STUDY ON WATER SUPPLY SYSTEMS IN RURAL UTTARAKHAND FOCUSSING ON MOUNTAIN SPRINGS OF TEHRI GARHWAL DISTRICT

Minor Project Thesis

Submitted by

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I have taken efforts in completion of this project. However, it would not have been possible without the kind support and help of many individuals. I would like to extend my sincere thanks to all of them.

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My thanks and appreciations also goes to all my friends and colleagues who has helped me in developing the project and all those people who have willingly helped me out with their abilities.

CERTIFICATE

This is to certify that TRINAYANA KAUSHIK has carried out her minor project in partial fulfillment of the requirement for the degree of Master of Science in CLIMATE SCIENCE AND POLICY on the topic “STUDY ON WATER SUPPLY SYSTEMS IN RURAL UTTARAKHAND FOCUSSING ON MOUNTAIN SPRINGS OF TEHRI GARHWAL DISTRICT”during May 2016 to July 2016. The project was carried out at the THE ENERGY AND RESOURCES INSTITUTE.

Date: 4 August 2016
Dr. Mini G
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Dr Suresh Jain
Professor & Head
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DECLARATION

This is to certify that the work that forms the basis of this project “STUDY ON WATER SUPPLY SYSTEMS IN RURAL UTTARAKHAND FOCUSSING ON MOUNTAIN SPRINGS OF TEHRI GARHWAL DISTRICT” is an original work carried out by me and has not been submitted anywhere else for the award of any degree.

I certify that all sources of information and data are fully acknowledged in the project thesis.

TRINAYANA KAUSHIK
Date: 4 August 2016

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1.0 Abstract

This study is a part of Hi-AWARE'sresearch component 3 'Climate change adaptation in the hills and drying up of springs'. My broader study area under Hi-AWARE is the Upper Ganga Basin where I have chosen to study the water supply, demand and usage of the rural areas of Uttarakhand. The aim is to have background knowledge on existing water supply system by collecting data on coverage of habitations by various water supply schemes. The detailed characteristics of these projects along with their challenges, benefits, success and failure have been discussed. Tehri Garhwal district is specifically chosen for the study as it is one of the largest districts in the mid-hills and is thought to be of relevance for the study of springs. Not much data is found for high-hill districts and also carrying out a field visit at a very high elevation is troublesome. The springs are studied based on their impacts on livelihoods of the rural population. Associated factors like climatic parameters, hydrogeology of the district, groundwater recharge, and socio-economic conditions prevalent in the district are elaborately discussed. Various studies that have been already done in this regard have been referred to, because secondary literature is the prime source for building up the report. However some primary data has also been used, which is obtained through field visits by self or by local partners in Uttarakhand. In conclusion, the probable causes for the changes observed in the past decade are discussed along with limitations of the study.

Key Words: Water supply scheme, climatic parameters, groundwater recharge, hydrogeology, socio-economic.

2.0 Introduction

Himalayas are experiencing climate change at an unprecedented rate, consequently resulting in extreme events like flash floods, glacial lake outburst floods (GLOFs), landslides and related disasters. (SANDRP, 2013). One of the recent visible trends in climate, felt almost all over India is the change in precipitation patterns. After many years of research the Himalayan Climate Change Adaptation programme (HICAP) has established that there will be an increase in the intensity of rainfall whereas a decrease in the frequency. Also it is established by SANDRP (South Asia Network on Dams, Rivers and People) that with the increase of high intensity rainfall the frequency of low intensity rainfall is decreasing. Many studiesconducted in the Himalayas have established that altering rainfall have affected lives of inhabitants in the region. Data analysis for AWS Gangtok from 2006 to 2010 indicated a trend of increasing rainfall intensities during summer and extremely poor or no rainfall during winters. (Seetharaman 2008; Ravindranath *et al.* 2006)

In Uttarakhand too, increasing intensity of rainfall have been felt over the past few years. (SAPCC 2014, Govt. of UK).This changing trend has caused an increase in the number of cases of flash floods, glacial lake outburst floods, landslides in the state. While these events manifests themselves in various initiatives by different agencies, there are other problems in Himalayan regions that are yet to be given the first string.One such issue that has come up is water security in the rural areas of the hills. Uttarakhand is well known for its mountainous terrain, rich biodiversity and forest cover manifested by its diverse eco-climatic conditions and topography. It also has a plethora of water resources and also houses the Ganges. In spite of this, the rural people in the mid and high hills are facing the problem of safe fresh water due to slope factor, management issues, urban conglomeration, deforestation, climate change. The state has a very has a very wide altitudinal range from the plains of Dehradunto Nanda Devi (7,817 meters) which is the second highest mountain range in India. It has a total area of 53,483 sq. kilometers of which 45.32% is covered by forests. (India State of Forest Report 2015, FSI). The population of Uttarakhand is 1,01,16,752 with a population density of 189 persons per sq. kilometer. (UKHFWS, Dehradun). The state has a high average annual rainfall of 1229 mm. (NIDM).Issues of water security have been evocative in the state for a long time and a lot of initiatives have been taken for the same; however the results obtained weren't as efficient. The purpose of this study is to throw light on the current scenario,

measures taken to establish water security in Uttarakhand along with a brief discussion on the causes of the problem.

The Himalayan Mountain system is called the water bank of Asia. They contribute a significant percentage to the country's total water resources. However, it is ironical that these rivers have not been of any use to the local residents, except for minor utilities in the form of a watermill, occasional irrigation, which is not exceeding 2% of its total potential for water provision. (Bhatt V., Pandey P., 2005)

The Uttarakhand JalSansthan has identified springs as a very important groundwater resource in rural Uttarakhand. Sustenance of these mountain springs depends on hydrogeology of the area. According to the Central Groundwater Board annual replenishment of groundwater resource is contributed by two major sources – rainfall and other sources that include canal seepage, which is the return flow from irrigation, seepage from water bodies and artificial recharge due to water conservation structures. However in states like Uttarakhand, which has wide altitudinal variation, the contribution of the later is more. (Remote Sensing Centre (West), 2011) RRSC(W).The springs and the seepages, wherever present cater to drinking and domestic demands. However in many locations they have been tapped along roadsides in tanks (locally called Hauj in many regions). Timely management of these tanks in done by Minor Irrigation Department or by Project Management Units (PMU) of Swajal. Artificial outlets mainly of PVC or wood are constructed to supply water to households. (Bagchi D.,2012)

3.0 Objectives:

- To study the work of water supply and management agencies in rural Uttarakhand
- To understand the hydrogeology of Tehri Garhwal district along with the spring hydrogeology
- To study the springs of Tehri Garhwal district in terms of their impact on livelihoods of the local people.

4.0 Methodology:

The methodology used for my work is a detailed review of existing secondary literature. Scientific studies and papers by various authors who have worked on the issue of springs in Uttarakhand and also in other parts of the Himalayas have been referred to, for building up the report. The objective of studying the water supply and management system in Uttarakhand is for the purpose of having background knowledge of the work that has already been done in the water sector. The findings for this are entirely based on existing reports. However the fundamental research based on the springs has been done through field visits with support from existing literature. Centre for Development Ecology and Research (CEDAR), Dehradun, which is a local partner of TERI for Hi-AWARE in Upper Ganga Basin has also provided a lot of data from their visit to Uttarakhand.

