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Environmental Impact Assessment for Brick Factory in Baghdad, Iraq

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Abstract- *The environmental and social impacts of bricks factory based on the information's collected from old brick factories in Al-Nahrawan. This information includes water, air and soil sample analysis, community questionnaire, climate and topography of the region and standards to create model for modern brick factory. Practically the results of the analysis of soil pH, exceed the determinants of the WHO, while some cations such as Ca^{2+}, Mg^{2+}, Zn^{2+}, Cr^{3+}, Ni^{2+} , carbon content, and TDS were within the limit. High values for volatile organic compounds, PMs, TSP, NO_2 and SO_2 resulting from the combustion of the fuel used in the manufacturing process during the four months were the outside the Iraqi determinants. The results of the questionnaire analysis devolve toward the creation of bricks factories with a modern and environment friendly technology. The study presented numbers of recommendations for modern brick factories and showed the extent of the community's awareness contaminants posed by traditional brick plants. Alternatives and environmental monitoring plan for the project so as to ensure the protection of the surrounding environment.*

Keywords- *Environmental Impact Assessment; Bricks factory; questionnaire analysis; pollutants; and environment friendly technology.*

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1. Introduction

The depletion of the natural resources due to human activities has attracted steadily growing environmental concerns in the last decades. It is necessary for the planning authorities to count on sound information concerning the possible environmental consequences of a new project. One of the tools is represented by the procedures of Environmental Impact Assessment (EIA). Its main aim is to ensure that the authority granting consent, for a particular project with full knowledge of any likely significant effects on the environment. Building materials based on natural resources are often used, such as the use of clay for making bricks, and river sand for making cement sand blocks [1]. Bricks are one of the most important materials for the construction industry, the consumption of earth-based materials as clay, shale and sand in brick production resulted in resource depletion, environmental degradation, and energy consumption. The numbers of brick factories in Al-Nahrawan, Baghdad were increased during the last five years, and all of them utilize black oil as an energy supply for the process need. This situation introduces more air pollution to the environment (Table 1), without improving the required protection measures.

The study aimed to evaluate environmental problems connected with brick industry, and the main points will be mentioned by collecting data about urban air pollution dispersion, waters, and soil samples of selected key points in Al-Nahrawan area. Field measurements of some common air pollutants such as H_2S, NO_2, SO_2, VOCs, TSP, and particle size meters (PM2.5, and PM10) were performed. The variables of Soil and Water which measured are; pH, EC, TDS, NO_3^-, Ca^{2+}, Mg^{2+}, SO_4^{2-}, PO_4^{2-}, Cl^-, Pb^{2+}, Zn^{2+}, Cr, Ni^{2+}, K^+, Fe^{3+}, and Carbon content.

Table 1: Number of brick factories from 2010 to 2015 in Baghdad area [2]

Year	2010	2011	2012	2013	2014	2015
No. of brick Factories	230	230	259	259	259	259

2. Methodology of Experimental Work

Al-Nahrawan industrial area is 40000 acres (100 Km^2), currently owned by the General Directorate for Industrial Development (cooperatives and industrial societies Directorate previously) [4,5]. It is a flat area and rises nearly about 34 meters above sea level, it is located between the two great circles (33° 45'00" N - 33° 17' 00"S) and two longitudinal circles of (45° 55' 00" E) and (44° 35' 00" W) [6] and its located within the Mesopotamian plain. The alluvial plain has a simple slope from the north to the south where the elevation is reduced from 50 meters near Khalis to 15 meters above sea level south of Al-Kut city [2]. It is a flat land where there are some hills such as Al-Ajrab hill and Halioat hill, and tend to slope slightly towards the east, where the maximum height of the east 31.8 meters from the west and up to 34 meters and have a clear gradient from north to south [7]. The depth of the groundwater (8-10) meters [7,8].

I. Field Measurement of Soil Pollutants

Appends the citizen as a result of this activity is non-committed to environmental determinants then is considered the soil samples were taken from the elected sites inside the industrial compound. The first model from one of the parties to the industrial compound, the second from the center of the industrial compound, the third of the front of the industrial compound, the fourth from the back the industrial compound and the Table 2, represents the results of soil tests of the four models within the industrial compound.

