available water on the planet Earth, only about 3% is safe and clean for human consumption (Molden et. al., 2001). Water resource plays an important role in the socio-economic development of a region or country (UNESCO, 1987). The rural-urban disparity is experienced in the access to drinking water throughout the world, i.e., rural areas have less access to drinking water than the urban areas (UNICEF and WHO, 2011). Omarovo et. al., (2019) studied the water supply challenges in rural areas of central Kazakhstan. On the one hand, the world population is increasing rapidly and on the other hand, the water resource availability is decreasing. The increasing population, growing urban centers, industrialization and advancement of agriculture have increased the water demand in India (Bhat, 2014). Due to the increasing population, the per capita water availability is decreasing in India continuously as in 1951, the per capita water availability in India was 5177 m³/year which has decreased to 1545 m³/year in 2011 and it is projected that the per capita water availability will further decrease down to 1293 m³/year and 1140 m³/year in 2025 and 2050, respectively (MJS, 2019). To cover all the villages in India under drinking water facility the government of India (GOI) has set a national standard of the minimum water supply of 55 liters per capita per day (lpcd) and most of the states and UTs follow this national standard (Singh et.

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al., 2020). So far, the GOI has made three national water policies to govern and manage the available water resources for sustainable development. The first national water policy was developed and accepted in 1987 and later on, it was revised and updated in 2002 and 2012 (Lalitha and Siromony, 2014). To provide a basic water facility in all the villages of India, the GOI is working on it since independence (Cronin et. al., 2016). The main sources of drinking water in the villages of Uttarakhand are springs, rivers, rivulets, well etc. In the study area, the rivulets (locally known as gadhera) and springs are used for domestic purposes and have about 48% and 14% of total water supply schemes, respectively (Kumar et. al., 2019). Uttarakhand state is rich in terms of freshwater resources. The main freshwater sources of Uttarakhand are glaciers, rivers, lakes, rivulets, springs etc. Uttarakhand state has total 968 glaciers which cover about 10% area of the state and many glacial-fed rivers are also originate from these glaciers (SSAP, 2018).

Materials and Methods:-

Uttarakhand state has been chosen as the study area. For the completion of this research paper mainly the secondary data is used. The secondary data is obtained from the integrated management information system (IMIS) portal of the department of drinking water and sanitation, Ministry of Jal Shakti, Government of India. The piped water supply (PWS) and functional household tap connection (FHTC) data are analyzed here to find out the current status of basic water coverage in the villages of Uttarakhand state. The location and thematic maps are constructed in QGIS and Arc GIS software using spatial analysis tools.

About the Study Area:-

Geographically the study area lies in the Central Himalaya region of India. The study area is located in between $28^{\circ}7' N$ to $31^{\circ}4' N$ latitudes and $77^{\circ}7' E$ to $81^{\circ}1' E$ longitudes having total geographical area of 53483 km^2 . 86.07% of total area is hilly area and 13.93% is the plain area (Kumar et. al., 2019). Uttarakhand is an international bordering state of India. The study area makes border with China in the North, Nepal in the East, Himachal Pradesh in the West and Uttar Pradesh in the South (Fig. 1). The study area is divided into two commissioners, Garhwal commissioner and Kumaun commissioner. There are 07 districts in Garhwal commissioner (Dehradun, Haridwar, Pauri Garhwal, Tehari Garhwal, Uttarkashi, Rudraprayag and Chamoli) and 06 districts in Kumaun commissioner (Almora, Nainital, Udham Singh Nagar, Bageshwar, Champawat and Pithoragarh) (Maithani et. al., 2015).

