Evaluate of Green space (Parks) in Duhok city by use Image satellite, Google earth, GIS, (NDVI), and Field survey Techniques

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Abstracts

Dohuk city represents the center of the Dohuk governorate which is considered the third governorate in the Kurdistan region of Iraq. Duhok is accounted as one of the safest tourist cities in Iraq. It located in the Northwestern part of the Iraqi Kurdistan between the latitude 36° -38°N, longitude 42°-43°E and on elevation 565 meter above sea level with area about 76.06 km^2. The approximate population of the city for the year 2021 is about 405636 persons according to the Duhok Department of Statistics. The tools and programs used in this study were Image satellite, Google Earth, GIS, GIS and remote sensory (NDVI), Field survey. This study aimed to evaluate the green space (Parks) to provide the best management and improve the quality of life by providing a sustainable green space within Duhok city. The results are summarized as following. Nine parks in Duhok city (Alin, Barzani, Buhar, Azadi, Bekhal, Kani Xishmana, Tahsen Taha, Nawroz and Dilshad M. Said). The total area of these parks was 217318 m^2, 71.66% of this area was green area. So that the green area percentage for each person in this city was 0.536 m^2 per person when compared with some city per capita share we found that this figure was less than the least one Damascus city (0.7) m^2 per person and far away from Vienna city that reach (124.6) m^2 per person. The evaluation degree of this parks was ranged between 55.2 for Nawroz to 86.6 for Azadi Park (from 100 mark). The irrigation system for all parks were sprinkle. The largest area was Barzani Park with 55879 m^2 whereas the smallest area was Alin (7494) m^2. The total number of plants are (7280) plants, 2254 of them include many kinds of tree, the highest number was *cupressus sempervirens* (428) tree then *Robinia pseudoacaia* (338) whereas the less one was *Acer negundo* just have (6) trees.

Keywords: green space, parks, GIS, Image satellite.

Introduction:

Many Parks were established in Duhok City, it need continue evaluation for renew and sustainability. Many green and non-green elements were established in this Parks that are among the important recreational areas that residents want to spend time in normal days or during official holidays, these facilities have environmental and climatic effects it is aesthetically pleasing, improves climatic conditions, reduces heat intensity, and restores balance Environmental pollution and reducing air pollution in the city through its precautionary measures to dry out from temperatures Increased humidity and then will have a role in lowering temperatures, especially in the summer (2**).**

Green space (makes our lives and places better) is term defined very broadly by the European Commission as simply refers to outdoor settings that contain a significant amount of vegetation playing a role in the urban micro-climate and in biodiversity (12 and 18). Parks differ according to their age, levels of maintenance, facilities, and size or partly due to the philosophy that motivated their creation and partly due to land development processes and municipal fiscal constraints (8). Urban green spaces play an important role and have a positive effect on the quality of life in cities (14 and 10). The greener growth is an important component for sustainable development as it protects environment and allow economic growth (7). Parks and any green spaces in the cities it fundamental for the people's needs and their rest and good indicator for progress and development of country and ensure continued tourists attracting, investors, and improving the quality of life for its residents (12). Preserving and maintaining open spaces in urban environments is considered a crucial aspect of fulfilling environmental quality goals and attaining a livable city (9). About 11% of the total land on earth would need to be fill with trees to reach the goal of removing two-thirds of all carbon emissions in our atmosphere. The removal would prevent the rise of temperature to reach 1.5°C (19). Lawns have shown their capacity to decrease the temperature peaks of hot summer days by approximately 1 ◦C (17). Also the Landscape plants that including tree, shrubs and turf remove smoke, dust, and other pollutants from the air so they improve air quality, one tree can remove 26 pounds of carbon dioxide from the atmosphere annually, equaling 11,000 miles of car emissions, study showed that 1 acre of trees has the ability to remove 13 tons of particles and gases annually **(3).** Trees absorb the carbon dioxide that contributes to global warming, as well as other gases that contribute to urban pollution by absorbing the carbon emitted by vehicles, lowering carbon emissions from fossil fuel-burning plants, and reducing the energy used for climate control in buildings. An urban ecosystem analysis of greater San Antonio (Texas) conducted by the organization American Forests has calculated that the area's tree cover is saving the city $70 million a year in ecological services, including storm water management, air quality, and energy conservation (3 and 21).

Estimated Value of Trees in U.S. Urban Parks $300 billion, Air temperature reduction likely in the billions of dollars per year, Air pollution removal $500 million per year, Grass provides the same function, one tree or a 2,500- square foot lawn each release enough oxygen each day to supply a family of four Reduced

ultraviolet radiations likely substantial. Properly selected and placed plantings absorb sound waves, and can significantly reduce unwanted 'noise pollution' additionally, some plants make pleasant sounds of their own. (5).

A recent study at the Sloan Kettering Institute in New York found that women recover from breast cancer surgery quicker if they spend time in a garden, according to a report by the American Horticultural Therapy Association. **(**11**).** Kuo, *et al* (15) found the more trees and grass in the common spaces of inner-city neighborhoods, the more that those spaces are used by residents. And, this means more opportunities for informal social interaction. In other words, relationships between neighbors are made stronger simply through the presence of vegetation. Among the participants who now live in a green neighborhood, those feeling depressed decreased by 41.5% and self-reported poor mental health decreased by 62.8% **(6)**. The Aims of this study to evaluate the green space (Parks) to provide the best management and improve the quality of life providing a sustainable green space within Duhok city.

Material and Methods

The study location is Duhok City, the center of the third Governorate in the Kurdistan region and one of the safe and tourist cities in Iraq, located in the Northwestern part of the Iraqi Kurdistan between the latitude 36°-38°N, longitude 42°-43°E and on elevation 565 meter above sea level with area about 76.06 km^2, the approximate population of the city for the year 2021 is about 405636 persons, according to the Department of Statistics as shown in Figure (1).

The tools and programs used in this study

1- Image satellite (MAXAR technologies, ArcGIS, and ArcMap online, then analysis was done in the GIS program by toots to extract the green space for each Park.

2- Use a mobile phone to locate GPS locations for each park or other thing such as Google Earth (is a computer program that renders a 3D representation of Earth based primarily on satellite imagery), Maps.ME (MAPS. ME, detailed offline maps of the world. Data version: 220614-version14.2.7) It functions almost similarly with Google Maps, only that Maps.me can work without internet access). And ArcMap (10.7.1) - Esri Support (version,10.7.1) (is a geographical information system (GIS) that allows handling and analyzing geographic information by visualizing geographical statistics through layer building maps like climate data or trade flows).

