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HOW DYNAMICS OF URBAN-RURAL WATER SUPPY IS AFFECTING THE URBAN-RURAL RELATION OF DEHRADUN DISTRICT UTTARAKHAND?

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ABSTRACT:

Around the world, over 2 billion people are experiencing high water stress, furthermore, during at least for one month of the year about 4 billion people undergoing the serious water scarcity. Undeniably, the stress level will continue to rise as the demands for water goes up and the effects of the global warming and climate change intensity. As we progress into the 21st century our nation is likewise facing a major crisis of clean safe water. Although, this water crisis has jeopardized the basic right of people to drinking clean water as a citizen but it has also put the livelihoods of million people at risk. Simultaneously, the rising demands of a instantaneously urbanizing society and rapid industrializing economy has put immense pressure on existing water supply, meanwhile the potential for rising supply is limited, Groundwater tables are dropping down & the water quality issues have progressively come forward (Shah, 2013). drinking water is less than hundred LPCD along with a merely 2.7 percent of surveyed municipalities have proclaimed to supply over this amount in the numerous urban centers of India. Whereas roughly 28 % of the various municipalities have distributed less than 50 LPCD. Rapid urbanization, Exponential and unplanned growth of cities energized by rural to urban migration has accelerated the primary challenge to supplying drinking water both in quantum and quality. This research paper is an analysis of census 2011 data and uses the Central Ground Water Board CGWB and Households level data of 2011 census to analyze the existing water supply system of all blocks in Dehradun excluding Chakrata and Kalsi Block due to its rugged terrain. So, this paper tries to examines the various government initiatives in urban water supply, their gaps in water provision, and the amount of this lack of access. It also tries to explain how growth trends of populations in urban and rural areas; their need for prompt solutions to encounter the challenges of safe water for the households leaving in urban and rural areas.

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Keywords: Water crisis, water supply, urbanization, urban-rural relation.

INTRODUCTION:

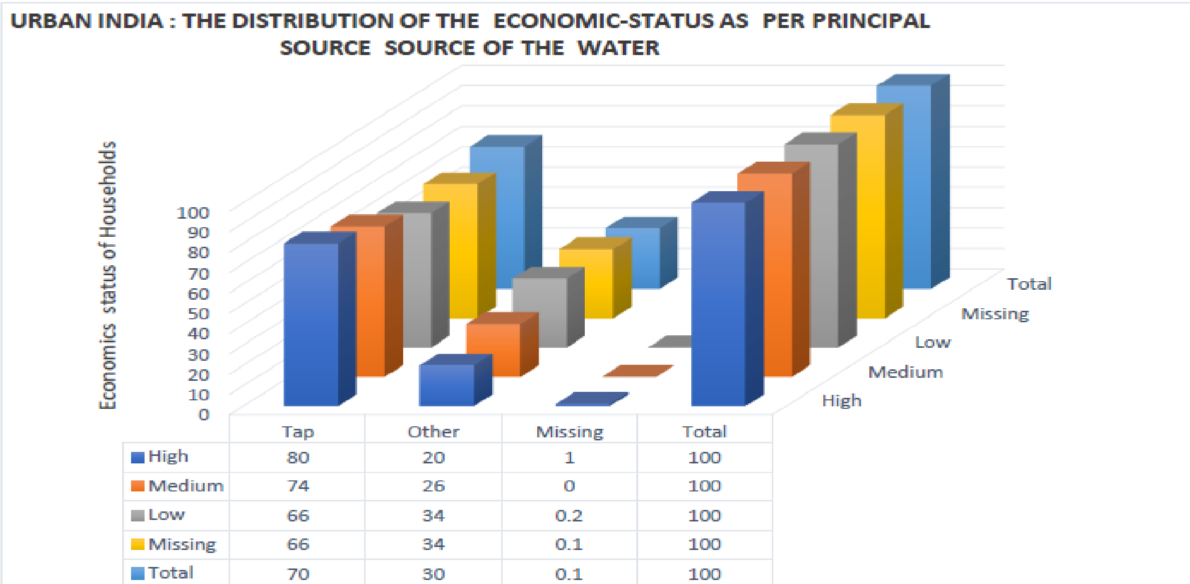
Around the world, over 2 billion people are experiencing high water stress, furthermore, during at least for one month of the year about 4 billion people undergoing the serious water scarcity. Undeniably, the stress level will continue to rise as the demands for water goes up and the effects of the global warming and climate change intensity. As we progress into the 21st century our nation is likewise facing a major crisis of clean safe water. Although, this water crisis has jeopardized the basic right of people to drinking clean water as a citizen but it has also put the livelihoods of million people at risk. Simultaneously, the rising demands of a instantaneously urbanizing society and rapid industrializing economy has put immense pressure on existing water supply, meanwhile the potential for rising supply is limited, Groundwater tables are dropping down & the water quality issues have progressively come forward (Shah, 2013). Indeed, numerous developing and developed countries of the world are facing water crisis and failed urban-water supply-system; as we know the water quality and availability is directly connected to climate and urbanization, but with increasing global warming, climate change and rapid urbanization events day by day the situation getting worse and worsen; additionally situation is getting more critical because of inadequate awareness to replacement & maintenance planning and growing safe and clean water demand and supply by the customers. Bringing safe clean water access to India's millions of people is a challenging task. There are over 97 million people without any sufficient access to safe potable water impacting morbidity and health, (Safe water network, 2016). Therefore, Adequate access to clean water supplies are one of the top-notch priorities in many

