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REALISTIC EVALUATION OF GREEN SPACES AND FALLING DUST RATE IN THE CITY CENTRE OF HOLY KARBALA, IRAQ

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Abstract

The study carried out within the administrative borders of the city centre of Holy Karbala to identify and classify the distribution of green spaces compared to the total area of the city. Thus, the share of green spaces for each citizen was determined to evaluate the environmental quality of the city. Accordingly, the falling dust was collected by using dust collection cylinders method and measured at different sites along with studying the prevailing winds and its relationship with the distribution of green spaces and the city green belt's design. The study used the Normalized Difference Vegetation Index (NDVI) technique to distinguish between executed and unexecuted parks. In addition, layers were created by using GIS system and recent satellite images to study and produce maps for the quantities of falling dust and prevailing winds direction. Also a suggested design for the green belt. The study provides a realistic assessment of the green spaces and the amount of falling dust in Karbala city centre which helps improve and develop the environmental quality and the urban areas in the city.
***Keywords*:** Realistic, Green Spaces, Falling Dust Rate

Introduction

The great increase in population and the expansion of cities in addition to the unprecedented number of cars, transportation, factories and the growing need to produce all energy forms caused directly or indirectly millions of tons of pollutants and harmful gases in the air (Kim *et al.*, 2015) . The increase in the proportion of carbon dioxide in the atmosphere contributed to global warming, therefore dry lands expanded at the expense of wet lands and this led to an increase in the frequency of sand storms over the last years (Ali Khan, 2012). Air pollution is the most dangerous issue that is debated daily worldly because of the great challenges associated with it as it threatens all life forms (Al Saadi, 2016). There is no doubt that increasing the green spaces and expanding trees planting is one of the best ways to address this danger or at least reduce its effects, moreover; carbon-fixation from Co_2 in the air that contributes to global warming and thereby causes global increase in temperature and climate variability (Sahu, 2015). Planting trees and bushes in cities and along roads is one of the best methods to reduce air pollution as trees play a vital role in purifying the atmosphere by absorbing and isolating gaseous pollutants and fine particles (Song *et al.*, 2020). These plants provide large zones of leaves in which atmospheric pollutants such as dust and gases are impeded, absorbed and accumulated, therefore the air pollution is reduced (Nowak *et al.*, 2018). Iraq is one of the most affected countries in the Middle East by dust and sand storms because of the Desertification and drought that affect the entire region (Sissakian *et al.*, 2013). Karbala is one of the most provinces affected by dust and Desertification throughout the months of the year due to its proximity to the Western Plateau and the increase in industrial and mining activities. In addition to the steady increase in the number of cars and population's expansion at the expense of wet lands (Alhesnawi *et al.*, 2019). The study aims to survey and classify green spaces, estimate the amount of falling dust and prepare spatial distribution maps for these indicators to find sustainable solutions to this problem in the Holy City of Karbala.

Materials and Methods

The study area is the Holy City of Karbala, which is located in Iraq among the provinces of the Middle Euphrates in the area of the Sedimentary Plain and the Western Plateau. It is characterized by flatness with some valleys, away from the capital Baghdad about 105 km to the South with coordinates of (3600.00 N , 4000.00 E UTM) (Figure 1). The desert lies in the Southern and Southeastern part of the city. The Euphrates divides its northwestern parts where Al-Husayniyya River is forked before ending up to the East by Al-Razazah Lake. The desert climate predominates as temperatures rise during the summer to exceed 45° C, while the winter is of mild climate and the level of rain fluctuating between (150-300 mm) (Alhesnawi *et al.*, 2018).

