

Present Status of Different Water Sources and Potentiality of Rainwater as Potable Water: a Study on Some Selected Areas in Bangladesh

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Abstract

Present situation of different sources of water used for domestic purposes in the rural areas were studied where scarcity of potable water exists during the dry spell. Primary data were collected from five selected villages. The results of the study showed approximately 32 percent of ponds hold water round the year and most of them were polluted from different sources. Hand tube-well water was the main source of domestic water supply in the study areas but most of the wells were not productive during the dry spell of the year. As an alternative source rainwater seems to be the most viable solution for providing quality drinking water to rural areas in the developing countries. This study significantly indicated that about 45 percent people of the study areas were interested on rainwater. Galvanized steel made storage tank of capacity 2.5 m³ for supplying only the drinking water during dry period of the year was used to observe the variation of stored rainwater quality. The stored rainwater was found to be safe in terms of p^H and bacterial quality during six months of storage period.

Keywords : Rain water, Potable water

1. Introduction

Bangladesh is one of the most densely populated country in the world and located between latitude 20° 34' to 26° 38' N and longitude of 88° 1' to 92° 41' E. The climate of Bangladesh is dominated by Indian subcontinental monsoon system. Annual rainfall ranges in Bangladesh from 1400 mm in the North-West region to over 5000 mm in the North-East region. The average annual rainfall is about 2300 mm. More than 80 percent of the total annual rainfall occurs during the rainy season in four months from May to August. Water is the main drinking liquid used by the mass population for everyday consumption in Bangladesh. This water for drinking purpose is usually derived directly from the ground water source. Besides ground water, there is abundant water supply in ponds, rivers and canals in the rainy season. The water from these sources is not usually suitable for drinking. Drinking water for human consumption should be easily available, clean and free from contamination. Sometimes, the geographical location, topography, climate, unavailability of clean water and economic condition of people force them to drink contaminated water. Due to excessive exploitation of ground water for irrigation and city supply, manual water lifting devices become out of order during the dry seasons as the water table goes down out of reach of the devices. Moreover, a

remarkable area of the country is affected with groundwater contamination from arsenic (Hussain *et al.*, 2001). The problem of getting potable water is acute in the coastal areas located in the southern region of Bangladesh. All the water sources, even ground water, in those areas are salty and the people suffers a lot for getting potable water (Hussain and Ziauddin, 1991)

Rain is the source of all our water and it simply refers to water got as a result of rainfall. Rainwater is said to be pure if it has no any chemical or other impurities mixed with it. It is only when rainwater is passing over any surface that it collect along with anything which it can carry; soil particles, organic and inorganic matter, bacteria and other organisms which will make to lose its purity (Beekalaze, 1992).

Rainwater collection depends on the type of roof belongs to the villager. Usually three types of roof were common in the area: C.I. sheet roof, thatched roof and tiles roof. The common types of gutters made of C.I sheet, bamboo half, betel nut tree half or bark of banana plant can be used for collection of rainwater from roof run off. Considering socio-economic condition, it is necessary to develop facilities to store rainwater ensuring quality. In Bermuda a more consistently high rainwater quality with no *E. coliforms* detected and a maximum of 2 or 3 total coliform per 100 ml (waiter, 1982).

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The specific objectives of the study were to study the present situation of different water sources in the study areas and to assess the possibility of storing rainwater maintaining drinking quality.

2. Methodology

The survey for this study was conducted during the period from October 2000 to October 2001. Therefore, the survey covered both the rainy season as well as the dry season.

2.1 Selection of sites

Five villages at different locations namely Bilboka, Somnuk Bailor, Gonshampur, Bohuly and Akanpara of greater Mymensingh district were selected for the study purposively:

- (i) Preliminary survey showed that different sources of water were severely contaminated and people in those areas were suffering from different diseases.
- (ii) The people of these areas showed interest to collect and store rainwater as a source of safe potable water as an alternative source of drinking water.
- (iii) Most of the surface water sources were dried up during the end of the summer season and simultaneously the hand tube-wells did not discharge water due to large draw-down.

2.2 Available water sources: present status, usage and contribution

Survey results regarding the available water sources in the study areas are presented in simple tabular forms showing percentage of total.

2.3 The rainwater storage system

The portable type rainwater collector made of galvanized steel was used for single family, which collected water as an open sky water catchment system.

