Chemical Proprieties of Selected Contaminated Soils from Basra City, Iraq

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Abstract The main objective of present study is both analyze the chemical properties of soil quality in the urban area of Basra City, southern Iraq, and realize contamination effect on seasonal and spatial differentiation of that soil quality. Soil samples were collected from already contaminated sites during winter and summer seasons of 2009. Sampling sites were selected from various urban land-use patterns. The findings have shown that chemical parameters of soils in the study area were seasonally and spatially varied, and that soil quality is deteriorating because of combined anthropogenic and natural influences. It has been indicated that, in average, soil quality was highly saline in terms of EC index, slightly alkaline in terms of pH index, and saline-sodic in terms of US salinity Lab index. Main reason for this urban soil degradation may be due to effect of contamination caused by various urban activities.

Key Words Soil, Urban Soil, Soil Quality, Contamination, Sanlinization.

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" (Bollag and Bollag, 2004).

Soil contamination mostly results from the intensification of agricultural production and from a general invasion of chemical products in all the fields of human activity (Frank, 1993). Thus, properties of the soil are affected by various processes occurring in the soil, by the chemical composition of the soil-forming substrate and by human interventions ((Tolgyessy, 1993).

Soil contamination by materials of urban sources is a problem as old as urbanization itself. Archaeological studies show that, through the construction and demolition of domestic concentrations and public centers of human activities (temples, sport arenas, etc.), a great deal of polluting substances were always dumped, or disposed of, on soils, resulting in their physical or chemical degradation. The damage of soil in those ancient days was of a limited scale, yet since the beginnings of the industrial revolution it has taken dimensions that are hardly controllable in modern times. A considerable quantity of construction materials (concrete, gypsum, asbestos, etc.) may come into contact with the water table and ultimately lead to changes in the chemistry of the soil waters. The main sources of urban soil contamination, however, are power generation emissions, releases from transport means and waste disposal (Mirsal, 2008).

Of all urban sources contributing to soil contamination, waste and sewage sludge disposal occupy a central role in this environmental problem. In general, as increasing rates of population growth, as the production of waste is increasing. In developing and under-developed countries, high rates of population growth and increasing waste and sludge production, combined with lack of municipal services, create a dangerous situation.

Waste produced by households is 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 under 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 ((Mirsal, 2008).

Soil scientists and land managers are faced with a wide range of threats to soil quality, including those from (Pollard and Kibblewhite, 2006):
- potentially toxic elements (pte) and pathogens in sewage sludge applied to agricultural land and forestry;
- industrial sludges (*e.g.* pulp and paper mill wastewater treatment, 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.

Health of many people may be exposed to harmful effects from contaminated soils and are they (WHO, 1999):
- 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.

Basra City (the study area) lies in southern Iraq, on the point of 30º34N and 47º50E coordinate (see 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 ton respectively (Al-Hassen, 2011).

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

There are little scientific studies on soil contamination within the urban areas, particularly for 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 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 involved human activities on it resulting soil contamination.

Materials and Methods

On the spatial scale, the soil samples have been selected from already contaminated sites within the study area. The contamination of these sampling sites are mostly due to municipal and industrial waste dumping. The selection of sampling sites have been on the basis of some considerations of spatial differentiation, as follows (see Tab.1, column *sampling site*, and Fig.1):

1- According to the forth geographical directions relative to the study area (such as Northern, Southern, and Western gates).