4.1 Literature Survey:

Ever since water scarcity is showing up as one of the many consequences of climate change, the central government has designed many state-run agencies in top-down manner with a focus on building infrastructure for the same. According to a report from the work bank named 'Uttarakhand - Decentralizes Rural Water Supply and Sanitation Project : innovations in development', the central government has claimed that 96% of the areas have been covered with a tap or a well within a reasonable distance from the houses. However most of them are not functional. The reasons attributed for this are negligence in maintenance, drying up of water sources, deterioration of water quality, and in some cases the systems have long outlived their use. The consumers have also treated water as a right to be provided free-of-cost by the government, rendering their water supply systems both financially and environmentally unsustainable.(World Bank, 2013) Owing to these

problems, the Rural Water Supply and Sanitation (RWSS) project launched in the late 1990s, to help low income states of India to achieve their targets of sustainable public health was activated in the state. In Uttarakhand, the key agencies responsible for water supply are Uttarakhand JalSansthan(UJS) and Uttarakhand Peyjal Nigam(UJN). They are responsible for planning, survey, design and execution of urban as well as rural water supply and sewage schemes in the state. (UJS, GoUK, 2016). In spite of these existing agencies there are a large number of areas that are not covered or are partially covered by a water supply scheme. A major policy change under the Uttarakhand rural water supply and sanitation project (URWSSP) launched in 2006 was when Uttarakhand became the first state in India to decentralize rural water supply in both letter and spirit across its entire territory. The project aimed to benefit about 1.2 million people through about 3500 rural water supply schemes.It was based on Sector Wide Approach (SWAp) and Bottom-up Approach and came to be popularly known as Swajal. (Sinha V. K., 2015)

Big picture of Swajal/URWSSP: The primary project development objective was "to improve the effectiveness of rural water supply and sanitation services (RWSS) through decentralization and increased the role of Panchayati Raj Institutions (PRIs) and involvement of local communities."(Sinha V. K., 2015). The existing WATSAN (water-sanitation) programmes were based on the build-forget-rebuild syndrome. With control of funds, functions and functionaries being transferred to the Gram Panchayat, the communities could choose the kind of water supply service they wanted and were willing to pay for. (Dobhal A.(n.d.) [ppt]). Thus the government's role became that of 'facilitator' from a 'water supplier'. The Project Management Unit (Swajal) came as a community based initiative and undertook various schemes in all districts of Uttarakhand. It was increasingly felt that pricing of water was essential in order to ensure economic and financial viability and sustenance of the water supply schemes. However, in case of rural households it was more important to consider this approach in a holistic manner and keep the households' affordability and willingness to pay to be reflected to develop a more acceptable pricing structure for all. (World Bank, 2013).

Uttarakhand JalSansthan (UJS) and Uttarakhand Peyjal Nigam (UPN) wereworking as a back support system is case of some major breakdowns and natural calamities. They assisted Swajal in providing portable water to 195 villages along with other associated benefits like reduced water- borne diseases and environmental sustainability. The salient features of Swajal are presented in *Annexure table 1:*

With the ever-increasing population, the need to provide a better quality of life to the people and the pressure on natural resources is compounding the problem of water security. The Uttarakhand Government therefore has realized the significance of taking up watershed based planning. A total of about 8 watersheds, 116 sub watersheds and 1110 Micro Watersheds have been identified in the state. A separate Directorate called The Watershed Management Directorate (WMD) has been established as a nodal agency for coordination, monitoring and implementation of integrated watershed development programmes in the state. As a public service delivery organization it works closely for and with the community. (WMD, Dehradun, 2013). WMD realizes that water is the most climacteric input, which acts as a catalyst in bringing in ecological, social and economic revolution. Its mission is not water security exclusively but involves a holistic development of the degraded and rainfed areas of the state through integrated management of natural resources on participatory basis to achieve ecological balance, income enhancement, increased livelihood opportunities, poverty alleviation, welfare of vulnerable groups including women, children and the landless. WMD has been working from before formation of Uttarakhand and has successfully completed several projects. These include South Bhagirathi Phase-I Project financed by the European Economic Community (E.E.C.) that started in the year 1981, Himalayan integrated Watershed Management Project financed by the World Bank started in the year 1983, The South Bhagirathi Phase-II financed by the E.E.C. and started in 1988, Bhimtal Project financed by the E.E.C. started in year 1991, Doon Valley Watershed Management Project financed by the E.E.C. started in the year 1993 which was a flexible initiative with full support and cooperation from the European Commission. This project helped in evolution of a participatory approach in the watershed projects. Various lessons learnt from this project have helped WMD to accumulate necessary experience to encourage similar participatory watershed management in other hill areas. (WMD, Annual Report 2015-16)

Some of the points to found about in any participatory work is:

1. Stable village level organizations formed under the project need to be focused on a common interest because ethnic complexity of villages often creates a problem.
2. The village organizations should build confidence among the villagers and sense of control over their own futures.
3. Women are found to be more responsive to project interventions. They were more attached to the land and more responsive to watershed management interventions.

UJS also has several water supply schemes for establishing water security in the state. Some of their schemes are under Urban Decentralized Watershed Development Programme (UDWDP). UDWDP project are completed in various phases that aims to cover an area from its highest point(ridge line) to its outlet and takes into account all factors operating within a watershed.

The National Rural Drinking Water Programme (NRDWP) launched by Ministry of Drinking Water and Sanitation, Govt. of India in 2009 has revised guidelines ofAccelerated Rural Water Supply Programme (ARWSP) launched in 1972–73. NRDWP has also contributed to supplying water in the state. It has 66% coverage in Uttarakhand and also has allocated central fund of INR 135.01 crores in the state. Out of 39,142 habitations, NRDWP has covered 24,195 in Uttarakhand by the end of 2014. It has an approach of achieving habitation level coverage towards household level drinking water coverage. It aims to discontinue over dependence on single drinking water source and aims a shift to usage of multiple sources, through conjunctive use of surface water, groundwater and methods like rainwater harvesting. NRDWP has a systematic way of information that involves habitation coverage, sustainability of water supply schemes, water quality, water accessibility in drought prone areas, and water accessibility during a natural calamity. NRDWP also has special provisions for special funding for areas dominated by Scheduled Castes and Scheduled Tribes. (Ministry of Drinking Water and Sanitation, NRDWP report)

Study Area: Tehri Garhwal

Tehri Garhwal is one the largest districts in mountainous regions of Uttarakhand. The district lies between latitudes 30°03' and 30°53' N and longitudes 77°56' and 79°04' E. It is well connected with Dehradun by the Rishikesh-Devprayag road (NH-58) and also the Narendranagar- Chamba- Tehri- Ghanshali road. Its current headquarter is shifted to New Tehri from Old Tehri after construction of the tallest dam in Asia; the Tehri Dam. Tehri Garhwal comes under the Garhwal division and has five Tehsils and nine Developmental blocks.

As a watershed, major perennial rivers like Bhagirathi, Bhilangana, and Alaknanda mainly control the drainage of the district. Apart from the rivers, many seasonal streams and rivulets (locally called gad or gadhera) drain the area. Some significant gadheras among them are Nailchami Gad, Lastar Gad, Nagun Gad, Bhadri Gad, Chandrabhaga Gad, BandalNadi etc. The most common drainage patterns in the area is sub-trellis and sub-dendritic. The perennial rivers are primarily fed by snowmelt with relatively smaller contribution from groundwater. However, during the lean period, the rivers are fed by groundwater occurring as base flow. Also

groundwater is the chief contributor to the flow of the tiny rivulets. The drainage pattern of Tehri Garhwal district is described in *Figure 1*.

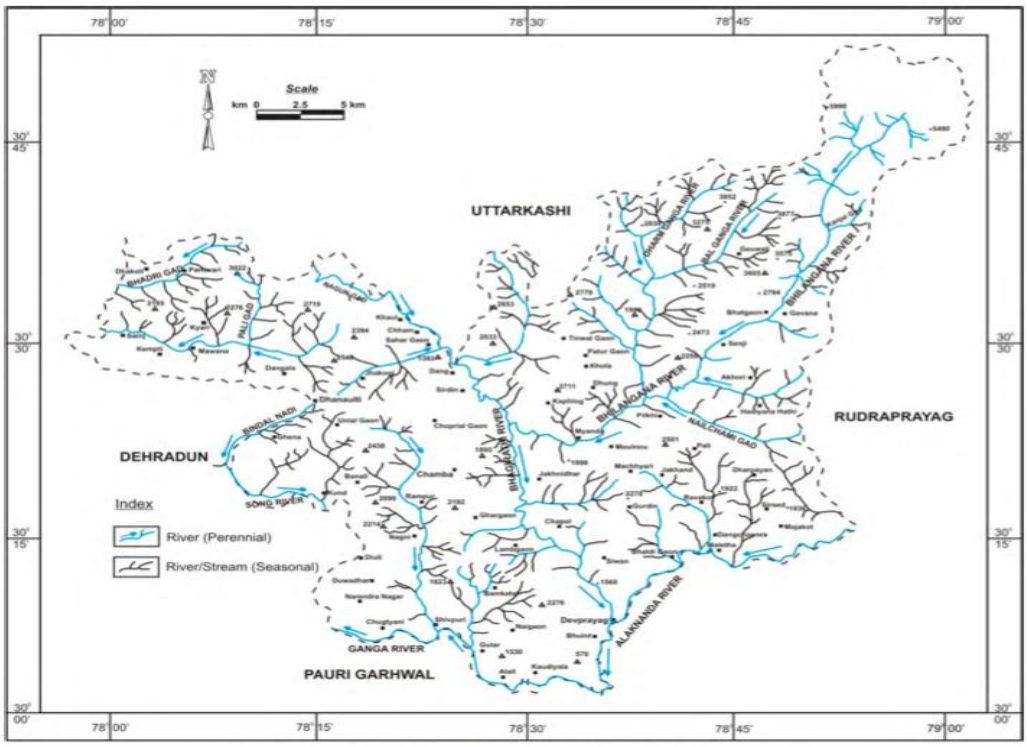

Figure 1: Drainage map of District Tehri Garhwal, Uttarakhand
Source: CGWB Brochure