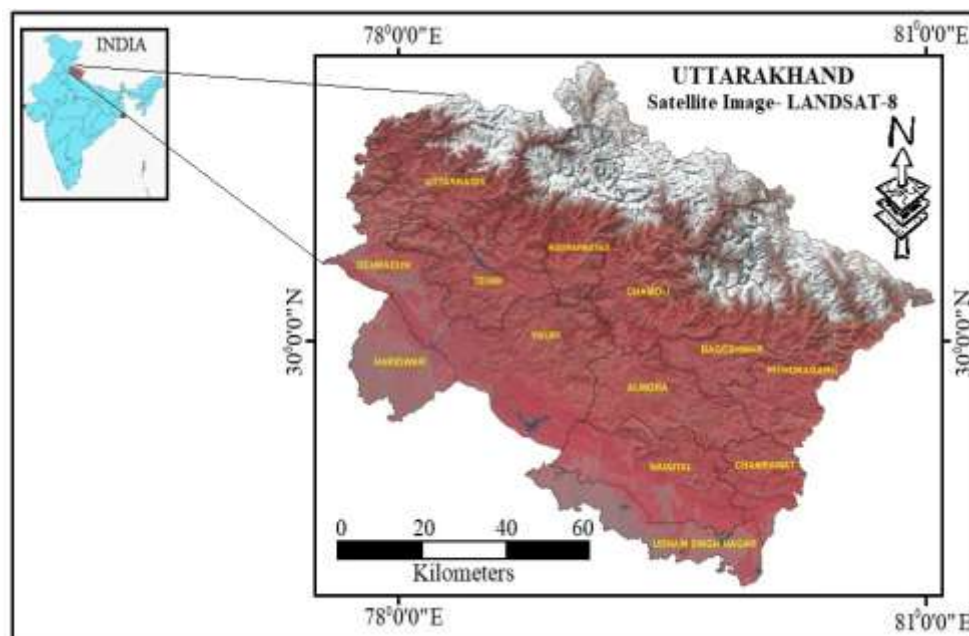


Fig. 1:- Location map of the study area, viz., Uttarakhand state.

Results and Discussion:-

As earlier discussed that the study area is a hilly region where the covering of villages under basic water facility is not easy. The detailed study of the development of drinking water coverage in the villages of the study area is

divided into four sections which are the history of rural water supply program, piped water supply, functional household tap connection and rural population and drinking water coverage. A brief description of these three sections is presented in the following paragraphs.

Histroy of Rural Water Supply Programs

Since independence, the Government of India is constantly making efforts to provide basic water facilities to all villages. For this purpose, the first nationwide drinking program was started in 1954 named the National Water Supply Program under the ministry of health. Till 3rd five year plan, the rural drinking water supply program was operated as a part of the community development program. In 1972-73, a new rural drinking water program was introduced named Accelerated Rural Water Supply Program (ARWSP) to provide support to state/UT governments' drinking water and sanitation program. This program was more strengthened during 5th five year plan under the minimum needs program. In 1986, the National Drinking Water Mission (NDWM) was started to address water scarcity and Swajaldhara drinking water program was launched in 2002. In 2004-05, ARWSP was merged in Bharat Nirman Program to achieve 100% household coverage by 2008-09 and in 2009-10 it was restructured and renamed as National Rural Drinking Water Program (NRDWP) aimed to achieve affordable access to safe drinking water in all the villages. The NRDWP was merged in Jal Jeevan Mission (JJM) in 2017. The main aim of the JJM program is to achieve 100% coverage of households with functional household tap connection by 2024 (MJS, 2019).

Piped Water Supply (PWS)

The detail of villages and household covered under piped water supply (PWS) is presented in table-1. There are total 16919 villages in the study area varies between 3483 (Pauri Garhwal) and 636 (Haridwar). In Uttarakhand, there are 1381007 households which varies between 210599 (Haridwar) and 45871 (Champawat). Out of the total villages, 351 villages and their 80903 households have not PWS coverage facility and 16568 villages and their 649426 households have PWS coverage facility. At present, 47% households are covered under the PWS facility which varies between 90.3% (Dehradun) and 15.4% (Udham Singh Nagar) (Table-1 and Fig. 2). The spatial distribution of PWS coverage of the study area is depicted in figure 3. The study area is divisible into three parts based on the PWS coverage facility presented in table-2.

Table-1:- Details of villages covered under PWS facility in Uttarakhand (Source: Department of drinking water and sanitation, Ministry of Jal Shakti, GOI, 2021).

Sanitation, Ministry of Jal Shakti, GOI, 2021).

