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Relationship between Climate Variables with Vegetation Cover Types and Surface Heat Types in some Iraqi Stations

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ABSTRACT: *Vegetation cover can be easily measured in the field by assessing the percentage of the ground that is covered by the existing vegetation. Aerial photographs or satellite images can be used for measuring vegetation cover in an extensive area. With time, vegetation cover can change, particularly for annual or perennial deciduous plants. Measuring the amount of vegetation is particularly crucial during the rainy season when soil erosion happens. In this work, the data of the European Center for Mediums-ranges Weathers Forecasts (ECMWF) was Low vegetation cover (LVC), High vegetation cover (HVC), Sensible heat (SH), and Latent heat (LH). Also. The research purpose was to find the relationship between LVC and HVC in the stations (Diyala, Mosul, and Arbil) for the period 2008-2022. The work was carried out with monthly and yearly mean data. It was found that there is an increase in low vegetation cover through the study period and this is due to Opinion and farmers' follow-up of low vegetation cover (for crops), and a decrease in high cloud cover through the study period this is due to the high temperatures and other weather factors such as the lack of rain. Also, the low cover has a heating effect on the weather, while the high cover has a cooling effect during the study period.*

Keywords: *Low vegetation cover, High vegetation cover, Sensible heat, Latent heat, Iraq.*

INTRODUCTION

The portion of soil that has green vegetation on it. Every type of plant, from grassy meadows and farmland to evergreen forests, is considered vegetation. Every kind of plant is involved in the Earth's energy balance as well as the water cycle (Nassif *et al.,* 2022). They influence weather and climate mostly through evapotranspiration. In contrast to the phenomenon of vegetation is desertification or erosion, which is intended to change the shape of the earth's surface from green to desert, and this is the result of weather factors and human interventions (Jawad *et al.,* 2018). This destroys the natural balance of the environment and the decline of the natural environment through the accelerated decline resulting from the various reasons that lead to the desertification of the land and its transformation into a desert (Gao, 2020; Zhou, 2008). In a wide range of environments, Sediment loss and surface water runoff are both significantly impacted by plant cover. Since soils are sufficiently shielded from the impact of raindrops and soil erosion is greatly decreased at this number, a plant cover of 45–50% is regarded as a critical value (Abbood et al., 2021). The percentage of the ground that is covered by the current annual or perennial vegetation can be used to calculate the amount of vegetation cover in the field (Nassif et al., 2021). Large-scale vegetation cover can also be measured using satellite or aerial photos (Nassif et al., 2020). Many authors have shown that when the proportion of plant cover increases, both run-off and sediment loss drop dramatically in a variety of situations (Foley, 2000; Hashim *et al.,* 2022). 40% vegetative cover is regarded to be the critical threshold in a sloping environment below which fast erosion predominates, according to (Abbood et al. 2020). This threshold can be modified according to the kind of plant, quantity of rain, and topography (Abbood et al., 2018; Nassif *et al.,* 2021).

Erosion processes may be quite active, and natural vegetation restoration may be irreversible when there is little to no plant cover (Richards et al., 2018; Salman *et al.,* 2022). Only when a significant area of the land is devoid of vegetation can soil erosion and degradation start, and even then, it advances quickly and cannot be stopped by just using land resistance. (Nassif *et al.,* 2024). Deep soils on loose parent materials degrade slowly and lose some of their capacity to produce biomass. (Arneth, 2015; Hashim *et al.,* 2023). On steep slopes, however, shallow soils with lithic contact have poor productivity and, in the absence of sufficient vegetation, poor erosion tolerance (Al-Taai *et al*., 2021). Data from the soil and vegetation study on the island of Lesvos showed that the depth of the soil in each of the different climatic zones had a significant impact on the percentage of plant cover (Al-Taai *et al*., 2021). As soil depth grew and drought duration decreased, so did the amount of vegetation cover. While the vegetation cover class of 25%–50% had the maximum frequency of appearance of 93% in the semi-arid zone in the soil depth class of 15–30 cm, areas with soils having the same soil depth class had a higher vegetation cover with a maximum frequency of appearance of 64% of the cover type 75%–90% cover in the dry sub-humid zone (Lindenmayer, 2019; Abbood *et al.,* 2023). Measurements of soil erosion in eastern Spain revealed that the rates of soil erosion for bare soils varied from 0 to 3720 g/m^2.h, but the rates of runoff and erosion in densely vegetated soils were negligible (Liu, 2018). Several factors influence water erosion, but terrain, vegetation, and climate are the most significant ones. There are various varieties of water erosion, such as gully erosion, rain drop erosion, sheet erosion, and crack erosion. The key elements influencing wind erosion are soil, cover, and climate. Wind erosion is the removal of soil by wind. The movement and circulation of the wind are primary climatic elements. The impact of the wind on erosion is dependent upon the internal qualities of the soil, namely the cohesiveness of soil aggregates, which is dependent upon the quantity of binder, soil content, and soil moisture (Cotton, 2006).

The benefits of vegetation cover and mulch are comparable in that they both lessen temperature variations throughout the day and the year. However, the extent to which the leaf shade covers the ground underneath it determines the size of the effect, which is proportionate to the covered area of soil. A fully covered area blocks all incoming radiation, allowing only long-wave radiation from the canopy to reach the soil's surface. Plant cover on the soil surface causes seasonal temperature changes to lag. But in the end, this will rely on the kind, height, and thickness of the vegetation present in the canopy. Grass leaves, for instance, retain air above the soil's surface, protecting it from variations. Conversely, a forest canopy cover has a higher convection potential due to the deep air column that sits on the soil surface. Furthermore, compared to grassland, the soil beneath a forest canopy typically has higher aeration and a higher likelihood of enhanced soil moisture (Al-Taai *et al.,* 2021). The kind of plant present also affects the penetration of frost, which in turn affects how deep it penetrates the soil. For instance, plants growing patchily experience deeper frosts than expansive, deeply rooted vegetation kinds like grasses (Taylor, 2022; Tchebakova *et al*., 2009).

Effects of vegetation on climate

Since plants make up almost 20% of the planet's surface, it makes sense that they have an impact on the climate and weather since they release water vapor, which condenses into clouds, which in turn influence humidity, temperature, and the weather (Pałubicki, 2022; Al-Kaissi *et al.,* 2021). Although they absorb a significant amount of energy as well, plants do not add to global warming because transpiration-induced evaporative cooling offsets the excess warmth (Bartholy *et al.,* 2006). Since the climate is essentially the long-term average of the weather, the amount of vegetation is a major determinant of the climate. By making up for variations in temperature and humidity during the process of extracting oxygen for photosynthesis, plants contribute to climate stabilization. Photosynthesis is the process that creates oxygen in the atmosphere, with a concentration of 21%. Vegetation is crucial to climate and weather because plants use carbon dioxide for photosynthesis and provide the number of gases released by fires into the atmosphere (De-Keersmaecker, 2015; Yehia et al., 2022).