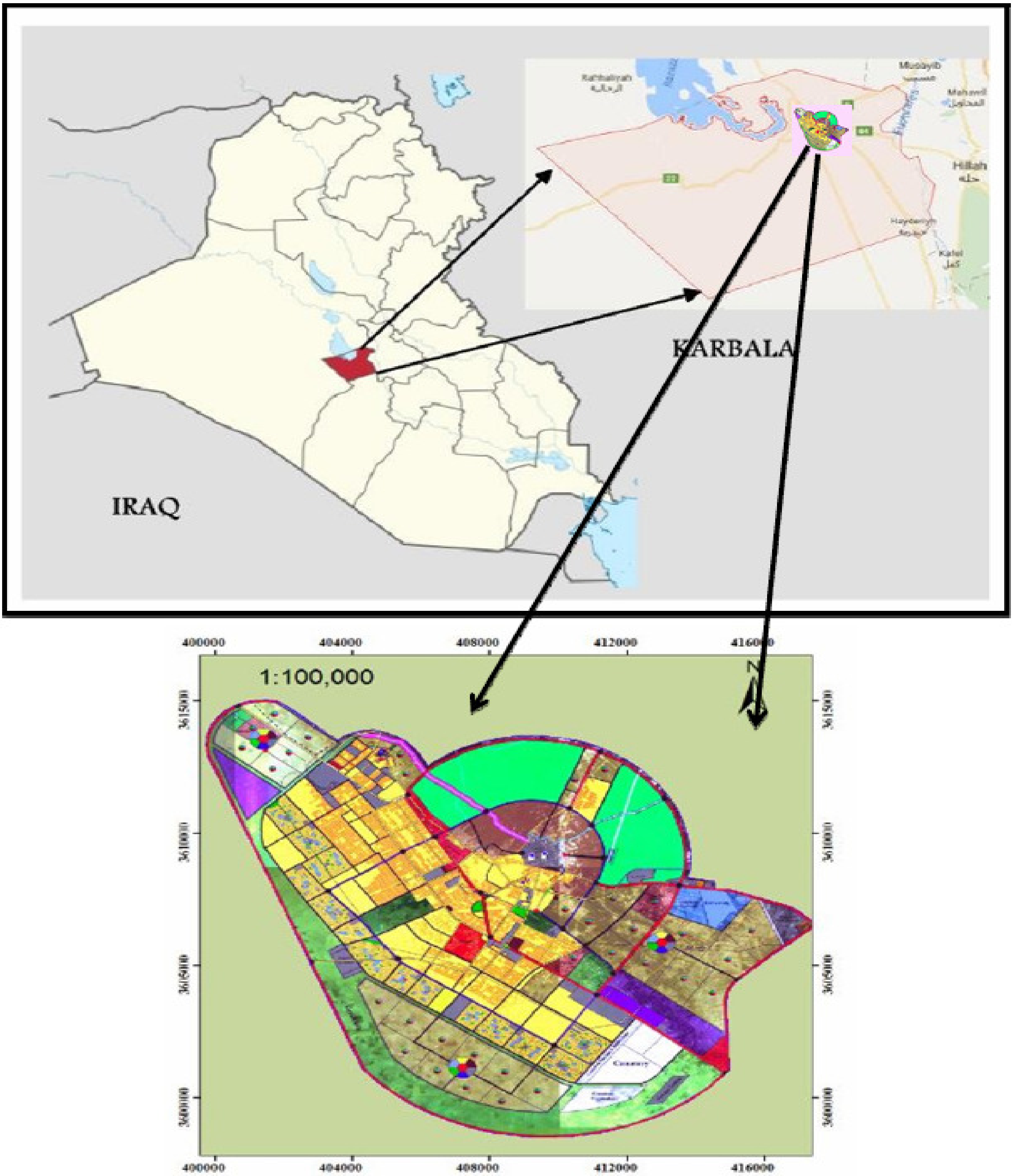

Fig. 1 : Map of the administrative borders of Karbala City and the city center district (study area)

Geospatial Data

The Metadata are obtained from the study field survey of the site and checking the high-resolution aerial and satellite imagery of the study area taken by SANTNEL-2A satellites, its multispectral image with 13 spectral bands. Table (1) taken on 5/12/2019 from the website of the European Space Agency (ESA), is geographically corrected according to (UTM WG, 1984) as shown in Figure (2). The ArcGIS 10.3v Software was used for analyzing and producing maps, data such as paper maps or the shape file for parks and green spaces, they are obtained from the GIS Center of Karbala's Municipality and The Technical Division of Lands Department in Karbala's Agriculture Directorate as well as the data obtained from the Global Positioning System (GPS) and finally by checking the high-resolution aerial images with field visit.