II. Field Measurement of Water Pollutants

To promote the environmental impact of the modern brick factories, of the old brick factories to see the damage objectively and appends the citizen as a result of this activity is non-committed to environmental determinants then is considered the water samples were taken from one of the marshes and ponds inside the compound to find out the amount of heavy metal falling from the atmosphere as a result of the emissions coming out of Chimneys that negatively effect on the environment. Table 3 represents the results of water tests of the tow samples within the industrial compound.

III. Climate of the Study Area

The climate of study area generally dries as a part of Mesopotamia, Middle East climate of, where the temperature, wind speed and rainfall all these elements will be presented in the following sections. The temperature rise during the summer season and it becomes less during the winter season [6].

Table 2: The chemical analysis results of soil.

Type Of Test	Sample No. (1)	Sample No. (2)	Sample No. (3)	Sample No. (4)
pH	7.58	7.22	7.3	7.1
*EC (μ_s)	700	868	4170	8800
Ca^{2+} (ppm)	18.3	691.6	562.4	1033.6
Mg^{2+} (ppm)	7.4	202.4	73.6	36.8
SO_4^{2-} (ppm)	50	2250	6100	1740
PO_4^{2-} (ppm)	11.02	53.6	138.1	14.8
Cl^- (ppm)	124.2	1261	329.8	1455
Alkalinity (ppm)	54.6	105	100.8	105
Pb^{2+} (ppm)	4.3	5.25	4.5	6
Zn^{2+} (ppm)	3.75	2.75	1.95	4.7
Cr (ppm)	1	-	-	-
Ni^{2+} (ppm)	2.9	1.5	3	8.55
K^{1+} (ppm)	11	56	14.6	15.2
Fe^{3+} (ppm)	590	4.5	5.5	2.5
Carbon-content %	0.12	1.4	1.66	1.74

Pollutants can be transported from these wind sources in the north-west of the region, so when constructed must be taken the direction of the prevailing winds in the area considered to be the chimney toward reversing the prevailing wind where the wind direction from the city to the factories. Rainfall records in Iraq, is divided by the two seasons, the duration of the first is the period of drought and starting from June and extends to September, while the second is the Period of rains starting from October, and continues to the end of May[6].Relative humidity in the study area, ranging from 12-14 % in the winter, while in the summer range from 55-60 % [8].

IV. Field Measurement of Air Pollutants

This work mainly deals with the in suite measurements of air pollutants (PM2.5, PM10 and TSP) and (VOCs, SO_2, NO_2, H_2S) at six different location. The locations have been chosen on the basis of land use pattern map, and distributed in study area where this six location mostly covered all bricks factory area. Plat 1, and Table 4, show six locations of samples distributed in the study area. The four month period of measuring gases and particulars are shown in the Table 5.

Table 3: The chemical analysis results of water

Type Test	Sample No. (1)	Sample No. (2)
pH	5.99	6.39
*EC (μ_s)	9170	46500
*TDS (Mg/L)	6400	29402
Ca^{2+} (Mg/L)	480	800
Mg^{2+} (Mg/L)	380	1425
K^{1+} (Mg/L)	12	14
Cl^{-} (Mg/L)	1406.5	7226
SO_4^{2-} (Mg/L)	1350	7100
NO_3^{-} (Mg/L)	10.6	4.1
Fe^{3+} (Mg/L)	0.12	0.21
Ni^{2+} (Mg/L)	0.07	0.3
Pb^{2+} (Mg/L)	0.07	0.44
Zn^{2+} (Mg/L)	0.13	0.15
PO_4^{2-}(Mg/L)	1.04	0.12

***TDS= Total dissolve salt; EC= Conductivity**

3. The Measurements

I. Soil Measurements

The results of the soil test for the four samples from Al-Nahrawan, as shown in Table 2, and Figure 3 these results are compared with the World Health Organization (WHO). The pH values for the four models are outside the specification. The carbon-content results showed that the highest value in the fourth form 1.74%. The lowest value was in the first model 0.12 % as in Figure 4. Depending on measurements taken for the four samples in the study area, as shown in Table 2 it observed that the higher value of Ca^{2+} was in the fourth sample 1033.6 ppm, and the lowest value is first 18.3 ppm. For SO_4^{2-} the highest value was the third sample 6100 ppm and the lowest value for the first sample 50 ppm. For Cl^- it was the highest value for the fourth sample 1455 ppm and the lowest value for the first sample 124.2 ppm.as show in Figure 5, and the Results showed that the highest value of Mg for the second sample 202.4 ppm and the lowest value for the first sample 7.4 ppm and the highest value of the PO_4^{2-} was the third sample 138.1 ppm and the lowest value for the first sample 11.02 ppm and value Higher of K^{1+} was the second sample where 56 ppm and the lowest value 11 ppm for the first sample, as shown in Figure 6 .

