Misr J. Ag. Eng., 25(4): 1323-1342 IRRIGATION AND DRAINAGE

EVALUATION OF DRAINAGE WATER QUALITY TO BE REUSED FOR IRRIGATION PURPOSES IN RIYADH AREA, SAUDI ARABIA

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ABSTRACT

Recent urban development tremendously increased the use of water in domestic, industrial and landscape irrigation which increased manifold production of wastewater of marginal quality. Saudi Arabia is an arid country having limited and non-renewable groundwater resources coupled with un-predictable and scanty rainfall. The growing demand of good quality water for various purposes has forced the water planners to find an alternate sources of water to lower burden on freshwater groundwater resources. In Riyadh city, about one million cubic meter of wastewater is flowing daily in Wadi Hanifah. To explore the quality of that water and its effect, a study was carried out along the main drainage channel known as "Wadi Hanifah Stream" often called as man–made-river to examine its quality including chemical composition, its predictive effects on soils and management alternatives for re-use for landscape irrigation in and around Riyadh city. The wastewater channel is composed of agricultural drainage water, sewage water, seepage losses from irrigated fields, leakage from water supply systems, runoff from over irrigation and waste effluent from Wastewater Treatment Plant Riyadh. Water samples from 31 locations along Wadi Hanifah stream were collected for quality evaluation for its reuse in landscape irrigation. The SAR and adj.R_{Na} of wastewater ranged from 4.06-7.66 and 4.75-10.75, respectively. The B concentration was above the permissible limit of 1.0 mg L^{-1} for crop irrigation. The predicted soil salinity values from hypothetical leaching fractions showed that the soil salinity falls in the category of moderate to highly saline soils where cultivation of moderate

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to high salt tolerant crops is possible provided 15-20 % excess water above crop water requirements is applied as leaching requirement to maintain soil salinity within acceptable limits. Careful analysis, improved irrigation systems and irrigation management practices are key factors for reusing drainage water.
Keywords: *Drainage water, irrigation water quality, total water salinity, boron, leaching requirement, predicted soil salinity*.

INTRODUCTION

Saudi Arabia has experienced tremendous urban, rural, agricultural and industrial development over the last two decades which increased manifold the demand of water. The total cropped area in the Kingdom increased from 1.25 million hectares in 1988 to 1.59 million hectares by 1994 (MAW, 1994). Currently, more than 80 % of water demand in agriculture sector is met from non-renewable groundwater sources (MAW, 1994). To meet the growing demand of water for domestic, industrial and agriculture sectors, alternative source of water especially for landscape development and agricultural expansion, has to be explored.

Information is limited on the re-use of waste water in Saudi Arabia. Previous research (Al-Rajhi et al. 1991; Al-Jaloud, 1994; Al-Jaloud et al. 1993, 1995 and Al-A'ama and Nakhla, 1995) addressed some of the issues on the re-use potential of treated sewage for irrigation purposes and its effects on soil and plants.

Irrigation water quality is determined by its physical, chemical and biological parameters as well as the conditions of use. Currently, there is a lot of awareness regarding the water pollution and environmental health hazards resulting from the use of wastewaters. Still, there is a great concern regarding the recycling and reuse of drainage water for irrigation. Besides total water salinity, the presence of certain toxic elements such as Pb, Ni, Cd, Co, Cu, Mo, Hg etc in the drainage waters is likely to create some environmental problems and needs evaluation prior to its re-use for purposes other than agriculture.

Population of Riyadh city has increased manifold over the last 25 years. One of the implications of population increase is the substantial increase in water requirements for different purposes consequently increasing the production of wastewater. As a direct result of massive expansion in size and population of Riyadh city, Wadi Hanifah channel has become a significant drainage water disposal outlet. The main objective of this study was to determine wastewater quality and its reuse potential in agriculture with minimum environmental hazards.

Drainage Water Availability

The wastewater running through Wadi Hanifah channel include agricultural drainage water, run-off losses from irrigation systems and fields, sewage water from cities and villages, leakage from water supply systems, high percolation losses from the irrigated fields, waste effluent from sewage water treatment plant (SWTP) Riyadh and the drainage effluent from aquaculture facilities. Drainage water also contains appreciable amount of plant nutrients such as N, P and others (Fe, Cu etc) and can prove a good source of plant nutrition especially for landscape establishment. Since, the use of reclaimed or treated wastewater for various purposes is in early development stages in Saudi Arabia but offers a good opportunity for considerable expansion in the future with simultaneous increase in population. It was reported in 1985 that wastewater treatment provided only 1% of the total supply which reached to 23% in 1998 with 336,000 m^3 of treated sewage water being used in agriculture sector (Ministry of Municipal and Rural Affairs, 1999). Figure 1 shows the quantity of wastewater available in some major cities in Saudi Arabia (Hussain and Al-Saati, 1999). Figure 2 shows mean weighted flow in Wadi Hanifah at some sites according to Al-Fayzi and Al-Fateh, 1996.

