INTERNATIONAL JOURNAL FOR INNOVATIVE RESEARCH IN MULTIDISCIPLINARY FIELD
ISSN: 2455-0620 [Impact Factor: 6.719]
Monthly, Peer-Reviewed, Refereed, Indexed Journal with IC Value : 86.87
Volume - 8, Issue - 6, JUNE - 2022 Publication Date: 30/06/2022

DOIs:10.2015/IJIRMF/202206019 --:-- Research Article

Assessment of traditional water source natural springs of a Lesser Himalayan town Almora, Uttarakhand

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Abstract: *In the era of climate change and global warming, the traditional water sources are transforming their nature from perennial to seasonal and seasonal to ephemeral. The fundamental objective of this study is to analyze the present status of natural springs of the study area. For this purpose, a field survey and temporal comparative study based on reliable literature on natural springs have been conducted. The study shows that there were total 100 perennial springs in the study area in 1842 which has decreased to 69 in 1995 and 43 in 2019. The study also reveals that during the last 25 years, 26 springs have been transformed into non-perennial stage, i.e., in the last two and half decades every year on an average one perennial spring has been transformed into non-perennial spring. Thus, the study shows that due to climate change and anthropogenic activities, the natural springs are transforming their nature and depleting very steadily. This is a big challenge to the water security of town Almora. Therefore, the study suggests that the spring rejuvenation and conservation program should be started immediately with government-cum people participatory approach.*

Key Words: *Almora town, natural springs, water security and spring rejuvenation.*

1. INTRODUCTION:

Natural springs are an important source of drinking water in the whole Kumaun Himalaya Region of Uttarakhand. In the local language Kumauni, the spring is called Naula and Dhara. There is a little difference between Naula and Dhara, in Naula water is stored in a pond shape a small structure and in Dhara water falls down from a certain height. Water is a precious and finite natural resource. All living things on the Earth get life from the water. It is well known that water resource is very important for the development of civilization. In the absence of water, no civilization can be fully developed.[1,2] Almost, all the cities (settlements) of the world are found situated near water bodies, e.g., rivers, ponds, lakes etc. This reveals the importance of water in human life. One of the main characteristics of water is this it can live in all the forms of matter, e.g., gas, liquid and solid.[3] In the present century, when many environmental problems are accumulating and the availability of drinking water is decreasing, then in this circumstance the importance of water resources is increasing more and more.[4,5,11] Scientists have expressed the possibility that if the drinking water resource is exploited and polluted presently, then serious drinking water shortage problems may arise in near future.[6] About 71% area of the Earth is covered by water and only 29% area is covered by land. Out of the 71%, only 3% is found in the form of safe drinking water. Most of this 3% is found in the form of snow caps and glaciers (67%) and groundwater (30%) and only 3% water is found in rivers, lakes etc (Plate-1).[7] India is in the northern hemisphere on the world map. India is a rich country in terms of renewable water resources. India is one of the 9th richest countries in the world in renewable water resources.[8] India is the 7th largest country of the world in terms of area, which covers 2.4% land and 4% water of the entire globe.[9] Uttarakhand is a northern Central Himalayan state of India which is rich in drinking water resources. Uttarakhand is home of many glaciers, lakes, and perennial rivers.[10] Almora is a hilly district of Uttarakhand state. The major hill town of Uttarakhand state is town Almora. The town Almora has been selected as the study area. It is one of the famous hill stations of India; its natural beauty makes it a unique tourist destination.

In the ancient time when the Almora city was established, the responsibility of water supply to the city was on the springs. Over time, the population of the city Almora increased and the springs were not able to supply water to the increased population.[12] Due to several environmental problems and anthropogenic activities, the natural springs have transformed their nature from perennial to non-perennial. Because of the above situations, the government made a plan for a new gravity flow drinking water scheme and drinking water pumping schemes so that the necessary water supply can be continued.[13] Thus, the implementation of new drinking water schemes led to the neglect of springs.

People started using the springs only during the water crisis. Thus, due to the lack of proper maintenance of the water sources springs, the water level of the springs has decreased. At present, the attention of the people and the state government has come back to these springs[12].