Based on long-term climatological data it has been ascertained that the district receives rainfall almost throughout the year. Maximum rainfall is recorded during the monsoon period i.e. from July to September. The annual rainfall at Tehri Observatory is 1028.6 mm whereas the average number of rainy days (having daily rainfall ≥2.5 mm) is 61.5 days. The annual rainfall at Mukhim Observatory is 1708.8 mm and the average number of rainy days is 87.4 days. The average annual rainfall (AAR) of the district is 1395 mm.

Owing to the hilly terrain of the region groundwater, in Tehri Garhwal district, generally occurs locally within disconnected water bodies under favourable geo hydrological conditions. The occurrence and movement of the groundwater depend not only on the nature of the rocks and the nature of their interspaces, but also on the degree of interconnection between them. Ground water emerges as springs and seepage (also locally called Srots and Naolas) under favourable physiographic conditions such as in sloping areas, broad valleys of rivers and along the faults between two lithological parts. Gadheras is the local name for a group of springs coming from higher reaches of the mountainous tracts. Precipitation as rainfall is the principal source of groundwater replenishment. However a very small fraction of

total rainfall contributes to groundwater replenishment. Certain part of the precipitation received is lost into the atmosphere as evaporation and evapotranspiration from soil and plants, a major part of it part flows as surface runoff due to extremely rugged and undulating topography with steep slope and only the remaining part infiltrates through the soil profile to add to groundwater storage. In Tehri Garhwal district, springs occur where the water table intersects the ground surface. The hydrogeology of the district comprises of mainly two zones: The Higher Himalayas and Lesser Himalayas. The Central Groundwater Board, Ministry of Water Resources, Govt. of India has prepared a hydrogeological map of Tehri Garhwal which indicates the presence of these two zones and the types of aquifers present in each.*(Figure 2)*

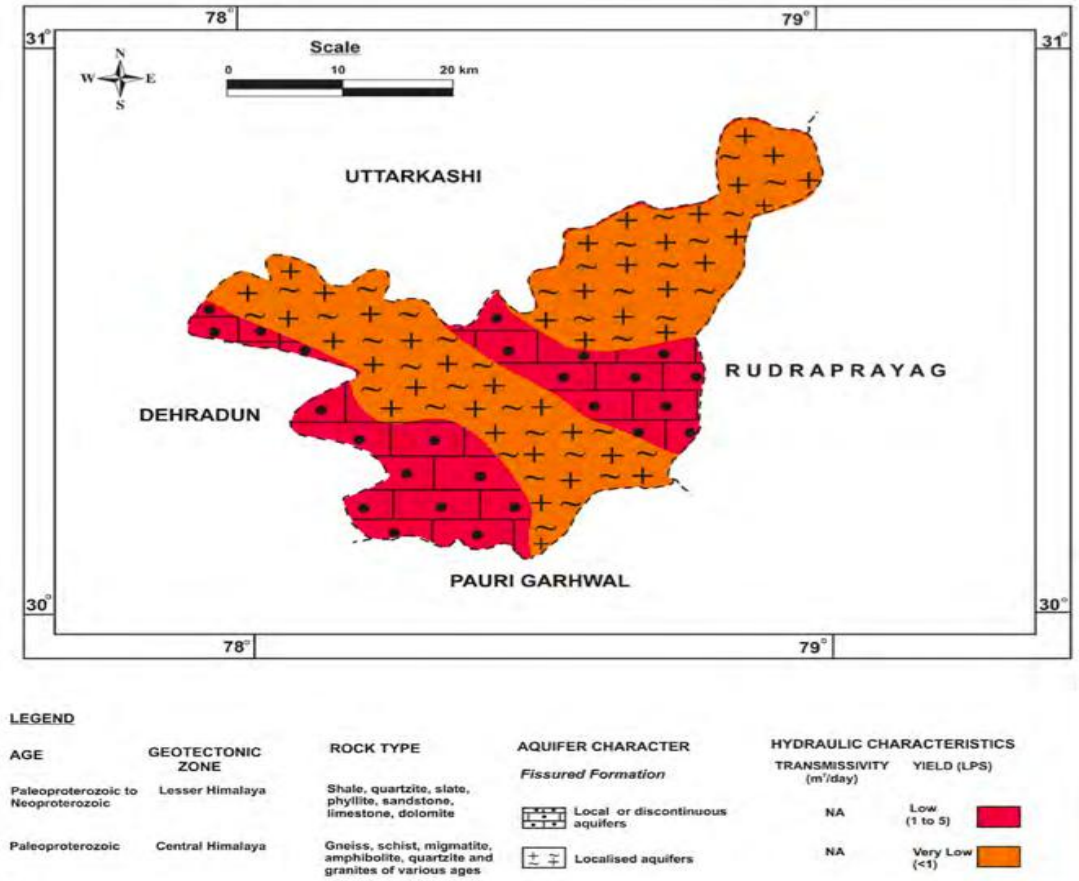

Figure 2: Hydrogeological map of Tehri Garhwal district
Source: CGWB Brochure

Local or Discontinuous Aquifers: These are confined or semi-confined aquifers located in Lesser Himalayan Zone. The rocks are mostly sedimentary rocks (sandstone, shale and limestone), meta-sedimentary and low-grade metamorphic rocks like dolomite, slate, phyllite, quartzite etc. along with some calcareous rocks. Characteristics for these aquifers are not available, as no pumping test has been carried out in these so far. However, a study of the springs and Naolas in these areas

indicates that the yield for these aquifers is low and varies from 1 to 5 liter per second (LPS).

Localised Aquifers: These aquifers occur both in the Lesser Himalayan and the Central Himalayan Zones. Occurrence of groundwater in these aquifers is very restricted because of the nature of hard, crystalline rocks. Study of a few springs in these areas showed that the yield of localised aquifers is very low, i.e. even less than 1 LPS. (Ministry of Water Resources, GoI, 2011, Groundwater Brochure for Tehri Garhwal)

As already mentioned, rural people of the mountains depend on springs for their daily chores. However this bounty has been decreasing over last few years. Springs of Uttarakhand hills, derived from seepage water are turning from perennial to seasonal and have been highly ignored, even though they are a secure source of domestic water availability. Various studies done for various springs in different parts of the district has brought out issues of concern related to springs of Tehri Garhwal district. Acute shortage of water is felt during the summer and low flow years. Research on small watersheds is important for generating understanding of physical processes that affect the quantity of water from small watersheds. The study area, Danda watershed, locally known as Khas Patti, is located in the Hindolakhal block of the Devprayag tehsil of Tehri Garhwal district. It has an area of around 1.34 sq. kilometer and is located geographically between latitude N30° 14' to N30° 16' and longitude E 78° 37' to E 78° 39' at an altitude of 780 m to 1800 m above mean sea level with average annual rainfall of around of 900 mm. However this area is known for its scarcity of drinking water. The area has many springs and the location of the springs is shown in *Figure 3*with its prospective position in the spring-shed and topographic information. These are gravitational fracture springs, which are perennial or seasonal in nature and mostly dries up with early summer. This is because of the soil's degrading water retaining capacity due to deforestation and thinning of forest cover and or due to rainfall pattern with increasing high intensity storms with longer dry spells.

