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DYNAMICS IN DRINKING WATER QUALITIES AND ACCESSIBILITY IN THE RURAL AREA OF THE EASTERN HISSAR DISTRICT

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Abstract: Water is an important natural resource that acts as the backbone for every living thing to survive. India accounts for 4 percent of fresh water, according to the Water Resources Information System, but this varies with the distribution of water. However, changing trends in drinking water quality and access have already been studied. The project's primary goal is to examine the trends in drinking water quality over a 25-year period in each block of the study region. The second objective is to study the underground water level in the study area so that we can get information about the rise or fall of the ground water level in the last twenty-five years. The study's third goal is to identify the source of drinking water and the distance travelled by households to obtain it. Eastern Hisar district is facing the problem of water logging, so the quality of drinking water is low in this area. There are many other factors contributing to the low quality of drinking water, such as excessive use of fertilisers in agriculture, lack of awareness, urbanisation, mismanagement of water, digging toilets (cutcha), borewells, etc. The purpose of the research was to evaluate the local drinking water's quality, accessibility to homes, and changes in ground water levels. It is helpful to make people aware of modern technology for water conservation, policies by the government to improve water facilities, and self-treatment of drinking water at home.

Keywords: Resource; Water-logging; Underground; Self-treatment; Eastern Hissar.

1. Introduction

The most important natural resource is water. About 0.32 percent of total water is usable fresh drinking water, which is very low and may be in dangerous condition, including in India, in a few decades. India has a wide variety of geographical locations, some of which struggle with water scarcity and water logging. A sizable section of the populace in Eastern Hissar's rural districts was impacted by the unavailability and poor quality of drinking water. The main freshwater reservoir is made up of groundwater, which needs specific consideration due to the system as a whole. The quality of groundwater needs special consideration; otherwise, serious consequences may result. It becomes vital to permanently employ natural resources to satisfy requirements in the current setting of global changes in the natural and cultural environment. Water is the most important natural resource that all living things need to survive. Organising a water awareness programme for the management and conservation of water in a rural area, educating people about the conventional techniques for filtering water with alum (fitkari) stone, and moving water from a region with abundant water resources to a region with dedicated water resources are just a few options for handling this issue. According to the UN, a fresh water shortage will affect more than half of the world's population over the next four to five years. Therefore, it is crucial to look into how quality and amenities are evolving in the study region's rural areas.

2. Study area

The study region of Eastern Hisar in Hisar district extends from 28.95 degrees north to 29.48 degrees north latitude and from 75.75 degrees east to 76.31 degrees east longitude. The research area is located in the state of Haryana's western region. It has Eastern Hisar in the north, which touches the Fatehabad district in the north; Bhiwani district in the south; Jind districts in the east; Rohtak district in the south-east; and Eastern Hisar in the west, which is adjacent to Rajasthan, respectively. Eastern Hisar consists of the four tehsils, i.e., Barwala, Bass, Hansi, and Narnaund. It consists of four community development blocks, i.e., Barwala, Hansi-I, Bass (Hansi-II), and Narnaund. Hansi-I block consists of 58 villages; Hansi-II block consists of 19 villages; Barwala block consists of 38 villages; and Narnaund block consists of 29 villages.

