

Can dugwell be used again as a safe drinking water source in Ganga-Meghna-Brahmaputra (GMB) plain taking care of the bacteriological contamination?

1. History of dugwell

People had been using dugwell as a source of drinking water for millennia. **Figure 1** shows a dugwell from Mohenjodaro civilization of the Indus valley (about 2600 B.C). Even to the modern engineers this is a surprising construction. **Figure 2** shows the



Figure 1: A dugwell from Mohenjodaro civilization of the Indus valley (about 2600 B.C).



Figure 2 : Sketch of a dugwell which was used by Buddhist Monks (about 500 B.C)

dugwell, which was used by Buddhist Monks (around 500 B.C.). **Figure 3** shows the dugwell 'ZAM-ZAM' in Makka in Saudi Arabia; Prophet Hazarat Mohammad drank water from this dugwell (around 600 A.D.). It is still producing good water supply. The people of Mesopotemia, Egypt, Greece, Rome and China enjoyed the benefit of good water supply from the dugwell.

Dugwell was also one of the drinking water sources in Europe before and after First World War. See few lines of the poem 'Send-off' by Wilfred Owen (1920).

"A few, a few, too few for drums and yells,
May creep back, silent, village wells
Up half known roads."

Octogenarian Prof. Richard Wilson, (Harvard



Figure 3 : Dugwell Zam-Zam in Mecca, whose water was drunk by Prophet Mohammad (around 600 AD)

University, USA), from England who is working on arsenic problem in Bangladesh informed that in his childhood he used to drink dugwell water.

2. History of dugwell use in GMB Plain

Dugwell was a traditional culture in GMB Plain including most parts of India. **Figure 4** shows the dugwell used by king's family in Sun Temple in Konarak, Orissa (1300 A.D.). Once dugwell was the only source of drinking water in water scarce areas like Rajasthan. **Figure 5** shows such a community dugwell in remote area of Rajasthan about 250 years before.

School of Environmental Studies (SOES) last 20 years survey shows that in all states and countries in GMB Plain community dugwell was one of the principal sources of drinking water.



Figure 4 : Dugwell in Sun Temple of Konarak, Orissa (around 1300 AD)



Figure 5 : A community dug-well in a remote village of Rajasthan (around 250 years old)

2. Community dugwell

We have noticed during our last 20 years field survey thousands of big diameter abandoned community Dugwells in Bihar, Uttar Pradesh, Jharkhand, West Bengal and Bangladesh. **Figure 6** shows a big diameter abandoned community dugwell in Maimansingh district, Bangladesh. Usually all over the Ganga Plain most dugwells were community based and each village usually had one dugwell and villagers from even far away used to collect drinking water from this source. Dugwells in Jharkhand, Bihar, Uttar Pradesh, were usually very big in diameter (4-5 m) and robust in construction. Even we noticed some of the abandoned dugwells are over 150 years old. During our survey the old villagers informed that they were using dugwells 30-40 years



Figure 6 : A big diameter abandoned community dug-well in Maimansingh, Bangladesh (69 years old)

before and the dugwells were the place of social gathering and community used to take care of the dugwell. They considered dugwell sacred. When the first tube-well was sunk in Nadia in 1960 villagers was not willing to use the tube-well water. They left the village screaming, 'Devils water is rising'. Aid agencies and government officials informed the villagers that the hand tube-well could be within the household campus and women would not go out side to fetch water. The water



Figure 7 : A big diameter abandoned dug-well in Semaria Ojha Patt, Bhojpur, Bihar

would be cold in summer and warm in winter. Finally we convinced them that this water will bring good health and green revolution and this is for them God's gift. In GMB Plain we have plenty of examples showing that when villagers abandoned their long traditional dugwell and opted hand tubewell they were suffering from arsenic toxicity, but those who used the dugwell were not arsenic affected. **Figure 7** shows a big diameter abandoned (small trees are visible inside the dugwell) in Semaria Ojhapatti, Bhojpur, Bihar. In this village about 30 years before when people used drinking water from this dugwell none was suffering from arsenic toxicity and now in this village there are at least one or two patients in each house with arsenical skin lesions (Kuneswar Ojha of this village is school teacher in Kolkata. His first wife had arsenical skin lesions and died from cancer. His second wife also has skin lesions and in his family 4 members have arsenical skin lesions).



