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Original Research Paper

Water Quality of Traditional Drinking Water Sources in Outer Himalayas - A Case Study of Hamirpur District, H.P.

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ABSTRACT

The study deals with the analysis of waters from traditional sources of drinking water like wells, baories and khatries in the Hamirpur district of Himachal Pradesh. Average pH value of the samples for the wells and baories is less than 7.0, but more than 7.0 for khatries. The average value of electrical conductivity for the wells and baories is much higher than the value for the khatries. Total alkalinity value for all the sources is almost the same. The total hardness value for the khatries is slightly more than the value for the wells and baories. The chloride content for the khatries is slightly higher than the value for the wells and baories. The calcium value of khatries is slightly higher than wells and baories. Bacteriological contamination is more in wells and baories than khatries. The water in 60% wells, 55% baories and 36% khatries is contaminated and not fit for human consumption.

INTRODUCTION

Himachal state has a very traditional, social and cultural heritage of conservation and judicious use of water that helped the people to survive over the centuries against all odds of the environment. Various water harvesting structures and techniques like baories, dug well, khatries, ponds, choes, springs, etc. were practiced to suit particular site conditions. A unique system of khatries was followed in some parts of the state for judicious use of rain water harvesting.

Though the piped water supply has been provided to almost every habitation, the level of service delivery is far from satisfactory besides mounting operation and maintenance cost. There is heavy misuse of water by the public residing near the storage tanks and the tail-ender is the major sufferer. They hardly get a few buckets of water during summer months and at that time they have no option but to bring water from traditional drinking water sources. Since most of the drinking water sources have been polluted, people using this water suffer from waterborne diseases. Many instances of water pollution have recently been reported in newspapers of the region (Thakur 2002), (Amar Ujala 2002) and Dainik Bhaskar (2002). Severe pollution of Hathli stream in Himachal Pradesh has been reported by Sharma et al. (2003).

As there is dearth of literature on water quality of the area, the present study was undertaken to assess the exact level of physico-chemical and bacteriological parameters of traditional drinking water sources of Hamirpur district. The study deals with the water quality of wells, baories and khatries.

STUDY AREA

Hamirpur is one of the 12 districts of Himachal Pradesh. It is having a geographical area of 1118

square kilometres and lies at 31°25'N latitude and 76°18' to 76°44' east longitude. The elevation varies from 400m to 1100 m. The district in the north is bound by River Beas which separates it from Kangra district. The area falls in Shiwalik hills of lower Himalayas. The middle and upper Shiwalik are the recent deposits, which constitute the main geological formations. The Shiwalik hills represent layered sequence of sandy rocks deposited in the floor plains of the area. The water table in the area varies from 30 to 50m below ground level. The main natural recharge to the groundwater is from precipitation and influent seepage from streams during rainy seasons with maximum contribution from rainfall. The rainfall varies from 1100 mm to 1900 mm per year.

MATERIALS AND METHODS

The present study is based on the data collected from Hamirpur district of Himachal Pradesh. Thirty samples for each source, i.e, wells, baories and khatries were collected in Hamirpur district from the traditional drinking water sources just to get a first hand information relating to their water quality. These samples were analysed for physico-chemical and bacteriological parameters.

Keeping in view the fact that concentration does not change rapidly, grab samples were collected. The polythene containers were used for collecting sample for analysis. Every container was first rinsed with a brush and phosphate free detergent and with cold tap water and then with distilled water three times. Standard methods (APHA 1992) were followed for sample handling and analysis in the laboratory for analysing temperature, pH, conductivity, turbidity, total alkalinity, total hardness and chloride.

RESULTS AND DISCUSSION

Water quality analysis of dug wells: The summary of results, i.e., maximum, minimum and mean concentrations of different constituents of water samples analysed from the wells are given Table 1. It has been observed that the pH value of water lies between 4.10 and 8.10 with the average value of 6.59 indicating slightly acidic nature of water. 25% of the samples have pH value beyond the acceptable limits laid down by IS: 10500. The electrical conductivity value varies from 390 to 1190 μmho/cm with only one sample having conductivity value above 1000 μmho/cm, indicating low mineralisation in the region. The value of turbidity in samples varies from 0 to 900 NTU indicating presence of suspended and colloidal matter. 47% of the samples have turbidity values beyond the acceptable limits laid down by IS: 10500. The total alkalinity as $CaCO_3$ varies from 140 to 525 mg/L with average value of 246 mg/L indicating alkaline nature of water in the area. Present findings are more akin to those of Sharma & Sharma (Sharma 2002) for spring water of the area.