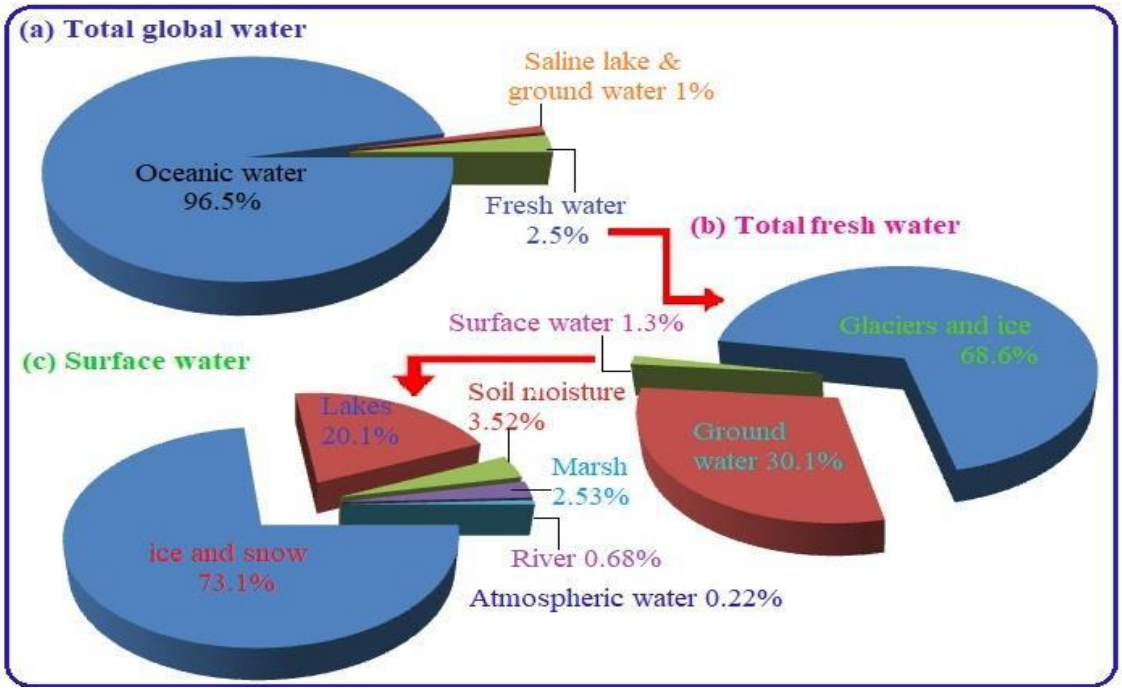

Plate-1: Demonstration of distribution of water resources on the planet Earth (After- Gupta, 2021).

2. OBJECTIVES:

The fundamental objective of the presented research paper is to study the current situation of the natural springs of the study area. Very few people know about the springs of Lesser Himalaya. There are three main objectives of this research paper which are:

- To study the current situation of natural springs.
- To make a temporal comparative study of natural springs.
- To provide suggestions to resolve the problem.

3. MATERIALS AND METHODS:

The city Almora has been selected as the study area. For the completion of this research paper the primary data such as spring data, observation etc have been collected by field survey. For the secondary data, the municipal council of Almora is consulted and many more miscellaneous sources are also approached such as census data 2011, research papers, Centre of Excellence for Natural Resources Data Management System (NRDMS), Almora, Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora (V.P.K.A.S.) etc. For the completion of this research paper QGIS (Quantum Geographical Information Science) and Arc GIS software, computer applications and tools are used. The Google earth pro and QGIS and Arc GIS software are used to develop spatial distribution maps of natural springs.

4. ABOUT THE STUDY AREA:

Geographically, the study area, viz., Almora town lies in the Lesser Himalayan region of the Uttarakhand state. The study area extends between in 29°33'47'' N to 29°52'20'' N latitudes and 79°33'12'' E to 79°48'11'' E longitudes, covering an area of about 7.539 km^2 (Fig. 1). The study area is a densely populated city of the Kumaun Himalaya. The average elevation of the study area from the mean sea level is 1644 m. The municipality council of Almora has 13 wards which are Badreshwar ward, Baleshwar ward, NTD ward, Dugalkhola ward, Laxmeshwar ward, Murlimanohar ward, Nandadevi ward, Railapali ward, Rajpura ward, Ramshila ward, Shailakhola ward, Tripurasundari ward, and Vivekanand ward.

