Water quality of small-scale desalination plants in southwest coastal Bangladesh

Md. Atikul Islam, Md. Ali Akber and Prosun Kumar Ghosh

ABSTRACT

Southwest coastal Bangladesh has an acute scarcity of safe drinking water. Both the government and non-government organizations are now promoting reverse osmosis based small scale desalination plants (SSDPs) to ensure safe drinking water. The aim of this study was to assess the physico-chemical and bacteriological quality of the desalination plants (DPs) installed in southwest coastal Bangladesh. Water samples were collected from the inlet and outlet of 10 DPs. The product water mostly complied with water quality standards. High levels of total dissolved solids (TDS) and electrical conductivity (EC) in feed water were reduced significantly after the treatment, although 10% and 20% of the product water samples respectively did not comply with the WHO drinking water standards for those parameters. Compliance of product water with the WHO and Bangladesh drinking water standards for chloride, bicarbonate and sodium were found in respectively 80%, 90% and 70% of the samples, although their concentrations in all the feed water samples were higher than both of the standards. About one-third of the DPs did not meet the drinking water standard for sodium, which may be an important health concern for the people consuming this water. Apart from one of the DPs, all of them complied with the standard for faecal coliform and *Escherichia coli*. Results suggest that proper maintenance of the SSDPs is necessary to ensure safe drinking water for the coastal population of southwest Bangladesh.

Key words | coastal Bangladesh, desalination, drinking water, reverse osmosis, water quality

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INTRODUCTION

Scarcity of drinking water is an acute problem in southwest coastal Bangladesh. Salinity intrusion in the exposed coast is mainly responsible for the drinking water crisis in this region (Khan *et al.* 2011; Rahman *et al.* 2016). The coastal population relies mainly on tube-wells (groundwater) and rain-fed ponds for drinking water (Islam *et al.* 2013). However, freshwater aquifers are heavily affected by salinity intrusion (Islam *et al.* 2015; Sultana *et al.* 2015). Fresh water ponds are also increasingly salinized by saline water from rivers, soil runoff, and shallow groundwater (Khan *et al.* 2011). Thus, both the fresh water and groundwater sources are unsuitable for human consumption, mainly because of high salinity (Benneyworth *et al.* 2016). In addition, natural sources of drinking water in coastal Bangladesh face higher microbial contamination and cause significant health hazard (Karim 2010; Islam *et al.* 2011; Islam *et al.* 2015). In this context, various water treatment technologies are being promoted by both the government and non-government organizations such as small-scale desalination plant (SSDP), piped water supply, and managed aquifer recharge (Kabir *et al.* 2016).

Bangladesh is one of the most vulnerable countries to global climate change and sea level rise, especially the southwest part of the country, which has an elevation lower than 10 m (Kabir *et al.* 2016). So, there is higher demand for long-term solutions to ensure safe drinking water to the inhabitants of southwest coastal Bangladesh. Desalination plant (DP) based on reverse osmosis (RO) technology could be considered as a safer and climate resilient drinking water supply option for the coastal areas, since

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it is one of the best technologies for resolving the problems of utilizing both sea-water and brackish water (Al-Jayyousi & Mohsen 2001). Due to the effectiveness of DP in providing safe drinking water, both the government and non-government organizations are now promoting this technology in southwest coastal Bangladesh. All the DPs installed in southwest coastal areas are RO plants, and their operational conditions are almost similar. Most of them were established between 2012 and 2015. They have a production capacity of about 20–60 m^3/d.

RO requires much lower energy compared to the thermal technologies used for desalination (Watson *et al.* 2003). In the RO filtration process, a semi-permeable membrane allows water to pass through, but not the salt. A schematic diagram of the RO plant installed in southwest coastal areas is shown in Figure 1. Water is pumped from a pumping well to the oxidation tank and stored in the raw water tank. Then the water flows through a gravel and ultrafine media filter. This filter is usually used as a pre-filter because it is an economical way to remove 98% of suspended solids, dirt, rust and other sediment. It also protects elements downstream from fouling or clogging. Next, the water flows to the activated carbon filter. After filtration, the water flows to the softener, which has a small tank full of NaCl. The softener's function is to replace Mg^{2+} and Ca^{2+} with Na^+, and this process is called ion exchange, aiming at reducing the water hardness. Next, the water flows through a 1-micron cellulose filter to ensure effective filtration. In the next stage of the process, the water flows to the RO membrane system. RO membranes are capable of rejecting practically all particles, bacteria, and viruses. In the water purification system, a pump with 14 bar provide enough pressure for RO application; pressure will be applied to the concentrated solution to counteract the osmotic pressure. Water pressure also affects the quantity and the quality of the water produced. Pure water is stored in a tank, and is collected from several collection points.