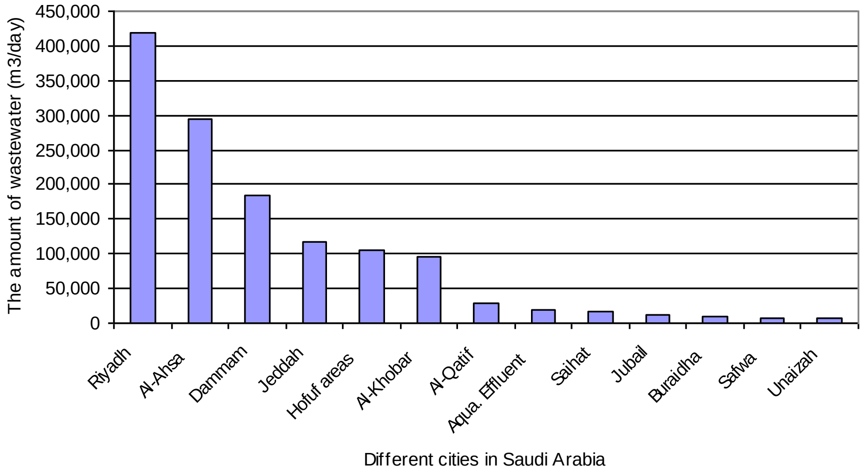

Fig.1. The quantity of wastewater available in some urban centres in Saudi Arabia (Hussain and Al-Saati, 1999).

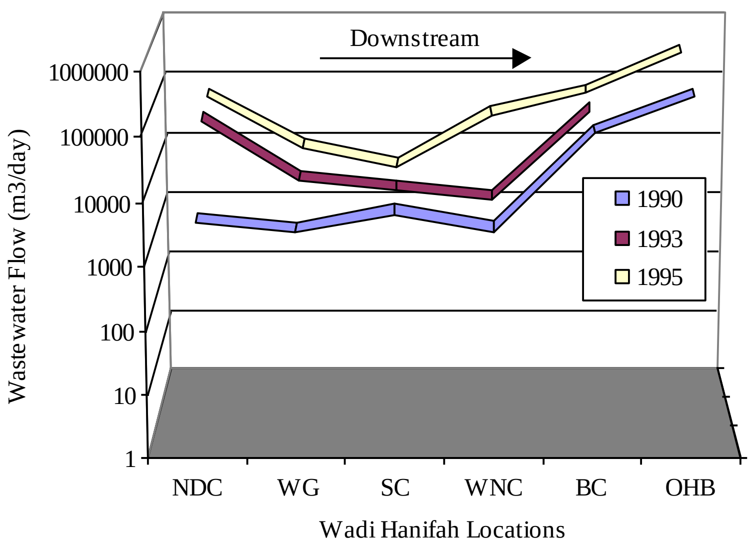

Figure 2: Weighted mean flow at various sites of Wadi Hanifah stream (measured by Al-Fayzi and Al-Fateh, 1996).

MATERIALS AND METHODS

A detailed survey was carried out in and around Riyadh city during 2004-2005 to determine the main drainage network for the disposal of wastewater into the main drainage stream passing through the main city of Riyadh.

A total of 31 drainage water samples were collected from the main drain and the sub-drains along the entire course of Wadi Hanifah channel (Figure 3). The drainage water samples were collected in three different types of bottles (after Shelton, 1994). For chemical analysis , water samples were collected in triplicate in sterilised, acid washed, plastic bottles (capacity one-litre). The bottle was kept airtight to avoid any contamination and stored in an icebox at 4 °C until analyzed. The analytical procedures used for these determinations were those described in USDA, 1954.

Water Quality Indicators for Landscape Irrigation

The criteria used to evaluate quality of drainage/wastewater for use in agriculture are 1) **Salinity** of irrigation water for salt build up in soils and its adverse effects on plant growth, 2) **Sodium Adsorption Ratio (SAR)** for its deleterious effect on soil physical properties, 3) **Residual Sodium Carbonate (RSC)** for its effects on final soil water SAR value with the loss or gain in Ca and Mg concentration due to the precipitation or dissolution of alkaline earth carbonates, and the **Toxic effects of Specific Ions** in irrigation water such as Na, Cl, SO_4 and B on plant growth and yield (FAO, 1985).

Besides the above indicators, some mathematical equations and models were applied to evaluate the water quality for its reuse as irrigation in the main Metropolitan City Riyadh for the development of community recreational sites. Soil salinity development (SSD), adjusted sodium adsorption ratio (adj. R_{Na}), and exchangeable sodium percentage (ESP) were calculated from the analytical data.

