Employing geospatial techniques in analyzing climate and soil elements to benefit them in the redesigning of Baqubah Central Park

Nadhar Adnan Miteb Raad W Al-Zuhairi

Department of Horticulture College of Agriculture University of Diyala,
Department of Horticulture College of Agriculture University of Diyala,32001, Baaqubah Diyala, Iraq , ,32001 , Baaqubah, Diyala, Iraq
nidarad39@gmail.com
raadalzuhairi@uodiyala.edu.iq

Abstract

A field study was conducted for the period from January 11, 2023 to January 11, 2024, using remote sensing techniques, spatial analysis, and field survey of the central park site that the local government in Diyala Governorate intends to establish. This site is located 5 km from the Diyala River and 4 km east of The city of Baqubah Which rises about 46 m above sea level , The park's area is 50 dunums. its longitude and latitude are 33.7596413, 44.6066578. Diyala Governorate Center: This study aimed to provide accurate information about climate elements and soil analysis for the study site. The main goal was to produce a design proposal for the park that simulates the data collected and analyzed. The most important findings of this study: The percentage of salts in the soil was fairly high, calcium carbonate salts prevailed, and the site's land was dry. It is arid most of the time of the year, and thermal hotspots spread on the soil surface. As for climate elements, temperature fluctuations varied between the four seasons, between a high altitude in summer and a moderate decrease in winter. Likewise, evaporation humidity decreased during the summer and relatively increased in the fall and winter. In the spring, the humidity and the amount of rainfall have priority over For the rest of the year, a smart design was proposed for the central park that can be described as sustainable in terms of choosing local tree species, identifying places for collecting water and reusing it again, and providing an entertainment atmosphere for the city's residents.

Keywords: Sustainable landscape remote sensing,. Sustainable parks

Introduction:

The environmental development of a modern urban area depends on the basic tools of urban sustainable development, which are reflected in developing the needs of the area while preserving the environment without compromising the needs of future generations [1]. Urban parks, as an important part of the urban green space system, have an important role in improving the ecological environment. , promoting urban economic development, enhancing people's daily living standards, and spatial planning and the number of urban parks effectively affect the development of recreational activities for urban residents [2]. The use of GIS is one of the most important methods used to identify and analyze sites, and parks are essential elements of sustainable urban landscapes that help the environment, society, and economy of cities [3]. The concept of sustainable development combines social progress, environmental conservation and economic success. Sustainable development of a region refers to development that ensures that the demand of the population is met without affecting the ability of the next generation [4]. The importance of

ISSN 2072-3857

sustainability in all aspects of our lives is increasing, and in this context, studies and investigations on the role and application of landscape sustainability standards take on special importance when considering the establishment of central parks in cities [5]. Remote sensing is one of the important technologies and matters through which features can be distinguished. Earth through the spectral reflectivity of the Earth's surface, where there is an overlap between the properties of the land and soil and the reflectivity values, and that is the spectral reflectivity curves of land covers and the characteristics of the surface materials of the Earth. The use of geospatial techniques is considered one of the easiest and fastest techniques in modeling climate elements and soil elements in cities and parks, as well as analyzing and interpreting them to help Decision makers in making the right decision [6]. In research [7] on establishing renewable energy plants using wind and sun using geospatial technologies. The researcher modeled the site suitability maps obtained in Kenya from land that is highly suitable and not permanently suitable for the establishment of solar and wind energy systems. The results also indicate that developing solar, wind, diesel and battery energy systems is the best sustainable solution to supply the studied region compared to other possible alternatives. In Singapore, population expansion has led to an increase in demand for converting natural spaces into housing, as hotspots of heat in general and humidity were documented in two large green areas. The results indicated that green areas led to cooling not only in the plant areas, but also in the surrounding built environments [8]. Types of plants in many climate-related functions, as green spaces can improve air quality, as plants absorb carbon dioxide through the process of photosynthesis and increase humidity through a combination of water evaporation from the Earth's surfaces and transpiration, the discharge of water from plant leaves. The more green spaces. The more rainwater is absorbed and utilized [9]. With the increase in urbanization, the United Nations expected (according to the United Nations Document 2019) that about 68% of people will live on Earth in urban areas, and this percentage calls for danger, and this increase is expected to occur until the year 2050. Therefore Maps and the use of modern technologies in determining climate are important elements for determining the best places to create sustainable parks [10]. Remote sensing is one of the necessary and important technologies. We distinguish the features of the earth through the spectral reflectivity of the surface of the earth and the soil. Therefore, the spectral reflectivity of land covers is considered the result of their physical and chemical properties. For surface materials of the Earth [11]. Usually, the temperature of city centers is higher than the temperature of the surrounding areas, and the temperature of green areas is lower than both, and because of the presence of green areas, they work to cool. This is called the vegetative heat island condition, and this difference in temperatures has been observed to rise in heat islands inside parks at different times in Different seasons and different times during the day. In different seasons, geospatial technologies are used to measure temperature, humidity, and the amount of rain to identify the most important hotspots and address their condition.[12[

