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Soil deterioration as influenced by land disposal of reject brine from Salbukh water desalination plant at Riyadh, Saudi Arabia

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ABSTRACT

Impact of reject brine chemical composition on soils in Riyadh Saudi Arabia, was evaluated. Soil samples at three depths along transect on both sides of the pond were taken, in addition to, water samples from feed, product, reject and pond. Results showed that, the salinity of the brine reached up to, 5500 mg l^{-1}. The concentrations of soluble ions were exceeding the allowable limits in most water samples. The ratio of major ions and concentration factor was higher. The concentrations of heavy metals were in the allowable limits for drinking water standards especially, in the feed, and product waters. Results pertaining soil properties indicated that the soil pH, EC_e values and, the concentrations of soluble ions were higher in soils closed to the pond. Also, the concentrations of heavy metals were negatively correlated with $CaCO_3$ content and soil pH (expect for Pb; Zn; Cd and Cr), while it was highly correlated with clay content of the soil. Generally, higher ESP and EC_e values in the studied soils can lead to lower permeability, poor aeration and consequently soil deterioration.

1. Introduction

The last 20 years have seen rapid growth in the number of desalination plants for producing drinking water in many parts of the world [1]. The Gulf countries, by necessity, have become the world leader in desalination of sea and brackish water, and currently have more than 65% of the world's total capacity [2,3]. The strategy of Saudi Arabia to meet present and future demands for water resources has shifted attention to the role of desalination technology in alleviating water shortages using sea and brackish water as feed. Reject brine, is a byproduct of desalination process. Brine discharged is more concentrated than the brackish water and contains inorganic salts and other chemicals, and other substances [4]. The reject brine from the seawater desalination is generally discharged to sea, while in the inland desalination plants of brackish water are the feed source and reject brine is disposed using evaporation ponds, discharged to the surface, etc. [5]. Consequently this may cause soil and groundwater contaminations with chemical constituents from various sources (i.e. reject brine, pretreatment waste and cleaning waste of desalination plants). Unfortunately, the environmental implications associated with the discharge of concentrate from desalination plants have not received adequate considerations by concerned authorities [1,6–8]. A high salinity of the reject brine can deteriorate the soil structure. This happens when calcium ions are replaced by sodium ions in the exchangeable ion complex. As a consequence, the infiltration rate of water and the soil aeration is reduced. This will only occur in extreme cases of salinity as a result the soils are degraded by the problems of salinity and sodicity [9]. However there is a shortage in the information towards the environmental impacts of the reject brine from desalination on the soil properties under Saudi Arabia conditions. Therefore, the objectives of the present work are: (1) to determine the composition of feed or raw water, product, reject brine, and pond water of Salbukh station for water desalination at Riyadh, Saudi Arabia; (2) to further evaluate possible hazards that might arise from the rejected brine, of such station. As well as (3) the changes in soil chemical and physical properties as affected by land disposal of reject brine from such station will be evaluated.

2. Materials and methods

2.1. In-place soil samples

The soil samples used for this study (90 soil samples e.g. 5 distances × 2 sites × 3 depths × 3 replicates) were collected in 2008 from the surrounding area of Salbukh station for water desalinization at Riyadh, Saudi Arabia (25°03′39.8″ N; 46°27′13.7″ E). Soil samples were taken from both right (45 samples) and left (45 sample) sides of the reject brine pond (Fig. 1) at intervals of 0, 10, 50,100 and 500 m

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Fig. 1. The brine disposal site at Salbukh.

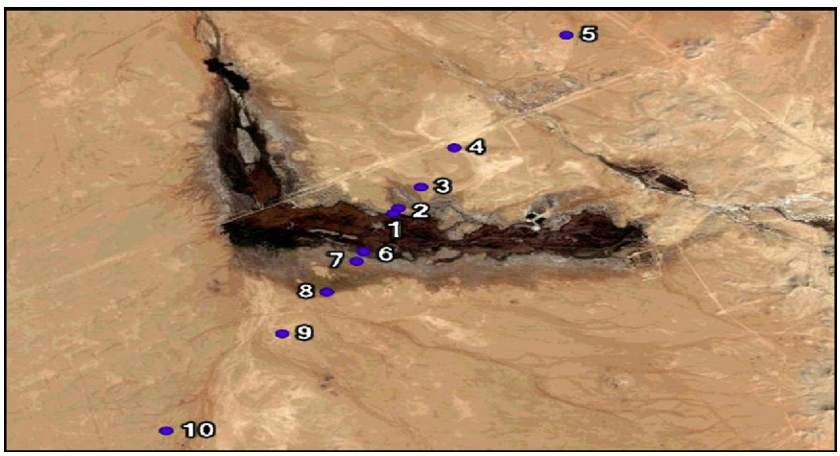

Fig. 2. Soil sampling location in the studying area at Salbukh.