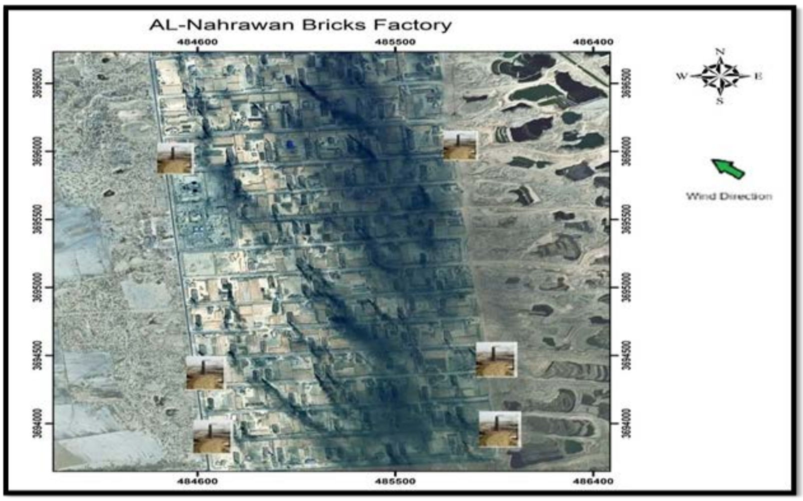

Figure 1: Spot 7 Satellite image (with resolution 1.5m) in 6/10/2014 of AL-Nahrawan show the Location Samples

Table 4: Coordinates of the sampling sites by GPS (Garmin navigator)

No.	EAST	NORTH
1.	484672	3693861
2.	485953	3694001
3.	485923	3694350
4.	484612	3694244
5.	484484	3695844
6.	485781	3695934

Table 5: The chemical analysis of Air Pollutants

	No.	H_2S (ppm)	SO_2 (ppm)	NO2 (ppm)	VOCs (ppm)	TSP (µg/m3)	PM2.5 (µg/m3)	PM10 (µg/m3)
February	**1**	0.339	0.198	0.099	0.038	313	144	299
	2	0.235	0.057	0.102	0.165	454	229	438
	3	0.472	0.021	0.103	0.004	91	48	89
	4	0.195	0.024	0.097	0.037	332	124	262
	5	0.33	0.145	0.086	0.084	456	151	39
	6	0.235	0.02	0.165	0.024	245	101	223
March	**1**	0.614	0.124	0.249	0.016	239	24	184
	2	0.811	0.218	0.416	0.022	237	66	214
	3	1.118	0.235	0.424	0.062	1065	159	888
	4	0.612	0.214	0.336	0.045	890	12	392
	5	0.703	0.231	0.359	0.027	379	43	335
	6	1.04	0.259	0.346	0.058	68	48	59
April	**1**	0.365	0.169	0.28	0.108	544	17	407
	2	0.639	0.257	0.284	0.1	147	22	116

	3	0.589	0.22	0.361	0.148	2098	152	1433
	4	0.648	0.122	0.589	0.211	666	160	579
	5	0.727	0.13	0.244	0.188	338	73	295
	6	0.695	0.128	0.365	0.225	1474	140	1467
May	**1**	1.0004	0.328	0.373	0.167	398	56	316
	2	0.993	0.423	0.588	0.202	629	120	489
	3	1.065	0.499	0.782	0.203	295	42	122
	4	0.903	0.515	0.751	0.185	459	34	418
	5	0.891	0.581	0.77	0.211	1127	267	908
	6	0.976	0.76	0.827	0.192	1260	163	1093

