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DETERMINING THE LIMITS OF THE NATURAL DISTRIBUTION OF PINE TREES USING RS TECHNIQUES AND GIS IN DOHUK GOVERNORATE

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Abstract

The study was conducted in the natural forests scattered in Dohuk governorate in northern Iraq and on trees of (*Pinus brutia* Ten.) and oak species (*Quercus spp.*), which constitute the largest percentage of the forests spread in the study area, as well as other types of trees and shrubs, but to a lesser degree. Determining the study area through field visits and using the Global Positioning System (GPS), by defining the outer limits of the study area and on a total area of (495.47 km²), and these forests are located on a latitude ranging from (36° 50' 0" N - 37° 0' 0" N) and a longitude ranging from (43° 5' 0" E - 43° 25' 0" E), and (542-1603) meters above the level of The sea surface, and the study area is located within the mountainous areas with geographical and environmental diversity, and the topographic factor (elevation, aspect and slope) is one of the factors that play a role in the distribution of vegetation covers. The results of the Sentinal-2 data analysis in the growing season and using the directed classification method showed that the total forest area amounted to (181.84) km² and a percentage of (36.7%) and other uses (313.63) km² and a percentage of (63.3%) and a total accuracy of (91%)) according to the error matrix, and the statistical scale (Kappa) reached a percentage of (0.82) As for the results of the static season analysis in order to determine the distribution limits for pine trees, the area of coniferous forests reached (34.30) km² and constituted (7%) of the total area of the study site, and the classification accuracy reached According to the error matrix (92%) and according to the Kappa scale (0.84) these results are consistent with the reality of the study area.

1. Introduction

Analysis and classification of tree species and tree species groups has a long history in the field of remote sensing. Recently, climate discussions have become more prominent and forests are among the ecosystems most affected by climate change [1]. Therefore, an understanding of forest dynamics and quantitative methods to assess climatic impacts on species distributions are of great relevance. Further interest in analyzing forest structures is driven by users of environmental monitoring, spatial planning enforcement

or ecosystem-oriented natural resources management systems [2,3]. In recent years, deca-metric-resolution imagery (e.g., Landsat) was easier accessible and often cost-free for a broad majority of users, leading to many research projects. With the launch of the Sentinel-2 series in 2015 (Sentinel-2A), a new mission of free and open satellite data with the main objective in land monitoring, new possibilities for research came into existence. The 180° phased twin-satellite constellation was completed with the launch of Sentinel-2B in March 2017. In the context of forest analysis, the Sentinel-2 mission is very important due to 10 m spatial resolution bands in the visible and the near infrared region (VNIR) as well as four bands (5, 6, 7, 8a) of 20 m resolution in the red-edge region of the electromagnetic spectrum and two bands (11,12) of 20 m resolution in the shortwave infrared (SWIR) [4]. The red-edge region is especially interesting, as it is well known for vegetation analysis and Sentinel-2 offers more bands in this spectral range than comparable satellite missions like the Landsat series. Fassnacht et al. [5] highlights that the respective visible to shortwave infrared Sentinel-2 wavelength regions mainly cover with absorption features of plant pigments and water, making it an ideal sensor for the analysis of vegetation characteristic. Thus, Sentinel-2 can set new standards for vegetation analysis with deca-metric-resolution imagery for areas that do not have a high complexity at a small scale. As the twin constellation of Sentinel-2 is phased at 180° in the same orbit, a high temporal revisit frequency of 5 days facilitates change detection analysis. It also has the advantage that many different scenes are available for one area of interest, which allows access to cloud-free data. Because of the limitations of such studies, we decided that our study in this field aims to achieve the following:

- Determining the limits of the natural distribution of Pine trees
- Mapping the forests and separating pine trees from the rest of the species.