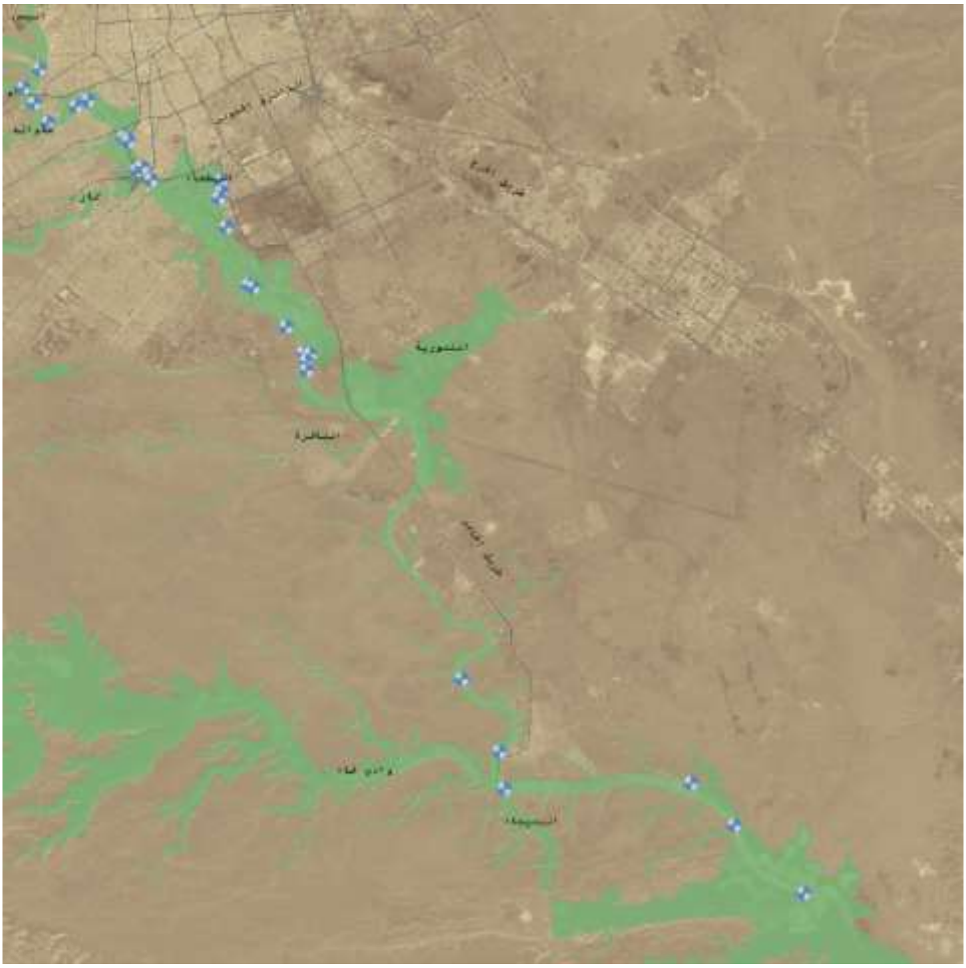

Fig. 3. Location map of different sampling stations in main Wadi Hanifah water stream.

(a) The SSD was calculated by the following equation according to Ayers and Westcot, 1985. $SSD = EC_{dw} = EC_{iw}/LF$ (1)

Where: EC_{dw} Salinity of the drainage water percolating below the root zone.

EC_{iw} Salinity of the drainage water to be used for irrigation.

LF Leaching fraction is the amount of irrigation water that leaves the root zone as drainage water.

(a). The sodium adsorption ratio (SAR) was calculated as below (USDA, 1954):

$$SAR = Na/[(Ca + Mg)/2]^{1/2} \quad (2)$$

(b) The adj.R_{Na} was determined according to Suarez (1981) using the following equation:

$$adj.R_{Na} = Na/ [(Ca_x + Mg)/2]^{0.5} \quad (3)$$

where all concentrations in meq L^{-1}, Ca_x represents concentration after counting for HCO_3 of wastewaters.

(C) The ESP was predicted as:

$$ESP = \frac{100 (-0.0126 + 0.01475 \times SAR)}{1+ (-0.0126 + 0.01475 \times SAR)} \quad (4)$$

where SAR is the SAR of the soil solution resulting from irrigation with drainage waters.

The salinity and sodicity hazards of the drainage waters were determined according to the classification given by USDA Handbook No. 60, 1954.

The drainage waters were also categorized for landscape irrigation and crop production according to the standards of Ayers and Westcot (1985).

The chemistry data were evaluated by applying various statistical techniques according to Snedecor and Cochran, 1973.

RESULTS AND DISCUSSION

Chemistry of Drainage Water

The ranges of different water quality parameters were 1.76-5.37 dS m^{-1} (EC), (all other cations and anions expressed as mg L-1) 1252-4263 (TDS), 168-571 (Ca),47-161 (Mg), 231-764 (Na), 15-30 (K), 163-274 (HCO_3), 279-826 (Cl), 414-1497 (SO_4), 22-136 (NO_3), 4.06-7.66 (SAR) and 4.1-10.75 (adj. R_{Na}) in the drainage water of Riyadh city at different locations (Table 2). The order of abundance for cations was Na > Ca > Mg, while that of anions was SO_4 > Cl > HCO_3. A significant correlation was found between Na and Cl ions (R^2=0.927), Ca and Cl ions (R^2=0.795) and Mg and Cl (R^2=0.842) in the drainage water of Riyadh city. This indicated that that the drainage water of Riyadh city is mainly Na, Ca and SO_4 water. Thermodynamic calculations revealed that a significant fraction of Ca and Mg in the groundwater was associated with SO_4 and HCO_3. The regression analysis showed (Fig. 4) a strong relationship between EC and SAR as well as between EC and adj. R_{Na} of drainage water (R^2= 0.677 and 0.792 for SAR and adj.R_{Na}, respectively). The results agree with those of Hussain and Sadiq (1991) who reported drainage water salinity between 1000 and 7273 mg L^{-1} in Al-Ahsa drainage water. They also observed that the drainage water salinity depends on the type and nature of drainage water.

The drainage waters were classified as C3S1 to C4S3 i.e. that is high to very high salinity and slight to very high sodicity problems (USDA, 1954). The drainage water could be used for irrigation provided certain management practices such as application of leaching requirement, selection of medium to high salt tolerant crops and improved irrigation system (drip or subsurface) are adopted in order to keep the soil salinity within acceptable limits for crop production and landscape development.

Ion Inter-Relationships

The regression analysis showed strong relationship between Na vs Cl ions (R^2 = 0.928), between Ca vs Cl (R^2= 0.795) and, between Mg vs Cl (R^2 =0.842; Fig. 5) as well as between Ca and SO_4 (R^2=0.912) and between Mg vs SO_4 ions (R^2=0.850) in the drainage water of Riyadh City (Fig. 6). With increased SO4, the Ca and Mg values tend to increase indicating an interaction between the aqueous and the solid phases. However, there is no evidence of any other relationship among various cations in the drainage water.