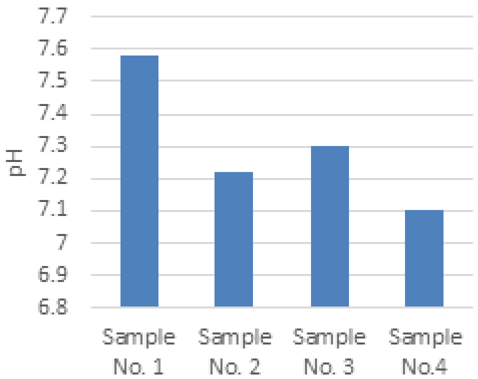

Figure 2: pH value of the samples

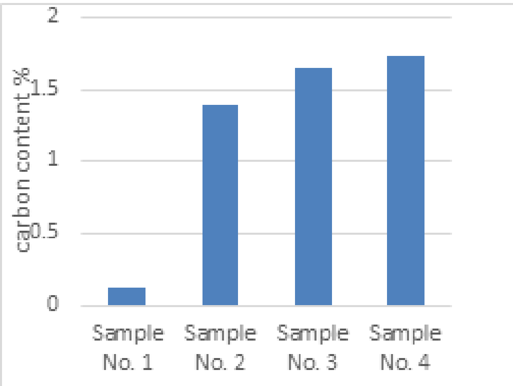

Figure 3: carbon content value of the samples

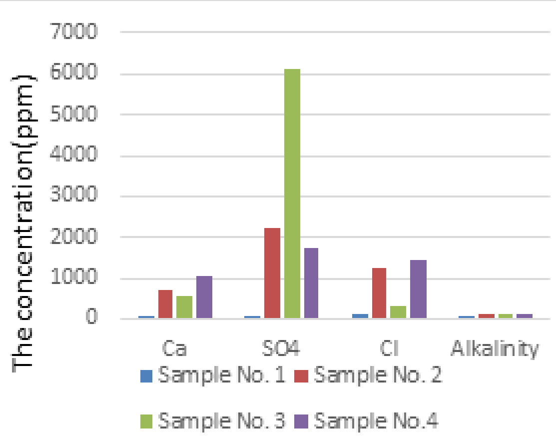

Figure 4: The obtained values of Ca^{2+}, SO_4^{2-}, and Cl^- samples

The highest value for the Pb^{2+} in the fourth sample 6.0 ppm The lowest value was the first of the sample 4.3 ppm, and the lowest value of Fe was the fourth sample 4.3 ppm and the highest value for the first sample 590 ppm As for Zn^{2+}, Ni^{2+} found it within the specified when compared with the WHO in the specified determinants of Zn^{2+} 50-300 ppm and Ni^{2+} (30-75) ppm, as show in Figure 7.

II. Water measurement

Measurements were conducted for two samples of the study area, as shown in Table 3, and the results showed that the highest values for Fe^{+3}, Ni^{+2}, Pb^{+2} and Zn^{+2} in the second sample are the values 0.21, 0.3, 0.44, and 0.15 Mg/L, respectively. While the value of the PO_4^{-3} for the first sample is higher than the second sample 1.04 Mg/L, as shown in Figure 8.When analyzing the results presented in Table 3, showed that the value of the pH and the K^+ to sample the second higher than the first. The NO_3^- were the result of the first sample is higher than the second as in Figure 9.