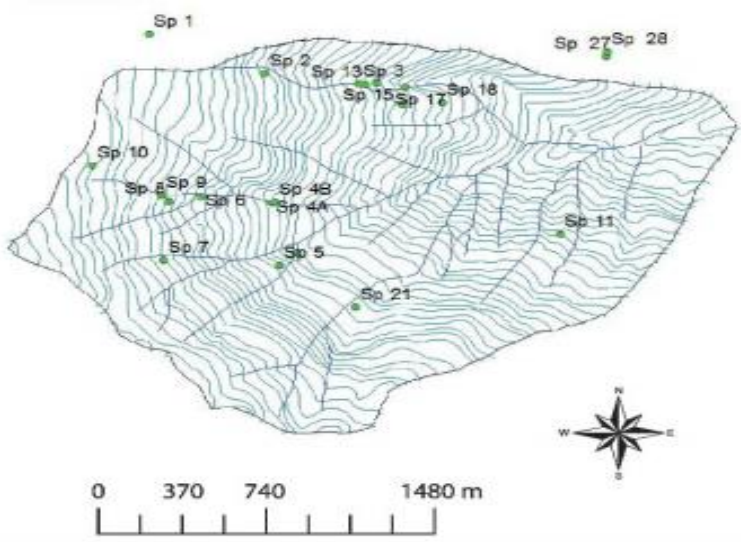

Figure 3: Springs of Danda on its Sub-Watershed
Source: (Agarwal A., Bhatnagar N. K., Nema R.K., Agrawal N. K., 2012).

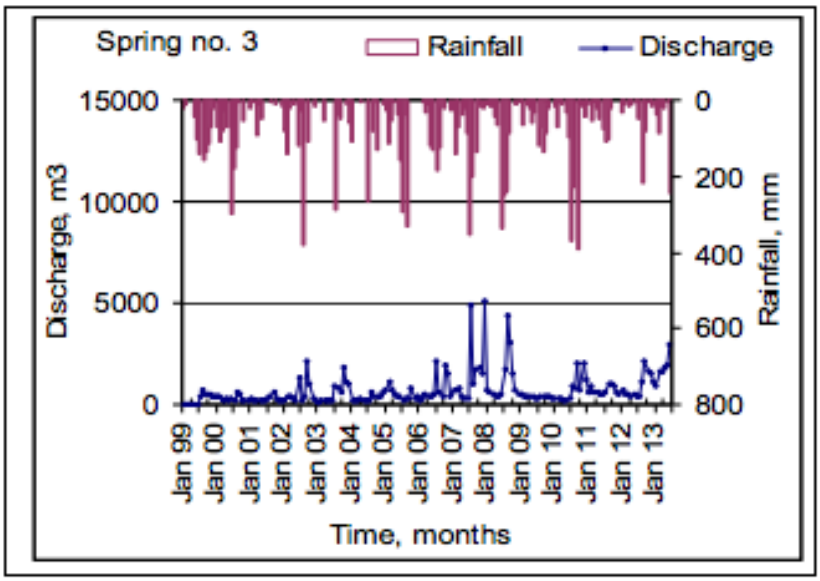

Figure 4: Monthly average discharge of spring 3
Source: (Agarwal A., Agrawal N.K., Nema R. K., 2014).

Spring 3 is one the high yielding springs in the watershed and its dependence with respect to rainfall is shown in *Figure 4*.The corresponding peaks of discharge and rainfall indicates how recharge is dependent solely on rainfall and also that the recharge area for the spring is located close to the spring. Also spring flow-rainfall lag characteristic studied for some springs showed a lag of 9-20 days, which is a low value. This is again indicative of the recharge area being in close vicinity of the spring.

Demand for spring water and usage in Danda watershed: The population of Danda watershed is 1,276, which includes 427 man, 377 women, 472 minors while the populations of animals is 367. A common trend observed for all springs in the Danda

watershed is that the total domestic water demand is 40,570 l/d while the actual domestic use is only 12,670 l/d. Thus the demand for water is three times more than what the population actually needs to fulfill their daily domestic chores. This reflects the population's living conditions and difficulty in acquiring water. The minimum monthly flow calculated for all springs in use is 38,364 l/d, which is around twice of the actual water use but is less than domestic water demand. It indicates that water availability even under lowest condition of flow can meet the uses but not the demand. This is indicative of self-restrictive water consumption practices. (Agarwal A., Agrawal N.K., Nema R. K., 2014)

4.2 Field Visit:

I along with my supervisor had taken up a field visit from 25th of May to 29th of May 2016, which was mainly to choose my site of study. CEDAR organized a meet for the initial discussion in the need for the future work to be done; where TERI, ICIMOD and CEDAR met, to develop a plan for taking up the spring initiative forward. Being a part of that meeting helped me clear my basics about the matter in question.

Visit to Uttarakhand: International Centre for Integrated Mountain Development (ICIMOD), which is playing a dominant role in catering to issues of drying springs in many Himalayan regions, discussed its initiatives on spring revival. General ideas that promulgated out of the discussion included:

•More than 60% of rural households across Hindu Kush Himalayas depend on springs

•They mostly use gravity-flow water supply systems

•Spring water is naturally filtered and free of physical and chemical contamination and hence becomes of key importance for sustainable water security.

•There are no other sources perennially accessible clean water in the Himalayas.

•The rivers are far below, glaciers are far above and rooftop rainwater harvesting is feasible only for part of the year.

ICIMOD also shared aneight-stepmethodology, which aims at spring revival. However its accomplishment is far fetched in most part of the Himalayas. The individual steps of the methodology being:

•Step 1: Comprehensive mapping of springs and spring-shed

•Step 2: Setting up data monitoring systems and training locals

•Step 3: Understanding social and governance aspects of springs

•Step 4: Hydrogeological mapping

•Step 5: Creating a conceptual hydrogeological layout of spring-shed

•Step 6: Classification of spring type, identifying mountain aquifer and demarcating recharge area

•Step 7: Developing spring-shed management protocols

•Step 8: Measuring hydrological and other impacts of spring revival activities

(ICIMOD's spring initiative, 2016)

The field visit also included travel to a spring site on the first day.

Spring Site: Dhobi Ghat in Mussoorie on 26.05.2016

Dhobi Ghat is a community of Dhobis (washer men) residing in a steep slip road opposite the Mussoorie Jheel (lake). It is also a significant place with respect to Mussoorie tourism as all the laundry from the hotels is done in this place. The population here is dependent on water pumped and supplied to them. It's a small place and is unlike the typical 'dhobi ghats'. Here, wash pens are arranged along the gradient of a hill adjoining a water stream locally called the *'khad'*. Small children bathing in the khad remarked that the water level has gone down over the years, however the concrete wash pens that were built would not survive the force of water sweeping down, especially during the monsoons. One of the community members helped us know that the water quality deteriorates during the monsoon. Also when the habitation residing uphill releases their septic tanks, the water of the khad becomes unsuitable for drinking and they only use it for other domestic chores. Out of the approximately 40 households that live there, about 30 works as dhobis and operate their individual laundry business. They use bleaching agents, detergents during the laundry practices which further degrades the water quality for the population downhill. Efforts to clean up the spring time to time are completely

missing in this area. Another community member remarked that despite being surrounded by such paucity, the abundance of water in the area isn't valued much.The *khad* is one among several springs that originate around Mussoorie. With the drying up of springs and a reduction in the flow of others, the water department supplying drinking water to Mussoorie decided to tap the spring at Dhobighat in the 1990s. This move was resisted by the residents of Dhobighat. In 1997, the Jal Nigam started to tap this spring at its source to supply water to Mussoorie town. In return, the Jal Nigam agreed to lay pipes for Dhobighat's drinking water source (another spring located some distance away from Dhobighat) and install community water taps at five points within the settlement. All water charges and water tax are levied on the community. However, the dependence on the *khad* has reduced ever since. (Singh N.,2016).