Cations and Anions Ratios

The Ca concentration is 1.39 -2.71 times higher than Mg in the drainage water of Riyadh (Fig. 4). This revealed that Ca dominant soils will develop and improve the soil structure with drainage water irrigation. The drainage water is a Na-Ca and Mg type water.

The SO_4 ion was the dominant anion than the Cl ion in the drainage water and the ratio ranged between 0.925 and 1.95 (Fig.7). The high sulphate (SO_4) concentration than chloride (Cl) might be due to the land disposal of industrial waste effluents rich in sulphur compounds.

Effect of Drainage Water Quality on Soil Properties

Besides fresh irrigation supplies, the available drainage water is an alternative source of irrigation for sustainable landscape development and crop production in the suburbs of Capital City Riyadh. Therefore, the effect of the prolonged use of drainage water for irrigation was predicted on soil salinity and the sodium hazards. The SAR of drainage water was calculated. This information was used to calculate adj.R_{Na} which accounts for alkalinity hazards and the exchangeable-sodium-percentage (ESP) of soil. The SAR of drainage water ranged from 4.06-7.66 with the corresponding adj.R_{Na} value of 4.75-10.75 (Table 2 & Fig. 8). The predicted exchangeable-sodium-percentage (ESP) using drainage water for irrigation is presented in Fig. 8. The ESP values predicted from adj. R_{Na} are much higher than those predicted from the normal SAR of drainage water. But the predicted ESP of soil from both the SAR and adj.R_{Na} does not show any sodicity hazards upon irrigation with drainage water. Because, the upper safe limit of ESP value for soil is 15 according to USDA, 1954, hence there is no immediate concern of soil sodicity problem from drainage water irrigation. In the case of long term irrigation practice, there might be some soil sodicity problems which could be managed if management practice such as leaching requirement (application of 15-20 % excess water above crop ET requirements) is followed to keep soil salinity and sodicity within safe limits.

Development of soil salinity from drainage water irrigation was predicted using five hypothetical leaching fractions ranging from 0.15-0.40 % (Fig.9). It was noticed that those locations, where drainage water EC is less than 2.5 dS m^{-1}, might develop soil salinity more than 10 dS m^{-1}. This indicated that cultivation of moderate to high salt tolerant crops is possible provided 15-20 % excess water above crop water requirements (ET) is applied as leaching requirement to maintain soil salinity within acceptable limits.

Nitrate (NO_3) Concentration

Most of the nitrogen in the drainage water is probably derived from the biosphere and land disposal of sewage effluent. Mean nitrate concentration (mg L^{-1}) in drainage water of Riyadh city ranged from 17.5-135.6 (Table 2). The ammonium compounds in the drainage water are oxidized and converted to more stable nitrogen compounds such as nitrate form of nitrogen (Al-Jaloud et al., 1993). The maximum permissible limit of nitrate concentration in water for irrigation purpose is 45 mg L^{-1} according to WHO (1984). Data revealed that about 18 % of the total drainage water samples contained high nitrate concentration which is above the permissible limits for agriculture use and needs pre-treatment before its intended use.

Phosphate (PO_4) Concentration

The PO_4 contents ranged between 0.162 and 21.910 mg L^{-1} in the drainage water of Riyadh City (Table 2). Ion inter-relationship analysis showed good relation between Ca and PO_4 ion (R^2= 0.654) and between Mg and PO_4 (R^2=0.629) whereas a poor relation was observed between Na and PO_4 ions (R^2= 0.429). This suggested that most of the PO_4 ion is associated with Ca and Mg ions. Data also revealed that about 55 % of drainage water samples from different locations of Riyadh District contain PO_4 higher than the established standards (3 mg L^{-1}) of MEPA, Saudi Arabia (MEPA, 1988) and requires consideration.

Boron (B) Concentration

Mean B contents ranged between 0.74 and 1.51 mg L^{-1} (Table 2). The safe limit of B content in irrigation water is less than 0.7 mg L^{-1} for crop irrigation (Mass, 1984 and Ayers and Westcot, 1985). The B concentration above this level can create toxicity in plants, create health hazards and could be a potential source of environmental pollution when used for crop irrigation (Lucho-Constantino et al., 2005). The permissible limits of boron contents in irrigation water are given in Table 3. The results revealed that most of the drainage water samples contains high level of B. The high B contents might be due to increased use of borax powder for the preparation of different types of detergents and later on the waste effluent from these small industries is released to the main Wadi Hanifah stream. The maximum permissible levels of different metal concentration in irrigation water according to Ministry of Agriculture and Water, Riyadh, Saudi Arabia is presented in Table 4.

CONCLUSION

The salinity and sodicity hazards of drainage water of Riyadh were classified as C3S1 to C4S3 i.e. that is high to very high salinity and slight to very high sodicity problems. A strong relationship existed between Na and Cl ions (R^2 = 0.9276), between Ca and Cl (R^2= 0.795) and, between Mg and Cl (R^2 =0.842; Fig. 5). Also, a strong relationship was found between Ca and SO_4 (R^2=0.912) and between Mg and SO_4 ions (R^2=0.850) in the drainage water of Riyadh City. The Ca concentration is 1.39 -2.71 times higher than Mg. The SO_4 is the dominant anion rather than Cl ion in the drainage water and the ratio ranged from 0.925 to 1.95. The SAR ranged from 4.06-7.66 with the corresponding adj.R_{Na} value of 4.75-10.75. The predicted ESP values from the adj. R_{Na} are much higher than those predicted from the normal SAR of drainage water and does not show any sodicity hazards upon irrigation with drainage water. Mean nitrate concentration (mg L^{-1}) varies from 17.5 and 135.6 and around 18 % water samples are above the maximum permissible limit of 40 mg L^{-1}. The PO_4 contents ranged between 0.162 and 21.910 mg L^{-1} in the drainage water of Riyadh City. Ion inter-relationship showed good relation between Ca and PO_4 ion (R^2= 0.0654) and between Mg and PO_4 (R^2=0.629) whereas a poor relation was observed between Na and PO_4 ions (R^2= 0.429). Mean B contents ranged between 0.74 and 1.51 mg L^{-1}. The predicted soil salinity falls in the category of moderate to highly saline soil. Application of 15-20 % excess water as leaching should be considered to maintain soil salinity within acceptable limits.