Study problem: Lack of site data and analysis of soil and climate at the study site

Objective of the study: 1) Create an advanced database to analyze the location of the central

ISSN 2072-3857

park of the city of Baqubah, which can be consulted at any time

(2 Make the right decisions regarding land use within the park

(3 Use the information portal to clarify the infrastructure and analyze climate and environmental data for the region.

(4Modeling of temperature maps, evaporation values, and spatial analysis of humidity elements for the four annual solstice, as well as rain maps for three decades from 1990 to 2023.

(5Work on planning and designing a central park in the city of Baqubah that is compatible with the environmental conditions of the city

Materials and methods

NASA's Giovanni information portal used accurate and scientifically sound information used in most geographical research to determine the geography of an area.

Data used

The data used are Giovanni (Giovanni Interactive Online Visualization and Analysis Infrastructure) is a NASA data portal that allows users to access a wide range of climate and environmental data. Data from multiple space missions and sensors such as NASA satellites and partner agencies. Available data include many types such as temperature, precipitation, humidity, soil, air quality, and others. Data from the European Centre for Medium-Range Weather Forecasts (ERA5) reanalysis project was also used to provide a deep understanding of the climate factors in the studied region and the seasonal average of climate inversions (summer, spring, autumn, and winter solstices). ERA5 provides comprehensive and accurate data on climate variables such as air temperature, humidity, wind speed and direction, and thermal radiation. These data, collected in NetCDF files for each day from 1997 to 2023, cover the geography at a resolution of 0.25° x 0.25°, providing high-quality details about the geographic data of the studied area. These detailed and accurate data allow for in-depth analysis of environmental and climatic changes in the region over the two decades, providing a solid basis for assessing how these changes have affected the environment of the study area. The use of such accurate data enhances the validity of the conclusions and recommendations resulting from the study, contributing to the development of effective and sustainable strategies for addressing environmental issues and decision-making.

Spatial analysis

Spatial analysis is the study and examination of entities by evaluating and modelling their features, including locations, properties, and relationships that reveal the geometric or geographic characteristics of the data. Spatial analysis uses a variety of computational models, analytical techniques, and algorithms to assimilate geographic information and determine its suitability for specific objectives. Spatial analysis provides important insights from spatial data, which reflects a numerical representation of any physical entity in a geographic coordinate system. Spatial data is classified into two basic types: geometric and geographic, which represent the latitude and longitude of an entity or location. Georeferencing and geocoding are vital aspects of geospatial analysis. Georeferencing models the Earth’s surface by assigning data coordinates to vectors or raster data. Spatial analysis allows these steps to be used to analyse and aggregate data in order to solve complex problems. It transforms raw data into valuable insights, revolutionizing decision-making across industries. By providing context-rich, visually compelling information,

organizations can make informed decisions and optimize resource allocation. Results from programs like ArcMap are used to predict the occurrence of similar future events and phenomena, making it easier for professionals to prepare and provide appropriate solutions to address their effects. The prediction feature allows for greater accuracy and clarity, as the scientific approach can be used to analyse data in ways that enable researchers to predict many future phenomena, in terms of their timing, rates, strength, or weakness.