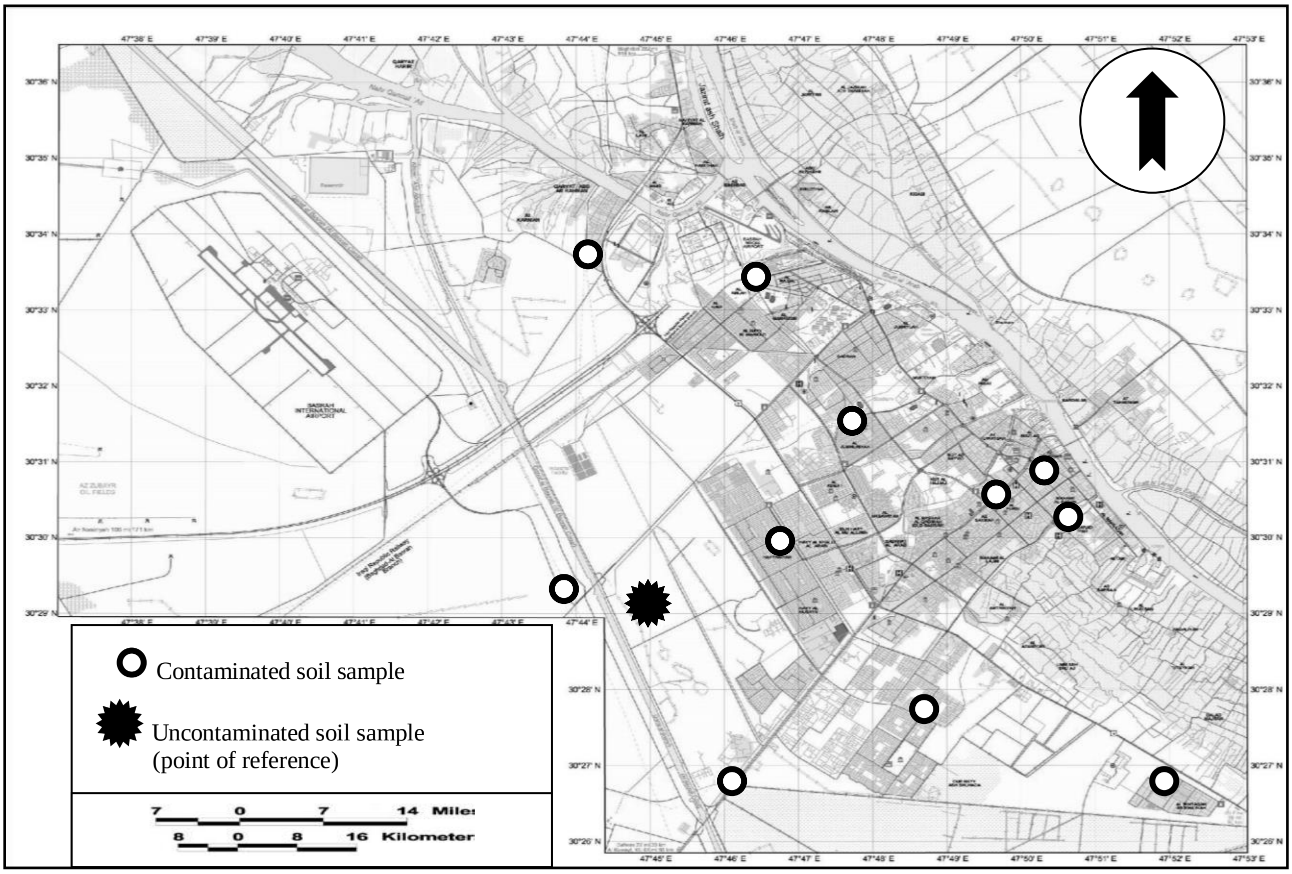


Figure 1: Map of the study area (Basra City) and sampling sites.

2- According to the density of commercially and popularly districts of the study area (such as high or low traffic and dense districts).
3- According to the land use patterns of the study area (such as residential, commercial, industrial, and agricultural land uses).

However, a soil sample from point of reference (with no urban activity) have been collected for comparison.

On the temporal scale, the soil samples were collected during the winter and summer seasons of 2009.

In the field, the samples have been taken by shave of the topsoil on the 0-10cm depth for each of sampling sites, and put them in marked plastic bags of 1kg capacity. The soil samples have been, then, brought into the laboratory.

