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Effect of Land Use on Runoff Water Quality in Sulaimani Governorate/ Kurdistan Region, Iraq

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Abstract

This study presents an assessment of the quality of rainfall and runoff water, at the studied area based on analysis of three rainfall storms representing two consecutive years (2013 - 2014). The aim of this research paper was to identify whether the rainfall and runoff water quality had been influenced by the land use in Sulaimani governorate. The rainfall and runoff water quality were determined by comparing their chemical composition of major cations and anions with maximum permissible limits for water consumption and irrigation use. Analysis of PHreaction, temperature, electrical conducting, total dissolved solids, were done.

Results showed that, values of electrical conductivity, total dissolved solids, took the highest values in forest land use for the first storms and took the highest values in asphalt land use in case of the two other storms. It also showed that the major ion contents show the trend Ca^{+2} > Mg^{+2} >K^{+}>Na^{+} except asphalt land use where Na^{+} was more than K^{+}, while anion composition follow the trend $SO^{=}_{4}$ > HCO^{-}_{3}>Cl^{-}> $NO^{=}_{3}$>$PO^{\equiv}_{4}$ except asphalt land use where Cl^{-} was more than HCO_{3}^{-}.

The results appeared that the runoff water of the studied area are found to be unsuitable for domestic use according to Water Quality Index(WQI), while all runoff water samples from the studied land uses were suitable for the purpose of irrigation according to Irrigation water Quality Index,(IWQI).

Introduction

Land use and practices are probably the most important factor in determining water quality.All land uses have an effect on water quality, whether positive or negative. In forests and other areas with good vegetation cover and little disturbance from humans, most rainfall soaks into the soil rather than running off the ground, stream flows are fairly steady, and water quality is good.

Understanding the relationship between land use and water quality is helpful for identifying primary threats to water quality, and the relationships are meaningful for effective water quality management because they can be used to target critical land use areas and to institute relevant measures to minimize pollutant loadings, [1]. Donohue et al., (2006) [2] identified that urban, arable and pasture lands were the principal factors affecting water quality in Irish rivers. Lee et al. (2009) [3] found urbanization, rather than agricultural land use, was a major factor in water quality degradation in South Korea. By sampling and quantifying the effects that land use and land cover have on water quality, we can develop recommendations for better watershed management to ensure the quality of our surface waters [4].

Nonpoint source pollution from rural and urban land use activities reduces water quality by adding sediment, nutrients, toxics, organic materials, and pathogens to surface and ground waters. Inputs of phosphorus from manure and commercial fertilizers may cause an excess of nutrients (eutrophication) in streams, rivers, or lakes, which often results in excessive aquatic plant growth and algal blooms.

Sediment covers important stream and river-bottom habitat, increases turbidity, and delivers particulate-bound nutrients, toxics, and pathogens to water resources. Increased surface runoff, water turbidity, and reductions in riparian vegetation all act to warm surface waters. Warming and eutrophication of surface waters reduces the amount of dissolved oxygen (DO) in water. In this study the effect of five land uses on runoff water quality were studied for three rainfall storms in sulaimani city in Kurdistan region / Iraq.

Objectives

1- To analyses rainfall and runoff water from different land uses for several storms, in respect to chemical and physical properties.
2- To compare the quality of rainfall water with that of different runoff samples.
3- To know the key effect of land use among other different land use effects on runoff water quality.

Materials and Methods

1. Location

The studied area was located between the latitudes of 35^0 35″ - 35^0 36″ and between the longitudes of 45^0 27″- 45^0 29″ namely at Sulaimani City and its surrounds.

2. Rainfall and runoff sample analyses

This study was conducted during 2013 and 2014. The water samples of rainfall and runoff water from five different land uses were collected for three rainfall storms which were produced runoff two of them were selected in 2013 and the third storm was at 2014.

Water samples were collected from selected locations as described by [5], using a 0.5 liter polyethylene bottle which was rinsed twice with water before filling with adding one drops of toluene. In return to laboratory water samples were kept in cool box.

3.Chemical analysis of water samples

The chemical analysis of water was conducted as follows:

3.1 Electrical conductivity (EC)

The EC was measured by using portable EC-meter (model PW9525 Philips Company), according to [6].

3.2 PH

At the laboratory, hydrogen ion potential of each water sample from each site was measured by pH-meter, model (Microprocessor pH meter, Hanna pH 211), according to [7].