Image 1: Source point of Dhobi Ghat spring is Mussoorie
Photo Credits: Trinayana Kaushik

Image 2: Dhobi Ghat spring site

Photo credits: Trinayana Kaushik

Image 3: Dhobi Ghat khad downhill

Photo credits: Trinayana Kaushik

Field Visit by CEDAR: A field visit to some villages was executed for the purpose of conducting a situational analysis of drying springs in the villages of Devprayag block, Tehri Garhwal district on 23rd and 24th of June 2016. All these villages are located at an elevation and the inhabitants hardly have any access to government set up of water supply. Researcher Dr. D S Chauhan from CEDARwas accompanied by his team, to Devprayag with the aim of gathering information about the village's water. To understand the socio-economic and political aspects related to springs one or two key informant from each village was asked to give an overview of the past and present scenario of the springs and water usage and supply to the households. The villages that were covered during this visit were Pyunkhari, Kimkhola, Kandi, Mehar, Amni, Jali, Gosayin, Jagthi&Baidgath. Most of these villages came under the Devprayag block while some of them came under the Narendra Nagar block of Tehri Garhwal district. This trip marked the initiation of work for fulfilling TERI's Hi-AWARE objective of Research Component 3 that is to be done in collaboration with CEDAR. Transect walks were organized to identify and validate information collected during the interviews.

Amar Singh Gosain, a local from Kim Khola village in Devprayag block of Tehri Garhwal district has been in constant connection with TERI from the beginning of TERI's work in the mid-hills of Uttarakhand and had served as a key informant in many of the related studies. In a detailed question and answer session he was asked to share his personal experience in regard to water supply, use, availability in his village and the surrounding areas. I also asked him certain question which were like:

Q1: From where do you get your daily water and who collects it?
Q2: Who collects water from the springs?
Q3: For what purposes is water used?
Q4: Has the flow changed over time? (increased, decreased, is same)
Q5: Are there any existing spring management institutions present?
Q6: Is there any government or local initiative taken to protect the springs?
Q7: Are there any dispute or conflict regarding distribution of spring water?
Q8: What are the other sources they are accessing due to unavailability of spring water? (river water, pond water, hand pumps, bore-wells etc. and their locations and timings)
Q9: How is the water quality?
Q10: Does the water quality change with seasons (poor quality due to flooding during monsoons)
Q11: How has the forest cover in the neighbouring area changed over time?

Q12: Do you know anything about groundwater recharge and is there any practice done for GWR?

Q13: Have people migrated to other areas due to lack of water?

Q14: Has there been a mass occupational shift due to water scarcity?

Q15: Do you pay any money for maintenance of the tapped springs?

Q16: What are you sanitation practices when water is unavailable?

Q17: Are there any operational rules with respect to the tapped springs?

5.0 Results:

According to Govt. of India RWSS coverage of an area by the project refers to "access to water" defined as 40 liters per capita per day within a distance of 1.6 Km. from the center of the village and 100 meters height. Out of 39,142 habitation in Uttarakhand (2014-1025 statistics by DWSM), Swajal had a target of covering 8,270 habitations for establishment of water security. The success of the project is represented by *Figure 5 and Figure 6:*

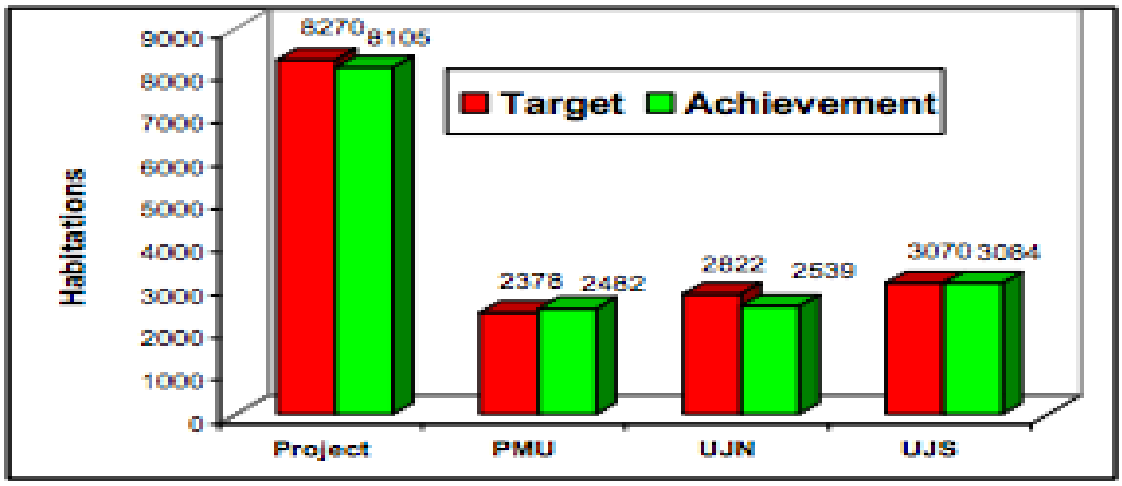

Figure 5: Agency wise project coverage of Swajal
Source: (Sinha V., 2015)

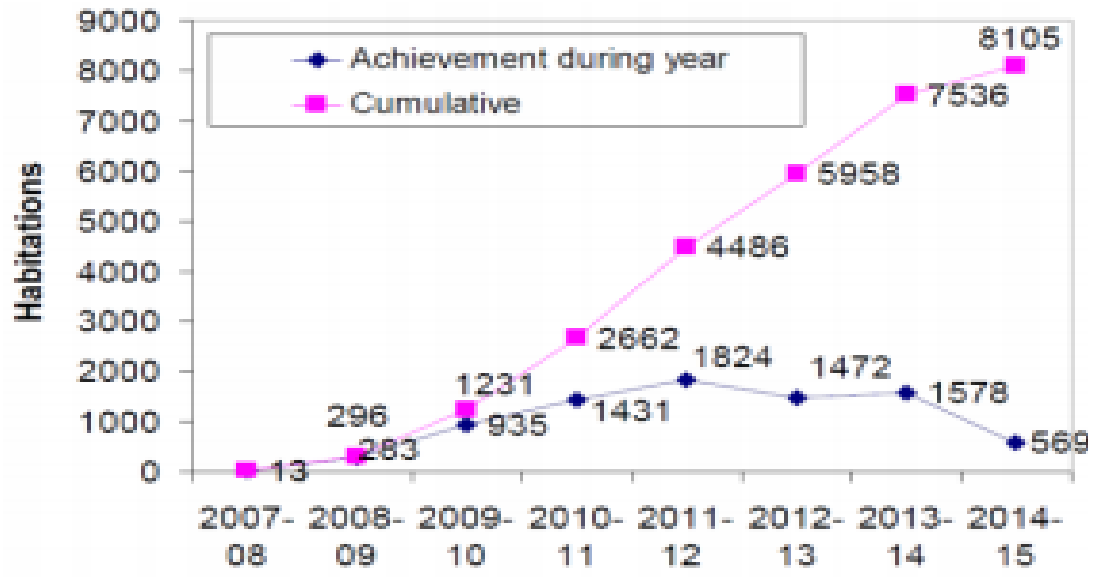

Figure 6: The achievement percentage of coverage of habitations
Source: (Sinha V., 2015)

The project has successfully completed more than 3600 water supply schemes through village level institutions. It benefitted 1.45 million people against project target of 1.2 million. The State Information Commission practice has twice honored the project with the RTI Award for transparency and good governance practices. Periodic assessment from the World Bank has reviewed the project as 'satisfactory' in terms of development, implementation process, financial management, and procurement management.

However the project, during its course of planning and implementation did face with certain challenges:

1. Like majority of government projects, Swajal too experienced either time run or budget run. Too many revisions of the Project Appraisal Document (PAD) had to be done due to certain unrealistic assumptions made by the project preparation team. The number of habitations covered was changed from 17,741 habitations to 8270 habitations. The implementation period had to be changed from June 2012 December 2015 which was a time runover of 42 months. There were modifications done for per habitation costs.
2. There has been many dropping out of schemes during the time period between project planning and implementation. Schemes at many villages were dropped out mainly due issues related to the water source and community disputes.
3. There was a change of government in Uttarakhand in the 2012 assembly elections when the project was in its critical phase. As a result, considerable efforts had to be exerted for consistent political acceptance of the SWAp

approach. Also all three elections were held during the running time of the project, which led to considerable waste of time.

4. The project's aim 'Reaching the unreached' is difficult and complicated because of inhospitable terrain of the rural Uttarakhand and the dispersed rural communities. Analysis of 3562 schemes revealed that 84% schemes can be reached only on foot where the distance on foot varies from 1 km. to 10 km. Furthermore, the working season for many of these was for about nine months only due to disruption of road networks during the rainy season.
5. Lack of human resource and resulting skill gap caused many mistakes in effective deliverance of project outcome. Among 900 civil engineers working in Swajal there was not a single project management professional.
6. The multiplicity of implementing agencies posed a major challenge due to diverse background, organizational culture, values, lack of knowledge on participatory planning; and no prior experience of working and planning with rural communities particularly in case of UJN and UJS.