S.N.	Name of districts	Total villages	Total households	Piped water supply (PWS) coverage			Households covered under PWS (in %)
				Without PWS	With PWS		
				Villages	Villages	households	
1	Almora	2294	128999	06	2288	40319	31.3
2	Bageshwar	948	52156	00	948	46751	89.6
3	Chamoli	1252	73991	04	1248	63030	85.2
4	Champawat	721	45871	01	720	25329	55.2
5	Dehradun	771	120660	00	771	109011	90.3
6	Haridwar	636	210599	104	532	39076	18.6
7	Nainital	1160	107300	30	1130	51433	47.9
8	P. Garhwal	3483	124167	07	3476	50567	40.7
9	Pithoragarh	1678	93885	00	1678	52043	55.4
10	Rudraprayag	690	55105	01	689	31704	57.5
11	T. Garhwal	1868	130754	03	1865	68284	52.2
12	U. S. Nagar	708	161817	194	514	24840	15.4
13	Uttarkashi	710	75703	01	709	47039	62.1
Total		16919	1381007	351	16568	649426	47.0

Low PWS Coverage Category:

The districts having less than 40% households PWS coverage are classified as low PWS coverage category. Three districts such as Almora, Haridwar and U.S. Nagar fall under this low PWS category (Fig.3). There are total 501415 households come in this category; out of these 104235 households (16.1%) have PWS coverage and there are also 304 villages that do not have PWS coverage facilities (Table-2).

Medium PWS Coverage Category:

The districts that have 40-80% household PWS coverage are classified as medium PWS coverage category. Seven districts such as Pauri Garhwal, Tehari Garhwal, Nainital, Champawat, Pithoragarh, Rudraprayag and Uttarakashi fall under this medium PWS category (Fig.3). There are total 632785 households in this category; out of these 326399 households (50.3%) have PWS coverage and there are also 43 villages that do not have PWS coverage facilities (Table-2).

High PWS Coverage Category:

The districts having more than 80% household PWS coverage are classified as high PWS coverage category. Three districts such as Dehradun, Chamoli and Bageshwar fall under this high PWS category (Fig.3). There are total 246807 households in this category; out of these 218792 households (33.7%) have PWS coverage and there are 04 villages that have not PWS coverage facilities (Table-2).

Table-2:- Detail of piped water supply (PWS) coverage category in the study area.

S. N.	PWS Class	PWS coverage			Remark
		No. of district	Households	Household in %	
1	<40%	03	104235	16.1	Low PWS
2	40-80%	07	326399	50.3	Medium PWS
3	80%	03	218792	33.7	High PWS
Total		13	649426	100.0	-

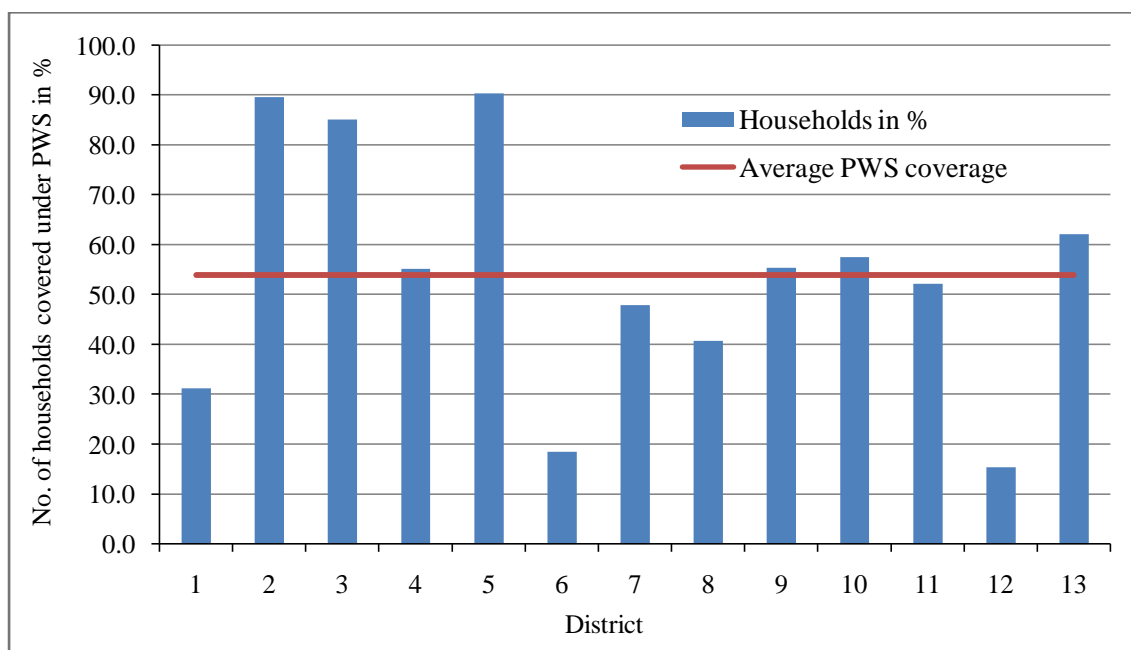
**Fig. 2:-** District wise presentation of coverage of households under PWS facility in the study area.**Functional Household Tap Connection (FHTC)**