Figure 8 : A dug-well (in operation) in Village Dihari, Jharkhand

Again in the village Hazipur Vitta of Sahibganj district of Jharkhand after discarding the dugwell hundreds are suffering from arsenic

toxicity. But a few km away in Dihari village none is affected from arsenic toxicity as they are drinking water from a dugwell (**Figure 8**). The most important fact is that due to subsurface geology in Dihari village they could not bore a hand tube well so they had to drink from dugwell, otherwise they might have the same fate of the village Hazipur Vitta. Now after seeing the serious condition of the patients of Hazipur Vitta village, they have decided not to install any hand tubewell in this village.

During last 12 years we have collected and analysed hundreds of dugwell water samples for arsenic, iron and bacteria from GMB Plain. We had discussed with hundreds of old peoples who once used those dugwells. We consider their comments and experiences very valuable for success of dugwell. Please see in **Table 1**, arsenic concentration in big

diameter community dugwells from GMB Plain and **Web links** of SOES (www.soesju.org) to get more information on dugwell.

Table 1*

State/ Country	No. of dugwells analysed for arsenic	Arsenic con. in µg/L				
		<3	4-10	11-50	51-100	>100
Bangladesh	181	59	28	67	5	22
West Bengal	296	153	76	55	4	5
Bihar	215	191	9	11	1	2
Uttar Pradesh	14	9	1	2	1	1
Jharkhand	45	43	-	2	-	-

**An old proverb runs in Bengal delta to dugwell users, "Drink water after settling." During our last 20 years survey in GMB Plain many villagers reported that they do so. The chemistry behind this is, on settling compounds of metal/metalloid particles will settle at the bottom, hence contamination of metal/metalloids in drinking water will be reduced. We have found on settling 40-60% of arsenic may be eliminated from arsenic contaminated dugwell water and sediment is rich in arsenic.*

3. The dugwell we (SOES) constructed in an arsenic affected area (Village: Betai, Dist: Nadia, State: West Bengal)

Based on gathered knowledge on dugwell during last 20 years, we constructed a dugwell in Chandranath Basu Seva Sanga, Betai, Nadia District of West Bengal [Figure 9(a), 9(b), 9(c), 9(d)]. We started this construction in early March 2002 and finished it in May



Figure 9(a): Cleaning of the dug-well



Figure 9(b): Use of glass fibre sheet to prevent surface contamination



Figure 9(c): The two storied storage tank.



Figure 9(d): Nearby pond to recharge the dug-well.

2002 since March to May is the right time to construct a dugwell. Our dugwell is of neat concrete structure having diameter of about 3.5 m and depth about 15m. The villagers started drinking this dugwell water from November 2003. For 18 months we studied the dugwell, made a lot of experiments to get knowledge how this could be a safe source for

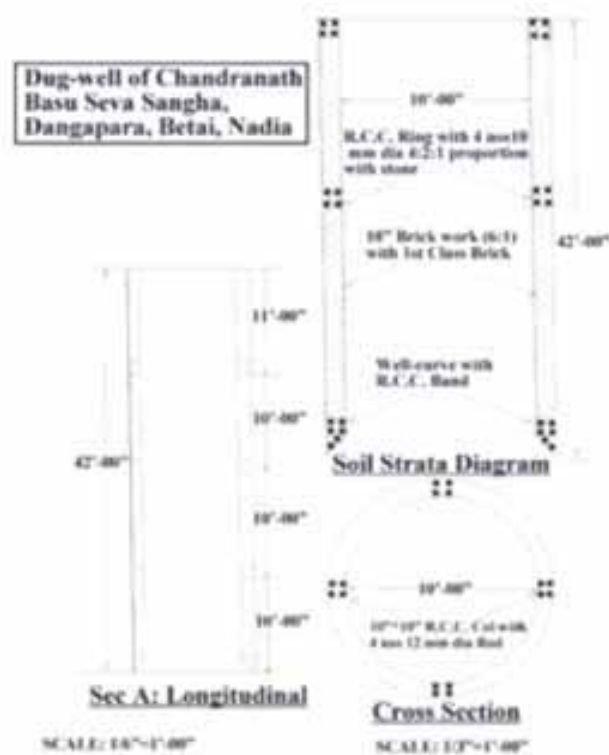


Figure 10(a) : The structural drawing of the dug-well



Figure 10(b): First stage of construction



Figure 10(c): Second stage of construction



Figure 10(d): The complete dugwell just after construction covered with mosquito net (to prevent surface contamination).