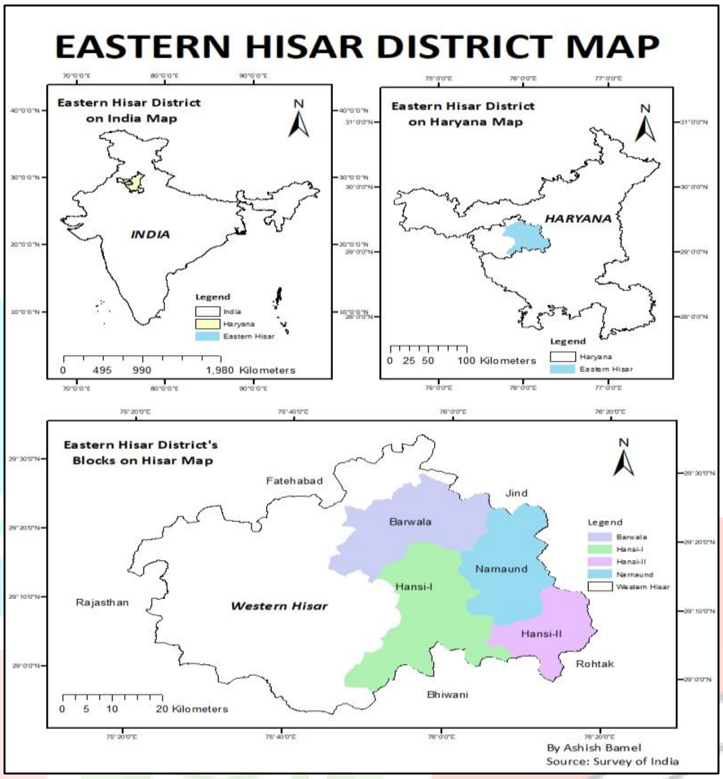

Figure 2.1: Study Area Map

Hisar district consists of alluvial plains, flood plains, aeolian plains, and fluvio-aeolian plains, in which dune complexes exist. The flood plain, which comprises fluvial deposits, has flat to gently sloping strips of land. This zone demarcates the extent to which water overflows the riverbanks during floods. The fluvio-aeolian plains are spread across the western part of the district. This alluvial plain is a comparatively low-lying area and occupies a major part of the district. It is basically part of the Indo-Gangetic plain and was created by the deposition of sands by the Saraswati River. It is covered by very hard, fine loamy soils and has good groundwater potential.

The area of Hisar is 3738 square kilometres, which is the 2nd biggest district of the state. It is part of the alluvial Ghaggar-Yamuna plain at an average elevation of 215 metres above mean sea level. Hisar consists 17.4 lakhs population according of census 2011 and 2nd largest populated district after Faridabad. Hisar experiences extremely hot summers and comparatively cold winters due to its continental climate. Koppen claims that the climate of Hisar is of the Cw type. Hisar's climate is characterised mostly by dryness, temperature extremes, and little rainfall. The highest daily temperature fluctuates between 41° and 45° Celsius in the summer and between 1° and 5° Celsius in the winter. The city of Hisar is situated on the southernmost edge of the southwest monsoon belt. The annual rainfall averages 43 cm, with July and August seeing the greatest proportion of that total.

3. Objective

- To explore the groundwater quality and spatial-temporal dynamics of drinking water quality.
- To look at how the situation with drinking water sources is changing.
- To determine the distance that families must walk to get drinking water.
- To offer recommendations for improvements in water conservation and drinking water quality.

4. Research techniques

Both primary and secondary data are used in this investigation. A village-level household survey was used to gather the primary data. Respondents used a well-organised programme to discover how people felt about the quality of drinking water. The quality of drinking water had been lab-tested in water samples. The town and village directories, district census handbook, and groundwater yearbook had been used to collect secondary data.

Sample villages and households were chosen to reflect the entire study region using a multi-stage random selection procedure. The district's governmental divisions are based on block size. Using a multi-stage random sampling technique, sample villages and households were chosen to represent the entire study region. The governmental divisions of the district are based on block size.

Table 4.1: Sample Area

Blocks	Sample Villages
Barwala	Dhad, Ghyanpura
Hansi-I	Kharkara
Hansi-II	Khanda kheri, Madan heri, Ugalan
Narnaund	Gabinagar, Mirchpur, Sulchani

Many kinds of statistical tools, such as average, percentage, maxima, and minima, will be utilised for the analysis of the data tabulation method, and the data will be represented using cartographic tools like maps, tables, and diagrams, among others.

5. Quality of ground water

To ascertain whether groundwater is suitable for the intended application, it is crucial to concentrate on its physical, chemical, and biological properties. Ground water is a significant resource for drinking, irrigation, and industrial uses in the majority of Haryana State's rural and semi-urban areas, particularly in places where surface water is insufficient or non-existent.

Table 5.1: Chemical Constituents in Groundwater (2023)

Blocks	EC (uS/cm)	Chloride (mg/L)	Nitrate (mg/L)	Fluoride (mg/L)
Barwala	750-3000	below 250	above 45	1.00-1.50
Hansi-I	below 750	below 250	above 45	above 1.50
Hansi-II	below 750	250-1000	below 45	below 1.00
Narnaund	below 750	250-1000	below 45	1.00-1.50

Electrical conductivity (EC) in drinking water is permitted to have a maximum concentration of 750 uS/cm at 25 degrees Celsius by the Bureau of Indian Standards (BIS). In light of this limit, we discovered that the EC limit in the Hansi-I, Hansi-II, and Narnaund blocks is less than 750; however, the EC level in the Barwala block has been determined to be between 750 and 3000 uS/cm, so it ought not to be taken.