In addition to the above, some equations specific to spatial analysis in GIS can be used to analyse data accurately, the performance of the interpolator can be summarized by computing the root-mean of squared residuals (RMSE) from the errors as follows:

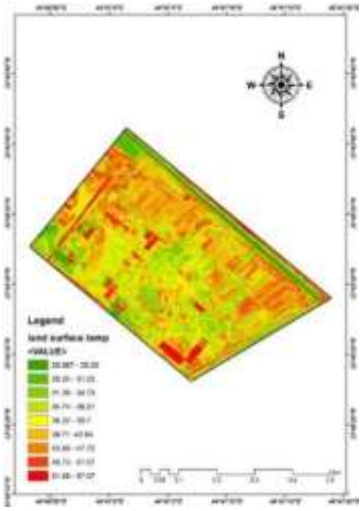
$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(\hat{Z}_i - Z_i)^2}{n}}$$

where ^ZiZi^ is the interpolated value at the unsampled location i (i.e. location where the sample point was removed), ZiZi is the true value at location i and nn is the number of points in the dataset. The second order surface polynomial (aka quadratic polynomial) is a parabolic surface whose formula is given by :

$$Z = a + bX + cY + dX^2 + eY^2 + fXY$$

we can compute their difference ($\gamma\gamma$) as follows

$$\gamma = \frac{(Z_2 - Z_1)^2}{2} = \frac{(-1.2 - (1.6))^2}{2} = 3.92$$



We can compute $\gamma\gamma$ for all point pairs then plot these values as a function of the distances that separate these points

Results and discussion

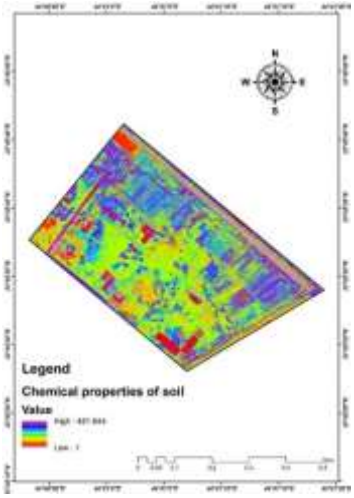
Soil analysis of the study site

Soil analysis data for the study site show that the land designated for the park is barren land and does not have any vegetation cover, and the thermal hotspots are distributed on the outskirts of the place, as shown in Figure No. (1), and it was characterized by a difference of 6.25 - 80.51. This picture was taken in

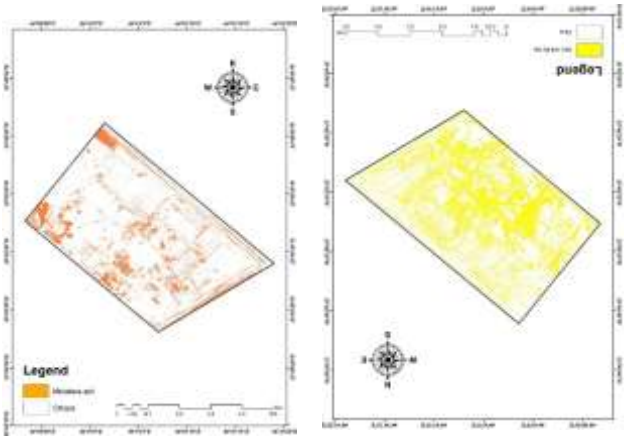
Figure showing soil surface temperature (1(

ISSN 2072-3857

It was planted in Figure No. (2), which indicates that through analyzing the soil of the study site, we notice that the high percentage of calcium salts, calcium carbonate, sodium carbonate, and a small amount of potassium carbonate, and this is evidence that the park's soil is salty and basic and needs to be repaired before establishing the park.



It is also noted from Figures (3 and 4) that the percentage of humidity is very low or almost non-existent, and it is almost crusty and dry except in some places.



Except at 2.5 km between one point and another

I took 4 readings of the average temperature on a date and were determined on the date of the annual elections (21-3, 21-6, 21-9, 21-12), which is applicable globally.

Where 4 maps are modeled with average temperatures, as can be seen from the figures (5) (6) (7) (8(

The study site is under the influence of high temperatures in the four seasons compared to its neighbors, although there are hotspots with higher temperatures, but they are mostly far from the study site.

Analysis of climate elements

The climatic elements at the study site were modeled in the form of maps that took the average temperature for the last 30 years from the Euro 5 satellite from the European Center for Climate Change for the climate at an altitude of 2 meters. The average distance between point and point is 2500 meters for the study area and what surrounds it, because the variation in the air mass does not appear.