3.3 Total Dissolved Solid (TDS)

The TDS of water samples was calculated by using the following equation, [8]:

TDS = EC * F   (1)

Where:

EC = Electrical conductivity in (µS cm-1).

F = Factor equal to 0.640 this factor is not stable.

3.4 Concentration of Cations and Anions:

They were determined as follow:

3.4.1Calcium and magnesium (Ca^{+2}, Mg^{+})

Determined by titrimetric method using EDTA di-sodium salt (0.02M) according to [9].

3.4.2 Sodium and potassium (Na^{+}, K^{+})

Determined by using flame photometer model (JENWAY PF P7), as described in,[5].

3.4.3 Carbonate and bicarbonate ($CO_3^{=}$, HCO_3^{-})

Determined by titrimetric method using (0.01*M*) HCl as mentioned by [9].

3.4.4 Chloride (Cl^{-})

Determined by titration with $AgNO_3$ (0.01*M*) according to [9].

3.4.5Nitrate-Nitrogen ($NO_3^{=}$, N)

In laboratory, the nitrogen concentration of each water samples was estimated by using a Photo Lab spectral model (82362 Weilheim) WTW company-Germany according to [5]. The results were expressed in (mg L^{-1}).

3.4.6 Phosphorus (PO_4^{-3}, P)

Determined by using a Photo Lab spectral model (82362 Weilheim) WTW company-Germany according to APHA (1989) [5]. The results were expressed in (mg L^{-1}).

3.4.7 Sulfate ($SO_4^{=}$)

Determined by Portable Data logging Spectrophotometer HACH model DR/2010 at (450) nm by using barium chloride (BaCl2) according to [10].

4.Physical analysis:

4.1 Temperature

Temperature was measured at the sample sites using Mercury's Thermometer in centigrade degrees.

4.2 Turbidity

Turbidity was measured with turbidity meter Model microprocessor HI 9303 and Model Del Ague for water sample with turbidity in the range of (0-1000) and (>1000) FTU respectively.

4.3 Calculation of Water Quality Index (WQI)

The WQI has been calculated using the drinking water quality standard recommended by the World Health Organization [11].The weighted arithmetic index method, [12] used for the calculating WQI of the water body.

$qn = 100 [Vn-Vio]/[Sn-Vio]$ (2)(

Where،

qn = Quality rating for the nth water quality parameters

Vn = Estimated value of the nth parameter at a given sampling station.

Sn = Standard permissible value of the nth parameters

Vio = Ideal value of nth parameter in pure water. (i.e., 0 for all other parameters except the parameter pH and dissolved oxygen (7.0 and 14.6 mg l-1 respectively) (Tripaty and Sahu, 2005).

Calculation of unit weight (Wn) for various water quality parameters are inversely proportional to the recommended standards value Sn of the corresponding parameters.

$Wn = K/Sn$ (3)

Where,

Wn = Unit weight for the nth parameters.

Sn = Standard value for nth parameters.

K = Proportional constant, this value considered (1) here, also can calculate using the following equation:

$K=1/\Sigma (1/Sn)$ (4)

Water Quality Index (WQI) :

$$WQI = \sum_{n=1}^{n} qnWn / \sum_{n-1}^{n} Wn \qquad (5)$$

Table -1: Water Quality Index (WQI) and status of water quality, [13].

Water Quality Index Level	Water quality status	Grading
0-25	Excellent water quality	A
26-50	Good water quality	B
51-75	Poor water quality	C
76-100	Very poor water quality	D
>100	Unsuitable for drinking	E

4.4 The Model of Irrigation Water Quality Index (IWQI)

The model of (IWQI) developed by [14] was applied on the observed data;

$(Qi = qimax - [(Xij - Xinf)*qiamp) / Xamp]$.... (5)

Where qimax is the maximum value of Qi for the class; xij is the observed value for the parameter; xinf is the corresponding value to the lower limit of the class to which the parameter belongs; qiamp is class amplitude; xamp is class amplitude to which the parameter belongs.The water quality index was calculated as:

$$IWQI = \sum_{i=1}^{n} Qi\ Wi \quad \text{……….. (6)}$$

Table-2: Parameter limiting values for (Qi) calculation, [15].