Due to these aesthetic considerations, 250 mg/L of chloride is the preferred level set by BIS for drinking water. Chloride (Cl) concentrations exceeding 400 mg/L give water a salty taste. In the absence of a source with the desired concentration, this limit can be raised to 1000 mg/L. It has been discovered that the water in the Barwala and Hansi-I blocks is within the acceptable limit of chloride for drinking. As opposed to this, Hansi-II and Narnaund block any water that has chloride levels above the safe drinking water limit.

Nitrate (NO3) can only have a maximum concentration of 45 mg/L in drinking water, according to BIS. When taking this limit into account, it is discovered that the water in the Hansi-II and Narnaund blocks has nitrate levels below 45 mg/L. In contrast, the water in the Hansi-I and Barwala blocks had nitrate levels of 45 mg/L.

According to BIS, fluoride (F) concentrations in drinking water should not exceed 1.0 mg/L; 1.50 mg/L is acceptable; and 1.50 mg/L or above is harmful. It has been discovered that while the water in the Hansi-II block has fluoride levels below 1 mg/L, those in the Barwala and Narnaund blocks are between 1 mg/L and 1.50 mg/L. Fluoride levels in the Hansi-I block are higher than 1.50 mg/L.

6. Spatial-temporal dynamics in quality of drinking water according to people responses

For the past 25 years, the situation with regard to the pattern of altering drinking water quality has improved. We can see that people were previously unaware of the detrimental consequences of filthy and salty water on their health, but that scenario is now changing, based on a personal survey done in the research region. In addition, the rural residents in the research area have become much more knowledgeable about the quality of drinking water over the past 25 years. The Hansi-I block had the lowest level of drinking water quality that we could find, which was quite concerning given that just 13.3 percent of individuals drank pure water at the time. However, 81.01 percent of individuals in the Narnaund block drink pure water, which is the maximum in the study area. In this part, each of the four rural blocks in the Eastern Hissar district is explored separately.

Table 6.1: Dynamics in drinking water quality in rural Barwala block (in %)

Quality	At Present	Before 5 years	Before 10 years	Before 15 years	Before 25 years
Pure	50.9434	33.96226	18.86792	9.433962	7.54717
Acidic	0	0	0	0	0
Salty	47.16981	50.9434	66.03774	60.37736	47.16981
Alkaline	1.886792	1.886792	1.886792	1.886792	1.886792
Heavy TDS	0	0	0	0	0
No response	0	13.20755	13.20755	28.30189	43.39623
Source: Personal survey of villages 2023					

25 years ago, the quality of the drinking water was at its absolute worst at the rural Barwala block facilities. Only 7.5 percent of people drank clean water at the time, compared to 47.1 percent who drank salty water, 1.88 percent who drank alkaline water, and 43.3% who had no idea. But today, only around 51% of people drank pure, clean water, and there were no changes in the proportion of people who drank salty or alkaline water.

Table 6.2: Dynamics in drinking water quality in rural Hansi-I block (in %)

Quality	At Present	Before 5 years	Before 10 years	Before 15 years	Before 25 years
Pure	13.33333	13.33333	0	0	0
Acidic	0	0	0	0	0
Salty	66.66667	66.66667	100	100	100
Alkaline	0	0	0	0	0
Heavy TDS	20	20	0	0	0
No response	0	0	0	0	0
Source: Personal survey of villages 2023					

Initially, 25 years ago, the drinking water quality was the lowest at the facilities in the rural parts of Hansi-I block. People back then drank salted water. However, during the past five years, 20.0% of individuals have consumed water with high TDS levels, 66.7% have used salty water, and just 13.33 percent have used clean water.