First: winter transfer temperatures

The results of the figure () degree of winter solstice show that the average temperature in the study site is 15.69 - 16.16, while it is noted that the area adjacent to the park area has lower temperatures, reaching up to 14.7. This indicator reflects the extent to which the study site is affected by changing temperatures and is affected by the neighborhoods, especially

since it is located on a public road. Thousands of vehicles pass through it every day, causing the emission of gases and engine combustion heat

Second: Spring solstice temperatures

It appears from the figure that the park site is exposed to higher temperatures compared to the nearby neighbourhood. There are multiple reasons that may be the reason for the rise in temperatures, including human activity and transportation traffic adjacent to the site, and that the land designated for the project is barren land with no vegetation cover and the salts prevailing in the soil and weakness. Vegetation cover in and around the study area as a whole

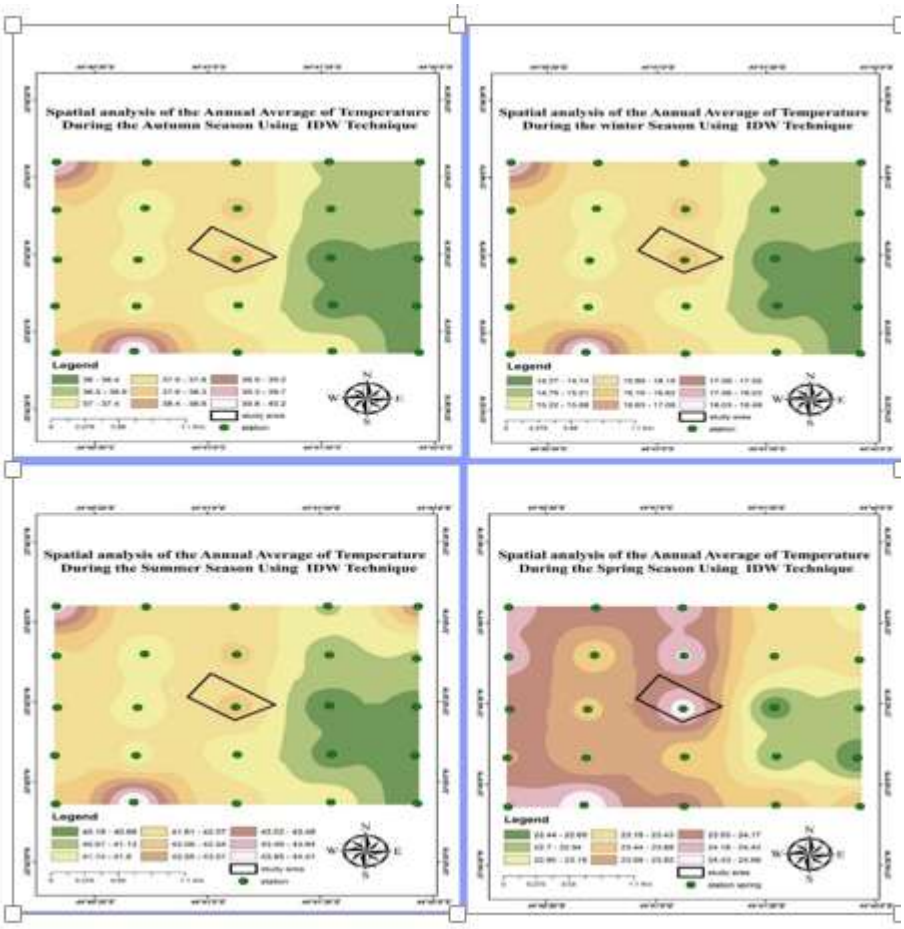
Third: degrees of the summer solstice

Despite the high average temperatures measured in the study area in general, the distribution of high thermal hotspots was outside the study area and far from it, while the average temperature in the study area was 41.6.

Fourth: The annual autumn temperature solstice

At the autumn solstice, temperature distribution behavior is observed to be very similar to the summer solstice, unlike what is found at the spring and winter solstice.

