Arsenic-Iron Removal Plants in a local context

Case study

Location: Bangladesh

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Project background and key drivers

Since 2000, Kalaroa municipality in the Satkhira district has seen an growth in population, which has resulted in an increase of rural households' migration towards the city. The current population reached 27,000 – which has increased the pressure on the limited safe water supply available to communities in Kalaroa.

Local households have been accessing water supply from shallow tube wells or unimproved water sources with high microbiological contamination. The water source of the shallow tube wells is groundwater that is heavily contaminated with iron, saline and arsenic. Over 80% of the tube wells presented high levels of arsenic, with concentrations reaching 150µg/l (while the national standard is 50µg/l) and iron with concentrations over 6mg/l. Some of the households have been able to access a privately-distributed safe water supply transported in tanks from Satkhira district towns. However, with prices reaching 2.5 BDT per litre of water (173 times the price of water supply in Dhaka), this expensive and private water selling service was only affordable to 10–12% of the households – further exacerbating the inequalities of water access in the communities.

Bangladesh

Figure 1: Water collection from unsafe sand distant sources.

WaterAid

Approach to increase safe water supply

Since 2012, WaterAid in partnership with the local partner Dhaka Ahsania Mission (DAM), have been working in the municipality to address the challenge of safe water supply and to increase access within the municipality.

The approach undertaken by WaterAid and partners included:

Step 1 – Community engagement by conducting a Community Situation Analysis (CSA).

Assessing water supply demand within the municipality and prioritising new access. Identifying the right locations and land availability for the positioning of the treatment technology, setting a tariff collection system and raising awareness on the importance of a safe drinking water supply.

Step 2 – Identifying suitable drinking water treatment technology that could address the groundwater contamination issues and was applicable to the local capacity and context.

Several methods for iron and arsenic removal exist and some are already applied in Bangladesh – from oxidation, adsorption of arsenic onto coagulated flocs, lime treatment, adsorption onto sorptive media and ion exchange, etc.

Figure 2: Community members are talking about the progress of CSA (Community Situation Analysis) through a mapping system. Sarder para community, Kalaroa.

▲ Sludge from the AIRPs is used in brick manufacturing to ensure safe waste management.

The Kalaroa municipality considered different technologies for iron and arsenic removal. These were also compared for long-term operation and maintenance (O&M) costs. Based on this, the Arsenic-Iron Removal Plant (AIRP) was selected as the most suitable solution for the local context – because it responded to both the treatment needs and required O&M activities that could be completed with local capacities.

The AIRP technology is based on consecutive processes: initial aeration and oxidation of iron and arsenic, then transformation into insoluble compounds, after that precipitation and finally two stage filters that reduce the concentrations by adsorption and filtration. The system can filter up to 1,200 litres of water per day.

The first installations in Kolaroa municipality have been in place since 2013. WaterAid has since reviewed and improved the design of the technology, by adding an additional treatment step to help improve its effectiveness.

With optimal maintenance, the system can provide effective treatment. Figure 3 gives an example of arsenic concentration reduction on an AIRP, showing an average of 94% reduction of arsenic concentration through the treatment plant across three years and no evidence of a reduction in effectiveness with time.

Variation of arsenic concentration in AIRP (Godokhali college, Kalaroa)

