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BIODIVERSITY STUDY OF THE SOUTHERN DESERT OF BASRAH GOVERNORATE, IRAQ

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Abstract

This study was conducted in the desert of southern Basra for the year 2021-2022 by selecting ten stations, namely Juwaibdah, Al-Haritha, Jabal Sanam, Khidr Al-May, Um-Qasr, Northern Rumaila, Al-Zariji, Qarmat Ali, Southern Rumaila, and Jarishan. The vegetation cover for each station was studied, and frequency and density were calculated. The results of the study showed that the highest number of plant species recorded was at Southern Rumaila station, with 60 plant species, followed by 56 plant species at Khader Al-May station, while the lowest number of recorded species was 14, 15, 16 plant species in Northern Rumaila, Al-Haritha and Juwaibdah stations, respectively. The highest density of species was recorded at Jarishan station, and the lowest density was at Al-Zariji station. At the species level, *Cynodon dactylon* exhibited the highest plant coverage (70%) in all the stations. Whereas the highest frequency (80%) in all stations was shared by *Medicago polymorpha* and *Plantago boissieri*. In this study, remote sensing technology was also used to assess the distribution pattern of natural vegetation in the study sites, as it was found that the vegetation of Safwan district had bigger cover compared to the rest of the studied sites. Khader Al-May and Jarishan stations recorded the highest similarity percentage according to the Jaccard index, amounting to 60%, while Simpson index showed the highest similarity between Juwaibdeh and Jabal Sanam stations (86.67%) and according to Bray-Curtis index, the highest similarity was 75% between Khudari Al-May and Jrishan stations.

Key words: Biodiversity; Basrah; Index; Similarity; Simpson index

Introduction

Diversity is an expression that refers to the extent of similarity and difference between a group of characteristics, while biological diversity refers to the similarity or difference between living organisms (Swingland, 2001). Biodiversity covers the variety of all living organisms, the intricate interactions among them, ranging from microorganisms to giant animals and towering trees and genetical variation within species, is one of the important global topics. It is also important for human-being as it provides essential ecosystem services including food, medicines and also controls the climate. Although scientists and researchers have long studied biodiversity, global awareness of its importance only gained momentum when alarming signs of its decline became evident. The deforestation of tropical forests during the late 1970s and 1980s marked a significant loss of habitats that harbor the majority of the world's biodiversity. This degradation, coupled with soil erosion and the disturbance of ecosystems, highlighted a global decline in biodiversity (Wilson, 2004). In recent decades, environmental specialists and researchers have increasingly focused on this issue. The loss of plant species or even a group of them within any ecosystem gives a disruption in its functional integrity or system (Rabie, 2008).

A study was conducted by Mousa (2018) of the Rutba Dam area in western Iraq, total 103 plant species belonging to 85 genera and 32 plant families were recorded and also found that the genus *Astragalus* L. was dominant in terms of the number of species, accounting to 6 species.

Abdullah & Al-Asadi (2018) studied the impact of environmental pollution on plant biodiversity in Basrah Governorate and found that the plant biodiversity was greatly deteriorated in Basra Governorate due to environmental pollution and the increase in greenhouse gases such as sulfur oxides, nitrogen oxides, and dioxycarbon gas, in addition to methane. They also reported the extirpation of many plant species from the area along with the shrinkage of green spaces due to urbanization.

Farooq & Mahmood (2020) indicated that the biodiversity in northern Iraq, especially the mountainous region of northern and northeastern Iraq, had deteriorated and declined in number, and the habitat loss for the plants and animals both. The degradation of the region's natural heritage was due to drastic changes in climate, topography, anthropogenic activities, and a significant reduction in water resources. All factors significantly impacted the environment of the study area.

Maleh (2015) studied plant diversity of the southern desert in Basra, examined vegetation cover, its density and distribution, as well as the dominant plant communities in the prevailing climatic conditions. This study covered large areas of the southern desert, including Al-Zubair, Safwan, Umm Qasr, North and South Rumaila, Khader Al-Maa, Jrishan, Jabal Sanam, and Al-Touba.

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A study was also conducted by Al-Mayah *et al*., (2018) in the Galat region, north of the Al-Tayeb region. They recorded 127 plant species belonging to 101 genera and 37 families of vascular plants. The Fabaceae family was represented by the largest number of species (19 species), followed by Asteraceae with 18 species. Similarly in another study of the Al-Tayeb region, northeast of Al-Amara, carried out Al-Knanny (2019) recorded 229 plant species. The most important plant communities recorded were *Ziziphus nummularia* (SIDR), *Hammadetum salicornici, Artemisietum herbae-albae, Pennisetum divisum*, *Convolvulus oxyphyllii*.

Tuaih & Al-Asadi (2023) examined the influence of some environmental factors on the distribution and spread of the *Artemisia scoparia* community in the southern desert of Basra. This community was recorded for the first time in Basra and also in many areas, including Hamar Musharraf, Al-Tuba, Artawi, Safwan, and Al-Zubair. The environmental factors suitable for its growth were the high temperature (49°C), relative humidity (62%) and soil (10.2%) with highest soil salinity 8.81 mg/L along with light soils poor in organic matter.

However, no biodiversity study was ever conducted in the desert of Southern Basra on a large scale. The present study was undertaken to fill the gap by selecting ten stations in the various parts of the region. The vegetation cover, frequency and density were also calculated.

Materials and Methods

Study stations: Ten stations were chosen to study the vegetation in the desert south of Basra: 1. Al-Haritha 2. Qarmat Ali 3. Al-Zariji 4. Rumaila Northern 5. Rumaila Southern 6. Juwaibdah 7. Jabal Sanam 8. Um-Qasr 9. Jarishan 10. Khidr Al-May, (Fig. 1) during the period 2022-2023.

