

Toward sustainable drinking water development: A case study of villagers' practices and development activities in coastal Bangladesh

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Background

Drinking water problem

World

- Human right (Gleick, 1998)
- Basic Human Needs (ILO, 1975; Word Bank, 1980)
- Final report of MDGs (United Nations, 2015)
 - Use of unsafe drinking water sources
 - ◆ Half of the population in Sub-Saharan Africa
 - ◆ A quarter of the population in South Asia
- Annual report of SDGs (United Nations, 2019)
 - Drinking water scarcity at least once in a year: approximately four billion people
 - No access to safe drinking water sources: approximately 785 million people

Bangladesh

- Coastal regions
 - Saline intrusion into groundwater and surface water (Figure 1)
 - ◆ Cyclone (Alam et al., 2003)
 - ◆ Shrimp cultivation (Deb, 1998; Haque et al., 2010b)
- Concerns about adverse effects on the human body due to excessive salt intake (Khan et al., 2011)

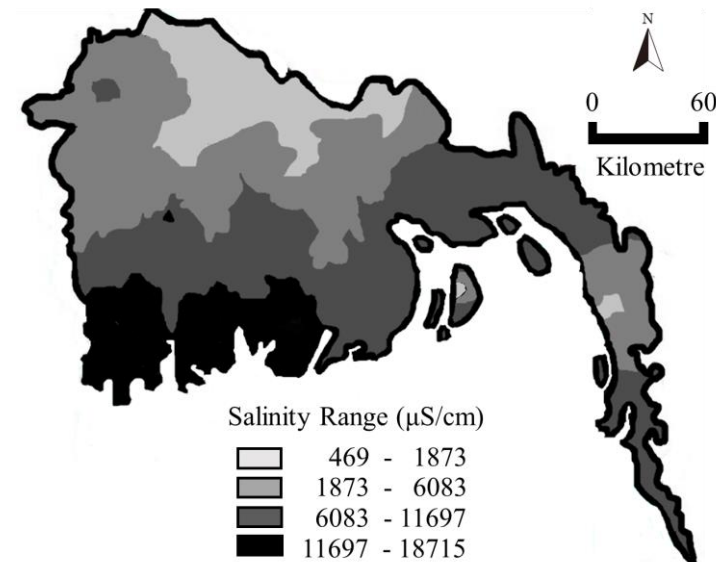


Figure 1. Electrical conductivity Level in the coastal Bangladesh

(Source) Generated by using data from BADC (2011).

Previous studies

- Water quality of drinking water sources and facilities (Figure 2)

- Drinking water ponds

- ◆ Contamination by *E. coli* because of close location of toilets and bathing activities (Islam et al. 2000)

- Pond sand filters (PSFs)

- ◆ Depending its purification results on water quality of pond water and maintenance (Alam and Rahman 2010; Harun and Kabir 2013; Islam et al. 2011)
- ◆ Impossible to purify salinity and *E. coli* (Harun and Kabir 2013; Islam et al. 2011)

- Use and installation status of water supply facilities

- Difficulty in joint management of drinking water facilities (Matsumura, 2007)

- Importance of leaders for sustainable use of drinking water facilities (Tsutsui and Tani, 2008)

- Importance of awareness of necessity and generation of ownership toward drinking water facilities for sustainable use (Tani, 2001, 2005)

- Importance of good water quality, sufficient water volume throughout the year, low installation costs, easy maintenance, training for managers of drinking water facilities, and participation of user for sustainable use (Alam and Rahman, 2010)



Figure 2. Drinking water pond (left) and PSF (right)

■ Remaining drinking water problem as the biggest issues all over the world

→ Research objectives

To investigate

1. difference between traditional and recommended operation and maintenance of drinking water sources and facilities
2. villagers recognition of safeness toward drinking water

• Significance of research

Contribution of

1. solving drinking water crisis in Bangladesh
2. improving effects development assistance

Methodology

- Field surveys in a coastal village (2017-2019)

- General information of the study village

- ◆ A village in Munshiganj Union, Shyamnagar Upazila, Satkhira District (Figure 3)
 - ◆ Number of Households: 738
 - ◆ Population: 1,001

- Contents of field surveys

- ◆ Choose major drinking water sources and facilities of villagers
→ Drinking water ponds and PSFs
 - ◆ Interviews (through English-Bengali translation) (Table 1)