2. Materials and Methods

2.1. Study Area

The study was conducted in the natural forests scattered in Dohuk governorate in northern Iraq and on trees of (*Pinus brutia* Ten.) and oak species (*Quercus spp.*), which constitute the largest percentage of the forests spread in the study area, as well as other types of trees and shrubs, but to a lesser degree. Determining the study area through field visits and using the Global Positioning System (GPS), by defining the outer limits of the study area and on a total area of (495.47 km²), and these forests are located on a latitude ranging from (36° 50' 0" N - 37° 0' 0" N) and a longitude ranging from (43° 5' 0" E - 43° 25' 0" E), and (542-1603) meters above the level of The sea surface, and the study area is located within the mountainous areas with geographical and environmental diversity, and the topographic factor (elevation, aspect and slope) is one of the factors that play a role in the distribution of vegetation covers. Figure 1. shows the geographical location of the study area.

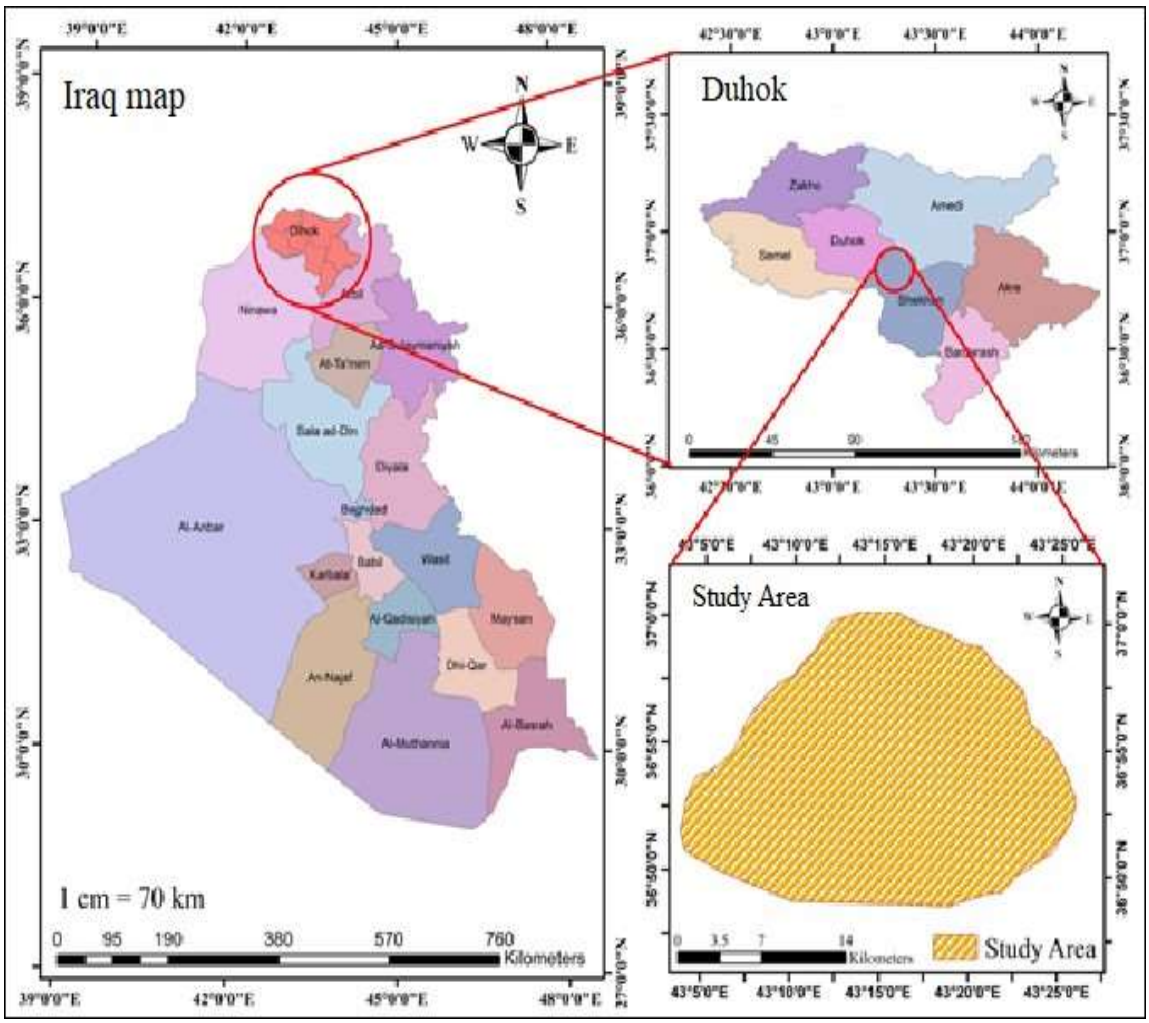

Fig 1. geographical location of the study area.