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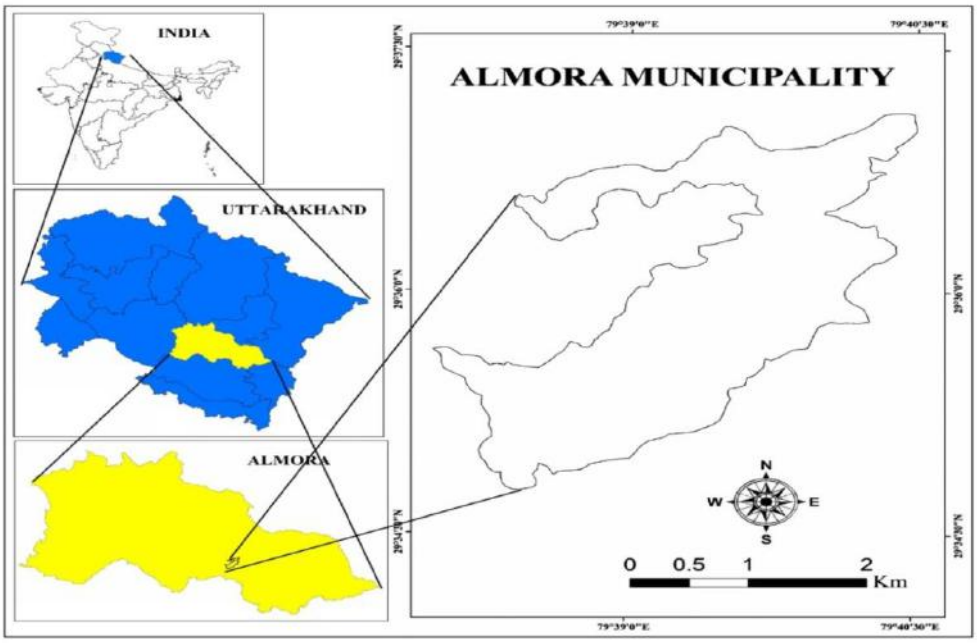

Figure 1: Location map of the study area, viz., Nagar Palika Parishad Almora *(CoE, NRDMS, 2019).*

The study area has a unique geomorphic setting and it is located on a mountain ridge. This city has developed on the gentler or gentler-steep slope.[14] The study area varies between the elevation of 1500 m to 1764 m. The meteorological data of the last six years from 2010 to 2015 is analyzed here. The maximum monthly temperature is registered 30 °C in the month of May whereas the minimum monthly temperature is recorded 9 °C in the month of January. The average annual temperature of the study area is 17.9 °C which varies between 23.6 °C maximum and 12.2 °C minimum (Table- 1). The study area receives 1110.9 mm total annual rainfall. The maximum and minimum rainfall occurs in the month of July (316.1 mm) and November (3.0 mm), respectively (Table-1). The thermograph and hyetograph of the study area have been developed which are presented in Figures 2 and 3. The study area has a unique geological setup which is made up of mainly crystalline and granite rock groups.[14] Town Almora has a rich cultural heritage and natural beauty. According to the census 2011, the total population of the town Almora is 34122 and out of the total population 17538 are male and 16784 are female. The population density of the city is 4525 people per km^2.

Table-1: Average monthly temperature and rainfall statistics (2010-2015) of town Almora.

Months	Temperature in °C			Rainfall	
	Maximum	Minimum	Average	Rainfall (mm)	Rainfall in %
January	14.7	3.3	9.0	38.0	3.4
February	16.5	5.2	10.9	82.9	7.5
March	22.4	9.0	15.7	37.3	3.4
April	26.2	12.8	19.5	34.7	3.1
May	30.0	17.3	23.6	31.5	2.8
June	29.8	18.6	24.2	165.1	14.9
July	26.9	18.9	22.9	316.1	28.5
August	27.0	18.8	22.9	204.8	18.4
September	27.3	17.3	22.3	144.0	13.0
October	24.6	12.5	18.5	20.3	1.8
November	20.9	8.0	14.4	3.0	0.3
December	16.7	4.2	10.5	33.3	3.0
Average/Total	**23.6**	**12.2**	**17.9**	**1110.9**	**100**

Source: Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora (V.P.K.A.S.).

