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MAJOR DETERMINANTS AND INVENTORY OF NATURAL WATER SPRINGS IN KHARAHAL REGION OF KULLU DISTRICT: A GEOGRAPHICAL ANALYSIS

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Abstract

Natural water springs are geological formations where groundwater is discharged onto the surface of the earth. They occur when the groundwater travels through permeable rocks and soils and reaches the surface, either as a trickle or as a powerful flow. Springs are found all over the world and are often associated with areas of geological activity, such as volcanic regions or mountain ranges. This research paper is based on the major determinants and inventory of natural water springs in kharahal region of kullu district. The main objectives of this research paper are to study the major determinants of natural water springs and prepare an inventory of water springs in the study area. This research paper is based on both primary and secondary data. Primary data has been obtained by the researchers from an in-depth field survey of the entire study area and secondary data has been obtained from various secondary sources such as Niti Aayog report, Indian Census Report, Panchayat office, bhuvan portal, geological survey of India, Sentinel-2 satellite etc. After the collection of data, data tabulation, compilation, analysis and presentation has been done through statistical methods, maps and diagrams. The maps are constructed by using ArcGIS and Q-GIS software and the diagrams are created by using Microsoft excel. This study has concluded that, there are 71 natural water springs in total 10 panchayats in the study area. In conclusion, the natural water springs in Kharahal region are a vital resource for the local communities and ecosystems. However, they face several threats, including pollution, deforestation, climate change, over-extraction, and unsustainable tourism. Therefore, it is essential to identify and prioritize the determinants of the springs' health and develop an inventory of the springs in the district. The determinants of spring health may include factors such as topography, geology, rainfall, land use, and land cover. By understanding these factors, it is possible to assess the potential risks to the springs and develop appropriate management strategies.

KEYWORDS *– ArcGIS, Determinants, Inventory, Kharahal region, Major threats, Natural springs, Q-GIS.*

Introduction

Natural water springs are geological formations where groundwater is discharged onto the surface of the earth. They occur when the groundwater travels through permeable rocks and soils and reaches the surface, either as a trickle or as a powerful flow. Natural water springs are often valued for their purity and are considered important sources of drinking water. Many people also visit springs for their therapeutic properties, as the mineral content of the water can have healing effects on the body. Additionally, springs can provide important habitats for a variety of plant and animal species, as well as contribute to the overall health of surrounding ecosystems. Natural water springs are formed by natural groundwater discharge emerging out of joints, pores, fissures and fractures, where an aquifer or water-bearing layer intersects with the earth surface. The site of the emergence of water is known as the orifice of spring (Kresic & Stevanovic, 2009). Springs are the most important source of high-quality freshwater for the Himalayan communities in such regions. More then 60–70% of the Indian Himalayan region peoples directly depends on springs to meet domestic and livelihoods needs (NITI Aayog, 2018b; Siddique et al., 2019). The erratic rainfall pattern, ecological degradation and seismic activity associated with land use/land cover change for infrastructural development is posing huge pressures on mountainous aquifer systems. It is reported that 50% of the perennial springs have already dried up or have become seasonal resulting into intense water shortage for drinking and other domestic purposes across hundreds of Himalayan villages. Continued crisis will consequently affect lives of millions of people in the mountains. (Inventory and Revival of Springs in Himalayas for Water Security, Report-2017)

Objectives

1. To study the major determinants of natural water springs.
2. To prepare the inventory of natural water springs in the study area

Study Area

Kharahal region is one of the major regions of Kullu district, Himachal Pradesh. The region lies between 31˚90′ to 32˚00′ north latitude and 77˚11′ to 77˚ 17′ east longitude. It is bounded on the north by Kais village and east by Kashawri village, on the south east by Bhrain village, on the south by Jia Village, on the west by Beas River. Its geographical area is 32.24 square kilometer. The total population of this region is 15609 and total number of families are 2585.