MATERIALS AND METHODS

Data source and study stations

Low vegetation cover, high vegetation cover, and surface latent heat flux in (W/m^2) were the monthly means used for the work, and Surface sensible heat flux in (W/m^2) taken from the European Center for Medium-range Weather Forecast (ECMWF) for the period (2008-2022) in main Iraqi stations (Mosul, Erbil, and Diyala) and some other stations in Iraq (Kurdistan region (Sumel (Duhok), Saladin Resort, Dokan, Sulaymaniyah), Kirkuk, Tikrit, Hit (Anbar), Kut, Karbala, Najaf, and Diwaniyah)), as shown Fig. 1 and Table 1 (Nassif *et al.*, 2024). SigmaPlot was used to draw the data, and MATLAB was used to manipulate it (Yehia et al., 2022).

RESULT AND DISCUSSION

Behavior analysis monthly mean of type of vegetation covers over Iraqi Stations

Fig. 2 shows that the high vegetation cover had the highest value in Mosul station, then Diyala station, followed by Erbil station, while the low vegetation cover had the highest value in Erbil station, then Diyala station, then Mosul station, with the lowest value. This is due to the nature of the area and the accompanying weather factors that work to develop plants, in addition to the human factor.

Behavior analysis monthly mean of type of vegetation covers and type of surface heat over Iraq Station

In Fig. 3, it was found that the low vegetation cover was highest in April at the Erbil station and lowest in June at the Mosul station, while the high vegetation cover was highest in the Mosul station in all months.

The sensible heat was highest in July for the Erbil station and lower in December at all stations, while the latent heat was highest in June for the Diyala station and less in September for the Erbil station. Both sensible and latent heat are regarded as thermal radiation released by the planet, whose surface absorbs solar energy in part and releases a significant portion of it as heat. Both tangible and latent, which are affected by several factors, the nature of the gaseous envelope, suspended matter, its intensity, the period of sunshine, the terrestrial reflectivity, and the Earth's rotation, in addition to other environmental factors, in addition to the negative sign representing that the radiation is bounced off the Earth's surface.

Distribution of vegetation cover types over Iraqi stations

Fig. 4 shows that the Mosul and Erbil stations had high and low vegetation cover and were very clear during the winter and spring. This is due to the weather factors that help the growth of plants during these seasons, while the Diyala station had a clear high and low vegetation cover during the summer season, and this is also due to the factors. The weather and nature of the area help plants grow significantly. Vegetation is essential for soil and water conservation and can even be effective against wind erosion. Vegetation can directly protect the surface of the soil, such as heavy and powerful raindrops, and helps in the infiltration of water and the stabilization of particles that begin to move. Also, increasing vegetation can gradually increase soil organic matter, stabilize soil composition and biological activities, and improve soil composition stability and water absorption. The cover should be near the surface of the soil and present during the seasons close to the planting season.

Relationship between the Analysis of the behavior of the high and low vegetation cover with heat types of Mosul, Erbil, and Diyala stations

Fig 5 shows the monthly averages of high vegetation cover and sensible and latent heat. In the Mosul station, the vegetation cover was high in April, the sensible temperature was high in June, and the latent temperature was high in March, but in the Erbil station, the vegetation cover was high in April, the sensible temperature was high in July, and the latent temperature was high in April. At Diyala station, the vegetation cover was high in June, the sensible temperature was in July and August, and the latent temperature was high in June. shows the monthly mean between thermal radiation (SH, LH) with low and high vegetation. Low vegetation cover increases the amount of thermal radiation (solar radiation) that reaches the Earth's surface by absorbing a significant portion of it and reflecting a small portion of it back into space. Low cover reduces the amount of heat radiation that reaches the Earth's surface because it absorbs a little portion of it and reflects a large portion of it. All vegetation cover absorbs some of the heat radiation that the Earth's surface generates, reemits a significant portion of it both towards the Earth and into space, and thereby lowers the quantity of energy that reaches the top. The low cover has a heating effect on the weather, while the high cover has a cooling effect during the study period.

Fig. 6, displays the low vegetation cover and sensible and latent heat monthly averages. The latent temperature, sense heat, and vegetation cover were all high in March at the Mosul station, but in April at the Erbil station, the sensible heat was high in July and the latent heat and vegetation covers were high in April. June saw a high level of vegetation cover at Diyala Station, while July and August had high sensible heat and June saw high latent heat. The difference in monthly mean between high and low vegetation levels and thermal radiation (SH, LH).

Analysis of High and low vegetation covers for stations in Iraq

Fig. 7 displays the greatest cumulative annual mean of HVC over Iraq from 2008 to 2022, encompassing northern sites like Mosul and Tikrit. The data spans 15 years. Weather-related factors, such as excessive humidity and low temperatures, are to blame for this. As a result, numerous clouds and rains are created, which promotes the growth of plants with a lot of cover. Type of soil, amount of water, and heat capacity the characteristics of the central and southern stations are high temperatures, low humidity, and high solar radiation, which reduces the number of clouds and prevents rain, as well as the characteristics of the surface as well as the many air masses passing over the country. may contribute to the development of dense vegetation cover.

Fig. 8 demonstrates that northern locations, such as Dokan and Sulaymaniyah, have the greatest cumulative annual mean of HVC. Weather-related factors, such as excessive humidity and low temperatures, are to blame for this. Due to the abundance of clouds and precipitation that result from this, plants with limited cover can flourish due to factors including soil type, water content, and heat capacity. The central and southern stations are distinguished by high temperatures, low humidity, and high solar radiation. These factors, along with the characteristics of the country's surface and the different air masses that blow over it, contribute to the formation of low vegetation cover. They also cause a decrease in cloud cover and a lack of precipitation.

The analysis of sensible and latent heat for stations in Iraq

Fig. 9 indicates that, throughout the spring and summer, the Kut and Hit stations have the greatest total annual mean of sensible heat. This is because of high temperatures and sun radiation. This results in an elevated sense of heat. Low temperature and low sun radiation, along with the characteristics of the surface and the many air masses blowing over the country, are what contribute to the lowest total yearly mean of sensible heat over Sumel throughout winter and fall.