The total hardness varies from 140 to 300 mg/L with average value of 214 mg/L, indicating hard water. 71.0% of the samples have total hardness more than 200 mg/L, indicating very hard water (WHO 1991). The chloride content ranged from 14 to 77 mg/L having average value of 35 mg/L, indicating low chloride content in the area. The calcium content varied from 18 to 104 mg/L with average value of 47 mg/L indicating high concentration. H_2S test has shown the presence of coliforms in 60% of the samples indicating contamination of water. The study has revealed that 60% of the wells are contaminated and their water is not fit for human consumption.

Water quality analysis of baories: The summary of results, i.e., maximum, minimum and mean concentrations of different constituents of the water samples is given in Table 2. It has been observed that the pH value of water lies between 3.22 and 7.67; the average value is 6.3 indicating slightly acidic nature of water. 44% of the samples have pH value beyond the acceptable limits laid down by

Table 1: Summary of water quality results for dug wells.

Parameters	Range	Mean	Standard limits Acceptable Limit	IS: 10500-1991 Permissible Max. Limit	Percentage of traditional water sources exceeding acceptable limits of the standards
pH	4.10-8.10	6.59	7.0-8.5	6.5-9.2	25.0%
Electrical conductivity (μmho/cm)	390-1190	626	-	-	-
Turbidity (NTU)	0-900	33.4	2.5	10	47%
Total alkalinity as $CaCO_3$, (mg/L)	140 -525	246	200	600	78.0%
Total hardness as $CaCO_3$, (mg/L)	140-300	214	200	600	71.0%
Chloride, (mg/L)	14-77	35	200	1000	Nil
Calcium (mg/L)	18-104	47	75	200	8.0%
H_2S test			0	0	60%

Table 2: Summary of water quality results for baories.

Parameters	Range	Mean	Standard limits Acceptable Limit	IS: 10500-1991 Permissible Max. Limit	Percentage of traditional water sources exceeding acceptable limits of the Standards
pH	3.22 - 7.67	6.30	7.0-8.5	6.5-9.2	44.0%
Electrical conductivity (μmho/cm)	310 - 822	560	-	-	-
Turbidity (NTU)	0-4	0.6	2.5	10	0.0%
Total alkalinity as $CaCO_3$, (mg/L)	145-300	218	200	600	60.0%
Total hardness as $CaCO_3$, (mg/L)	165 - 280	212	200	600	72%
Chloride (mg/L)	14-49	25	200	1000	Nil
Calcium (mg/L)	22-72	30	75	200	Nil
H_2S test			0	0	55%

Table 3: Summary of water quality results for khatries.

Parameters	Range	Mean	Standard limits Acceptable Limit	IS: 10500-1991 Permissible Max. Limit	Percentage of traditional water sources exceeding acceptable limits of the Standards
pH	7.46 - 8.30	7.86	7.0-8.5	6.5-9.2	Nil
Electrical Conductivity (μmho/cm)	172-977	340	-	-	-
Turbidity (NTU)	0-15	1.4	2.5	10	13%
Total alkalinity as $CaCO_3$, (mg/L)	160-270	219	200	600	36.0%
Total hardness as $CaCO_3$, (mg/L)	180-300	227	200	600	73%
Chloride (mg/L)	21-56	42	200	1000	Nil
Calcium (mg/L)	44-88	56	61	200	20%
H_2S test			0	0	36%

IS: 10500. The electrical conductivity value varied from 310 to 822 µmho/cm with no sample having conductivity value above 1000 µmho/cm. The value of turbidity in samples varied from 0 to 4 NTU indicating little presence of suspended and colloidal matter. The total alkalinity as $CaCO_3$ varied from 145 to 300 mg/L with average value of 218 mg/L indicating highly alkaline nature of water in the area.

Table 4: Comparison showing average values of parameters analysed for wells, baories and khatries.