That is, there is stability in the distribution of temperatures during the summer and fall seasons. These indicators are very important and influential in choosing the type of trees and the afforestation style, because the moderate behavior of temperatures helps in

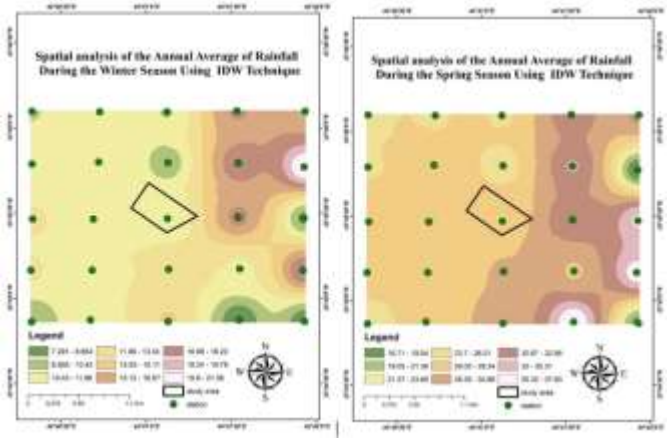


choosing heat-tolerant plants during the fall.

Modeling rainfall maps in the study area

The results of Figure No. (9) show that the rate of rainfall in the study area and its surroundings is relatively low, starting from a value of 7.29 to the highest value of 21.3 mm annually for the average of the last 30 years, according to the European Center for Climate Change and collecting information from stations spread over a distance of 2500 km between One station and another, and the average rainfall ranges from 11.98 to 10.43 mm annually. These values are in the winter season.

While in Figure (10), the rate of rain fall in the spring season gave relatively higher rates than the winter solstice map, if the amount of rain falling ranged from 16.71 mm to 37.63 mm, and the rate of rain fall in the study area was 23.7 to 26.01 mm, meaning that the cumulative values of the winter solstice and solstice In spring, the cumulative value of rain ranges between 36 to 31 mm. This indicator is very important for the process of selecting known shrub species and the known amount of supplementary irrigation that achieves water sustainability. A policy of supplementing irrigation, calculating water consumption for all planted shrub species, and maintaining water storage must be followed, especially in the spring season. Surplus



Modeling of site evaporation maps throughout the park's surroundings, with the highest and lowest value reaching 127 - 131 for the spring solstice.

The results of the spatial analysis of water evaporation at the four annual solstices are shown in Figures (11) (12) (13) (14(

The results of the four annual evaporation inversions show that the highest evaporation values are in the fall season if the evaporation value at the study site reaches 160, while the lowest evaporation value in the vicinity of the park is 159 and the highest value is 162.

The evaporation values at the spring solstice reached 128.7 - 129, which were close

While winter evaporation values:

The lowest evaporation rates were observed in the winter and summer solstices, where the evaporation value in the winter solstices for the study site was 60, while the vicinity of the study site recorded the lowest 58.8 and the highest evaporation value was 63.09.

As for the lowest values, they were recorded at the summer solstice if the value of evaporation

ISSN 2072-3857

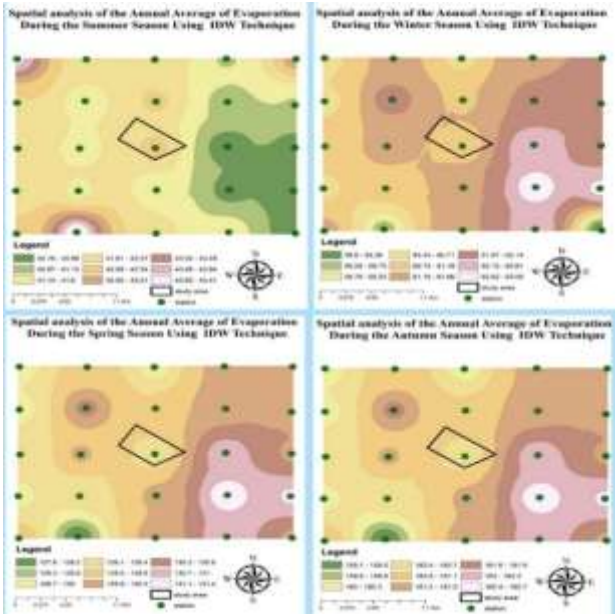
in the summer was 41.61. The neighborhoods of the site according to the summer form recorded the lowest value at 40.19 and the highest value at 44.41.