Benefits and success of Swajal:*Figure 5* suggests that Swajal could achieve 98% of its target habitations. Though in the first three years its progress was gradual, it gained speed from 2010. *(Figure 6)*. The project has brought the Uttarakhand government closer to achieving goal 'seven' of the Millennium Development Goals (MDGs). Outcomes of the project suggest that it has been successful in bringing some transformational change in the way rural water supply was procured and delivered. Decentralization of power has been a major cause of success of Swajal for it lessened the burden of manpower on the two state-level agencies- UJN and UJS. Community driven initiative as the name 'Swajal' suggests was the key criteria for extracting out a sense of responsibility and ownership among local people who then started to participate in project planning and implementation with greater vehemence. Another co-benefit achieved through this project is strengthening of the Gram Panchayat activities. (Sinha V.K., *Review of Multilateral RWSSP*, 2015)

UJS along with being the implementation agency for Swajal, also had many schemes under UDWDP. However not all districts of the state are covered under UDWDP. *Table* below lists the water supply schemes under UDWDP in Uttarakhand.

Table 1: District wise coverage list of schemes by UJS under UDWDP

Districts covered under UDWDP	Number of schemes	Number/Name of micro watershed
Almora	9	Kuthlargad

Bageshwar	2	Anarsa
Champawat	19	5 (covers the 19 schemes)
Dehradun	6	3
Nainital	15	5
Pauri	3	3
Pithoragarh	1	GanaiGadera
Rudraprayag	4	2
Tehri Garhwal	10	3 (covers 10 schemes)

Source:UJS

The following *table* shows the coverage by National Rural Drinking Water Programme by Ministry of Drinking Water and Sanitation in the state of Uttarakhand*:*

Table 2: Coverage by NRDWP in Uttarakhand
(Data for the state of Uttarakhand as per 01.04.2016)

LPCD (liters/capita/day)	As per 40 LPCD	As per 55 LPCD
Total number of Habitation	39,209	39,209
Partially covered habitation with <40/<55 LPCD	17,846	33,425
Fully covered habitation with >=40/>=55 LPCD	21,345	5,766
Number of quality affected habitations	18	18
Number of slipped back habitation with <40/<55 LPCD	1,438	752
Number of Households	15,10,347	15,10,347
Number of Households with Public Water Supply (PWS) connection	2,03,665	2,03,665
Population provided water by PWS	53,34,065	53,34,065

Number of public delivery points	55,126	55,126

Source: NRDWP reports

The district wise coverage of NRDWP in Uttarakhand is shown in the following *table:*

Table 3: District wise coverage of NRDWP in Uttarakhand

Districts	Habitations covered	Water supply scheme sources	Delivery points	Public Private Sources
Almora	64.69%	4992	9238	309
Bageshwar	78.46%	848	4083	132
Chamoli	58.35%	1390	4021	41
Champawat	85.91%	1047	3471	174
Dehradun	94.28%	1056	3796	109
Garhwal	30.40%	5289	10493	118
Hardwar	48.78%	868	132	416
Nainital	84.79%	2288	3493	1839
Pithoragarh	90.80%	1530	6481	158
Rudraprayag	46.75%	1781	3137	6
Tehri Garhwal	25.09%	4543	8039	108
Udham Singh Nagar	99.91%	1745	131	1293
Uttarkashi	29.23%	2959	2752	20

Source: NRDWP reports

Study on Springs by Central Ground Water Board: A total of 48 cold-water springs and 6 group of springs (gadheras) were inventoried in Tehri Garhwal district by Central Ground Water Board. Besides these, measurement of discharge and water temperature of two streams was also carried out during the systematic studies. A

brief description of the springs and gadheras occurring in different rock types in Tehri Garhwal is given in the *table* below:

Table 4: Results obtained from springs inventories by CGWB

Rock type	Phyllite	Limestone and Dolomite	Quartzite
Number of springs inventoried	22	9	unspecified
Pre monsoon (min) 2010 (LPM)	0.71 (Malupani)	<0.0001 (Nagni)/1.39(Yamuna Bridge)	0.19 (Muneth)
Pre monsoon (max) 2010 (LPM)	56 (Bandkot) (2002 data)		54.5 (Silasu Bridge)
Post monsoon (min) 2010 (LPM)	1.32 (Nandgaon)	4.92 (Kauriyala)	0.41 (Aindi)
Post monsoon (max) 2010 (LPM)	57.36 (Malupani)	60 (Chaudana)	100 (Phakot)
Water temperature- Pre monsoon (min-max) (degree C)	21.0-24.0	19.0-25.0	13.0-35.5
Water temperature-Post monsoon (min-max) (degree C)	7.0-27.0	7.5-30.0	2.5-27.0
Gadhera discharge (post/pre-monsoon) 2002	700 (Syansu)/ 150 (BudgiKhala)	800 (Neergarh)/ 600 (Dhaulagiri)	

Source: CGWB Brochure

Due to hilly tracts, utilization of groundwater in most parts of Tehri Garhwal district is much less than the desired level. Also there no data on estimation of annual groundwater recharge as per the standard norms of Ground water Estimation Committee (GEC, 1997) for Tehri Garhwal district. This limits the possibility of various agencies to work for the development of this particular resource for water needs of the district.

Also many other significant findings resulted from the study done by CEDAR in June 2016 in the villages of Devprayag. They are:

- Each village had access to at least one hand pump/tap constructed by the JalSansthan, which, on an average, provided water every 3rd day. The flow of water varies from village to village. This was adequate in some cases and not in others. The villagers reported that collection of a few cans of water from these taps could sometimes take the whole day for they need to wait in long queues. Since these taps are almost always inadequate, they rely on springs. However, the quality of the water from these springs is not always good and, therefore, this water is used for other household purposes or for the livestock.
- An average household requires about 100 liters of water for their daily needs, including the livestock needs as well. Each household has cans with a capacity of 20 liters. One trip to the water source is at least 2-4 kilometers away from the households.
- Children also contribute to this daily activity of collecting water from the sources. They can be seen carrying 5 liters cans at least twice a day to support the family needs.
- The agricultural productivity suffers due to absolute dependence on rainfall. The annual output is barely enough to sustain the agricultural practice.
- A local initiative taken in this regard was a percolation pit, locally known as *chahal,* was constructed in 1984 by the villagers under MGNREGA which provides water to Kimkhola, Pyunkhari, Kandi, Jali, Koti&Mehar. This *chahal* is located at the top of the watershed area and has been quite successful in maintaining water levels till date.
- It was observed that the villagers possessed the basic understanding of spring terminology and displayed interest in issues regarding springs. They understood the importance of recharge zones and structures built to channelize spring water.
- Female drudgery was rampant. Each woman covered a total distance of at least 10 kilometers for her daily chores. Even among children, girls were seen accompanying their mothers on these trips. Their daily activities included fetching water, fodder, tending to the fields and the livestock along with fulfilling the other family responsibilities. (CEDAR,2016)

Also as revealed by Amar Singh Gosain (Contact no.+919634410245), the major source of water in rural areas of Tehri Garhwal is springs but unfortunately it is not a perennial source. Our key informant let us know that the PeyJal Nigam (UJN), Uttarakhand has tapped the springs in and around the area for making water access

easy for the locals of the villages. Mostly women and sometimes children go to fetch water for daily domestic chores. The taps supply water once in every 2-3 days but are located within the reach of 100-500 meters of almost each household. So for the days water is not supplied, the villagers live, based on the amount of water they can stock from the previous day when water was supplied. He also said that the taps are functional only during the months of rain and during the winter months the taps works once in 15 days or sometimes never at all. In this case the villagers are supplied water from the river or they walk to ponds, streams located far off, to collect water. There is no such spring operational or management institution established in villages of Devprayag but the villagers are charged INR 20/month for accessing the tap water in Kim Khola.

It was also found out that no local initiative has been taken from the community's side to solve the problem of water scarcity. Various inter-community disputes have taken place in the past few years, which has often prevented people from coming together to find a logical solution to this problem. It came into light that male members of a few families have migrated to states like Punjab and Haryana because agricultural practice in these villages became highly unsustainable in the winter. Even during the summers, there is hardly any water left after usage for domestic chores; that could be used for irrigation. As a result crop growth would be completely dependent on rainwater which again makes winter agriculture a punishing job for the farmers with strenuous work but a very little reap.