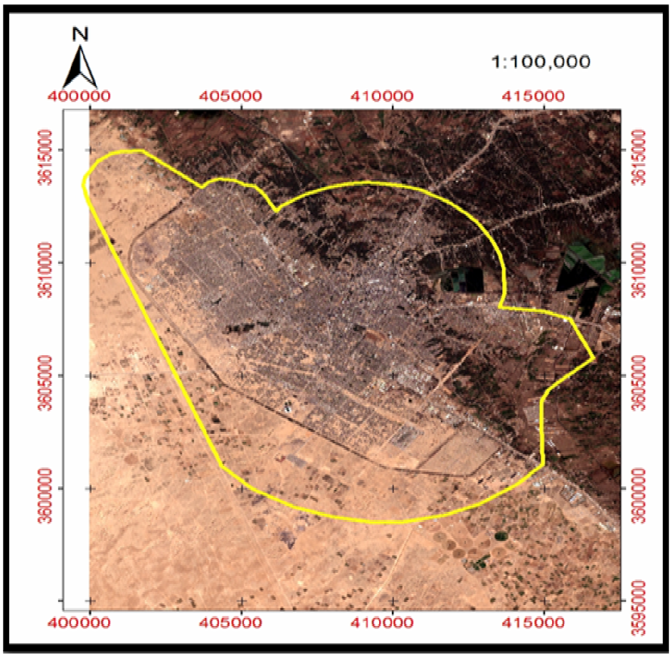

Fig. 2 : Satellite image of the city center of Holy Karbala, taken on 5/12/2019 (Sentinel -2A)

Table 1 : The number of bands, wavelength and images resolution of the European satellite (Sentinel -A2). (Technical Guide – Sentinel Online, 2019)

Band Number	Bands	Wavelength (μm)	Resolution (m)
1	Band1	0.443	60
2	Band2 -blue	0.490	10
3	Band3-green	0.560	10
4	Band4-red	0.665	10
5	Band5	0.705	20
6	Band6	0.740	20
7	Band7	0.783	20
8	Band8-NIR	0.832	10
8a	Band8a	0.865	20
9	Band9	0.945	60
10	Band10	1.373	60
11	Band11	1.613	20
12	Band12	2.202	20

Steps for Mapping

A recent satellite image was downloaded on 5/12/2019, and geographically corrected according to the Global Coordinate System (WGS-1984 UTM). There was a need to draw and export a shape file that represents the administrative borders of the city center of Holy Karbala, the study area. Then, the satellite image was clipped for produce a map that represents the study area using (Extract by Mask) tool**.** Next, to get a shape file includes locations of parks, public gardens and central reservations from the GIS Centre to apply them on the map (Karbala 2019).

The Normalized Difference Vegetation Index –NDVI map was made according to the following equation (Gandhi, *et al*., 2015):

$$NDVI = \frac{NIR - RED}{NIR + RED} \quad where\ (-1 < NDVI > 1)$$

where RED is visible red reflectance**-**

- NIR is near infrared reflectance

The need for this indicator is to identify the executed and unexecuted green spaces because they were not identified in the file received from the Geographic Information Center. By using the Index values between (+1 and -1), it is possible to distinguish between the indicate the presence of vegetation area. Whenever it approaches (+1), it indicates the presence of vegetation and execute by the Municipality. As for the values close to (0) or less, it means that it is not execute area Figure (6). After surveying and categorizing these areas, maps were reconsidered to identify the green spaces and calculate them using ArcGIS.

As for the maps of disparities of falling dust quantity, they were made according to IDW method (Invers Distance Weighting) in ArcGIS (Sankar *et al*., 2016). After data entry, such as the average weight of dust collected in the dust collection cylinders which were distributed uniformly within the study area to increase homogeneity and accuracy of description in the map (Nofal, 2020), these data were entered into Excel tables and restored to the ArcGIS to process and make various maps**.**

Falling Dust Collection Samples

Samples were collected every month from June to December 2019, by placing polyethylene cylinders with a diameter of 15 cm and a height of 30 cm according to the specifications indicated in the field guide for collecting environmental samples (Harrison, 2012). They were fixed in the chosen sites distributed in the study area, Figure (3), by three iterations per site and at a height of 3 meters above the ground for 30 days. The cylinders were collected monthly and taken to the laboratory. The total amount of the accumulative dust was weighed, then the results were put in units of g**.**m^{-2} per month (Zhao *et al*., 2010).