Fig. 10 demonstrates that throughout the spring and summer, Kirkuk, Sumel, Saladin Resort, and Dokan stations have the greatest total annual mean of sensible heat. This is because of meteorological conditions, including high temperatures and strong sun radiation. This results in an elevated sense of heat. The low temperature and low SR, along with the characteristics of the surface and the various air masses blowing over the country, are what cause the lowest total yearly mean of latent heat over Najaf, Karbala, and Diwaniyah stations during winter and autumn.

CONCLUSIONS

The vegetation cover is present throughout the year but varies according to the seasons. During the winter months, a high percentage of the cover was in contrast to the hot summer seasons. The positive relationship was between LVC in the years 2008-2022, and this is due to Opinion and farmers' follow-up of LVC (for crops). The inverse relationship was between the HVC in the years 2008-2022, and this is due to the high temperatures and other weather factors, such as the lack of rain. The low cover has a heating effect on the weather, while the high cover has a cooling effect during the study period. The high vegetation cover reaches about 2.51 in Mosul, 2.20 in Diyala, and 1.87 in Erbil stations. that the low vegetation cover reaches about 0.49 in Mosul, 1.09 in Diyala, and 1.64 in Erbil stations. The low vegetation cover was highest in April at the Erbil station and lowest in June at the Mosul station, while the high vegetation cover was highest in the Mosul station in all months. While the sensible heat was highest in July for the Erbil station and lower in December at all stations, the latent heat was highest in June for the Diyala station and less in September for the Erbil station.

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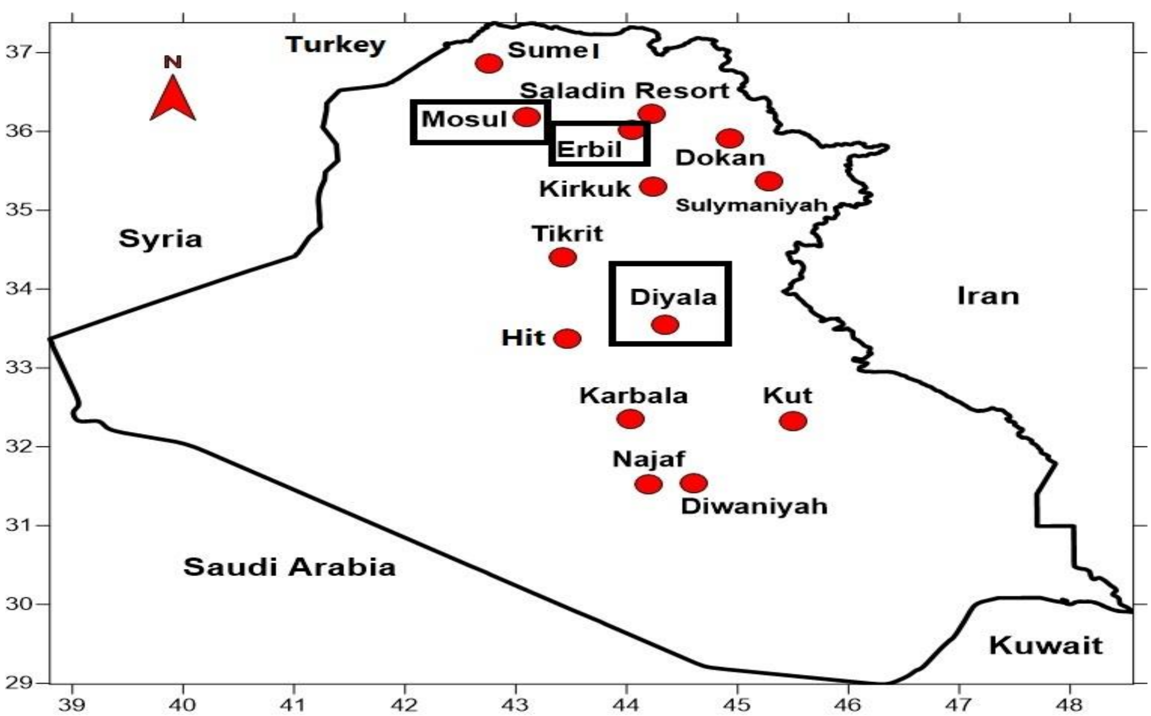

Fig. 1. The Iraq map, illustrates the location of the study stations ((Kurdistan region (Sumel (Duhok), Saladin Resort, Erbil, Dokan, Sulaymaniyah), Mosul, Kirkuk, Diyala, Tikrit, Hit (Anbar), Kut, Karbala, Najaf, and Diwaniyah) and Neighboring countries (Turkey, Iran, Syria, Saudi Arabia, and Kuwait).

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TABLE 1. The station name, vegetation type (tree and grass), altitude in meters, longitude in degrees East, and latitude in degrees North.

Stations		Vegetation type (tree and grass)	Altitude (m)	Longitude (°E)	Latitude (°N)
Kurdistan region (North of Iraq)	Sumel (Duhok)	LVC	250	42.75	36.87
	Dokan	LVC	276	44.95	35.95
	Saladin Resort	LVC	658	44.35	36.27
	Erbil	HVC	420	44.03	36.18
	Sulaymaniyah	LVC	882	45.43	35.55
North of Iraq	Mosul	HVC	223	43.15	36.35
	Kirkuk	LVC	331	44.35	35.47
Middle of Iraq	Diyala (Baqubah)	HVC	44	45.40	33.53
	Tikrit	LVC	137	43.70	34.57
West of Iraq	Hit (Anbar)	LVC	53	42.75	33.63
South of Iraq	Kut	LVC	21	45.75	32.49
	Karbala	LVC	28	44.05	32.57
	Najaf	LVC	53	44.32	31.05
	Diwaniyah	LVC	20	44.95	31.95