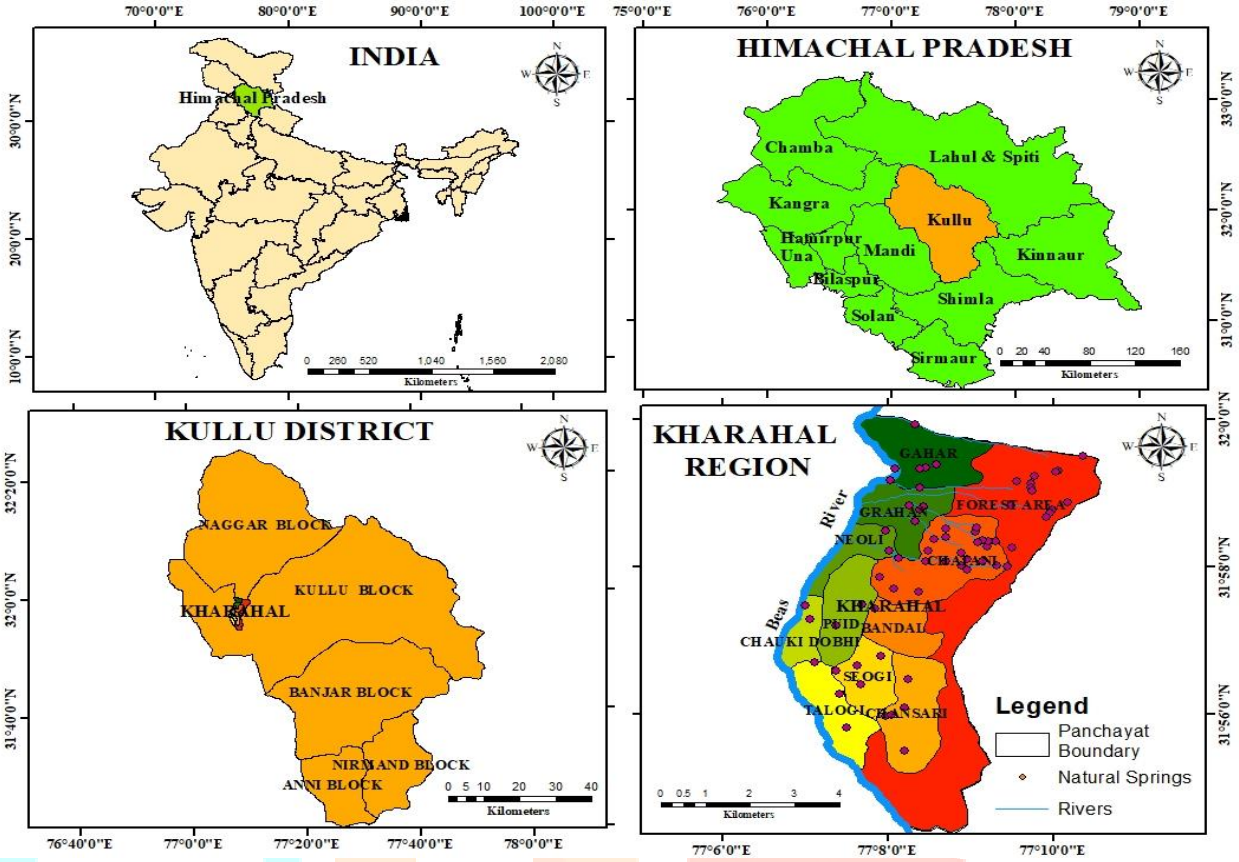


Figure – 1 Location map of the study area

Database and Methodology

Selection of the Problem

Natural water springs in the study area are the main sources of pure drinking water, but these springs have not been studied so far, so this topic has been selected by the researcher. So that these springs can be studied and protected.

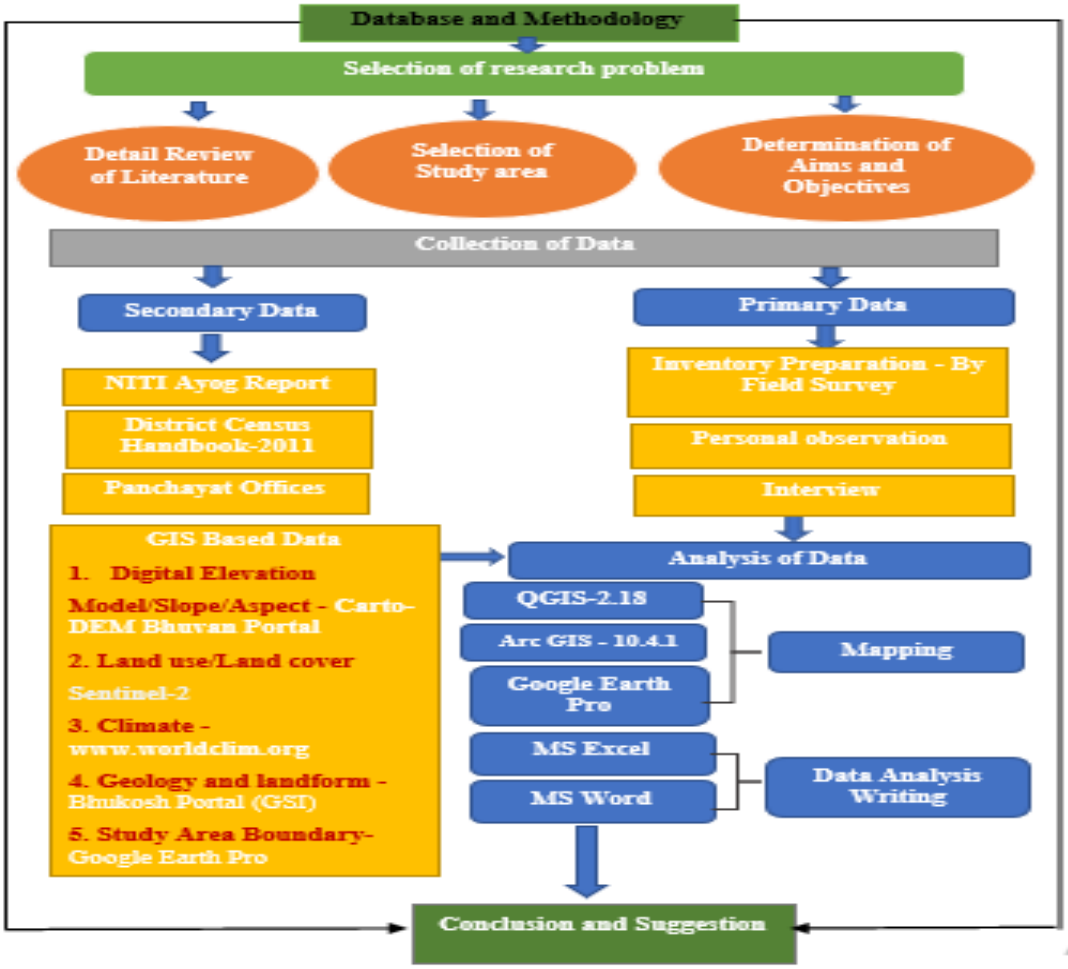


Figure – 2 Database and methodology

Data Collection

Secondary data has been obtained from various secondary sources. Elevation, Slope and Aspect data obtained from Carto-DEM Bhuvan Portal, Land use Land cover data from Sentinel-2 satellite, Climate data from www.worldclim.org, Geology and landform data from Geological Survey of India, Himalayan spring data from NITI AayogReport-2017, and the data related to the study area has been obtained from District Census Book 2011 and Panchayat Office. Apart from this, the primary data has been obtained by the researchers by conducting an in-depth field survey. The Spring Inventory has been prepared on the basis of an in-depth study of each spring by the researcher. Water discharge is measured in liters per minute by the researcher during field study in the study area. Liters per day is calculated by multiplying liters per minute by 1440 because there are 1440 minutes in a day. Liters per month is calculated by multiplying liters per day by the number of days in the month and liters per year is calculated by multiplying liters per month by the total months of the year.

Data analysis and Representation

After collection of data, the data has been analyzed through maps and diagrams. Data analysis has been done by Microsoft excel software and mapping by Arc GIS 10.4.1and Q-GIS 2.18 software. In the writing of this research paper, help has been taken from various government reports, books and research papers.