The DPs installed in the southwest coastal areas mainly purify brackish shallow groundwater. The quality of the desalinated water depends on proper operation and maintenance of the plant. To our knowledge, no studies have been conducted to evaluate the chemical and bacteriological quality of those DPs. Since the community based water supply options in rural southwest coastal Bangladesh suffers from lack of proper operation and maintenance (Islam *et al.* 2013), it is essential to evaluate the potability of the desalinated water. The objective of the study was to evaluate the physico-chemical and bacteriological quality of the DPs in the southwest coastal areas of Bangladesh, as a way to ascertain the water quality for human consumption. This study is the first effort to assess the performance of RO technology based SSDP to purify brackish shallow groundwater in the rural coastal area of Bangladesh. The findings of this study are expected to provide new insights into the potability of desalinated shallow brackish water. This information is urgent for management of the existing SSDPs in this region, and to promote a reliable source of drinking water. The findings are also expected to be useful in applying this low-cost technology with similar hydro-geological condition elsewhere.
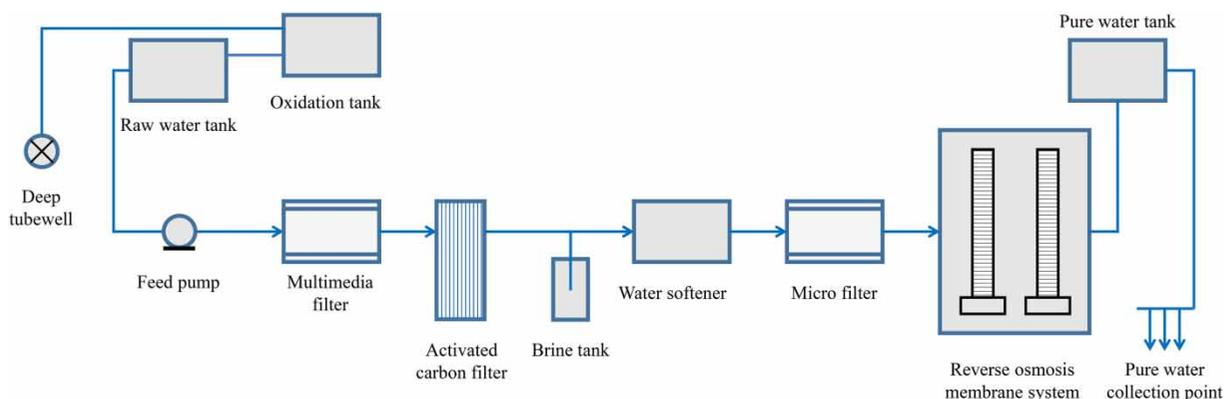
Figure 1 | Typical RO unit used in southwest coastal Bangladesh.

METHODS

Study area

We considered southwest coastal Bangladesh as the study area (Figure 2). The southwest coastal area of Bangladesh includes three districts: Satkhira, Khulna and Bagerhat. This low lying coastal plain is gently sloped toward the Bay of Bengal at the south, and consists of a complex river network. At the southern fringe, there stands the *Sundarbans*, which is the largest single tract of mangrove forest in the world. This area has a humid climate with three distinct seasons: pre-monsoon (March to June), monsoon (July to October), and post-monsoon (November to February). The annual rainfall ranges from 1,500 mm to 2,000 mm, where about 70% of the rainfall occurs in the monsoon season (Kabir *et al.* 2016). We collected water samples only from the DPs, which were in operation during the sampling time. Out of nine and seven DPs of Khulna and Satkhira districts respectively, we found six and four of them in operation during our sampling time. All the five DPs present in Bagerhat districts were out of operation at that time. So, we were able to collect samples from 10 DPs of Khulna and Satkhira districts only. Locations of the studied DPs are shown in Figure 2, and their descriptions are presented in Table 1.

