Chemical Properties of Selected Contaminated Soils in Basrah City, Southern Iraq

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Abstract. The main objective of this study are both analyzing the chemical properties of soil quality in the urban area of Basra City, southern Iraq, and identifying the contamination effect on seasonal and spatial variations in chemical properties of the selected soil samples. Soil samples were collecting from known contaminated sites during winter and summer seasons of 2009. Sampling sites were selecting from various urban land-use patterns. The results of chemical parameters of soils in the study area have shown that seasonally and spatially varied, and that soil quality is deteriorating because of combined anthropogenic and natural factors. It has been indicating that, on average, soil quality was highly saline in terms of EC index, slightly alkaline in terms of pH index, and sodic-saline in terms of the US salinity Lab index. The main reason for this urban soil degradation it can be concluded due to the effects of contamination caused by various urban activities.

Key words: Soil, Chemical Properties, Contamination, Salinization.

Introduction

Soil contamination can defined as "the pollution of soils with materials, mostly chemicals, that are out of place or are present at concentrations higher than normal which may have adverse effects on humans or other organisms" (3).

Soil contamination results from the intensification of agricultural production and from a general invasion of chemical products in all the fields of human activity (7). Thus, properties of the soil affects by various processes occurring in the soil, by the chemical composition of the soil-forming substrate and by human interventions (12).

Waste produced by households known collectively as municipal waste, in order to differentiate it from waste originating from industrial processes. It includes various types of materials that may contribute to changing the environment of soil. Municipal waste disposal by landfills and incineration may in both cases lead to a concentration of many pollutants, either directly from landfill leachates that may be polluting soil and underneath groundwater, or by ash fallout from incinerating plants. To this may add the effect of landfill gases that may pass to neighboring soils, causing a change in their soil air environment (8).

Soil scientists and land managers are facing with a wide range of threats to soil quality, including those from: Potentially toxic elements (pte) and pathogens in sewage sludge applied to agricultural land and forestry; Industrial sludges (*e.g.* pulp and paper mill wastewaters, saline process residues) and canal dredging applied to land as a means of waste disposal; Radioactive isotopes released following industrial accidents or from wastes disposal; POPs deposited on soils following their aerial release from industrial processes; Residues from production chemicals used in agriculture (pesticides, fungicides, herbicides); Spent munitions and explosives following demilitarization; Heavy metals (Pb, Hg, As) and organic contaminants (petroleum hydrocarbons, polynuclear aromatic hydrocarbons (PAH)) from historic land contamination, discovered during redevelopment or factory decommissioning; Nitrogen-rich organic manures and wastes applied to soils in nitrogen vulnerable zones; Prison materials from wastes removed from the food chain to control bovine spongiform encalopathy (BSE) in cattle; and considerable quantities of animal carcass material released to soils during foot and mouth disease (FMD) outbreaks and similar emergencies involving animals reared for human consumption (9).

Health of many people may expose to harmful effects from contaminated soils and are they: consume soil or dust; have direct skin contact with soil if they get soil on their hands and feet; eat vegetables grown in contaminated soil (13).

Basra City (the study area) lies in southern Iraq, at the point of 30º34N and 47º50E coordinate as shown in Fig.1. The total population is numbered about 1.337.000 person (according to 2002 UN estimates), and the total area is around 270 km^2. This city faced a serious challenge represented by solid waste and garbage dumping. It, widely and harmfully, spreads across the most of residential quarters, commercial and industrial districts, and streets. In Basra City, the total disposal of garbage and solid waste is about 900.000 and 600.000 metric tons respectively (1).

Several reasons led to this increasing problem, including the rise in the standard of living, population growth, inadequate cleanup, and popular unawareness.

There are few scientific studies on soil contamination within the urban areas, particularly in the urban environment of Basra. The most of previous studies have focused on the quality of agricultural and terrestrial soils rather than urban soils. The present study, therefore, seeks to evaluate the values of some chemical parameters (including EC, pH, Ca, Mg, Na, K, Cl, HCO_3, SO_4, SAR, and EPS) of the urban soil quality in Basra City, and to determine the impact of involving human activities on it resulting in soil contamination.