In the laboratory, according to Tolgyessy's method (1993), the sample prepared in way is poured to form a conical pile. The pile is then quartered with the help of a suitable tool. The two opposite portions are taken as a sample. The quartering procedure is repeated to reach the sample amount required for the chemical analysis. The soil analysis is then frequently performed 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, then purify the soil sample extract by filtration paper of Whatman NO.1 type.

Values of EC and pH were measured by using WTW pH/Cond 3L5i meter, made in Germany.

Measurements of major elements (Cations and ions) were performed by using following techniques:

1- Calcium (Ca^+) was determined by titration with solution of 0.01*N* Na_2-EDTA, and using Murxide index.
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^+) were measured by Flame Photometer, type of Jenway PEP7.
4- Chlorides (Cl^-) were determined by titration with solution silver nitrates ($AgNO_3$), and using ($K_2Cr_2O_7$).
5- Bicarbonates (Hco_3^-) were estimated by pH-Alkalinity method.
6- Sulfates ions (SO_4^-) were determined by Turbidimetric technique and using Spectrophotometer, type of HITACHI (U-1500) on the wavelength of 420nm.

Results and Discussion

The nature of soil in the study area could be considered, which is part of the soils of Mesopotamian floodplain, with loamy silt clay texture, mainly caused by alluvial deposition. Thus, soil texture is characteristic of fine, because of a large proportion of clay and silt particles. The infiltration rate is moderately slow, permeability are moderately rapid, and retentive capacity is high due to very fine porosity (Al-Rubaiay, 1984).

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

Electrical Conductivity (EC): As shown in Tab.1 and Fig 2a, the salinity in soil samples (represented by EC) is spatially varied. The soil salinity being largely high at sampling sites such as Qublah, Baradithyah, and Dumpsite, while being so low at the sampling sites of Maqal, Ashar, and Southern Gate. This spatial variation may mainly ascribed that groundwater table of former districts is higher than earlier districts, leading to severe sanlinization occurred in soils. The depths of water table from ground surface in districts such as Qublah and Baradithyah are around 21 and 22cm, whereas in districts such as Maqal and Ashar amounted to 50 and 75cm, respectively.

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

There are seasonal variations in the levels of EC at 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 record EC concentration of 107.7dS/m. This is, of course, referred to temperature increase during summer that, in turn, raised to evaporate the soil moisture 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, Baradithyah, and Hamdan industrial district. This is 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 be mobilized in soil profiles, causing land and water degradation. The salts can also effect release and solubilization of heavy metals into solution, with potential adverse effects on water quality and plant growth (Sparks, 2003).

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

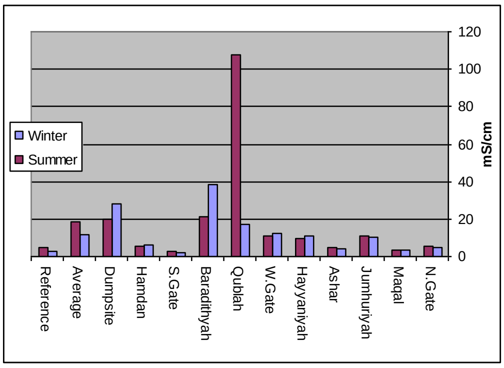
Table 1: Concentrations of EC, pH, cations, and ions in soil samples at the study area during the winter and summer seasons of 2009.

(a) during Winter

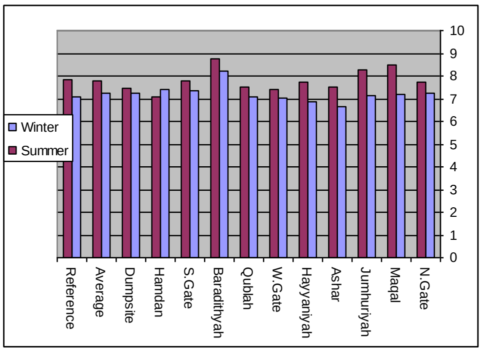
NO.	Sampling Site	EC (dS/m)	pH	Ca^+ (ppm)	Mg^+ (ppm)	Na^+ (ppm)	K^+ (ppm)	Cl^- (ppm)	Hco_3^- (ppm)	SO_4^- (ppm)
1	Northern Gate on Basra City (Garmmat Gate)	4.66	7.25	320	97.2	637.8	6068	1169.8	305	543.9
2	Maqal District	3.36	7.20	200	413.1	446.4	61.8	886.2	336	631
3	Jumhuriyah District	10.26	7.15	600	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 Gate on Basra City (AzZubyer Bridge Gate)	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	Baradithyah District	38.4	8.19	880	1555.2	2248.3	412.6	6983.6	610	8029.8
9	Southern Gate on Basra City (Abo Al-Khaseb Gate)	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	Main 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	Point of Reference	2.45	7.1	200	235	484.2	23.9	757.4	289	520.2