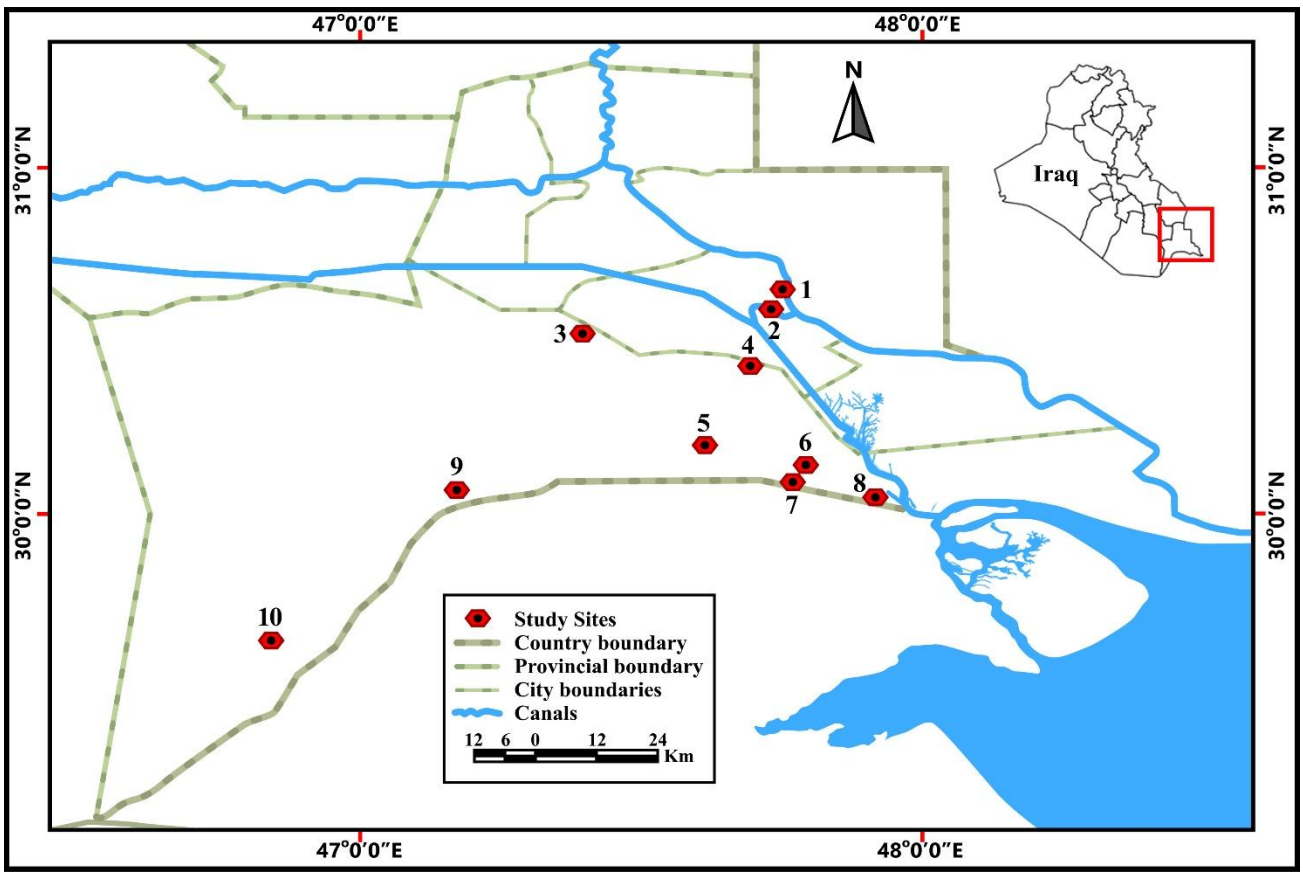

Fig. 1. Vegetation cover study sites in Basra Governorate – Iraq.

Collecting and diagnosing plant samples: Monthly field trips were arranged to collect plant samples from each station. The plant samples were collected in plastic bags and transported to the laboratory to dry and press them. The plant specimens were identified in the herbarium of the College of Science/ University of Basra using the taxonomic keys of various volumes of Flora of Iraq (1966-1985) Townsend & Guest, Flora of Iraq (1968, 1974, 1980, 1985) and Townsend (1966); Ghazanfar & Edmondson (2013 and 2016), and the Davis Encyclopedia of Turkey's Plants (1965-1985) and Flora of Kuwait, Daoud & Al-Rawi (1985) and Al-Rawi (1987) and Rechinger's Flora of Lowland Plants (1964).

Quantitative study of vegetation cover: Quadrat and the Transect Methods were used to study vegetation cover. The square (1 x 1) m was used to study the herbaceous vegetation cover. As for the shrub cover, a strip of length 150 m was used. Based on the vegetation cover, the number of species, and the number of individuals of each plant species in the studied square, with five replicates per station, in addition a monthly general environmental survey of the study areas was conducted to collect those species which were not present in the square and the sector method. The environmental standards were calculated according to the method used by Shaltout (2002), and Rabie (2008).

Frequency: It is the number of times the species appear in the studied area and is calculated according to the following equation:

$$\text{Frequency \%} = \frac{\text{Number of squares in which the type appeared}}{\text{Total number of squares studied}} \times 100$$

Coverage ratio: It is the ratio of the area covered by plants to the total area of study.

$$\text{Percentage coverage \%} = \frac{\text{Area covered by plant type}}{\text{Total area}} \times 100$$

Density: Density representing the number of individuals of a species per unit area (individual/m^2), was calculated according to the following equation:

$$\text{Density} = \frac{\text{The total number of individuals of one species}}{\text{The total number of squares studied}}$$

Results and Discussion

Table 1 and Fig. 2 showed the number of species in the study stations. The highest number of species was 60 at the South Rumaila station, followed by 56 species at the Khader Al-May station, while the lowest number was 14, 15, and 16 species at the North Rumaila, Al-Haritha, and Juwaibdah stations, respectively. This variation in the number of species between the study stations could be attributed to the elevation above sea level and the nature of the soil at each station, as diversity was associated with increasing elevation above sea level and the organic and clay contents of the soil had a positive relationship, while the negative relationship between diversity, salinity, and the sandy nature of the soil was recorded by El-Wahab *et al*., 2008.