The size of storage tank depends on intensity of use and demand of drinking water, availability of roof area or collector area and intensity of rainfall in the area. The Galvanized steel made storage tank was used for observed variation of rainwater quality. The size of the storage tank was 2.5 m³ used for supplying only the drinking water during the dry period of the year. Rainwater was collected to the storage tank through a flexible pipe attached to a 1.4 m² portable type catchment system. The storage tank was completely leak proof as even a minute seepage over a long period will amount to a considerable loss of water. It was covered by a

thatched shade to minimize evaporation losses and possible pollution. The tank was also provided with insect proof ventilation.

2.4 Quality of stored rainwater

The water from rainwater collector was conveyed into storage tank using flexible pipe. Collector made of galvanized steel as well as polythene sheet were used to collect the water that was stored into storage tank made also of galvanized steel. Sample test was done during June to November 2001.

The p^H value was determined by a p^H meter. The bacteriological quality of water is generally expressed in terms of the parameters: *Escherichia coliform* (*E. coli*) and total bacteria. These are important water quality parameters from the public health view point since they play key roles in water born diseases.

2.4.1 *Escherichia coliform* (*E. coli*)

Culture medium for *E. coli* was: 10 g peptone + 10 g lactose + 2 g KH₂PO₄ + 15 g agar + 0.4 g Eosin Y + 0.065 g methylene blue in 1 liter distilled water (p^H 7.1 after sterilization). A diluted (10²-10⁴ times) sample of 0.1 ml was taken and incubated in cosine methylene blue-agar medium at 37⁰±1⁰C for 48 hours. A pink to red color with metallic surface sheet developed. The number of coliform colonies was counted and expressed as colony counts/ 100 ml sample.

2.4.2 Total bacteria

Culture medium for total bacteria was: 3 g beef extract + 5 g tryptone + 1 g glucose + 15 g agar in 1 litre distilled water (p^H 6.8 to 7.0 after sterilization). A diluted sample (10²-10⁴ times) of 0.1 ml was incubated in tryptone glucose agar medium at 35⁰±0.5⁰C for 48 hours. The number of colonies was counted and expressed as number of counts/ 100 ml sample.

3. Results and Discussion

3.1 Present condition of water sources

Basically three sources of water existed in the study areas namely precipitation (rain), surface water and ground water. Rainfall starts from the month of April to last up to October with 95% precipitation. The average annual rainfall more or less is 2400 mm at Mymensingh region (Meteorological report, 2001 at Mymensingh).

The surface water sources in the study areas were classified as impounding reservoirs (pond, ditch

Table 1. Number of ponds and availability of water in different seasons (Dry: 15th October-15th April).

Villages	Total no. of ponds	Condition of ponds in different seasons		
		Availability of water in monsoon season	Availability of water in dry season	*Non-Availability of water in dry season
Bilboka	110	110	32	78
S. Bailor	90	90	18	72
Goneshampur	30	30	18	12
Bohuly	39	39	08	31
Akan-para	83	83	36	47
Total	352	352(100)	112(31.82)	240(68.18)

* Non-availability of water in the dry season is considered when depth of water in the pond ≤ 0.9 m. Figures in the parentheses indicate percentages of total.

etc.) and rivers. Table 1 illustrates the present condition of ponds in five villages of the study areas. About 68 percent of ponds were found to be out of use during the dry season because of non-availability of water. Furthermore, 11 percent of remaining was not in use as these were polluted by different sources of pollution. Rainfall was considered as the main source of pond water and this water had been using in the study areas for domestic purposes as well as fish culture and cattle feeding. The water in the pond was normally not pure and considered hazardous for human health. The pond water remains soft with the high volume of water.

Tube-wells were used exclusively to extract ground water for domestic purposes. Bangladesh is almost entirely underlined by water-bearing layers, with ground water present at depths varying from 0 to

12 m below the surface, except in the Chittagong hill tracts, Rajshahi high *Barind*, the Madhupur tract. Apart from these areas, groundwater levels are at or near ground level during period August to October, and are lowest in the April to May. Groundwater levels rise in response to recharge during May and generally reach their highest level in late July. The number of tube-well with respect to depth in the study areas are shown in Table 2. Water qualities depend on the depth of tube-wells. About 68%, 22% and 10% of tube-wells were found to be sunk up to 18.29 m, between 18.29 to 45.72 m and above 45.72 m depth in the study areas respectively. About 50 percent of tube-wells were not workable during the dry spell in each area. This percentage is even higher in case of the tubewells having lower depths as because the water table drops down out of reach of the suction lift.