2.2. Data

In order to evaluate the potential of the Sentinel-2 data in an optimal scenario, several scenes were selected according to the criteria of minimum cloud cover for several stages of the vegetation period. Furthermore, data was selected for a year that was close to the data of the collection of the inventory data. Table 1. Data was downloaded and Spatial and Spectral resolution of Sentinel-2 show in Fig 2.

Table 1. Data time was downloaded and Spatial and Spectral resolution of Sentinel-2

Data	Time	Cloud Coverage %
29 Jun 2020	10:27 am	1 %
15 Jan 2020	9:30 am	9%

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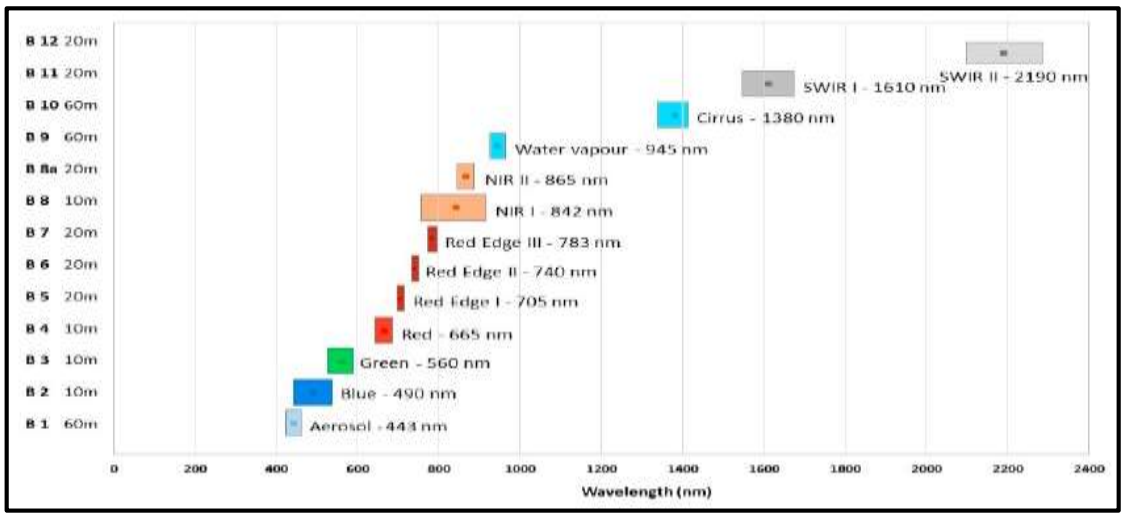

Fig 2. Spatial and Spectral resolution of Sentinel-2

Four spectral bands from the space manifest were used. Table .2 , The four domains were merged with the aim of creating and transforming the original visual domains into new ones that represent the objectives of the visual.

Table .2 . Spatial and Spectral resolution bands of Sentinel-2

No	Bands	Wavelength (nm)	Resolution (m)
1	Band-2 Blue	490	10
2	Band-3 Green	560	10
3	Band-4 Red	665	10
4	Band-8 Near Infrared	842	10