developed & developing countries of the world over the past 3 to 4 decades and a huge amount of capital have been invested in pursuit of the desired result of "universal service." (The Economist., 2002).
Indeed, the latest reports by (United Nations: 2003) pointed out that; the world "is facing a serious water crisis"; that safe water access as well as safe water service delivery. That's why in many developing countries of the world, it should be very important to enhanced urgently and remarkably especially if we have to absolutely win the battle against the hunger, poverty and diseases. In India, with rapid urbanization & population growth the domestic safe and clean water requirements are increasing alongside increase in living standards of the people. Nevertheless, water resources availability hasn't gone along with the growing population density, and currently, there exists a slippage between the demand & supply system for the sufficient water resources. Numerous regions of our nation are already experiencing a scarcity of potable water supply notably during the dry seasons; this perhaps ascribed to the unavailability of the safe water resources and an irregular water distribution system and its economic management. In spite of the fact, that a few cities are reinforced by equitable water supply, but there are some certain pockets within the cities, that undergo from the scarcity of the safe domestic water supply owing to the fact that, to impact the pressure heads of the municipalities water supplies, the major role is played by the local topography. On this subject, now there is an urgency to measure the domestic water demands at this stage; as well as in, the near future to deal with the water distribution systems in spatial domain for achieving the successive adequate supply of the domestic water demands and its most optimum management. (Durga Rao, 2005). On the other hand, as per the 2011 census; the urban population was 377 million; with a domestic water demand of 50,895 Million liter per day (MLD). So, this data reveals that the growth in urban population bring about additional water demand of 12,420 MLD in the India's Urban area. As well as, the data obtain from Central Public Health & Environmental Engineering Organization (CPHEEO) reveals that the average water supply in (ULBs) urban local bodies of India is 69.25 liters per capita per day (LPCD), whereas, as per the service level benchmark it should be around 135 LPCD. So, it also exhibits that in India; there is a huge Demand and supply gap of clean water in urban area (Mr Qazi Syed Wamiq Ali, 2018).

Moreover, as stated in Census 2011, 91.4 per cent households in urban India, had access to the clean drinking water as compared to 90 percent in year 2001.Additionally, large inter-state-disparities also exist here too. Moreover, as per the report published by (NIUA Urban Statistics, 2016) stated that ; the Lakshadweep only 20.2 % of house holds had access to the source of drinking water, on the contrary, In Chandigarh 99.4 % of house holds recieves access to the source of drinking water in the year 2011. In comparison, to the other cities of the world's developed countries, none of the Indian cities are capable to supply water for the twenty-four hours a *day*. Roughly, all neighborhoods and localities collect the water twice or once a day. Therefore, they are compelled to store & draw the water for their day-to-day expected demands. Throughout this process of storing and drawing water, some amount of water is lost. Additionally, users have to draw more water now, than they even required. On the other hand the contaminated water storage, leaking pipes and the sluggish movement of the water during distribution and transmission contributes to the various health problems, Predominantly to the urban slums.(Bouselly, Gupta, & Ghosh, 2006). A research performed in year 2016 by (NIUA Urban Statistics, 2016) revealed that; the accessibility of clean drinking water is less than hundred LPCD along with a merely 2.7 percent of surveyed municipalities have proclaimed to supply over this amount in the numerous urban centers of India. Whereas roughly 28 % of the various municipalities have distributed less than 50 LPCD. Rapid urbanization, Exponential and unplanned growth of cities energized by rural to urban migration has accelerated the primary challenge to supplying drinking water both in quantum and quality.

In the journal article published by (A. Khare & L. Bhandari, 2006). "Poor provision of household water in India" have introduced a simple-index; which depend on the ownership of certain amenities and lifestyle characteristics to examine the economicstatus of the households. Therefore, the households were categorized in three types as H : high, M : medium, and L : low . Around 41 per cent reside to the low economic strata, and 13 per cent to the medium & 23 per cent to the high strata. (The remaining percent was unable to be categorized partly because of the lack of the appropriate information) as shown in **Graph:1**

Graph:1: *THE DISTRIBUTION OF THE ECONOMIC STATUS*



	Tap	Other	Missing	Total
High	80	20	1	100
Medium	74	26	0	100
Low	66	34	0.2	100
Missing	66	34	0.1	100
Total	70	30	0.1	100

These above figures reveal the distribution between untapped & tapped for the class-L to be 66: 34 as related to the class-M ; with a ratio of the 74:26 and Class H with ration 80:20. Simultaneously, the definite figures are putting more on show; Approximately, 7 mn households of the urban India is associated with the lower (L) economic-strata and they don't have sufficient access to the tap water. However, this data pertains only to legitimized slum household settlements. For that reason, the unauthorized and semi-legitimized-slums are not legally recognized by the government of India; Hence, these peoples are not obligatory to obtain tapped water. (A. Khare & L. Bhandari, 2006). As per census of India 2011 Dehradun is regarded as a Class-I city (population greater than 1,00,000), it is a Largest urban agglomeration in the entire Uttarakhand after Haridwar and Roorkee. The hilly districts neighboring district Dehradun have seen a four-fold hike in the number of the towns between year 1901 and 2001.The Dehradun district's population had registered increase of 41.08 percent between year 1961 to 1971, 32.84 percent between year 1971 to 81, 25.39 percent between year 1981-91 and during 1991-2001 it increased by 52.45 percent (Gupta & Goyal, 2014). As well as the decadal growth rate of Dehradun from year 2001 to 2011 also exhibit the same story, as shown in below