qi	***EC (dS /m)***	***SAR° (meq/l)$^{1/2}$***	***Na^+***	***Cl^-***	***HCO_3^-***
85-100	*0.20 ≤ CE < 0.75*	*2 ≤ SAR° < 3*	*2 ≤ Na < 3*	*1 ≤ Cl < 4*	*1 ≤ HCO3<1.5*
60-85	*0.75 ≤ CE < 1.50*	*3 ≤ SAR° < 6*	*3 ≤ Na < 6*	*4 ≤ Cl < 7*	*1.5 ≤HCO3<4.5*
35-60	*1.50 ≤ CE < 3.00*	*6 ≤ SAR° <12*	*6 ≤ Na < 9*	*7 ≤ Cl <10*	*4.5 ≤HCO3<8.5*
0-35	*EC< 0.20 or EC ≥ 3.00*	*SAR° <2 or SAR° ≥ 12*	*Na<2 or Na ≥ 9*	*Cl <1 or Cl ≥1*	*HCO3<1 or HCO3 ≥8.5*

Table -3: (IWQI) Characteristics [16] and [17].

IWQI	***Water use restrictions***	***Recommendation***	
		Soil	***Plant***
85-100	***No restriction (NR)***	*May be used for the majority of soils with low probability of causing salinity and sodicity problems, being recommended leaching within irrigation practices, except for in soils with extremely low permeability.*	*No toxicity risk for most plants*
70-85	***Low restriction (LR)***	*Recommended for use in irrigated soils with light texture or moderate permeability, being recommended salt leaching. Soil sodicity in heavy texture soils may occur, being recommended to avoid its use in soils with high clay.*	*Avoid salt sensitive plants*
55-70	***Moderate restriction (MR)***	*May be used in soils with moderate to high permeability values, being suggested moderate leaching of salts.*	*Plants with moderate tolerance to salts may be grown.*
40-55	***High restriction (HR)***	*May be used in soils with high Permeability without compact layers. High frequency irrigation schedule should be adopted for water with EC above 2000 dS m-1 and SAR above 7.0*	*Should be used for irrigation of plants with moderate to high tolerance to salts with special salinity control practices, except water with low Na, Cl and HCO_3 values*
0-40	***Severe restriction (SR)***	*Should be avoided its use for irrigation under normal conditions. In special cases, may be used occasionally. Water with low salt levels and high SAR require gypsum application. In high saline content water soils must have high permeability, and excess water should be applied to avoid salt accumulation.*	*Only plants with high salt tolerance, except for waters with extremely low values of Na, Cl and HCO_3*

Results and Discussions

1.PH

From figure (1) appeared that the value of PH of runoff water for the three studied storms and for all studied land uses are greater than the PH of the rainfall water which was 6.39. This attributes to the existence of different chemical compounds in the different land uses.

In the case of asphalt road land use, the PH took the highest value among the rest which was8, but in the second storm the highest value found in no-tillage land use which was 8.18, while the minimum value of PH of runoff water obtained in forest land use, which was 7.75. Over all the water pH is mildly to moderately alkaline, and the alkalinity is therefore almost due to the presence of bicarbonate, which was found at slightly higher levels.

2. Temperature

The temperature of rainfall generally was greater than the runoff water taken from different land uses and for all storms except of runoff samples of asphalt road and concrete, this is due to that the asphalt and concrete substances are wormer than that of the other land uses, Tables (4, 5, and 6).

3. EC

From the Figure (2) appeared that the EC values of runoff water taken from each land use were greater than that of rain water samples for the three studied storms, this was due to, entering, different chemical substances and salts to runoff water during its travels over these land uses. Moreover in the case of the asphalt road land use,the EC took the highest value among the other land useswhich was 133.7 S/cm at storm No. 2, and the minimum value of 62.7 was at the case of tillage land use and for storm No.1.