Table 2. Depth wise number of tubewells workable during wet and dry seasons in the study areas

Depth of H.T.W	Number of workable hand tube-wells										Total
	Bilboka		S.bailor		G.pur		Bohuly		Akan para		
	Monsoon	Dry	Monsoon	Dry	Monsoon	Dry	Monsoon	Dry	Monsoon	Dry	
Up to 18.29 m	38	19	59	27	64	18	16	3	108	49	285
18.29 m to 45.72 m	16	7	12	4	17	5	12	6	33	19	90
Above 45.72 m	9	5	7	4	5	2	4	1	17	7	42
Total	63	31	78	35	86	25	32	10	158	75	417
											(100)

Figures in the parentheses indicate percentages of total.

3.2 Usage of the different sources of water

The households for different works used different sources of water. Presently, households had shown their interest for rainwater considering the present situation of drinking water in the different villages. Table 3 shows that about 46 percent of households were interested on rainwater and about 15 percent of households showed their interest for using surface water by purification. The influencing factors were contamination of surface water with impurities and unwanted chemicals, arsenic contamination of ground water and acute shortages of drinking water during the dry spell as water table went down the reach of tube wells. Possible sources of surface water contamination found in the survey areas were use of agro chemicals,

water run-off from thatched roof, waste materials, open toilet, refused polyethylene, fertilizer use for fish culture, fish feed, jute rotting, washing of cows, cow-dung and urine, straw, weed, poultry dropping, washing of cloths in closed water bodies with soap & detergent and dropping from engine boats.

The contribution of water from rainwater, tube-wells and ponds water adopted by the users for domestic purposes are shown in Table 4. Most of the households used tube-well water for domestic purposes. Considering the present situation, villagers started to use rainwater but limited during the monsoon only. Due to lack of proper storage system, rainwater can not be used during the dry season.

Table 3. Households interest on rainwater, surface water and dug-well water or purified water

Villages	Number of households interested on				Total
	Rainwater	Surface water	Dug-well water	Purified water	
Bilboka	12	3	4	6	25
S. Bailor	14	1	7	3	25
Goneshampur	10	5	8	2	25
Bohuly	09	7	5	4	25
Akan-para	12	2	6	5	25
Total	57(45.6)	18(14.4)	30(24.0)	20(16.0)	125(100)

Figures in the parentheses indicate percentages of total.

Table 4. Contribution of rainwater, tube-wells and ponds water adopted by the users in present

Villages	Purpose	Sources and season					
		Rainwater		H.T.W		RCP**	
		Monsoon	Dry	Monsoon	Dry	Monsoon	Dry
Bilboka	Drinking		0			05	
	Cooking	14	0	81	93	37	07
	Others	21	0	42	86	45	14
		15	0	40	39		
S. Bailor	Drinking		0			02	04
	Cooking	06	0	92	96	24	35
	Others	03	0	79	65	03	44
		12	0	64	56		
Goneshampur	Drinking		0			--	04
	Cooking	18	0	79	96	39	23
	Others	15	0	46	77	31	45
		20	0	49	55		
Bohuly	Drinking		0			03	03
	Cooking	09	0	84	97	39	28
	Others	06	0	57	72	31	39
		12	0	51	61		
Akan-para	Drinking		0			02	11
	Cooking	17	0	81	89	19	31
	Others	12	0	69	69	21	42
		19	0	60	58		

*Washing, bathing etc. ** River, Canal and Pond.

3.3 Type of storage containers used in the study areas

The containers used for harvesting and keeping water were of different types. Some were earthen jars locally known as *motka*. Jar was used for collecting water from tube-wells. These jars were also of different size: small, medium and large. In context of present problematic situation of drinking water, household's members of the study areas showed interest to use jars of large size for collecting rainwater having capacity usually ranging from 60 to 400 liters. For immediate use water also stored in oil drums, buckets, plastic buckets, large utensils, pots and earthen container and silver made large container (bowl), earthen jar known as pitcher, etc. These types of containers are placed under the edge of the gutter in a corrugated iron roof. Presently most of the households of the study areas used this water for washing and cooking purposes during the rainy season. Now-a-days, villagers started to use rainwater for drinking purposes and even they tried to store the water to use round the year. Table 5 shows the pitchers that was widely used to harvest and store water for on time utilization followed by bucket. Most of the households used different types of containers. Khan (2000) stated that jar made of fired unglazed clay used as reservoir for drinking water by 80 percent of the people in Bangladesh.