Drinking water. Even now we are experimenting on it and trying to make it better and better. Total money we spent for this dugwell is 1.5 lacks (the dugwell and a 2 storied tank having 6m length, 6m width and 1.5m depth) and about 2000 people can use this dugwell for drinking and cooking purpose. Round the year we can get easily water. In fact from morning till evening water level decreases but during next 12 hours water accumulates in the well. See below our stepwise construction of the dugwell [Figure 10(a), 10(b), 10(c), 10(d)]. Quality of our dugwell water is shown in Table 2.

Table 2*: The quality of our dugwell water

Parameters	Concentration	Provisional Guideline Value(WHO)
pH	9.06	6.5-8.5
Conductivity($\mu\text{s}/\text{cm}$)	718	---
DO(mg/l)	4.78	---
TDS(mg/l)	335	---
Iron(mg/l)	0.09	0.3
Arsenic(mg/l)*	Min. <3, Max. 20 (N=40)	0.01
Manganese(mg/l)	0.2	0.4
Phosphate(mg/l)	0.66	---
Ammonia(mg/l)	0.09	35 (taste), 1.5 (odour)
Nitrate(mg/l)	0.7	50
Nitrite(mg/l)	0.54	3
Floride(mg/l)	0.38	1.5
Hardness(mg/l)	348	---
Turbidity(FAU)	4	---

**From our last two years analysis of this dugwell water we have seen that the arsenic concentration of the dugwell water increases in the summer and decreases in the rainy season (without settling) whereas the bacteriological contamination decreases in the summer and increases in the rainy season.*

4. For construction and management of dugwell in flood plain we recommend the followings:

- a) Concrete structure of dugwell with diameter 3-4m and depth >10m. If electricity is available a pump will fill up the storage tank [Figure 9(c)]. If electricity is not available the consumer will fill up the amount he would draw from the tank by pumping through attached tube-well with the dugwell to the storage tank.
- b) Dugwell should be close to pond or water resource [Figure 9(d)] to ensure the recharge of dugwell. The dugwell should be far away from sanitary toilet. Since dugwell is continued concrete structure, horizontal leaching not expected. Since recharge to dugwell occurs from higher depth vertical surface contamination is not also expected.

- c) To preventing surface contamination fish net/glass fiber sheet [**Figure 9(b)**] could be used. If pump is available then it could be used for half an hour every day to lift water from dugwell and pour it down to dugwell.
- d) Cleaning the dugwell after every 3 months with lime and sodium hypochlorite and removal of bottom sediment is necessary.
- e) Once a year a thorough cleaning of dugwell is necessary, this will also take care of sand building [**Figure 9(a)**] in dug well.
- f) Even if bacteria are not detected after periodic cleaning, we recommend addition of sodium hypochlorite to dugwell (depending on water in dugwell and WHO recommended value) at night every day.
- g) Our study during last 4 years finally indicates that cleaning the dugwell as we mentioned, may not always produce bacteria-free water. To get water safe from bacteriological contamination we need to pass water either through UV-radiation or a shock killing system for bacteria as shown in **Figure 11**. In this procedure a coil about 6m in length (figure inset) in two layers placed on an oven or inside the country oven in the rural area. The villagers can use the technique, while they are cooking in the household oven.



Figure 11: A shock killing system for removing bacteriological contamination from dug-well water

5. Conclusion:

We do not recommend any shallow dugwell of depth. less than 10m in flood plain area.

- a) We only recommend a community dugwell and in flood plain a concrete structure.
- b) Money required to maintain the dugwell would be paid by the community
- c) We do not recommend dugwell having smell in water and color in water.
- d) We do not recommend dugwell in highly marshy and dumped (reducing) area.
- e) We do not recommend dugwell in peat area.

- f) During our arsenic analysis in dugwell we sometime noticed that in the dugwell water, often particles visible, invisible are present. Some of these particles could be rich in arsenic mineral and when acid (HNO₃ or HCl) added as preservative during collection, may dissolve a portion showing elevated arsenic during analysis. We have established this fact by filtering water by millipore filter or allowing to settle the water overnight (Groundwater arsenic contamination in West Bengal, India Characterisation and chemical analysis of bore-hole sediment samples, roto-evaporated arsenic rich water residues and present status of three arsenic affected blocks of 24-Parganas (North), Tarit Roy Chowdhury, PhD Thesis, 1999).
- g) We suggest to drink dugwell water after settling. In Bengal delta it is a common proverb, 'use water for drinking after overnight settling'.

Ancient dugwell history all over the world and traditional dugwell history in India and Bangladesh show big diameter, community dugwells, were maintained with peoples' participation.

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