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Relationship Between Street Dust and Development Problem of Suspended, Accumulated Dust in Atmospheric of Baghdad City (Applied Study in Elshaab Region)/Iraq

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Abstract: The current study was implemented in the Shaab area in the Northeast of Baghdad (as an applied model) to follow the role of solid residues and street dust in the growing problem of increasing the percentage of dust suspended and falling in the atmosphere of the city of Baghdad. Through several tests to know the nature of synthetic, chemical and shape the size of solid residue particles and the dust of sidewalks left for long periods in the streets of the study area and compare these particles with dust particles suspended and accumulated in the atmosphere of the city using several techniques, including; Separating the dust particles of the street mechanically by means of the vibrator soil sieve into seven volume and weight categories, in order to determine the amount of the part that can become suspended and accumulated dust, especially the seventh category. Determination of the size, shape and content of the metal molecules of the seventh category by the technique of electronic microscope SEM. Determination of the quality of chemical compounds and their relationship to minerals in the molecules of this category XRD technology. Apply the same tests on the particles of dust suspended and accumulated which were extracted from the dust collectors and sedimentation cylinders of accumulated dust and accumulated, respectively. The results of the study showed a direct relationship between the components of the street dust and the nature of its particles, especially the seventh category with the components for the particles of the two kinds of dust suspended and falling. The mechanical separation technology showed that the diameters of the particles of this category were <53 μ and form about 45.3% of the total weight of the test sample (1 kg). The technique of the scanning microscope SEM has shown the great similarity in the shapes, diameters, colors and composition of most of the molecules of this class and the particles of the two types of dust mentioned (8-8, 75-7, 9.8-3.3) μ for pavement and high dust S and accumulator, respectively. Moreover, its mineral content is very similar in the three types of dust. The EDS technique showed the following elements in the first envelope of the molecule (carbon, silicon, iron, aluminium and molybdenum). The XRD technique also showed similarity the following compounds were detected in SiS_2, SiO_2, NiCx, $CaCO_3$, CaO, V_3InO_7, Ca1.5 and SiO3.5.xH_2O).

Key words: Street dust, suspended dust, accumulated dust, metal molecules, sedimentation cylinders, SEM

INTRODUCTION

The scientists agree fields, that the neglect of human society warnings issued by scientific institutions and the failure to reach a comprehensive system of collective work to protect the environment and the maintenance of natural resources from the basic sources of natural resources (raw materials). As well as animal society and vegetation, ecosystems and human life will be subject to significant environmental damage leading to imbalance in nature. In addition, a sharp deterioration descended upon meetings in the direction of disasters of life, natural beauty and human relations (Dayan *et al*., 2008). Recently, researchers have found that most Iraqi cities do not have proper urban planning services in the absence of an integrated environmental management system for handling solid waste which is the main reason of street dust. Road dust is consider one of major air pollutants besides, the increase in urbanization and construction lead to increase in the concentrations of dust and suspended substances in the atmosphere. Further, the spread of random workshops and establishment of industrial complexes inside cities which makes it more dangerous to civilian life (Butte, 2003). The exposure of

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these pollutants to the process of mechanical crushing, turning into particles of varying sizes, including very small <10 μ. These small size particles will be lifted by the movement of the air currents that effect most of Iraqi cities, especially in the hot Summer, depending on the geographical location and its daily changing weather condition. These tiny particles pose a very serious risk because of their small size and ability to enter the respiratory tract of the airways reaching lungs and blood. In addition, these dust particles have different sizes and contain a percentage of the heavy metals (mercury, cadmium, iron, lead, copper, chromium, etc.) (Al-Salman *et al*., 1994; Rasmussen *et al*., 2001). In turn, this dust affects even the chlorophyll content of the plants present in the area and thus reduces the proper afforestation (Alhesnawi *et al*., 2018). The relationship between street dust, suspended dust and falling dust is the aim of this study. In addition to the illustration of whether street dust is the source of these two types of pollutants (dust, suspended and falling).