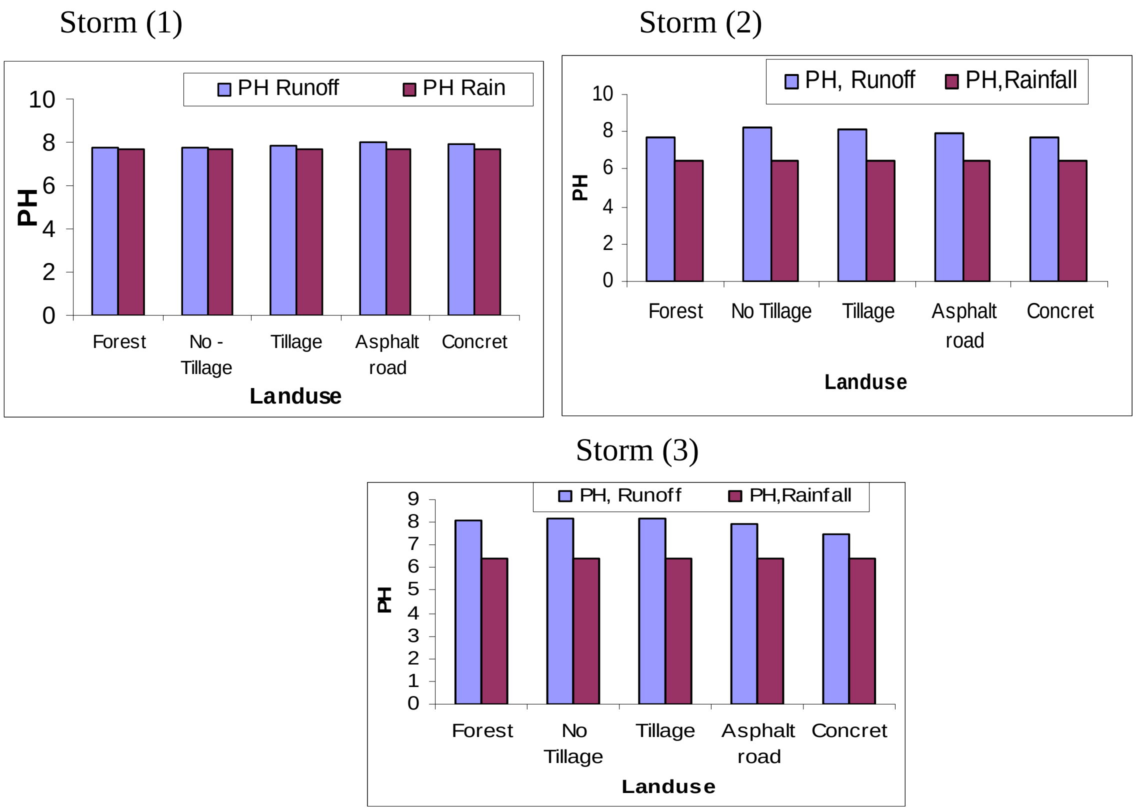


Figure-1: PH values of runoff water samples from different land uses.

Table - 4: Some Physical properties of runoff water samples for storm No.1

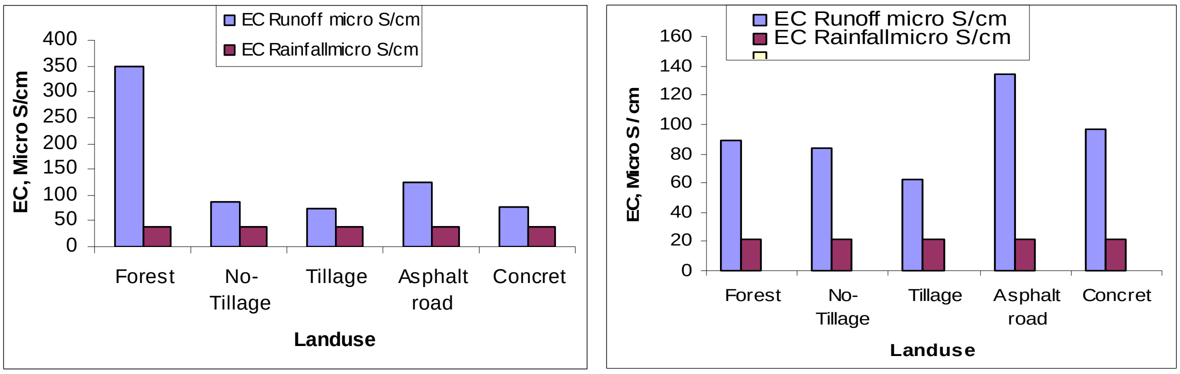
Land use	*Temperature*	*Turbidity NTU*
Forest	*16*	*271*
No Tillage	*16.6*	*284*
Tillage	*16.9*	*899*
Asphalt road	*18.6*	*222*
Concrete	*19.9*	*113*
Rain	*19.2*	*10.8*

Table - 5: Some Physical properties of runoff water samples for storm No.2

Land use	*Temperature*	*Turbidity NTU*
Forest	13.8	259
No Tillage	11.1	790
Tillage	11.5	600
Asphalt road	13.4	441
Concrete	13.4	14.5
Rain	13.4	2.79