Materials and Methods

Soil samples have been selecting from already contaminated sites within the study area. The contamination of these sampling sites is mostly due to municipal and industrial waste dumping. The selection of sampling sites based on some considerations of spatial differentiation, as follows (as listed in Tab.1, column *sampling site*, and Fig.1):

1- Based to the geographic directions of the study area (such as Northern, Southern, and Western parts).
2- Based to the density of commercially and popularly districts of the study area (such as high or low traffic and dense districts).

3- Based to the of land-use patterns in the study area (such as residential, commercial, industrial, and agricultural land uses). However, a soil sample from the point of reference (with no urban activity) has been collecting for comparison.

The soil samples were collected during the winter and summer seasons of 2009.

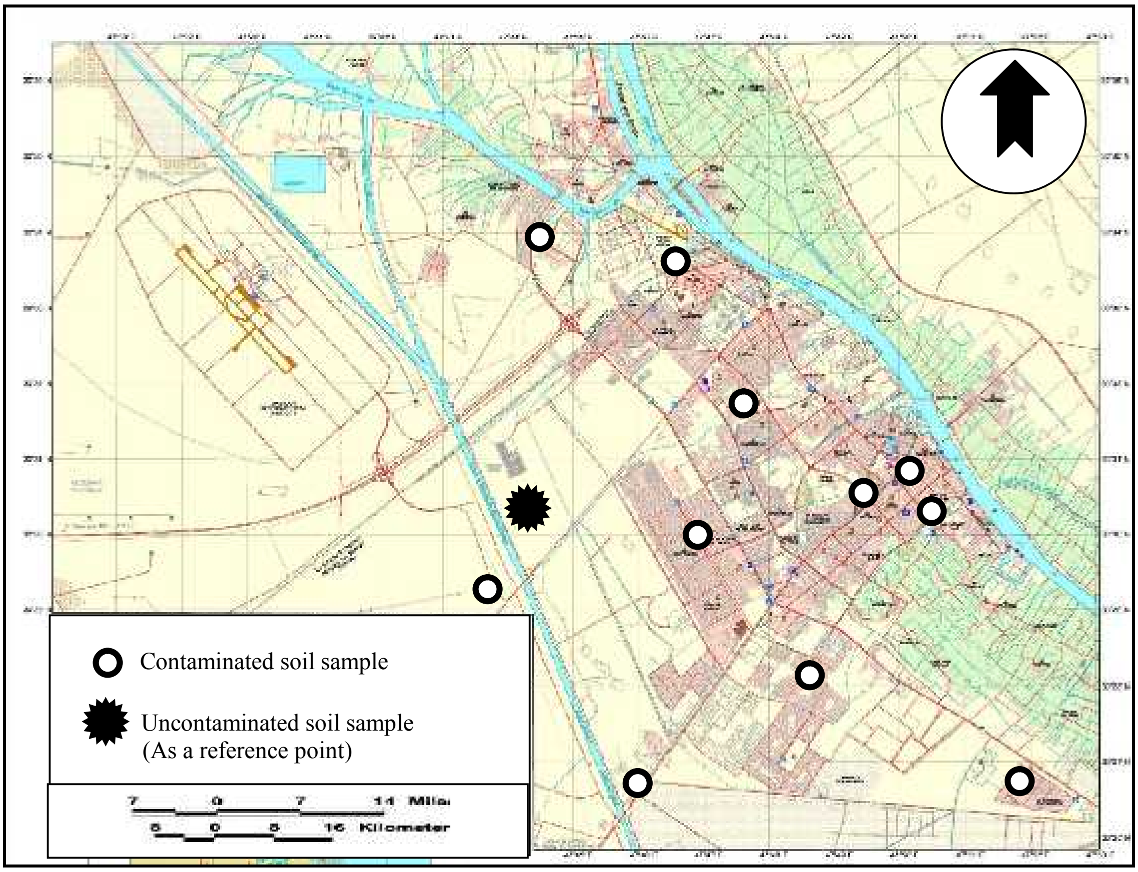

Figure 1: Map of the study area (Basra City) and sampling sites.