3- GIS and Normalized Difference Vegetation Index (NDVI), after knowledge of data on the city boundaries of Dohuk Municipal City from maps and knowledge of the total area, polygon the total green space was obtained using remote sensing Difference Vegetation Index (NDVI) quantifies vegetation by measuring the difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs).

4- Satellite data were that is from sentinel2 (10 m resolution) at date 11-10-2021 (D/M/YEAR) and by using (GIS) technology, analysis by toolbar and then getting the results of the total green areas and non-green areas of the study area.

5- Field surveys for nine parks (Alin, Barzani, Buhar, Azadi, Bekhal, Kani

Xishmana, Tahsen Taha, Nawroz, and Dilshad M. Said) were performed to obtain the number and scientific names of trees, shrubs, climbers and any type of ornamental plants and lawns. The total area of all green space, lawn type, irrigation systems, and location of gardens. Evaluation of green space (Parks) by using some world standard, which consists of the number of questions, using the questionnaire for 10 visitors as a (table1). Then analyze it and obtain an evaluation degree.

6- Per capita share from the parks as green areas only, By knowing the total green area (m2) from NDVI and the number of people in the city for the year 2021, depending on the statistics department in a city so to calculate it uses the following equation: T=G/P when T: green area per capita (m^2/capita), G: green space in the city (m^2), P: population number in the city (405634 person). So, we find that one per capita green space is calculated, which is estimated at (m^2 per person).

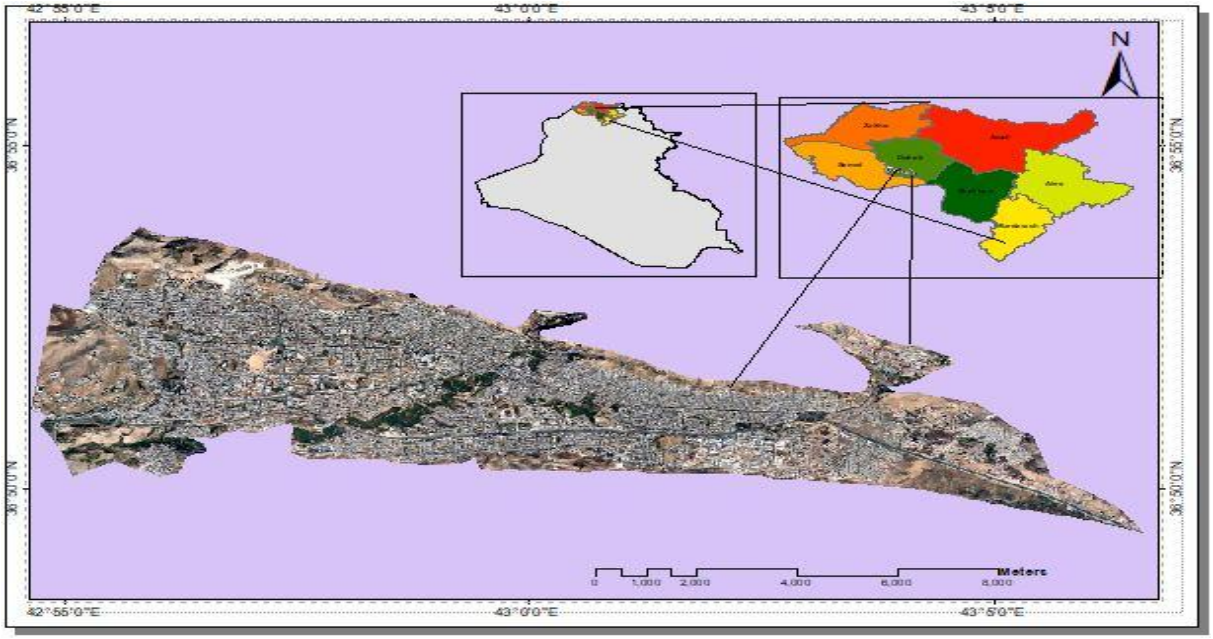

Figure (1). The location of study area (Dohuk city).

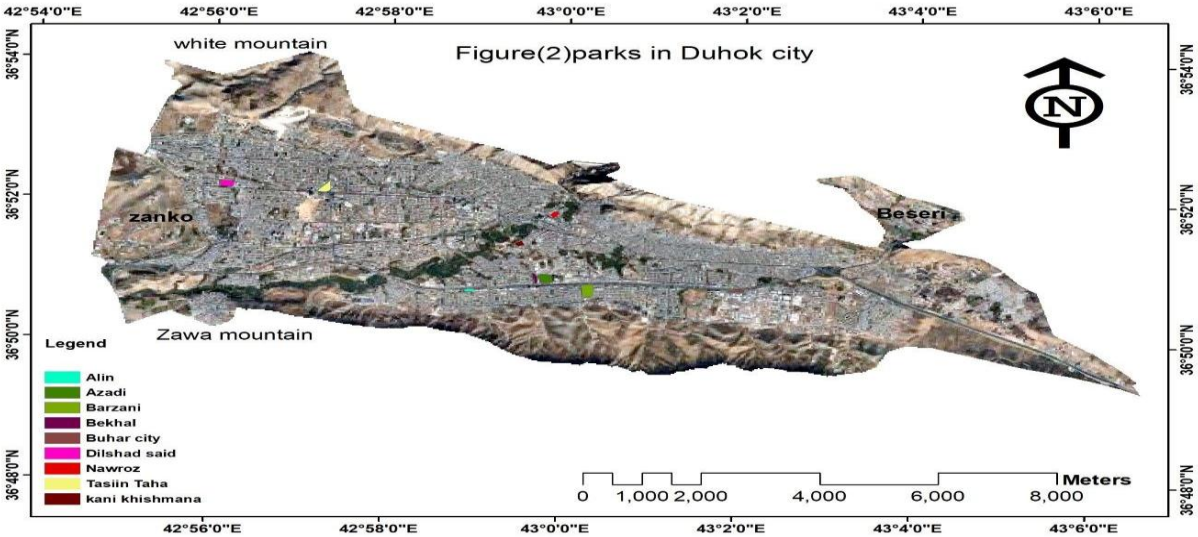

Figure (2). The Parks locations in the Dohuk city.