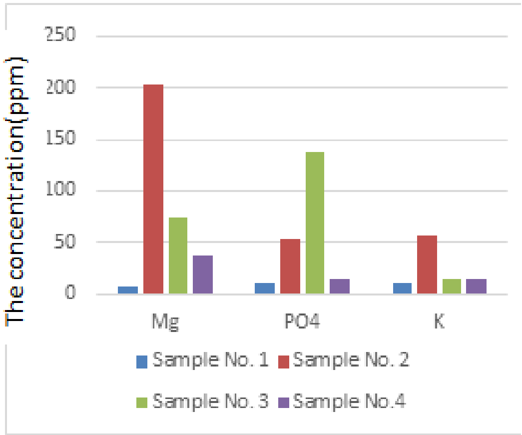

Figure 5: The obtained values of Mg^{2+}, PO_4^{3-}, and K^+ samples

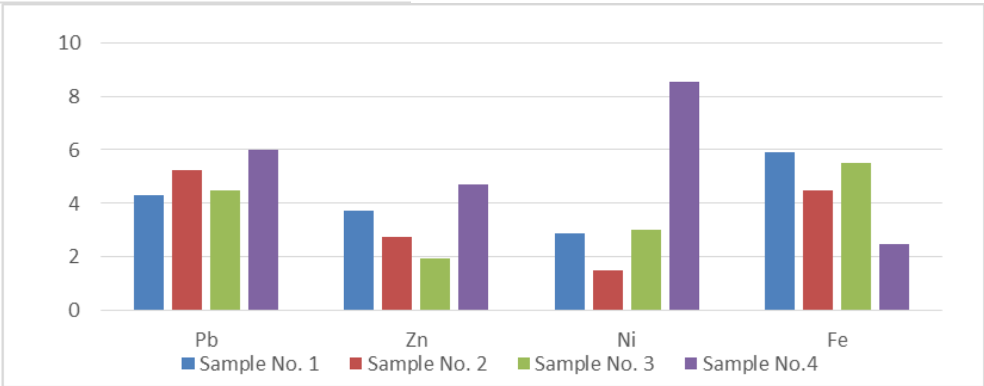

Figure 6: The measured values of Pb, Zn, Ni, and Fe samples

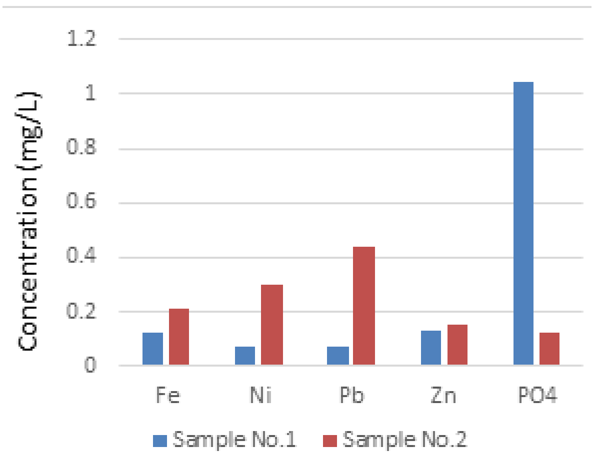

Figure 7: The measured values of Fe^{3+}, Ni^{2+}, Pb^{2+}, Zn^{2+}, and PO_4^{3-} samples

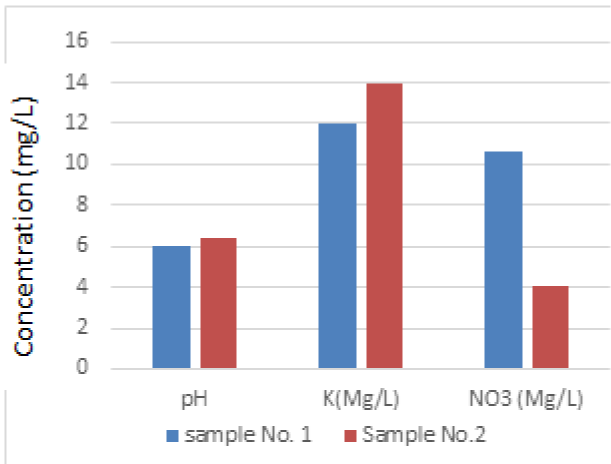

Figure 8: The measured values of pH, K^+, and NO_3^- samples

III. Air measurements

Depending on the results given in Table 4, the maximum concentration of H_2S is found in the third site in March 1.118 ppm, the minimum value of H_2S recorded in February at second and sixth Site 0.23 ppm. This change in values due to operating by black oil (heavy oil) in bricks factory, using generators. Those differences in concentration are shown in the Figure 10.