In the field, the samples have been taking from the topsoil on depth of 0-10cm depth for each of sampling sites, and put in marked plastic bags of 1kg capacity. Then the soil samples brought into the laboratory.

In the laboratory, according to Tolgyessy's method (12), the sample prepared in a way is pouring to form a conical pile. The pile is then quartering with the help of a suitable tool. The two opposite portions are taking as a sample. The quartering procedure is repeats to reach the sample amount required for the chemical analysis. The soil analysis is then frequently performing without further sample treatment. In certain cases, however, it is necessary to obtain a solution from the sample, i.e. to make an extract.

Sample decomposition is frequently necessary, depending on the purpose of the analysis and character of the component to be determined. In this study, the adopted procedure is decomposition of 50 gm of the sample by melting with 100 ml of deionised water, and then purifies the soil sample extract by filtration with paper of Whatman NO.1 type.

Measuring of values of EC and pH was by Mulitmeter, WTW pH/Cond 3L5i. Measurements of major elements

(Cations and ions) performed by using the following techniques:

1- Calcium (Ca^+) determined by titration with solution of 0.01*N* Na_2-EDTA, and using Murxide as indicator.

2- Magnesium (Mg^+) was estimated by calculation of both calcium and magnesium ions that determined by titration with solution of 0.01*N* Na_2-EDTA, and using Erichrome Black index, then mules Calcium concentration.

3- Sodium and Potassium (Na^+ & K^+) measured by Flame Photometer, Jenway PEP7.

4- Chlorides (Cl^-) determined by titration with solution of silver nitrates ($AgNO_3$), and using ($K_2Cr_2O_7$) as indicator.

5- Bicarbonates (HCO_3^-) estimated by pH-Alkalinity method.

6- Sulfates ions (SO_4^-) determined by Turbidimetric technique and using Spectrophotometer, type of HITACHI (U-1500) at the wavelength of 420nm.

Results and Discussion

The nature of the soil in the study area, which is part of the soil of Mesopotamian floodplain, is with loamy silt clay texture, mainly caused by alluvial deposition. Thus, soil texture is characteristic of heavy, because of a large proportion of clay and silt particles. The infiltration rate is slow, permeability is very slow, and retentive capacity is high due to very fine porosity (2).

The results of soil sample analysis at the studied area and duration are listing in Table 1. Geographical and environmental analysis of these findings is as follows:

Electrical Conductivity (EC): As shown in Tab.1, the salinity in soil samples (represented by EC) is spatially varied. The soil salinity seems largely high at sampling sites such as Qublah, Barathyah, and Dumpsite, while being so low at the sampling sites of Maqal, Ashar, and Southern Part. This spatial variation may mainly ascribe that the groundwater table of former districts is higher than earlier districts, leading to severe sanlinization occurred in soils. The depths of the water table in districts such as Qublah and Barathyah are around 21 and 22cm, whereas in districts such as Maqal and Ashar, water table depth is about 50 and 75cm, respectively.

Averages of EC in the rest of sample sites, however, are significantly higher than in reference point. This indicates to the way in which human activity creates sanlinization in urban soils unlike wild soils such as reference point.