Water sampling

Water samples were collected from the selected DPs of the study area in the dry season (April and May 2015). It is the hottest period of the year and consequently water salinity goes up with the increased scarcity of water. We considered only the dry season for sampling, since households are generally dependent on RO plant water during the dry season. In the rainy season, people prefer drinking rainwater for easy availability. Due to the bad transportation system in the study area, we did not consider the rainy season for sampling. Only one of the DPs (DP2) was using rain-fed pond water as the feed water, while the rest of them were using shallow ground water (Table 1). Samples were taken from all the inlets and outlets of the DPs following the standard procedures (APHA 1998) to examine the efficiency in improving the potability of the water. For physico-chemical analyses, 1-litre volume of water samples were collected at each sampling point by labeling separately and using polyethylene bottles. For bacteriological analysis, 500-ml water samples were aseptically collected in sterile Nalgene plastic bottles. All samples placed in an insulated box filled with ice packs (Johnny Plastic Ice; Pelton Sheperd, Stockton, CA, USA) and transported to the laboratory of Environmental Science Discipline, Khulna University, for analysis immediately after collection.
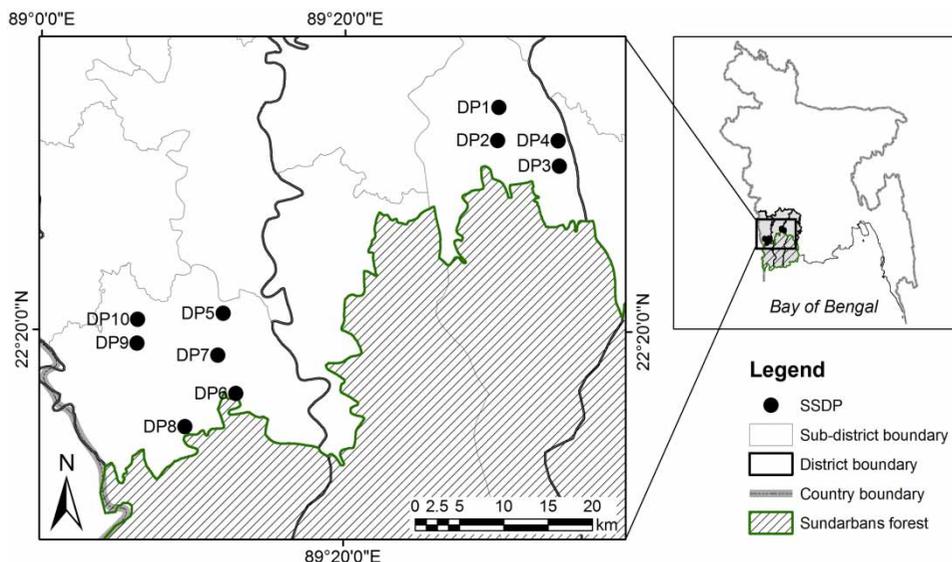

Figure 2 │ Locations of the small-scale desalination plants (SSDP) in the study area.

Table 1 | Description of the SSDPs

Site code	Description of the site	Year of establishment	Founding organization	Water	Capacity (m³/day)	Productivity (m³/day)	Brine disposal
Khulna District							
DP1	Desalination pump, Dacope	2012	GO	GW	30	15	River
DP2	Tripti pure water, Dacope	2012	NGO	Rain-fed pond water	30	25	Natural drain
DP3	Ad-din pure water plant, Laudobi, Dacope	2013	NGO	GW	30	15	River
DP4	Water treatment plant, Nazarin Mission, Bajua, Dacope	2012	NGO	GW	30	10	Natural drain
Satkhira District							
DP5	Desalination water plant 01, Noubeki, Atulia Shyamnagar	2013	NGO	GW	60	60	Natural drain
DP6	Desalination plant, Crab project, Datinakhali, Burigualini, Shyamnagar, Satkhira	2014	GO	GW	30	30	River
DP7	Desalination water plant 02, Noubeki, Atulia, Shyamnagar	2015	NGO	GW	50	20	Natural drain
DP8	Desalination plant, Munshigonj, Shyamnagra	2012	GO	GW	30	15	Natural drain
DP9	Safe Water Safe Life, Charkhali, Shyamnagar	2014	NGO	GW	50	20	River
DP10	Pollibondhu drinkable water project, Kaligonj, shyamnagar	2012	GO	GW	20	20	River

DP = desalination plant; GO = government; NGO = non-government organization; GW = shallow ground water.

Physico-chemical analysis

pH, electrical conductivity (EC) and total dissolved solids (TDS) were measured immediately after sampling in the field by a portable pH (Hanna) and an EC/TDS meter (Hanna). All the chemical analyses were performed using standard methods (APHA 1998). Sodium and potassium were analyzed using a flame photometer. Calcium and magnesium were determined by titrimetric method using a high purity EDTA solution. Bicarbonate and fluoride were determined by potentiometric method while chloride was determined by ion selective electrode method (Cole-Palmer Model 27502-13) using standard silver nitrate solution. In addition, nitrate and sulphate were determined by spectrophotometric method. In the case of sulphate determination, a high purity berelium chloride was used. Arsenic was measured using the Econo Quick test kit (Industrial

Test Systems, Rock Hill, South Carolina) (George et al. 2012).

Bacteriological analysis

For enumeration of faecal coliforms (FC) and Escherichia coli, 100 ml water samples were filtered through a 0.45 μm pore-size membrane filter (Millipore Corp., Bedford, MA, USA), and then the filters placed on membrane faecal coliform (mFC) and m-TEC agar plates, respectively, following procedures that have been described elsewhere (APHA 1998; Islam et al. 2001). The mFC plates were incubated at 44°C for 18 to 24 h to enumerate the FC, and the mTEC agar plates were incubated at 35 ± 0.5°C for 2 h followed by further incubation at 44.5 ± 0.2°C for 22–24 h to enumerate the E. coli. Characteristic blue colonies were counted as FC. Pale yellow, yellow brown, and yellow green colored

colonies were counted as *E. coli*, and expressed as colony forming units (cfu) per 100 ml.