Result and Discussion

1. Determinants of Springs in the Study Area

Natural water springs are formed when underground water is forced to the surface by geological or hydrological processes. The major determinants of natural water springs in the Kharahal region include:

2.1 Geological Structure and Landform Features

The geological structure of the surrounding land is a major determinant of natural water springs. Springs typically form in areas where underground water flows through permeable rock layers or along faults and fractures in the bedrock. Most of the terrain of the study area is made up of rocks of Paleoproterozoic age, mainly rocks like gneiss, schist, phyllite, feldspar quartz etc. The

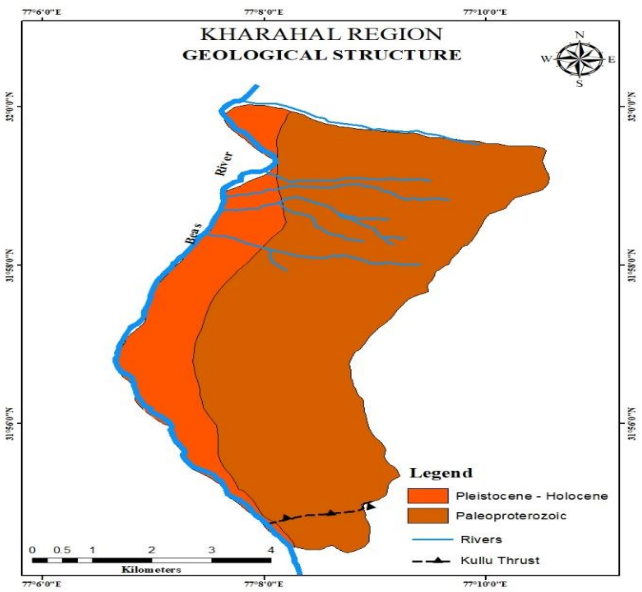


Figure – 3 Geological structure

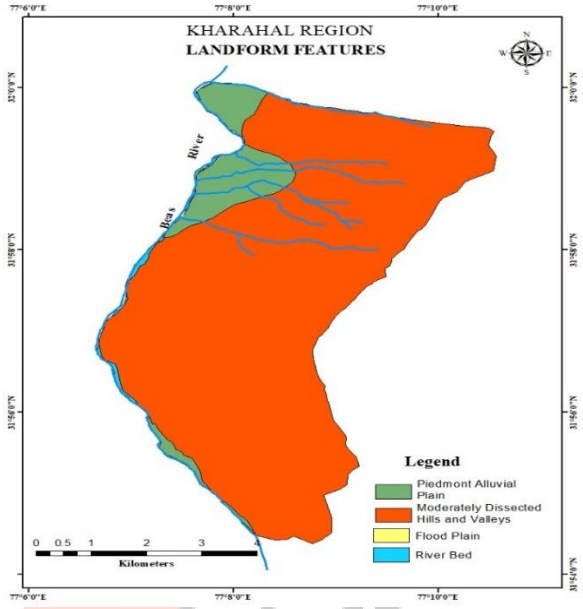


Figure – 4 Landform features

western part of the study area is made up of glacier and river deposits of the Pleistocene-Holocene age. (Figure – 3)

Most of the terrain of the study area are made up of Moderately Dissected Hills and Valleys but its northwest and southwest terrain is made up of alluvial piedmont plain, in addition, a small part in its northwest is made up of flood plain formed by the river. (Figure – 4). The number of natural springs is more in the northern and central part of the study area because of the dominance of Permeable rocks in this area and the number of rivers is more and most of the area is covered with snow due to which the number of springs is more here.

2.2 Topographical Features

The topography of the surrounding land plays a significant role in determining the location and characteristics of a natural water spring. Springs are often found in areas where the land slopes downward, creating a natural pathway for underground water to flow to the surface.

2.2.1 Altitude

The study area is a completely mountainous area, which is situated between the height of 1107 meters to 2970 meters above sea level, the height of its eastern part is high and the height of the western part is low, here there are 21 natural springs between the height of 1107-1600 meters, 23 natural springs are located between the height of 1600-2000 meters, 15 springs are located between the height of 2000-2400 meters and 13 natural springs are located in the height of more than 2400 meters. The main reason for the high number of springs in the middle and low altitude areas is that in the high-altitude areas, the snow melts and gets stored in aquifers, which appear as springs near the lower parts of the mountains or near the foothills. (Figure – 5)

2.2.2 Slope

The slope is very high in the north, north-eastern and southern parts of the study area and very low in the north-west and western parts of the study area. The slope in the central region is low and normal. Most of the spring numbers are located in the normal and low gradient area. The number of springs is less in the areas of very steep and very low slope and the number of springs located in the areas of high slope is normal. (Figure – 6)

Figure – 5 Altitudinal zones

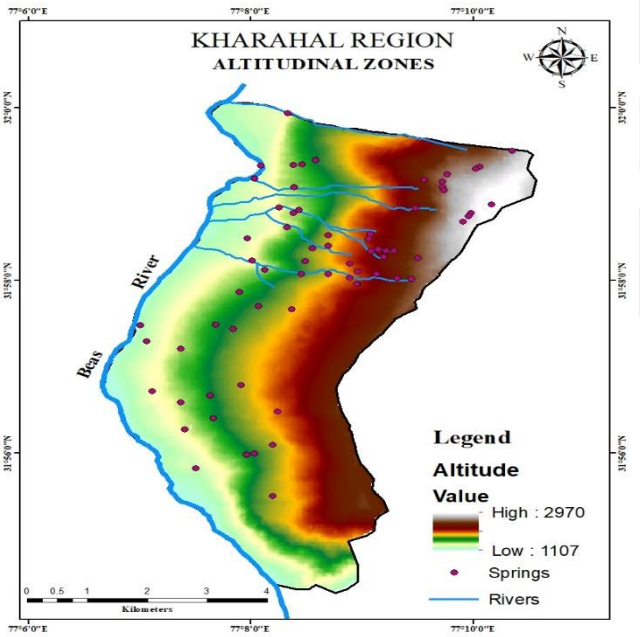
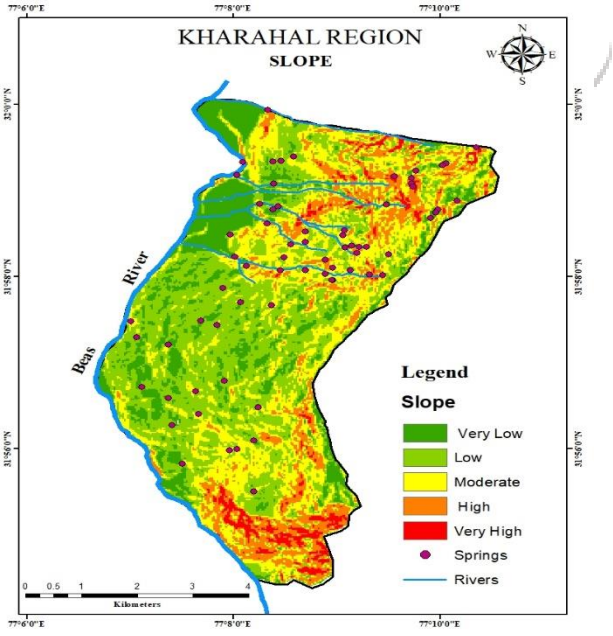