Table 6.3: Dynamics in drinking water quality in rural Hansi-II block (in %)

Quality	At Present	Before 5 years	Before 10 years	Before 15 years	Before 25 years
Pure	80.90909	78.18182	76.36364	37.27273	37.27273
Acidic	0	0	0	0	0
Salty	5.454545	5.454545	5.454545	27.27273	27.27273
Alkaline	0	0	0	0	0
Heavy TDS	13.63636	10.90909	13.63636	0.909091	0
No response	0	5.454545	4.545455	34.54545	35.45455
Source: Personal survey of villages 2023					

25 years ago, only 37.5 percent of individuals in the Hansi-II block's rural regions drank pure water, 27.2 percent drank salty water, and 35.5 percent were unaware of the time. Today, however, only roughly 80.9% of people use pure, clean water for drinking, whereas 5.45% use salty water and 13.6% use water with high TDS levels.

Table 6.4: Dynamics in drinking water quality in rural Narnaund block (in %)

Quality	At Present	Before 5 years	Before 10 years	Before 15 years	Before 25 years
Pure	81.01266	68.35443	27.8481	11.39241	5.063291
Acidic	1.265823	1.265823	0	0	0
Salty	16.4557	26.58228	48.10127	41.77215	32.91139
Alkaline	1.265823	1.265823	3.797468	3.797468	2.531646
Heavy TDS	0	0	0	0	0
No response	0	2.531646	20.25316	43.03797	59.49367
Source: Personal survey of villages 2023					

In the rural areas of the Narnaund block 25 years ago, just 5% of residents drank clean water, 32.9% drank salty water, 2.3% drank alkaline water, and 59.4% had no notion. Today, however, just 81.01 percent of people drink clean water, 16.4 percent consume salty water, 1.26 percent consume acidic water, and 1.26 percent use alkaline water.

Table 6.5: Dynamics in drinking water quality in Study Area (in %)

Quality	At Present	Before 5 years	Before 10 years	Before 15 years	Before 25 years
Pure	56.54962	48.45796	30.76992	14.52477	12.4708
Acidic	0.316456	0.316456	0	0	0
Salty	33.93668	37.41172	54.89839	57.35556	51.83848
Alkaline	0.788154	0.788154	1.421065	1.421065	1.10461
Heavy TDS	8.409091	7.727273	3.409091	0.227273	0
No response	0	5.298435	9.501542	26.47133	34.58611
Source: Personal survey of villages 2023					

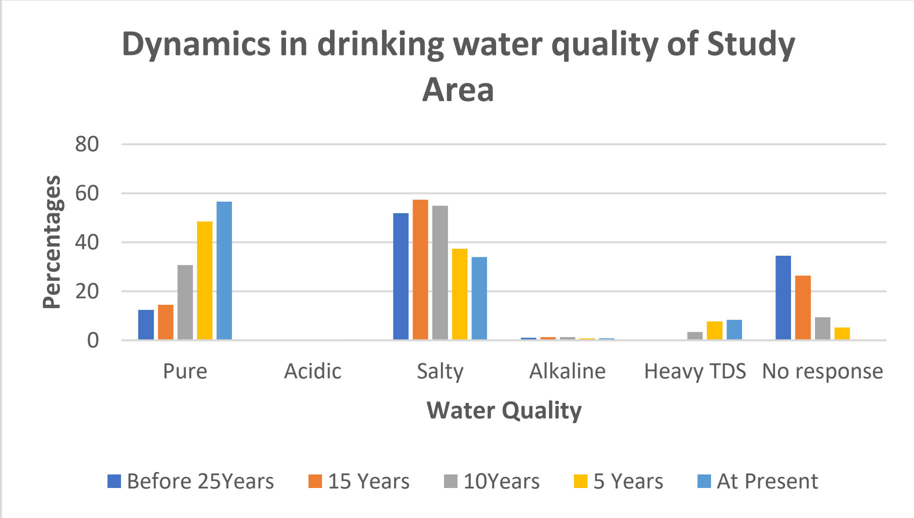

Figure 6.1: Dynamics in drinking water quality of study area

In the rural areas of the Eastern Hissar district, we can observe an increase in the percentage of people who use pure water for drinking from 12.4 to 56.4, a decrease in the percentage of people who use salty water from 51.8 to 33.9, and a decline in the percentage of people who drink alkaline water from 1.1 to 0.78. Currently, 13.6% of people consume water with high TDS, while 0.3 % of people drink acidic water.