(Fig. 2). Also, three soil depths (0–15, 15–30, and >30 cm.), were sampled at each point to assess the vertical distribution of soil parameters. Soil samples were air dried at room temperature and thoroughly mixed and gently ground to pass through a 2 mm sieve and stored for the physical and chemical analysis.

2.2. Chemical and physical analysis of the soil samples

Soil pH values were measured in soil paste after equilibration for 24 h [10,11]. While the soil EC_e values as well as the concentrations of soluble cations and anions (e.g. Ca^{2+}, Mg^{2+}, Na^+, K^+, HCO_3^-, CO_3^{2-} Cl^-, and SO_4^{2-}) were determined in soil paste extracts [12,13]. Particle size distribution was determined by the hydrometer method [14]. Content of $CaCO_3$ was determined by calcimeter method [15]. Also, soil samples were digested with HNO_3, $HClO_4$ and HF [16] for the determination of the total concentrations of Al, Ni, Fe, Cu, Mn, Cd, Cr, Pb and Zn using ICP-AES (Perkin Elmer, 4300 DV).

2.3. Collection and analysis of water samples

Representative discharge effluents from the inland desalination plant along with feed, reject brine, product and pond water of Salbukh station for water desalinization plant were collected and analyzed. The pH, EC_w, TDS, soluble cations (Ca^{2+}, Mg^{2+},Na^+, and K^+), soluble anions (CO_3^{2-}, HCO_3^-, CL^-, SO_4^{2-} and NO_3^-) and B were determined according to standard methods [17]. Also, concentrations of Al, Ni, Fe, Cu, Mn, Cd, Cr, Pb and Zn in the collected water samples were measured by ICP-AES (Perkin Elmer, 4300 DV).

Table 1
Mean values for the chemical composition of the feed, product, reject and pond water samples.

Sampling source	pH	EC_w (dS m^{-1})	TDS (mg l^{-1})	Soluble cations (meq l^{-1})				Soluble anions (meq l^{-1})					B mg l^{-1}	SAR
				Ca^{++}	Mg^{++}	K^+	Na^+	CO_3^-	HCO_3^-	Cl^-	SO_4^{--}	NO_3^-		
Feed	7.9	2.1	1357.2	8.5	6.6	0.9	7.5	0.0	3.1	9.8	6.8.0	0.00	0.2	2.8
Product	6.9	0.6	407.2	2.0	2.0	0.2	1.9	0.0	1.1	2.8	4.3.0	0.00	0.1	1.4
Reject	7.2	7.9	5030.4	19.1	14.4	1.7	17.0	0.0	4.0	20.4	18.9	0.00	0.3	4.2
Pond	8.3	12.5	8009.2	52.0	48.1	5.8	57.4	2.3	7.45	73.2	63.9	0.85	0.85	8.3
Ratio[a]	0.9	3.8	3.7	2.25	2.2	1. 9	2.3	0.0	1.3	2.1	2.8	0.00	1.5	1.5
C.F[b]	1.15	1.58	1.59	2.7	3.3	3.4	3.4	0.0	1.86	3.6	3.4	0.00	2.8	1.96

[a] Ratio of major ions of feed and reject brine.
[b] Concentration factor (C.F.) = Pond water/Reject water.

Table 2
Metals content in feed, product, reject and water samples.

Water sample	Metals concentration ($mg\ l^{-1}$)								
	Al	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn
Feed	Nd	Nd	Nd	Nd	0.244	0.117	Nd	Nd	0.008
Product	Nd	Nd	Nd	Nd	Nd	0.001	0.005	0.005	Nd
Reject	Nd	Nd	Nd	Nd	0.013	0.381	Nd	0.002	0.003
Pond	Nd	Nd	Nd	Nd	0.002	0.289	Nd	0.016	0.019

Nd = not detected.

Table 3
Statistical summaries for the major physical and chemical properties of the studying soil.