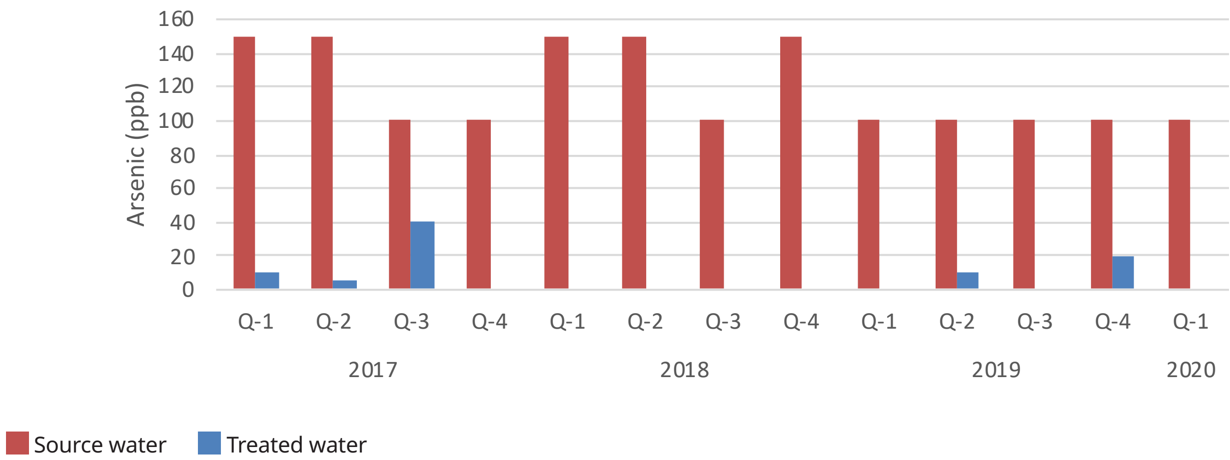


Figure 3: Water treatment efficiency with AIRP in Godokhali college, Kalaroa.

In Kalaroa, local government and operators identified the need to find an alternative solution to dispose of the sludge (high in iron and arsenic) generated from the backwashing of the filters from being sent to the pit.

To increase resources recovery, a solution was identified to reuse the sludge as raw material for the production of bricks. The local government now supports the regular collection of the sludge and delivers it to the brick company.

The overall capital investment costs for each AIRP unit is approximately BDT 165,000 (less than US$2,000), while operational costs are around BDT 2000 per month, broken down as following:

- Caretaker costs: BDT 700–1000 (US $2–$8.50) per month.
- Cleaning cost: BDT 700 (US $8.50) per month.
- Regular maintenance: BDT 300 (US $3.50) per month.

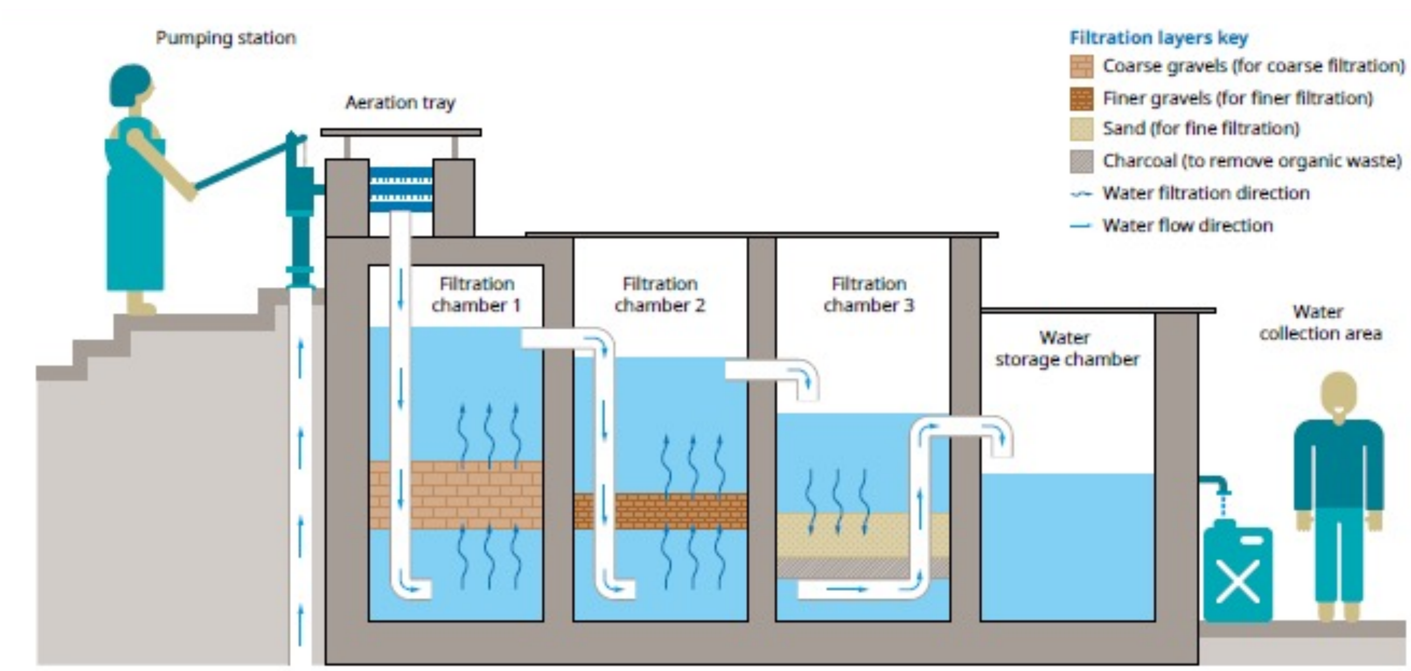
Each unit is designed for up to 35 households, although water volumes can vary. Large maintenance of the system is performed by local operators and the main activity is to replace the filtering media every year, including the coarse and fine gravel and charcoal. This has a cost of BDT 3,000 (US $35) per year.