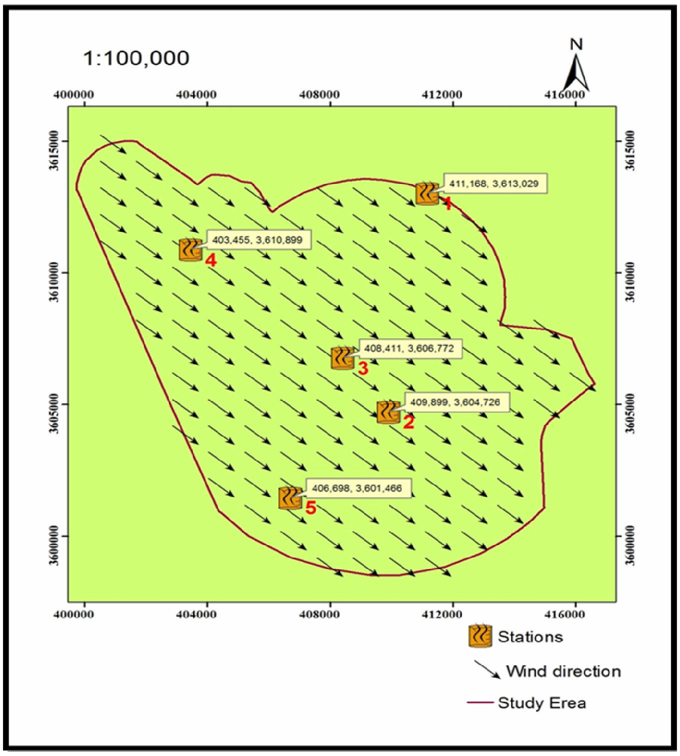

Fig. 3 : The distribution map of the dust collecting stations with wind direction

Results and Discussion

1. Spatial distribution of parks and gardens in the city center

The results showed by means of surveying and classification of green spaces, which were identified in the satellite image captured on 12/12/2019. Consequently, the number of parks including the central reservations, roundabouts and planted crossroads are (648) spaces. The smallest one is (30.23 $m^{2)}$, the largest is 35815.60 m^2 and the total area is (1665735.14) m^2. As for the study area (the focal point), is about (180,997,628 m^2), Figure No. (4). Thus, the ratio of the green spaces area allocated to the total area is 0.92% m^2, Figure (4). This percentage is very poor compared to the international percentage that allocates 10% - 20% of the city's area as green spaces (Faryadi and Taheri, 2009). But if it is compared to the population of the city center (816,550 people) according to the Ministry of Planning 2018, then the percentage will be approximately (2% m^2) for each individual. Even though the international percentage according to the international programme for the environment and cities (UNEP, 2007) must be (12-16 m^2) per individual, hence there is an urgent need to increase parks number and afforestation in the city center.

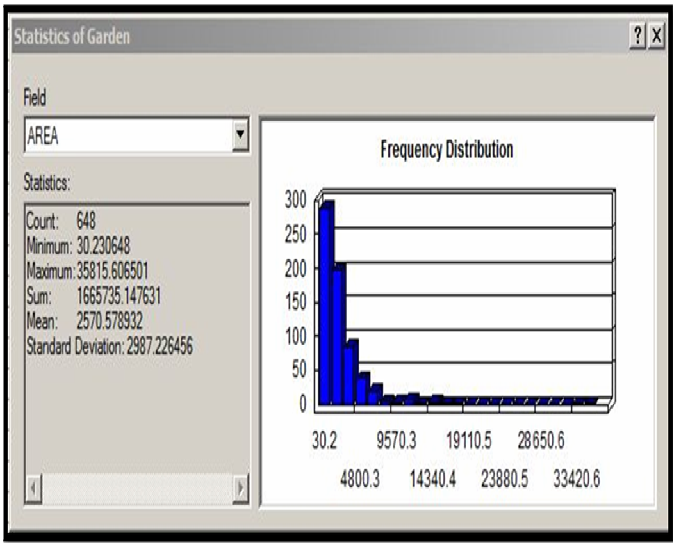

Fig. 5 : Spatial distribution map of the green spaces in Karbala city centre

2. Green Spaces Classification

Depending on Figure (6) that shows a map of the normalized difference index of the vegetation cover NDVI, the executed and unexecuted or abandoned parks have been identified. Out of (648) parks, (276) of which were exploited with an area of (783071.8 m^2) (Figure 7). The rest 372 parks were under construction or not execute with an area of (882663.34 m^2), Figure 8, thus the share for each individual in Holy Karbala city center was reduced to 0.95 m^2.