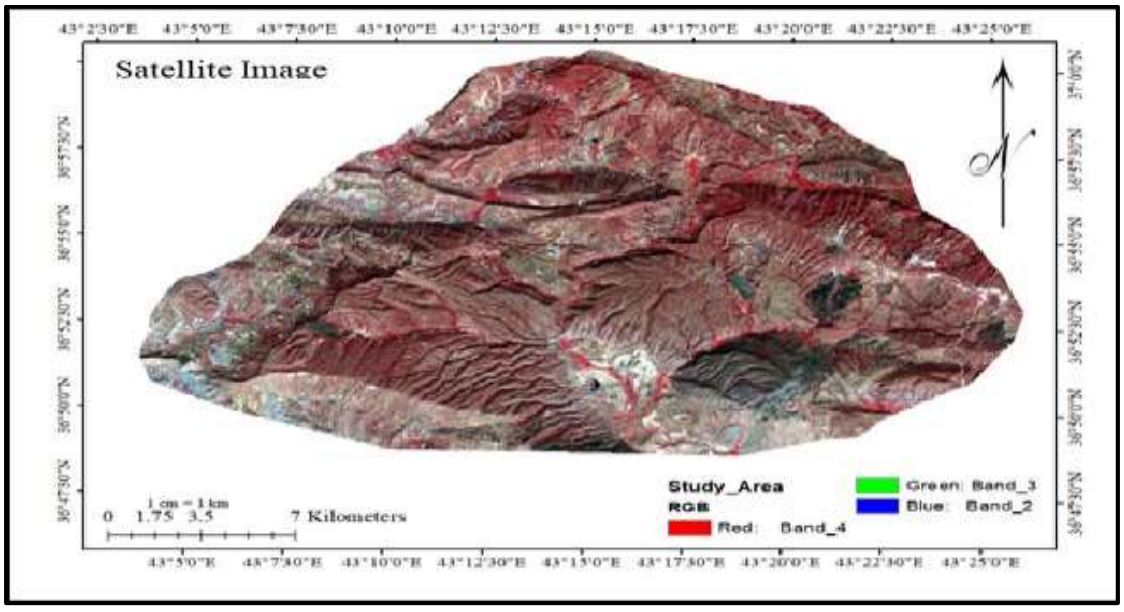

Fig 3. Satellite Image (Composite Bands)

2.3. Supervised classification and Accuracy Assessment

Supervised classification is the technique most often used for the quantitative analysis of remote sensing image data. At its core is the concept of segmenting the spectral domain into regions that can be associated with the ground cover classes of interest to a particular application. In practice those regions may sometimes overlap. A variety of algorithms is available for the task, and it is the purpose of this chapter to cover those most commonly encountered. Essentially, the different methods vary in the way they identify and describe the regions in spectral space. Some seek a simple geometric segmentation while others adopt statistical models with which to associate spectral measurements and the classes of interest. Some can handle user-defined classes that overlap each other spatially and are referred to as soft classification methods; others generate firm boundaries between classes and are called hard classification methods, in the sense of establishing boundaries rather than having anything to do with difficulty in their use. Often the data from a set of sensors is available to help in the analysis task.

The main goals of our study were to (1) evaluate Sentinel-2 data with its particular spectral bands but also multitemporal characteristics, to (2) use and compare different machine-learning algorithms.

3. Results and Discussion

3.1. Supervised Classification (29 Jun 2020)

The results of the first classification step, which is to identify the distributed forests in the study area, which include broadleaf and coniferous trees, are summarized in Table 3. Using the Supervised Classification method, which depends on the ground training areas, which were taken for all the species in the study site, the space data was classified into two categories (Forest and Non Forest): lands covered with forests and non-forest lands that include (natural pastures, barren lands, urban areas) and other uses) Fig 4.