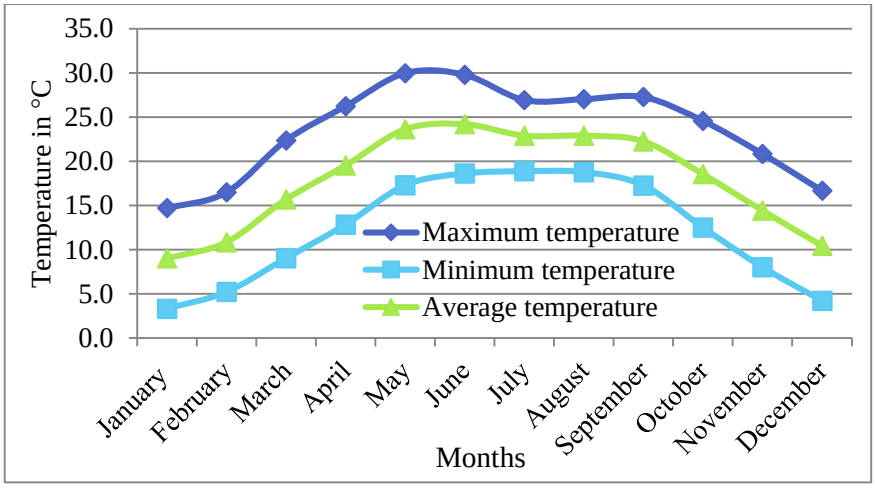

Figure 2: Average, maximum and minimum monthly thermograph of the study area (2010-2015).

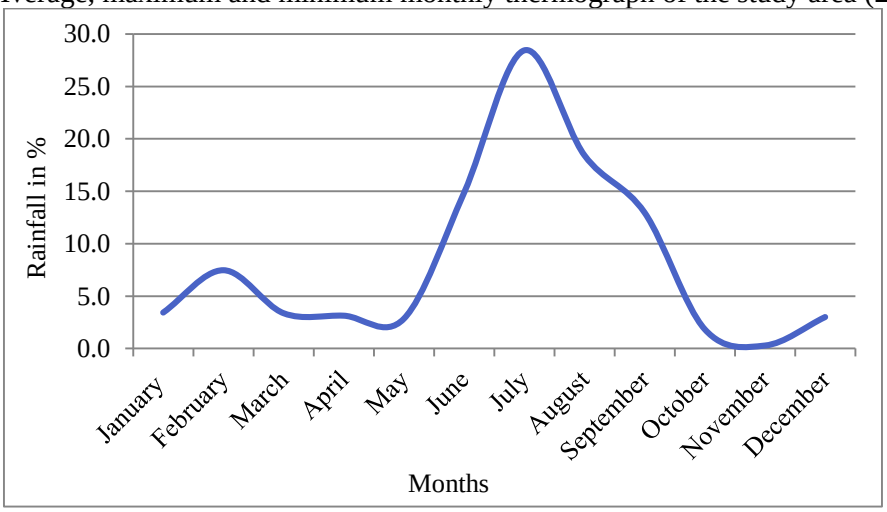

Figure 3: Demonstration of average monthly hyetograph of the study area (2010-2015).

5. RESULT AND DISCUSSION:

Since ancient time, the responsibility of supplying drinking water needs of the mountain residents have been on the natural spring, viz., Naula and Dhara. Even at the present, most of the people of mountain areas go to springs to meet their drinking water needs. In the study area, at present time, the gravity flow drinking water scheme and drinking water pumping schemes have been started to supply the drinking water to the city and adjoining villages. At present, the local people go to springs only during water crisis times when the water supply is disturbed, i.e., the people use spring water only during the water crisis. There is a belief that there were 360 springs in ancient times in this beautiful hill town.[16] In 1842, here 100 perennial springs were available in the city. Later on, Pant (1995) studied the natural springs of town Almora in 1995, he found only 69 springs in the perennial stage and 31 springs in the non-perennial stage[12]. According to the field survey conducted in December, 2019, only 43 springs have found in the perennial stage and the rest springs have been dried up or transformed into the non-perennial stage. People use these springs to meet their various water needs but at the same time, it is also true that the water level of most of the springs has seen a serious decline in the last few years and the water sources are getting increasingly polluted. These water sources have played a significant role in the establishment and expansion of this city. Many muhallas of the city are named on the name of spring, e.g., Dharanaula, Dhungadhara, Ranidhara, Dhar ki Tuni etc. It is well known that the springs are merely the result of groundwater.[17] During the rainy season rainwater is stored as underground water. It is considered that there is a positive relationship between recharge zone area and groundwater storage, i.e., larger the recharge area higher the groundwater table and smaller the recharge zone lower the groundwater table.[15] The town Almora is situated on the horse saddle ridge of Kumaun Himalaya which has clearly defined two slope portions