It is noted from the results of evaporation for the four solstices that the autumn solstices have the highest and best results for evaporation, then the spring solstices. This is the result of moderate temperatures and an abundance of water, as in the spring the amount of rain falls is large, and in the fall the amount of water is available in rivers and lakes as a result of there being no need for it for irrigation at the end of the season. Agricultural

The water content is high in the plant and the environment is high with an abundance of water and as the day turns, high and large evaporation occurs from the surface of the soil and the surface of the leaves, especially since the study site is surrounded by palm and fruit orchards on the Khresan River and Khresan River sides, as well as the nearby agricultural areas, so an evaporation process occurs from the soil surface as well. Nearby streams, rivers, and marshes have high levels of evaporation

During the winter season, despite the drop in temperatures, the rate of evaporation decreases as a result of the drop in temperature and the drop in water content in streams and rivers, unlike the summer solstice, in which temperatures rise very significantly, and evaporation is rapid during the day and even at night, and the soil does not retain water content, which helps in continuous evaporation.

These differences in evaporation are an important factor in understanding the changing behavior of climate elements in the study area. Therefore, a great effort must be directed to maintenance, irrigation, and tree care during the summer season and even in the winter season, using modern irrigation techniques such as drip irrigation, sprinkler irrigation, and the use of sprinklers to raise the relative humidity when it decreases. To critical levels and provide irrigation water



The results of the spatial analysis of the elements of relative humidity in the air for the study site are shown for the four annual solstices

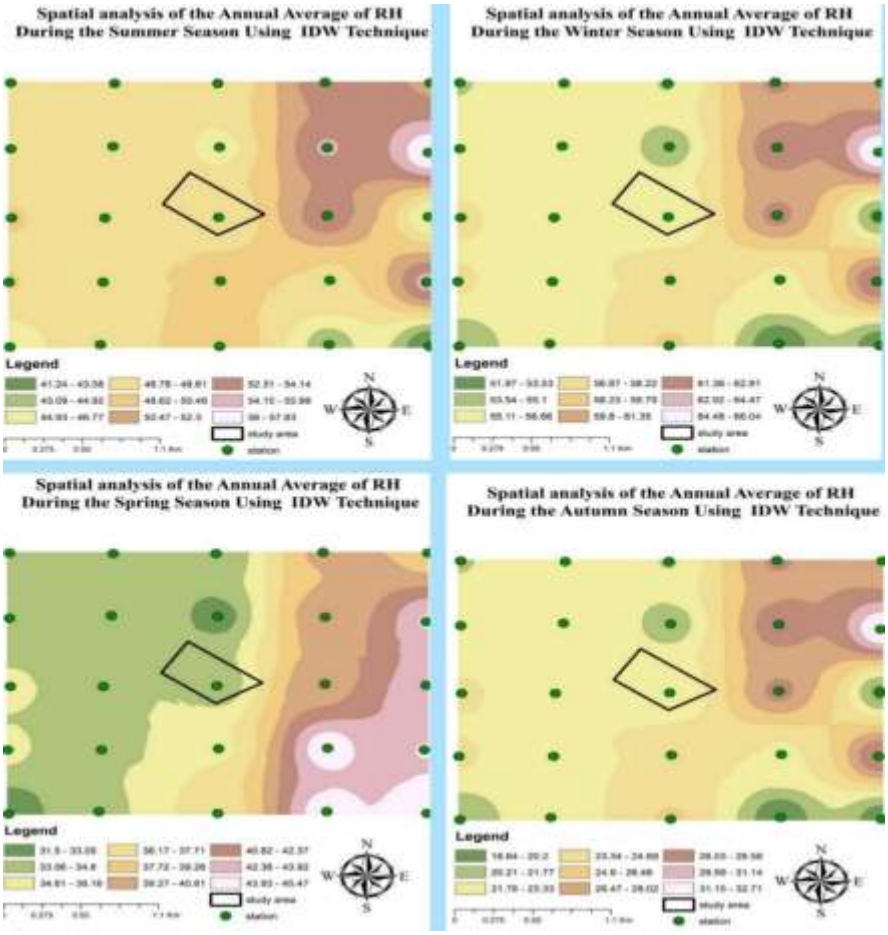
The results of modeling the cumulative relative humidity maps and their environs for the past three decades show that the relative humidity rates vary in value according to the annual solstices. The annual winter solstices are the highest among the solstices than the rest of the other rates from the study site, as in the figure the average humidity at the study site is 56.06, although it is lower in humidity. In the vicinity of the study site, it was 51.07, while the highest value was 66.4, while the summer solstice recorded second place in relative humidity, as the relative humidity of the study site reached from 46.78 to 48.61, followed by the annual spring solstice value, which recorded a humidity percentage of 33.06 to 34.6, and the lowest values in relative air humidity were in the autumn season. It reached 21.6 to 23.3

