

Section 3

Programs

Chapter 7

Social enterprise on sky water harvesting for solving drinking water crisis in coastal areas in Bangladesh

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7.1 DRINKING WATER CRISIS IN COASTAL AREAS OF BANGLADESH

At the moment, there are still more than 20 million people in rural areas of Bangladesh who have no access to safe drinking water. Women and children must take more than one hour every day to fetch water from the pond. Sometimes the pond is located 4 km from their house; water fetching is a very heavy burden. Local people sometimes buy water from a water seller so they don't have to fetch water themselves, but it costs 6 Tk (1USD = 80 Bangladesh Taka) per 20-liter barrel (NEC Corporation, 2013). This is an additional economic burden. Moreover, the water source for local people and water sellers is the same pond which is polluted by water-borne pathogenic microorganisms. Countless people who have drunk pond water suffered from severe diarrhea, in some cases causing death. It has been estimated over 45,000 under-five children die every year in Bangladesh from diarrhea caused by contaminated water (WHO, UN-Water, 2017).

Besides, to the diarrhea issue, more than 35 million people are under threat of arsenic contamination from groundwater in 59 of 64 districts. There are currently

1.4 million tube wells painted red which means they are contaminated with arsenic at a level which exceeds national drinking water standards (0.05 mg/l). Arsenic contamination is not artificial pollution; it originated from natural soil contamination.

Some local people continue to drink arsenic-contaminated groundwater. They can not recognize arsenic poison as it has no taste, no smell, and no color. Arsenic is easily absorbed and accumulated into the human body. After drinking arsenic-contaminated water over a long time, people suffer from melanosis, symmetric hyperkeratosis, and skin cancer in the worst case (Islam & Islam, 2018). Also, groundwater and pond water in the coastal areas have been affected by saline damage, which has been accelerating year by year due to the rising seawater level caused by climate change and shrimp farming. It is difficult to remove salinity with the pond sand filters installed for purification of pond water. In addition to the saline issue, almost all tube wells are heavily contaminated with iron. Local people have been suffering from bad tasting drinking water and food which is cooked in this water.

In 2011, in cooperation with JICA and local NGOs, I started a base of the pyramid (BOP) social enterprise for sky water harvesting as CEO of the Institute for Sky Water Harvesting Ltd (ISWH) to solve the drinking water crisis in rural areas in Bangladesh. The basic concept of social enterprise is the effective use of available materials and human resources in local societies. That is, for example, in the AMAMIZU project described in this chapter, materials for an AMAMIZU tank, such as mud, sand, and cement should be purchased in local areas, and AMAMIZU masons should be nurtured through job training of local people. Also, transportation of the AMAMIZU facilities to customers should be carried out through local transportation methods such as rikisha vans, engine vans, and boats. Social projects make the local economy sustainable.

7.2 BASE LINE SURVEY

ISWH started a baseline survey regarding a BOP social enterprise on sky water harvesting in cooperation with JICA and local NGOs at coastal areas in Bangladesh in 2011. 300 local people were surveyed on drinking water issues, awareness of sky water harvesting, affordable price of sky water harvesting, etc. The result was very interesting. Almost all local people replied that pond and groundwater have an odor and are discolored and also that fetching water is a heavy burden for them. And they recognized that diarrhea is caused by water contamination (Table 7.1 & Table 7.2) and that sky water harvesting is a key solution to solve the diarrhea issue.

More than 50% of local people could afford up to 3000 Tk for a tank. Regarding this, we had one more important piece of evidence for social enterprise. Local people have spent on average 1425 Tk for medical expenses to treat water-borne diseases and 1416 Tk for buying water, including transport of water (Figure 7.1 & 7.2). It means if local people buy a tank for 3000 Tk, they could reduce their overall

Table 7.1 Baseline survey of drinking water issue in Morrelganji (1).

	Village-1 Baroikhali	Village-2 Tetubari	Village-3 Kailikabari	Village-4 Bashbaria	Total (n)	All Villages %
What do you think 'Water is the main reason of health problems here'?						
Not at all	4%	8.3%	0%	0%	3	3.1%
Some extent	12%	8.3%	13%	16%	12	12.4%
Definitely	84%	83.3%	87%	84%	82	84.5%
Total	100%	100%	100%	100%	97	100%
Your friend's Opinion about Drinking waterproblem (What do you think about your friends, neighbors opinions or judgement on drinking water problem of the locality)						
Good	0%	0%	0%	0%	0	34.3%
Okay (Not bad)	4%	0%	4%	0%	2	62.6%
Bad	96%	100%	96%	100%	98	3%
Total	100%	100%	100%	100%	100	100%

Table 7.2 Baseline survey of drinking water issue in Morrelganji (2).