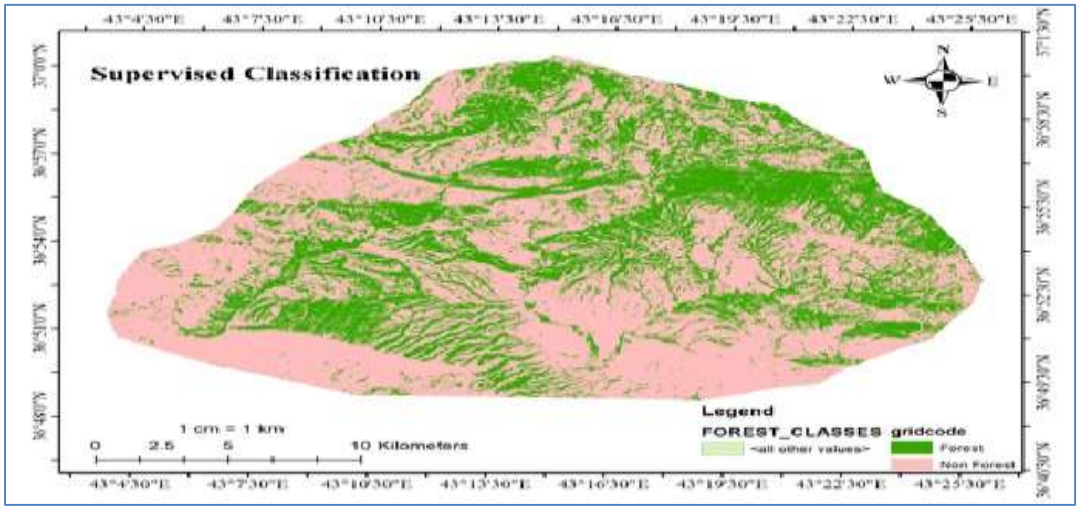

Fig 4. Classes in the supervised classification study site

The total area and percentage of each land type were calculated

Table 3. Classes, areas, and percentages for each classes in the study site

No	Classes	Area km²	Ratio
1	Forest	181.84	36.7 %
2	Non Forest	313.63	63.3 %
Total		495. 47	100 %

It is noted from the table that the area of lands covered with forests amounted to (181.84) km² and a percentage of (36.7%), while the area of non-forested lands reached (313.63) km² and a percentage of (63.3%). They are mixed natural forests of unequal age, and we note that oak trees of all kinds come in the first place and the protean pine in the second place, and the degree of mixing varies according to different locations and environmental conditions. different.

3.2. Accuracy Assessment of an Image Classification

After classifying and analyzing the satellite data of the Sentinel-2 satellite with a precision of (10) m, the classification accuracy was calculated, which is the real similarity between the classes classified on the satellite visual and compared to the data classified in the real world based on the scales used for these studies such as the error matrix for the percentages of each Classify and for the map as a whole, as in Table 4.

Table 4. Accuracy Assessment (29 Jun 2020)

Classes	Forest	Non Forest	Total (User)	User Accuracy %
Forest	92	8	100	% 92
Non Forest	10	90	100	% 90
Total (Producer)	102	98	200	-
Producer Accuracy %	% 90.1	% 91.8	-	-
Overall Accuracy		% 91		
Kappa Coefficient		0.82		

It is noted that we obtained an overall classification accuracy of (91%), and this indicates that the overall classification accuracy is good, also a single classification accuracy was obtained and the rates were high for all varieties, as forests reached (92%) and non-forests (90%), and it is considered These ratios are good and agree with what was reported [6]. The statistical scale (Kappa) was also adopted to calculate the accuracy of classification, which depends on the degree of difference between the ground control points that were installed and the changes that were classified for the site and compared, which reached an accuracy of (0.82), and this ratio is good for the ground covers in the study site.

3.3. Supervised classification to determine the limits of the natural distribution of pines (*Pinus brutia* Ten.)

For the purpose of determining the limits of the natural distribution of pine trees, the observed classification method was used for the spatial data captured in the winter season, by collecting field data, the coordinates of trees from different directions and heights. Accuracy in choosing the training points, and thus a map of the natural distribution of pine (*Pinus brutia* Ten.) trees was obtained, as shown in Fig 5.