MATERIALS AND METHODS

The study area (Al-Sha'ab) is located in the Northeast part of the capital Baghdad. The neighbourhoods belonging to this region are Al-Taghar, Aden, Al-Seha District and Ur. This study area included the Arab Club Street, the streets of the oil club housing and the main Al- Sha'ab Road where a large commercial market is located which ranks as the fifth largest market in Baghdad and the city market. The city of Al-Sha'ab is surrounded by a dirt dam from the North to protect it from flooding and by Sadr City from the South. The three streets were chosen in the following districts: Al-Taghar District, Ur District and Aden District are shown in Fig. 1.

Collection of samples

Street dust: During November, samples were collected from each of the locations mentioned above by nine locations from both sides of the street back and forth up to 3 kg per sample. A square meter was set for each location and dust collected from its four corners. Samples away from polluted places such as various workshop pollutants and car oil stains, then the large-size materials was isolated such as cigarette remnants, coarse-grained materials, large stones and others (Al-Khashman, 2004). Samples were stored in paper bags and transferred to the laboratory for examination. The samples were mixed well to become homogeneous after sorting the impurities. One

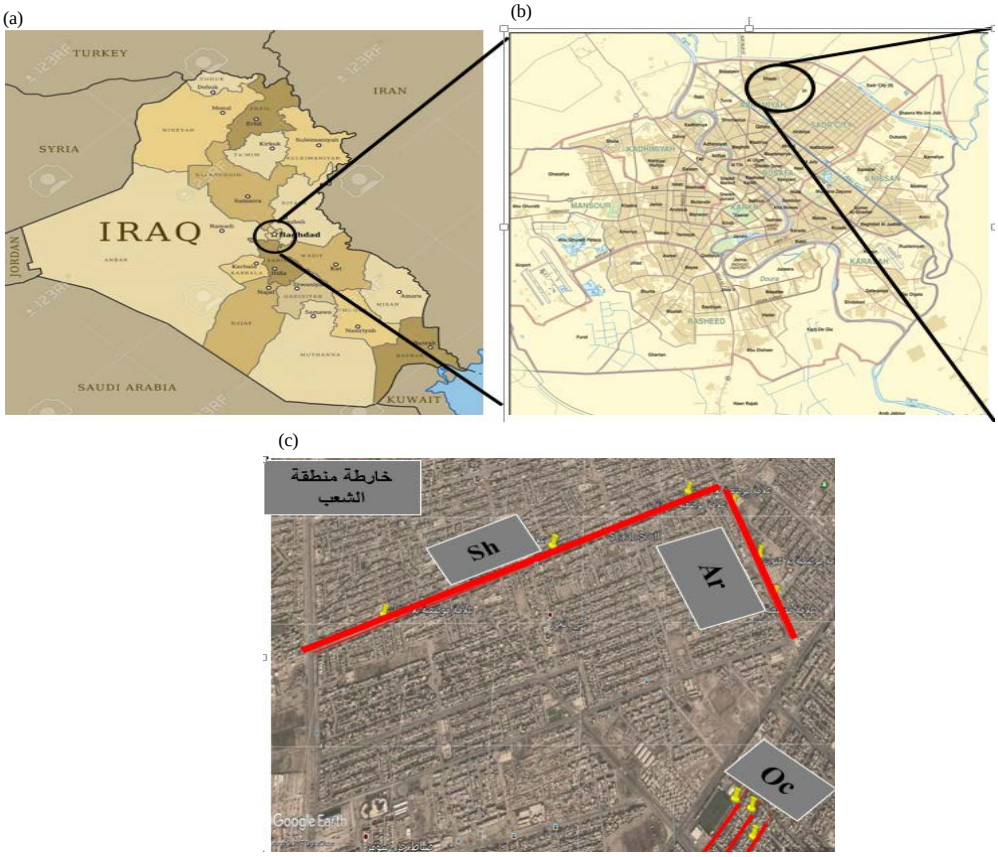

Fig. 1: Study area

kilogram of each location was analysis and the mechanical analysis has been done. The sample was separated into different size categories by using the sieve soil sieves (2, 1, 0.5, 0.25 mm , 150 and 53 μ), respectively for 30 min and then weighed each category with a sensitive balance (Yuan *et al*., 2003).