	Village-1 Baroikhali	Village-2 Tetubari	Village-3 Kalikabari	Village-4 Bashbaria	Total (n)	All Villages %
Is there 'order' in your drinking water?						
No Order	8%	0%	4%	0%	3	3%
Little Order	68%	66%	56%	56%	59	59%
Strong Order	24%	44%	40%	44%	38	38%
Total	100%	100%	100%	100%	100	100%
Is there 'Color' in your drinking water?						
Very dirty and Muddy	20%	33.3%	44%	44%	34	34.3%
Not so clean	68%	66.7%	56%	66%	62	62.6%
Clean	12%	0%	0%	0%	3	3%
Total	100%	100%	100%	100%	99	100%
Distance and time; Do you think fetching water is burdensome for you in terms of distance and time?						
A great deal	92%	100%	91.3%	100%	88	34.3%
Some deal	4%	0%	8.7%	0%	3	62.6%
Not at all	4%	0%	0%	0%	1	3%
Total	100%	100%	100%	100%	92	100%

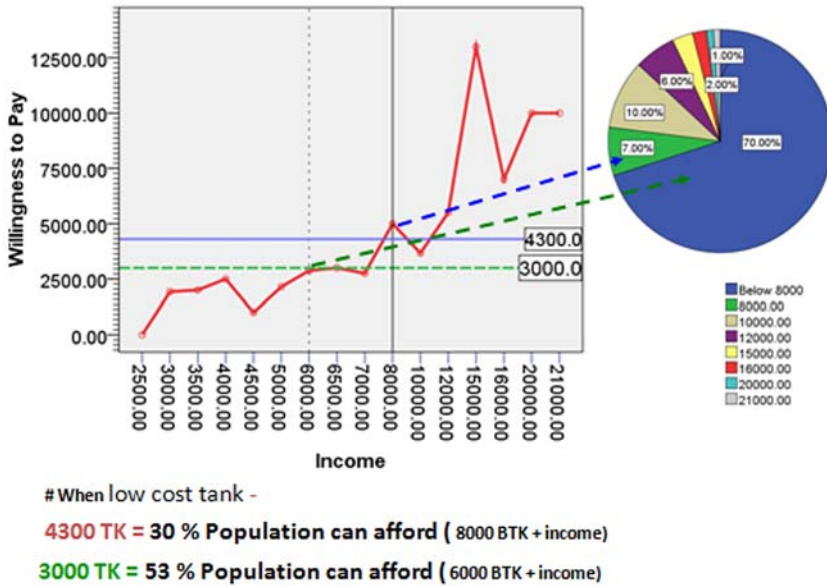


Figure 7.1 Baseline survey of affordable cost of rainwater jar. (Source: Author's own).

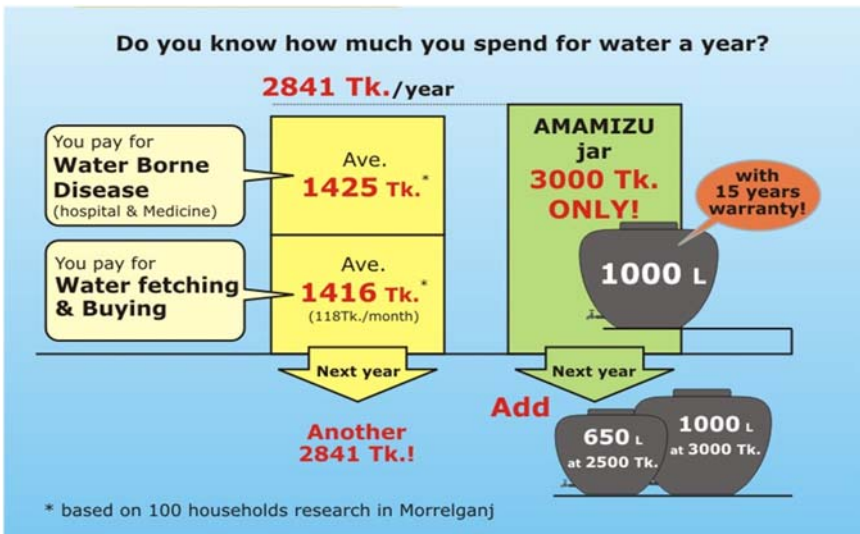


Figure 7.2 Baseline survey of water cost. (Source: Author's own).

household costs for water and medical treatment, so installing AMAMIZU is not so expensive. The drinking water issue would also be solved at the same time (WHO, UN-Water, 2017).