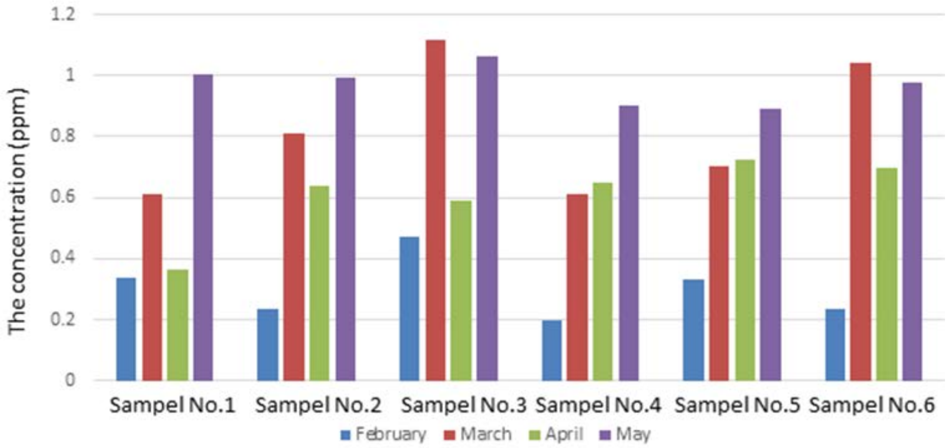

Figure 9: H_2S values of the four month

Results were compared to SO_2 were presented in the Table 4, with the Iraqi standard determinants and the WHO and the Egyptian determinants were the highest value 0.76 ppm for the sixth site during the month of May and the lowest value was 0.021 ppm, the third of the site during the month of February, The results were allowable in the World Health Organization and the Egyptian determinants which are values 500 µg/m^3, 350 µg/m^3 respectively and also it was part of the Iraqi determinants permitted and which are worth 0.15 ppm except the first site either during the month of March and April were among the WHO determinants Egyptian determinants either the month of May. Some results were within the set and the other outside either for the Iraqi standards the results of the month of May all the results out limit as in Figure 11. The results shown in Table 4 are comparable with the Iraqi, Egyptian and WHO determinants. The highest value 0.827 ppm for the sixth site during the month of May and the lowest value it was 0.087 ppm for the fifth site during the month of February, and the results of the month of February within the allowable limits in Iraq and the WHO and the Egyptian determinants either the month of May were all the results outside the allowable limit for the Iraqi determinants of the WHO As for Egyptian determinants was the first site only within the limit, the fourth month results were outside the allowable limits in Iraq except the fifth site, As for the determinants of the WHO were all results outside its allowable limits, the Egyptian determinants was the fourth location just outside the allowable limit, as shown in Figure 12. The minimum concentration of VOCs at the study area is 0.004 ppm at third site in February and the maximum value is 0.225 ppm at sixth site in April. While in March, the value increase slightly started from 0.016 ppm at first site until it reaches to 0.062 ppm at third site. In May the value of VOCs start from 0.167 ppm at first site and reaches to the maximum value 0.211 ppm at fifth site.

Volatile organic compounds VOCs and hydrocarbon pollutants most are invisible. Often have a very noticeable smell, Figure 13 show this is due to the industrial area in which the hydrocarbons are widely founded. The use of fossil fuels produces VOCs. And VOCs could effects on Health and that such as damage of liver, kidney, eye, nose, loss of coordination, and throat irritation; headaches, nausea; and central nervous system. Some organics can cause cancer in humans or cause cancer in animals. Results of TSP (Table 4), are compared with the Iraqi standards for the six sites during the four months after reaching its highest value 2098 µg/m^3 for the third site during the month of April and the lowest value it was found at 68 µg/m^3 for the sixth site during the month in March. The month of May was the most results outside the specified limit of 350 µg/m^3 and followed by the month (April, March, and February respectively). Figure 14.