Recommendations

Presently, the drainage water is moderate to high salinity water, contains high level of nitrates and phosphate ions, and the B concentration is also above the permissible limits. Therefore, Its reuse in agriculture is recommended only under special conditions fulfilling the recommendations made elsewhere. Further studies are required for its micro-biological evaluation for its safe use as a supplementary source of irrigation.

Acknowledgment

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Table 2. Chemical Composition of Drainage Water of Riyadh District**.**

Sr.No	Location	pH	EC dS m^{-1}	TDS mg L^{-1}	Ca mg L^{-1}	Mg mg L^{-1}	Na mg L^{-1}	K mg L^{-1}	HCO_3 mg L^{-1}	Cl mg L^{-1}	SO_4 mg L^{-1}	SAR	NO_3 mg L^{-1}	PO_4 mg L^{-1}	B mg L^{-1}	Water Class
1	**SW1c**	7.90	4.654	3712	542.87	138.8	564.75	33.05	224.4	826	1466	5.58	116.1	1.226	1.45	C4S2
2	**SW4c**	8.04	4.065	3130	495.5	110.7	499.20	17.30	273.6	535	1411	5.26	73.1	0.548	1.48	C4S2
3	**SW22**	7.89	4.825	3777	571.1	150.6	565.18	29.83	248.4	818	1455	5.42	108.9	0.972	1.51	C4S2
4	**SW5c**	7.94	3.648	2722	436.69	96.8	414.47	18.84	252.2	470	1332	4.66	67.2	0.605	1.35	C4S2
5	**SW5d**	7.86	4.72	3690	486.21	135.0	553.01	28.17	249	769	1469	5.7	117.7	0.782	1.41	C4S2
6	**SW2c**	8.20	1.974	1429	221	68.3	252.50	18.80	192.6	363	454	3.79	19.0	3.512	0.74	C3S1
7	**SW2b**	7.85	4.685	3656	493.69	138.9	558.64	28.67	237.6	781	1447	5.7	95.1	0.730	1.47	C4S2
8	**SW3a**	7.93	4.769	3728	560.27	149.5	597.18	29.37	259.8	798	1497	5.77	99.0	0.656	1.52	C4S2
9	**SW3c**	8.04	2.511	1845	312.79	115.4	296.79	24.55	222	350	817	3.63	27.9	0.334	1.07	C4S1
10	**SW12a**	7.96	4.022	3037	408.03	133.4	449.57	26.29	227.4	623	1291	4.92	78.6	0.516	1.25	C4S2
11	**SW6a**	8.05	5.367	4263	483.86	161.1	763.91	15.53	223.8	967	1561	7.66	135.6	0.162	1.22	C4S3
12	**SW6b**	8.01	4.088	3146	433.98	131.7	456.42	27.05	227.4	664	1337	4.91	77.9	0.676	1.28	C4S2
13	**SW12c**	7.99	3.999	3112	398.62	123.6	415.69	25.99	226.8	662	1326	4.65	86.3	0.676	1.13	C4S2
14	**SW8a**	8.21	2.262	1649	305.21	72.5	245.30	21.74	187.8	295	685	3.27	28.7	1.183	0.85	C4S1
15	**SW8b**	7.53	1.944	1398	218.4	53.5	262.21	23.91	169.8	309	504	4.11	18.4	13.824	0.94	C3S1
16	**SOUTH STP**	7.50	1.757	1252	168.32	46.5	231.47	21.97	187.2	279	414	4.06	21.9	21.910	0.79	C3S1
17	**SW8c**	7.60	1.947	1396	203.35	50.8	271.40	22.59	162.6	317	477	4.4	17.5	15.686	0.93	C3S1
18	**SW14**	7.93	4.048	3108	472.9	133.5	468.02	23.61	212.4	640	1345	4.88	83.8	0.534	1.22	C4S2
19	**SW20**	7.94	3.107	2333	407.3	106.4	404.04	23.05	195.6	508	870	4.59	50.7	9.190	0.95	C4S2
20	**SW21**	7.97	2.911	2172	337.65	88.9	361.28	22.90	185.4	470	829	4.51	50.4	9.022	0.88	C4S2
21	**SW8d**	8.01	2.903	2164	311.63	90.2	360.33	22.37	185.4	476	838	4.61	48.7	9.232	0.86	C4S2
22	**SW8f**	7.83	3.995	3095	372	160.9	514.85	26.00	245.4	640	1265	5.6	37.3	4.396	1.21	C4S2
23	**SW8e**	7.98	2.626	1939	301.91	84.4	332.50	22.04	172.8	423	752	4.35	38.4	11.669	0.82	C4S2
24	**SW8g**	7.96	2.652	1957	251.54	78.1	323.95	21.70	183	435	739	4.56	41.1	11.663	0.81	C4S2
25	**SW9b**	7.96	2.461	1807	271.25	78.7	339.34	21.04	163.2	382	634	4.65		12.395	1.42	C4S2
26	**SW9a**	7.87	2.473	1814	258.9	78.2	323.51	20.75	174	372	640	4.51		11.898	1.38	C4S2
27	**SW15**	7.79	2.513	1853	246.9	80.4	336.38	20.50	184.8	390	660	4.74		10.842	1.34	C4S2
28	**SW10b**	7.60	2.563	1890	259.3	79.4	334.32	20.50	175.8	392	682	4.65		12.315	1.21	C4S2
29	**SW11a**	7.85	3.131	2364	297.77	103.4	426.05	19.63	258.6	496	864	5.4		8.419	1.17	C4S2
30	**SW11b**	7.72	2.453	1800	252.34	78.2	333.90	19.64	175.8	385	652	4.69		12.217	0.99	C4S2
31	**SW16**	7.81	2.515	1826	263.7	81.7	332.10	19.94	179.4	389	672	4.57		11.055	0.90	C4S2