(b) during Summer

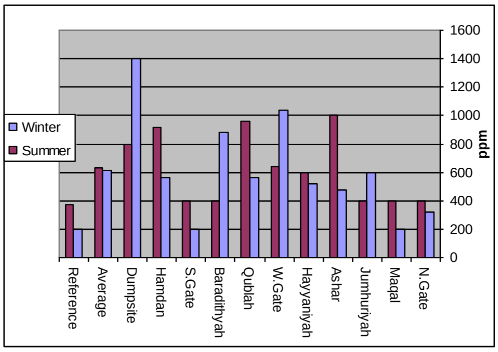
NO.	Sampling Site	EC (dS/m)	pH	Ca^+ (ppm)	Mg^+ (ppm)	Na^+ (ppm)	K^+ (ppm)	Cl^- (ppm)	Hco_3^- (ppm)	SO_4^- (ppm)
1	Northern Gate on Basra City (Garmmat Gate)	5.28	7.73	400	850.5	282.8	31	1240.7	305	678.7
2	Maqal District	3.22	8.47	400	874.8	169.6	35.9	531.7	1037	571.8
3	Jumhuriyah District	11.29	8.26	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 Gate on Basra City (AzZubyer Bridge Gate)	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	Baradithyah District	21.4	8.76	400	2114.1	614.0	196.6	4927.5	610	2101.3
9	Southern Gate on Basra City (Abo Al-Khaseb Gate)	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	Main 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	Point of Reference	4.86	7.82	375	633.4	412.9	45.3	758.1	722	425.6