eastward slope part and the Westward slope part. In the local Kumauni language, the Eastward slope part is known as Teliphat whereas the Westward slope part is Seliphat. There is a lack of responsible organization for the conservation and development of springs still now. Due to poor maintenance, many springs have been disappeared or transformed into non-perennial stage. In 1842 there were 100 perennial natural springs in the town Almora. Later on, Pant studied the springs of town in 1995, in his study Pant found 69 springs in the perennial stage and 31 springs in the non-perennial stage (Table-2 and 3). Out of total springs, 21% springs of Teliphat and 34% springs of Seliphat have been transformed in the non-perennial stage till 1995. Out of the total springs, 41 were located in Teliphat and the rest were located in Seliphat. He developed a spatial distribution map of the natural springs of town Almora presented in figure 4.[12]

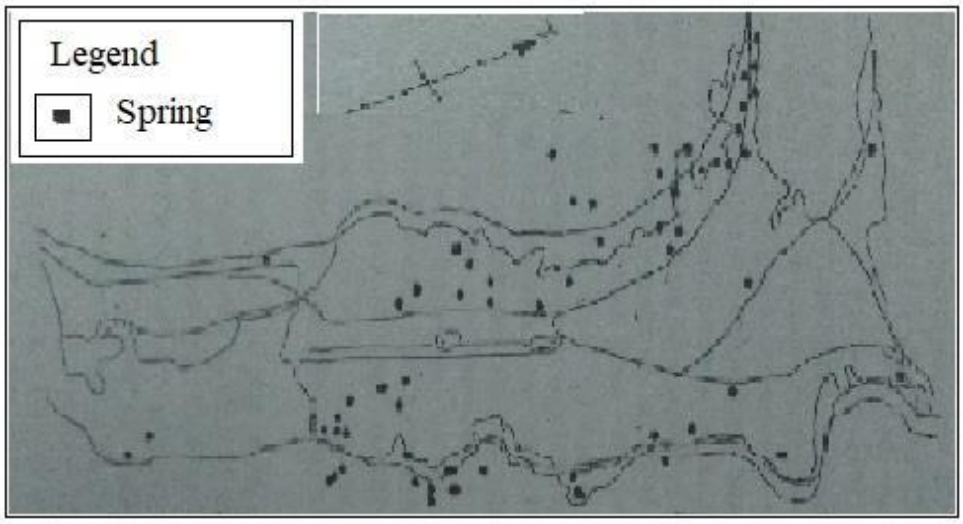

Figure 4: Spatial distribution map of natural spring of town Almora *(Based on Pant, 1995).*

Table-2: Details of Seliphat natural springs of town Almora *(Based on Pant, 1995).*

S.N.	Muhalla Name	T.S.	P.S.	D.S.	S.N.	Muhalla Name	T.S.	P.S.	D.S.
1	Pandeykhola	9	3	6	9	Gururanikhola	1	1	-
2	Laxmeshwar	4	2	2	10	Champanaula	5	5	-
3	Kosiyad	1	1	-	11	Tilakpur	6	1	5
4	Ranidhara	1	1	-	12	Khatyari	6	3	3
5	karnatak khola	9	8	1	13	Pataldevi	1	1	-
6	Galli	2	-	2	14	Paniudiyar	2	-	2
7	Talla Chausar	1	1	-	15	Bakhasikhola	1	1	-
8	Chausar	5	5	-	16	Chilakpita	4	4	-
Total							59	37	22

Table-3: Details of Teliphat natural springs of town Almora *(Based on Pant, 1995).*