The highest number of genera was 44 in the South Rumaila station, followed by Jabal Sanam and Khader Al-Mai, with 38 genera, while the lowest was 11 in the Al-Haritha station. The highest number of plant families (20) was recorded in the Rumaila station. This was due to the large number of plant species in this station, the lowest of which were 3 families in Khader Al-Mai station. This may be due to low humidity, high temperatures, and scarcity of rainfall. The dry climate also results in increased soil salinity, which affects plant distribution. Overgrazing also has negative effects on biodiversity in the study area. Most of the dominant species in the study area such as *Phragmatis australis, Stipa capensis, Schismus barbatus* were herbaceous belonging to the Poaceae family. The largest number of species recorded in the study were of Asteraceae family, followed by the Chenopodiaceae. These two families are the most widespread families in Iraq, and in most of the plant biodiversity studies recorded the highest number of species in these families, such as Maleh (2015) and Al-Knanny (2019) (Figs. 3 and 4).

Life forms: It was found that the highest prevalence of life forms in the different study areas were Therophytes. Some of the common Therophytes were *Arnebia decumbens, Asphodelus tenuifolius, Savigyna parviflora* and *Senecio glaucus*. The highest number of Therophytes (43) were reported from Khader Al-May station, followed by Jabal Sanam with 41, and the lowest in the South Rumaila station with 7 (Fig. 5). Chaemohytes occupied the second position in all the study stations the highest number of in the North Rumaila station, which amounted to 22, and the lowest was 3 in the Juwaibdah station (*Alhagi graecorum, Anabasis setifera, Artemisia herba–alba* and *Astragalus spinosus*. Hemicryptophytes (*Citrullus colocynthis* and *Cynodon dactylon*), which appeared twice in both Al-Hartha and North Rumaila stations, with a single number. No Geophytes were recorded from all of the stations except at Khader Al-May station, with only two species. (*Bellevalia mosheovii* and *Bellevalia saviczii*).

The number of Therophytes is more in all the stations compared to other life forms. This may be due to the fact that these plants are annuals with a short life cycle, and they grow quickly once the appropriate environmental conditions of soil moisture and moderate temperature are available. Therefore, it was noticed that they were more numerous, widespread, and diverse in any ecosystem. They also produce numerous small and light seeds with high vitality and can be transmitted and spread quickly, and their ability to adapt is high (Abd El-Ghani & Abd El-Khalik, 2006; Al-Mayah *et al.*, 2016; Abd El-Ghani *et al*., 2017).

Density: It was found that the highest density of species 3.01 individuals/m^2 was at Jrishan Station, followed by Jabal Sanam Station, about 2.93 individuals/m^2 (Fig. 6). This could be attributed to the fact that these two stations are sparsely grazed and quite far from anthopogenic activities. The lowest species density was 0.69 individuals/m^2 at Al-Zariji station. The density at the species level was 15 individuals/m2 the highest for *Melilotus indica* followed by the *Plantago amplexicaulis* reaching 5 individuals/m^2. As for most of the recorded species namely *Alhagi graecorum, Astragalus spinosus, Emex spinosa, Hammada salicornica, Juncus rigidus,* and *Picris desertorum*, the density reached between 1-2 individuals/m^2. The most abundant and dense plants covering the large area were by annual species with short life cycle because rainfall strongly affected their continuity. Therefore, these plants were most abundant, especially in the Safwan and Jershan stations (Weltzin & Tissue, 2003).

Table 1. Plants cover area and percentage.

Region	Total area/ km2	Vegetation area/ km^2	Barren land area/ km^2	Water area/ km^2	Percentage of vegetation cover %
Al-Zubair	8764.7427	90.1737	8674.569	---------	1.03
Shatt al-Arab	1431.9027	5.7204	1426.1823	---------	0.4
Hartha	823.2984	1.9152	736.5708	84.8124	0.23
Safwan	594.6138	27.9468	566.667	--------	4.7

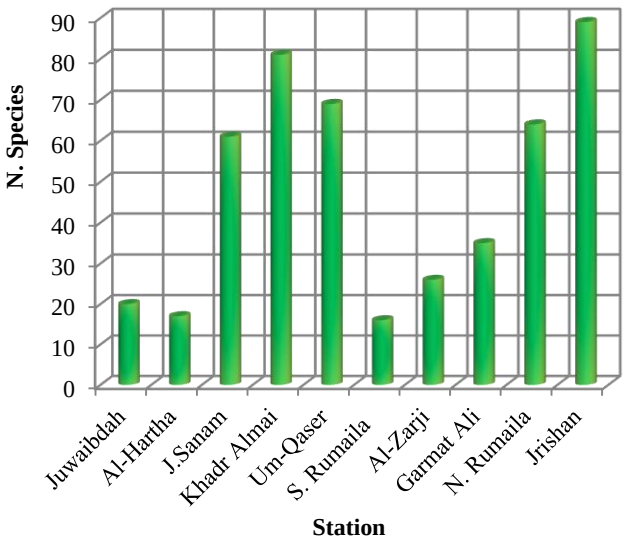

Fig. 2. Shows the number of species in the study stations.