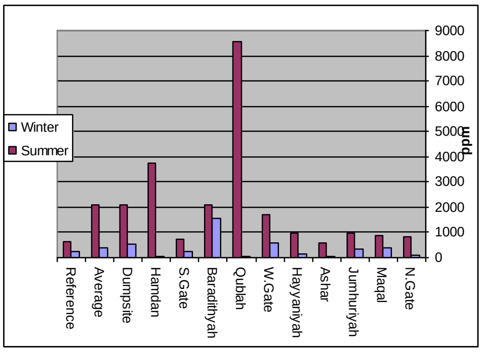
(a) EC



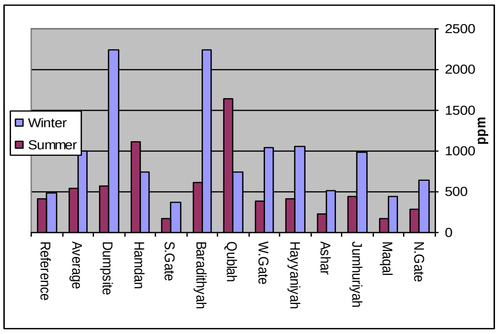
(b) pH



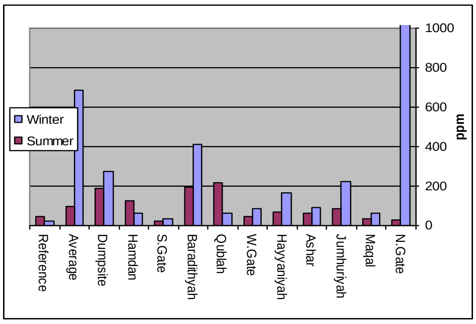
(c) Ca



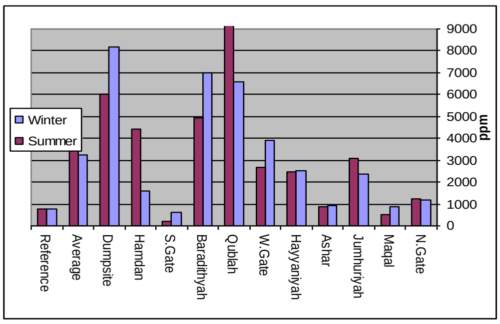
(d) Mg



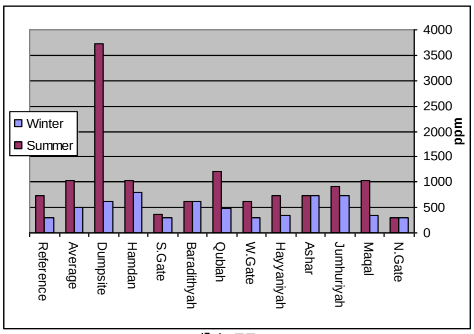
(e) Na



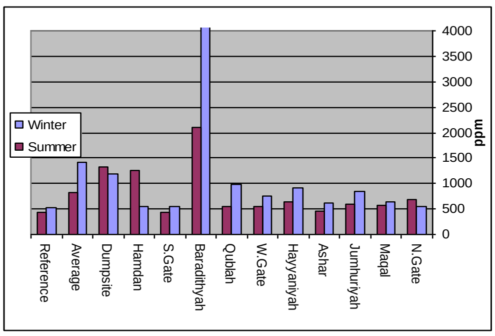
(f) K



(g) Cl



(h) Hco_3



(h) SO_4

Figure 2: Graphic representation of the cations and ions of soil samples in the study area.

Table 2: Categories of soil salinity (EC index), according to USAD classification of 1954. (FAO & UNESCO, 1973)

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

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

NO.	Sampling Site	EC (Average of two readings) (dS/m)	Category of Soil
1	Northern Gate on Basra City (Garmmat Gate)	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 Gate on Basra City (AzZubyer Bridge Gate)	11.32	Highly saline
7	Qublah District	62.4	Extremely saline
8	Baradithyah District	29.90	Extremely saline
9	Southern Gate on Basra City (Abo Al-Khaseb Gate)	2.46	Slightly saline
10	Hamdan Industrial District	5.80	Moderately saline
11	Main Dumpsite	23.7	Extremely saline
12	**Average**	**14.95**	**Highly saline**
13	Point of Reference	3.65	Slightly saline

This resulting classification is obviously indicated 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 Gate, and Point of Reference. Values of EC in these sampling sites, however, reduced during summer to limit on only tow sampling sites of Maqal and Southern Gate. In the other sampling sites, values of EC ranged from "moderately saline" to "extremely saline" categories, indicating that urban soils of the study area being suffering from severe contamination.

pH: The pH of a solution is defined as the negative common logarithm (denoted by “p”) of the hydrogen ion (H+) activity. A common misconception is that the pH of a solution is the negative logarithm of the molar concentration of the hydrogen ion. As well, pH is an measure of acidity and alkalinity in soil solution (Essington, 2005).

As shown in Tab.1 and Fig 2b, there are slight variations in pH values during winter and summer in all of sampling sites. It ranged from 6.6 and 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 Baradithyah on the other hand. This spatial and seasonal variation may referred to effects of chemical interactions which activated as a result 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 pH index (see Tab.4) was performed, detecting on more specific and more

Table 4: Categories of soil quality according to pH index. (Ellis and Mellor, 2003)

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

Table 5: Categories of soil quality (pH index) in the study area.