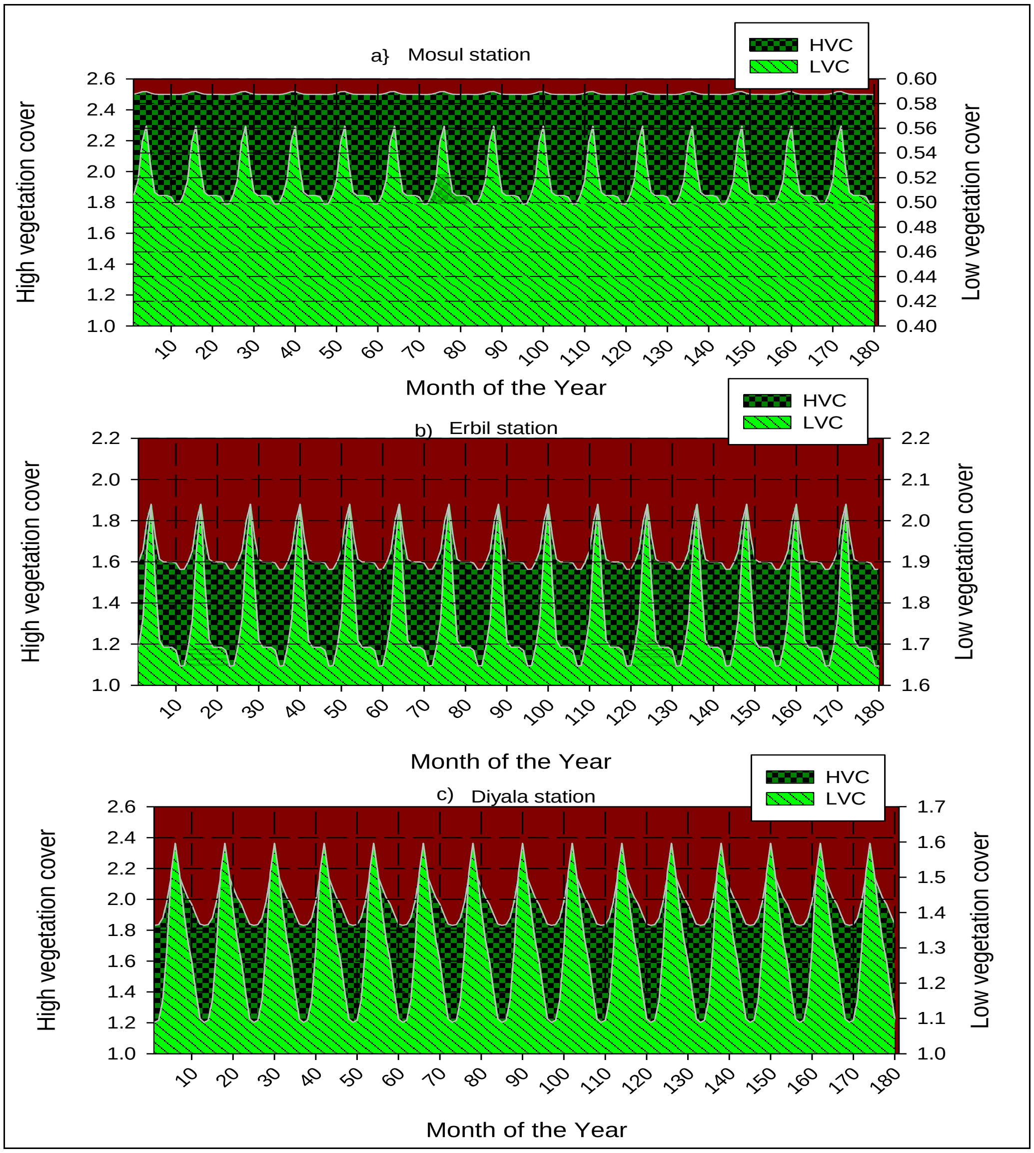


Fig. 2. The month-of-the-year distribution of vegetation cover types (HVC and LVC) over Iraqi Stations a) Mosul, b) Erbil, and c) Diyala for the period 2008-2022.

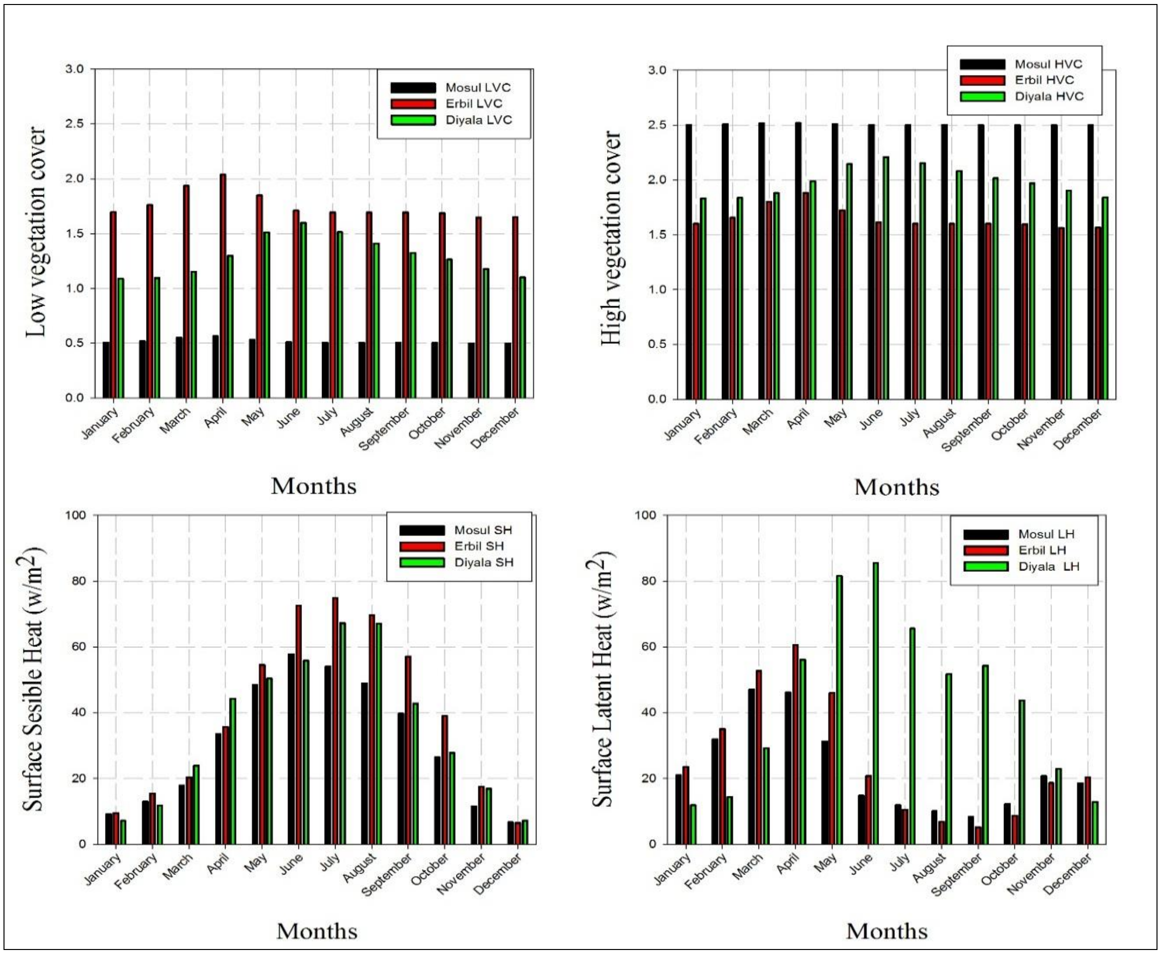


Fig. 3. Comparison between vegetation cover types (LVC, HVC), and surface heat types (LH, SH) for three study stations (Mosul, Erbil, and Diyala).