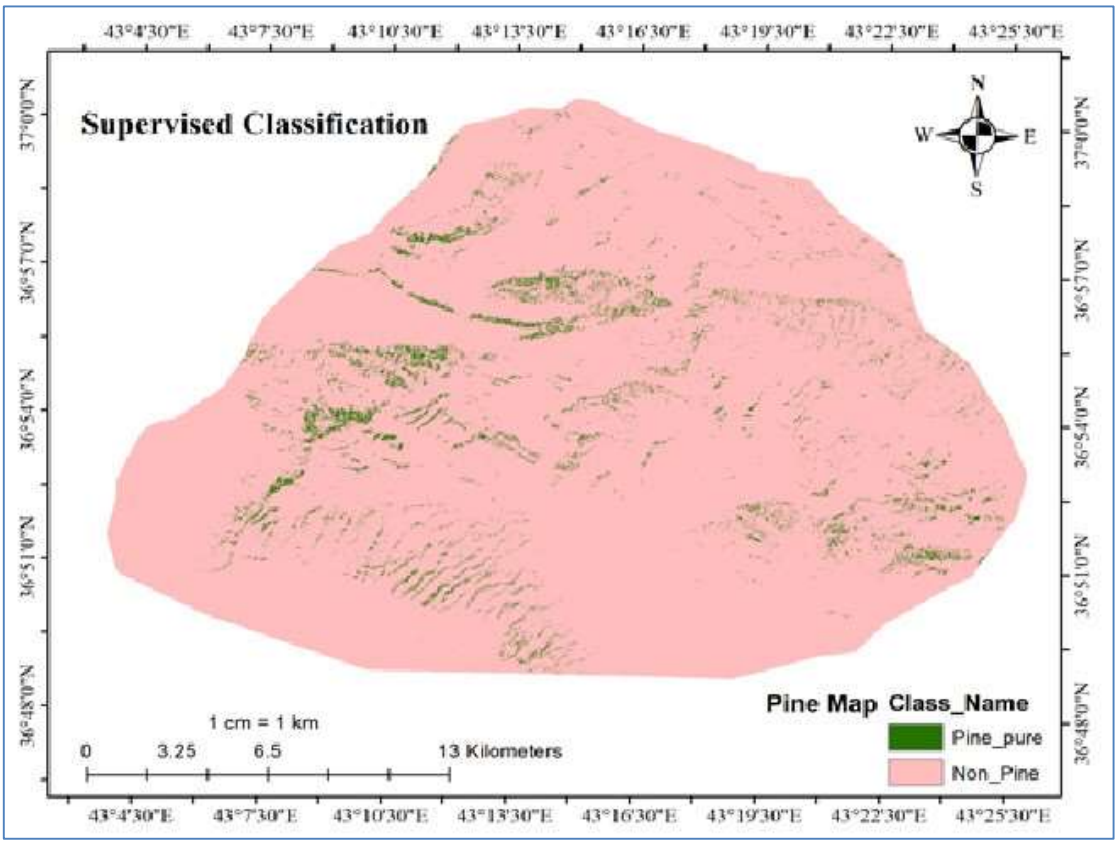

Fig 5. Map of the natural distribution of pine trees in the study site

It was found through the classification process that the pine trees were distributed in the study area over an area of (34.30) km² and a percentage of (7%) of the total area of the study site.

3.4. Accuracy assessment of an image classification for pine map (15 Jan 2020)

To calculate the classification accuracy and evaluate the classification map for the classified classes, the error matrix method was also used for the percentage of each class and for the map as a whole, and the statistical scale (Kappa) was used to assess classification accuracy, Table 5.

Table 5. Calculation of classification accuracy for pine tree boundaries

Classes	Pine Forest	Non Pine	Total (User)	User Accuracy %
Pine Forest	90	10	100	% 90
Non Pine	6	94	100	% 94
Total Producer	96	104	200	-
Producer Accuracy %	% 93.7	% 90	-	-
Overall Accuracy %		% 92		
Kappa Coefficient		0.84		

Table 5 shows that a total accuracy of 92% was obtained, and this indicates that the overall classification accuracy is good, while a single accuracy was obtained for each class as well. The percentage was high for both categories, reaching 90% for pine trees, and 94% for other uses. These percentages Accepted according to what has been adopted globally and this is indicated by [7]. The (Kappa) scale was also adopted to calculate the overall accuracy of the classification, as it reached (0.84), which is a good and reliable value.

4. Conclusions

Results of the present study indicate the high potential of Sentinel-2 data for applications in applied forestry and vegetation analysis despite the deca-metric spatial resolution.

1- The multi-temporal spatial data during the growth period of the year, the influential role in separating the Pine Brute trees from the other deciduous trees.
2- The classification according to the indicators is one of the appropriate methods for the study site, as it can be relied upon in classifying the lands with complex topographies, since the classification operations according to the indicators depend on mathematical equations specific to each indicator, so it can be used to estimate the densities of trees.

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