There are seasonal variations in the levels of EC in studied soil samples. In general, soil salinity increased during summer compared to winter. Soil salinity, in some cases, reached to very high concentration, as in Qublah sample site with a record EC concentration of 107.7dS/$m^{-1.}$ This is, of course, referred to temperature increase during summer that, in turn, increased the soil capillary force and then to accumulate salts on the soil surface. However, a little increase in salinity during winter compared to summer, including in some sampling sites of Maqal, Hayyaniyah, Barathyah, and the Hamdan industrial district. This has meant that salinity increase in urban soils is not only necessarily related to the rise in groundwater table and temperature increase, but also to soil contamination by solid waste, garbage, and so on, eventually leading to rise of soil sanlinization even during winter. Sanlinization of soils results in soluble salts that can increase salt content in soil profiles, which causing land and water degradation. The salts can also affect the release and solubilization of heavy metals into solution, with potential adverse effects on water quality and plant growth (11).

Table 1: Concentrations of EC (dS/m), pH, cations (ppm), and ions (ppm) in soil samples at the study area during the winter and summer seasons of 2009.

(a) Winter season

NO.	Sampling Site	EC	pH	Ca^+	Mg^+	Na^+	K^+	Cl^-	HCO_3^-	SO_4^-
1	Northern part of Basra	4.66	7.25	320	97.2	637.8	6068	1169.8	305	543.9
2	Maqal District	3.36	7.20	200	413.1	446.4	61.8	886.2	336	631
3	Jumhuriyah District	10.26	7.15	600	364.5	988.6	222	2375.1	732	838.6
4	Ashar District	3.9	6.67	480	72.9	510.2	93.4	921.7	732	626.9
5	Hayyaniyah District	10.95	6.87	520	170.1	1052.4	167.4	2516.9	336	921.7
6	Western part of Basra	12.02	7.03	1040	583.2	1036.4	83.7	3899.5	305	759.8
7	Qublah District	17.23	7.1	560	72.9	749.4	60.6	6558.2	488	979.8
8	Barathyah District	38.4	8.19	880	1555.2	2248.3	412.6	6983.6	610	8029.8
9	Southern part of Basra	2.39	7.33	200	243	366.7	36.4	602.6	305	543.9
10	Hamdan Industrial District	6.25	7.38	560	72.9	749.4	60.6	1595.2	793	552.2
11	Dumpsite	27.8	7.25	1400	534.6	2248.3	271.8	8153.5	610	1199.9
12	**Average**	**11.6**	**7.22**	**614**	**379.9**	**1003**	**685.3**	**3242**	**504**	**1420.6**
13	Reference Point	2.45	7.1	200	235	484.2	23.9	757.4	289	520.2

(b) Summer season

NO.	Sampling Site	EC	pH	Ca^+	Mg^+	Na^+	K^+	Cl^-	HCO_3^-	SO_4^-
1	Northern part of Basra	5.28	7.73	400	850.5	282.8	31	1240.7	305	678.7
2	Maqal District	3.22	8.47	400	874.8	169.6	35.9	531.7	1037	571.8
3	Jumhuriyah District	11.29	8.26	400	972	444.4	84	3084.1	915	595.0
4	Ashar District	4.57	7.51	1000	607.5	226.2	62.8	886.25	732	455.5
5	Hayyaniyah District	9.8	7.75	600	972	412.0	70.9	2481.5	732	636.9
6	Western part of Basra	10.63	7.43	640	1701	387.8	48.1	2694.2	610	553.2
7	Qublah District	107.7	7.53	960	8553.6	1640.2	218.6	21270	1220	553.2
8	Barathyah District	21.4	8.76	400	2114.1	614.0	196.6	4927.5	610	2101.3
9	Southern part of Basra	2.53	7.76	400	753.3	169.6	24.4	212.7	366	441.6
10	Hamdan Industrial District	5.35	7.08	920	3766.5	1115.0	124.8	4431.2	1037	1259.8
11	Dumpsite	19.63	7.46	800	2089.8	573.6	190.1	6026.5	3721	1324.9
12	**Average**	**18.30**	**7.79**	**629**	**2114.1**	**548.6**	**98.8**	**4344.2**	**1025**	**833.8**
13	Reference Point	4.86	7.82	375	633.4	412.9	45.3	758.1	722	425.6

According to the USAD classification of 1954, soil quality in the study area can classify based on EC index is as follows (as shown in Tab.2 and 3):

Table 2: Categories of soil salinity (EC index), based on USAD classification of 1954.