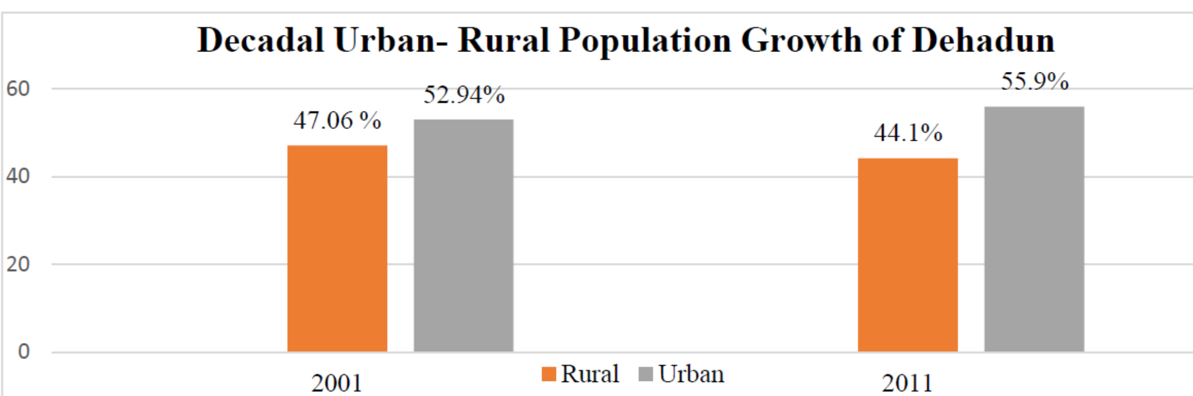


Figure 1:Decadal Urban - Rural population growth

figure 1. Moreover, As per the census 2011 report the decadal growth of urban population in district Dehradun was rose by 2.96%, whereas the decline percentage from rural areas was also similar as 2.96%. Consequently, it shows clearly the migration of people from rural areas to the urban areas within this period of time. Increasing population of urban areas or city demands more resources especially when it comes to clean water supply; Hence, Dehradun's ULBs struggle to keep up the water delivery services, the urban poor bear the costs, especially those living beyond the pipe networks. Mostly, Urban poor households leaving in the squatter settlements in Dehradun are not able to afford domestic networked water supply access, and more likely to depend on common facilities (natural or manmade) available to their local regions.

A rising proportion of users with-out access to sufficient clean domestic water supplies in urban areas; Outbreak of the waterborne diseases are more prevalent in city slums of Dehradun around Bindal and Rispana river, due to high-density living, poverty, inadequate water and sanitation services, inadequate hygiene practices, Low water quality, poor access to health care, and malnutrition. Due to non-existence of integrated management of water sources. during dry season, many households and especially Urban poor leaving in the Dehradun districts are undergoing the permanent water crises, in addition, rising population pressure, urbanization and poor waste management coupled with poor management of existing water resources has added fuel to the fire. Consequently, many urban cities dwellers specially the urban poor of the state don't have the adequate water availability to meet their daily requirements. Furthermore, the absence of the detailed planning and management of existing water supply systems; and while also being cautious of the floating population in the cities; and an appropriate management of the sewage and storm water systems, including rain water harvesting schemes. For this reason, there is a vital need to embrace the comprehensive approach to dealing with urban water crisis issues in the Dehradun urban agglomeration especially for urban poor; as well as covering all the facets of the demand and supply system and water resource management in Dehradun's ULBs for the adaptable water supply management. (Bouselly et al., 2006) have interpreted the four major common obstacles to gain the access to safe water for the urban poor. These major obstacles are : (1) the expenditure of accessing water services, (2) the legal position of the residents in the matter of land tenure. (3) the locality of the settlements, and distance from the municipal authority & water accessibility; and of course (4) political barriers; Whereas, to adjoin the (GIS) geographical information systems techniques to the water resource management (Leipnik, Leipnik, & Kemp, 1993), have elucidated the different kinds of available software and hardware technologies.

So, this paper tries to examines the various government initiatives in urban water supply, their gaps in water provision, and the amount of this lack of access. It also tries to explain how growth trends of populations in urban and rural areas; their need for prompt solutions to encounter the challenges of safe water for the households leaving in urban and rural areas.

RESEARCH METHODOLOGY:

This research paper is an analysis of census 2011 data and uses the Central Ground Water Board CGWB and Households level data of 2011 census to analyze the existing water supply system of all blocks in Dehradun excluding Chakrata and Kalsi Block due to its rugged terrain. The study method can be classified as follows. (1) Water supply data and other variables were collected from remaining four block (Doiwala, Raipur, Sahaspur and Vikashnagar blocks) and block wise available data. (2) ArcGIS 10.5 software has been used for Study area map. (2) For data and statistical analysis Microsoft Excel 2013 student version has been used. (4) and, for data visualization; several Graphs, Table and Radar chart has been used to show various variables to its best forms. (5) the various indicators were calculated from block wise available data from government organization and institutions. Further, the descriptions of all variables mentioned in the following sections are displayed in various tables alongside data source.