The high rates of air humidity are due to the low rates of temperature with rainfall, which causes the relative humidity to rise, while in the summer the relative humidity in the air rises because the site is located in an agricultural area and is close to swamps, marshes, and barracks, which causes

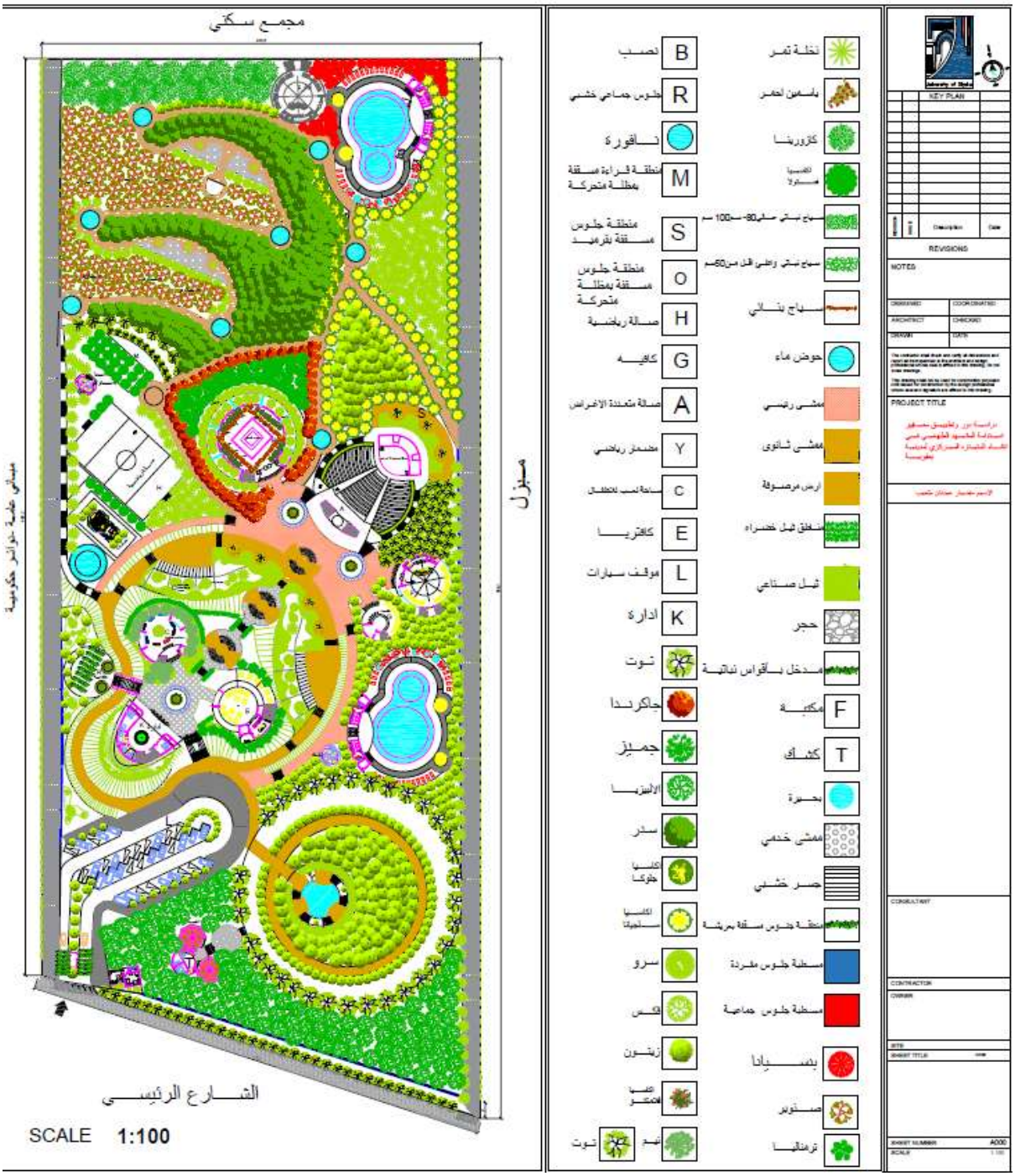
In high evaporation and high humidity, while it decreases in the moderate seasons, the indicator of the difference in relative humidity values gives us a complete picture of the study site, how to deal with it, and how to use the optimal method for agriculture and irrigation and achieve the best results.