Table (1). Standards for Evaluating Landscape Design - Judging Gardens Marilyn, (1999)

Questions	standard value
First question	
1- First impression (5%)	5
Second question	
2- Suitability of design to purpose (5%)	5
Third question	
3- Design (45%)	
A. Functional aspect	
1- Suitability	5
2- Creation and utilization of space (Including circulation patterns, activities, rest area, etc.)	15
B. Aesthetic aspect	
1- Design principles employed successfully ((balance, contrast, dominance, proportion, scale, rhythm).	10
2- Design elements applied successfully ((line, form, color, texture, pattern, size, space and light).	10
3- Originality and distinction ((Including unusual qualities, features, accents, and enhancements. Successful solution of site problems.)	5
Fourth question	
4- Implementation (30%)	
A- Materials and Structures	
1- Suitability to purpose, site, and design	15
2- Perfection of details	5
B- Plant materials	10
Fifth question	
5- Maintenance (10%)	
A- Incorporation of maintenance awareness into design and selection of materials	5
B- Current, sustained maintenance	5
Six question	
Sixth question. Final Impression	5
Total	100

Results and Discussion

1- Barzani Park

Data in the table (2) and figure (4) explained that the total area of this park is 55879 m2, 38061 m2 was a green area, total ornamental plants reach (1331) plants, green space evaluation of this park is 75.2 degrees (sensory evaluation). Sprinkler irrigation was used in this location and a mixture of cool-season grasses was planted in it. Fourteen kinds of trees were planted, the largest number is for *Pinus spp* which reached 193 trees then *Bauhinina varigata* (148) tree, whereas the less number was magnolia grandiflora (2) tree only. Eight species of shrubs were found in it the largest number was *Photinia fraseri* (196) shrubs the second was *Jasminum officinal* (87) shrubs while the less number was *Granatum nana* and *Syzygium aqueum* (16) shrubs. A few perennial plants (small shrubs) were planted in this location such as rose spp. (85) plant, and others *Cyperus papyrus* (15).

Table (2). Barzani Park contents (area, evaluation, irrigation system and type of all ornamenta plant).

Total Area (m²)	55879
Green Area (m²)	38061
Evaluation of the garden	75.2
Irrigation System	Sprinkle
Types of ornamental plant	
Trees	
Pinus spp	193
Bauhinina varigata	148
Fraxinus exceisior	77
Platanus orientalis	46
Arizona Cypress	39
Washingtonia filifera	34
Cupressus sempervirens	31
Olea europaea	22
Robinia pseudoacaia	18
MOrus alba var.pendula	14
Pissardi plum	14
Acer negundo	6
Melia azedrach	3
Magnolia grandiflora	2
Shrubs	
Photinia fraseri	196
Jasminum officinal	87
Ligustrum japonicum	79
Lagerstroemia indica	40
Thuja orientalis	38
Pyracatha coccina	33
Granatum nana	16
Syzygium aqueum	16
Perennials plant	
Rosa spp	*85*
Others	
Cyperus papyrus	15
Lawns	*Mixed*
Total Plants	1331

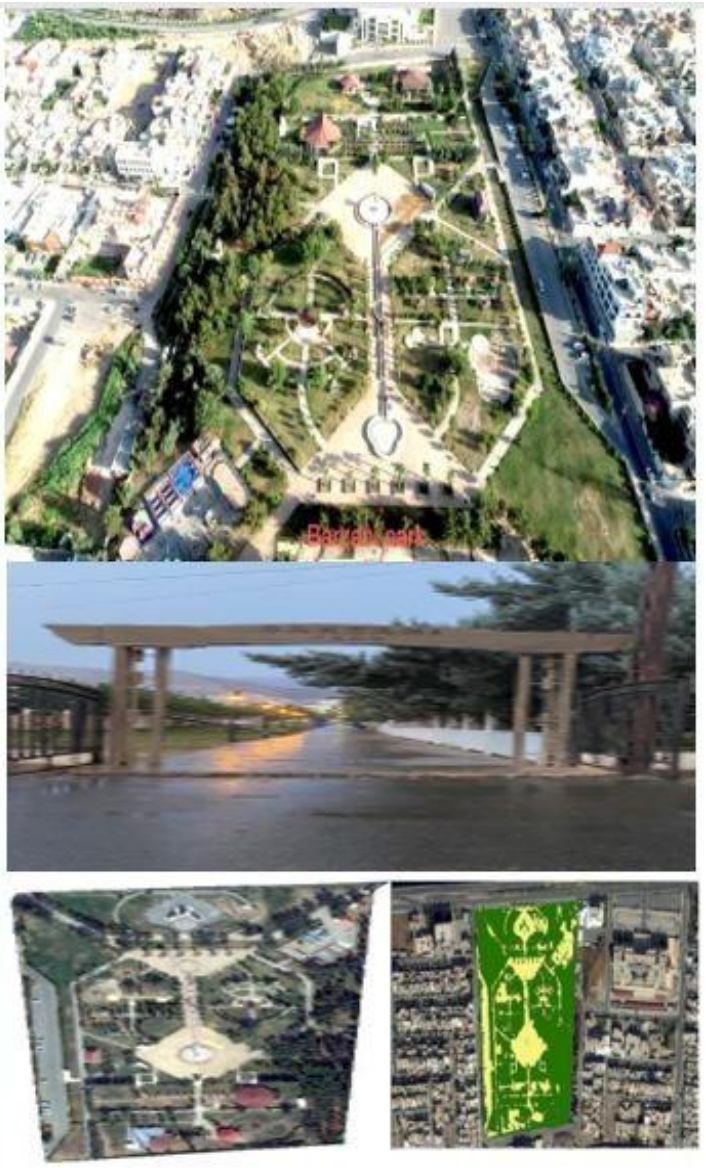

Figure (4) contents (Drone images, photographs and analytics images from GIS program to extract green area.).

2- Azadi Park

Data in table (3) and figure (5) explained that the total area of this park 45726 m^2, 34064. m^2 of this area are green area and the total ornamental plants reach 1745 plants, the evaluation of this park reaches (86.6) degree (sensory evaluation from 100 mark). Sprinkler irrigation was used in this location and cool season grasses mixture are planted. 10 kinds of trees were planted the largest number reached 144 tree was *Robinia pseudoacaia* then *Arizona Cypress* that reached 129 tree, whereas the less number was *Magnolia grandiflora* (7) tree. Ten species of shrubs were found in it the largest one was *Photinia fraseri* (175) shrub the second was *Pyracatha coccina* (150) shrub while the less number was *Granatum nana* that reached (8) shrub. Little perennial plant was planted in this location such as *rose spp*. (393). The Climbers include *Parthenocissus triuspidata* (38) and *Jasminum gradiflorum* (7) shrub

Table (3). Azadi Park contents (area, evaluation, irrigation system and type of all ornamental plant).