Table 1. Targets and contents of interviews

Targets	Contents
<u>Villagers:</u> those who used and maintained the above drinking water sources and facilities	<ul style="list-style-type: none"> • How to use • How to maintain • Reasons to choose etc
<u>Staffs of development agencies:</u> those who distributed and constructed drinking water facilities in the study village	<ul style="list-style-type: none"> • What to instruct for operation and maintenance etc

- ◆ Water quality rests

- ✓ Electrical conductivity (EC)
 - ✓ pH
 - ✓ Chemical oxygen demand (COD)

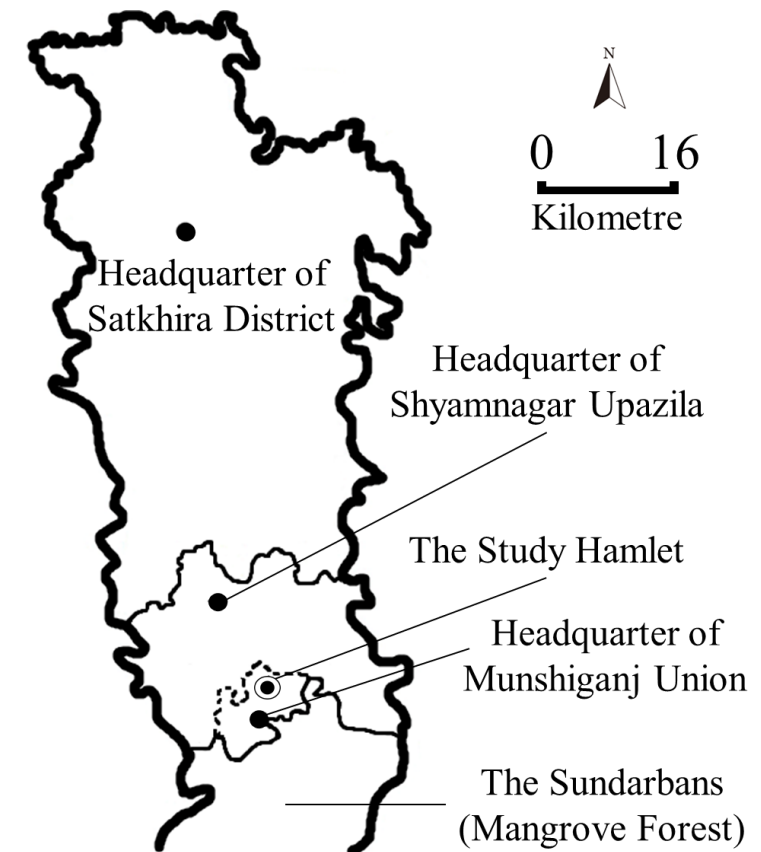


Figure 3. Map of Satkhira District

(Source) Generated by using a map data from LGED (1999).

Results and discussions

1. Operation and maintenance of drinking water sources and facilities

Table 6: General situation of drinking water ponds and PSFs

No	Year of formation (Place)	Intended usage after formation	Current usage	Annual maintenance frequency	Year of PSF construction	Annual maintenance frequency of PSF
1	Before 1920s (Private land)	Drinking/ Others	Others	1	2008	2-3
2	1990s (Market)	Drinking	Drinking/ Others	1	2010	2
3	1970s (School)	Drinking	Drinking/ Others	0	1980s	3-4
4	1960s (Private land)	Drinking/ Others	Others	1-2	No construction	
5	Before 1920s (Private land)	Drinking/ Others	Others	2-3	No construction	
6	1960s (Private land)	Drinking/ Others	Drinking/ Others	2	2002	≥4
7	1970s (Private land)	Drinking/ Others	Drinking/ Others	2	2008	2
8	1960s (Private land)	Drinking/ Others	Others	1	No construction	
9	1960s (Private land)	Drinking/ Others	Others	1	1999-2003	3-4
10	1960s (Private land)	Drinking	Drinking/ Others	0	2005	1
11	1960s (Private land)	Others	Drinking/ Others	1	2004-2006	4-6
12	1920s (Eidgah)	Drinking	Others	1	2010	2-4
13	1980s (Private land)	Others	Others	1	No construction	
14	2000s (Private land)	Others	Drinking/ Others	1	No construction	
15	1960s (Private land)	Drinking/ Others	Others	2	2010-2011	2-4
16	1940s (Private land)	Drinking/ Others	Others	1	1996	4-6
17	Before 1920s (Private land)	Drinking/ Others	Drinking/ Others	1	2015 (2009)	3-6 (2-4)
18	1980s (Private land)	Drinking/ Others	Drinking/ Others	1	1994	2-5
19	1940s (Private land)	Drinking/ Others	Others	0	No construction	
20	1970s (Private land)	Others	Drinking/ Others	0	2003	2-3