Parameter	Maximum	Minimum	Average	SD	Coef. variation
pH	8.9	6.6	8.2	0.5	6
EC ($dS\ m^{-1}$)	172.6	1.3	49.1	54.1	110.3
Ca^{2+} ($meq\ l^{-1}$)	1170	8.5	120	285.7	238
Mg^{2+} ($meq\ l^{-1}$)	1248.6	4.1	202	292.8	144.9
K^{+} ($meq\ l^{-1}$)	146.6	0.5	22.5	37.7	167.3
Na^{+} ($meq\ l^{-1}$)	4960.2	3.9	958.4	1462.4	152.6
CO_3^{2-} ($meq\ l^{-1}$)	1.0	0.0	0.2	0.3	167
HCO_3^{-} ($meq\ l^{-1}$)	8.8	0.6	2.2	2.1	96.3
Cl^{-} ($meq\ l^{-1}$)	4905	12.5	833.9	1333.9	160
SO_4^{2-} ($meq\ l^{-1}$)	94.0	5.0	52.9	31.1	61.9
SAR	322.5	1.1	60.4	75.6	125
Clay%	26.3	2.5	13.6	5.0	37
Silt%	60	6.0	24	12.3	51
Sand%	86.7	37.5	62.4	11.9	19
$CaCO_3$%	65.1	18.5	36.0	15.8	44
SSP%	89.7	8.8	57.4	23.4	40.8
ESP%	82.6	0.3	34.1	24.7	72.6
TDS ($mg\ l^{-1}$)	110,464	844.8	31,407	34,635.9	110.3

SD = Standard deviation.

Table 4
Mean values of some physical soil properties in the studying area at different depths regardless of the distance from the pond.

Depth (cm)	SP	Θ_w %	Particle size (%)			$CaCO_3$%	SSP	ESP	TDS ($mg\ l^{-1}$)
			Clay	Silt	Sand				
0–15	31.56	3.44	15.72	28.00	56.28	33.80	62.10	51.39	64,442.92
15–30	32.41	5.09	13.02	21.90	65.08	37.23	54.90	26.08	15,496.98
30–45	33.77	5.28	12.06	22.10	65.84	36.84	55.60	24.96	13,635.22

Θ_w = hygroscopic water.

2.4. Quality control

Due care was taken to avoid metal contamination in the process of sampling, drying, grinding, extracting and analysis. All equipments and containers were soaked in 10% NHO_3 for 24 h then rinsed thoroughly in de-ionized water before use. Also, quality control was assured by performing duplicate analyses on all samples and by using reagent blanks and standard reference soil (Till 4) which yielded Al, Ni, Fe, Cu, Mn, Cd, Cr, Pb and Zn contents close to the certified values.

2.5. Data analysis

Descriptive statistics (range, median, SD, max, min, etc.…) were calculated using SPSS [18] and STATGRAPHICS [19]. Moreover, the relationships between the studying elements and between some soil parameters were assessed.

3. Results and discussion

3.1. Chemical composition of water samples

Data presented in Table 1 show the chemical constituents of feed, product, and reject brine as well as pond water at Salbukh water desalination plant. Apparently, all of studying parameters were so much high in the pond water followed by the reject and feed water. However, the lowest values of pH, EC_w, and the concentrations of soluble ions, were obtained for the product water. The data show that the pH values ranged from 6.9 to 8.3, whereas, EC_w ranged from 0.6 to 12.5 day m^{-1} (i.e. 407.2 to 8009.2 $mg\ l^{-1}$). The concentrations of Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, and SO_4^{2-} in most water samples, were exceeding the allowable limits set by Gulf cooperation council countries [2]. Except for the pond water, the NO_3^{-} was not detected in the other water samples. On the other hand, the quality of reject water was found to be unsuitable for irrigation due to its higher salinity levels and its higher sodium content [20,21].

The ratio of major ions in feed water and reject brine were found to be, 0.9, 3.8, 3.7, 2.25, 2.20, 1.9, 2.3, 1.3, 2.1, 2.8, 1.5 and 1.5 for pH, EC, TDS, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, SO_4^{2-}, B and SAR, respectively (Table 1). On the other hand the concentration factor in the disposal ponds, were found to be, 1.15, 1.58, 1.59, 2.7, 3.3, 3.4, 3.4, 1.86, 3.6, 3.4, 2.8 and 1.96, respectively for pH, EC, TDS, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, SO_4^{2-}, B and SAR, (Table 1). Such results were stood in a good agreement with the results of Mohamed et al. [4].