During monsoons, though the quantity increases but the quality of water sometimes degrades if flooding takes place in the source spring catchment. Not much impact on health has been reported so far however there lies great risk if the locals use this contaminated water for drinking purposes. In spite of this perpetual state of water crisis the locals still haven't figured a way out of it. In spite of growing awareness and knowledge about spring hydrogeology, as displayed by some locals during the field visit; the locals have yet not figured out a way to find a way out of their perpetual water-deficient situation. According to the locals the vegetation cover in the district has reduced in the past few years; however there is still a lot of greenery around.

Other blocks of Tehri Garhwal are facing the same problem. Female drudgery has increased, as major workforce in the entire Garhwal region is women. They take care of household chores along with outdoor works because many of the male members of these families have migrated to towns and other states. In some households of village Nagri in Tehri Garhwal women engage themselves in the job of water

collection from 3 a.m. Another village Kandakholi in Tehri located at an altitude of 1800 meters has worse conditions. A local mentioned that there is no source of water nearby and the taps established by the government deliver water once in a week or sometimes fortnightly. UJS supplies water to this village from Bhilangana river through a pumping station. The villagers have also reduced the number of livestock as a result of water crisis. The nearest source of water is 1.5 kilometers away and the discharge rate is 1 LPM. It takes the women folk around an hour to fill one 20 litre water canister (buntha). Another local from the same village expressed her sorrow by mentioning that her family members take bath one by one and only once in a week. Some times they directly go to the spring very early in the morning to take bath. She also mentioned that the villagers fear that this existing source will also dry up and then they will have no water left at all. (Bhatt V., Pandey P., 2005)

6.0 Discussions and Conclusion:

The problem of establishing water security in rural Uttarakhand is very much prevalent. Both and state and central government has taken time, funds and labour-intensive measures, but there is still room for a much improved situation. Groundwater in Uttarakhand is relatively pristine with no contaminants, but the complex hydrogeological set-up coupled with lack of hydrogeological database hampers precise estimation of groundwater resource potential and its development in Uttarakhand. As evident from the study of three types of rocks by CGWB; spring discharge varies with season and time, which are ultimately factors of climatic parameters. Geology of the spring is also very crucial for spring sustenance. According to the Uttarakhand State Action Plan Climate Change (UK SAPCC,2014) published by Ministry of Environment, Forests and Climate Change the state of groundwater development is 51% in the state.

In Tehri Garhwal too, the northernmost part is covered with snow throughout the year and thus the possibility of groundwater development is almost nil. However the remaining part of the district show moderate to good scope of groundwater development. Most springs in the region are gravitational type and the water is tapped in surface tanks, which are supplied by gravity flow through parallel pipelines or through a pumping station to different villages depending on the discharge. But as evident from records not all habitations of the Tehri Garhwal were accessible by the various projects executed in the district. NRDWP has the least coverage in Tehri i.e. only 25.09%. Also watershed development in this region

focuses more on farming and livelihoods rather than water supply in the rural areas. Various projects by WMD were mostly characterized by variety of possible interrelationships between productivity, conservation, and poverty-alleviation while using the natural resources present in that watershed. (Chauhan M., 2010). When it comes to local initiatives artificial recharge must be encouraged using local people's participation. A highly integrated approach involving revival of hilltop lakes, critical streams and springs can be undertaken by the villagers. Conjunctive use of water resources is another solution for the villagers to apply in their day-to-day lives to secure their water resources. Tehri Garhwal has high average annual rainfall and thus has good scope for rainwater harvesting (Ministry of Water Resources, GoI, 2011, Groundwater Brochure for Tehri Garhwal). If all households practice small-scale water harvesting during the monsoon, the harvested water can be used during the winter months till the next pre-monsoon season when spring discharge is very low. Decentralization of rural supply was a very important step taken with respect to involving the locals for better efficiency in the undertaken projects. Existing policies like MGNREGA can be used to take a step ahead from usual adaptation measures. A classic example of community participation is Sikkim's DharaVikasYojna (DVY) by the Department of Rural Management and Development (RMDD), Sikkim under centrally sponsored Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) scheme. DVY's innovative approach served multiple purposes of employment generation, awareness generation and establishing water security. Since DVY was community driven, it maintained a sense of ownership among the villagers during its operation and management. DVY also brings out a very important ingredient of spring revival, i.e. rock types of aquifers. Though the Groundwater Brochure by Ministry of Drinking Water and Sanitation describes the hydrogeology of Tehri Garhwal, detailed study on the rocks, their porosity estimation is required for practicing artificial recharge for increasing spring discharge. Also identification of recharge area is an extremely crucial step for the process of spring revival. The study from Danda watershed in Tehri, involved discharge data for the springs from more than 10 years. Only such explicit data can give accurate information about fast or slow responding springs and we can say identification of a spring's recharge area is a time consuming process.. ICIMOD's eight-step methodology for spring revival also includes hydrogeological mapping of spring-shed as a decisive step in the process of spring revival followed by spring mapping and socio-economic mapping.

Studieson the springs of Tehri Garhwal and related socio-economic changes brought about by its drying are clear indicative of the emergence of a grave problem. The demand exceeding usage scenario of the Danda watershed in Devprayag is

suggestive of how each household's sole aim is to acquire and stock water whenever possible. This is a clear indication of scarcity. While certain habitations of one block are water-sufficient as evident from the key informant's interview from the villages of Devprayag, some other poorly accessible habitation of the same village are suffering from acute shortage. These are the habitations where water supply schemes were probably dropped out, by Swajal and other agencies, due to reducing water in the sources and hostile terrains. In some villages of Tehri; no supply of water for a week's time, fetching water at 3 a.m. in the morning and taking bath only once a week are extreme outcomes where basic human entitlements are being breached because of water scarcity.

Another aspect of the issue of water scarcity is gendered vulnerability. While the entire population is facing consequences the women of the state are suffering the most. As established from all the primary data gathered, it is the women of the villages who walk for several kilometers at dawning hours of the day. After implementation of Swajal, many women of those areas have been relieved, as taps have been installed at approachable distances from their homes. However out of 15,761 habitated villages in Uttarakhand *(Census, 2011)* only 195 of them are covered under Swajal. No doubt Swajal project has been very successful is grievance redressal of millions of people but a much higher population is still under the threat of water insecurity. Women of these villages are still walking on their foot fetching water in their canisters early in the mornings. They walk on the rugged sloppy mountains carrying 40-50 litres of water everyday.

The causes of this change seen over a period of time can be attributed to both climate change as well as direct anthropogenic factors. Dynamiting of mountains for road construction, and for the construction of various hydel power projects in Uttarakhand are said to be responsible for the drying up of the natural water sources. Meanwhile water resource minister of Uttarakhand also said that the central government has not sanctioned sufficient amount of fund, to the state government, for solving this problem. Also advanced drilling techniques has led to an increase of hand-pumps by 59% and bore wells up to 250 meters can be dug in the state. Though it has benefitted one section of the people, rural people have faced the consequence of lessening discharge in the mountains springs. (Bhatt J., 2015, The Hill Post)

Some measures taken by people involves construction of the structure called chal-khal, which is similar to the *chahal* as already mentioned by our key informants in the interview. The retained water from chal-khal, infiltrates into the soil and serves

through replenishment of groundwater. The method is practiced in the many habitations nearly 40 villages including the villages of Kimkhola, Pyunkhari, Kandi, Jali, Koti&Mehar of Tehri Garhwal. To encourage more such initiatives hydrogeological training needs to be imparted to the locals along with awareness generation.