Total Area (m^2)	45726
Green Area (m^2)	34064
Evaluation of the garden	86.6
Irrigation System	Sprinkle
Types of ornamental plant	
Trees	
Robinia pseudoacaia	144
Arizona Cypress	129
Fraxinus exceisior	117
Platanus orientalis	90
Catalpa speciosa	18
Cupressus sempervirens	17
Washingtonia filifera	14
Pissardi plum	14
Melia azedrach	13
Magnolia grandiflora	7
Shrubs	
Photinia fraseri	175
Pyracatha coccina	150
Ligustrum japonicum	102
Ligustrum vulgare	101
Thuja orientalis	83
Buxus sempervirena	68
Lagerstroemia indica	28
Hibscus rosa sinensis	18
Syzygium aqueum	11
Granatum nana	8
Perennials plant	
Rosa spp	393
Climbers	
Parthenocissus triuspidata	38
Jasminum gradiflorum	7
Lawns	Mixed
Total Plants	1745

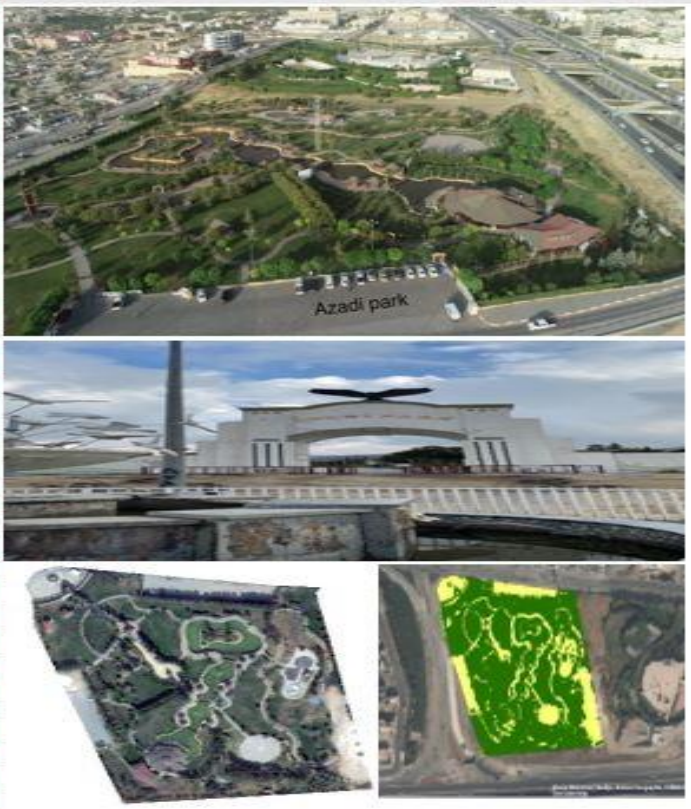

Figure (5) contents (Drone images, photographs and analytics images from GIS program to extract green area.)

3- Bekhal Park

Data in table (4) and figure (6) clarified that the total area of this park was 11000 m^2, 9502 m^2 of this area are green area and the total ornamental plants reach (606) plants, the evaluation of this park reached (67.4) degree. Sprinkler irrigation was used in this location and cool season grasses mixture were planted. Five kind of trees were planted in this park the largest number was *cupressus sempervirens* (332) tree then *Platanus orientalis* that reach 36 tree, whereas the less number was *Robinia pseudoacaia* (8) tree. Six species of shrubs were found in it the largest one was *Dodonaea viscesa* (76) shrub the second was *Buxus sempervirena* (56) shrub while the less number was *photinia fraseri* that reach (5) shrub.

Table (4). Bekhal Parkcontents (area, evaluation, Irrigation system and type of all ornamental plants).

Total Area (m^2)	11000
Green Area (m^2)	9502
Evaluation of the Garden	67.4
Irrigation System	sprinkle
Types of ornamental plant	
Trees	
Cupressus sempervirens	332
Platanus orientalis	36
Washingtonia filifera	17
Salix safsaf	11
Robinia pseudoacaia	8
Shrubs	
Dodonaea viscesa	76
Buxus sempervirena	56
Callistemon floribunda	22
Ligustrum japonicum	22
Lagerstroemia indica	21
Photinia fraseri	5
Lawns	Mixed
Total Plants	606