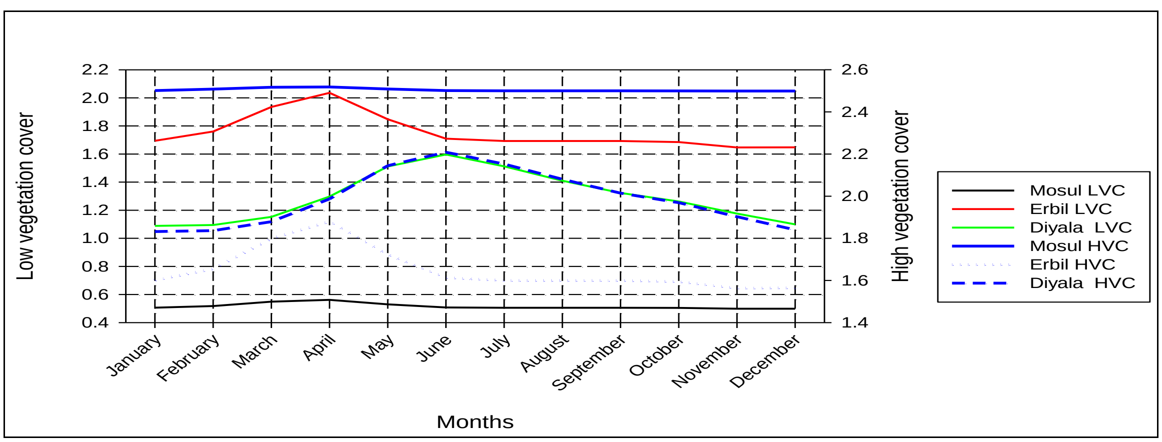


Fig. 4. The monthly mean distribution of vegetation cover types (LVC, HVC) and surface heat types (LH, SH) in Iraqi stations for the period 2008-2022.

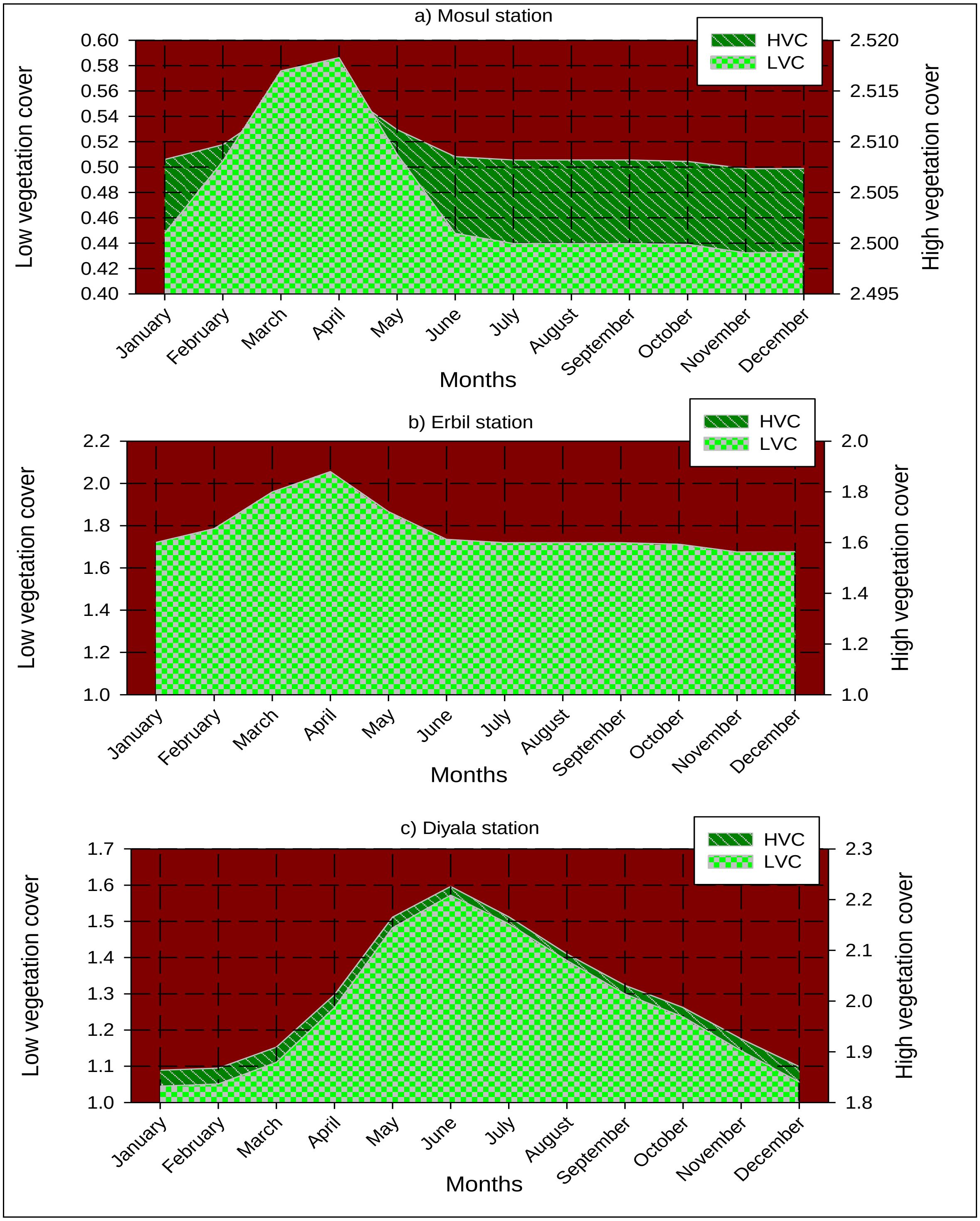


Fig. 5. Behavior of monthly mean vegetation cover types over Iraq stations, a) Mosul b) Erbil, and c) Diyala.