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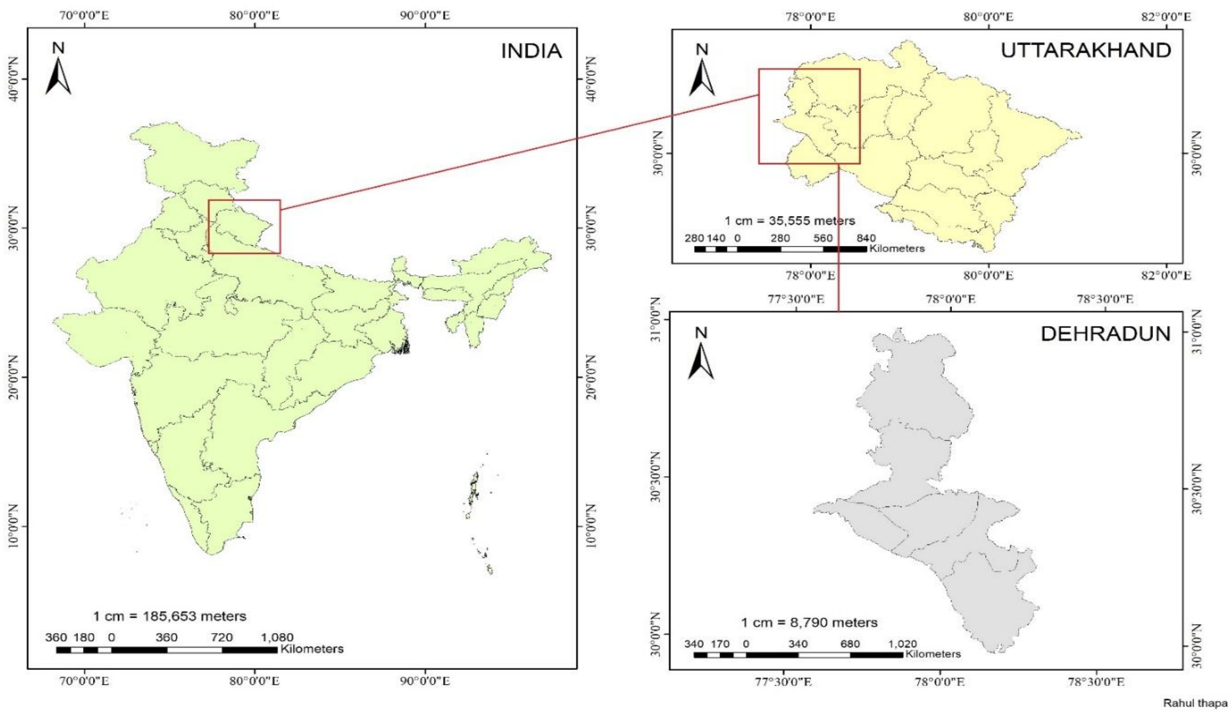
OVERVIEW OF THE DEHRADUN DISTRICT:

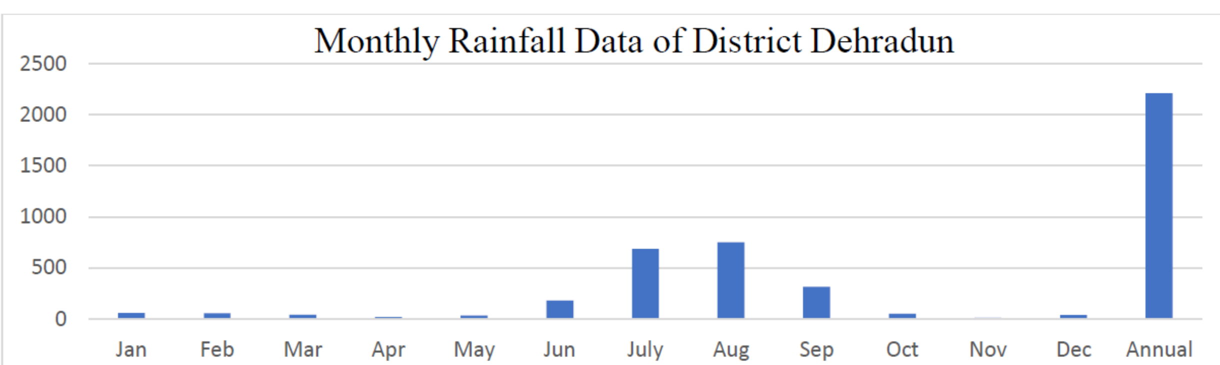
Figure 1 Map of Study area Dehradun District

Dehradun city is the capital of Uttarakhand state, and it is fall into Dehradun district. Geographically: the total area



of the Dehradun district is 3088 square kilometers. And the district lies between the latitudes 29˚58′ and longitudes 31˚2′30″N and 77˚34′45″ and 78˚18′30″ E. it has the altitude of 640 meters that is 2100ft above MSL mean sea level. In terms of direction the district located in the NW direction of the state. It is surrounded by Uttarkashi, Tehri Garhwal and Pauri Garhwal in the North west and east direction respectively. While in the southern direction by Saharanpur district (Uttar Pradesh). The boundary of Haridwar as the southernmost district touches UP and its western most boundary adjoins the Nahan or Sirmur district of Himanchal Pradesh with the Yamuna and Tons rivers separating the two states.

Climate: Dehradun has subtropical climate with very cold winters. Maximum temperature is 40℃ in summer and minimum 5℃ in winter. It reaches to freezing temperature in winter sometimes.



Topography: The city is situated in the hilly areas of Shivalik Mountains and is enclosed by river Song in North West & river Bandal in south east. Average elevation from mean sea level is 600 m. and Variation in levels is about 300 m.

Soil Conditions: The subsoil condition is soft rock with boulders. Water table level ranges from 5 meter to 10 meters below the ground level.

Road: Total road length which will be going to disturbed by laying of pipeline is 441 km. out which 220 km is concrete roads, 198 km is bituminous road and 22 is WBM roads. The width of the roads which is going to be cut varies from 0.7 m to 1.0 m.