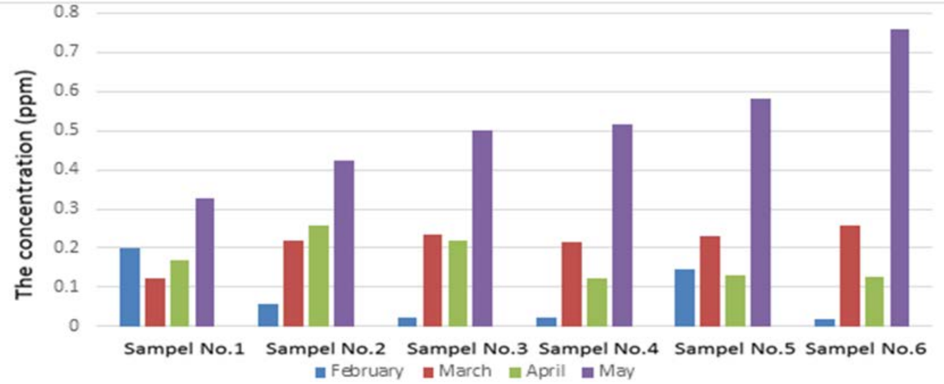

Figure 10: SO_2 values of the four month

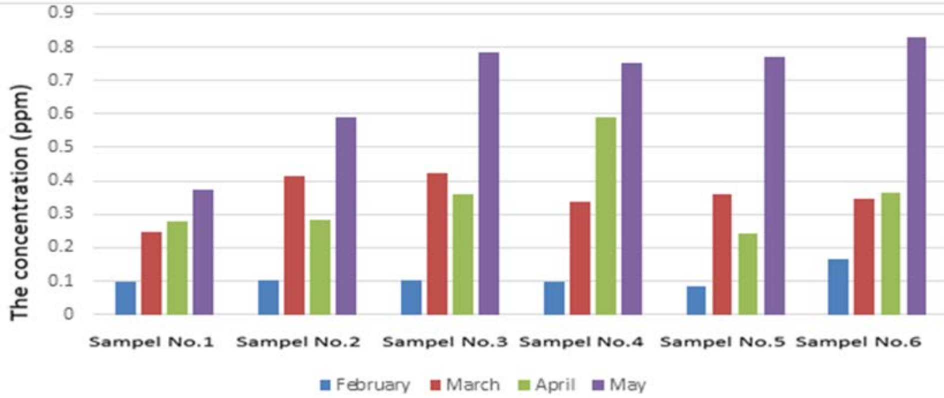

Figure 11: NO_2 values of the four month

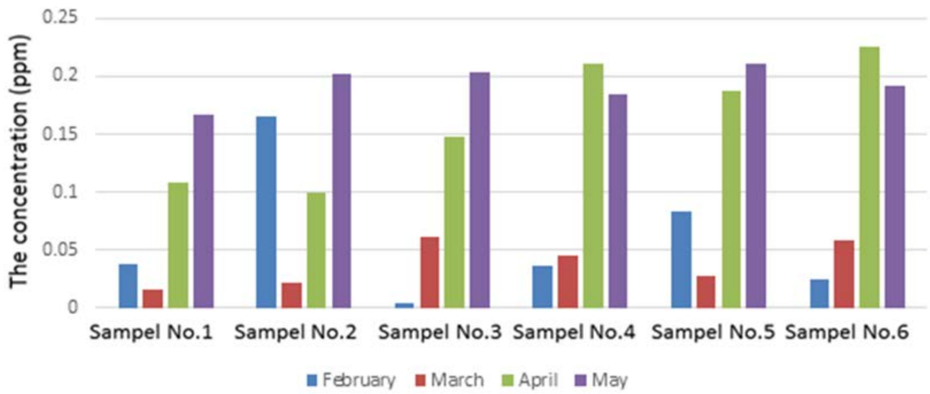

Figure 12: VOC_S values of the four month

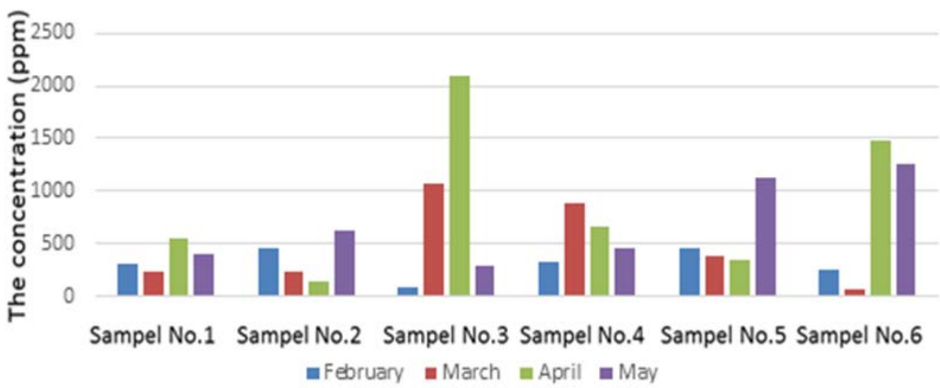

Figure 13: TSP values of the four month

Results $PM_{2.5}$ in the Table 4 are compared with the standard WHO determinants were the highest value 267 $\mu g/m^3$ for the fifth site during the month in May and the lowest value it was 12.0

μg/m^3 for the fourth site during the month of March and that most of the results were outside the specified 25.0 μg/m^3 the results of the February and May are all outside the allowable limit and comes in March and April then as in Figure 15. Results PM_{10} in the Table 4 are compared with the standard determinants of the World Health Organization and the Egyptian determinants were the highest value 1467 μg/m^3 for the sixth site during the month in April and the lowest value was 39.0 μg/m^3 for the fifth site during the month of February and that most of the results have been out of the World Health Organization limits, which are 50.0 μg/m^3 as well as for the Egyptian determinants by Law No. (4) of the year 1994, where the specified value 70.0 μg/m^3, the month of May and April all the results outside the global and Egyptian Health Organization determinants as in Figure 16.