7.3 DEVELOPMENT OF LOW-COST RAINWATER TANK

Based on the above baseline survey, I decided to take up the challenge of developing a new low-cost tank which could be produced at a selling price of 3000 Tk.

Before drinking water was artificially purified by modern water supply systems in Japan, which started 128 years ago, people drank ‘natural water’, such as, river water, lake water, spring water, groundwater, and rainwater. Rainwater has been the main source of drinking water in isolated islands in Japan. Bangladesh has the same history. Local people in rural areas collected rainwater to drink in an earthenware pot called a ‘Motka’ (Figure 7.3). Still now they harvest rain into a Motka and use it for drinking and cooking in the rainy seasons.

When I went to a customer’s house to install a concrete rainwater tank six years ago, I discovered several Motka in a line filled with rainwater at the back of the house. I asked the house owner why they did not drink rainwater. They replied, ‘Yes, rainwater is safer than pond water, that’s why we have reserved rainwater for our friends and relatives’. After 10 minutes, when rainfall with high intensity flushed out dust and leaves on the roof, local people harvested clean rain through galvanized gutters into a Motka with its mouth covered with cloth. The cloth filters the water and prevents invasion from mosquitos. Over time local people have learned how to harvest safe rainwater through their own experiences.

Motka is cheap and has been affordable for poor local people. But it has weak points. Motka has a capacity of 50–100 liters. It is too small to cover drinking



Figure 7.3 Motka. (Source: Author’s own).



Figure 7.4 Thailand giant jar. (Source: Author’s own).

water needs over the dry season and is also fragile. I came up with the idea of new jumbo Motka which is solid and has a larger capacity than traditional Motka.

To meet the above requirements, I found a mortar or concrete water jar in Thailand, called ‘Giant Jar’ (Figure 7.4), which has been used by local people in the northwest rural areas. The capacity of this jar was between 650 and 2000 liters. The selling price of a 650-liter Giant Jar was 3000 Tk. Thais have harvested sky water into the Giant Jar to use as safe drinking water. They purchase an additional Giant Jar every year. There were 4–6 Giant Jars in a house.

ISWH dispatched two Bangladeshi masons to the National Chombri Job Training Center in Thailand to acquire the skill of Giant Jar technology. After training, they came back to Bangladesh. ISWH hired them and started to develop the Bangladesh version of a low-cost water container. This technology is popular in Thailand and Cambodia, but not found in Bangladesh. ISWH improved the Giant Jar technology.

The production method is as follows: (1) make a mother mold; (2) make a dice based on the mold, a die consists of 16 parts; (3) third, set up the dice on the base and fix with wire (Figure 7.5); (4) mud treatment of the outside wall followed by mortar treatment on the mud layer (Figure 7.6); (5) reinforcement with steel wire net and mortar (Figure 7.7); (6) remove the dice from inside the jar after the mortar has dried (Figure 7.8). It looks a little like an apple which has been hollowed out in the middle. All die can be reused.

ISWH could complete the Bangladesh version of the Giant Jar, which is made from mortar reinforced with steel wire net and has a capacity of 1000 liters. This new low-cost jar was named ‘AMAMIZU’. AMAMIZU in Japanese means ‘sky water’. I decided to call rainwater ‘sky water’ through learning the wisdom of our ancestors. Sky water is a gift from heaven. Our ancestors have harvested rain and used it for drinking water and they called rainwater ‘sky water’ with great respect. AMAMIZU also has another meaning. It means ‘sweet water’. When Bangladeshis drank sky water instead of pond water, which has high salinity, they told me that sky water tasted sweet.



Figure 7.5 Set up dice. (Source: Author's own).



Figure 7.6 Mortar treatment on the mud layer. (Source: Author's own).



Figure 7.7 Reinforcement with wire net. (Source: Author's own).



Figure 7.8 Remove dice from inside the jar. (Source: Author's own).

ISWH obtained the patent for AMAMIZU systems in February 2015. A description of the AMAMIZU systems is given below and in [Figure 7.9](#):

- **Catchment:** The sky water catchment area should be the roof. Roofs made of anything except jute are acceptable, for example, tin, concrete and mortar or ceramic tiles.
- **Collection:** Rain falling on the roof is collected by a plastic gutter and flows into a jar through chains hanging from the gutter. Chain gutter systems have been used commonly at temples in Japan. But we experienced problems with the chain gutter system: whenever we had heavy rain, water splashed from the plastic chain into the house through open windows. Now we use a movable elbow pipe instead of a plastic chain.
- **Storage:** Sky water is stocked in AMAMIZU. When an AMAMIZU tank fills up with rain, it flows to the next AMAMIZU through an overflow pipe.