Falling dust: Collect dust falling in the Winter during the month of December. The same process was repeated the dust falling in Winter was collected during the month of December. Plastic transparent cylinders were placed in the walls which was designed to work in bad weather conditions (i.e., heavy rain and high wind). The height of cylinders is twice its diameter to avoid the effects of the air current from the dust fallen inside it. It was placed in the specified locations within the study area and at an altitude of 2.5-3 m for 30 days. To prevent the tampering of children and pedestrians where the cylinders placed 4 m away from the main streets, as for the residential areas were placed inside houses overlooking the streets. The cylinders were removed from their positions after 30 days and had taken to the laboratory and then are dried at room temperature for 12 h to remove the moisture from the samples and its outside wall was cleaned before weighting it.

Suspended dust: Its samples were collected in Winter during January. A special device was used to collect the suspended particles in the locations specified in the study plan at a height of 1-1.5 m and away from the street at a distance of 4 m (Alhesnawi, 2015). The weight of the filter was taken before and after the experiment, in order to determine the amount of dust suspended. The filter was transferred to the laboratory after the completion of the process of air sampling collection.

Analysis of samples: The Scanning Electronic Microscope (SEM) used to show the size of the dust particles of the seventh class of the dust from street, suspended and falling dust. In addition, scanning electronic microscope (EDS) was used to detect the Heavy metals in the first envelope of dust particles in samples. X-Ray Diffraction (XRD) device was used to show the compounded related to the heavy metals in the samples.

Samples examined by using Scanning Electron Microscope (SEM and EDS): Three samples were extract from the experiment, each sample being a mixture of the three locations in the studied streets to know the percentage of heavy metals. The first sample consisted of a traffic lane (Aden Street) and the second sample of a street containing trees with moderate traffic density at Arab Club. The third sample is a mixture of the three sectors in the neighbourhood (oil club). Then a one-gram sample was taken from each sample of the seventh class of size <53 μ and it was placed in the gold plating for 20 sec for gold plating before inserting it into the scanner electron microscope. At the end of the golden coating, process the sample was inserted into the electron microscope scanner by placing it on the holder. The sample was pasted by adhesive tape connector on the rack and then insert the pregnant to a special place inside the electron microscope scanner after removing the air from the scanner. The examination process took 15 min which has been done by the Scanner Software (Anwar, 2018). The same method was repeated for falling dust and suspended dust.

Analysis of samples using X-Ray Diffraction technology (XRD): The seventh category of street dust was selected for each of the studied locations for the purpose of XRD analysis. The objective is to identify the crystalline structure of the dust particles analysis their components by dropping the X-ray spectra to 1 g sample placed on the chip of the device. Then the samples are placed in a dry and clean glass slide in order to preserve the sample from pollution and to ensure that the surface of the sample is levelled, so that, all sample materials stay on it surface . Then the prepared sample is placed in a special place inside the scanner for 12 min (Anwar, 2018). The same procedure was used to analyse suspended and falling dust samples.

RESULTS AND DISCUSSION

Street dust: The volume and weight analysis of street dust led to the separation of street dust samples into seven categories that varied in size and weight depending of the collection locations. This is due to the different levels of municipal services, population density, human activities and solid waste sources even within the same study area. This comes close to results by Alhesnawi (2015), Anwar (2018). The proportion of the most dangerous categories (6 and 7) in the overall rate of the seven categories is relatively high and has a great impact on human health because these groups can turn into suspended or accumulated dust. Thus, the suspended and falling dusts have a serious impact on human health as in Lu *et al*. (2009). Figure 2 shows the percentage of the rate of the seven categories in the study area. Table 1 lists the seven categories with the details.