RESULTS AND DISCUSSION

Physico-chemical water quality

Table 2 and Figure 3 represent the chemical properties of the water samples, and compare them with WHO (WHO 1997)

and Bangladesh (BD) drinking water standards (GOB 1997). Apart from chloride, the mean concentration of all the parameters of the product water were within the WHO and BD standards. Table 2 also shows the percentage of product samples that exceed WHO and BD standards. The bacteriological quality of water samples are presented in Figure 4 and Table 3. About 90% of the samples comply with the water quality standards.

All the chemical and biological reactions are directly and indirectly governed by the pH of the water. Figure 3(a) shows the pH values recorded for feed (raw) and product

Table 2 | Comparison of physico-chemical properties of feed and product water of the DPs with WHO and Bangladesh (BD) drinking water standards

Parameter	Sampling sources	Mean (SD)	Standard deviation	Minimum	Maximum	Percentage of samples above WHO standard	Percentage of samples above BD standard	WHO standard	BD standard
pH	Feed	7.09	0.24	6.57	7.38	0	0	6.5–8.5	6.5–8.5
	Product	7.42	0.37	6.60	7.80	0	0		
TDS mg/l	Feed	5,246	2,343	1,450	9,883			1,000	–
	Product	494	383	208	1,171				
EC µS/cm	Feed	8,651	3,843	2,507	16,400			1,500	–
	Product	792	596	338	1,922				
Cl^- mg/l	Feed	2,567	1,608	422	6,094	90	90	250	150–600
	Product	261	247	88	786	20	20		
Na^+ mg/l	Feed	1,470	697	285	2,600	100	100	200	200
	Product	122	113	5	300	30	30		
K^+ mg/l	Feed	22.28	21	1.67	55	50	50	5	12
	Product	3.31	2.81	0.50	8.33	0	0		
Ca^{2+} mg/l	Feed	232	143	72.14	441	90	90	100	75
	Product	8.81	2.70	6.00	14	0	0		
Mg^{2+} mg/l	Feed	125	48.1	48.61	170	100	100	60	30–35
	Product	10	5.81	2.43	18	0	0		
HCO_3^- mg/l	Feed	752	272	366.00	1,220			200	–
	Product	80	103	27.45	360				
NO_3^- mg/l	Feed	8.84	10.6	1.08	30.77			50	–
	Product	2.35	2.66	.06	8.30				
SO_4^{2-} mg/l	Feed	69	123.7	6.25	415			250	400
	Product	6.76	7.63	1.00	27.5				
F^- mg/l	Feed	0.29	0.2	0.04	0.63			1.5	–
	Product	0.09	0.06	0.02	0.23				
As mg/l	Feed	0.03	0.09	0	0.3			0.01	0.05
	Product	0.05	0.1	0	0.3				