Drainage system of Dehradun District:

Dehradun District is very rich in terms of Drainage system. Ganga and Yamuna as a major river along with their tributaries plays an important role in district. geologically, it is separated by the ridge which passes through Doon valley and Mussorie range. All the eastern side rivers of the Dehradun district merge in to Ganga river, whereas on the western side; all rivers mergers into Yamuna river. Here in Dehradun the Ganga rives has two main tributaries i.e., Suswa and song rivers, and both rivers enter the district through Chandrabhaga near Rishikesh, On the other hand the eastern part of the Dehradun is drained by the Suswa river and its tributaries i.e., Rispana rao and Bindal rao river. Whereas the song river a tributary of Ganga river; that originates from Tehri district and joins with Suswa river on the southeast of Doiwala region. The Yamuna river is a main tributary of ganga river; it orginates from yamunotri glaciers; which flows through the District Uttarkashi; than Yamuna rivers enters into the district at a point known as Khat Bhondar, that lies on the eastern side of Deoban. Rupin and supin rivers is the major tributaries of the Tons river which splits Himanchal Pradesh from Uttarakhand as well as Tons rivers is also a tributary of Yamuna river. The district is roughly divided into two halves by Yamuna river, Doon valley in the south and Hilly region in the Northern side. On the western side the Dehradun district is drained by Asan river a its tributaries. After covering some distance, it finally joins Yamuna near Rampur mandi.

Dehradun - Source of water:

Predominantly the hydrogeological setup of Uttarakhand state is varied and broadly dividend in to two distinct hydrological regimes.

1) The (HMB) Himalayan Mountain belts: It consist Predominantly hilly areas so it offers very less potential for large scale development of groundwater. The source of groundwater in hilly region lies mainly in fissures/fractures or emerging as springs. These small springs are responsible to small scale development of ground water resources in many districts of the state.
2) Whereas, the Gangetic Alluvial Plain: It consist the vast expansion of Unconsolidated sedimentary material ranging from clay to boulder.

In terms of hydrological set up on district Dehradun falls in the HMB Himalayan mountain belt. Consequently, yields generated by the tube wells in Siwalik range formation of Dehradun is quite low and as the collected secondary data it ranges from 50.4 m3/hours to 79.2 m3/hours. As well as the depth of groundwater ranges between 80- 100 meter. the source of water is combination of surface and ground water from river Bandal, Bijapur canal & other mountain falls. Ground Water: Presently, the water supply of Dehradun is dependent on tube wells and mini tube wells yielding 142 MLD and surface water to the extent of 36 MLD. Vigorous efforts were made to obtain the quantum of groundwater availability, and extraction and recharge, from Groundwater Board and other related organizations.

Type of Flow: Based on the type of flow, Dehradun district is majorly classified in to three water supply zones; pumping flow zone, mixed flow zone and gravity flow zone. The town of Rajpur road and its localities situated on the northern part fall under the gravity flow zone and; therefore, it receives only a surface water; whereas, the southern part of the town which includes the old city area receives the water through groundwater sources. the zone lies between these two zones can be called as Third zone or Mixed flow zone. In this zone the water is supplied from groundwater & also from surface water sources. The overall current water situation of the city to meet its water supply needs with respect to the different sources including tubewells, surface water and mixed zone. -Further the District wise division of the Active Ground Water Monitoring Stations(AGWMS) and including Springs monitored in Dehradun district.

Table:1-Ground Water Monitoring Stations

Serial. No.	District	No. of Groundwater monitoring stations			
		May 2016	**Aug 2016**	**Nov 2016**	**Jan 2017**
1.	Dehradun	55	53	51	54
Total		**55**	**53**	**51**	**54**

source 2: (http://cgwb.gov.in)

Apart from the Hand pumps, dug wells & piezometers, Dehradun district also comprises natural springs,

Table:2-Dehradun district breakup of springs:

Serial. No.	District	Number of springs			
		May2016	**Aug2016**	**Nov2016**	**Jan2017**
1.	Dehradun	03	03	03	02
Total		**03**	**03**	**03**	**02**

source 3: (http://cgwb.gov.in)

furthermore, on the basis of the catchments and different geological set-up & of the river basins in Dehradun district the (GWMS) Groundwater monitoring stations (includes springs) has been furthermore categorized. To the point information on this subject is shown in **Table 4.**

Table:4- Basin and Geology wise break-up of the existing Groundwater monitoring-stations in Dehradun station (as on 2017 January)