NO.	Sampling Site	pH (Average of two readings)	Category of Soil
1	Northern Gate on Basra City (Garmmat Gate)	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 Gate on Basra City (AzZubyer Bridge Gate)	7.2	Slightly acid to neutral
7	Qublah District	7.3	Slightly acid to neutral
8	Baradithyah District	8.4	Alkaline
9	Southern Gate on Basra City (Abo Al-Khaseb Gate)	7.5	Slightly alkaline
10	Hamdan Industrial District	7.2	Slightly alkaline
11	Main Dumpsite	7.3	Slightly acid to neutral
12	**Average**	**7.5**	**Slightly alkaline**
13	Point of Reference	7.4	Slightly alkaline

obvious spatial variations as shown in Tab.5.

These spatial variations in pH significantly affects the availability of plant nutrients and microorganisms. At low pH (as in sampling sites of Ashar, Hayyaniyah, Western Gate, 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 Gate, Maqal, Jumhuriyah, Baradithyah, Southren Gate, and Hamadan industrial district), their solubility decreases and precipitation occurs. Plants may suffer deficiencies as pH rises above neutrality (Sparks, 2003).

Cations and Ions: Soil solution is consisted of water and solutes that to be in constant change as a result of processes such as decomposition, addition, transport, and loss for colloids. As well, soil solution is a medium to 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 and Fig.2(c,d,e,f,g,h), 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 Baradithyah. Na concentrations ranged from 366.7 to 2248.3ppm in Southern Gate and dumpsite. K concentrations ranged from 36.4 to 6068ppm in 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 Gate and Dumpsite. Hco_3 concentrations ranged from 305ppm in Northern, Western, and Southern Gates to 793ppm in Hamadan Industrial District. SO_4 concentrations ranged from 543.9 to 8029.8ppm in Northern Gate and Baradithyah, respectively. The averages of ions values (Cl, Hco_3, and SO_4) in all the sampling sites amounted to 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 Point of Reference and Ashar. Mg concentrations ranged from 753.3 to 8553.6ppm in Southern Gate and Qublah. Na concentrations ranged from 169.6 to 2248.3ppm in Maqal and Western Gate. K concentrations ranged from 31 to 218.6ppm in Northern Gate and Qublah, respectively. During the same season, averages of cations values (Ca, Mg, Na, and K) in all the sampling sites amounted to 629, 2114.1, 548.6 and 98.8ppm respectively.

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 Gate and Dumpsite. SO_4 concentrations ranged from 441.6 to 2101.3ppm in Southern Gate and Baradithyah, respectively. The averages of ions values (Cl, Hco_3, and SO_4) in all the sampling sites amounted to 4344.2, 1025, 833.8ppm respectively.

Broadly speaking, 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, Baradithyah, Qublah, Hayyaniyah, Ashar, Jumhuriyah, Maqal, and Western Gate).

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

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

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

5- Soil contamination caused by sanlinization involved in previously agricultural lands (as in as in sampling sites of Baradithyah and Southren Gate).

6- Combination of natural influences 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 exchanger phases. These are, for example, 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, indicating a nonsodic soil, and an ESP >15, indicating a sodic soil, the accuracy of the number is often a problem due to errors that may arise in measurement of CEC and exchangeable Na+. Therefore, the more easily obtained SAR of the saturation extract should be used to diagnose the sodic hazard of soils. Although ESP and SAR are not precisely equal numerically, an SAR of 15 has also been used as the dividing line between sodic and nonsodic soils (Essington, 2005).

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+}

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

NO.	Sampling Site	during Winter		during Summer	
		SAR	ESP%	SAR	ESP%
1	Northern Gate on Basra City (Garmmat Gate)	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 Gate on Basra City (AzZubyer Bridge Gate)	36.39	34.40	11.32	13.37
7	Qublah District	42.14	37.84	23.81	25.30
8	Baradithyah District	64.64	48.39	16.08	18.34
9	Southern Gate on Basra City (Abo Al-Khaseb Gate)	24.64	25.95	7.06	8.39
10	Hamdan Industrial District	42.14	38.02	23.03	24.64
11	Main Dumpsite	72.25	51.30	15.09	17.36
12	**Average**	**44.99**	**39.41**	**14.81**	**17.08**
13	Point of Reference	27.29	28.03	18.39	20.56

deficiencies. In saline soils soluble ions such as Cl^-, SO_{2-4} , 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 dire 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 (Sparks, 2003).