N/A indicates no published WHO and BD standard.
BD standard = Bangladesh standard.
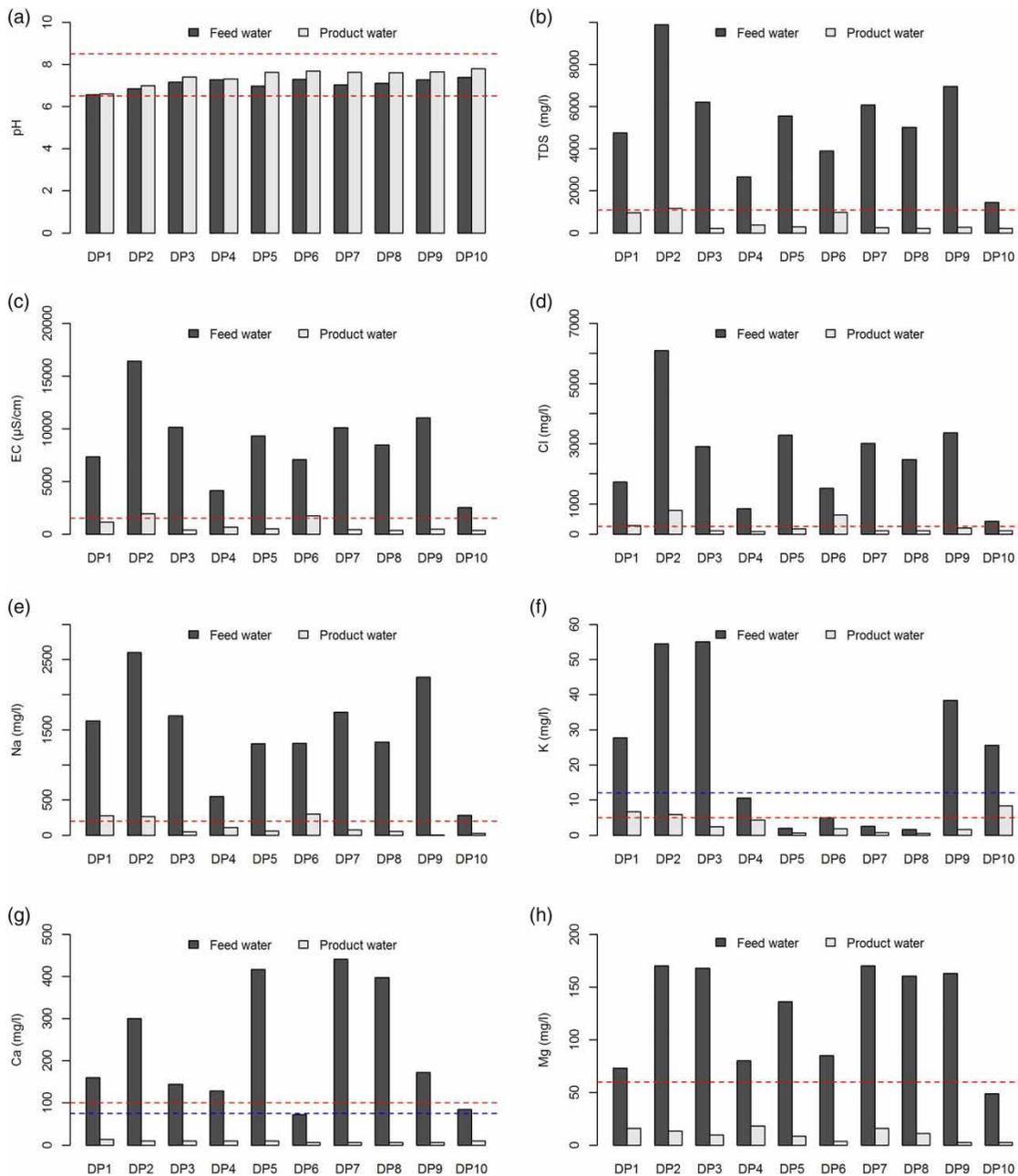
Figure 3 │ Concentrations of the physico-chemical parameters in feed and product water samples of the SSDP. *Note:* Red and blue color lines indicate WHO and Bangladesh standard respectively. Please refer to the online version of this paper to see this figure in color: http://dx.doi.org/10.2166/ws.2017.222. (*Continued.*)

water samples of all DPs compared with maximum and minimum allowable limits (6.5–8.5) of both WHO and BD standards. pH value for all feed and product waters were within the range of WHO and BD standards. Product water pH was found to be slightly higher than feed water