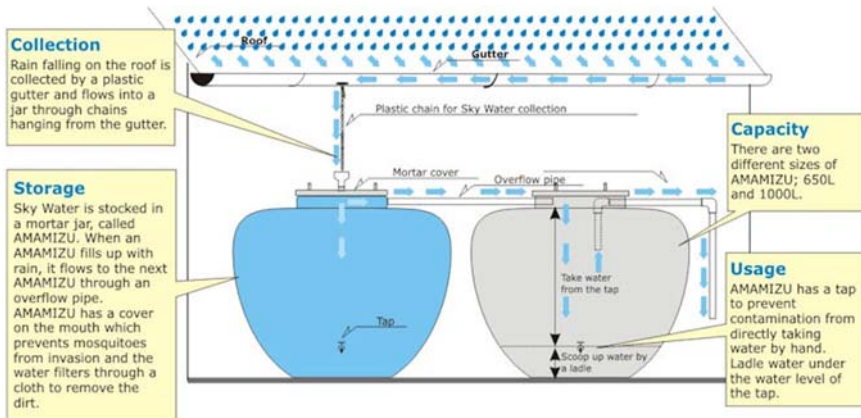


Figure 7.9 AMAMIZU systems. (Source: Author's own).

AMAMIZU has a cover net on the inlet pipe which prevents mosquito invasion. Sometimes local people put a cover on the mouth of AMAMIZU and filter the water through a cloth to remove the dirt. One AMAMIZU can connect with another one through a connection pipe.

- *Usage:* AMAMIZU has a tap to prevent contamination from directly taking water by hand. The tap is made from plastic, but metal taps are also available which can be locked.
- *Transportation:* One AMAMIZU was transported by a Rikisha van to customers living within 2 km. Engine van instead of Rikisha van is available for transportation to customers more than 2 km away. But we had trouble. The total weight of AMAMIZU is 250 kg. The AMAMIZU body was affected by strong shaking during transportation which caused crack issues. From this lesson, we have developed a new AMAMIZU, called 'Super AMAMIZU' which was reinforced with steel wire net by the adaptation of ferro-cement technology. Also, we have transported AMAMIZU to stock yards by an engine boat which are located more than 4 km distant. Nine AMAMIZU could be transported this way at one time.

The AMAMIZU production center (APC) was constructed in Morrelganji in 2012 in cooperation with JICA.

7.4 AMAMIZU SOCIAL PROJECT

ISWH started a pilot project of AMAMIZU social enterprise in cooperation with JICA and PR Bangladesh (a local NGO which I established in 2008) in 2012. The price of AMAMIZU, including installation and gutter pipe was 3000 TK and transportation was 1300 TK. The total selling price of AMAMIZU systems was 4300 TK. So that more BOP (Base of Pyramid) people could buy AMAMIZU systems, we introduced a more flexible payment method. After local people paid the down payment of 2000 TK, AMAMIZU systems were installed. PR Bangladesh raised awareness of sky water harvesting (SWH) and provided operation and maintenance training of AMAMIZU systems to local people. The remainder was reimbursed within 6 months. The pilot project was successful, 200 AMAMIZU were sold and installed. 97% of remaining payments were recovered.

Following the pilot project, Skywater Bangladesh Ltd. (SBL) was established to tackle the social enterprise side of sky water harvesting. A production manual of AMAMIZU was prepared for quality control. Patent of AMAMIZU systems and design registration of AMAMIZU were secured. Also, a training center was opened to develop skilled masons and water quality control. A newsletter published the results of monitoring and was also used for marketing and awareness. The total number of AMAMIZU produced reached 3600 in March 2018.



Figure 7.10 CHB tank of Morrelganji Health Complex. (Source: Author's own).

The main target of the AMAMIZU social project is private houses. But for supply of safe drinking water for all, the social enterprise of sky water harvesting should be promoted not only at private houses but also at community and public facilities in rural areas where there are no piped water supply systems. Application of the sky water harvesting technologies to community and public facilities should be different from AMAMIZU systems. SBL developed the concrete hollow block tank (CHB tank) in 2013. Capacity could be scaled up from 5 tons to several hundred tons. In September 2013, in cooperation with JICA, SBL constructed CHB tanks with a total capacity of 150 tons (50 tons \times 3 unit) at Morrelganji Health Complex, Bagerhat district, to supply safe drinking water to patients and medical and official staff (Figure 7.10).