Figure 4: An AIRP Plant.

Step 3 – Setting up management committee, operation and maintenance plans, and financial arrangements for a sustainable water supply.

To ensure proper maintenance of the systems, WaterAid and its partners have worked with the local municipality and community to set-up:

- A community forum (also known as a Community Based Organisation (CBO) which oversees the O&M contract – setting the tariffs and collecting the fees. Almost all of these forums are led by women (traditionally in charge of water collection and household water use).
- A management committee which includes 5–6 people from each plant. Every quarter the committee have meetings with WaterAid and its partner staff to review and provide necessary training on funding management and technical maintenance.
- A cleaning group who performs the regular cleaning and maintenance of the system. Usually, the caretaker backwashes the filters weekly if iron concentration is very high in that area. The dedicated cleaning group cleans the plant every 1–1.5 months and washes the filter media every 6 months, while more extensive maintenance includes the replacement of filter media yearly.
- Strengthening the capacity of the municipality to perform their role as a technical support agency who participates in the procurement and supervision of construction; a trainer for caretaker responsibilities and extended support for O&M; regular monitoring of the overall effectiveness of the systems and management practices (including water quality testing, fee collection and maintenance).
- Financial management that includes:
    - Each system and management team have a bank account to manage the tariffs paid and to address O&M costs. The account signatories include the caretaker and two users from the community to ensure ownership. Monthly tariff collection is carried out by the caretaker, who record payments in the register and transfers fund to the bank account.



Step 1: Groundwater is extracted by a hand pump and travels through an aeration tray before settling in a sedimentation chamber.

Step 2: The water is then pushed up through a filter of coarse gravels and shifted to a second chamber where it passes through filters of fine gravels.

Step 3: In the third chamber, the water is pressured down through a fine sand filter and a layer of charcoal before being pushed up into the storage unit.

Step 4: The community now has 24/7 access to clean drinking water from taps.

- Monthly tariff per family is BDT 50 (increased from an initial fee of BDT 30) for for 20L of treated water for each household (sufficient for drinking and cleaning). A willingness to pay and affordability analysis was completed in communities at the beginning of the project and it was confirmed that the tariff was affordable for most of the households. Through these customer surveys, it was also possible to identify a number of families who were unable to pay and who are now supported with cost subsidised by other users tariff.

Figure 5: Example of a balance sheet from an AIRP.

Next steps

WaterAid Bangladesh is planning to cover another nine councils with the AIRP model in an aim for 100% of the district to gain access to a safe water supply. At the same time, WaterAid and its partners started to handover overall supervision of AIRPs to the local government institutions. Currently, additional funding from donors and local government is being secured to support this target.

Outcome

- 94 plants have been installed (76 for community access and 18 for schools), which contributes in covering 100% of population within the municipality with safe water.
- 10 local O&M workers are providing cleaning and minor maintenance – which has resulted in the AIRP being regularly functional.
- The role of the local government has been clearly defined:
  - They are committed to allocating regular budget to support reserves for the major maintenance of the infrastructure (for example, tanks concrete maintenance).
  - They regularly check payments at each plant and the bank account balance sheet to ensure financial sustainability.

Challenges

- Initially, there was some reluctancy from the communities to pay for the improved water supply, as they had access to a free, unprotected, and untreated water source. Extensive community engagement and collaborative situation analysis helped to engage communities and increase understanding of the health benefits of safe water and therefore increased the willingness to pay.
- The elective nature of the local government has been identified by WaterAid as a risk to the sustainability of the AIRPs. Political elections can lead to changes in leaders of local government and its staff members, leading to a loss of capacity and buy in on the support of the AIRPs. WaterAid is looking at the setting up a 'consumers' association' that could continue to lobby and advocate with the local government in supporting the long-term functionality of the AIRPs.

Lessons

- The multi-actors' engagement and definition of the clear roles and responsibilities – including maintenance groups, caretaker roles and local government input – has been instrumental in ensuring the effective implementation and sustainability of the AIRPs.
- Community management of the treatment plant was not sufficient, so the creation of local maintenance groups has ensured the regular O&M of the plants which maintain the effectiveness of the treatment process.
- There is a need to ensure the approach and management model for the treatment and supply of water, accounts for possible changes to the heads of local governments. For example, establishing consumers' associations who can continue to hold local governments accountable, so the service can be sustained.

Resources

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