for all DPs. Generally, desalination media is acidic, which is typical for RO membranes used for desalination (Al-Khatib & Arafat 2009; Mogheir *et al.* 2013). Due to the desalination process, the pH value of product water may lower to the minimum concentration (6.5)
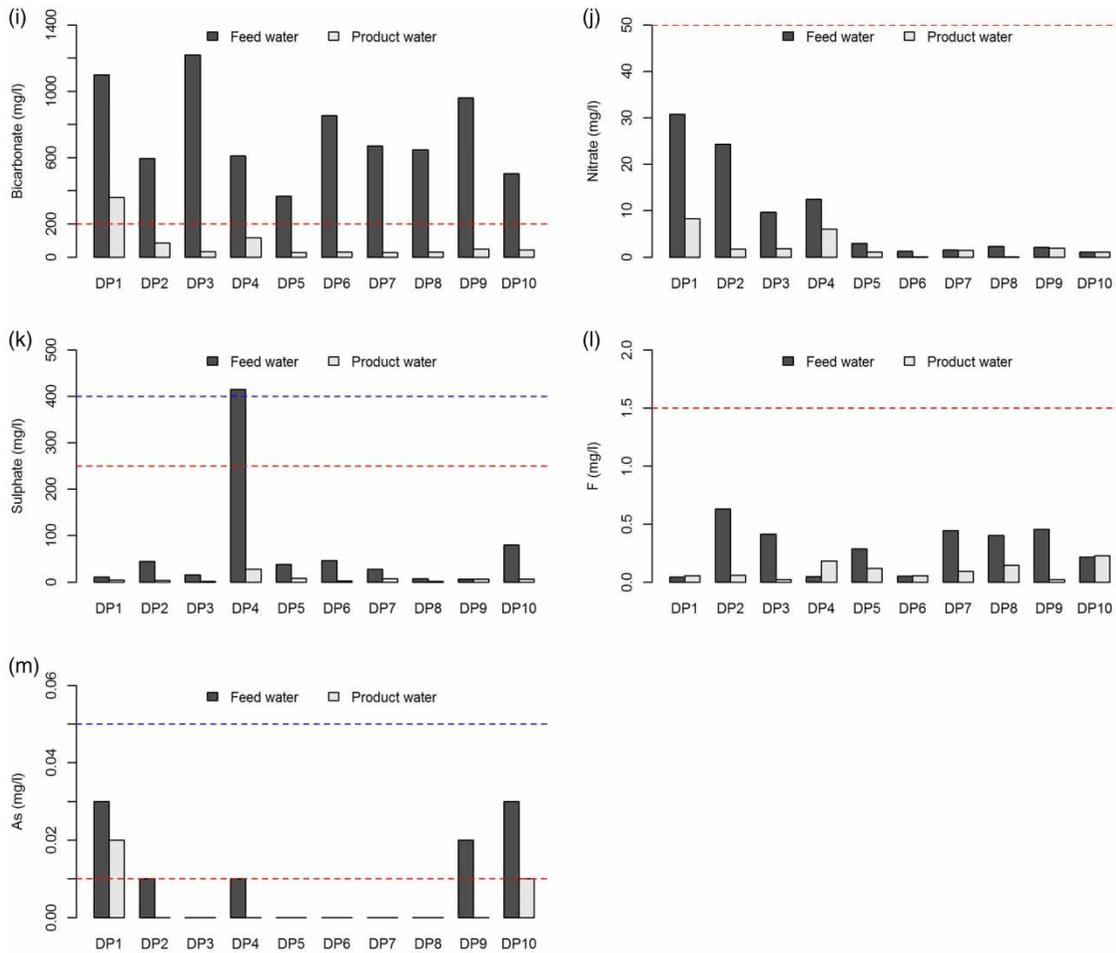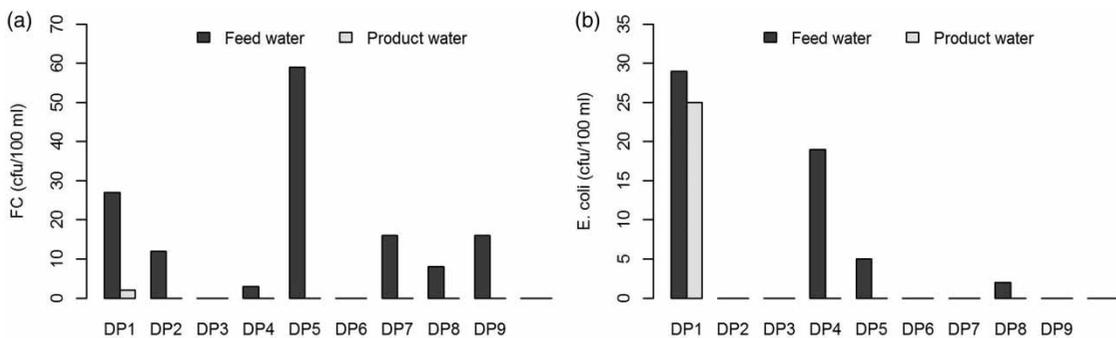
Figure 3 │ Continued.

Figure 4 │ FC and *E. coli* concentrations of the feed and product water samples of the SSDP. *Note:* WHO and BD guideline value for FC and *E. coli* is 0 cfu/100 ml.

recommended by the WHO (Al-Khatib & Arafat 2009; Aish 2011). Aish (2011) found a reduction of pH in product water for all the examined DPs.

TDS of water is an important parameter in assessing its potability. The mean concentration of TDS at the inlet was 5,246 mg/l and the TDS ranges from 1,450 to 9,883 mg/l

Table 3 | Removal efficiency of Indicator bacteria by DP

Parameter	Feed water			Product water			Average % of reduction
	Median	Range	% of samples within WHO and BD GV	Median	Range	% of samples within WHO and BD GV	
FC (cfu/100 ml)	10	0–59	30%	0	0–7	90%	95
E. coli (cfu/100 ml)	0	0–29	60%	0	0–25	90%	91

Note: WHO and BD guideline value for FC and E. coli is 0 cfu/100 ml.

(Table 2). The mean concentration at product was 494 mg/l and the TDS ranges from 208 to 1,171 mg/l. This indicates the high desalination efficiency and salt rejection of the RO membranes of those treatment plants. Figure 3(b) shows the TDS concentrations of feed and product water samples. All the feed samples were found to be higher than WHO standards. The highest TDS concentration (9,883 μS/cm) was found in DP2, which used rain-fed pond water as feed water. Most of the feed samples (80%) had TDS concentration above 3,500 mg/l. This is much higher compared to the other studies (Al-Khatib & Arafat 2009; Aish 2011). Except for DP2, significant reduction of TDS was found in the product water of all the DPs. TDS concentration of the product water for DP2 was 1,171 mg/l. Al-Khatib & Arafat (2009) also found a TDS concentration of desalinated water above standard. Drinking water containing a TDS of greater than 1,000 mg/l may cause some long term public health problems and could be associated with health risks (Kempster et al. 1997). TDS removal percentage of the DPs of our study area ranged between 75% and 96%.