- I. Drinking water ponds
 - A) Formation
 - Formed by big land holders at their lands
 - B) Usage
 - Drinking and other purposes (bathing, washing and fish culture)
 - C) Maintenance
 - Frequency: less than 2 times/ year
 - Activities: removal of leaves in water
 - Practitioner: land owners of each pond
- II. PSFs
 - A) Formation
 - Formed by development agencies
 - B) Usage of water source pond of PSF
 - Broken rules (prohibition of bathing, washing, and fish culture) by villagers
 - C) Maintenance of PSF
 - Frequency: generally 2-4 times/ year
 - No remembrance of advice from development agencies
 - Activities: removal of leaves in water, wash sand and gravel by water, cleaning up surroundings of PSFs
 - Practitioner: management committee (initially)→ land owners of each PSF (current)

■ Regional and local features related to drinking water in coastal Bangladesh

1. Pond maintenance by a single household
2. Multipurpose use of the ponds

■ Differences in perceptions of water resources between villagers and agencies that installed water supply facilities

1. Ownership of water resources
 - a single household vs commons
2. Scarcity of water resources
 - For all purpose vs for drinking water

→ The regional and local features of the target area may not be fully considered when implementing development assistance such as the installation of water supply facilities.

⇒ The operation and maintenance of the water supply facility (PSFs) may not be performed as instructed and pointed out by the PSF installation organisation and previous research.

2. Drinking water purification practices and villager recognition of safeness toward drinking water

Table. 2. Results of water quality tests and villager recognition of safeness toward drinking water

Drinking water sources and facilities	Results of water quality tests*	Villager recognition		Purification practices
		Recognition of safeness toward drinking water	Reasons for recognition of safeness	
Drinking water ponds	Unsafe	Unsafe	<ul style="list-style-type: none"> • Salty taste • Greenish colour • Entry of livestock • Bathing and washing 	Purification
Pond sand filters	Unsafe	Safe	<ul style="list-style-type: none"> • Salty taste • Greenish colour (water source of pond) • Purification by layers 	No purification

→ Villagers may recognise drinking water to be safe when purification system is installed.

Table 4. Water Quality of Drinking Water Ponds

No	EC ($\mu\text{S}/\text{cm}$)	pH	COD (mg/ L)
1	565	7.34	≥ 8
2	580	7.64	≥ 8
3	700	7.23	≥ 8
4	816	7.81	≥ 8
5	1,576	8.63	≥ 8

Table 5. Water Quality of Pond Sand Filters

No	Before & after purification	EC ($\mu\text{S}/\text{cm}$)	pH	COD (mg/ L)
1	Pond (raw water)	416	7.09	≥ 8
	PSF	434	7.18	≥ 8
2	Pond (raw water)	405	7.46	≥ 8
	PSF	458	7.88	7
3	Pond (raw water)	434	7.86	7
	PSF	477	7.89	≥ 8
4	Pond (raw water)	554	7.33	≥ 8
	PSF	623	7.45	≥ 8
5	Pond (raw water)	615	7.35	≥ 8
	PSF	642	7.54	≥ 8
6	Pond (raw water)	1,070	7.58	≥ 8
	PSF	1,063	8.77	4

Conclusion as policy implication

- Major findings of this research
 - **Unintended consequence derived from efforts to fulfil guidelines for drinking water quality** (WHO, 2017)
 - ◆ Development assistance related to drinking water
 - ✓ Construction of drinking water facilities
 - ✓ Advice and suggestions for operation and maintenance for sustainable use
 - ◆ Regional and local features of using drinking water sources
 - ✓ Importance of water sources not only for drinking but also for domestic usage
 - ✓ Perception for safeness of drinking water sources by existence of purification system
- **Necessity for concerning drinking water in new point of view to conduct development assistance**
- Policy implication
 - Necessity to adjust developments assistances related to drinking water into regional and local contexts