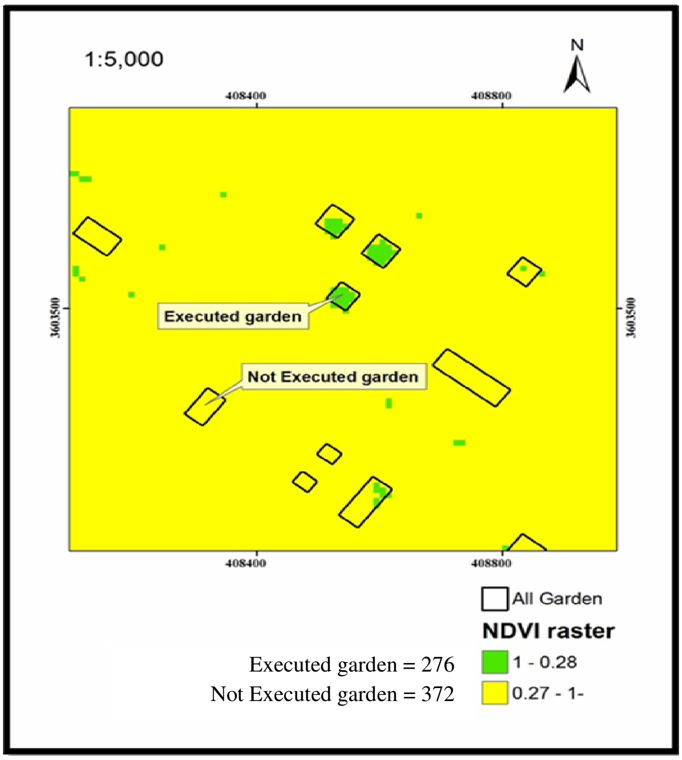

Fig. 6 : Map of normalized difference index of vegetation cover NDVI

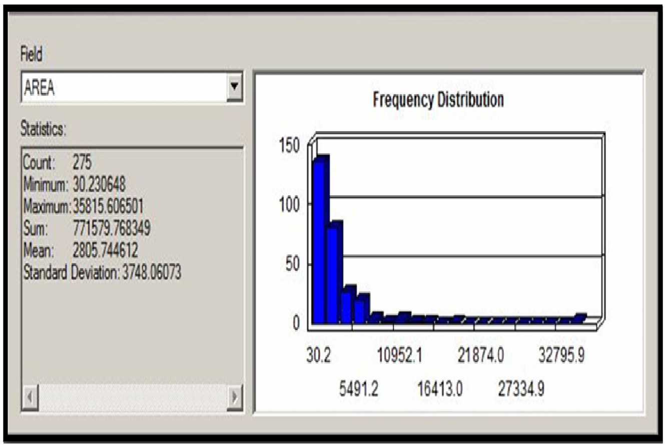

Fig. 7 : Statistical data for executed parks in Karbala Holy city

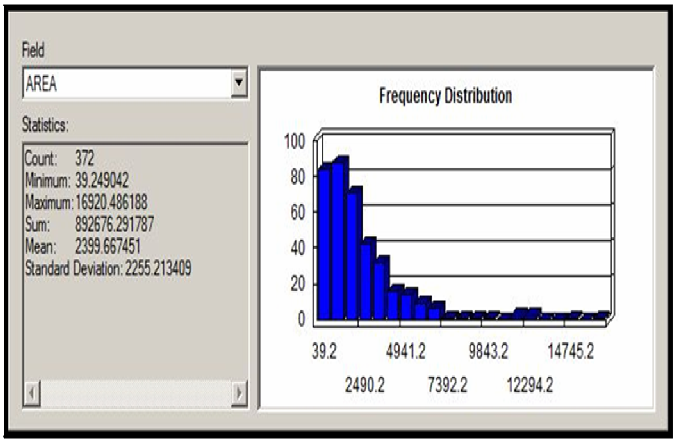

Fig. 8 : Statistical data for unexecuted parks in the Holy city of Karbala

3-Falling Dust

The results showed that the lowest amount of falling dust was in station (4), where it recorded (11.07 $g.m^{-2}$) in December and at an average of (19.63 $g.m^{-2}$) during the study period. The highest amount was recorded in station (2) located in the eastern side

of the study area which was (62.31 $g.m^{-2)}$ in July, 2019 at a rate of (54.03 $g.m^{-2}$) during the study period, Figure (9). The general average for the six months in the study area was (33.52 $g.m^{-2}$), Table (3). The statistical analysis results and Duncan's multiple-range test showed significant difference between the period of months and sites in addition to negative Correlation with the relative humidity and the amount of rain, nevertheless; weak positive Correlation relationship with the wind speed and temperature, Table (2).