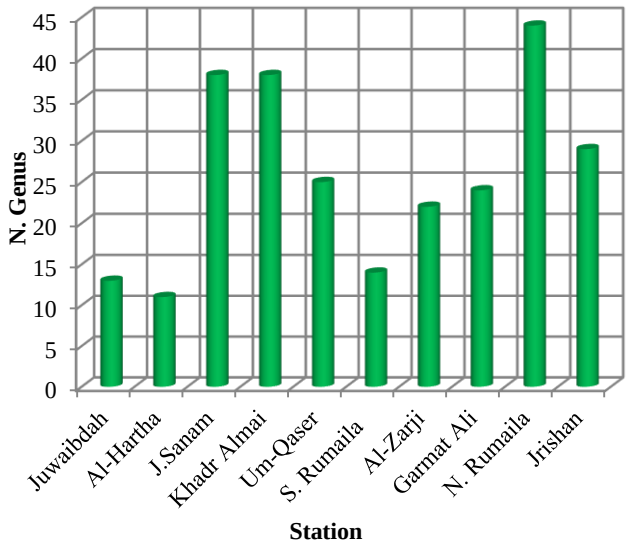

Fig. 3. Shows the number of genera in the study stations.

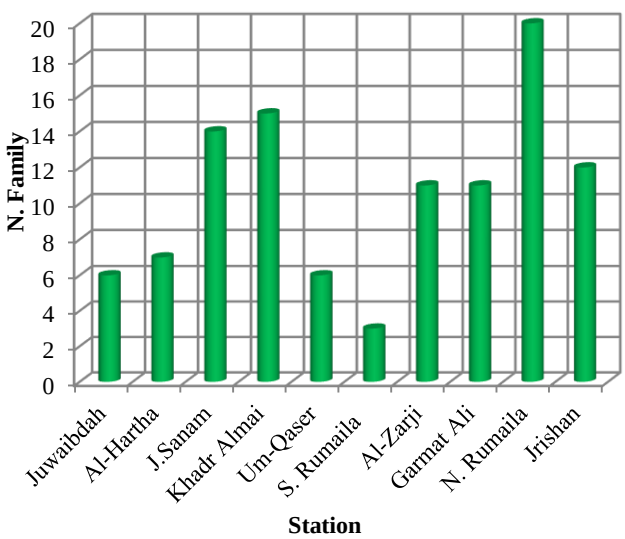

Fig. 4. Shows the number of families in the study stations.

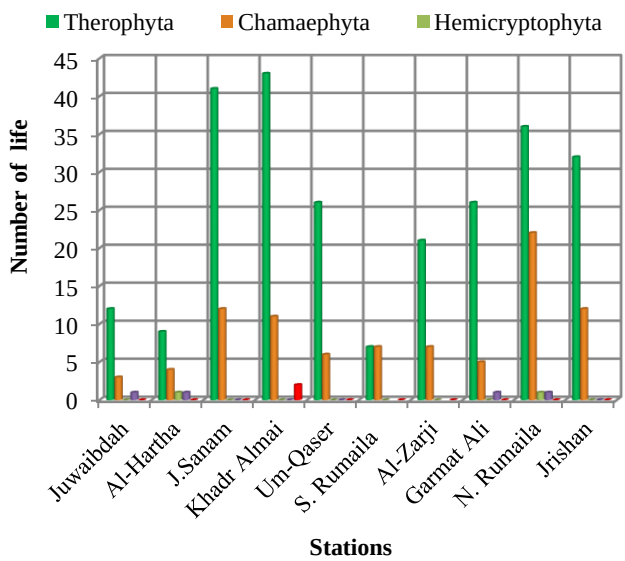

Fig. 5. Number of life forms in the study stations.

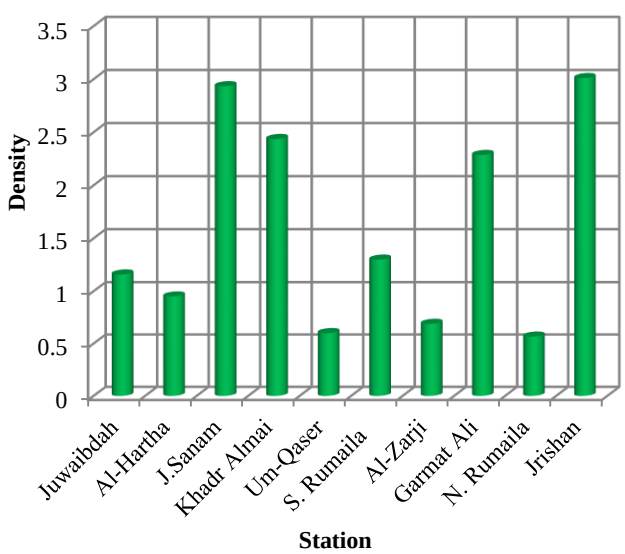

Fig. 6. Shows the density of species at the study stations.

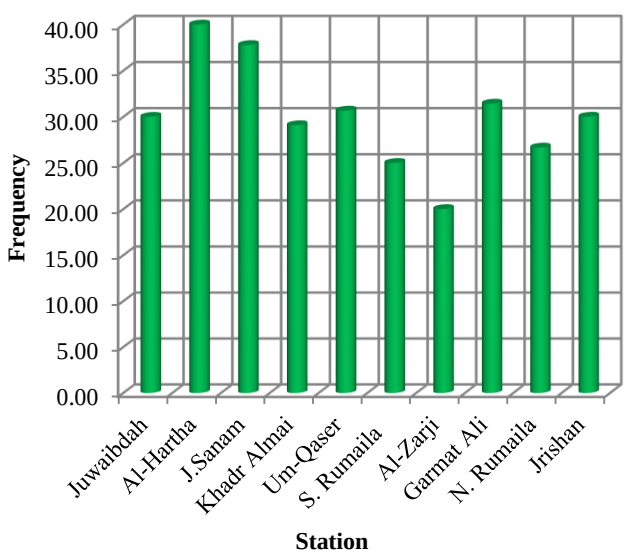

Fig. 7. Shows the frequency of species at the study stations.