Volumetric categories (1st-4th) indicate that most of the sources of pavement or street dust particles are

Table 1: Volumetric categories (mm, µm) and the weight (g/kg) for samples of residential, service and public street dust

Categories/Location	Category 1 2 mm	Category 2 1 mm	Category 3 0.5 mm	Category 4 0.25 mm	Category 5 150 µm	Category 6 53 µm	Category 7 >53 µm
Sh	31.22	56.03	219.93	488.31	0.7	152.85	46.48
Ar	54.48	56.11	251.29	573.50	1.0	82.13	16.71
Oc	150.37	64.36	110.82	359.92	1.0	199.41	72.72

Table 2: Related compounds with heavy metals

Name of compound	Compound in street dust	Compound in suspended dust	Compound in falling dust
Silicon Sulfide	SiS_2	SiS_2	SiS_2
Silicon Oxide	SiO_2	-	SiO_2
Nickel Carbide	NiCx	-	NiCx
Calcium Carbonate	$CaCO_3$	$CaCO_3$	$CaCO_3$
Calcium Oxide	CaO	CaO	CaO
Indium Vanadium Oxide	V_3InO_7	-	V_3InO_7
Calcium Silicate Hydrate	$Ca_{1.5}SiO3.5\text{-}xH_2O$	-	$Ca_{1.5}SiO3.5xH_2O$
Aluminium Magnesium Silver	-	-	$Mg_{55}AL_{40}Ag_5$
Chromium Iron Carbide	-	$(Cr, Fe)_{23}C_6$	-
Silicon Carbide	-	SiC	-
Sulphur Bromide Nitride	-	-	(SNBr0.33)
Boron Iron Silicon Zirconium	-	$BFe_{12}Si_2Zr_2$	-

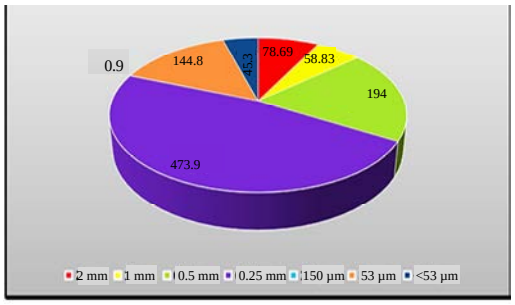

Fig. 2: The average of the seven weight categories in the study area

residues of building wastes, residues of solid waste and soil, due to the large size of these categories and their differing distribution within the study area. For the sixth and seventh categories as shown in Fig. 2. The source of these categories is the mechanical crushing and grinding of the solid residues of the previous categories (1st-4th) by human transportation and chemical reactions during the seasons because of oxidation and reduction. The seventh category of street dust samples was selected for analysis by SEM microscopy because it is the primary source of falling dust and suspended as mentioned (Lu *et al*., 2009). The results of this category are used to compare with the results of the analysis of the suspended and falling dust, for determining the correlation between these types of dust. The results of the analysis by using SEM show the sizes and shapes of dust particles for the seventh category as shown in the following Fig. 3.

Figure 3 shows the shapes and sizes of dusty particles of street dust in the three studied locations. The sizes of these particles ranged between 8-88 µ. Their shapes were circular, cylindrical, starch, conical, square, ovary and cubic (Fig. 4).

The results of the analysis for the seventh class in the dust of the street by using the electron microscopy (EDS) showed that a number of elements are present in the first layer of the dust particles. The highest elements were carbon, silicon, iron, aluminium and molybdenum as shown in the following charts:

Falling and suspended dust: The analysis of the falling dust by the SEM resulted in the appearance of similar sizes and shapes of the particles of street dust particles as shown in Fig. 5. The thickness of the dust particles ranged between 7-75 µ within the three streets in the study area and it was found that the forms of falling particles similar to the particles of street dust is oval and asterisk, conical and cubic.

The results of the analysis for the suspended particles are shown in Fig. 6 by using SEM. The sizes of the suspended particles ranged between 3.3-9.8 µ and shapes were similar to the shape of falling and street dusts.