Table-3 depicts the detailed account of functional household tap connection (FHTC) in the study area. All the villages of the study area are classified into five categories based on their FHTC coverage. Out of the total villages, 2765, 1433, 1036, 920 and 10765 villages have 100%, 90-100%, 80-90%, 70-80% and <70% FHTC coverage, respectively. As per >70% FHTC coverage, there are total 6154 villages which varies between 24 (U.S. Nagar) and 918 (Pauri Garhwal) (Table-3 and Fig. 4). Figure 5 depicts the spatial distribution of FHTC coverage of the study area. The study area is divisible into three categories based on the >70% coverage of villages under FHTC facility which are low FHTC category, medium FHTC category and high FHTC category (Table-4). A brief account of these categories is presented in the following paragraphs.

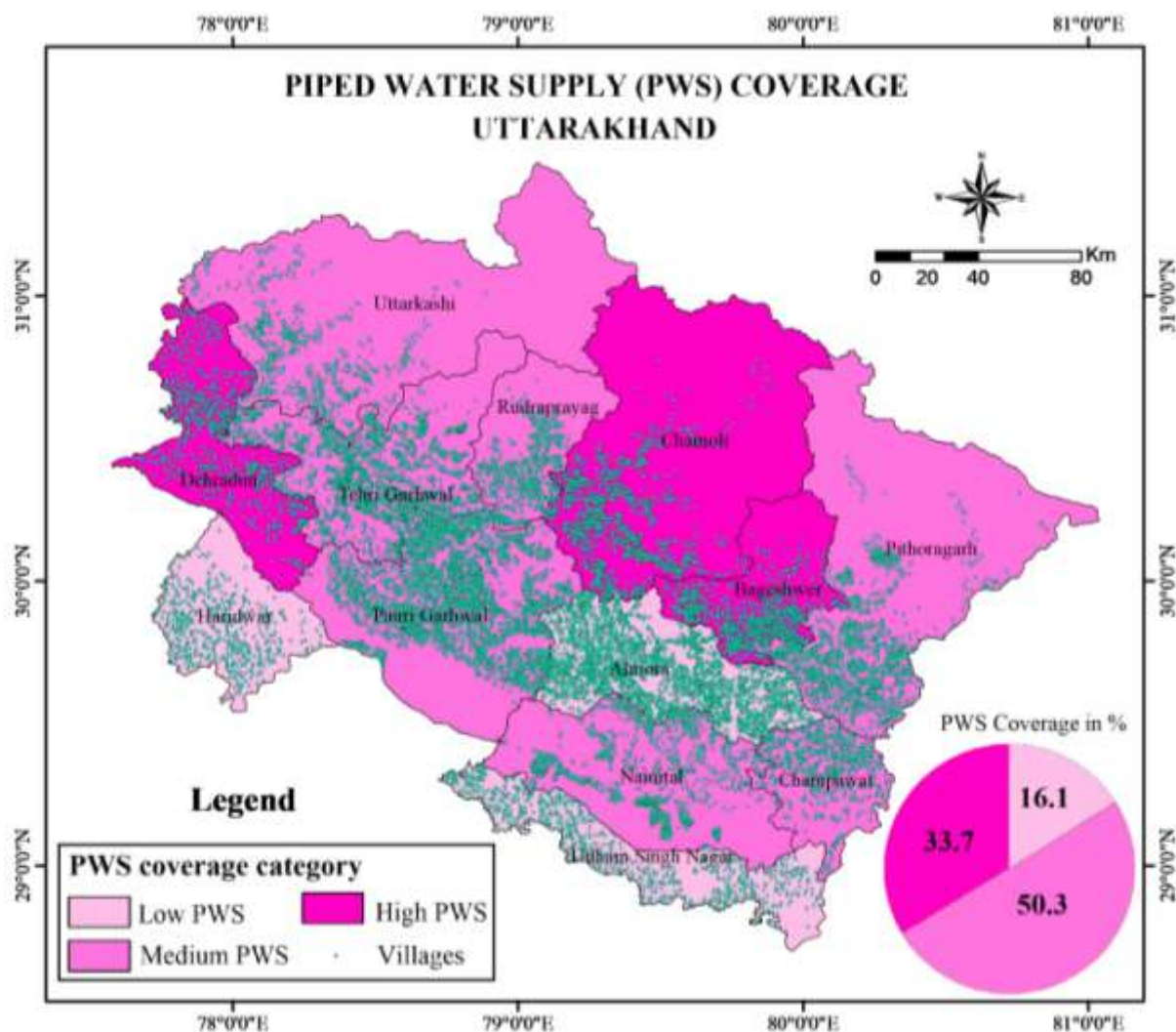


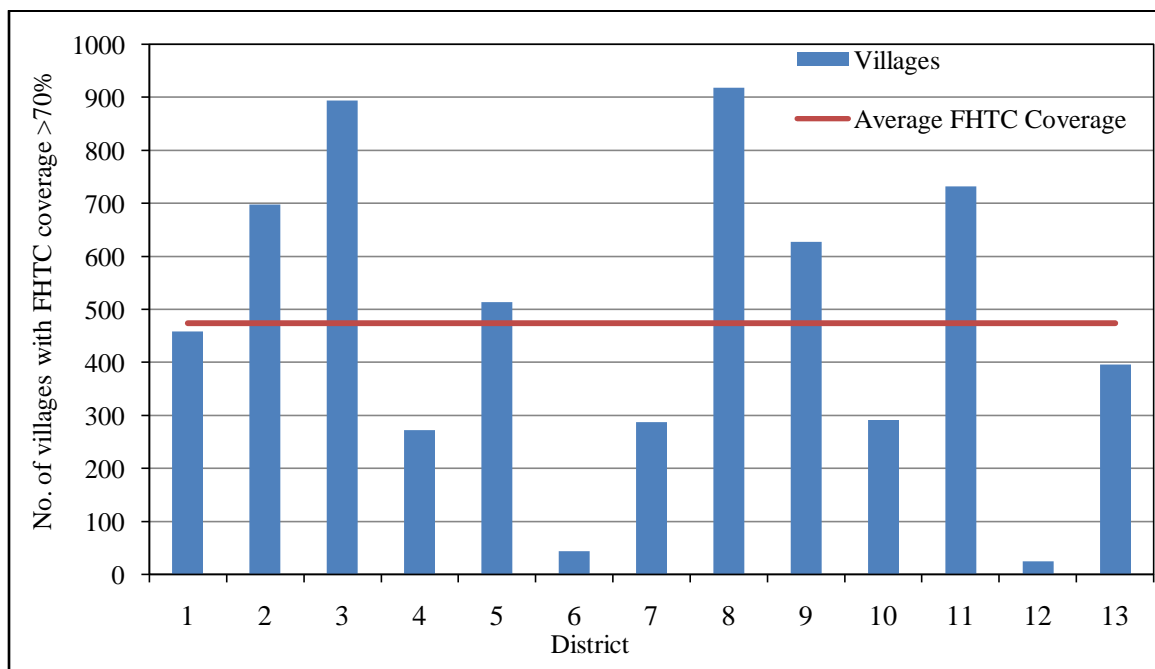
Fig. 3:- Spatial distribution of PWS coverage category in the study area, viz., Uttarakhand.