Table 2 : Simple Correlation and P-Value analysis between dust fall concentration and metrological factors

Parameters	r	p-values
Temperature (C)	0.752	0.084
Humidity (%)	- 0.837	0.037
Rain (mm)	-0.746	0.088
Wind Speed (m-1 sec)	0.904	0.013

Table 3 : Stations' falling dust rate for six months during summer and winter ($g .m^{-2}$) tested in Duncan's multiple-range test

Station	Dust fa. $g.m^{-2}$	Season	Dust mean
1	26.76 d	summer	35.32 a
2	54.03 a	winter	31.72 b
3	32010 c	Total Ev.	33.52
4	19.63 e		
5	43.54 b		

According to the results of the study and statistical analysis, there were a clear significance in the site effect on the total amount of falling dust, as the highest rates were in stations (2) <(3) <(5) <(1) <(4) respectively. This can be explained due to the nature of the dust-forming activities near station (2) whose location is close to the industrial area. and the increase of cars passing by as compared to other sites of the study in addition to the by coincidence resurfacing and civil works of removing and backfilling the soil of streets, especially in winter during the study period and taking samples. As for the decreased amount of dust in the city center, station (3) and (1), it is because of the lack of industrial activities and the high number of tall buildings and the fact that most of the area is paved. The role of vegetation in station (4) is also clear since it lies near the green belt which reduces falling dust, as plants and trees are natural barriers and fenders for winds laden with dust and sand in addition to holding dust particles on their leaves (Singh and Tripathi, 2007). The cause of noticing significant differences among months is attributed to the influence of climatic factors such as dust storms, especially in summer compared to winter, and this is confirmed by the strong correlation coefficient with high temperature and wind speed, which are two main factors in increasing the amount of dust, Figure (9).

The high temperature increases the rate of evaporation and reduces the weight of dust particles to a level that the air can carry and spread them in the air. Even though, we find the amount of dust is inversely related to the relative humidity, therefore; we find the amount of dust decreasing in these months and these results were coincided with some similar studies (Biglari *et al*., 2017). The rate of falling dust in this study is (33.52 $g.m^{-2}$) while the British determinants are (6 $g.m^{-2}$) and of New Zealand is (4 $g.m^{-2}$) and the rate is more than (7 $g.m^{-2}$) which is regarded as an excessive increase that should be reduced (VanLoon & Duffy, 2011).

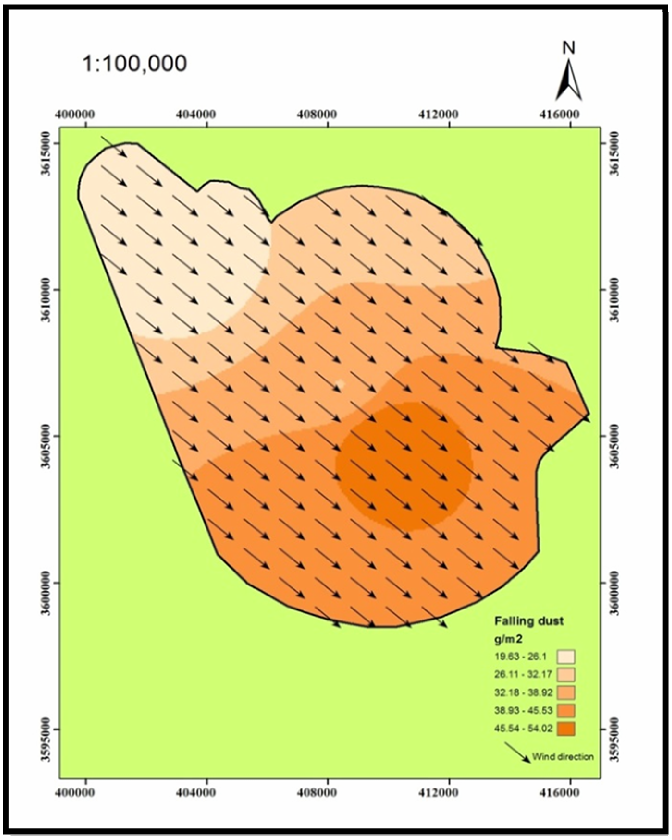

Fig. 9 **:** Map of falling dust average concentration and wind direction

Conclusion

According to the surveying and sorting of green spaces in the city center of Holy Karbala, the deficiency is extremely obvious in green spaces allocation in relation to its area or population. Also, the lack of implementation of the allocated areas for parks or green spaces as the rate of implementation until the writing of this research paper is (42.59%) of the total areas. Concerning the falling dust, its concentration rates are relatively high, affected by climatic factors, this clearly reflects the desertification and drought in the region and most of their sources are local since there is a strong association with population activities, As for the design of the green belt, it needs more studies and development to Consider the direction of the Prevailing wind and choose the type of trees suitable for Catching dust, (Figure 10).