Respecting the concentrations of Al, Cd, Cr, Cu, Fe, Mn, Ni, Pb and Zn in the collected water samples, data in Table 2 show that some of the studying metals were detected in the feed, reject and pond water, while the other metals were undetected or found to be in the allowable limits of the drinking water set by World Health Organization (WHO) [22]. In this respect Alabdula aly and Khan [23] analyzed the feed, and brine water of four ground water RO plants in the central rejoin of Saudi Arabia for their content of Al, As, Cd, Fe, Mn, Ni, Pb, Se and Zn. They found that only Ni and Cu were found to be absent in all water samples However, all other metals were observed within the drinking water limit set by (WHO) [22].

3.2. Impact of reject brine on physical and chemical soil properties

The basic physicochemical properties of the studied soil are statistically summarized in Table 3. The soils are classified as *Typic Torriorthents* according to [24]. The texture class of soil samples was generally, ranged from sandy loam, to loamy sand in most cases. The maximum percentages of sand, silt, and clay were 86.7, 60 and 26.3%, while the respective minimum percentages reached 37.5, 6.0 and 2.5% respectively. The studying soils were calcareous in nature as the $CaCO_3$ content ranged from 18.5 to 65.1% in such soils average at 36.0% (Table 5). The pH values ranged from 6.6 to 8.9, with an average of 8.2. i.e. most of the soil samples had neutral to alkaline conditions. On the other hand, EC_e values showed a variation interval which ranged from 1.3 to 172.6 dS m^{-1} with a general mean of 49.1 dS m^{-1}. This means that the studying soils were saline to alkaline affected soils in most

Table 5
Mean values of some chemical soil properties in the studying area at different depths regardless of the distance from the pond.

Depth (cm)	pH	EC_e ($dS\ m^{-1}$)	Soluble cations ($meq\ l^{-1}$)				Soluble anions($meq\ l^{-1}$)			
			Ca^{++}	Mg^{++}	K^{+}	Na^{+}	CO_3^{-}	HCO_3^{-}	Cl^{-}	SO_4^{--}
0–15	8.05	100.69	250.15	468.50	56.32	2419.99	0.20	3.81	2023.00	40.90
15–30	8.22	24.21	63.15	73.00	6.06	236.84	0.10	1.23	255.00	59.17
30–45	8.23	21.31	46.80	63.80	5.19	222.17	0.33	1.54	219.75	58.57

Table 6
Mean values of heavy metals content in the studying area at different depths regardless of the distance from the pond.

Depth (cm)	Total concentrations (mg kg^{-1})								
	Al	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn
0–15	14,404.99	0.63	22.23	13.93	7814.48	107.06	12.75	8.73	18.41
15–30	14,077.73	0.02	21.36	13.27	7488.89	99.11	11.01	6.39	16.90
30–45	12,327.49	1.11	19.30	13.06	6753.11	83.72	9.93	8.06	14.85

cases, thus, high salt contents in such soils can reduce soil productivity [25]. Moreover, higher ESP values of the studied soil samples can lead to lower permeability. This will be reflected on increasing irrigation and rain water runoff due to poor aeration and reducing leaching of salts from the root zone, [26], and consequently this leads to soil deterioration. Such results were confirmed by the field observation of few scattered salt tolerance plant species namely: *Tamarix nilotica*; *Zygophyllum propinquum* sp. *migahidii*; *Rhazya stricta*; and *Lasiurus scindicus* in the studying area.

The soil sampling depth was also effective in a way that, the EC_e or the salinity content, ESP values, and the concentrations of soluble ions (Ca^{2+}, Mg^{2+}, Na^+, K^+, Cl^-, HCO_3^- and SO_4^{2-}), were so much higher in the first soil depth (0–15 cm), followed by sharply decreased in the other two depths (Tables 4 and 5). Increasing the evaporation in such area may be the reason for such effect. It's worth to mention that, the total concentrations of Al, Cd, Cr, Cu, Fe, Mn, Ni, Pb and Zn followed nearly the same manner of both salinity and soluble ions e.g. the total concentration of such metals were increased in the first soil depth (0–15 cm), and gradually decreased in the other two depths(Table 6).

Respecting the effect of distance from the pond, data in Table 7 and Figs. 3 and 4 clearly appear that, the EC values or the soil salinity content, and the soil ESP values, as well as the concentrations of soluble ions (Ca^{2+}, Mg^{2+}, Na^+, K^+, Cl^-, HCO_3^- and SO_4^{2-}), were gradually increased with increasing the distance from the pond up to 100 m. this was true for both right and left distance, however the values of the studying parameters were somewhat higher in the left distance, due to its relatively lower elevations compared to the right one.