The indicator of the difference in relative humidity values gives us a complete picture of the study site, how to deal with it, and how to use the optimal method for agriculture and irrigation and achieve the best results.

ISSN 2072-3857



ISSN 2072-3857



A figure showing the design of a proposal (the researcher's work(

Conclusion

- 1The park's land was barren, dry, and lacking in moisture in some few places

_2Thermal hotspots are distributed differently in the soil of the study site in barren areas and areas where salts such as calcium carbonate and potassium carbonate are widespread.

Recommendations

•We recommend adding amendments to the site's soil before starting the afforestation

ISSN 2072-3857

process, since the site's soil is basic and contains little organic matter, and adding manufactured organic fertilizers and agricultural sulfur to reduce the soil's pH.

•We recommend using a smart and regulated irrigation system since the site's soil is arid and dry and the temperatures are high

REFERENCE

[1] Y. Chen, Q. Weng, L. Tang, L. Wang, H. Xing, and Q. Liu, "Developing an intelligent cloud attention network to support global urban green spaces mapping," ISPRS J. Photogramm. Remote Sens., vol. 198, pp. 197–209, 2023, doi: https://doi.org/10.1016/j.isprsjprs.2023.03.005 .

[2] R. Myalkovsky, D. Plahtiy, P. Bezvikonnyi, O. Horodyska, and K. Nebaba, "Urban parks as an important component of environmental infrastructure: Biodiversity conservation and recreational opportunities," Ukr. J. For. Wood Sci., vol. 14, no. 4, pp. 57–72, 2023, doi: 10.31548/forest/4.2023.57.

[3] J. M. Park and Y. S. Hong, "POE research on the role and effect of landscape design supervision in the creation of large parks: Gwanggyo Lake Park," Int. Rev. Spat. Plan. Sustain. Dev., vol. 7, no. 4, pp. 4–17, 2019, doi: 10.14246/irspsd.7.4_4.

[4] S. H. Khahro, M. A. H. Talpur, M. G. Bhellar, G. Das, H. Shaikh, and B. Sultan, "GIS-Based Sustainable Accessibility Mapping of Urban Parks: Evidence from the Second Largest Settlement of Sindh, Pakistan," Sustain., vol. 15, no. 7, 2023, doi: 10.3390/su15076228.

[5] G. Chowdhury and S. Chowdhury, "Information and the Sustainable Development Goals," 2024, pp. 21–40. doi: 10.29085/9781783306688.003.

[6] "CHAPTER1_manuel.pdf ".

[7] M. R. Elkadeem, A. Younes, S. W. Sharshir, P. E. Campana, and S. Wang, "Sustainable siting and design optimization of hybrid renewable energy system: A geospatial multi-criteria analysis," Appl. Energy, vol. 295, p. 117071, 2021.

[8] Y. Chen and N. H. Wong, "Thermal benefits of city parks," Energy Build., vol. 38, no. 2, pp. 105–120, 2006, doi: 10.1016/j.enbuild.2005.04.003.

[9] A. Addas, "The importance of urban green spaces in the development of smart cities," Front. Environ. Sci., vol. 11, no. May, pp. 1–18, 2023, doi: 10.3389/fenvs.2023.1206372.

[10] N. Weng, C. Universiti, and N. W. Chan, "Chapter 1 Introduction to Sustainable Urban Development Program," no. October, 2016.

[11] R. W. Al-Zuhairi and S. N. Jasim, "Employment Geospatial Technologies in Landscape Sustaiability of Diyala Campus," Int. J. Agric. Stat. Sci., vol. 17, no. January, pp. 1451–1456, 2021.