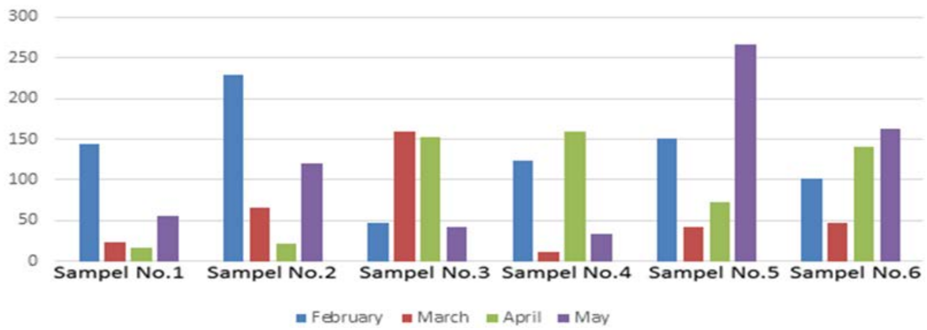

Figure 14: Represent the difference value for $PM_{2.5}$ in four month

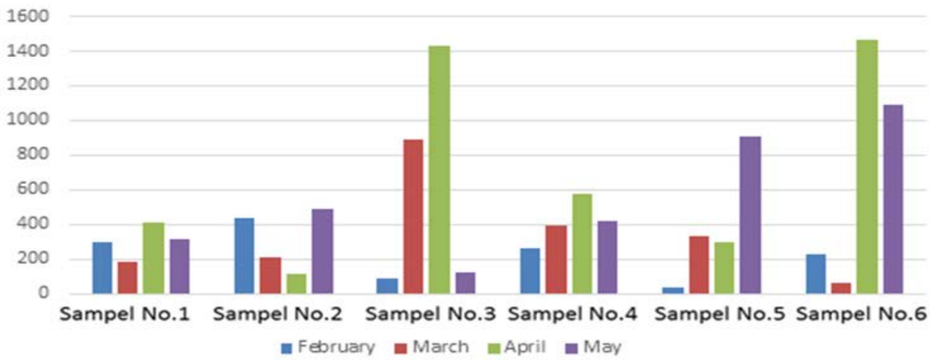

Figure 15: PM_{10} values of the four month

4. Conclusions and Recommendations

No improvement for the technological process and the environmental management was observed on the brick factories, through the field tour around the area of study in Al-Nahrwan. The impact of carbon pollution resulted from burning black oil and related fuel for long time can be observed on the residential buildings and plants, trees, and land. The average concentration of and other gases in the air is 591.25 μg/m3 for TSP; sulfur dioxide, 0.245 ppm; nitrogen oxide 0.37 ppm; and these values are higher and exceeds the national and international allowable limit. Sulfur dioxide is highly found in the site No.1 1.0004 ppm and site No.3 1.065 ppm in May period, the concentration of H2S is found in a high level in the site No.3 for all the months of the study period. The location of this site is approximately in the middle of area under study. Based on the field measurements, the highest concentration of VOCs was in the April 0.225 ppm and May 0.211 ppm, and this approves that VOCs concentration increases in summer season. The industrial process represented by brick factory and tanning factory considered the main reason for high level of air and soil pollutants in Al-Nahrawan area. Community participation is one of the basic items for the development of methodology for assessing the environmental impact and this in turn confirms the importance that stems including the participation of society in the process of development and improvement of the work and performance of the construction and establishment of projects. The results of questioner, in which the participant are inhabitant and workers, revealed that 80 % of them they believe that more brick factories increase will increase the emissions of carbon dioxide, while 81.5 % of them recommend modernization of these factories. As a result of the poor quality of fuel used in combustion processes viz. black oil, which causes air and soil pollution with sulfur compound emission, necessitate the addition of fuel quality enhancer, or the use of better quality fuel, or currently use electricity to keep the environment clean. Issuing legislation and laws to ensure the stringent measures to curb environmental waste that get by the lack of commitment to implement precautionary measures to prevent cases for pollution. Encourage community participations or contributions in all segments, mainly from the foundations of the environmental impact assessment and policy for each different life activities. Reducing the particles released from the chimneys in the brick factory by using new method to control these particles. Setup a monitoring station permanently in Al-Nahrawan area to know the amount of emission and the concentration of the pollutant. Support research and development in the fields of environmental protection using cleaner fuels and alternative fuel projects and production methods.

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