The EC of feed and product water of all the DPs are shown in Figure 3(c). EC for all feed water samples were found to be higher than the WHO standard. The analytical data of product water samples showed that 20% of the samples had EC concentrations above the WHO standard. EC above standard was also reported in a study conducted by Al-Khatib & Arafat (2009). The trend of EC concentrations were almost similar to that of TDS for both feed and product water samples.

Presence of chloride in water is considered as one of the major causes of salinity (Mogheir et al. 2013). Figure 3(d) shows the chloride concentrations of feed and product water samples. The mean chloride concentration of feed and product water were respectively 2,567 mg/l (422–6,094 mg/l)

and 261 mg/l (88–786 mg/l) (Table 2). Chloride concentrations at the inlet were much higher than the maximum allowable limit of the WHO (250 mg/l). The maximum chloride concentration was found in the feed water of DP2 (which use rain-fed pond water). About 30% of the product water samples were above the WHO standard. DP2 and DP6 product water did not satisfy the maximum allowable limit (600 mg/l) of the BD standard. However, previous studies (Al-Khatib & Arafat 2009; Aish 2011) have found that RO plants can ensure chloride concentrations much below the standard limit. It is worth mentioning that the chloride rejection percentages of the studied DPs were between 73% and 96%.

Figure 3(e) shows the sodium concentration of feed and product water samples. Sodium concentrations of all feed samples were found to be higher than the maximum allowable limit of the WHO and BD standards, ranging from 285 to 2,600 mg/l. The highest concentration was found in DP2 (which is fed by rain-fed pond water) (2,600 mg/l), although the mean sodium content in tube-well water (885 mg/L) in southwest coastal Bangladesh is higher than pond water (738 mg/L) (Talukdar et al. 2015). Except for DP 1, 2 and 6, all the product waters were found to have lower sodium concentrations than the maximum allowable limit of both the WHO and BD standards, with average removal between 77% and 99%. The lowest removal was found in DP6 (77%).

Sodium is the most important ion for human health because a higher sodium intake may cause hypertension, congenital heart diseases, nervous disorders and kidney disease. In addition, high salt contents in drinking water decrease the palatability of water, and cause intestinal irritation and laxative effects in humans (WHO 1997). Hypertension is a major risk factor for cardiovascular diseases, which now account for more than 27% of all deaths in Bangladesh (WHO 2011a). Recent studies (Rasheed et al.

2014; Talukdar *et al.* 2016) have found that the southwest coastal population is more vulnerable to hypertension due to the high sodium content in drinking water. It is also an important cause of infant mortality in the coastal area of Bangladesh (Khan *et al.* 2011; Dasgupta *et al.* 2016). Therefore, the sodium concentration in product water samples above the guideline value may be a health concern for the coastal population. Previous studies (Al-Khatib & Arafat 2009; Aish 2011) have found that RO plant can ensure sodium concentration much below the standard limit. So, proper operation and maintenance may warrant the sodium concentration within the standard limit.

Figure 3(f) shows the potassium concentration of the feed and product waters of all the DPs. The potassium concentration of 60% and 50% of the feed water samples were above the WHO and BD standards respectively. However, 70% and 100% of the product water samples were found to have lower concentrations than the maximum allowed by both WHO and BD standards. The potassium removal percentage ranged between 58% and 96%.

Figure 3(g) shows the calcium concentration of the feed and product waters of all the DPs. Two plants feed water samples had calcium concentration less than the standard of WHO (100 mg/l). All product water samples had calcium concentration accepted by the WHO and BD standards. The calcium concentration in product water samples ranged from 6.02 mg/l to 14.02 mg/l (Figure 3(g)).

Magnesium concentrations of feed and product waters of all DPs are shown in Figure 3(h). Lower concentration of magnesium than the maximum allowable limit of the WHO standard was found only for DP10. In addition, all feed waters were found to have higher magnesium concentrations than the maximum allowable limit of the BD standard. However, product waters from all the DPs were found to have lower concentrations than the maximum allowable limit of the WHO and BD standards. Magnesium removal percentage ranged between 78% and 99%.

All the feed water samples showed alkalinity higher than the WHO standard (200 mg/l) (Figure 3(i)). However, all the product water samples except DP1 showed alkalinity less than 200 mg/l.

Nitrate is one of the important drinking water quality parameters because it causes blue baby syndrome in infants (Mohsin *et al.* 2013). Figure 3(j) shows the nitrate concentration levels of the feed and product water samples of all the DPs. Nitrate concentrations of the feed and product water samples for all plants were lower than the maximum allowable limit of the WHO standard. The DP10 product water sample showed a nitrate concentration slightly higher than the feed. The nitrate concentrations in product water ranged between 0.06 and 8.3 mg/l (Figure 3(j)).