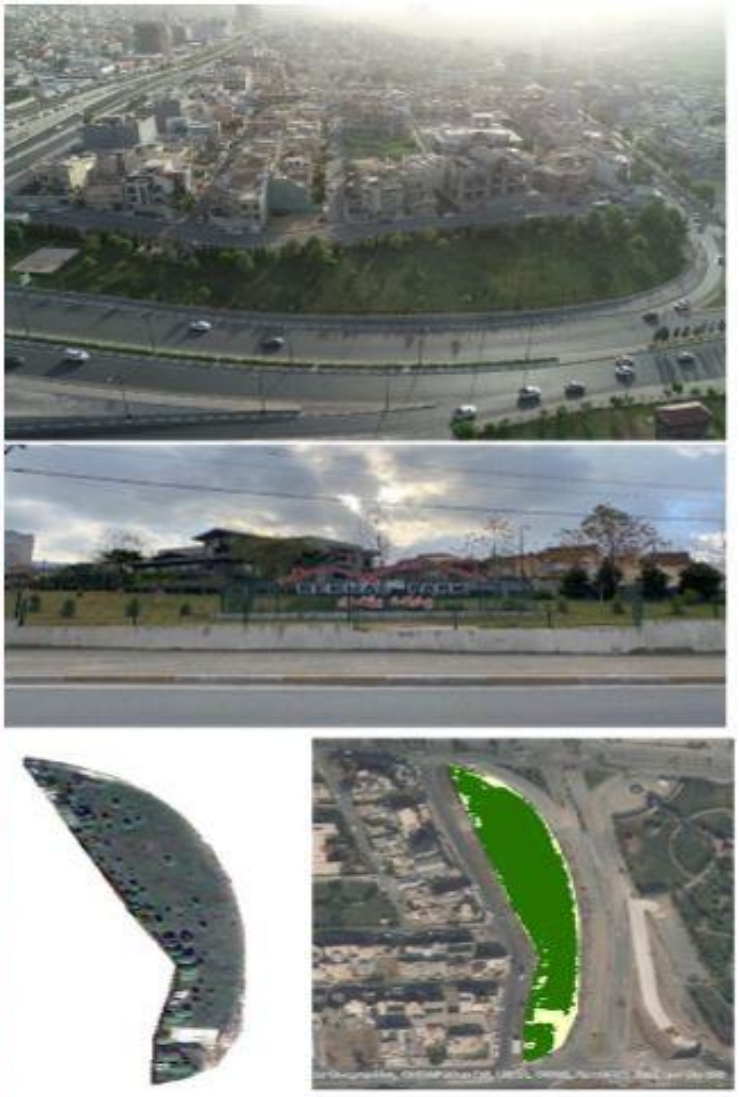

Figure (6) contents (Drone images, photographs and analytics images from GIS program to extract green area.)

4- Kani xishmana

Data in table (5) and figure (7) clarified that the total area of this park 8865 m^2, the green area reach 7934 m^2 of this area, the total ornamental plants reach 1153 plants, the evaluation of this park reach 62 degree. Sprinkler irrigation was used in this location and the Cool season grasses mixture are planted in it. Tow kind of trees were planted the largest number was *Platanus orientalis* (60) tree, whereas the less number was *Platanus orientalis* that reached 36 tree. Two species of shrubs were found in it the largest number was *Buxus sempervirena* (445) while the less number was *Jasminum officinal* that reached (5) shrub. Perennial plant was planted in this location such as *rose spp*. that reached 560 plant.

Table (5). Kani xishmana Park contents (area, evaluation, irrigation system and type of all ornamental plants).

Total Area (m²)	8865
Green Area (m²)	7934
Evaluation Of The Garden	62
Irrigation System	Sprinkle
Types of ornamental plant	
Trees	
Platanus orientalis	60
Cupressus sempervirens	36
Shrubs	
Buxus sempervirena	445
Jasminum officinal	52
perennials plant	
Rosa spp	560
Lawns	Mixed
Total Plants	1153

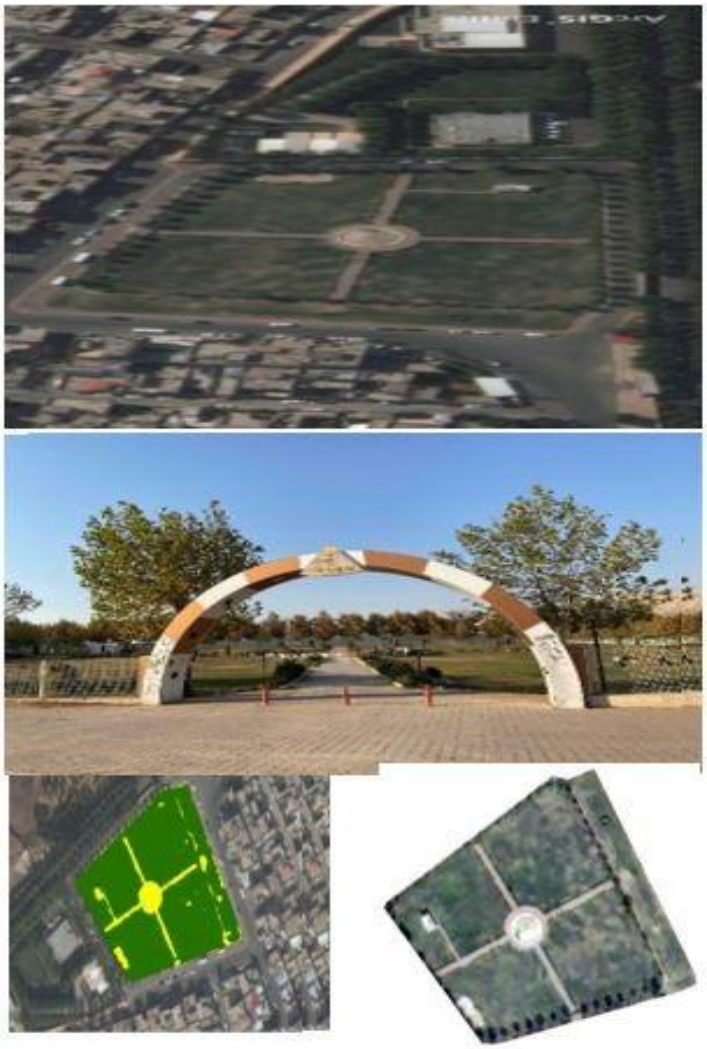

Figure (7) contents (Drone images, photographs and analytics images from GIS program to extract green area.).

5- Alin Park

Data in table (6) and figure number (8) clarified that the total area of this park (7494) m^2, 6846 m^2 of this area are green area and the total ornamental plants reached (962) plants, the evaluation of this park was about 75.5 degrees (sensory evaluation). Sprinkler irrigation was used in this location and cool season grasses mixture were grown in it. Two kinds of trees were planted the largest number was *Robinia pseudoacaia* that reach 43 tree then *cupressus sempervirens* (12) tree. Six species of shrubs were found in it the largest number was *Buxus sempervirena* (112) shrub, the second was *Pittosporum tobira* (72) shrub while the less number *Hibscus rosa sinensis* that reached only 2 shrub. Little perennial plant were planted in this location such as *rose spp*. (615) plant.

Table (6). Alin Park contents (area,evaluation,irrigationsystem and type of all ornamental plants)

Total Area (m^2)	7494
Green Area (m^2)	6846
Evaluation of the garden	75.5
Irrigation System	Sprinkle
Types of ornamental plant	
Trees	
Robinia pseudoacaia	43
Cupressus sempervirens	12
Shrub	
Buxus sempervirena	112
Pittosporum tobira	72
Ligustrum japonicum	44
Pyracatha coccina	30
Thuja orientalis	9
Hibscus rosa sinensis	2
Perennials plant	
Rosa spp	615
Lawns	*Mixed*
Total Plants	962

Figure (8) Satellite images, photographs and analytics images from GIS program to extract green area.