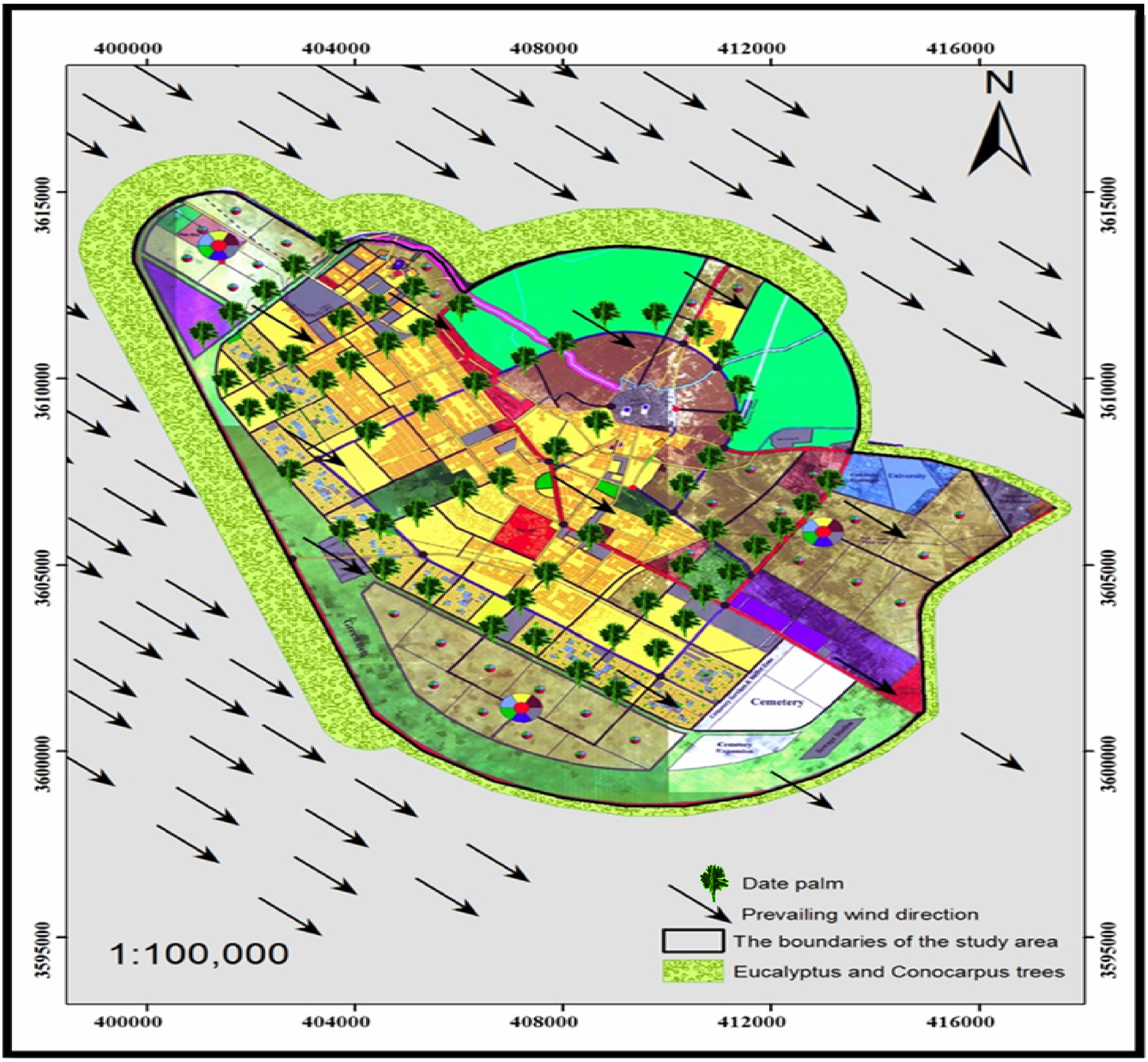

Fig. 10 : Suggested map for green belt design

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