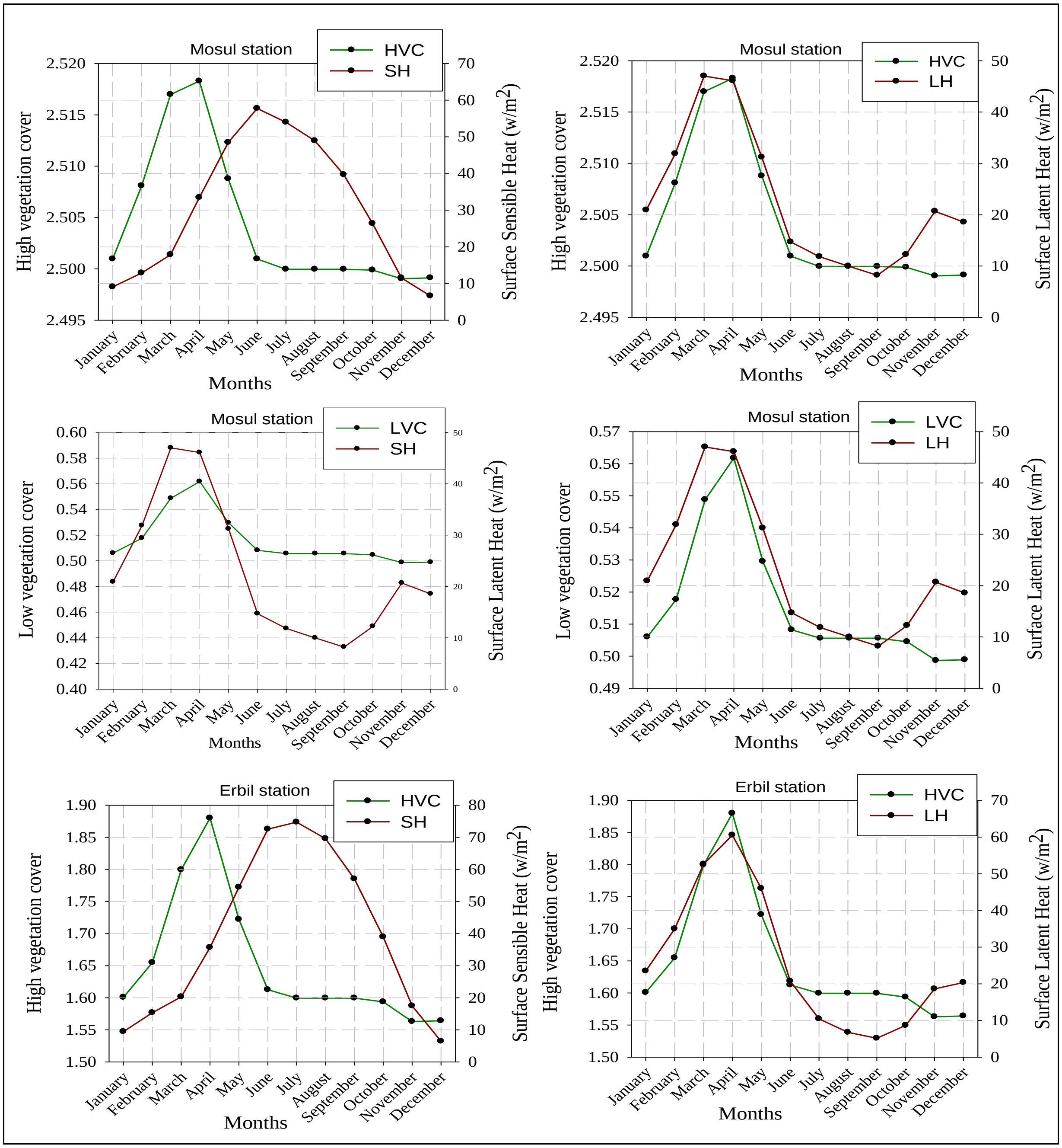
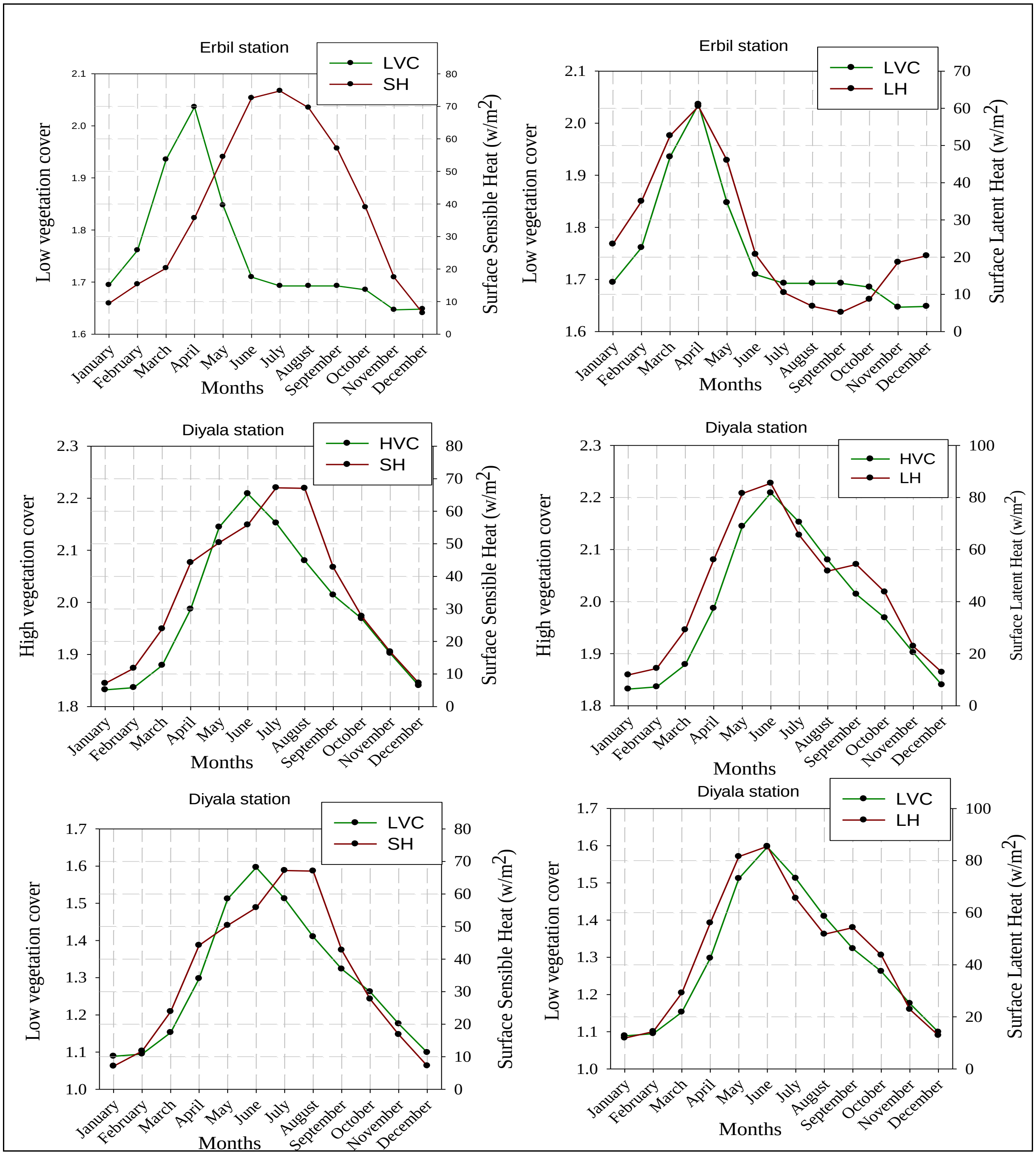


Fig. 6. Analysis of monthly mean of the vegetation cover types (HVC, LVC) with surface heat types (SH, LH) for (Mosul, Erbil, and Diyala) stations.