Table 3. Permissible Limits of Boron (mg L^{-1}) in Irrigation Water**

Class of Water	Sensitive Crops	Semi-Tolerant Crops	Tolerant Crops
Excellent	< 0.33	< 0.67	< 1.00
Good	0.33-0.67	0.67-1.33	1.00-2.00
Permissible	0.67-1.00	1.33-2.00	2.00-3.00
Doubtful	1.00-1.25	2.00-2.50	3.00-3.75
Unsuitable	> 1.25	> 2.50	> 3.75

** Source (FAO, 1985)

Table 4. Maximum Contamination Levels in Restricted and Unrestricted Irrigation Waters (Draft Standards by Ministry of Agriculture and Water).

Parameters	Unrestricted Irrigation	Restricted Irrigation
Biochemical Oxygen Demand	10-15	20-30
Total Suspended Solids (TSS)	10	20
Aluminum (Al)	5	5
Arsenic (As)	0.1	0.1
Beryllium (Be)	0.1	0.1
Boron (B)	0.5	0.5
Cadmium (Cd)	0.01	0.01
Chromium (Cr)	0.01	0.01
Cobalt (Co)	0.05	0.05
Copper (Cu)	0.4	0.4
Cyanide	0.05	0.05
Fluoride (F)	2	2
Iron (Fe)	5	5
Lead (Pb)	0.1	0.1
Lithium (Li)	2.5	2.5
Manganese (Mn)	0.2	0.2
Mercury (Hg)	0.001	0.001
Molybdenum (Mo)	0.01	0.01
Nitrate as N	10	10
Selenium (Se)	0.02	0.02
Vanadium (V)	0.01	0.01
Zinc (Zn)	4	4
pH	6.0	8.0
Fecal Coliform (MPN)/100 ml	5-100	20-200
Turbidity, NTU	1	1

** All unspecified units are in mg L^{-1}

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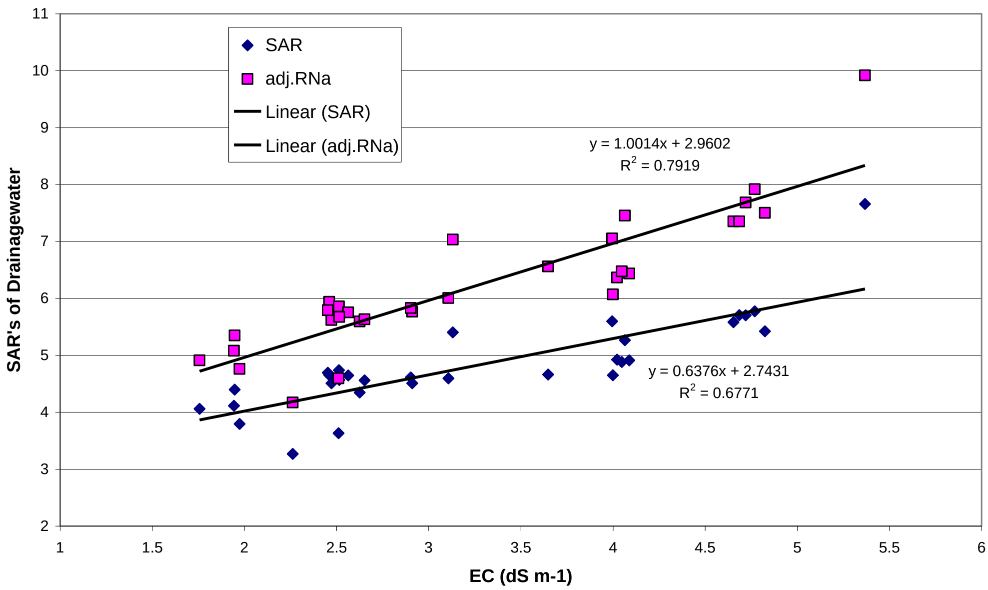