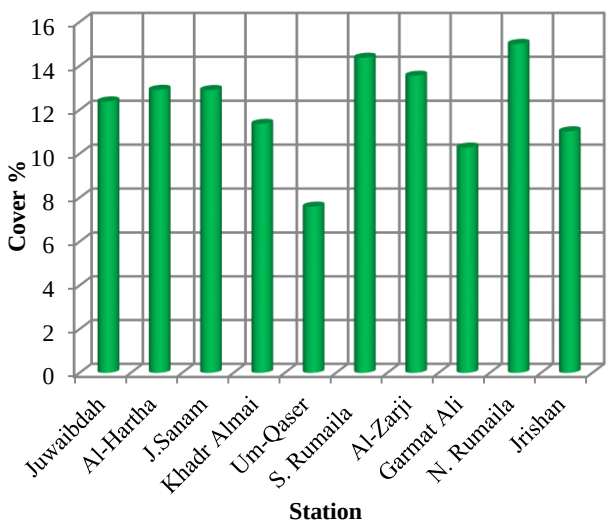

Fig. 8. Shows the species coverage at the study stations.

Frequency: The highest species frequency was 40% at Al-Hartha station and the lowest was 20% at Al-Zariji station. At the species level and for all stations, the frequency was 80% for the two species *Medicago polymorpha* and *Plantago boissieri*. These results are consistent with the study of Al-Mayah *et al*., (2018), reported that *Plantago boisseri* exhibited the highest value and frequency index in the Al-Tib-Amara region. The reason may be attributed to the ability of these species to withstand the environmental conditions of the region. These species have developed various methods to increase their chances of survival and resistance to different environmental conditions (Fig. 7). Many therophytes species are able to exploit the fluctuations of humidity, rainfall, and moderate temperatures and quickly complete their life cycle. This strategy is adopted by many plants to confront the harsh environmental conditions in the region as the region is characterized by low rainfall and the sandy nature of the soil, which cannot retain rainwater for a long time (Schutz and Milberg, 1997; Moruno *et al*., 2011) Species-specific effects correspond to the abundance of the entire plant community, the most important of which is water availability. The differences and multiplicity of species mean this different species contribute more to the total community abundance (Tilman *et al*., 2006). In typical plant communities (Chesson *et al.*, 2001), high species diversity is important for the community to maintain ecosystem functioning in the presence of environmental fluctuations that Prefers different species which are important component of biodiversity (Chesson *et al*., 2004).

Plant coverage: The highest percentage of coverage of the studied species was recorded about 15% in the North Rumaila station. This is due to the fact that the largest number of species was recorded at this station, and this is consistent with what Al-Knanny (2019) findings in Wadi Al-Tib region, Iraq. It was followed by the South Rumaila station, where the species coverage was 14.37%, and the lowest was 10.28% at Qarmat Ali station. The highest coverage at the species level for all stations was about 70% for *Cynodon dactylon*, followed by *Cressa cretica*, with a coverage rate of 50%. The lowest was 2% *Plantago amplexicaulis*. This study agreed with Al-Mayah *et al*., (2018), who also recorded *C. dactylon* as more dominant, widespread, and having higher coverage in the study area (Figs. 8 & 9).

Plants cover area: The vegetation cover area and its corresponding percentage for the provinces encompassing the study stations are presented in Table 1. Al-Zubair Province includes North and South Rumaila and Juwaibdah, recorded the largest vegetation cover area at approximately 90.1737 km², representing 1.03% of its total area. In contrast, Safwan District—which comprises Khader Al-Mai, Jrishan, Jabal Sanam, and Umm Qasr exhibited the highest percentage of vegetation cover within the study area estimating at 27.9468 km² representing 4.7%. This higher percentage may be attributed to the fact that in most of the study stations within Safwan District the number of species were the highest compared to other districts.

Graphical analysis of plant cover using remote sensing technology: The percentages of plant cover at the study stations are depicted in Table 1 and Figs. 10-12. A significant reduction in vegetation cover and a considerable decrease in green spaces was observed. It was also noted that the Safwan district was more densely vegetated, followed by Al-Zubair and then the Shatt Al-Arab, represented by the Karma Ali and Al-Zariji stations. And then Al-Haritha.

The decrease in vegetation cover in wild areas may be due to climate change leading to global warming, and a decrease in rainfall levels, coupled with an increase in temperature. Consequently, this extreme climate factors negatively impact plant growth, especially at the early stages of growth. Urbanization in most of the study areas has led to the over-exploitation of land for building houses or establishing factories as well as the spread of sand quarry sites and the conversion of many wild areas into sanitary landfills, especially in the areas of Juwaibdeh, Safwan and Al-Zubair. Overgrazing, especially at the beginning of the spring growing season also leads to the elimination of many plants before the completion their life cycle and form fruits and seeds, thus exposing many plants to local extinction (Al-Mayah *et al*., 2016).

Diversity indicators: The dendrogram showed the similarity and correlation relationship between the study stations (Fig. 13). According to the Jaccard index the highest similarity (60%) was recorded between the Khader Al-May and Jarishan stations, while the lowest percentage of similarity was 4.55% between the North and South Rumaila stations. representing the dendritic shape. All the studied stations were divided into three groups. The first group included the Juwaibdah station and the airport, with a connection rate of 17.39%. The second group included the stations of Jabal Sanam, North Rumaila, Khader Al-May, Jrishan and Um-Qasr, as these stations were located on one line south of the southern desert of Basra Governorate. These stations were distributed into three branches, the first being Jabal Sanam. North Rumaila with a connection rate of 39.24%, the second branch is Khader Al-May and Jershan, with a connection rate of 60%, and the third branch represented the lone station of Um-Qasr station. The third group included two branches, the first consisted of Al-Hartha and Qarmat Ali stations with a similarity rate of 36.36% because these two stations were located on the same line and close to each other. The second was represented by single station Al-Zariji station.