3.4 Quality of stored rainwater

After six months the p^H value of stored rainwater was found higher (6.9 to 8.2) than that of fresh rainwater. This variation of p^H value is shown in Table 6. The material of the tank might be an important factor in this case. However, addition of new rainfall helped to decrease p^H value. Based upon the EEC standards (Lloyd and Heathcode, 1985) the maximum admissible concentration of p^H is 9.5 and minimum required concentration is 6.0. The dissociation constant for the weak acid is such that when rain is saturated with carbonic acid, the p^H is 5.65. However,

there are instances where the presence of sulfuric acid in the air has resulted in acid rain with p^H of 2.5 to 3.0 (Likens, 1979). Such low p^H values will create much higher treatment costs but one way to avoid its impact, which is greatest, is to divert the first flush by operation of a suitable bypass (King, 1982). In West Africa, rainwater has long been collected from thatched roofs and there appears to be no strong objection regarding taste to its use for drinking purpose (Noveiku, 1980). Rainwater tends to be soft in most cases. Table 6 also shows that the coliform bacteria in the stored rainwater were found to be of low value while *Escherichia coli* (*E. coli*/100 ml) value was nil in most of the cases. The change in bacterial quantity was inconclusive as it varied inconsistently during the storage period. Sample handling procedure might be responsible for this. Further investigation is needed to reveal the fact. In one case, the highest coliform bacteria concentration was found to be 18 cfu/100 ml in the sample of stored rainwater from Bilboka. The results show that most of the rainwater samples collected from the tanks was bacteriologically polluted due to inappropriate handling during storage. Simmonds (2001) demonstrated that roof collected rainwater systems provide potable supplies of relatively poor physicochemical and microbiological quality in Auckland areas of New Zealand and 56.0% of the supplies exceeded the microbiological criteria of <1 fc/100 ml (faecal coliform). However, in this study the stored rainwater collected from the portable type catchment system showed lower concentration of coliform bacteria (maximum number was 2- 3/100 ml in few case whereas most of the cases had nil) within the safe limit assigned by FAO (1973) which describes the maximum permissible limit of *E. Coli* as 10/100 ml for potable water. Catchments surface, gutter, flexible pipe and storage tank should be cleaned properly before using. First rain of the season should not be collected into the storage tank rather drained out by using bypass line.

Table 5. Types of container used by the household for harvesting and storing rainwater for on time utilization

Villages	Types of containers used by the households						Total
	Pitcher	Bucket	Jar	Oil Drum	Plastic Tank	Others	
Bilboka	24	12	3	1	2	6	48
S. Bailor	21	9	2	2	1	3	38
Goneshampur	25	15	2	0	3	4	49
Bohuly	18	8	1	2	1	3	33
Akan-para	15	11	2	4	3	5	40
Total	103	55	10	9	10	21	208

Total household surveyed= 125

Table 6. Rainwater quality in the storage tank in terms of p^H and bacterial count

Villages	Bacteria counts & p ^H	Months					
		June	July	August	Sept.	Oct.	Nov.
Bilboka	Tc	18	7	2	6	10	3
	Ec	2	nil	nil	nil	1	nil
	SPC	212	118	<100	<100	<100	172
	p ^H	7.0	7.3	7.6	7.8	7.4	8.2
S. Bailor	Tc	5	7	0	3	4	6
	Ec	nil	nil	nil	nil	nil	nil
	SPC	136	<100	<100	<100	<100	<100
	p ^H	6.9	7.1	7.4	8.1	7.1	7.9
Goneshampur	Tc	10	4	5	7	4	8
	Ec	3	nil	nil	1	nil	2
	SPC	197	114	<100	153	<100	<100
	p ^H	7.1	7.3	7.8	7.2	7.4	8.1
Bohuly	Tc	11	3	5	4	3	3
	Ec	2	nil	nil	nil	nil	1
	SPC	154	<100	<100	<100	<100	<100
	p ^H	6.8	7.0	7.2	7.5	7.8	8.0
Akan-para	Tc	15	6	4	3	5	2
	Ec	2	nil	nil	nil	nil	nil
	SPC	127	<100	<100	<100	<100	<100
	p ^H	7.0	7.1	7.3	7.3	7.6	7.8

T_c = Total coliforms/100 ml, E_c = *Escherichia coliforms*/100 ml & SPC = Standard plate count, colonies/100 ml

4. Conclusion

In context of contamination of different sources of water and scarcity of potable water during the dry spell, rainwater showed the potentiality to be accepted by the people of the study area as an alternative source of safe potable water. Rainwater can be stored safely for several months into steel tanks in order to use during the dry spell. But hygienic practices should be adopted during collection, handling and usage of rainwater to ensure its potable quality. To mitigate the need for safe potable water in areas with contaminated tubewell water and dry spell water shortage, more experimental works are still required to finalize an appropriate methodology for bacterial control of rainwater.

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