Figure – 6 Slope



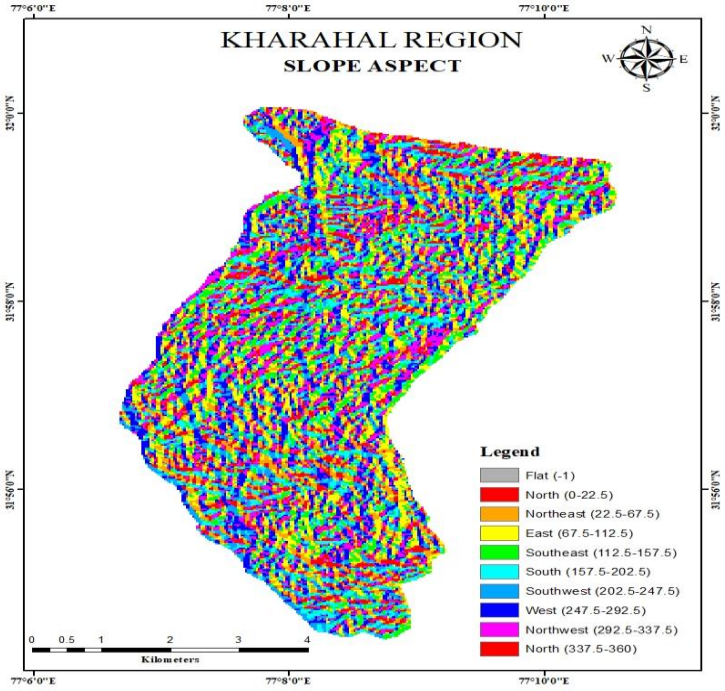


Figure – 7 Slope aspect

2.3 Land use and Land cover

The type and density of vegetation in the surrounding area can also affect the formation of natural water springs. Plants help to capture and retain water in the soil, which can increase the

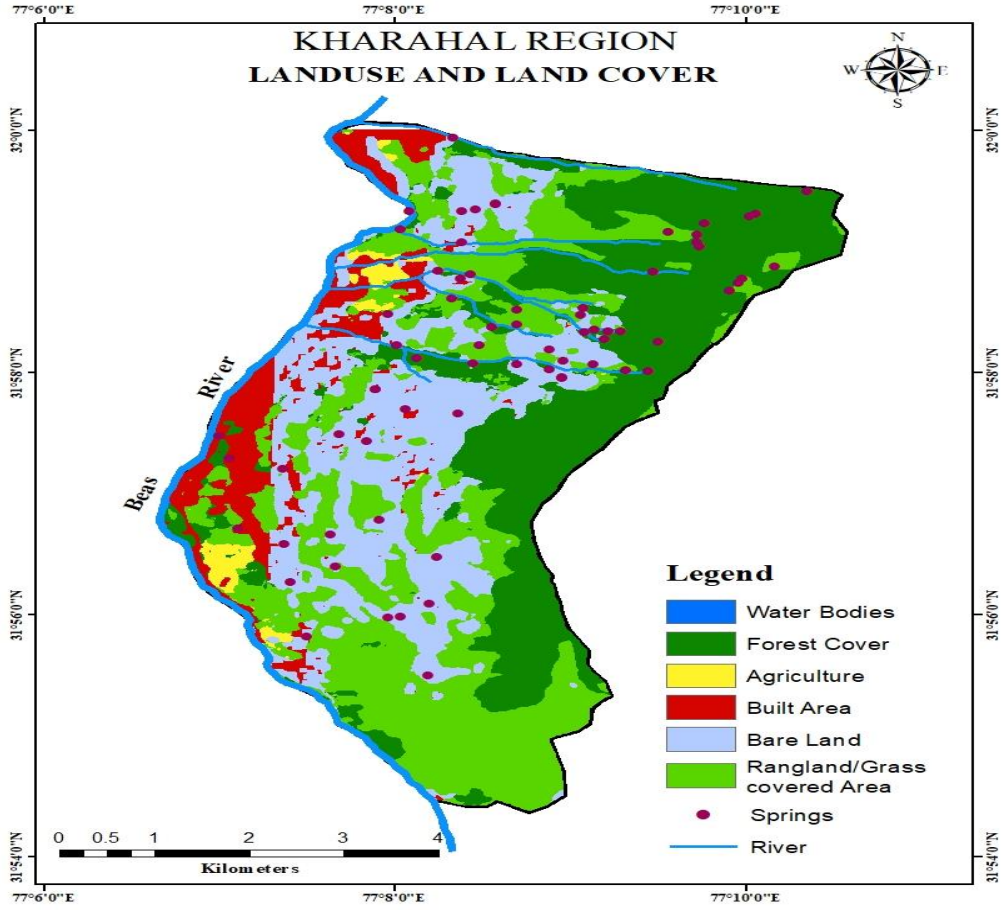


Figure – 8 Land use and land cover

amount of groundwater available and potentially lead to the formation of a spring. The northeastern and eastern parts of the study area are covered with thick deodar, silver fir and oak trees, while most of the southern, central and northern parts are covered with rangeland or grassland. Its western, northwestern and some part of the central land is covered with human habitation, some part of the central and northwest is covered with barren land. Here, most of the springs are around the vegetation area and grassland area, while their number is less around built-up areas and barren land. Out of the total number of springs in this region, the area of about 32 springs are surrounded by horticulture (artificial vegetation) land, in addition to this, 18 springs are surrounded by natural vegetation, 9 springs surrounded by barren land, 7 springs surrounded by human settlements and 5 springs surrounded by grassland. (Figure – 7)