River-basin and Sub-Basin	Geology	Well No. and Area Location
Dehradun district		
Yamuna river Basin, Tons river Sub-basin	Doon Gravels (bouldery formation)	DDN-HP-8 (Nanurkhera), DDN-09 (Motichur), DDN-HP-7 (TarlaNagal), DDN-HP-2 (Redapur), , DDN-HP-5 (Balliwala), DDN-06 (Herbertpur), DDN-HP-26 (Barothiwala), DDN-07 (Jhajra), DDN-DW-30 (Haripur), DDN-08 (Lal Tappar), DDN-04 (Rampura), DDN-05 (Kuanwala), DDN-11 (Selaqui), DDN-10 (Nanda ki Chowki), DDN-DW-23 (Duggiawala), DDN-18 (Kanwali), DDN-20 (Shankarpur), DDN-19 (Chhorba), DDN-HP20 (Lal Tappar), DDN-22 (Dandi), DDN-HP-36 (Chandmari), DDN-PZ1 (Chhorba), DDN-PZ2 (CGWB Office), DDN-HP-1 (Jhajra), DDN-HP-3 (Majra), DDN-DW-13 (Dharmawal), DDNHP-4 (Bhaniawala), DDNHP-6 (Harbanswala), DDN-HP-9 (Nanda Ki Chowki), DDN-HP-11 (Badripur), DDN-HP-13 (Kuanwala), DDN-HP-12 (Baronwala), DDN-HP37 (Chhorba), DDN-HP-17 (Gularghati), DDN-HP-19 (Khandgaon), DDN-HP-18 (Vikas Nagar), DDN-HP-21 (Kotimaichak), DDNHP-23 (KhadiriKhadakmap), DDN-32 (Baluwala), DDN-HP-31 (Baronwala), DDN-HP-25 (Dakpatthar), DDN-HP-24 (Dudhli), DDN-HP-27 (Dhakrani), DDN-HP-35 (Mathrowala), DDN-HP-33 (Telpura), DDN-HP-28 (Timli), DDN-HP-10 (Selaqui), DDN-21 (Judli),
	Upper Shiwalik (conglomerate, pebbly sands, clay) & Doon valley Gravels (boulder formation)	DDN-14A (Sabhawala), DDN15 (Singhniwala), DDN-DW16A(Ramgarh), DDN-16 (Ramgarh), DDN-SP3 (Soda Sarauli), DDN-HP22 (Soda Sarauli), DDN-HP16 (Maldeota), DDN-SP2 (Khandoli), DDN-12 (Redapur).
	Blaini – Krol, boulder beds	DDN-SP1 (Bhatta), DDN-HP-15 (Purukulgaon), DDN-03 (Rishikesh), DDN-HP14 (Rishikesh).

source 4(http://cgwb.gov.in, 2016-2017)

The CGWB in Uttarakhand region systematically monitors the groundwater levels and spring discharge four times in a year, in order to categorize the various hydro geological units within the state and to estimate the impact of continuously rising stress on the groundwater regime. Just like other district in Dehradun; the Groundwater monitoring stations includes; the periodic measurement of springs discharge in the hilly region of Dehradun and Uttarakhand.

Temporal behavior of Water Level

In Dehradun district the water level data of groundwater monitoring wells were measure 4 times during the period of (2016- 2017) water level observed are given in **Table :3**

Table:3 *Temporal behavior of water level.*

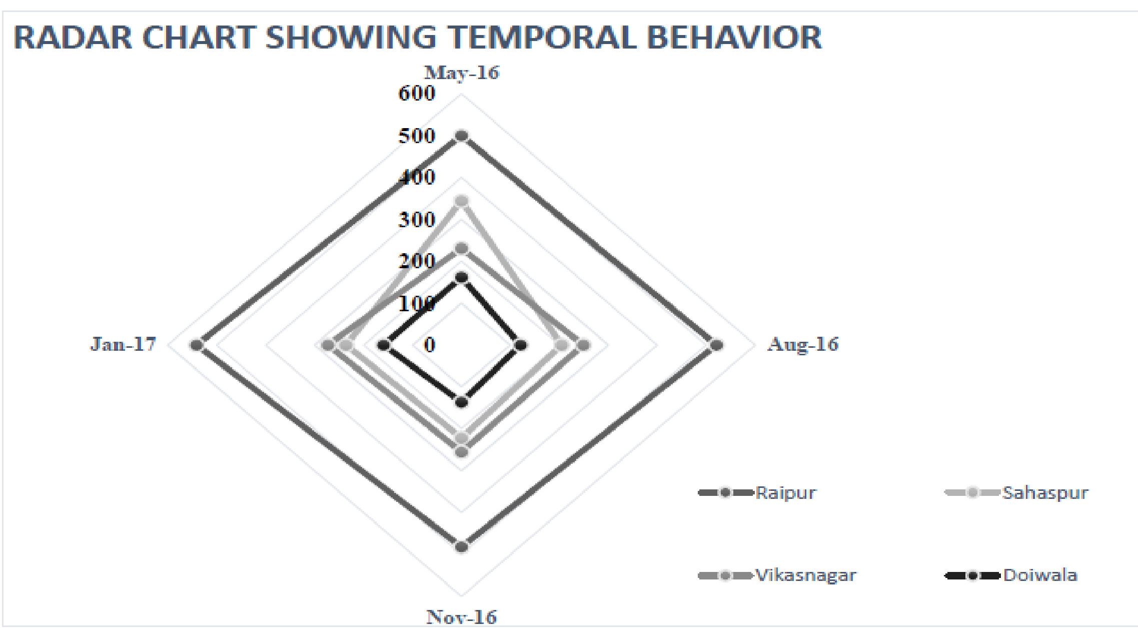
z	Location	May-2016	Aug-2016	Nov-2016	Jan-2017
DEHRADUN DISTRICT					
Raipur Block					
1.	Soda Sarauli	5.21	5.76	6.54	5.61
2.	Nanurkhera	71.4	59.56	63.19	59.98
3.	Ladpur pz*	NA	85.32	NA	85.65
4.	Maldeota	13.25	4.78	9.98	13.73
5.	Gularghati	6.28	7.97	11.29	12.66
6.	Kanwali	14.22	8.34	12.45	13.2
7.	Tarla Nagal	56.17	61.31	63.16	52.97
8.	Majra	27.16	25.59	31.1	7.79
9.	Kuanwala	15.96	4.91	8.16	11.95
10.	Purukulgaon	29.14	14.44	12.48	26.48
11.	CCWB Office	63.28	62.08	57.34	57.51
12.	Tarla Nagal	77.42	70.4	71.7	73.65
13.	Balliwala	58.4	58.21	67.18	58
14.	Harbanswala	61.85	52.21	67.48	62.05
Total		**499.74**	**520.88**	**482.05**	**541.23**
Doiwala Block					
15.	Mathrowala HP	10.7	8.34	9.9	10.31
16.	Chandramari HP	32.57	26.93	27.31	29.96
17.	Rishikesh DW	14.12	16.29	12.66	12.32
18.	Rishikesh HP	5.21	5.76	6.54	5.61
19.	Khadak Maaf	16.22	7.97	15.97	19.72
20.	Baniawala	22.3	14.6	16.73	29.36
21.	Duggiawala DW	7.2	5.69	6.91	2.1
22.	Lal tappar	17.2	16.03	16.05	14.82
23.	Motichur	13.64	4.08	10.48	11.03
24.	Dandi	3.85	4.66	5.06	6.06
25.	Khandgaon	9.15	5.16	4.61	8.97
26.	Kotimaichak	9.15	5.16	4.61	8.97
Total		**161.31**	**120.67**	**136.83**	**159.23**
Sahaspur Block					
27.	Rampura	Chhorba DW	17.35	NA	NA
28.	Jharia DW	Nanda ki Chowki DW	12.98	8.24	8.04
29.	Jharia HP	Sahaspur HP	11.8	8.54	16.96
30.	Selakui DW	Jharia DW	12.58	NA	NA
31.	Selakui HP	Chhorba HP	38.75	39.21	42.43
32.	Nanda ki Chowki DW	Baronwala HP	28.58	26.07	27.26
33.	Nanda ki Chowki HP	Corba PZ	71.74	NA	NA
34.	Redapur DW	Jharia HP	14.8	7.08	8.46
35.	Redapur HP	Telpura HP	37.2	40.72	43.4
36.	Shankarpur	Rampura	12.35	7.24	9.72
37.	Chhorba DW	Redapur HP	9.55	8.08	9.4
38.	Corba PZ	Selakui DW	11.77	7.61	9.12
39.	Baronwala HP	Selakui HP	15.77	12.61	12.44