Table 3:- Details of FHTC coverage in the study area (Source: Department of drinking water and sanitation, Ministry of Jal Shakti, GOI, 2021).

S. N.	Name of districts	Total villages	Number of villages with FHTC coverage (in %)				
			100	90-100	80-90	70-80	< 70
1	Almora	2294	222	66	80	90	1836
2	Bageshwar	948	478	109	64	47	250
3	Chamoli	1252	374	327	128	65	358
4	Champawat	721	134	39	41	58	449
5	Dehradun	771	294	102	60	58	257
6	Haridwar	636	17	11	08	07	593
7	Nainital	1160	132	62	43	50	873
8	Pauri Garhwal	3483	413	136	181	188	2565
9	Pithoragarh	1678	272	155	97	103	1051
10	Rudraprayag	690	116	51	70	54	399
11	Tehri Garhwal	1868	180	225	187	140	1136
12	U. S. Nagar	708	08	04	05	07	684
13	Uttarkashi	710	125	146	72	53	314
Total		16919	2765	1433	1036	920	10765

Table 4:- Detail of functional household tap connection (FHTC) category in the study area.

S. N.	FHTC (Villages)	FHTC coverage			Category
		No. of Districts	No. of Villages	Villages in %	
1	<300	05	917	14.90	Low FHTC
2	300-600	03	1368	22.23	Medium FHTC
3	>600	05	3869	62.87	High FHTC
Total		13	6154	100.00	-

**Fig. 4:-** Graphical presentation of villages covered under >70% FHTC facility in the study area.**Low FHTC Category:**

Districts that have less than 300 villages with more than 70% FHTC coverage are termed as low FHTC category. Out of 13 districts, 05 districts fall under this low FHTC category which are; U.S. Nagar, Haridwar, Champawat, Nainital and Rudraprayag (Fig. 5). Out of the total villages, 917 villages are fall in this low FHTC category (Table-4).

Medium FHTC Category:

Districts that have 300 to 600 villages with more than 70% FHTC coverage are classified as medium FHTC category. Out of the total, 03 districts such as Uttarkashi, Almora and Dehradun come under this medium FHTC category (Fig. 5). Out of the total villages, 1368 villages come under the medium FHTC category (Table-4).

High FHTC Category:

Districts that have more than 600 villages with more than 70% FHTC coverage are classified as high FHTC category. Out of the total, 05 districts such as Pithoragarh, Bageshwar, Tehari Garhwal, Chamoli and Pauri Garhwal come under this high FHTC category (Fig. 5). Out of the total villages, 3869 villages come under the high FHTC category (Table-4).