Table - 6: Some Physical properties of runoff water samples for storm No.3

Land use	*Temperature*	*Turbidity NTU*
Forest	*10*	*317*
No Tillage	*9.5*	*234*
Tillage	*8.8*	*592*
Asphalt road	*9.6*	*43.6*
Concrete	*9.6*	*1.85*
Rain	*12.6*	*1.5*



Storm (1) Storm (2)

Storm (3)

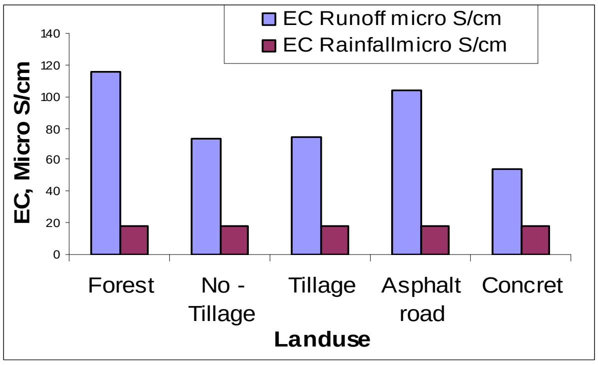


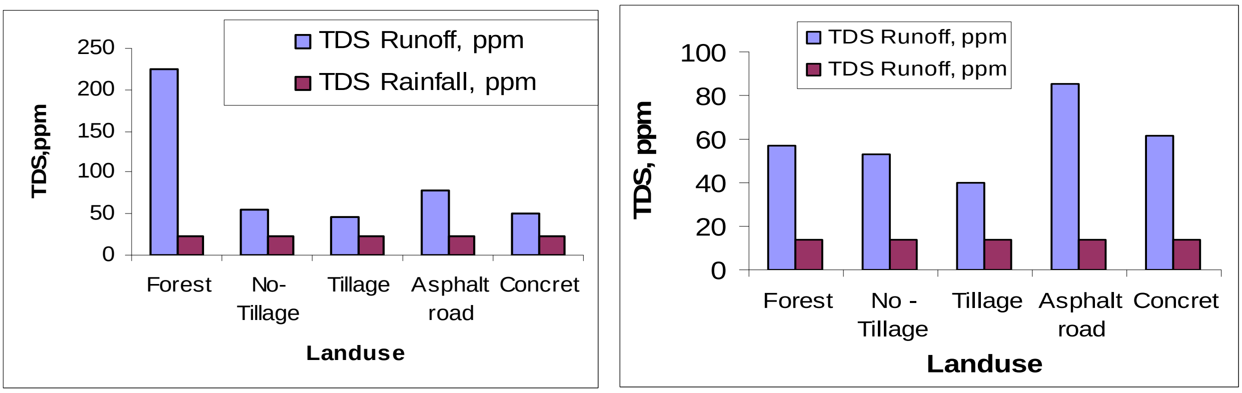
Figure-2: Different EC values of runoff water from different land uses.

4. Turbidity

The value of turbidity takes its maximum in runoff samples from tillage land use which was 899 NTU and has the minimum value of 1.5 NTU in the rain water samples of the third storm; certainly this was because of the clearance of the atmosphere by the falling rains. Tables (4, 5 and 6) showed that turbidity was caused by a wide variety of suspended materials from sand to clay fractions resulted from the washing of topsoil, domestic wastewaters and stream washings. The measurement of this parameter is important for drinking water in the field of disinfections,filterability and aesthetic, [18].

5. Total Dissolved Solid, TDS

The TDS value in the runoff samples of the first storm which was the first rain storm of the hydrologic year of (2013) took the highest value in case of the samples of forest land use in compare to the rest two storms , where the highest amounts appeared in asphalt land uses, this attributes to that the dissolved solids were less in the raining seasons due to its washes by consequent rainfall storms, also in the rain water reduces its amount, due to washing considerable amounts of it in atmosphere in raining seasons., and these results illustrated by Figure No. (3).