40.	Chhorba HP	Shankarpur	24.67	23.86	23.18
41.	Telpura HP	Nanda ki Chowki HP	15.93	11.02	11.77
42.	Sahaspur HP	Redapur DW	7.87	4.44	NA
Total		**343.69**	**204.72**	**222.18**	**235.75**
Vikashnagar Block					
43.	Dhakrani	17.52	11.44	13.36	21.28
44.	Dak Patthar	28.59	22.93	25.79	26.57
45.	Baluwala HP	30.87	39.06	41.77	36.8
46.	Timli	NA	56.56	66.78	62.95
47.	Luxmipur HP	31.54	28.96	NA	28.84
48.	Judli	13.9	11.86	13.56	13.4
49.	Sabhawala	9.7	5.32	8.29	14.92
50.	Vikas Nagar	24.03	22.78	26.76	27.33
51.	Ramgarh	7.74	5.32	5.99	6.3
52.	Barotiwala	30.94	20.64	22.56	NA
53.	Badripur	9.4	7.47	8.57	12.03
54.	Herbertpur	9.61	7.45	9.77	10.1
55.	Singhniwala	9.76	8.84	8.41	6.64
56.	Dharmawala	7.1	NA	3.94	5.9
Total		**230.7**	**248.63**	**255.55**	**273.06**

source 1: (http://cgwb.gov.in, 2016-2017)

Furthermore, below I have used the Radar chart (a graphical method) to display multivariate data in the form of two-dimensional chart of 4 quantitative variables (years) represented on axes starting from the same point, the relative positions & angle of the axes is typically uninformative as shown in below **figure:3**

Figure 3: Over all Temporal behavior of water level in the all blocks of Dehradun



source: by Author

Groundwater Resources: Dehradun consist six development blocks. These blocks are Doiwala, Raipur, Vikas agar, Sahaspur, chakrata and Kalsi. Out of which two blocks Kalsi and Chakrata blocks fall in the hilly terrain, where the slopes are not gentle but high and water resources are not estimated for these blocks due to its rugged topography. To estimate the water resources GEC 1997 methodology is applied to four blocks i.e. Doiwala, Vikas nagar, Raipur and Sahaspur blocks as the topographical features of these region is by and large plain in these blocks. Further, these blocks areas are bifurcated into Commands & Non-Commands areas simultaneously, gross groundwater draft for all uses and recharge and net annual ground water availability are calculated from commands & non-commands areas. The Stage of Groundwater Development has been accomplished by applying the formula given below:

Formula: {Stage *of Ground Water Development*

*= Existing Gross Ground Water Draft for all uses/Net Annual Ground Water Availability *100*}

Further, the block-wise stage of ground water development, gross groundwater draft, net annual groundwater availability, and category have been classified in below **Table 4**. Furthermore, the stage of ground water development, for the non-commands area 19.23 per cent to 51.23 percent for non-command areas; while it ranges from ranges from 53.78 per cent to 78.34 percent for command area and all the four blocks falls in the Safe category.