3.3. Metals content in the soil

Table 8 shows the descriptive statistics, maximum, minimum and average concentrations of heavy metals of soil samples studied compared to the average concentrations and the normal ranges in soils. There is no doubt that soil samples are generally low in their metals content as compared to the common range of each metal reported by Lindsay [26]. The mean values of the metals content could be arranged in the following order: Al > Fe > Mn > Cr > Zn > Cu > Ni > Pb > Cd. Obviously, the levels of Al and Fe were higher, whereas the Cd values were the lowest observed. Such results were stood in agreement with the findings of Bech [28]. Furthermore, most of the soil samples had concentrations extremely lower than the maximum of Cu, Pb, Mn, Ni, and Zn in soils according to Lindsay [27]. Although, the concentrations of Cd were relatively lower than the other metals, the maximum Cd concentrations were somewhat higher than their common range reported by Lindsay [26]. This may be referred to the higher $CaCo_3$ content in the studying soils (Tables 3 and 4). In this respect, Lindsay [27] reported that Octavite ($CdCO_3$) controls Cd^{2+} activity at values of pH ≥ 7.84. Holm et al. [29] concluded that precipitation of $CdCO_3$ is not very likely to occur except under very extreme conditions. So, they suggested that Cd concentrations in calcareous soils (like the studying soils) are controlled primarily by sorption processes.

Table 7
Impact of the distance from the pond on the chemical properties of studying soils (regardless of soil depth).

Distance (m)	pH	EC_e dS m^{-1}	Soluble cations (meq l^{-1})				Soluble anions (meq l^{-1})				SSP	ESP	TDS (mg l^{-1})
			Ca^{++}	Mg^{++}	K^+	Na^+	CO_3^-	HCO_3^-	Cl^-	SO_4^{--}			
Right distance													
0	8.3	15.3	25.7	70.0	11.0	108.7	0.5	2.0	125.0	74.7	50.3	18.0	9775.1
10	8.6	53.5	21.7	162.3	48.3	981.4	0.0	1.2	695.0	66.1	69.0	40.6	34212.3
50	8.6	61.0	25.7	115.3	54.0	1456.1	0.0	1.1	985.0	62.5	73.7	43.4	39016.5
100	8.1	79.0	451.3	274.0	17.2	1133.1	0.0	0.8	1275.0	30.6	63.3	42.0	50581.3
500	7.7	13.2	111.0	25.0	0.8	36.1	0.0	0.8	128.3	9.1	20.0	4.6	8448.1
Left distance													
0	8.6	42.3	20.0	243.3	28.7	927.8	0.5	4.3	323.3	70.9	63.7	37.7	27,044.3
10	8.5	66.8	34.0	320.7	19.3	1443.5	0.3	4.5	1040.0	89.4	74.3	50.9	42,730.7
50	8.2	74.9	32.0	478.0	32.4	1950.1	0.3	3.6	1780.0	82.0	77.7	54.1	47,957.3
100	7.5	79.4	430.7	310.3	12.8	1537.4	0.0	2.1	1940.0	37.6	69.7	48.2	50,837.3
500	7.6	5.4	48.3	22.0	0.8	9.5	0.5	1.5	47.5	6.6	12.7	1.1	3468.8