Storm (1)

Storm (2)

Storm (3)

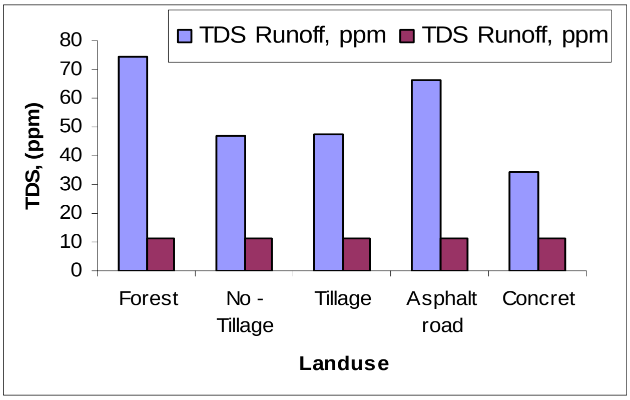


Figure-3: TDS of runoff water samples from different land uses

6. Chemical Substances

6.1 [$PO_4^{\equiv}$]

In respect to $PO_4^{\equiv}$ions it can be noticed from Tables (7, 8,and 9), that it has less value in rain water samples and runoff samples of asphalt land use which were 0.11ppm and 0.14 ppm respectively, and has the highest value in no-tillage land use water samples which was 2.3 ppm at storm No.2. This is because in non - tillage land use there was no loss of this ion by plant uptakes.

6.2[Ca^{+2}] and [Mg^{+2}]

The highest value of the ions [Ca^{+2}] appeared in forest land use which was 261ppm and the highest value of [Mg^{+2}] appeared in the runoff samples of tillage land uses which were 436ppm and 223 ppm for the storms No. 1 and 2 respectively. The high values of Ca returned to high content of (Ca) in the soil of the studied area, and then dissolving high amounts of Ca in runoff water. But the minimum values for both two ions appeared in concrete land uses. See Tables (7, 8, and 9).

Table - 7: Some chemical properties of runoff water samples for storm No.(1)

Land use	***$NO_3^{=}$***	***$PO^{\equiv 4}$***	***$SO4^{=}$***	***$HCO3^{-}$***	***Cl^{-}***	***K^{+}***	***Na^{+}***	***Mg^{+2}***	***Ca^{+2}***
Forest	1.1	0.17	198	36.6	29	5.522	3.046	175.8	261
No Tillage	1.9	1.06	72	42.7	34	3.213	2.419	239	205
Tillage	3.2	0.49	157	36.6	36	2.61	0.986	436	250
Asphalt road	4.4	0.25	126	42.7	40	2.51	6.182	192.3	200
Concrete	1.2	0.14	75	30.5	30	2.51	3.584	130	187
Rain	1.3	0.11	61	18.3	30	0.201	0.358	145	270

6.3 [$NO_3^{=}$]

Nitrate ($NO_3^{=}$) has its minimum value in runoff samples of forest land use which was 1.1ppm, Tables (7, 8, and 9). The low level of nitrate in forest land use samples is attributed to the existence of high level of organic matter, where the water which is polluted with nitrogen-rich organic matter, might show low nitrate levels, where decomposition of the organic matter lowers the dissolved oxygen level, which in turn slows the rate at which ammonia is oxidized to nitrite (NO_2^{-}) and then to nitrate ($NO_3^{=}$). While the highest value of $NO_3^{=}$ was 4.4 ppm at the case of asphalt follow that in tillage land use, the relatively high concentration of $NO_3^{=}$ in asphalt and tillage land uses is an indicator of the impact of urbanization and fertilization on quality of water respectively. However the $NO_3^{=}$ concentration does not exceed highest limit of this anion in drinking water (50 ppm).

Table - 8: Some chemical properties of runoff water samples for storm No.(2)

Land use	***$NO_3^{=}$***	***$PO^{\equiv 4}$***	***$SO4^{=}$***	***$HCO3^{-}$***	***Cl^{-}***	***K^{+}***	***Na^{+}***	***Mg^{+2}***	***Ca^{+2}***
Forest	*1.1*	*0.37*	*117*	*38.8*	*37*	*5.422*	*3.674*	*123.9*	*156*
No Tillage	*1.3*	*2.33*	*82*	*42.7*	*41*	*5.12*	*2.061*	*113*	*175*
Tillage	*2.4*	*0.54*	*60*	*36.6*	*37*	*3.414*	*0.717*	*112*	*142*
Asphalt road	*2.3*	*0.64*	*115*	*36.6*	*44*	*3.65*	*10.752*	*140*	*143*
Concrete	*1.4*	*0.15*	*60*	*24.4*	*28*	*0.904*	*5.555*	*89*	*134*
Rain	*1.3*	*0.11*	*57*	*9.15*	*34*	*0.1*	*0.627*	*83.7*	*108*