EC range (dS/m)	Soil Category
≤ 0 – 4	Slightly saline
4 – 8	Moderately saline
8 – 15	Highly saline
≥ 15	Extremely saline

Source: (6)

Table 3: Categories of soil salinity (EC index) in the study area, based to USAD classification of 1954.

NO.	Sampling Site	EC (Average of two readings) (dS/m)	Category of Soil
1	Northern part of Basra	4.97	Moderately saline
2	Maqal District	3.29	Slightly saline
3	Jumhuriyah District	10.77	Highly saline
4	Ashar District	4.23	Moderately saline
5	Hayyaniyah District	10.32	Highly saline
6	Western part of Basra	11.32	Highly saline
7	Qublah District	62.4	Extremely saline
8	Barathyah District	29.90	Extremely saline
9	Southern part of Basra	2.46	Slightly saline
10	Hamdan Industrial District	5.80	Moderately saline
11	Dumpsite	23.7	Extremely saline
12	**Average**	**14.95**	**Highly saline**
13	Reference Point	3.65	Slightly saline

This resulting classification is obviously indicates that most of soil samples in the study area being experienced to degradation due to the high levels of sanlinization. "Slightly saline" category only found in few sampling sites as in Maqal, Ashar, Southern part, and Point of Reference. Values of EC in these sampling sites, however, reduced during summer to limit on only two sampling sites of Maqal and Southern part. In the other sampling sites, values of EC ranged from "moderately saline" to "extremely saline" categories, indicating that urban soils of the study area have been suffering from severe contamination.

pH: pH (log $[H^+]$) is referred to acidity or alkalinity of soil solution.

As shown in Tab.1, there are slight variations in pH values during winter and summer in all of sampling sites. It ranged from 6.6 to 8.7 on the pH scale. Despite the pH average tends to be neutral (7.2 in winter and 7.7 in summer), its offer a little tendency towards acidity as in soil sampling sites of Ashar and Hayyaniyah during winter on the hand, and a little tendency towards alkalinity as in sampling sites of Maqal, Jumhuriyah, and Barathyah on the other hand. This spatial and seasonal variation may refer to the effects of chemical interactions that activated because of increase in soil moisture during winter season in particular, as well as the nature of mineral composition of the soils.

Although these slight variations in pH values, a classify of the soil quality according to a pH index (as shown in Tab.4) was performed, detecting on more specific and more spatial variations as shown in Tab.5.

Table 4: Soil quality categories based to pH index.

pH value	Soil Category
≤ 4.5	Extremely acid
4.5 – 5.0	Very strongly acid
5.1 – 5.5	Strongly acid
5.6 – 6.0	Moderately acid
6.1 – 7.3	Slightly acid to neutral
7.4 – 7.8	Slightly alkaline
≥ 7.8	Alkaline

Source: (4)

Table 5: Soil quality categories (pH index) in the study area.

NO.	Sampling Site	pH (Average of two readings)	Category of Soil
1	Northern part of Basra	7.4	Slightly alkaline
2	Maqal District	7.8	Slightly alkaline
3	Jumhuriyah District	7.7	Slightly alkaline
4	Ashar District	6.9	Slightly acid to neutral
5	Hayyaniyah District	7.3	Slightly acid to neutral
6	Western part of Basra	7.2	Slightly acid to neutral
7	Qublah District	7.3	Slightly acid to neutral
8	Barathyah District	8.4	Alkaline
9	Southern part of Basra	7.5	Slightly alkaline
10	Hamdan Industrial District	7.2	Slightly alkaline
11	Dumpsite	7.3	Slightly acid to neutral
12	**Average**	**7.5**	**Slightly alkaline**
13	Reference Point	7.4	Slightly alkaline

These spatial variations in pH significantly affect the availability of plant nutrients and microorganisms. At low pH (as shown in Ashar, Hayyaniyah, Western part, Qublah, Dumpsite) one sees that Al, Fe, and Mn become more soluble and can be toxic to plants. In contrast, as pH increases (as in sampling sites of Northern Part, Maqal, Jumhuriyah, Barathyah, Southren part, and Hamadan industrial district), their solubility decreases and precipitation occurs. Plants may suffer deficiencies as pH rises above neutrality (11).