6- Buhar city Park

Data in table (7) and figure number (9) showed that the total area of this park (11868) m^2, the green area reach 8083 m^2 and the total ornamental plants reached (830) plants, the evaluation of this park is reached (66.4) degree (sensory evaluation). Sprinkler irrigation was used in this location and cool season grasses mixture were grown in it. One kind of trees was planted *Robinia pseudoacaia* that reached (38) tree. Sex species of shrubs were grown in it the largest number was *Buxus sempervirena* (64) shrubs whereas the second was *Ligustrum japonicum* (46) shrub, the less number *Lagerstroemia indica* that reached (6) shrubs only. A few perennial plant was planted in this location such as *Rose spp*. (616).

Table (7). Buhar Park contents (area, evaluation, irrigation system and type of all ornamental plants).

Total Area (m^2)	11868
Green Area (m^2)	8083
Evaluation of the garden	66.4
Irrigation System	Sprinkle
Types of ornamental plant	
Trees	
Robinia pseudoacaia	38
Shrubs	
Buxus sempervirena	64
Ligustrum japonicum	46
Pittosporum tobira	29
Pyracatha coccina	17
Callistemon floribunda	14
Lagerstroemia indica	6
perennials plant	
Rosa spp	616
Lawns	Bermuda
Total Plants	830

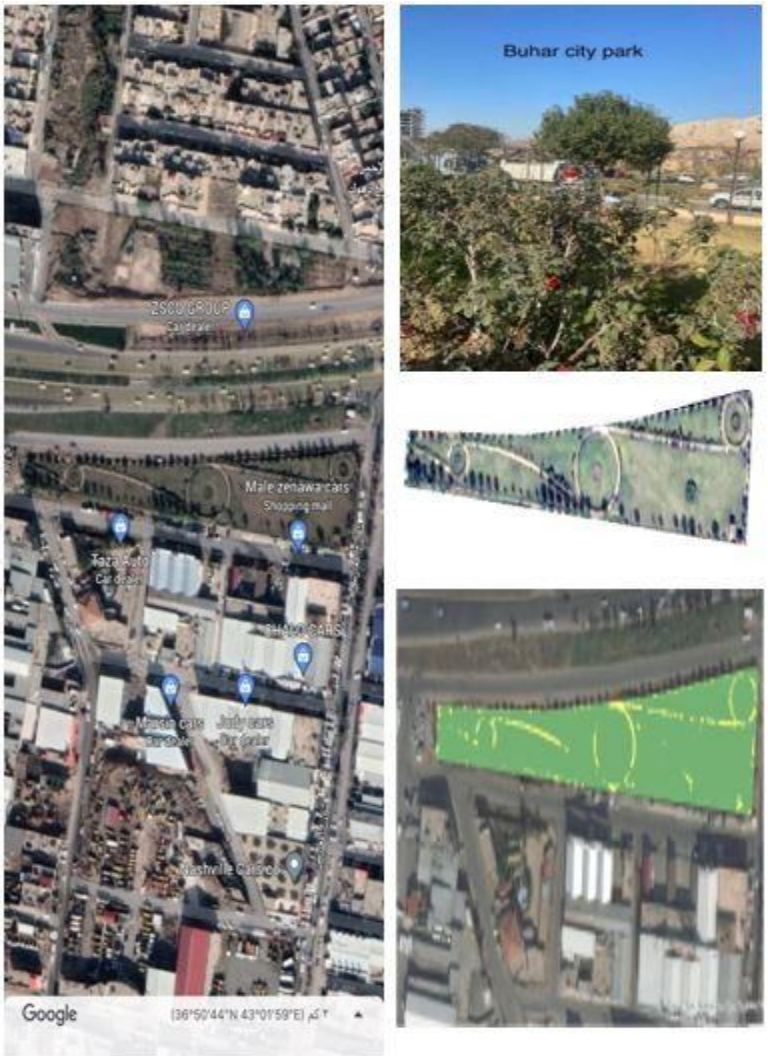

Figure (9) Satellite images, photographs and analytics images from GIS program to extract green area.

7- Nawroz Park

Total area of this park reached 12418 m^2 as shown in table (8) and figure number (10), 2161 m^2 of are green area and the total ornamental plants that planted in it reached 378 plants, the evaluation of this park reaches 55.2 degree (sensory evaluation). Sprinkler irrigation was used in this location and cool season grasses mixture were planted in it. Three kind of trees were planted the largest number was *Platanus orientalis* that reached 51 tree then *Melia azedrach* (50) tree, whereas the less number was *Salix safsaf* (8) tree. Five species of shrubs were found in it the largest number was *photinia fraseri* (150) shrub the second was *Duranta erecta* (66) shrubs while the less number was *pyracatha coccina* that reach (2) shrub only. Many perennial plant (small shrubs) were planted in this location such as *Berberis Vulgaris* (20) and *rose spp* (18) plant.

Table (8) Nawroz Park contents (area, evaluation, irrigation system and type of all ornamental plants).

Total Area (m^2)	12418
Green Area (m^2)	2161
Evaluation of the Garden	55.2
Irrigation System	Sprinkle
Type of ornamental plant	
Trees	
Platanus orientalis	51
Melia azedrach	50
Salix safsaf	8
Shrubs	
Photinia fraseri	150
Duranta erecta	66
Jasminum officinal	8
Buxus sempervirena	3
pyracatha coccina	2
perennials plant	
Berberis Vulgaris	20
Rosa spp	18
Lawns	Mixed
Total Plants	376

Figure (10) Satellite images, photographs and analytics images from GIS program to extract green area.

8-Tahsin Taha Park

The total area of this park was 31620 m^2 as shown in table (9) and figure number (11), 19791 m^2 of this area were green area and the total ornamental plants reached 7869 plants, the degree of its evaluation reached (73) mark. Sprinkler irrigation was used in this location and cool season grasses mixture were planted in it. Three types of trees were planted in this park the largest number reached (24) tree was *Washingtonia filifera* then *Morus alba var.pendula* that reached (14) tree, whereas the less number was *Pinus spp* (11) tree. Seven species of shrubs were found in it the largest number was *Dodonaea viscesa* (3500) shrub then *pittosporum tobira* (193) shrub whereas the less number was *Duranta erecta* that reached (6) shrub. Many perennial plant (small shrubs) were planted in this location such as *Rose spp* (3208) plant and *Berberis Vulgaris* (550) plant.

Table (9). Tahsin Taha Park contents (area, evaluation, irrigation system and type of all ornamental plants).