S.N.	Muhalla Name	T.S.	P.S.	D.S.	S.N.	Muhalla Name	T.S.	P.S.	D.S.
1	Dugalkhola	3	1	2	11	Rajpura	1	1	-
2	Paltan bazar	3	2	1	12	Talla Odhkhola	1	1	-
3	Doba Naula	1	1	-	13	Dharanaula	1	1	-
4	Narsingh Bari	6	5	1	14	Kilani	1	1	-
5	Leesa factory	2	2	-	15	Damudham	1	1	-
6	Khagmara court	2	2	-	16	Tamta Muhalla	1	1	-
7	Pulice line	2	2	-	17	Chinakhan	3	2	1

8	Dubkiya	3	-	3	18	Dhungadhara	1	1	-
9	Nayalkhola	1	2	-	19	Baldhauti	4	3	1
10	Bari Bagicha	3	3	-	20	NTD	1	1	-
Total							41	32	9

Note: There, T.S., A.S. and D.S. are stands for total spring, perennial spring and dead spring, respectively.

5.1 Current situations of natural springs:

The importance of water resources is increasing in the 21st century. Due to several environmental problems, the water sources are changing their nature from perennial to non-perennial. At present, the condition of the natural springs of the study area has become very worrying. The springs are drying up very steadily which shows the insecure water future of town Almora. According to the field survey, there are only 43 springs in the perennial stage, out of these 23 are located on the Eastern slope (Teliphat) and 20 are on the Western (Seliphat) slope (Table-4 and Plate-2) and in 1995 there were 69 perennial springs. Out of the total perennial springs, 53.4% springs are located on the Eastern slope and 47.6% are on the Western slope. It means 26 perennial springs have been transformed into non-perennial springs in the last 25 years. In the last two and half decades about 37.68% springs have been dried up. Out of the total dried springs, 24.63% are from the western slope and 13.04% from the Eastern slope. The spatial distribution map of the natural spring of the town Almora is developed and presented in figure 5.

Table-4: Details of perennial natural spring of town Almora in December, 2019.

Natural Springs of Teliphat		**Natural Springs of Seliphat**
S.N.	Name of Spring	Name of Spring
1	Siddhi Naula	Chikalpita Naula
2	Dugalkhola Naula	Khatyari Naula
3	Tapkeshwar Mahadev Naula	Rajnaula
4	Tularameshwar Naula	Ramphanaula
5	Doba Naula	Gurudwara Naula
6	Khazanchi Naula	Sunari Naula
7	Nayalkhola Nuala	Champa Naula
8	Baribagicha Naula	Mahar Naula
9	Baribagicha Naula upper Naula	Gururani Naula
10	Malla Naula	Chausar Naula
11	Talla Odhakhola Naula	Karnatakkhola Naula
12	Dharanaula	Karnatakkhola Naula 2
13	Kilarinaula	Ranidhara Naula
14	New colony naula	Pataldevi Naula
15	Makedinaula	Gururani Khola Naula
16	Umapatinaula	Shikhar Naula
17	Darbari Naula	Pandeykhola Naula
18	Baleshwar Naula	Sarkar ki ali Naula
19	Chimasim Naula	Kapina Naula
20	Ramdeyi Naula	Kapina Naula 2
21	Hathi Naula	
22	Khagmara court Naula	
23	Khagmara court Naula 2	