2.4 Climate

The climate of an area can also impacts the formation of natural water springs. Areas with high levels of precipitation or snowmelt tend to have more springs as the excess water flows underground and is forced to the surface. The temperate climate is found in the study area. Its western and south-western parts have warm temperate climate in the parts with an altitude of 1107-1600 m, cold temperate climate in the eastern part with altitude above 2400 m and cold temperate climate in the central part with 1600-2400 m. This area is located near Kullu town where the average summer temperature is 10-26˚C and winter temperature is 8.5-11˚C. The average annual rainfall here is up to 1110.2 mm. (Figure – 8)

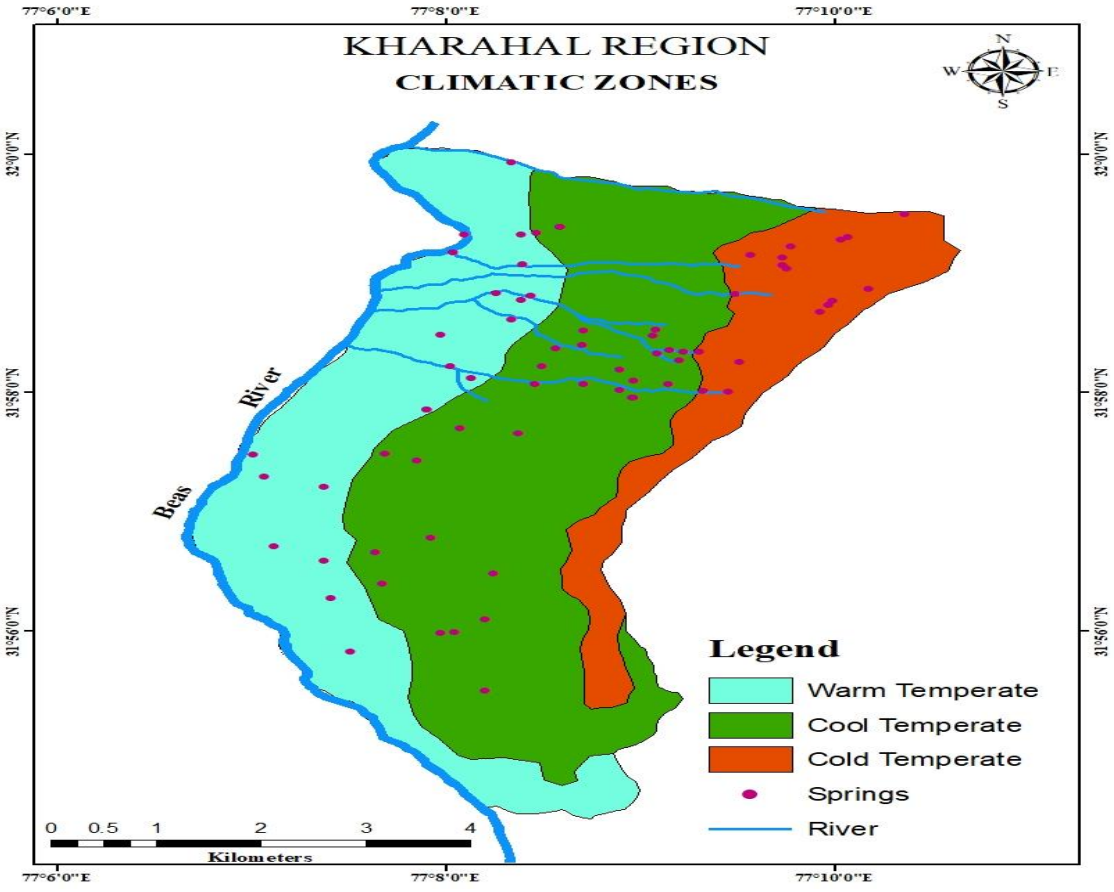


Figure – 9 Climatic zones

The region receives rainfall in both summer and winter. The rainfall in summer are from the south-west monsoon and in winter from the western disturbance. The rainfall in summer is more than that in winter. In winter, the precipitation is in the form of snow, due to which the northern and north-eastern parts of the region are covered with snow. Its northern, southern and eastern parts have a steeper slope, due to which the rain water here flows directly through the surface flow, while its western and central land has a gentle and normal slope, due to which most of the water in this area goes underground, due to which the number of springs is more in this area.

2.5 Population and Human Activity

Human activity can also impact the formation and flow of natural water springs. Activities such as drilling, mining, and construction can alter the geological structure and hydrological processes of an area, potentially affecting the availability and quality of groundwater and spring water. At present, there are 15609 people living in total 10-gram panchayats of Kharahal region. Between 1200 to 2000 people live in all the gram panchayats. Here the population density per square kilometer is 484 persons. Here only 2-gram panchayats, Neoli and Chowki Dobhi, have a population density of more than 1000 people, while in all other gram panchayats, 500 to 1000 people live per square kilometer. (Table – 1 & figure – 10,11)

Table-1 Gram Panchayat Wise Population Distribution and Density in Kharahal Region

S. No.	Name of Gram Panchayat	Population	Population Density
1	Gahar	2029	707
2	Grahan	1642	798
3	Neoli	1488	1279
4	Puid	1450	675
5	Chauki dobhi	1250	1228
6	Talogi	1530	714
7	Seogi	1350	834
8	Chansari	1450	520
9	Bandal	1280	834
10	Chatani	2140	571
11	Forest area	0	0
Total		**15609**	**484**