Cations and Ions: Soil solution consists of water and solutes that to be in constant change because of processes such as decomposition, addition, transport, and loss for colloids. As well, soil solution is a medium for many bio-chemical interactions involving in soil. Cations and ions are resulted in organic matter decomposition and salt dissolution within the soil profile, across the atmosphere, or in the groundwater, leading to elevated dissolved salts.

As shown in Tab.1, there are both spatial and seasonal variations in values of cations and ions at all of the sampling sites.

During winter, the geographical distributions of cations values were as follows: Ca concentrations ranged from 200 to 1400ppm in Maqal and Dumpsite. Mg concentrations ranged from 72.9ppm in Ashar, Qublah, and Hamadan Industrial District to 1555.2ppm in Barathyah. Na concentrations ranged from 366.7 to 2248.3ppm in Southern part and Dumpsite. K concentrations ranged from 36.4 to 6068ppm in the Hamadan Industrial District, respectively. The averages of cations values (Ca, Mg, Na, and K) in all the sampling sites amounted to 614, 379.9, 1003, 685,3ppm respectively.

Ions values were as follows: Cl concentrations ranged from 1602.2 to 8153.5ppm in Southern part and Dumpsite. HCO_3 concentrations ranged from 305ppm in Northern, Western, and Southern parts to 793ppm in the Hamadan Industrial District. SO_4 concentrations ranged from 543.9 to 8029.8ppm in Northern part and Barathyah, respectively. The averages of ions values (Cl, HCO_3, and SO_4) in all sampling sites were about 3242, 504, 1420.6ppm respectively.

During summer, however, the geographical distributions of cations values were as follows: Ca concentrations ranged from 375 to 1000ppm in Reference Point and Ashar. Mg concentrations ranged from 753.3 to 8553.6ppm in Southern Part and Qublah. Na concentrations ranged from 169.6 to 2248.3ppm in Maqal and Western part. K concentrations ranged from 31 to 218.6ppm in Northern part and Qublah, respectively. During the same season, averages of cations values (Ca, Mg, Na, and K) in rest of sampling sites were 629, 2114.1, 548.6 and 98.8ppm respectively.

However, ions values were as follows: Cl concentrations ranged from 531.7 to 6026.5ppm in Maqal and Dumpsite. HCO_3 concentrations ranged from 305 to 3721ppm in Northern part and Dumpsite. SO_4 concentrations ranged from 441.6 to 2101.3ppm in Southern part and Barathyah, respectively. The averages of ions values (Cl, HCO_3, and SO_4) in other sites were 4344.2, 1025, 833.8ppm respectively.

Generally, high concentrations in cations and ions of studied soil samples can be explained by a combined variety of anthropogenic and natural influences are as follows:

1- Direct and indirect contamination of soil caused by solid waste and garbage dumping (as in sampling sites of Dumpsite, Hamadan Industrial District, Barathyah, Qublah, Hayyaniyah, Ashar, Jumhuriyah, Maqal, and Western part).

2- Soil contamination caused by precipitation of gaseous residues from exhaust and combustion on the ground surface (as in Dumpsite, Hamadan Industrial District, Northern part, Southern part, Western part, Hayyaniyah and Ashar).

3- Soil contamination resulted in wastewater effluents (as in Dumpsite, Hamadan Industrial District, Hayyaniyah, Jumhuriyah, and Qublah).

4- Soil contamination due to elevated soil salinity and waterlogging because of poor drainage practices (as in Qablah and Hayyaniyah).