Before installation of sky water harvesting systems, water for drinking and cooking was taken from a pond in the hospital. But when there were water shortages in the dry seasons, river water which flows nearby the hospital and is contaminated with domestic waste water and salinity was drawn into the pond. A sand filter had been installed for purification of the pond water, but it is difficult to remove pathogenic microorganisms and salinity. Many people suffered from diarrhea.

A Health Complex management committee for the maintenance of sky water harvesting systems has been organized with medical doctors and official staff members in cooperation with SBL. They clean the roof catchment areas every month and made rules about intake of sky water from the tank so as to secure drinking water for the whole the year. The hospital has been satisfied with the quality of their drinking water by good ownership.

In addition to Morrelganji Health Complex, in 2019, seven CHB tanks whose capacity is 50 ton have been installed to secure safe drinking water in an emergency at seven cyclone shelters in Chittagong City where a cyclone resulted in a drinking water crisis.

Besides coastal areas, such as Morreganji, there are many places experiencing the same drinking water crisis, such as in the northern areas of Bangladesh and the hill tracts of Chittagong. There are more than 20 million people who have no access to a safe drinking water source. This means there is a big demand for sky water harvesting. A sustainable social enterprise model of sky water harvesting is shown in Figure 7.11. SBL has three social enterprise plans for different targets. The first is AMAMIZU social enterprise for BOP people, called the mother business, which is production, sales, and installation of AMAMIZU (1000 liter). The second is high-quality concrete ring (CR) tanks (4400 liters) for people with a higher income. The third is concrete hollow block (CHB) tanks (more than 5000 liters) for communities and public facilities. AMAMIZU business is low profitability compared to CR and CHB tanks. The profit made on CR and CHB tanks is used effectively for the mother business and mason training. Also, donations are used for making the mother business sustainable.

SBL will start social franchise (NORENWAKE) systems to promote sky water harvesting all around Bangladesh in the future. NORENWAKE is part of Japanese traditional commercial culture, which has secured a high-quality product and sustainable service with ownership. After 10 years of experiencing the sky water harvesting social enterprise, if some skilled masons and staff want to take

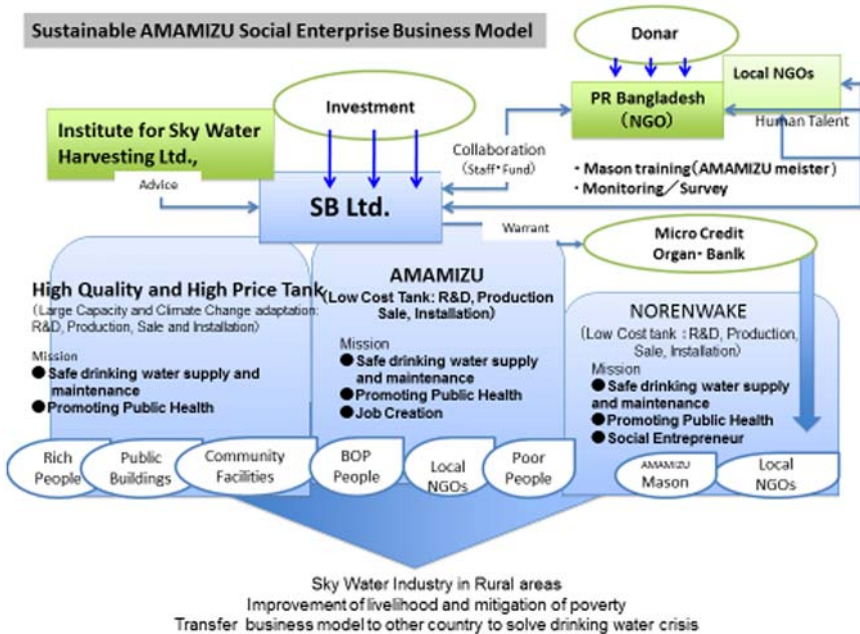


Figure 7.11 Sustainable AMAMIZU social enterprise business model. (Source: Author's own).

up the challenge of NORENWAKE, they could become independent with microcredit systems and start to produce, sell and install AMAMIZU in cooperation with SBL. If AMAMIZU NORENWAKE could spread all around Bangladesh, it could make a significant contribution to solving the drinking water crisis in rural areas of Bangladesh. We hope it will create a 'sky water industry' by circulating human talents, materials, and sustainable funds in local communities and become part of the social fabric.

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