Source: - Panchayat office, 2022

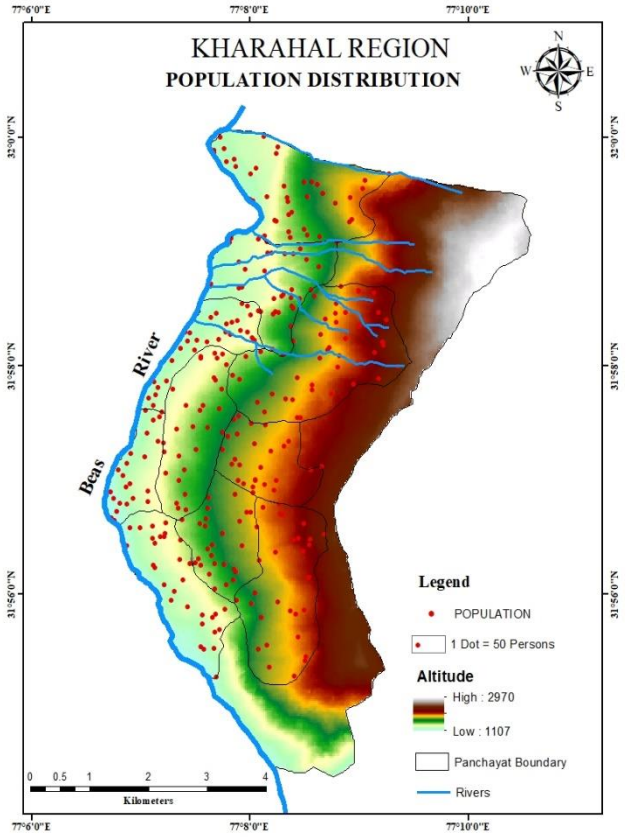


Figure – 10 Population distribution

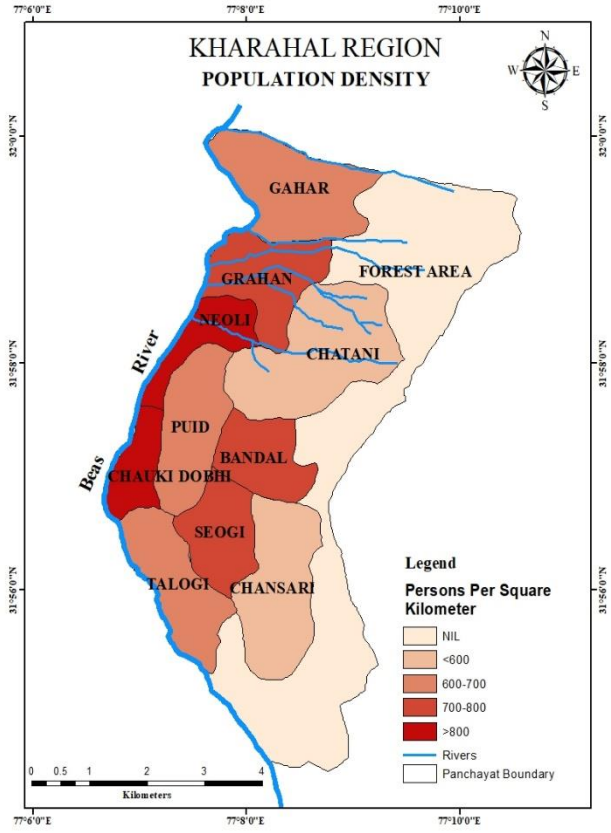


Figure – 11 Population density

Majority of the population of the study area resides in the northwest and west of the region. Its eastern, north eastern and southern parts are unpopulated and the population is normally distributed in the central part. The population density is also the highest in the west-located Neoli, Chowki Dobhi and Grahan gram panchayats. In any area where population and population density are high, the number of natural springs is less, whereas in its north-eastern and central part, population and human activities are less, due to which the number of princes in this area is more.

2. Spring Inventory of Kharahal Region

Water spring inventory refers to a comprehensive list of water springs within a specific geographic area, such as a region or a watershed. The inventory typically includes information on the name, location, altitude, water discharge rate, water quality, spring surrounding conditions and other characteristics of each spring. Water spring inventories are important for managing and protecting water resources, as they provide valuable information for assessing the quantity and quality of available water, identifying potential water sources for human and ecological use, and developing strategies for sustainable water management. In addition, water spring inventories can be used for monitoring changes in water resources over time and identifying potential threats to water quality or availability. Out of total 71 natural water springs in the study area, 60 are perennial, which have water throughout the year, 6 are seasonal, which have water only in the rainy season and there is a shortage of water in the dry

season. Along with this, 5 springs have completely dried up, which were perennial earlier but currently do not have water in any season. There are 45 springs under the jurisdiction of the local community and 3 springs in the forest area which is under the jurisdiction of the state forest department, besides three springs are in the private jurisdiction which is owned by an individual. Out of the total number of springs in this region, the area of about 32 springs are surrounded by horticulture (artificial vegetation) land, in addition to this, 18 springs are surrounded by natural vegetation, 9 springs surrounded by barren land, 7 springs surrounded by human settlements and 5 springs surrounded by grassland. The total water discharge in all the 71 springs of the study area is 189.66 liters per minute, along with this, 273111.84 liters per day, 8193355.2 liters per month and 2990574648 liters per year. (Table - 2).