Total Area (m^2)	31620
Green Area (m^2)	19791
Evaluation of the garden	73
Irrigation System	Sprinkle
Types of ornamental plant	
Trees	
Washingtonia filifera	24
MOrus alba var.pendula	14
Pinus spp	11
Shrubs	
Dodonaea viscesa	3500
pittosporum tobira	193
Photinia fraseri	164
Ligustrum japonicum	110
Parthenocissus triuspidata	75
Jacaranda ovalifolia	14
Duranta erecta	6
Perennials plant	
Rosa spp	3208
Berberis Vulgaris	550
Lawns	Mixed
Total Plants	7869

Figure (11) Satellite images, photographs and analytics images from GIS program to extract green area.

9- Dilshad .M said Park

Data in table (10) and figure number (12) clarified that the total area of this park (32448) m^2, 29289 m^2 of this area was green area and the total ornamental plants reached 2425 plants, the evaluation of green space of this park was (76) mark. Sprinkler irrigation was used in this location and cool season grasses mixture were planted in it. Five kind of trees were planted the largest number that reached (164) tree was *Melia azedrach* then *Thuja orientalis* (98) tree, whereas the less number was *Parthenocissus triuspidata* (20) tree. Nine species of shrubs were found in it the largest number was *Buxus sempervirena* (193) shrub, the second was *Ligustrum japonicum* (167) shrub, while the less number *Parthenocissus triuspidata* that reached (6) plant. Many perennial plant were planted in this location such as *rose spp* (1191) plant and *Berberis Vulgaris* (226) plant.

Table (10). Dilshad .M said Park contents (area, evaluation, irrigation system and type of all ornamental plants).	
Total Area (m²)	32448
Green Area (m²)	29289
Evaluation of the garden	76
Irrigation System	sprinkle
Types of ornamental plant	
Trees	
Melia azedrach	164
Thuja orientalis	98
Robinia pseudoacaia	87
Arizona Cypress	21
Washingtonia filifera	21
Shrubs	
Buxus sempervirena	193
Ligustrum japonicum	167
Jasminum gradiflorum	116
Thuja orientalis	98
Dodonaea viscesa	60
Callistemon floribunda	35
pittosporum tobira	25
Lagerstroemia indica	15
Parthenocissus triuspidata	6
perennials plant	
Rosa spp	1191
Berberis Vulgaris	226
Lawns	Bermuda
Total Plants	2425

Figure (12) Satellite images, photographs and analytics images from GIS program to extract green area.

10- All Parks in Duhok city

Nine parks in Duhok city (Alin, Barzani, Buhar, Azadi, Bekhal, Kani Xishmana, Tahsen Taha, Nawroz and Dilshad M. Said). The total area of these parks were 217318 m^2, 71.66% of this area was green area whereas the 28.44% were roads building and non-green garden elements with evaluation degree between 55.2 for Nawroz to 86.6 for Azadi park (from 100 mark), the system irrigation is sprinkle for all parks. The largest area was Barzani Park with 55879 m^2 whereas the smallest area was Alin (7494) m^2. The total number of plants are (7280) plants, 2254 of them include many kind of tree, the highest number was *cupressus sempervirens* (428) tree then *Robinia pseudoacaia* (338) whereas

Table (11). All Park contents (area, evaluation, irrigation system and type of all ornamental plants)

PARKS	Barzani	Azadi	Bekhal	Kani Xishmana	Alin	Buhar City	Nawroz	Tahsen Taha	Dilshad .M Said	Total Area
Total AREA(M²)	55879	45726	11000	8865	7494	11868	12418	31620	32448	217318
Green Area(M²)	38061	34065	9502	7934	6846	8083	2162	19791	29289	155733
Evaluation Of The Garden	75.2	86.6	67.4	62	75.5	66.4	55.2	73	76	
Irrigation System	sprinkle	sprinkle	sprinkle	sprinkle	sprinkle	sprinkle	sprinkle	sprinkle	sprinkle	
Types of ornamental plant										
Trees										
cupressus sempervirens	31	17	332	36	12					428
Robinia pseudoacaia	18	144	8		43	38			87	338
Platanus orientalis	46	90	36	60			51			283
Melia azedrach	3	13					50		164	230
Pinus spp	193							11		204
Fraxinus exceisior	77	117								194
Arizona Cypress	39	129							21	189
Bauhinina varigata	148									148
Washingtonia filifera	34	14	17					24	21	110
Morus alba var.pendula	14							14		28
pissardi plum	14	14								28

olea europaea	22									22
Salix safsaf			11				8			19
Catalpa speciosa		18								18
magnolia grandiflora	2	7								9
Acer negundo	6									6
Total trees										2254
Shrubs										
Dodonaea viscesa			76					3500	60	3636
Buxus sempervirena		68	56	445	112	64	3		193	941
photinia fraseri	196	175	5				150	164		690
Ligustrum japonicum	79	102	22		44	46		110	167	570
pittosporum tobira					72	29		193	25	319
pyracatha coccina	33	150			30	17	2			232
Thuja orientalis	38	83			9				98	228
Ligustrum vulgare	79	101								180
Jasminum gradiflorum		7							116	123
Lagerstroemia indica	40	28	21			6			15	110
callistemon floribunda			22		23	14			35	94
Duranta erecata							66	6		72
syzygium aqueum	16	11								27
Granatum nana	16	8								24
Hibscus rosa sinensis		18			2					20
Jacaranda ovalifolia								14		14
Total shrubs										7280
Climbers										
jasminum officinal	87			52			8			147
Parthenocissus triuspidata		38						75	6	119
Total climbers										266
Perennials plant										
Rosa spp	85	393		560	615	616	18	3208	1191	6686
Berberis Vulgaris							20	550	226	796
Total perennials plant										7482
Others										
cyperus papyrus	15									15

Lawns	1331	1745	606	1153	962	830	376	7869	2425	17297
Bermuda grass						1			1	
Mixed(cool season grasses)	2	2	2	2	2		2	2		

the less one was *Acer negundo* just have (6) trees.The total number of shrubs are (7280) which distributed in many types and area the kinds and highest number of shrubs are *Dodonaea viscesa* which reached (3636) decreasing to *Buxus sempervirenaare* (941) until reach the less one which are *Jacaranda ovalifolia* just have (14) shrubs. The total numbers of climbers are (266) plant, divided in to two types. *Parthenocissus triuspidata* just have founded in both Tahsen Tahaand, Azadi and Dilshad .M Said about (75, 38, 6) and *Jasminum gradiflorum* have little founded in Barzani, Kani Xishmana and Nawroz as (87, 52, 8).The Total number of perennials plant are (7482).The highest number was *Rosa spp* which reached (6686) and *Berberis Vulgaris* (796) plant.