5- Soil contamination caused by sanlinization involved in previously agricultural lands (as in as in sampling sites of Barathyah and Southern part).

6- Combination of natural factors to contaminate soil in the study area, such as increased air temperature and evaporation particularly during summer, capillary porosity effect, inherited poor structural properties of soils, elevated groundwater table, etc.

(SAR) & (ESP): There are several important parameters commonly used to assess the status of Na^+ in the solution and on the exchange passes. These are the Sodium Adsorption Ratio (SAR) and the Exchangeable Sodium Percentage (ESP). The ESP is used as a criterion for classification of sodic soils with an ESP of <15 and EC > 4, indicating a nonsodic soil, and an ESP >15 and EC > 4, indicating a sodic soil, the accuracy of the number is often a problem due to errors that may arise in the measurement of CEC and exchangeable Na+. Therefore, the more easily obtained SAR of the saturation extract has to use to diagnose the sodic hazard of soils. Although ESP and SAR are not precisely equal numerically, an SAR of 15 has also used as the dividing line between sodic and nonsodic soils (5).

Soil salinity and sodicity can have a major effect on the structure of soils. In addition, salinity and sodicity have pronounced effects on the growth of plants. Sodicity can cause toxicity to plants and create mineral nutrition problems such as Ca^{2+} deficiencies. In saline soils soluble ions such as Cl^-, SO_4^{2-} , HCO_3^-, Na^+, Ca^{2+}, Mg^{2+}, and sometimes NO_3^- and K^+ can harm plants by reducing the osmotic potential. However, plant species, and even different varieties within a particular species, will differ in their tolerance to a particular ion. Therefore, degradation of soils by salinity and sodicity profoundly affects environmental quality. In particular, the dispersive behavior of sodic soils, coupled with human activities such as agriculture, forestry, urbanization, and soil contamination, can have direct effects on the environment and humankind. The enhanced dispersion promotes surface crusts or seals, which lead to waterlogging, surface runoff, and erosion. Consequently, high levels of inorganic and organic colloids can be mobilized, which can transport organic and inorganic contaminants such as pesticides, metals, and radionuclides in soils and waters (11).

SAR and ESP values of the sampling sites are varying spatially and seasonally. During the winter, as listed in Tab.6, values of SAR and ESP are respectively ranges from 24.64ppm and 25.95% in Southern part to 72.29ppm and 51.30% in Dumpsite. During summer, it is ranges from 6.71ppm and 7.95% in Maqal to 23.81ppm and 25.30% in Qublah. Averages of SAR & ESP values are also varied, which were about 44.99ppm and 39.41% in winter and 14.81ppm and 17.08% in summer respectively.

Increases in SAR and ESP values can ascribe, in turn, to elevated EC value. As mentioned above, high concentrations in salinity are because of combined anthropogenic and natural factors.

Based to US Salinity Lab classification of 1954 (as shown in Tab.7), in which EC, ESP, and pH values have altogether taken in consideration, as shown in Tab.8. There is, then, a significant spatial differentiation in the resulting classification of soils in the study area, as follows: the soil samples of Northern part, Jumhuriyah, Ashar, Hayyaniyah, Western part, Qublah, Barathyah, Hamdan Industrial District, and Dumpsite lies within the saline-sodic category. While the soil samples of Maqal, Southern part, and Reference Point lies within the sodic-nonsaline category. On average, the soil category of all sampling sites is saline-sodic.

Conclusion

The results confirmed that soil quality in the study area is deteriorating, because of the impacts of pollution. The evidence supported by the obvious difference between values at the reference point which located outside the urban area and those which located within the urban area (the other sites). It is clear that there is a decline in values for the earlier when compared to the former. This difference may explained by the profound effect of contamination due to human activities involving in the urban area, while there is a little urban effect on the reference point.

Table 6: Values of SAR & ESP in soil samples at the study area during the winter and summer seasons of 2009.