Table – 2 Panchayat Wise Natural Water Spring Inventory of Kharakal Region

S. No.	Name of Spring	Altitude	Nature of Spring	Spring Ownership	Spring Water Discharge				Spring Surrounding Condition	Gram Panchayat
					Liter/Minute	Liter/Day	Liter/Month	Liter/Year		
1	Kuhadi	2087	Perennial	Community	0.24	345.6	10368	124416	Horticulture	Chatani
2	Dhaunsi Paut	1738	Perennial	Community	3.98	5731.2	171936	2063232	Horticulture	Chatani
3	Mankhadi	1726	Dry	Community	-	-	-	-	Horticulture	Chatani
4	Bargo	1994	Perennial	Community	1.52	2188.8	65664	787968	Horticulture	Chatani
5	Manari	2097	Seasonal	Individual	3.91	5630.4	168912	2026944	Horticulture	Chatani
6	Kufri	2262	Dry	Community	-	-	-	-	Natural Vegetation	Chatani
7	Lari	2188	Perennial	Community	1.23	1771.2	53136	637632	Natural Vegetation	Chatani
8	Deeman	2269	Perennial	Community	0.27	388.8	11664	139968	Natural Vegetation	Chatani
9	Kotaseri	2057	Perennial	Individual	1.52	2188.8	65664	787968	Horticulture	Chatani
10	Kot	1870	Perennial	Individual	-	-	-	-	Horticulture	Chatani
11	Koshnala	1805	Perennial	Community	3.84	5529.6	165888	1990656	Settlement	Chatani
12	Badhayi	1988	Perennial	Community	0.78	1123.2	33696	404352	Horticulture	Chatani
13	Badhayi-1	1988	Perennial	Community	2.42	3484.8	104544	1254528	Horticulture	Chatani
14	Tundi Ra Nala	1681	Perennial	Government	0.091	131.04	3931.2	47174.4	Barren Land	Chatani
15	Chhanga	1537	Perennial	Community	1.62	2332.8	69984	839808	Barren Land	Chatani
16	Chhanga-1	1538	Perennial	Community	0.98	1411.2	42336	508032	Horticulture	Chatani
17	Shilu	1483	Perennial	Community	5.39	7761.6	232848	2794176	Horticulture	Chatani
18	Chatani	2010	Perennial	Community	0.49	705.6	21168	254016	Horticulture	Chatani
19	Badlogi	1864	Perennial	Community	4.82	6940.8	208224	2498688	Horticulture	Chatani
20	Kochhan Pani	1810	Perennial	Government	1.27	1828.8	54864	658368	Horticulture	Chatani
21	Bhakhal	1706	Perennial	Community	4.93	7099.2	212976	2555712	Horticulture	Chatani
22	Narantni	2242	Perennial	Community	1.21	1742.4	52272	627264	Horticulture	Chatani
23	Dhaunsi Nala	2161	Perennial	Government	3.2	4608	138240	1658880	Barren Land	Chatani
24	Thaig Nala	2118	Perennial	Government	3.91	5630.4	168912	2026944	Barren Land	Chatani
25	Malanbai	1876	dry	Community	-	-	-	-	Horticulture	Chatani
26	Dharth	1980	Seasonal	Community	-	-	-	-	Settlement	Chansari
27	Pechha	1824	Perennial	Community	-	-	-	-	Settlement	Chansari

28	Mahish	1810	Perennial	Community	5.23	7531.2	225936	2711232	Settlement	Chansari
29	Tharku	1672	Perennial	Community	2.41	3470.4	104112	1249344	Horticulture	Chansari
30	Lower Tharku	1607	Perennial	Government	0.99	1425.6	42768	513216	Horticulture	Chansari
31	Chanjar	1350	Perennial	Community	0.98	1411.2	42336	508032	Settlement	Chauki Dobhi
32	Chanjar-1	1290	Perennial	Community	7.66	11030.4	330912	3970944	Horticulture	Chauki Dobhi
33	Hargundhar	1240	Perennial	Community	2.73	3931.2	117936	1415232	Horticulture	Chauki Dobhi
34	Gahar	1653	Perennial	Community	6.31	9086.4	272592	3271104	Horticulture	Gahar
35	Gahar-1	1653	Perennial	Community	6.31	9086.4	272592	3271104	Horticulture	Gahar
36	Gahar-2	1653	Perennial	Community	9.98	14371.2	431136	5173632	Horticulture	Gahar
37	Gahar-3	1504	Perennial	Community	7.78	11203.2	336096	4033152	Horticulture	Gahar
38	Banki	1469	Perennial	Government	5.38	7747.2	232416	2788992	Barren Land	Gahar
39	Seobagh	1383	Perennial	Government	3.27	4708.8	141264	1695168	Natural Vegetation	Gahar
40	Sarudu	1251	Perennial	Government	3.12	4492.8	134784	1617408	Barren Land	Gahar
41	Sarudu-1	1120	Perennial	Government	4.47	6436.8	193104	2317248	Barren Land	Gahar
42	Grahan	1465	Seasonal	Community	-	-	-	-	Horticulture	Grahan
43	Jagot	1480	Perennial	Community	1.75	2520	75600	907200	Horticulture	Grahan
44	Shadhara	1514	Perennial	Community	7.32	10540.8	316224	3794688	Natural Vegetation	Grahan
45	Disco	1345	Perennial	Community	1.74	2505.6	75168	902016	Natural Vegetation	Grahan
46	Puid	1612	Perennial	Community	5.81	8366.4	250992	715392	Settlement	Puid
47	Bhaunbai	1614	Perennial	Community	4.79	6897.6	206928	393984	Barren Land	Puid
48	Seogi	1790	Perennial	Community	3.86	5558.4	166752	2001024	Settlement	Seogi
49	Beogi	1663	Perennial	Community	4.81	6926.4	207792	2493504	Horticulture	Seogi
50	Bari Padhru	1457	Perennial	Community	6.89	9921.6	297648	3571776	Settlement	Seogi
51	Jhaul	1612	Perennial	Community	1.28	1843.2	55296	663552	Horticulture	Seogi
52	Neoli	1313	Perennial	Community	5.9	8496	254880	3058560	Settlement	Neoli
53	Juani	1371	Perennial	Community	4.31	6206.4	186192	2234304	Natural Vegetation	Neoli
54	Nagoni	1696	Perennial	Community	1.37	1972.8	59184	710208	Barren Land	Bandal
55	Talogi	1299	Perennial	Community	2.28	3283.2	98496	1181952	Natural Vegetation	Talogi
56	Trambli	1438	Perennial	Community	3.32	4780.8	143424	1721088	Horticulture	Talogi
57	Aahni Thach	2626	Perennial	Government	3.31	4766.4	142992	1715904	Natural Vegetation	Forest Area
58	Aahni Thach-1	2615	Perennial	Government	0.6	864	25920	311040	Natural Vegetation	Forest Area
59	Aahni Thach-2	2603	Seasonal	Government	0.77	1108.8	33264	399168	Natural Vegetation	Forest Area