Fig.4. Relationship between EC and SAR's of Drainagewater of Riyadh

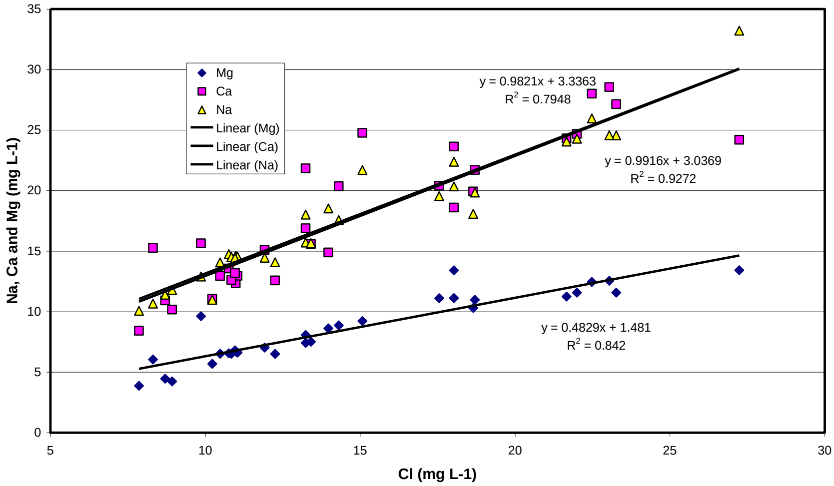

Fig.5. Ion Inter-Relationships in Drainagewater of Riyadh

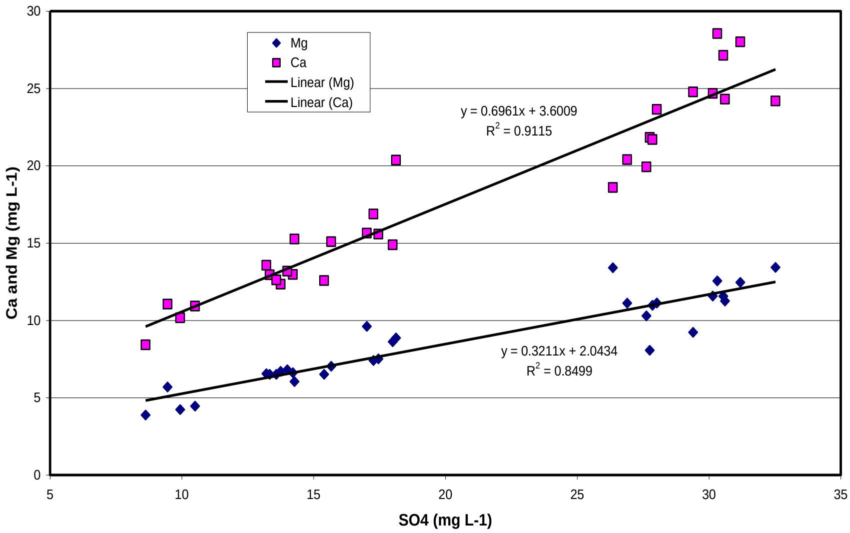

Fig.6. Ion Relationships in Drainagewater of Riyadh

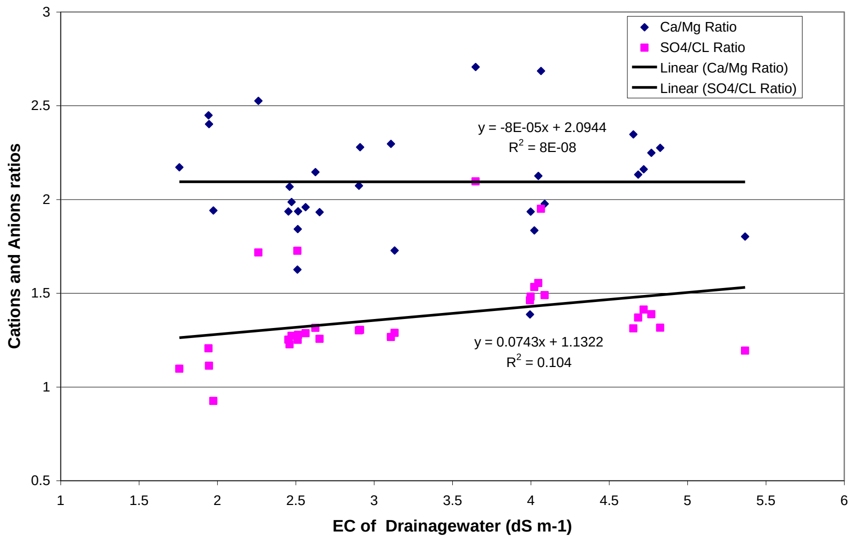

Fig.7. Relationship of EC and Cations/Anions ratios of Drainagewater of Riyadh

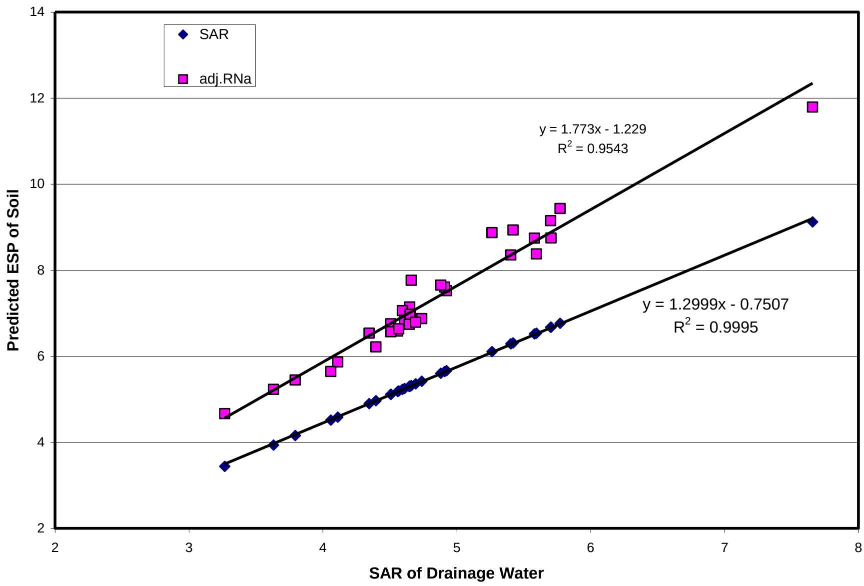

Fig.8. Predicted ESP of Soil from SAR's of Drainage Water of Riyadh

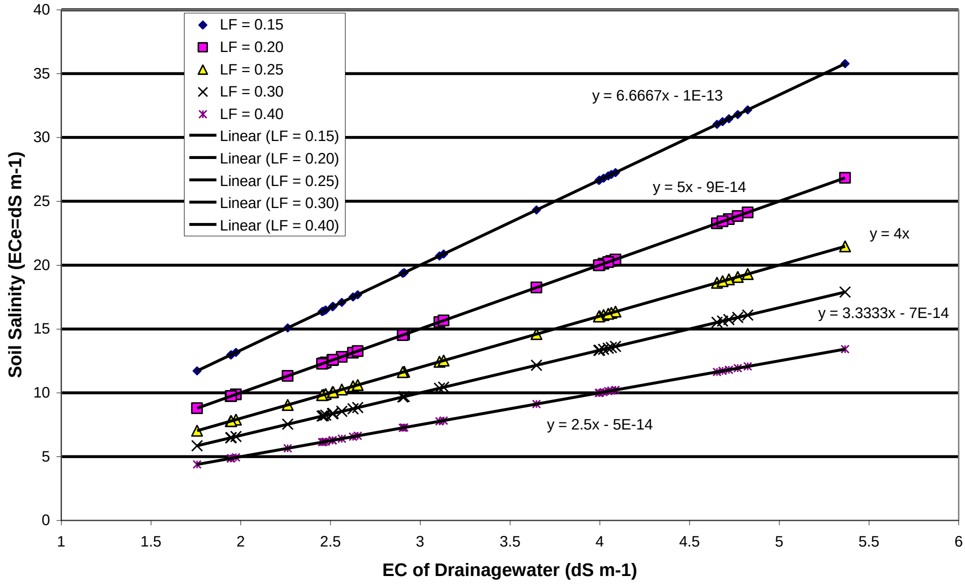

Fig. 9. Predicted Soil Salinity (ECe) from Drainagewater Salinity against Hypothetical Leaching Fractions

الملخص العربي

تقييم نوعية مياه الصرف لأعادة استخدامها في اغراض الري في منطقة الرياض ، المملكة العربية السعودية

د. أحمد بن عبدالرحمن العثمان

: أن التطور الحالي الذي طرأ على المناطق الحضرية رافقه استهلاك كبير للمياه في الاستخدامات المدنية والصناعية وري المسطحات الخضراء والذي نتج عنها زيادة ماء الصرف الصحي ذو النوعية الرديئة. تعتبر المملكة العربية السعودية بلد جاف ومحدود المصادر المائية حيث المياه الجوفية غير المتجددة والأمطارا قليلة وغبر معروف زمن سقوطها، والطلب المتزايد على الماء ذو النوعية الجيدة للأغراض المختلفة أجبر المخططين البحث عن مصادر مياه بديلة لتقليل الطلب على المياه الجوفية العذبة. يتدفق يوميا ما يقارب مليون متر مكعب من ماء الصرف الصحي في مدينة الرياض. ولاكتشاف مدى