Table-4

BLOCK	TYPE AREA	Stage Ground water development (%)	Existing Draft for all Uses (HAM)	Net Available Ground water reserve (HAM)	Category
Raipur	Command	61.71	1257.46	2037.67	Safe
	Non-Command	30.8	7882.13	25585.85	Safe
Vikas Nagar	Command	53.78	1780.61	1780.61	Safe
	Non-Command	51.23	19824.35	19824.35	Safe
Sahaspur	Command	75.85	1573.01	1573.01	Safe
	Non-Command	19.23	30283.3	30283.3	Safe
Doiwala	Command	78.34	2058	2626.92	Safe
	Non-Command	20.97	6675.26	31828.65	Safe

As the the norms the rural domestic water supply is through India Mark-II hand pumps, guls, springs and tube wells. Being a hilly region Chakrata and Kalsi blocks for drinking water mainly depends on natural Springs. According to the collected secondary data, there are 13 scarcity villages, in the district, out of which 3 are in Chakrata block and 10 are in Kalsi block.

The annual replenishable groundwater resources, current draft for domestic, industrial uses; and the groundwater resources allocated up to 2025 for Doiwala, Raipur,Vikas Nagar and Sahaspur block for command and non-command areas are given in **Table:4**

Table :4

S.No.	Block	Command/ Non-command /total	Allocation for domestic and industrial Water supply up to 2025 (HAM)	Current Ground water Draft for Domestic and Industrial Supply (HAM)	Net ground water availability (HAM)
1	Raipur	Command	216.41	59.88	2037.62
		Non-Command	2776.27	375.34	25586.8
		Total	2992.68	435.22	27624.47
2	Sahaspur	Command	263.05	56.82	1573.01
		Non-Command	5570.37	278.25	30283.3
		Total	5833.42	335.07	31856.31
3	Doiwala	Command	372.63	98	2626.92
		Non-Command	5176.86	317.86	31828.65
		Total	5549.49	415.86	34455.57
4	Vikas Nagar	Command	312.12	45.6	1780.61
		Non-Command	2878.27	483.62	19824.3
		Total	3190.39	5294.22	21604.96

Result and analysis: The below **Table:4** showing the projection of required demand and supply Gap of water within district to the population; which are receiving water as per the Government of India standards. All these data were obtained from the GGWB.

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Table:4 - Demand and Supply Gap

Parameters	Present status	Requirement/demand 2011	2026	2041	Gap
Population covered with city water supply system	6,25,206	6,25,206	10,12,189	14,88,274	2011: Nill 2026:3,86,983 2041:8,63,068
Population receiving water as per GOI standards	Nil	6,25,206	10,12,189	14,88,274	2011:6,25,206 2026:10,12,189 2041:14,88,274
Service Delivery standards at the consumer end **Average PCS** **Duration** **Quality**	114 lpcd 8 hours Contaminated (7%), and Hard water (6%)	135 lpcd 24hours Potable water (100%)			21 lpcd 16 hours.
Production of potable water	178 MLD	118MLD	189MLD	279MLD	2011: Nill 2026:11MLD 2041:101MLD
Physical Losses	107MLD	23MLD (20%)	38 MLD (20%)	56MLD (20%)	Reduction by 71 MLD (40%)
Consumer end supply	71MLD	95MLD	151MLD	223MLD	2011: 24 MLD 2026:80 MLD 2041: MLD
Transmission Line	Length:23.5 km Condition: Leakages and incrusted	Replacement of 16 (14+2) km. Transmission main.			2011: -- 2026: 16 km 2041: Replacement
Distribution line	Length: 564 km Condition: Outlived, many leakages	1050km	1050km	1050km	2011:1050km 2026:1050km 2041:1050km. (Distribution Lines including replacement of 564 km. existing).
Storage requirements	72.11 ML	92.93 ML	92.93 ML	92.93 ML	2011: 20.82 ML 2026: 20.82 ML 2041: 20.82 ML
House connection	1,21,130	1,26,127	2,02,438	2,48,045	2011: 4,997 numbers
Meter	Nil	1,26,127	2,02,438	2,48,045	2011: 1,26,127 numbers

Source: cgwb (2015-17)

What are the reasons of the demand and supply gap in the Dehradun district?

The following are the prime reasons for demand supply gap:

1) With the increase in population, demand has increased the resource constraints for systematic upgradation of the system.
2) WTPs have outlived their design period life and therefore are not functioning at their full capacity.

3) The existing water transmission & distribution system suffers from defects and huge system losses as these have also outlived their design period life and have become insufficient to cope with increased demands of the city.
4) There is no water metering system at consumer end and therefore, there is indiscriminate usage of water and losses in water supply and revenue.

CONCLUSION:

This paper has attempted to highlight the aspect of how dynamics of urban-water supply is affecting the urban-rural relation of Dehradun district Uttarakhand. Where major population of ULBs is lacking adequate clean water supply. Hence there is an urgent need to shift in the way we manage urban water system challenges, and there is wide scope for achieving such target an integrated urban water management approach along with modern RS and GIS techniques must be adopted which includes managing storm water, fresh water , waste water using an urban areas as the unit of management thereby aiming to achieve the sustainable development goa 6. The Water supply geographic information system utilizes GIS techniques to create a digital database of design and properties information of water pipes, supporting components and other urban facilities in general to counter the any obstacle and enhance overall decision-making process. As per the paper, in present the water supply of Dehradun is dependent on tube wells and mini tube wells yielding 142 MLD and surface water to the extent of 36 MLD. Further the rapid rising population of Dehradun districts demands better equitable supply with systematic management of these water resources. Vigorous efforts were made to obtain the quantum of groundwater availability, and extraction and recharge, from Groundwater Board and other related organizations. So, this paper will provide a platform to highlight present and future of water related issues and have highlighted the water demand and supply gaps; and provides an avenue for further research to encounter the rising water supply problem in the various blocks of Dehradun district.

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