7. Changing scenario of drinking water sources

Over the past 25 years, the geography of drinking water sources has altered, which has had an impact on the circumstance. A personal survey that was conducted in the research region revealed that whereas wells and handpumps were once the only sources of drinking water available, individuals are now turning to private wells, public supplies, campers, tankers, and other sources.

Table 7.1: Dynamics in drinking water sources in Barwala block (in %)

Sources	At Present	Before 5 years	Before 10 years	Before 15 years	Before 25 years
Hand pump	48.15	53.7	51.85	55.56	53.7
Wells	3.704	5.556	7.4	24.07	38.89
Private Tap	0	0	0	0	0
Govt. Supply	37.04	35.18	37.04	20.37	7.4
Tanker	0	0	0	0	0
Camper	11.11	5.56	3.7	0	0
No response	0	0	0	0	0
Source: Personal field survey of villages 2023					

Table 7.2: Dynamics in drinking water sources in Hansi-I block (in %)

Sources	At Present	Before 5 years	Before 10 years	Before 15 years	Before 25 years
Hand pump	23.08	30.77	76.92	7.69	7.69
Wells	0	0	23.08	92.3	92.3
Private Tap	0	0	0	0	0
Govt. Supply	53.85	53.85	0	0	0
Tanker	0	0	0	0	0
Camper	23.08	15.38	0	0	0
No response	0	0	0	0	0
Source: Personal field survey of villages 2023					

Table 7.3: Dynamics in drinking water sources in Hansi-II block (in %)

Sources	At Present	Before 5 years	Before 10 years	Before 15 years	Before 25 years
Hand pump	26.55	24.78	21.24	20.35	19.47
Wells	0.88	0.88	2.65	14.16	13.27
Private Tap	4.42	1.77	1.77	0	0
Govt. Supply	15.93	16.81	22.12	51.33	47.79
Tanker	9.73	10.62	7.96	0	0
Campers	42.48	42.48	40.7	0	0
No response	0	2.65	3.54	14.16	19.47
Source: Personal field survey of villages 2023					

Table 7.4: Dynamics in drinking water sources in Narnaund block (in %)

Sources	At Present	Before 5 years	Before 10 years	Before 15 years	Before 25 years
Hand pump	34.83	39.33	20.22	7.86	2.25
Wells	5.62	12.36	38.2	56.18	64.04
Private Tap	6.74	6.74	0	0	0
Govt. Supply	33.71	26.97	32.58	24.72	21.35
Tanker	12.36	3.371	0	0	0
Campers	6.74	6.74	0	0	0
No response	0	4.49	8.99	11.24	12.36
Source: Personal field survey of villages 2023					

We found that hand pumps were mostly used by the people of Barwala block, wells inside Hansi-I block were used most, and government supplies in Hansi-II block were used most 25 years ago. But now the wells are rarely used for drinking water sources in all blocks.

Table 7.5: Dynamics in drinking water sources in Study Area

Sources	At Present	Before 5 years	Before 10 years	Before 15 years	Before 25 years
Hand pump	33.46	35.69	29.74	22.68	20.07
Wells	2.97	5.576	16.36	33.83	39.03
Private Tape	4.09	2.97	0.74	0	0
Govt. Supply	27.88	25.65	27.51	33.83	28.62
Tanker	8.18	5.58	3.35	0	0
Campers	23.42	21.93	17.84	0	0
No response	0	2.6	4.46	9.66	12.27
Source: Personal field survey of villages 2023					