Followed Fig. 6.

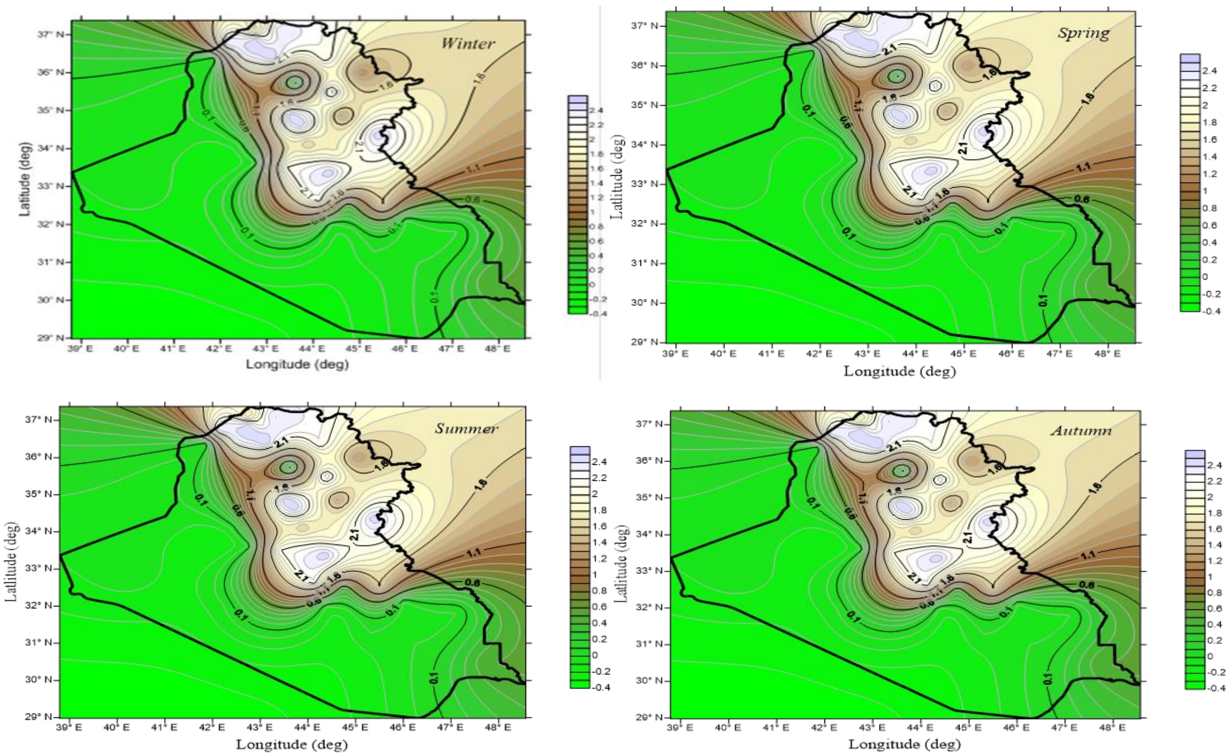


Fig.7. The total yearly mean of high vegetation cover over Iraq for 15 years, from 2008 to 2022.

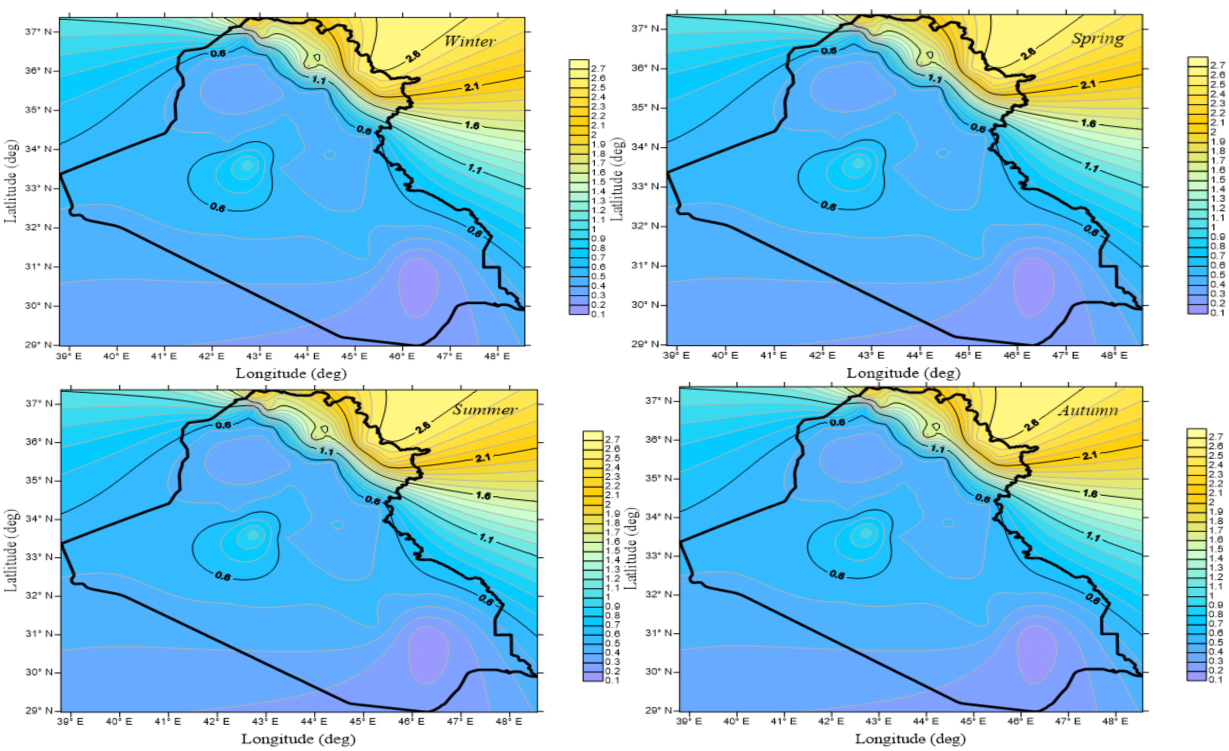


Fig.8. The total yearly mean of low vegetation cover over Iraq for 15 years, from 2008 to 2022.