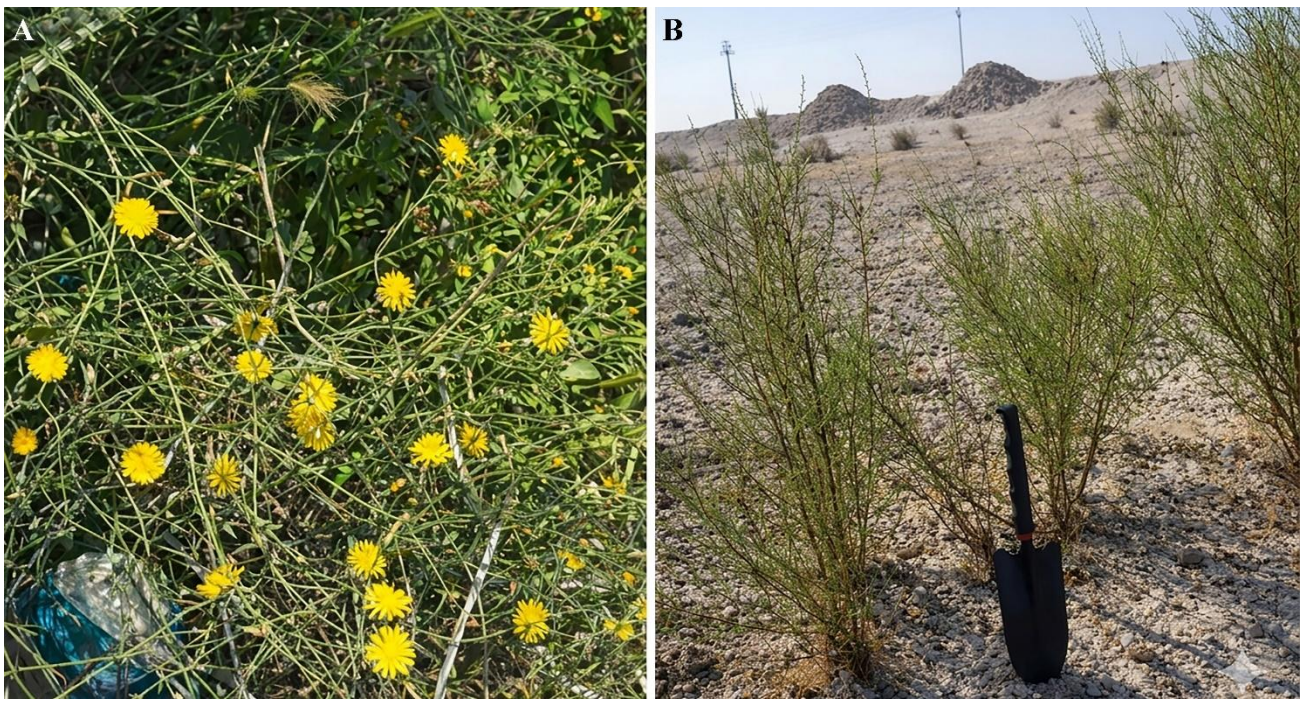

Fig. 9. Pictures of some of the plants recorded in this study: A, *Launaea mucronata*; B, *Artemisia herba-alba.*

Simpson: The percentages of similarity and connection among the stations, according to Simpson's guide are shown in the dendrogram (Fig. 14). The tree shape divided the stations into 4 groups. The first group included three branches, the first comprised of Juwaibdah and Jabal Sanam stations, with a similarity rate of 86.67%, and the second branch, the Khader Al-May and Jarishan stations, with a similarity rate of 84.78 % similarity to Um-Qasr station with a third branch alone. The second group included Al-Zariji and North Rumaila stations, with a similarity rate of 53.57%. The third group was represented by only one station, South Rumaila, while the fourth group included Al-Hartha and Qarmat Ali stations, with a similarity rate of 85.71%. This may be due to the inverse relationship between species diversity and dominance. The high value of the index indicated that the plant community in the two sites, Juwaibdah and Jabal Sanam, has similar dominant species (*Juncus rigidus, Launaea angustifolia, L. mucronata, Plantago amplexicaulis, Senecio glaucus, Suaeda aegyptiaca*. (Palaghianu, 2014).

Bray-curtis: According to the Bray index, the highest similarity rate was 75% between the Khudari Al-May and Jarishan stations, and the lowest of similarity was 8.7% between the southern and northern Rumaila stations. Also, the dendrogram divided the stations into three groups, the first group included the Juwaibdah and Airport stations with a similarity rate of 29.63%, the second group consisted of three branches. The first branch was linked to Jabal Sanam and North Rumaila stations, with a similarity rate of 56.36%. The second branch, Khader Al-May and Jershan stations were linked, with 75% similarity. Whereas the third branch consisted of only one station, Um-Qasr station. The third group was divided into two branches: the first, Al-Hartha and Qarmat Ali stations, were linked with a similarity rate of 53.33%, and in the second branch, Al-Zariji station appeared to be closely related to the two stations above, with a similarity of 28.57% and 47.46%, respectively (Fig. 15).