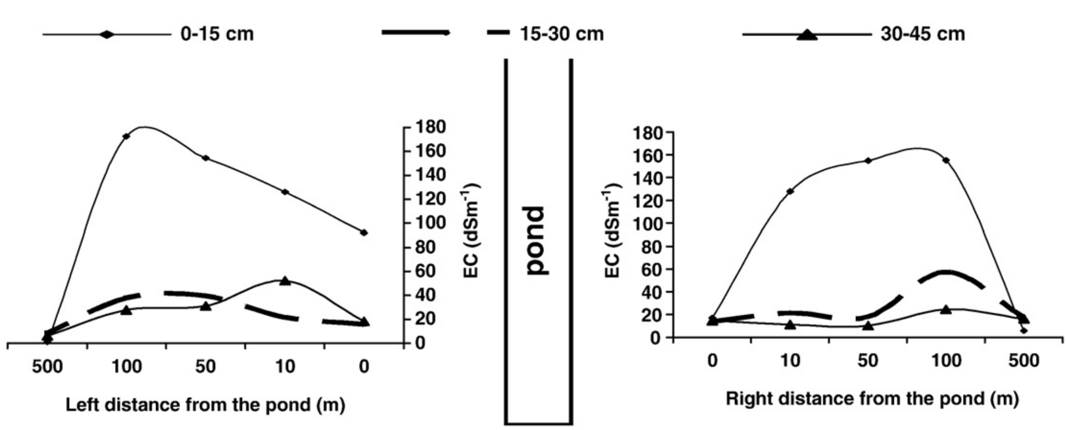

Fig. 3. Distribution of soil salinity throughout soil depths of the studying area as affected by the distance from the pond.

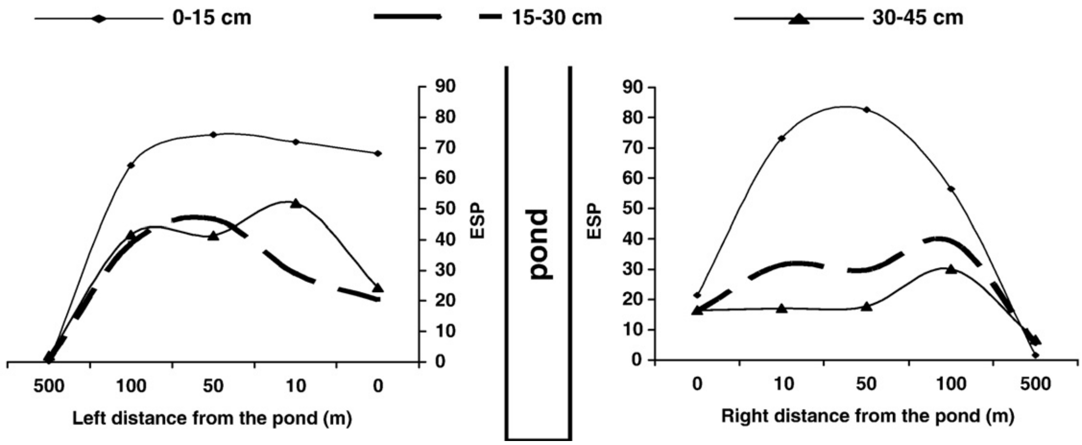

Fig. 4. ESP values throughout soil depths of the studying area as affected by the distance from the pond.

3.4. Correlation analysis between metal contents and soil properties and among metals

Data in Table 9 clearly appear that, the pH only correlated positively with Pb, Zn, Cr and Cd. The limited range of pH values in the soils of the studying area may cause such effect, as indicated by the low standard deviation. Although not very high, the relationship between pH and heavy metals in basic and alkaline soils is usually significant [30,31]. Also electrical conductivity had a negative correlation with the studying metals except Cd and Pb (Table 9). Data also reveal that, except for Cd, $CaCO_3$ had negatively correlated with Al, Fe, Mn, Cr, Zn, Cu, Ni, and Pb. This means that $CaCO_3$ may control the activity of Cd as previously mentioned. On the other hand, the clay content exhibited a positive correlation with all studying metals; this may be rendered to the role of clay in increasing the capacity of the soil to bind elements [28,32–34]. Such results suggest that the adsorption and retention of the studying metals in the soils at Salbukh area are influenced mainly by clay and carbonate contents.

As for the correlations between the studying metals, data in Table 9 indicated that, all of the correlations between the studying metals were significant. For example (Al and Fe), (Fe and Zn), (Pb and Zn) were very strongly correlated. The strongest correlations were found also between Al and Fe ($r = 0.988$, $p < 0.01$), followed by Al and Mn ($r = 0.982$, $p < 0.01$), Al and Ni ($r = 0.964$, $p < 0.01$), Al and Zn ($r = 0.903$, $p < 0.01$), Al and Cr ($r = 0.899$, $p < 0.01$), Al and Cu ($r = 0.843$, $p < 0.01$), and Al and Pb ($r = 0.657$, $p < 0.01$). On the other hand a positive correlation between Al/Cd was observed ($r = 0.216$, $p < 0.05$). In the same manner, strongest correlations were attained between (Cd and Pb), (Cr and Fe), (Cr and Mn), (Cr with Ni), and (Cr and Zn). These results are similar to those obtained by Chen et al. [35], Nicholson et al. [33], Rodriguez-Martin et al. [31], Bech et al. [28], and Dragovic et al. [36].