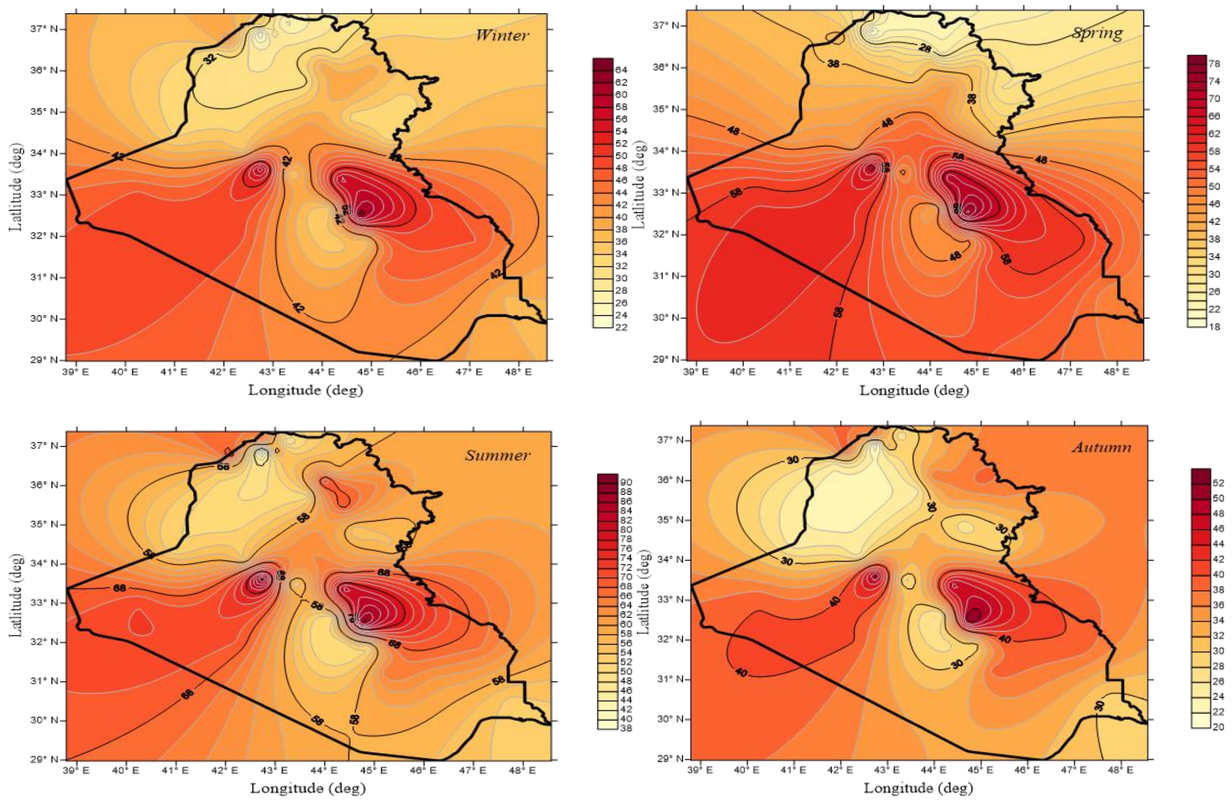
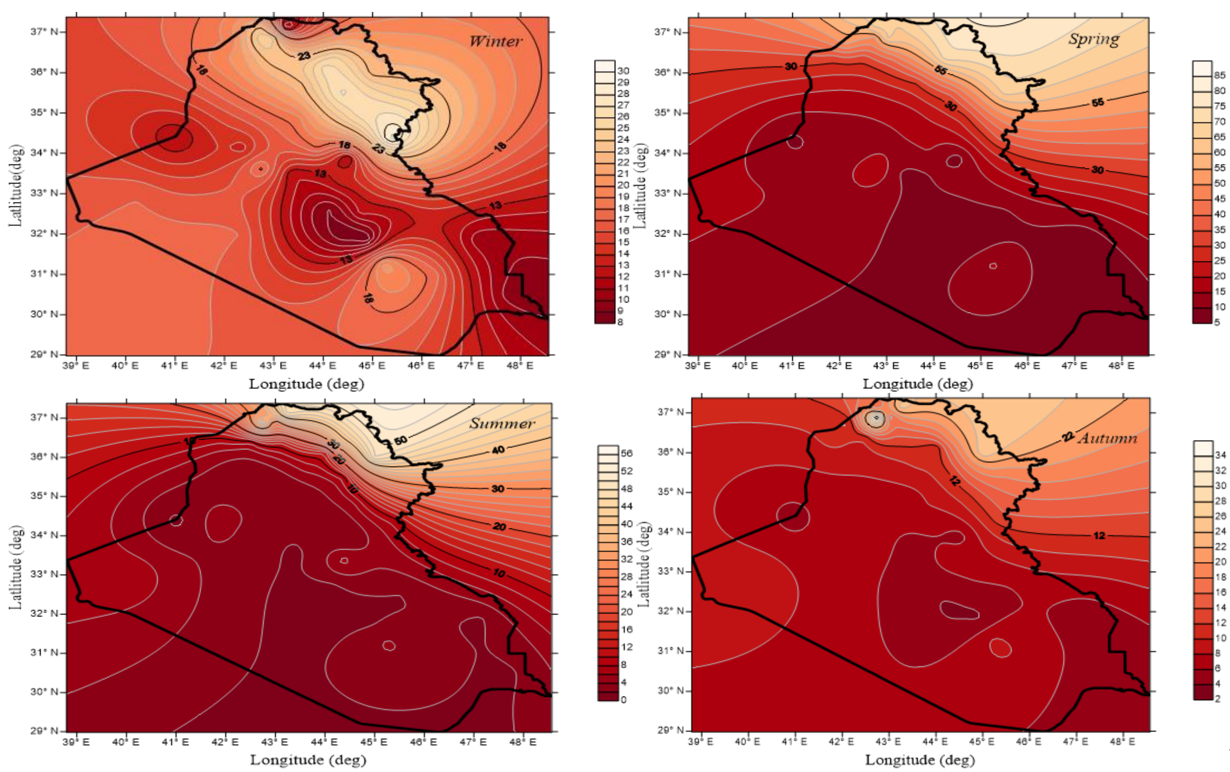


Fig.9. The total yearly mean of surface sensible heat over Iraq for 15 years, from 2008 to 2022



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g.10. The total yearly mean of surface latent heat over Iraq for 15 years, from 2008 to 2022.