تأثير نوعية هذه المياه أجريت دراسة على امتداد قناة المصرف والتي تعرف "مجرى وادي حنيفة" والذي غالبا ما يسمى النهر الصناعي بفحص نوعيته التي تشمل مركباته الكيميائية وتأثيره على التربة مع مقترح لادارة ملائمة لإعادة استخدامه لأغراض الري في مدينة الرياض وحولها. تحتوي قناة مياه الصرف على مياه الصرف الزراعي وماء الصرف الصحي وفواقد رشح الري من الحقول الزراعية والتسرب من الشبكة

قسم الهندسة الزراعية، كلية الزراعة، جامعة الملك سعود، ص. ب ٢٤٦٠ الرياض ١١٤٥١، المملكة العربية السعودية. البريد الالكتروني: othmana@ksu.edu.sa

الرئيسة لايصال مياه الشرب والجريان السطحي من فائض الري وكذلك من مخلفات محطة الرياض لمعالجة مياه الصرف الصحي. أخذت عينات للمياه من ٣١ موقع على امتداد مجرى وادي حنيفة لتقيم نوعيتها بغرض أعادة استخدامها في ري المسطحات الخضراء. مدى نسبة ادمصاص الصوديوم SAR و نسبة الصوديوم المدمص المعدل للمياه المصروفة كان بحدود ٤,٠٦-٧,٦٦ و ٤,٧٥-١٠,٧٥ على التوالي. وكان تركيز البورون أكثر من الحد المسموح به ١ ملجرام/لتر لري المحاصيل. أما قيم الملوحة المتوقعة من جزء النظري للغسيل أظهرت بأن ملوحة التربة تقع في تصنيف المتوسط إلى عالية حيث الزراعة للمحاصيل التي يكون مستوى تحملها للملوحة من متوسطة إلى عالية ومن المحتمل إضافة ١٥-٢٠٪ ماء زائد عن الاحتياجات المائية لأغراض الغسيل للحفاظ على الملوحة في الحدود المسموح بها. التحليل الجيد واستخدام أنظمة الري المطورة مع إتباع إدارة ري جيدة كل هذه تعتبر عوامل تساعد في أعادة استخدام مياه الصرف.