11- Per capita share from the green areas (parks only) and compared with some country or city in the world by use the International Standard criteria (1). By knowing the total green area in the nine parks in Duhok city (217318) m^2 which clarified in table (11) and the number of population approximately (405634) persons (Duhok Statistics Department, 2021), and by dividing the total green area of the nine Parks on the number of persons we found that 0.536 m^2 per person is the percentage for each person in this city and when compared this percentage with some city per capita share (table 12) we found that this figure was less than the least city which that Damascus (0.7) m^2 per person and far away from Vienna city that reach (124.6) m^2 per person.

Table (12). Per capita share of green spaces in the cities of developed and non- developing countries (13).

Developed countries		Non-developing countries.	
City	Per capita share of green space, m^2 per person	City	Per capita share of green space, m^2 per person
Rome	23.5	Cairo	1.5
Brussels	29.2	Damascus	0.7
Copenhagen	35	Dubai	13.1
Glasgow	55.6	Manama	2.5
Vienna	124.6	Baghdad	1

Conclusion

The numbers and the total area of Parks in Dohuk city is very little, so the Per capita share was only 0.536 m^2 per person compared with some cities (table 12), we note that the range of the service and the green areas do not cover all the neighborhoods of the city. Most public parks do not perform their purpose and function for there are no essential elements in the garden, so it is considered as a green space only. Irregular distribution of plants (the right plant in the right place) led to the creation of a kind of crowding, especially in public parks. Lack of importance and maintenance of children's playgrounds in parks, and their complete absence in public parks. So, we recommend the responsible in this city to giving the green spaces the same importance that is given to buildings during planning and increase the number and the areas of parks and distribute them in many deferent locations in the city. Cultivation of plants that tolerate the conditions of the region according to the results of Iraqi research, which classifies the types of plants that tolerate the northern regions, in addition to the new tolerant types.

References

1. Abo-Saad, H.J., and B.A. Badr.2003. Fundamental of design plant coverage in outdoor. The Emirates Journal for Engineering Researches, 21-1(2):8. (http://www.momra.gov.sa).

2. Al-Dulaimi, K.H.2002.Community Services and Infrastructure Planning (Foundations - Standards – Techniques). Dar Safaa for Publishing and Distribution. Amman, Jordan, pp.1.

3. Anonymous.1996. Enhancing Our Environment through Landscaping", Virginia Cooperative Extension, http://www.ext.vt.edu/ departments/ envirohort/ articles/lawns and landscaping/enhance.

4. Anonymous 2002. Trees Save San Antonio Millions Each Year. Florida Arborist 6 (1): 1, 6 (spring).

5. Anonymous 2003. Washington State Nursery and Landscape Association. USA.

6. Barton, S.2009. Human Benefits of Green Spaces, Sustainable Landscape Series. University of Delaware.

7. Bel, E., A. I Akov; M. Swiąder and Bartyna-Zieli, N. M.2019.The green infrastructure in cities as a tool for climate change adaptation and mitigation: slovakian and polish experiences. Atmosphere 10 (9): 552.

8. Byrne, J., and J. Wolch 2009. Nature, race, and parks: past research and future directions for geographic research. Progress in human geography, 33 (6):743-765.

9. Clark, P and J. Jauhiainen.2006. Introduction in the European city and green space: London, Stockholm, Helsinki and St. Petersburg, 1850-2000., ed. P. Clark, 1-29. England: Ashgate Publishing Ltd. (C.F. C. M. Sutton (2008). Urban open space: A case Study of Msunduzi Municipality, South Africa, a thesis submitted to the School of Environmental Studies in conformity with the requirements for the degree of Master. Environmental Studies Queen. University Kingston, Ontario, Canada.

10. Dou, Y.; L. Zhen; R. De Groot; B. Du and Yu, X 2017. Assessing the importance of cultural ecosystem services in urban areas of Beijing municipality. Ecosystem. Serv. 24: 79–90.

11. Frank, M.S 2003. The Benefits of Plants and Landscaping Addendum. Geographical perspective, Landscape and Urban Planning, 986: 1 - 12.

12. Hall, R 2003. Design Center for American Urban Landscape, Minneapolis, MN 55455, Design Center, www.designcenter.umn.edu.

13. Jihad M.2012. Foundations of planning and design of green spaces in cities, a study case of a city Gaza, Al-Azhar University. Egypt. pp. 98

14. Kronenberg, J. A.; A. Pietrzyk-Kaszynska; A. Zbieg and Zak, B.2016. Wasting collaboration potential: A study in urban green space governance in a post–transition country. Environ Sci. Policy., 62: 69–78.

15. Kuo, F.; W.C Sullivan; R.L. Coley and Brunson, L.1998. Fertile ground for community: Inner-City neighborhood common spaces. American Journal of Community Psychology, 26(6):823-851. http://www.herl.uiuc.edu/Neighbors.ht.

16. Marilyn K.A. and P.P DeVeer.1999. Text Book, Stewards of the Land: A Survey of Landscape Architecture and Design in America, published by the National Council of State Garden Clubs, Inc. (now National Garden Clubs, Inc.) St. Louis, Missouri, 1999. See p. 111 and Chapter 30, "Guidelines for Evaluating Landscape Design," pp. 230-235. 20.jihad meme. The foundations of planning and designing green spaces in cities, a city case study Gaza, Al-Azhar University. Egypt. pp. 98.

17. Monteiro, J.A.2017. Ecosystem services from turf grass landscapes. Urban For. Urban Green, 26:151–157.

18. Sutton, M.R 2008. Urban open space: a case study of Mundus, I Municipality, South Africa, a thesis submitted to the school of environmental studies in conformity with the requirements for the degree of Master. Environmental studies Queens University Kingston, Ontario, Canada.

19. Vandermel J. 2020. Tree planting and negative emissions. Home about new sevents projects blog.

20. Wagner, J. 2003. Urban forestry: Making a global difference". International Society of Arboriculture Arborist News, 12(2):26-28..

21. Yeang, L.; D. Pike; O. M Durney and Zero, G.2008. Urban Design Manual a best practice guide, a companion document to the Draft Planning Guidelines on Sustainable Residential Development in Urban Areas Department of Environment, Heritage and Local Government. http://www.designforhomes.org/