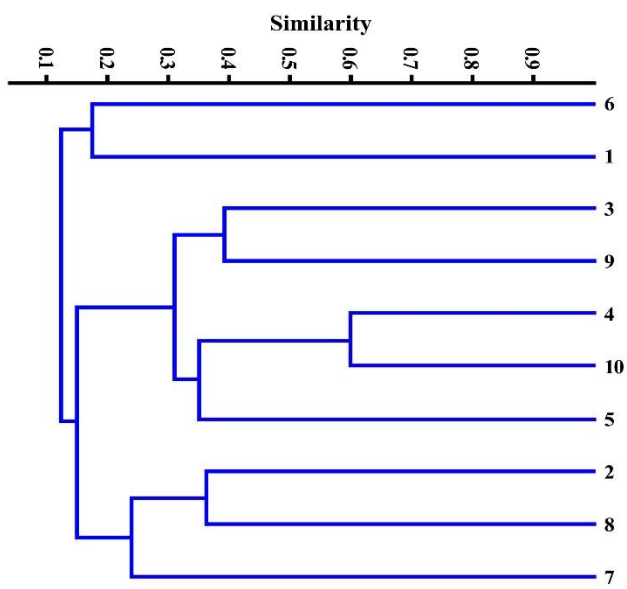

Fig. 13. The dendrogram of the connections between the study stations. 1: Juwaibdah 2: Hartha 3: Jabal Sanam 4: Khader Al-May 5: Um-Qaser 6: South Rumaila 7: Zariji 8: Qarmat Ali 9: North Rumaila 10: Jrishan.

The three indicators showed that the highest percentage of similarity was between the two stations, Jershan and Khader Al-May. The reason is that these two stations are located close to each other, and that the vegetation extends to the either station and both of them are the same environmental conditions. The second is located within the Western District (DWD), based on all the indicators studied, Al-Hartha and Qarmat Ali stations are also linked. The reason is also because both stations are an extension of the other and are located within the Southern Marshes District (LSM), to the northeast of Basra Governorate. As for the remaining stations, their correlation rates with each other varied according to the three studied indicators (Jaccard, Simpson, and Bray-Curtis). (Maleh, 2015 & Al-Knanny, 2019).

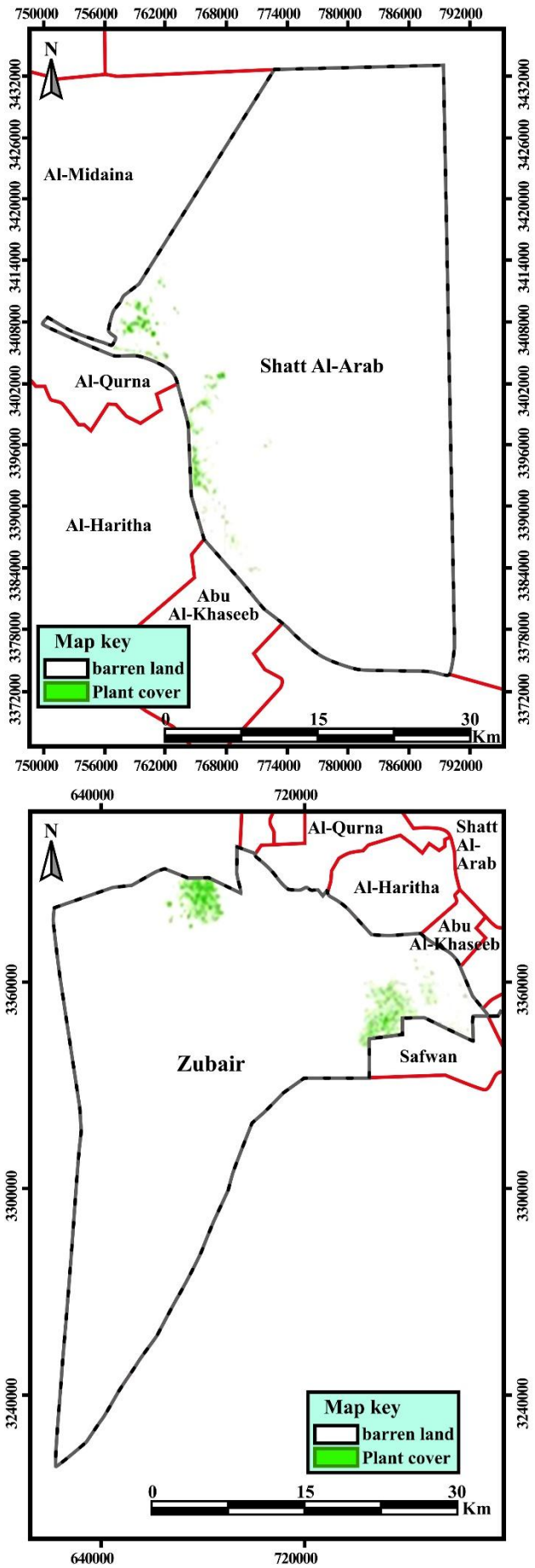

Fig. 10. The green area of plants using remote sensing technology in Safwan district.

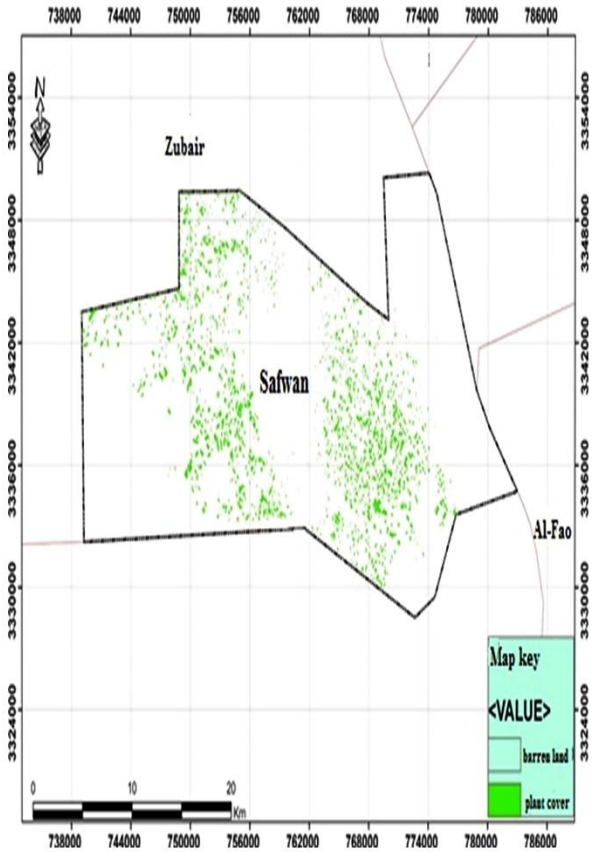

Fig. 11. The green area of plant cover using remote sensing technology in Zubair and Shatt Al-Arab district.