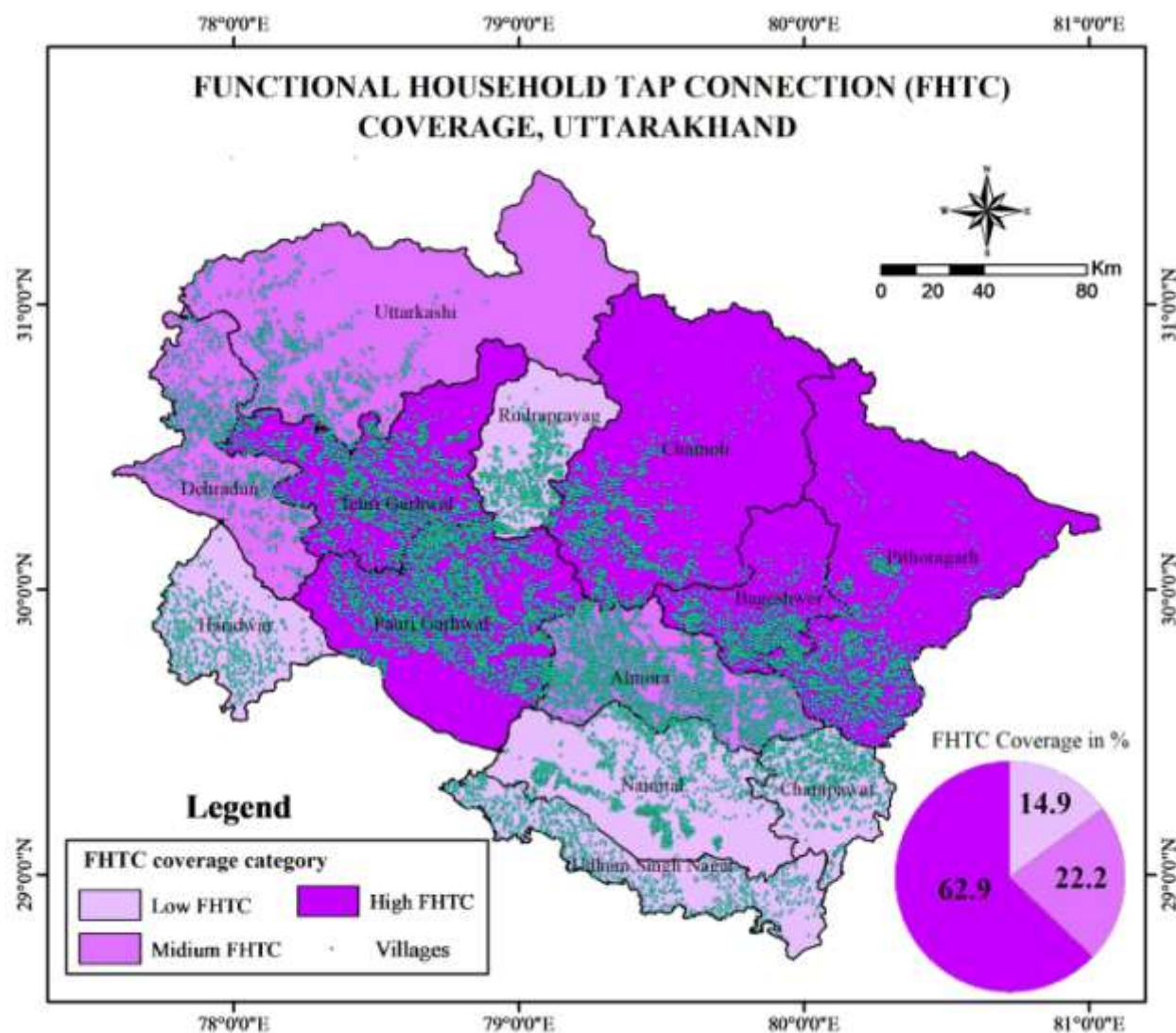


Fig. 5:- Spatial distribution of FHTC coverage category in the study area, viz., Uttarakhand.

Rural Population and Drinking Water Coverage

According to census 2011, the total population of the study area is 10086292. Out of the total population, 7036954 is rural and 3049338 is urban population (Tripathy and Kumar, 2014). The coverage of rural population under household PWS facility and villages having more than 70% FHTC facility are analyzed in this section. The minimum rural population is recorded in Dehradun district (44.48% of the total population) which covers 66.67% villages and 31.26% households under FHTC and PWS facility, respectively. And the maximum rural population is recorded in Bageshwar district (96.51% of the total population) which covers 73.63% villages and 89.64% households under FHTC and PWS facility, respectively (Table-5). Figure 6 depicts the coverage of the rural population of different districts of the study area under FHTC and PWS facility which reveals unbalanced development of FHTC and PWS facility.

Table 5:- Detail of rural population (2011) of the study area under FHTC and PWS coverage facility (Source: *Ministry of Jal Shakti and ** Tripathy and Kumar, 2014).