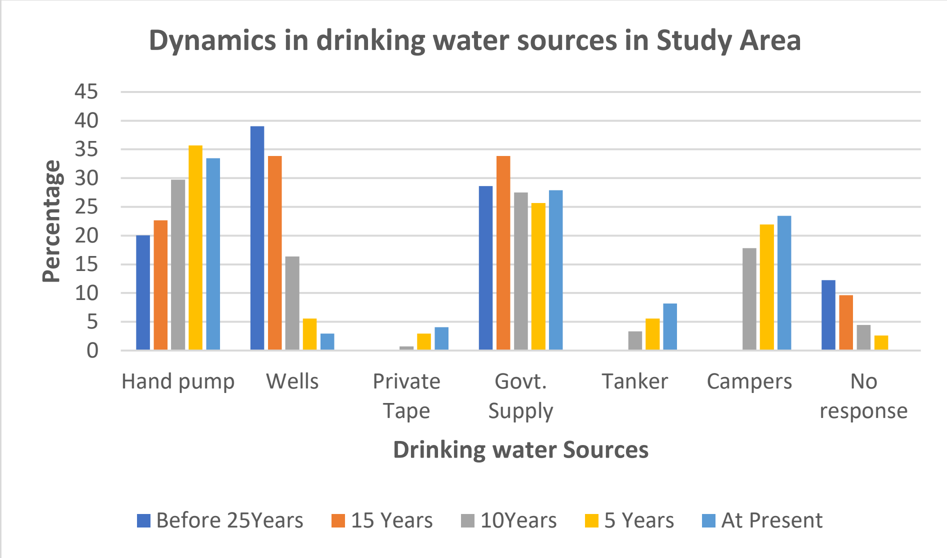

Figure 7.1: Dynamics in drinking water sources in Study Area

In this figure no. 3, we found that in the last 25 years, in our study area, hand pumps, private tape, tankers, and campers have been used more for drinking water. Not much change is observed in the use of the government supply for drinking water because the quality of the water that is delivered through the government supply is bad and cannot be used directly without any treatment. Well, now it is being seen that the practise of using wells for drinking water is ending. We can also assume the reason behind this is that a lot of chemical fertilisers are being used in fields, due to which the quality of underground water is decreasing.

8. Distance that families must walk to get drinking water

In India, a growing nation, homes in rural areas do not have access to drinking water supply facilities. Because of this, most villagers' residents must travel far to access the source of potable water. As a result, it takes longer than an hour to get drinking water at home.

Table 8.1: Distance that families must walk to get drinking water from source (in meters)

Sources	Barwala	Hansi-I	Hansi-II	Narnaund	Study Area
At home	55.17	53.33	73.11	75.49	69.39
Below 100	3.45	0	0	10.78	4.42
100-500	0	0	8.4	9.8	6.8
500-1000	3.45	20	3.36	2.94	4.08
Above 1km	37.93	26.67	15.13	0.98	15.31
Source: Personal survey of villages 2023					