The results from dust suspended by EDS revealed that the presence of a number of elements in the first layer of the suspended particles. The most concentrated elements were (carbon, iron, silicon, magnesium and calcium), their percentage are shown in the following chart:

Analysis of street dust, suspended dust and falling dust by XRD technology: The analysis of the seventh class samples of street dust, suspended dust and falling dust by using the XRD resulted in the presence of a number of compound connected with heavy metals which are shown in the Table 2.

That the presence of a number of elements such as carbon, iron, silicon, molybdenum, chlorine and cadmium

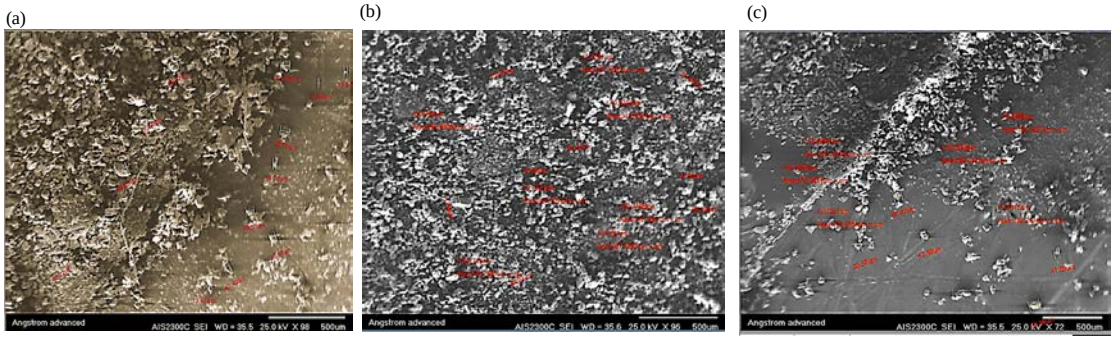

Fig. 3: Forms and sizes of street dust particles by SEM with a magnification force 500 μ: a) Sh; b) Ar and c) Oc

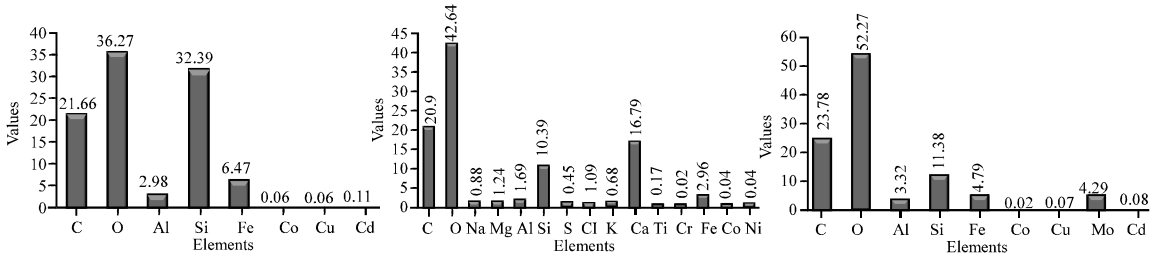

Fig. 4: Percentage of the presence of elements in the first envelope of street dust particles within the study area on the three streets by using EDS: a) Sh; b) Ar and c) Oc

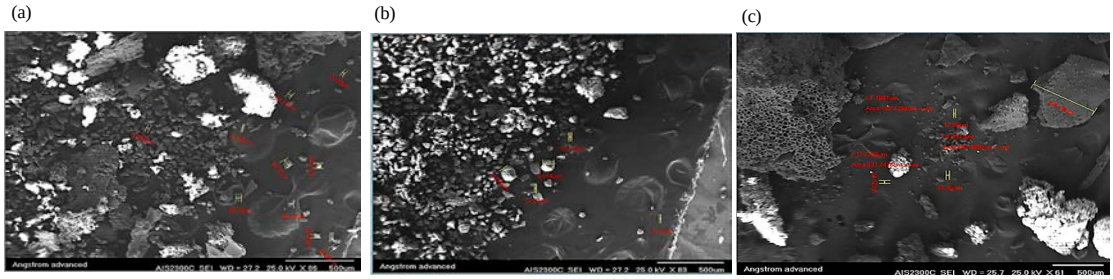

Fig. 5: Shapes and sizes of dust particles for falling dust samples within the study area by using SEM with a magnification force 500 μ; a) Sh; b) Ar and c) Oc