S.N.	Name of District	*Villages with >70% FHTC Coverage (in %)	*Households with PWS (in %)	**Total rural population (in %)
1	Almora	19.97	31.26	89.99
2	Bageshwar	73.63	89.64	96.51
3	Chamoli	71.41	85.19	84.83

4	Champawat	37.73	55.22	85.23
5	Dehradun	66.67	90.35	44.48
6	Haridwar	6.76	18.55	63.34
7	Nainital	24.74	47.93	61.06
8	P. Garhwal	26.36	40.72	83.60
9	Pithoragarh	37.37	55.43	85.60
10	Rudraprayag	42.17	57.53	95.90
11	T. Garhwal	39.19	52.22	88.67
12	U. S. Nagar	3.39	15.35	64.42
13	Uttarkashi	55.77	62.14	92.64
Total		36.37	47.03	69.77

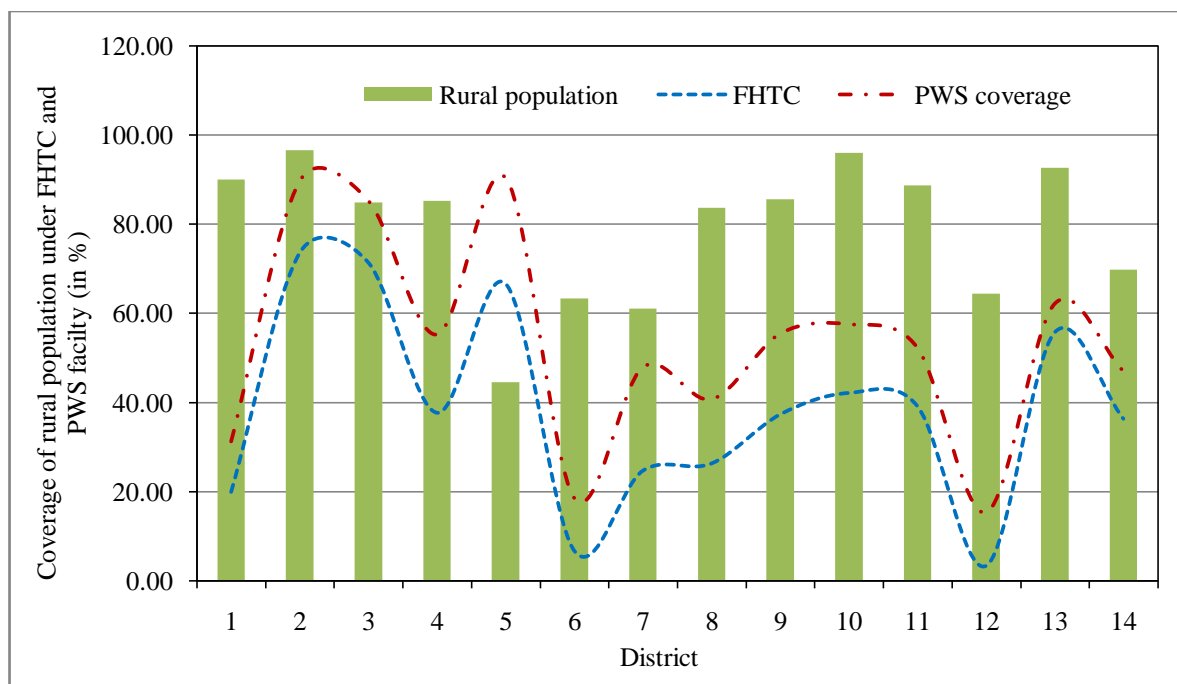


Fig. 6:- Diagrammatic presentation of rural population, villages with FHTC and households with PWS coverage in the study area.

Conclusion:-

Water is a very important natural resource for the existence of all forms of life. It is difficult to provide basic water facilities in the rural areas of the study area because of rough terrain. The Union and State government both are making continuous efforts to provide basic water facilities in the villages of the study area. According to census 2011, there are total 16919 villages in the study area. Out of the total villages, 16568 villages have been connected with the PWS system and 351 villages and their 80903 households have not covered under the PWS facility still. Out of the total villages, 2765, 1433, 1036, 920 and 10765 villages have 100%, 90-100%, 80-90%, 70-80% and <70% FHTC coverage, respectively, i.e., 6154 villages have more than 70% FHTC coverage. The PWS and FHTC coverage varies from district to district, viz., some districts have high coverage and some low. The study reveals the unbalanced development of PWS and FHTC facility among different districts. The study suggests that all the villages and households should be covered equally under PWS and FHTC facility to ensure basic water security.

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