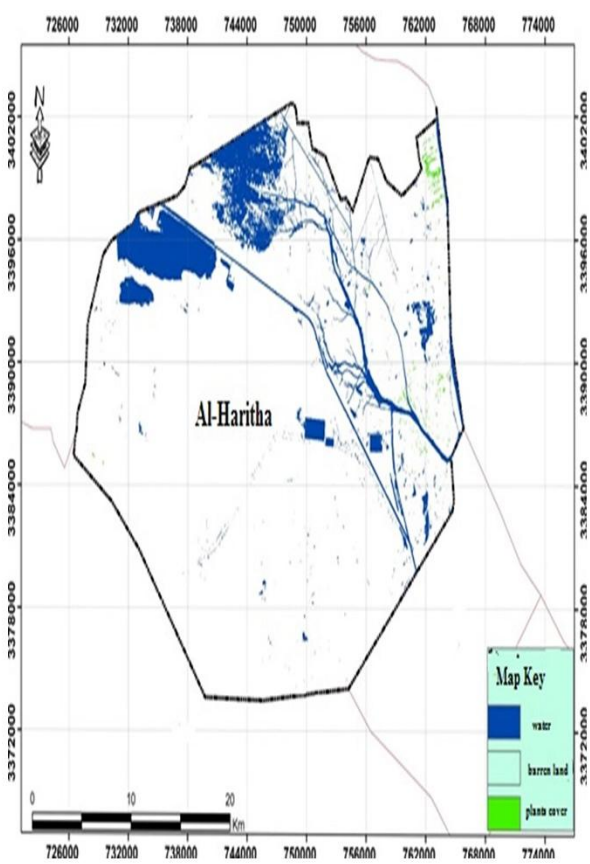

Fig. 12. The green area of plants cover using remote sensing technology in Al-Haritha district.

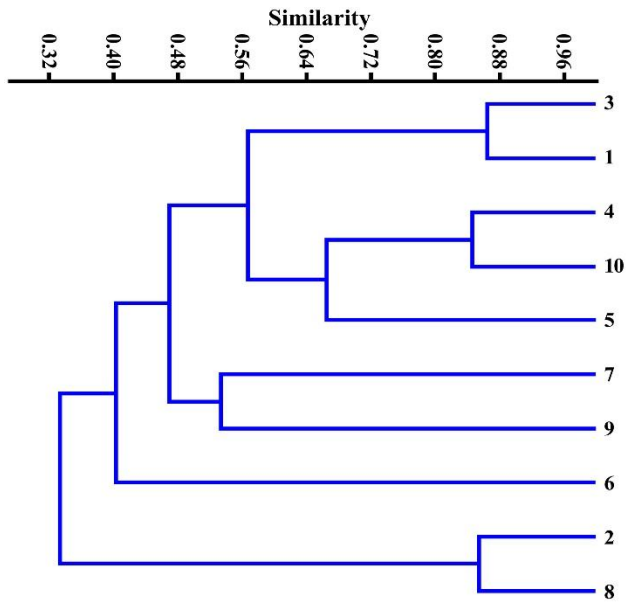

Fig. 14. The dendrogram of the connections between the study stations. 1: Juwaibdah 2: Hartha 3: Jabal Sanam 4: Khader Al-May 5: Um-Qaser 6: South Rumaila 7: Zariji 8: Qarmat Ali 9: North Rumaila 10: Jrishan

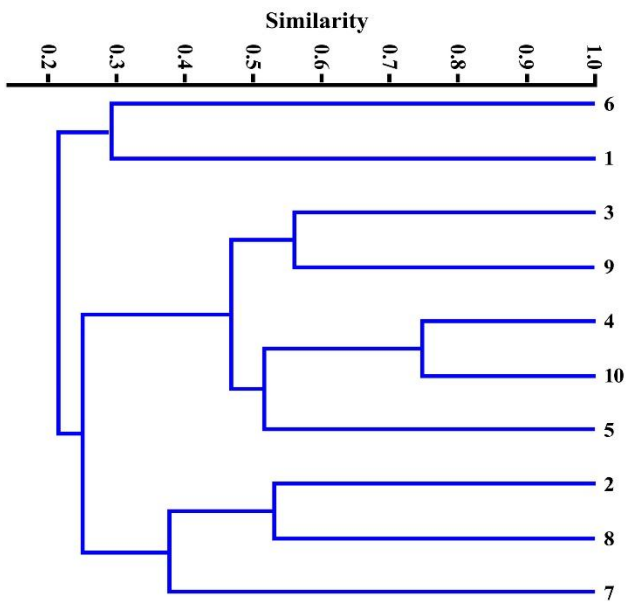

Fig. 15. The dendrogram of the connections between the study stations 1: Juwaibdah 2: Hartha 3: Jabal Sanam 4: Khader Al-May 5: Um-Qaser 6: South Rumaila 7: Zariji 8: Qarmat Ali 9: North Rumaila 10: Jrishan

Conclusions

We conclude from this study that plant biodiversity in different areas of Basra, especially the natural vegetation, is subjected to significant deterioration, and that most of the widespread and abundant species are herbaceous, such as *Cynodon dactylon*, alongwith some other annuals (*Arnebia decumbens*, *Launaea angustifolia*, and *Silene arabica*) that quickly complete their lifespan in the ecosystem, and that in most of the study areas. The similarity ratios were according to the results of diversity indicators (Jaccard, Simpson, and Bray-Curtis), it was very similar in terms of vegetation cover and type.

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