Parameters	Wells	Baories	Khatries
pH	6.59	6.30	7.86
Electrical conductivity (µmho/cm)	626	560	340
Turbidity (NTU)	33.4	0.6	4.1
Total alkalinity (mg/L)	246	218	219
Total hardness (mg/L)	214	212	227
Chloride (mg/L)	35	25	42
Calcium (mg/L)	47	30	61
H_2S test found positive	60%	55%	36%

The total hardness varied from 165 to 280 mg/L with an average value of 212 mg/L, indicating hard water. 72% of samples have total hardness more than 200 mg/L, indicating very hard water (WHO 1991). The chloride content ranged from 14 to 49 mg/L; average value being 25 mg/L indicating low chloride content in the area. The calcium content varied from 22 to 72 mg/L with an average value of 30 mg/L, indicating high concentration. H_2S test has shown the presence of coliforms in 55% of the samples indicating contamination of water.

The study has revealed that 55% of the baories are contaminated and their water is not fit for human consumption.

Water quality of khatries: The results of the water analysis are given Table 3. The pH of waters lies between 7.46 and 8.30, the average value is 7.86 indicating slightly alkaline nature of water. None of the samples has pH value beyond the acceptable limits laid down by IS: 10500. The electrical conductivity varied from 172 to 977 µmho/cm. The value of turbidity in samples varied from 0 to 15 NTU indicating little presence of suspended and colloidal matter. The total alkalinity varied from 160 to 370 mg/L with average value of 219 mg/L, indicating highly alkaline nature of water in the area.

The total hardness ranged from 180 to 300 mg/L with an average value of 227 mg/L, indicating hard water. 73% of the sample had total hardness more than 200 mg/L, indicating very hard water (WHO 1991). The chloride ranged from 21 to 56 mg/L having an average value of 42 mg/L. The calcium content varies from 44 to 88 mg/L with an average value of 61 mg/L. H_2S test has shown the presence of coliforms in 36% of the samples indicating that water is not fit for human consumption.

The traditional water sources are in the state of neglect and need urgent repair. These sources are not being regularly cleaned and disinfected properly. It was found that 25% of the sources do not have proper arrangement to divert storm water. It is the general practice in the region that earthen pitchers are used to store and carry water from these sources. These pitchers are placed directly on the ground and sometimes even near the cowsheds. These pots are generally not cleaned from outside and are dipped directly into wells and baories, which is also one of the causes of pollution of water.

The study has shown that the average pH value of the samples analysed for the wells and baories is less than 7.0, whereas this value is more than 7.0 for khatries. The average value of electrical conductivity for the samples taken from the wells and baories is much higher than the value for the khatries. Total alkalinity value for all the sources is almost the same. The total hardness value for the khatries is slightly more than the value for the wells and baories. The chloride content for the khatries

is slightly higher than the corresponding value for the wells and baories. The calcium value for the khatries is a little higher than the value for the wells and baories (Table 4). The bacteriological contamination is more in wells and baories than in khatries.

CONCLUSIONS AND RECOMMENDATIONS

- The study has shown that there are number of traditional drinking water sources in this Himalayan belt. The main traditional sources for the drinking water in Hamirpur area are wells, baories and khatries.
- The water in 60% wells, 55% baories and 36% Khatries is contaminated and not fit for human consumption.
- Though the piped water supply has been provided to almost every habitation, the level of service delivery is far from satisfactory besides mounting operation and maintenance cost. There is heavy misuse of water by the public residing near the storage tanks and the tail-enders are the major sufferers. They hardly get a few buckets of water during summer months and at that time they have no option but to bring water from traditional drinking water sources. Since most of the drinking water sources have been polluted, people using this water suffer from waterborne diseases.
- Traditional water harvesting systems definitely have relevance in areas where water scarcity is acute or where ground water is too deep to obtain cheaply. However, in some areas a supplementary source may be necessary. Traditionally, in these areas people have developed cultural practices, which encourage judicious use of water but now these practices are dying. Water conservation education needs to be encouraged.
- Attempt to restore traditional systems must be based on a clear understanding of whether the conditions for their restoration are today present or not and whether it is or it is not possible to adopt these.

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