Source- Primary data

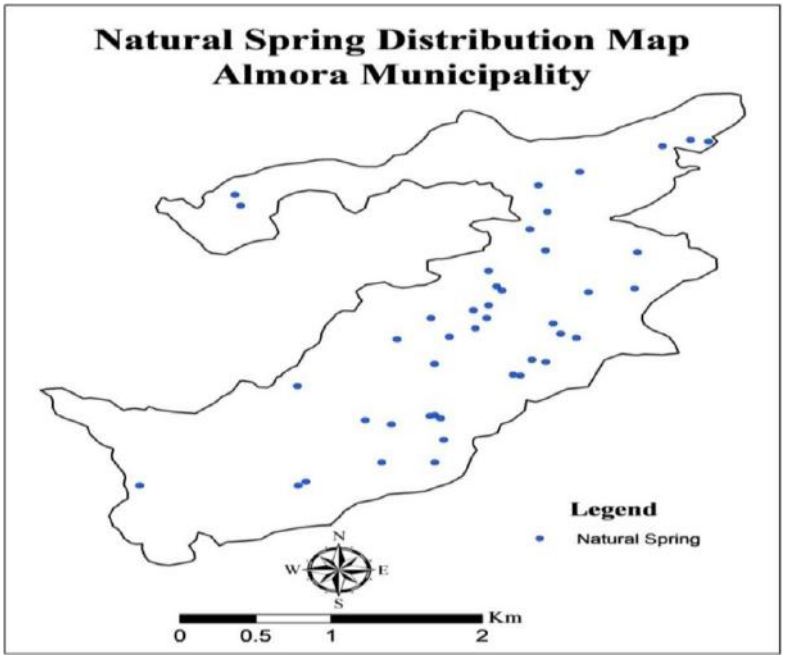

Figure 5: Spatial distribution of perennial natural springs of the Almora town area.

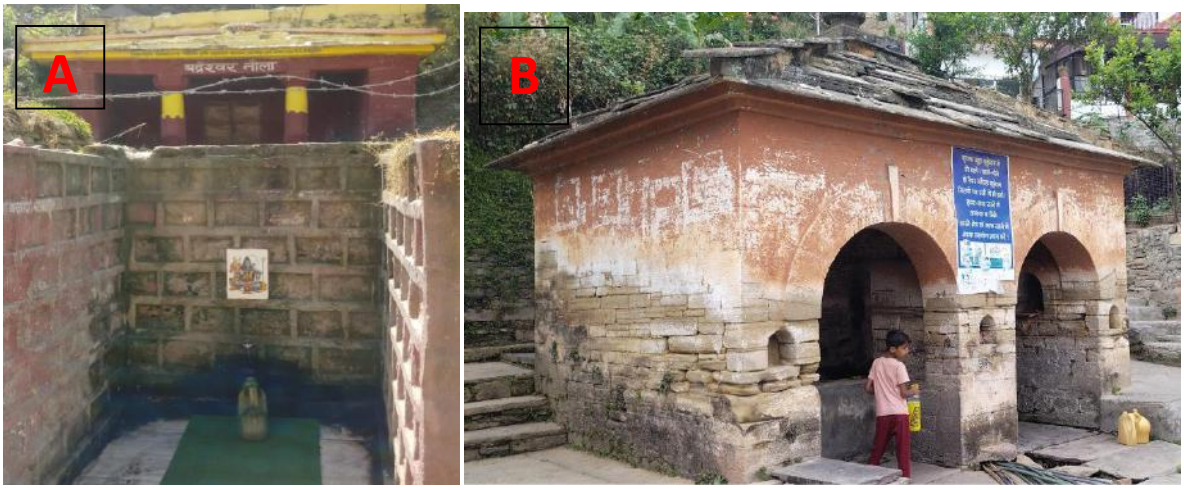

Plate-2: Typical example of natural springs in the study area: A- Badreshwar Naula and B- Makedinaula in the Almora town area.

5.2 Water availability and utilization of springs:

In ancient times, the availability of water in springs was sufficient quantity and people were using the spring water for various purposes, e.g., drinking, washing, for pet animals and agricultural fields. These springs had a good discharge and safe clean water. But gradually, the expansion and population of the city increased. Then, because of the above situation, the government started to develop alternative drinking water schemes for the city. To supply sufficient drinking water to the city, the drinking water gravity flow scheme and drinking water pumping scheme was started and drinking water facility provided to people at their home. Due to getting water at home, people stopped going to springs or started neglecting the springs. Thus, natural springs were neglected and several springs of the city have dried in the lack of proper maintenance. If we talk about the water availability and utilization of spring water at present we found that water availability has decreased. The local people go to springs only during the water crisis, especially in the summer season. 1842 year is selected as the base year for the temporal comparative study of springs of town Almora. Table-5 reveals that in 1842 there were total one hundred natural springs in the city Almora which were in the perennial stage. Later on, after 153 years a detailed natural spring survey was conducted in 1995 by Pant. According to this survey in the city Almora only 69 natural springs were found in the perennial stage and 31 springs were found in the non-perennial stage[12]. The latest survey was conducted in December, 2019 according to this survey 43 springs are found in the perennial stage and rests are found in the non-perennial stage. From 1842 to 1995 (153

years), 31 natural springs and 1995 to 2019 (25 years), 26 springs have been transformed into non-perennial nature. The status of springs for the years 1842, 1995, and 2019 is presented in Table-5 and figure 6. Anthropogenic activities such as unplanned development, deforestation, unexpected population growth etc and environmental problems such as climate change, global warming etc are caused of this drastic change.