60	Aahni Thach-3	2587	Dry	Government	-	-	-	-	Natural Vegetation	Forest Area
61	Gobha	2597	Dry	Government	-	-	-	-	Natural Vegetation	Forest Area
62	Khunti Ruadi	2597	Perennial	Government	1.6	2304	69120	829440	Natural Vegetation	Forest Area
63	Khunti Ruadi-1	2615	Seasonal	Government	0.25	360	10800	129600	Natural Vegetation	Forest Area
64	Sanyara Thach	2490	Perennial	Government	0.23	331.2	9936	119232	Grass land	Forest Area
65	Khadak Nala	2251	Perennial	Government	1.21	1742.4	52272	627264	Natural Vegetation	Forest Area
66	Sarumaru	2444	Perennial	Government	4.01	5774.4	173232	2078784	Natural Vegetation	Forest Area
67	Deemnu Pani	2460	Perennial	Government	1.1	1584	47520	570240	Natural Vegetation	Forest Area
68	Mahut	2788	Perennial	Government	2.21	3182.4	95472	1145664	Grass land	Forest Area
69	Mahut-1	2787	Perennial	Government	2.56	3686.4	110592	1327104	Grass land	Forest Area
70	Mahut-2	2786	Seasonal	Government	1.38	1987.2	59616	715392	Grass land	Forest Area
71	Soilang	2958	Perennial	Government	0.76	1094.4	32832	393984	Grass land	Forest Area
Average water discharge					189.661	273111.84	8193355.2	98320262.4		

Source: - Primary field survey, 2021-2022

3. Major Threats to Natural Springs

1. In the Kharahal region, 5 springs Gobha, Ahni Thach-3, Kufri, Malanbai and Mankhadi have become completely dry. Earlier there was water in these springs throughout the year but at present they have become dry. Among these, Ahni Thach-3, Kufri and Gobha Spring have become dry due to road construction and Malanbai and Mankhadi have become dry due to human activities.
2. The natural water springs in Kharahal region are at risk of pollution from human activities such as dumping of garbage, discharge of untreated sewage, and use of pesticides and fertilizers in nearby agricultural fields.
3. Deforestation can lead to soil erosion and loss of vegetation cover, which can affect the recharge of groundwater and the flow of water in the springs.
4. Climate change can lead to changes in precipitation patterns, which can affect the recharge of groundwater and the flow of water in the springs. It can also increase the frequency and intensity of extreme weather events such as floods and droughts, which can impact the water quality and quantity in the springs.
5. Over-extraction of water from the springs for domestic, agricultural, and industrial purposes can lead to a decrease in the water table and the flow of water in the springs.
6. The growing tourism industry in Kharahal region can put pressure on the natural water springs. Tourists can contribute to pollution, littering, and over-extraction of water from the springs.

Conclusion

Out of total 71 natural water springs in the study area, 60 are perennial, which have water throughout the year, 6 are seasonal, which have water only in the rainy season and there is a shortage of water in the dry season. Along with this, 5 springs have completely dried up, which were perennial earlier but currently do not have water in any season. There are 45 springs under the jurisdiction of the local community and 3 springs in the forest area which is under the jurisdiction of the state forest department, besides three springs are in the private jurisdiction which is owned by an individual. Out of the total number of springs in this region, the area of about 32 springs are surrounded by horticulture (artificial vegetation) land, in addition to this, 18 springs are surrounded by natural vegetation, 9 springs surrounded by barren land, 7 springs surrounded by human settlements and 5 springs surrounded by grassland. The total water discharge in all the 71 springs of the study area is 189.66 liters per minute, along with this, 273111.84 liters per day, 8193355.2 liters per month and 2990574648 liters per year. In conclusion, the natural water springs in Kharahal region are a vital resource for the local communities and ecosystems. However, they face several threats, including pollution, deforestation, climate change, over-extraction, and unsustainable tourism. Therefore, it is essential to identify and prioritize the determinants of the springs' health and develop an inventory of the springs in the district. The determinants of spring health may include factors such as topography, geology, rainfall, land use, and land cover. By understanding these factors, it is possible to assess the potential risks to the springs and develop appropriate management strategies. An inventory of the springs in Kharahal region can help to identify the number, location, and characteristics of the springs. This information can be used to develop a comprehensive management plan that includes

measures to conserve and protect the springs. The management plan can also include strategies to raise awareness among the local communities and stakeholders about the importance of the springs and the need to protect them.

Suggestions for Conservation of Natural Water Springs

1. A comprehensive management plan is necessary to ensure the sustainable use and conservation of the springs. The plan should include measures to monitor and manage the springs, such as regular water quality testing, identification of pollution sources, and groundwater recharge programs.
2. The local communities should be involved in the conservation of the springs. Awareness programs and education campaigns can be conducted to inform the communities about the importance of the springs and the need to protect them. The involvement of local communities can also help to prevent illegal activities such as over-extraction and pollution of the springs.
3. The extraction of groundwater should be regulated to prevent over-extraction, which can affect the flow and quality of water in the springs. The authorities can implement policies and regulations to limit the extraction of groundwater, especially during periods of low rainfall.
4. Measures should be taken to reduce pollution of the springs. This can include banning the dumping of waste near the springs, regulating the discharge of untreated sewage, and enforcing laws to prevent the use of pesticides and fertilizers near the springs.
5. The tourism industry in Kul Kharahal region can put pressure on the natural water springs. Sustainable tourism practices such as limiting the number of visitors and regulating the activities near the springs can help to minimize the impact of tourism on the springs.
6. Deforestation can affect the recharge of groundwater and the flow of water in the springs. Therefore, afforestation programs should be promoted to restore the vegetation cover and protect the springs from soil erosion.
7. Research studies can be conducted to understand the hydrogeology and ecology of the springs in Kharahal region. The results of these studies can be used to develop effective conservation strategies and management plans.

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