Table - 9: Some chemical properties of runoff water samples for storm No.(3)

Land use	***$NO_3^{=}$***	***$PO^{\equiv 4}$***	***$SO4^{=}$***	***$HCO3^{-}$***	***Cl^{-}***	***K^{+}***	***Na^{+}***	***Mg^{+2}***	***Ca^{+2}***
Forest	*1.2*	*0.21*	*126*	*32.4*	*33*	*5.344*	*3.371*	*142*	*198*
No Tillage	*1.6*	*1.26*	*94*	*42.1*	*38*	*4.203*	*2.172*	*186*	*175*
Tillage	*2.9*	*0.52*	*134*	*36.3*	*36*	*3.437*	*0.846*	*223*	*187*
Asphalt road	*3.6*	*0.31*	*117*	*38.9*	*40*	*4.829*	*7.913*	*135*	*179*
Concrete	*1.3*	*0.14*	*71*	*29.2*	*29*	*2.31*	*3.083*	*127*	*168*
Rain	*1.3*	*0.11*	*59*	*9.12*	*31*	*0.198*	*0.429*	*92.64*	*98*

6.4[$CO_3^{=}$ and HCO_3^{-}]

From the tables (7,8 and 9) appeared that bicarbonate ions HCO_3^{-} took less value in concrete water samples, which was 24.4 ppm, while the highest value appeared in non-tillage land uses 42.7ppm, this was due to the existence of calcareous soil in the studied area. No carbonate ($CO_3^{=}$) could be found as dissolved carbonates raise the pH to about (8).

6.5 [Cl^{-}]

From the three tables of (7, 8 and 9) appeared that the Cl^{-} shows a wide range of values from (29 - 44) ppm. It took the less value when the runoff water from concrete land uses which was28 ppm, and took the highest value when the runoff water from asphalt land uses which was 44 ppm, this is because of the chloride often elevated in hot, and arid areas, and this is true when the asphalt roads are more warmer than other land uses, in addition to that, the concentration of total chlorides increased downstream which can be attributed to the waste inflow in the form of domestic sewage.

6.6 [K^+ and Na^+]

The maximum and minimum values of K ions appeared in runoff water samples of forest and concrete land uses which were 5.52 ppm and 0.1 ppm respectively, while the maximum and minimum values of Na ions appeared in asphalt and tillage samples 10.75ppm and 0.84 ppm respectively. The elevated value of Na in asphalt road land use refers to that the asphalt roads are warmer than the other land uses and the high amounts of Na often exists in the hot places. The low value of Na in tillage samples referred to the leaching of this ion in the tillage lands by the water or reduced its amounts by plant uptakes. But the highest value of K in forest samples was due to the existence of high sources of K in the forest land use such as plant residues as well as to the origin sources of the soil content. See tables (7, 8 and 9).

6.7 [$SO_4^=$]

In respect to $SO_4^=$ ions, the minimum values appeared in runoff sample of concrete land use and the maximum value appeared in the forest samples which were 60 ppm and 198ppm respectively, Tables (7, 8 and 9), the highest values in the runoff water samples of forest land use, was due to easily washed by water in the forest samples which the forest lands have high contents of sulfur sources. The sulfur sources were from the oxidation of sulfide minerals during chemical weathering, atmospheric deposition from acid rain, human and animal waste, farming, and industrial processing and manufacturing, [19].

7. Assessment of water quality for drinking

According to the Water Quality Index (WQI), The results in Table (10) appeared that all of the runoff samples were unsuitable for drinking, and by return to Table (1), all of them took the grade of (E), Except the samples of rainfall water were took the grade of (B) which are of good quality, this was due to the rainfall water unmixed with pollutants with compare to runoff water, which passed over the different land uses.

8. Assessment of water quality for Irrigation

The results in Table (11) demonstrated that all of the runoff samples were excellent for irrigation according to the Irrigation Water Quality Index (IWQI) purposed by [14].According to (IWQI) characteristics proposed by [5] and [15], the values of (85-100) of (IWQI) took no any restriction to use the water for irrigation, Table (3).Whenever the values of 100 is the critical point of the restriction of use, this indicated to that, any value more than that, will increase itssuitability to use. While theobtained values of IWQI for all runoff samples in this study were more than 100, indicated to that, there isno any restriction to use them for irrigation, in other words, all were excellentfor irrigation.

Table -10: The mean of physiochemical parameters for all studied water sites.