Table-5: Temporal comparative analysis of natural springs of the study area.

S.N.	Year	Total springs	Perennial springs	Dead springs
1	1842*	100	100	0
2	1995*	100	69	31
3	2019**	100	43	57

* Based on Pant, 1995 ** Based on the field survey conducted in December 2019.

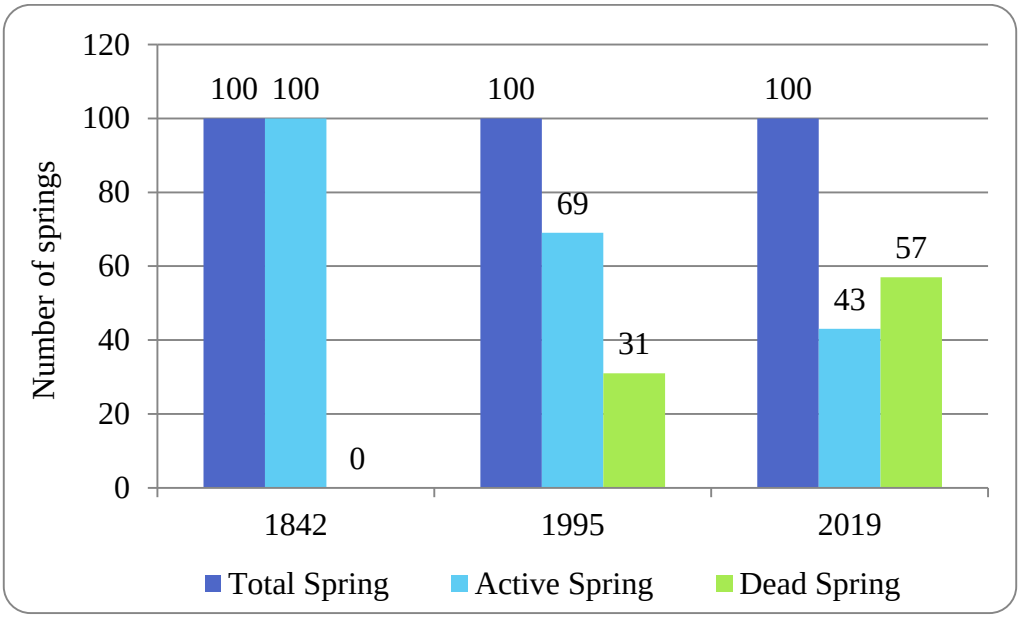

Figure 6: Status of natural springs of the study area for the different years.

6. RECOMMENDATION:

For the improvement of the present conditions of natural spring of town Almora the following suggestions or recommendations can be suggested.

i. The expansion of the city should be controlled and the spring recharge zones should be declared as reserve zone. In 1951, the total population of the town was 12116 which increased to 32518 in 2011 which shows the sprawl of the town Almora (Census, 2011).
ii. To increase the groundwater table spring sanctuary development program should be started. In the spring sanctuary development program, an area is declared as a reserved area and treatment measures (i.e., technical, social, and biological measures) are applied to augment the groundwater table.[15]
iii. For the rejuvenation of spring, the spring rejuvenation program should be started. The spring rejuvenation measure differs from the spring sanctuary measure in the context of the time, cost, and measures.
iv. A comprehensive public awareness program should be initiated in the society to motivate local people to use spring water.
v. The quality of spring water should be tested by the government at timely.
vi. Efforts should be made to keep the springs clean and pollution-free and Dirty drains flowing near the springs must be moved elsewhere by the local governing body.

7. CONCLUSION:

The traditional water sources (natural springs) of the Almora town have been studied in this research work. Due to climate change and human activities, the traditional water sources of the study area are drying and depleting

very steadily. For instance, there were 100 perennial springs in the study area in 1842 which has decreased to 69 by 1995 while in 2019 the number of perennial springs has come down to only 43. The study reveals that 26 springs have become non-perennial during the last 25 years. It reveals that every year minimum one perennial spring has transformed into non-perennial spring. The study shows that the natural springs of the study area are dying steadily. The study recommends the spring rejuvenation or spring revival program for the sustainability of natural springs and water security of Almora town.

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