SAR and ESP values of the sampling sites are spatially and seasonally varied. During winter, as Tab.6 indicates, values of SAR and ESP are respectively ranged from 24.64ppm and 25.95% in Southern Gate to 72.29ppm and 51.30% in Dumpsite. While, during summer, its ranged from 6.71ppm and 7.95% in Maqal to 23.81ppm and 25.30% in Qublah. Averages of SAR & ESP values are also varied, its respectively amounted to 44.99ppm and 39.41% in winter and 14.81ppm and 17.08% in summer.

Increases in SAR and ESP values can be ascribed, in turn, to elevated EC value. As mentioned above, high concentrations in salinity are as a consequence of combined anthropogenic and natural influences.

According to US Salinity Lab classification of 1954 (see Tab.7), in which EC, ESP, and pH values have altogether taken in consideration, it as indicated in Tab.8 is that there are significant spatial differentiation in the resulting classification of soils at the study area, as follows: the soil samples of Northern Gate, Jumhuriyah, Ashar, Hayyaniyah, Western Gate, Qublah, Baradithyah, Hamdan Industrial District, and Dumpsite lies within the saline-sodic category. While The soil samples of Maqal, Southern Gate, and Point of References lies within the sodic-nonsaline category. In average, the soil category of all sampling sites is saline-sodic.

In conclusion, the findings confirmed that soil quality in the study area (Basra City) is deteriorating, because of impacts of the pollution. The evidence supported by the obvious difference between values of soil parameters at the point of reference located outside the urban area and those that located within the urban area (the other sampling

Table 7: Categories of soils affected by salinization, according to US Salinity Lab (Richards, 1954).

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

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

NO.	Sampling Site	EC (dS/m) (Average)	ESP% (Average)	pH (Average)	Category of Soil
1	Northern Gate on Basra City (Garmmat Gate)	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 Gate on Basra City (AzZubyer Bridge Gate)	11.32	23.88	7.2	Saline-sodic
7	Qublah District	62.4	31.57	7.3	Saline-sodic
8	Baradithyah District	29.90	36.84	8.4	Saline-sodic
9	Southern Gate on Basra City (Abo Al-Khaseb Gate)	2.46	17.17	7.5	Sodic-nonsaline
10	Hamdan Industrial District	5.80	31.33	7.2	Saline-sodic
11	Main Dumpsite	23.7	34.33	7.3	Saline-sodic
12	**Average**	**14.95**	**28.24**	**7.5**	Saline-sodic
13	Point of Reference	3.65	24.29	7.4	Sodic-nonsaline

sites. It is clear that there is decline in values of parameters for the earlier with comparison to the former. This difference may explained by the profound effect of contamination due to various human activities involving in the urban area, while there is little urban effect on the point of reference.

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الخصائص الكيميائية لترب ملوثة مختارة
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المستخلص تهدف هذه الدراسة إلى تحليل الخصائص الكيميائية لنوعية التربة في المنطقة الحضرية لمدينة البصرة، جنوبي العراق. وكذلك معرفة تأثير التلوث في التباين الفصلي والمكاني لنوعية التربة تلك. وقد تم 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، وأن نوعية التربة تعاني تدهوراً بسبب تضافر مجموعة من العوامل البشرية والطبيعية. كما أتضح أن نوعية التربة، بالمعدل، كانت عالية الملوحة بدلالة مؤشر التوصيلية الكهربائية (EC)، وذات قلوية منخفضة بدلالة مؤشر درجة الأس الهيدروجيني (pH)، وأنها ملحية صودية بدلالة مؤشر مختبر الملوحة الأمريكي. وقد يعزى السبب الرئيس في هذا التدهور للتربة الحضرية إلى دور التلوث الناجم عن أنشطة مختلفة تجري في داخل المدينة.