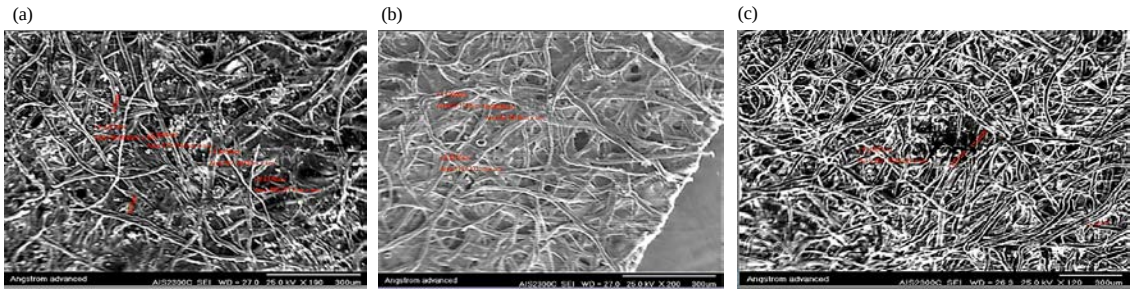

Fig. 6: Shapes and sizes of dust particles for suspended dust samples within the study area by using SEM with a magnification force 300 μ: a) Sh; b) Ar and c) Oc

in the dust samples in general indicates the contamination of the study area with harmful elements. The reason for the presence of these elements is due to high traffic and remnants of construction waste as well as local activities of industrial and commercial workshops. This is agreed with the findings in Gonzalez *et al*. (2016). Table 2 shows

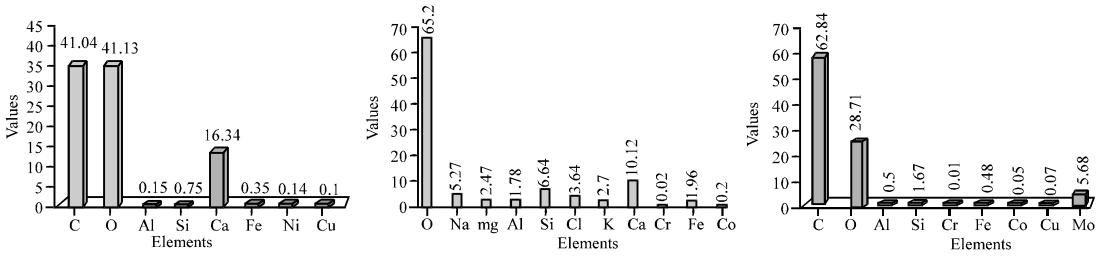

Fig. 7: Percentage of the presence of elements in the first layer of suspended dust particles within the study area on the three streets: a) Sh; b) Ar and c) Oc

that the compounds detected in the dust samples are 12 compounds. The results show that the appearance of most of the compounds in each of the samples of street dust and suspended and falling and this is a sign that the dust of the street and especially, the seventh category is a source of the spread of dust suspended and falling this is agreed with the findings by Gonzalez *et al*. (2016). Also what was approved by Wang *et al*. (2017), that the car traffic and street dust play a role in air pollution in dusty particles which is the conclusion that is fully consistent with was reached in this study. The same size and shape are appearance of the dust particles in the seventh category of street, falling and suspended dusts. Moreover, the appearance of the same elements related to the compounds in these molecules, all of this indicates that the fact that the source of air pollution with suspended and falling dust is the seventh category of dust of the street.

CONCLUSION

It can be concluded from the study that the quality and quantity of streets dust and solid residues left in the streets and squares of the city of Baghdad, a large role in the growing problem of air pollution in general and high levels of pollution of dust in all its types in particular.

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