Table 8
Maximum, minimum and average concentrations of the studying metals found in the soil in reference to the common ranges.

Metal	Total concentration mg kg^{-1}			[a]$E.F_M$		Common range in soil[b] mg kg^{-1}		
	Max.	Min.	Average	Max.	Min.	Max.	Min.	Average
Al	27,207	2703.60	13,053.0					
Cd	1.07	0.03	0.6	2.83	0	0.7	0.01	0.06
Cr	33.4	8.50	19.6	3.00	1	1000	1.00	100.00
Cu	24.0	5.20	13.4	4.00	1	100	2.00	30.00
Fe	14,039.9	1717.90	6998.5	1.00	1	55,000	7000.00	38,000.00
Mn	195.3	26.70	94.2	1.00	0	3000	20.00	600.00
Ni	20.4	0.70	9.9	1.00	0	500	5.00	40.00
Pb	36.4	0.05	7.3	19.00	0	200	2.00	10.00
Zn	33.2	5.20	16.3	3.00	1	300	10.00	50.00

[a] $E.F_M = ([M]/[Fe])_{soil}/([M]/[Fe])_{crust}$ after [35].
[b] [26].

Table 9
Correlation between metal content and soil properties and among metals in the studied soils.

	pH	EC	$CaCO_3$	Clay	Silt	Sand	Al	Cd	Cr	Cu	Fe	Mn	Ni	Pb
Al	−0.157	−0.035	−0.726[a]	0.472[a]	−0.566[a]	0.386[b]	1							
Cd	0.008	0.120	0.288	0.064	−0.216	0.196	0.216	1						
Cr	0.001	−0.012	−0.542[a]	0.458[a]	−0.357[b]	0.175	0.899[a]	0.098	1					
Cu	−0.118	−0.131	−0.680[a]	0.371[b]	−0.629[a]	0.493[a]	0.843[a]	0.149	0.763[a]	1				
Fe	−0.124	−0.052	−0.699[a]	0.478[a]	−0.537[a]	0.353[b]	0.988[a]	0.187	0.927[a]	0.810[a]	1			
Mn	−0.137	−0.031	−0.652[a]	0.460[a]	−0.505[a]	0.327[b]	0.982[a]	0.183	0.923[a]	0.817[a]	0.977[a]	1		
Ni	−0.225	−0.028	−0.630[a]	0.404[b]	−0.480[a]	0.325[b]	0.964[a]	0.290	0.900[a]	0.781[a]	0.966[a]	0.958[a]	1	
Pb	0.002	0.047	−0.574[a]	0.301[b]	−0.408[b]	0.294	0.657[a]	0.814[a]	0.496[a]	0.477[a]	0.641[a]	0.624[a]	0.678[a]	1
Zn	0.002	−0.128	−0.622[a]	0.394[b]	−0.538[a]	0.389[b]	0.903[a]	0.126	0.906[a]	0.838[a]	0.915[a]	0.910[a]	0.843[a]	0.543[a]

[a] Correlation is significant at the 0.01 level (two-tailed).
[b] Correlation is significant at the 0.05 level (two-tailed).

4. Conclusions

Disposal of reject brine from Salbukh water desalination plant at Riyadh, Saudi Arabia, has a significant environmental consideration. The obtained results pertaining water analysis indicated that, the lowest values of pH, EC_w, as well as the concentrations of soluble ions, were obtained for the product water. The pH values ranged from 6.9 to 8.3. The total salinity ranged from 407.2 to 80,009 mg l^{-1}). Also, the concentrations of Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, and SO_4^{2-} were exceeding the allowable limits for drinking water set by the Gulf Cooperation Council Countries [19] in most water samples. The ratio of major ions of feed water and reject brine was found to be higher. The respective concentration factor in the disposal ponds was also higher. Moreover, the concentrations of heavy metals were found to be in the allowable limits for drinking water standards. Results pertaining to soil properties emphasized the role of reject brine from Salbukh water desalination plant, on deteriorating the soil chemical properties. As the soil pH, EC_e and ESP values as well as, the concentrations of Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, and SO_4^{2-} were so much higher in the upper soil layers especially in the soil samples that were closer to the pond. Higher EC_e and ESP values of the studied soils can lead to lower permeability, thus, increase irrigation and rain water runoff, poor aeration and reduce leaching of salts from the root zone, consequently lead to soil deterioration.

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