Sampling Sites	*Forest*	*No Tillage*	*Tillage*	*Asphalt road*	*Concrete*	*Rain*
Sample Site codes	***1***	***2***	***3***	***4***	***5***	***6***
pH	*7.86*	*8.04*	*8.04*	*7.97*	*7.69*	*6.85*
Electrical Conductivity (EC) $\mu S\ cm^{-1}$	*185.03*	*81.10*	*70.17*	*120.20*	*75.90*	*25.63*
Total Dissolved Solid (TDS) $mg\ l^{-1}$	*118.42*	*51.90*	*44.91*	*76.93*	*48.58*	*16.41*
Turbidity NTU	*282.33*	*436.00*	*697.00*	*235.53*	*43.12*	*5.03*
Calcium (Ca^{2+}) $mg\ l^{-1}$	*205.00*	*185.00*	*193.00*	*174.00*	*163.00*	*158.67*
Magnesium (Mg^{2+})$mg\ l^{-1}$	*147.23*	*179.33*	*257.00*	*155.77*	*115.33*	*107.11*
Total Hardness as $CaCO_3$ *TH* $mg\ l^{-1}$	*1118.04*	*1200.26*	*1539.99*	*1075.77*	*881.84*	*837.18*
Chloride (Cl^-) $mg\ l^{-1}$	*33.00*	*37.67*	*36.33*	*41.33*	*29.00*	*31.67*
Sulfate (SO_4^{2-}) $mg\ l^{-1}$	*147.00*	*82.67*	*117.00*	*119.33*	*68.67*	*59.00*
Phosphate (PO_4-P) $mg\ l^{-1}$	*0.25*	*1.55*	*0.52*	*0.40*	*0.14*	*0.11*
Sodium (Na^+) $mg\ l^{-1}$	*3.36*	*2.22*	*0.85*	*8.28*	*4.07*	*0.47*
Potassium (K^+) $mg\ l^{-1}$	*5.43*	*4.18*	*3.15*	*3.66*	*1.91*	*0.17*
Nitrate (NO_3-N) mg^{-1}	*1.13*	*1.60*	*2.83*	*3.33*	*1.30*	*1.30*
Overall Water Quality Index = WQI $=\Sigma\ qnWn / \Sigma\ Wn$	*1551.332*	*2390.342*	*3797.964*	*1300.923*	*250.903*	*37.197*
Grades	*E*	*E*	*E*	*E*	*E*	*B*

Table -11: Calculation of (IWQI) for all studied sites.

Sampling Sites	***Forest***	***No Tillage***	***Tillage***	***Asphalt road***	***Concrete***	***Rain***
Sample Site codes	**1**	**2**	**3**	**4**	**5**	**6**
Electrical Conductivity (EC) dS/m	*0.19*	*0.08*	*0.07*	*0.12*	*0.08*	*0.03*
Na^{+}*meq* l^{-1}	*0.15*	*0.10*	*0.04*	*0.36*	*0.18*	*0.02*
HCO_3^{-} *meq* l^{-1}	*0.59*	*0.70*	*0.60*	*0.65*	*0.46*	*0.20*
Cl^{-}*meq* l^{-1}	*0.93*	*1.06*	*1.02*	*1.16*	*0.82*	*0.89*
SAR° (meq/l)$^{1/2}$	*0.04*	*0.03*	*0.01*	*0.11*	*0.06*	*0.01*
IWQI	*129.62*	*130.26*	*130.91*	*128.35*	*130.52*	*132.17*
Water quality	*Excellent*	*Excellent*	*Excellent*	*Excellent*	*Excellent*	*Excellent*

Conclusion

From this study, the results showed that, values of electrical conductivity, total dissolved solids, took the highest values in forest land use for the first storms and took the highest values in asphalt land use in case of the two other storms. It also showed that the major ion contents show the trend Ca^{+2}> Mg^{+2}>K^{+}>Na^{+} except asphalt land use where Na was more than K, while anion composition follow the trend $SO^{=}_4$>HCO_3^{-} >Cl> $NO^{=}_3$>$PO^{\equiv}_4$ except asphalt land use where Cl^{-} was more than HCO_3^{-}. Concrete surfaces and no-tillage land uses produced weak impacts on water quality respectively, in comparison with the other studied land uses. Except the water samples of the rain before reaching the earth's surface, all water samples were unsuitable for drinking according to the (WQI). All water samples were excellent for irrigation purposes according to the (IWQI) purposed by [14].

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