6.1 Limitations: The National Disaster Management Authority of India (NDMA) marks Uttarakhand as having a hazard profile for floods and landslides. The 2013 cloudburst in Uttarakhand is one the worst disasters India has seen since the 2004 tsunami. Every year during the monsoons, frequent landslides block the hilly roads disrupting communication and causing inconvenience to local people and tourists. As result of these factors, undertaking research in this state becomes very laborious. NDMA marks most of Tehri Garhwal district as a very high landslide prone zone. *(Figure 7)*

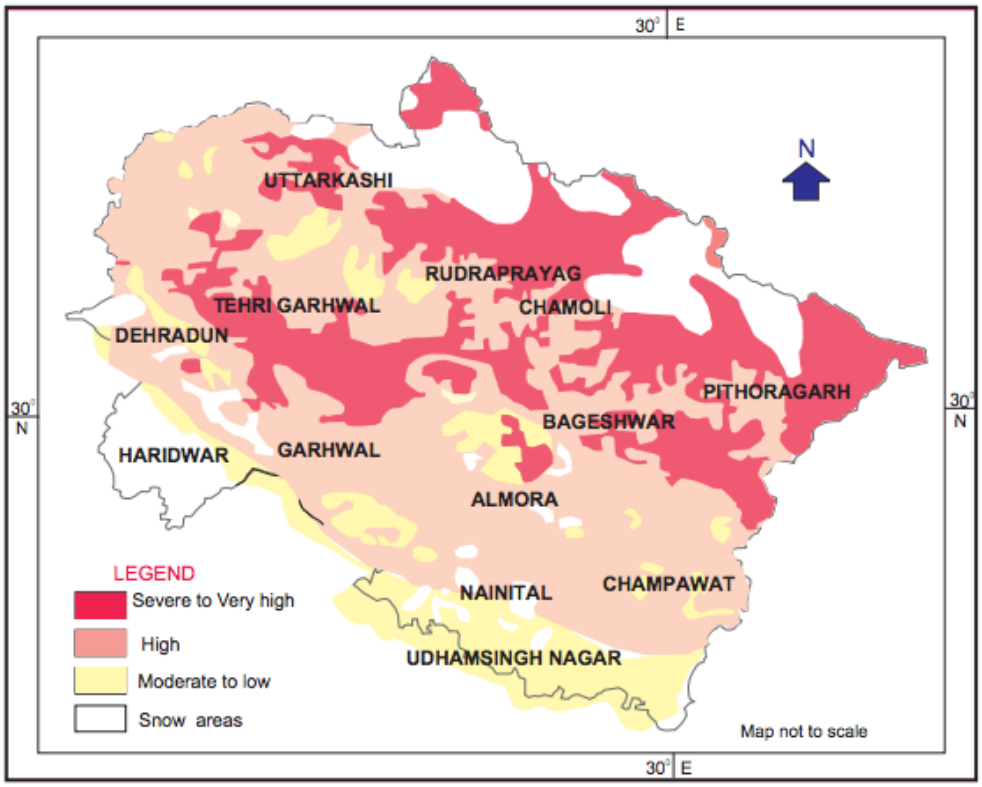

Figure 7: Landslide prone areas of Uttarakhand
Source: CGWB Brochure

A situational study of springs is a field-intensive study, which requires detailed mapping, calculation of discharge in different seasons, quality check of spring water in different seasons. However an extensive field visit could not be possible because of unfavourable weather conditions in the study area, which made travel extremely dangerous. Time constraint was another limitation that prevented exhibition of much more detailed data including water quality of collected samples of the mapped

springs, hand pumps, tanks in the pumping stations. Thus we can conclude various set of drawbacks associated mainly with topography and geographical location of the district as well as the state led to a concise documentation of the water demand, supply and usage scenario of rural Uttarakhand.

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8.0 Annexure

1. Salient features of Swajal/ URWSS programme

Particulars	Remarks
Date of start	30th November, 2006
Date of closure	31st December, 2015
Original target for habitation coverage	17,741
Revised target	8,270
Population to be benefited	1.2 Million
Original cost estimation per habitation	US$ 9,700
Revised cost	US$ 20,000
Total project cost	US$ 224 Million
World Bank share	US$ 120 Million
GoI share	US$ 69.1 Million
GoUK share	US$ 29.7 Million
Community share	US$ 5.03 Million
Facilitating agencies	Department of Drinking Water and Sanitation, Government of Uttarakhand (GoUK) through State Water and Sanitation Mission (SWSM)
Implementing agencies	(i) Uttarakhand Peyjal Nigam (UJN): (ii) Uttarakhand JalSansthan (UJS): (iii) Project Management Unit (PMU), Swajal

2. Transcript of interviews

Pradhan: Matwar Singh Rawat

Contact: 9720604788, 7248547055

Villages: Kim Khola&Jali

1. **Village:**Mehar
    a. Name: Smt. Lakshmi Devi
    b. Occupation: Basic Health Worker
    c. Summary: Works in 7 Gram Sabhas; Kandi, Mehar, Kimkhola, KotiGosayin, Gosayin, GosayinGaon, Gadakot, Amni. Heavy rainfall causes flooding and destruction in 2010. Helicopters were brought in for aid. Cases of viral fever are widely reported during monsoons, as well as typhoid and increase of uric acid. Also many cases of Chikanguniya were reported in 2010.
    d. Water: Hand pump was constructed in June, 2000 and tapping by JalSansthan has existed since 90s. The flow of water has relatively increased since last year as compared to before. It has become even better since a month, i.e. it now comes twice a day.
        i. Hand pump- 1. It used to be the main source. It has an 11^{th}-12^{th} Century temple, built around the same time the village was setup. This source dried up 25 years ago. Mostly children carry water from handpumps. 1 child carries around 5 liter/can/trip
        ii. Crop: Sesame (Black)
        iii. Status: Non functioning – 3 days
        iv. 30 households are dependent. Few people have private connections from the tank. Tank capacity is 10Kl which delivers water every day at 3 p.m.. 1 can of water = 20 liters. Private connection provides an average of 100 liters per day

2.**Village:**Amni
    a. Name: Harish Chandra
    b. Occupation: Ex-army, currently working as farmer & daily shop owner

c. Summary: Amni has 4 springs. Piped water is supplied from Bhagwan village (80 kms away) by JalSansthan since 1985 due to growing shortage of water in springs. Common crops grown are *daal, mandwa, jhangora(Sawank), gehat, chaulayi and soya bean*. But he hasn't grown anything since two years due to lack of adequate rainfall.

d. Water: The JalSansthan tap which is about 1-2 kms away from home provides water every third day. He believes that the hand pumps are drawing all the water of springs leading to dry springs. He talks about a *chahal,* a percolation pit constructed with funding from Forest Department in 1984 to provide water to villages, Kimkhola, Pyunkhari, Kandi, Jali, Koti&Mehar.

3. **Village:**Pyunkhari
    a. Households: 50
    b. Location: Topmost part of the hill, near the Chahal
    c. Population: 200-250 voters
    d. Crops: Rotational basis; *Sawank-Gehun, Mandwa-Dhan*
    e. Landholding: Average – 50 nali

4. **Village:**Jali
    a. They have a water guarding system where people of the village periodically guard the water source and everyone ration their use of water in times of shortage.

5. **Village:**Baidgath
    a. Households: 18
    b. Crops: *Jhangora (Sawank), gehat, daal, dhaan*
    c. Water: A structure for collection of water for irrigation was made 7-8 years ago. Check dams were built by villagers with the help from the Forest Department. They believe the water in the spring decreased after the road was built. Now the villagers depend largely on JalSansthan's tap. The spring swells during rains.

6. **Village:**Kandi
    a. Households: 70
        i. Interview: Female Resident
        ii. Summary: There are two hand pumps close to the village; one is preferred more than the other because of the

quality of water. However, it is subject to frequent malfunctions. There was also a well which dried up 7-8 years ago but has water in the 1-2 months of rainfall each year. In case if both hand pumps break down the women have to walk to the hand pump in Amni. The JalSansthan tap also provides water every alternate day, but the discharge is very low.It takes almost a day to fill cans. They have a mutual agreement regarding tap water and each household is allowed to draw only 2 pots of water from it. They do not have concrete tanks for storage and carry out rain water harvesting on a very small scale using the plastic drums. This water although covers a very small portion of the demand but is quite helpful and can potentially be a relief mechanism for at least 2-3 months.

iii. Agriculture: Crops - *soya bean, dal, dhan;* they were provided guava seeds by the Pradhan but the trees did not survive due to lack of water.

iv. Cash crops: *toor dal, soyabeans, marsu, udad dal, chaulayi, mandwa*

v. Output: 1 sack = 50 kg; 561 landholding produces minimum 2 sacks of crop. The output is sold to the *artiya* who visits them frequently at their village to collect the crop.

vi. Human Wildlife Conflict: Wild Boar