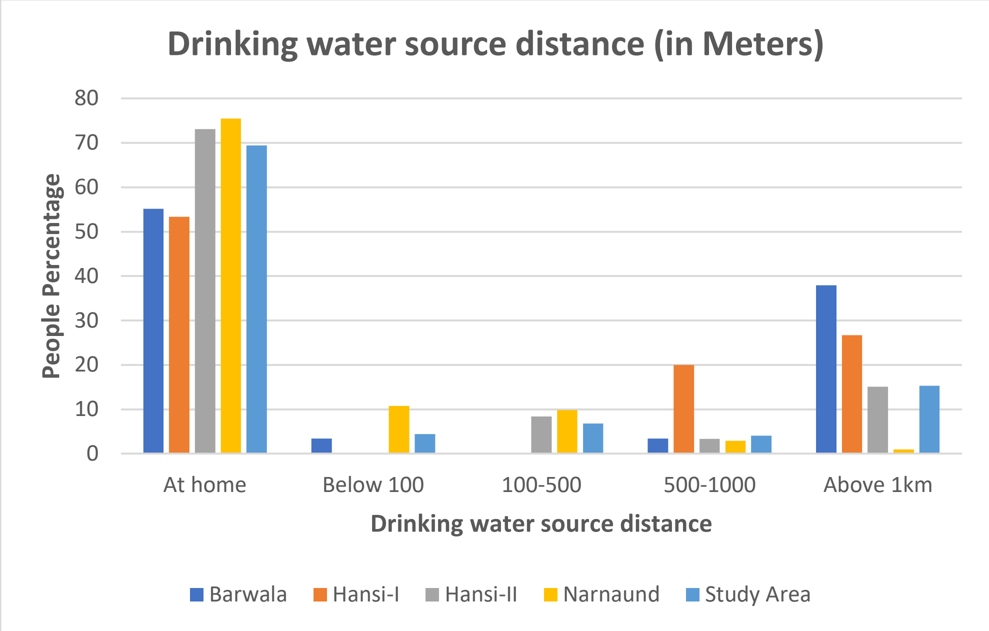

Figure 8.1: Drinking water source distance

According to Table No. 10, drinking water facility in the household is observed at its maximum inside rural areas of Narnaund block and at its minimum inside rural areas of Hansi 1 block. Within rural areas of Barwala Block, around 55.17% of people have drinking water facilities at home; 3.45% have to travel about 100 metres to get drinking water; 3.45% of individuals must walk between half a km and one km to access drinking water; and about 38% of individuals must travel more than a km to acquire drinking water from a source near their residence. If we talk about the rural areas of Hansi-I block, then 53.33% of people have drinking water facilities at home, 20% have to travel half to 1 km, and 26.67% must travel more than one kilometre to acquire water at home. If we talk about the rural areas of Hansi-II Block, 73.11% of people have drinking water facilities at home; 8.4% have to travel a distance of 100 to 500 metres; 3.36% have to travel a distance of half to 1 km; and 15.13 percent have to cover a distance of more than 1 km to bring drinking water home. If we talk about rural areas of Narnaund block, 75.49% of people have drinking water facilities at home, 10.78% have to cover distances up to 100 metres, 9.8% cover distances of 100 to 500 metres, 2.94% have to travel a distance of 500 to 1000 metres, and approximately 1% of individuals must walk more than a km to receive water at home. If we talk about our study area, 69.39% of people have drinking water facilities at home, 4.42% have to travel up to 100 metres for drinking water, 6.8% have 100 to 500 metres, about 4% have to travel a distance of half to 1 km, and 15.3% of people must walk more than one km to access drinking water at home.

9. Recommendations for improvements in water conservation and drinking water quality

We can employ the following approaches and methods to raise the standard and amenities of drinking water in rural regions:

The latrine digs are unripe from the bottom in rural places. Because of this, the quality of subsurface drinking water degrades, and waste gets diluted with underground water aquifers. Therefore, we need to inform the local population that latrine pits will be cemented, including the bottom.

The government must move quickly to provide drinking water supply pipe connections to every residence in rural regions, and the frequency of daily water delivery must be established.

For humanitarian initiatives, emergency aid, and disaster relief, the Sky Hydrant water filtration device is a portable, long-lasting, and reasonably priced water filtration system. The World Health Organisation's standards for safe drinking water are met by this low pressure, high-flow ultrafiltration technology. This can be used at the macro level for three to five villages simultaneously.

A cheap option for areas that might otherwise lack access to clean drinking water is the Cambodia (RDIC) ceramic water filter. RDI manufactures and sells water filters all across Cambodia, using resources and manufacturing techniques from the country. A ceramic filtering system may be built and installed for around $10 US using materials that are readily available locally, according to detailed technical information that is being made available by RDI. This method is particularly helpful in areas without power or in which people are ignorant about germs and water-borne ailments.

Water that is secure and safe to drink and use every day is delivered by the Compact Reverse Osmosis Desalination System. The systems can clean germs, viruses, arsenic, and metals out of pools, rivers, wells, etc. Since the pumps are either manually operated or powered by an engine, no energy supply is needed. The systems have a daily water capacity of 250–5000 people.

The M-Drop is a ceramic tablet that purifies drinking water for homes in an all-natural, affordable way. The pill eliminates waterborne germs and shields families from disease. The M-Drop pill eliminates 99.9999% of waterborne microorganisms that can lead to illness, disease, and death by releasing silver ions into the water. The M-Drop is installed in the home's primary water collection and storage unit, and water (up to 10 litres per day) is poured into the container. Water is safe to drink after 10 to 24 hours. The M-Drop can stay in the unit for up to six months as long as water is added and used every day. This is repeated every evening. It is simpler for individuals to adopt it into their routine for purifying water because it does not chemically alter the flavour or smell of the water. Additionally versatile, portable, and simple to store, the M-Drop.

In essence, the Bio-Sand Filter is a container with some graded sand and gravel within. Water is poured into the top of the device and passes through the sand filtering medium. Predation in the biological layer and the sand's function as a natural mechanical barrier both contribute to the biological improvement of the raw water. The mould unit is a high-quality, all-steel construction that was constructed to exacting standards. The exploded view below shows the following as the key components of the mould unit: The puller, an inner mould, and an exterior mould come first.

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