Sulphate concentrations of feed and product water of all the DPs are shown in Figure 3(k). Except for DP4, all the feed water samples had lower sulphate concentrations than the maximum allowable limit of the WHO and BD standards. However, all the product water samples were found to have acceptable sulphate concentrations.

Fluoride is an important chemical element of the drinking water found in geochemical forms, and is required for the prevention of tooth decay. The intake of fluoride is harmful when it exceeds its permissible limits. It is reported that intake of fluoride with drinking water above 1.0 mg/l may cause dental fluorosis and above 3.0 mg/l may cause skeletal fluorosis (USPHS 1987). Figure 3(l) shows fluoride concentrations of feed and product water samples for all the DPs. Concentrations of fluoride in all of them were lower than the WHO standard. However, the product waters of DP4, 6 and 10 had higher concentrations of fluoride than that of the feed water.

Arsenic contamination is one of the most important issues regarding public health and safety in Bangladesh, which is the most arsenic affected country in the world (Ahmed *et al.* 2016). Excessive intake of arsenic with drinking water is harmful for human health and hence, WHO (2011b) determined the desirable limit for arsenic to be 0.01 mg/l, However due to massive groundwater arsenic contamination, the government of Bangladesh has determined a standard of 0.05 mg/l. Among the DPs we studied, feed water samples from three of them had As concentration above the WHO standard (Figure 3(m)). For the product water samples, only one of the DPs had As concentration above the WHO standard. However, the concentration of As in all the water samples (both feed and product) were within the BD standard.

Bacteriological water quality

Figure 4(a) shows FC concentration of feed and product water samples. Only three of the DPs had FC concentrations of feed waters within the WHO and BD standards

(0 cfu/100 ml). However, all the product waters except DP4 met the standard. Several studies reported high FC concentration in product water compare to the feeds (Al-Khatib & Arafat 2009; Aish 2011). Bad quality filters may play a significant role in the formation of bacterial biofilm inside the filters (Aish 2011). Al-Khatib & Arafat (2009) also found that the percentage of samples with FC contamination of product water was higher (7%) than the rain-fed cisterns (3.9%). So, regular monitoring of microbial quality of product water is essential to ensure the potability of desalinated water.

Feed samples from four of the DPs showed *E. coli* contamination (Figure 4(b)). However, except DP1, all the DPs met the standard of 0 cfu/100 ml at product. Table 3 shows median, range and percentage of samples exceeded the WHO and BD standard for *E. coli* and FC at feed and product. The median *E. coli* and FC concentration of the desalinated water were 0 cfu/100 ml. The average reduction of FC and *E. coli* was 95% and 91% respectively.

Overall, the DPs studied were good in improving the potability of the water. The few cases of failure to comply with salinity and bacterial concentration could be prohibited by improving the maintenance and operation of the DPs. Regular monitoring of the water quality is also necessary to assess the performance of the DPs. Since SSDPs are suitable for coastal regions, government need to promote this technology in water stressed areas like southwest coastal Bangladesh. However, special care is required in maintenance and operation of the DPs to achieve long-term sustainability. Future study may investigate water quality in different seasons, since the present study considered water quality during the dry season only.

CONCLUSIONS

This study examined physico-chemical and bacteriological quality of recently installed SSDPs in southwest coastal Bangladesh. From the quality point of view, pH, calcium, magnesium, nitrate, sulphate and fluoride concentrations of product water of all the DPs were found to be within WHO and BD drinking water standards. Very high TDS and EC were found in the feed; however, at product significant reduction was found, although 10% and 20% of the product respectively did not comply with the WHO

standards. Chloride, bicarbonate and sodium in the feed for all of the DPs were higher than WHO and BD standards; about 80%, 90% and 70% of the product water respectively complied with those standards. In addition, one product sample showed arsenic concentration above the WHO standard. Sodium concentration in product water above the guideline value may be a health concern. Except for one of the DPs, all of them complied with the standard for FC and *E. coli*.

To ensure the quality of product water, it is essential to implement necessary pre and post treatment as per the requirement, along with proper maintenance of the desalination units. Therefore, DPs have to be operated maintaining global standards for desalinated water. As the DPs could be a potential source of drinking water for coastal areas of Bangladesh, the government can emphasize promotion of this technology. There is also research needed on the socio-economic effectiveness of this water treatment technology in coastal Bangladesh. This will help decision making about the expansion and required maintenance of the DP. There is also very limited information on the point-of-use water quality and hygiene practice associated with this kind of SSDP in existing literatures. Previous studies conducted in this region regarding other low cost water supply options (Islam *et al.* 2015; Kabir *et al.* 2016) identified that contamination of drinking water occurs at the point-of-use. Further study is necessary to investigate water quality at point-of-use.

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