NO.	Sampling Site	Winter season		Summer season	
		SAR	ESP%	SAR	ESP%
1	Northern part of Basra	44.16	38.33	11.31	13.36
2	Maqal District	25.50	26.66	6.71	7.95
3	Jumhuriyah District	45.01	39.41	16.36	18.62
4	Ashar District	30.64	30.48	6.37	8.71
5	Hayyaniyah District	56.67	45.13	14.69	16.94
6	Western part of Basra	36.39	34.40	11.32	13.37
7	Qublah District	42.14	37.84	23.81	25.30
8	Barathyah District	64.64	48.39	16.08	18.34
9	Southern part of Basra	24.64	25.95	7.06	8.39
10	Hamdan Industrial District	42.14	38.02	23.03	24.64
11	Dumpsite	72.25	51.30	15.09	17.36
12	**Average**	**44.99**	**39.41**	**14.81**	**17.08**
13	Reference Point	27.29	28.03	18.39	20.56

Table 7: Categories of soils affected by salinization, according to US Salinity Lab.

Category of Soil	EC (dS/m)	ESP%	pH
Nonsaline-nonsodic	> 4	> 15	> 8.5
Saline-nonsodic	< 4	> 15	> 8.5
Saline-sodic	< 4	< 15	> 8.5
Sodic-nonsaline	> 4	< 15	< 8.5

Source: (10)

Table 8: Categories of soils affected by salinization in the study area, based to US Salinity Lab of 1954.

NO.	Sampling Site	EC (dS/m) (Average)	ESP% (Average)	pH (Average)	Category of Soil
1	Northern part of Basra	4.97	25.84	7.4	Saline-sodic
2	Maqal District	3.29	17.30	7.8	Sodic-nonsaline
3	Jumhuriyah District	10.77	29.01	7.7	Saline-sodic
4	Ashar District	4.23	19.59	6.9	Saline-sodic
5	Hayyaniyah District	10.32	31.03	7.3	Saline-sodic
6	Western part of Basra	11.32	23.88	7.2	Saline-sodic
7	Qublah District	62.4	31.57	7.3	Saline-sodic
8	Barathyah District	29.90	36.84	8.4	Saline-sodic
9	Southern part of Basra	2.46	17.17	7.5	Sodic-nonsaline
10	Hamdan Industrial District	5.80	31.33	7.2	Saline-sodic
11	Dumpsite	23.7	34.33	7.3	Saline-sodic
12	**Average**	**14.95**	**28.24**	**7.5**	Saline-sodic
13	Reference Point	3.65	24.29	7.4	Sodic-nonsaline

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الخصائص الكيميائية لترب ملوثة مختارة في مدينة البصرة، جنوبي العراق

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المستخلص. تهدف هذه الدراسة إلى تحليل الخصائص الكيميائية للتربة في المنطقة الحضرية لمدينة البصرة، جنوبي العراق، وكذلك إلى معرفة تأثير التلوث في التباين الفصلي والمكاني للخصائص الكيمائية للترب المدروسة. وتم جمع العينات من مواقع ملوثة مسبقاً خلال فصلي الشتاء والصيف من العام 2009. واختيرت مواقع العينات من مناطق ذات أنماط استعمالات أرض مختلفة. وقد أظهرت النتائج المستحصلة أن المؤشرات الكيميائية للترب في منطقة الدراسة كانت متباينة فصلياً ومكانياً، و أن نوعية التربة تعاني تدهوراً بسبب تضافر مجموعة من العوامل البشرية والطبيعية. كما أتضح أن نوعية التربة كانت عالية الملوحة بدلالة مؤشر التوصيلية الكهربائية (EC) للتربة، وذات قلوية منخفضة بدلالة مؤشر درجة تفاعل التربة (pH)، وأنها ملحية صودية بدلالة مؤشر مختبر الملوحة الأمريكي. ويعزى السبب الرئيس في تدهور التربة الحضرية إلى دور التلوث الناجم عن أنشطة مختلفة تجري في داخل المدينة.