Land Cover Classification Using Remote Sensing in Amadiyah Province

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Abstract

This study was conducted on the vegetative and non-vegetative land cover spread in the Amadiya District of Dohuk Governorate, northern Iraq, located between longitudes (43 ° 25'24.309” - 43 ° 11'6.839”) east and latitudes (37 ° 12'36.359” - 37 7'25.484”) north. They rely on a spatial indication of accuracy (10 m) and are reduced to (5 m) from Sentinel -2. Using unsupervised classifications, to form a general perception of the items in the studied area. As the number of varieties and the number of spectral bands used were determined, then the Supervised Classification to classify the spatial indication at the site to determine the plant and non-plant ground targets. These two classifications resulted, using the (ArcGIS) program, we obtained 12 types when classifying the space declaration for the Amadiyah district. We noticed that the area occupied by the terrestrial targets of the site are (water, medium-density forests (sloping lands), medium-density forests (flatlands), low-density forests (sloping lands), low-density forests (flatlands), limestone rocky areas, dense forests. (Sloping lands), limestone and paved roads, barren lands, residential areas, pastures, dense forests (flatlands) and their areas respectively are (283.9 - 408.6 - 556.2 - 829.2 - 983.6 - 1022.8 - 1066.4 - 1138.8 - 1148.5 - 1172.2 - 1218.4. - 1272.4) km².

The classification accuracy of the spatial indication was estimated based on the error matrix and the Kappa test. From there we found that the accuracy was (84.6%) for the error matrix and (83.34%) for the Kappa test, and this indicates that the classification accuracy is very good It is acceptable and can be relied upon and recommended for classification.

Keywords: Natural forests, Remote sensing, Mixed forests, Land Cover Classification.

1. Introduction

Forests are a renewable natural resource that plays a major role in preserving the environment. In addition to their role in the production of various wooden products and services, which we live in, it is a shelter for wild animals, a renewable source of pure natural water, and also tourist areas. From that, we see that the forest department undertakes many basic natural products within the areas that are spread over by the forest. Therefore, the preparation of sustainable plans for forest natural resources requires us to rely on a database of the site with high accuracy. This requires us to carry out an inventory of the forest and to know what it contains the various natural resources available on the site.

Whereas the traditional inventory process requires a lot of time, high costs, and expertise to implement the inventory process and to bypass these obstacles and obtain information for administrative decision-making that is based on sound scientific foundations, remote sensing techniques R.S and Geographic Information Systems (GIS) have been used in mapping and managing renewable natural resources and this corresponds to With what he mentioned [1].

It is also consistent with what [2]. Indicated that the geographic information system (GIS) is a data collection technique that has been used in drawing environmental decision-making policies and forest planning in the past two decades. Forests management has expanded its tasks, products that were previously considered by-products have become priorities at present, and also monitoring forests from space, classifying them, and conducting surveys on them are important for many activities related to determining vegetation covers and forests and in managing natural resources and reforestation. Forests and other matters related to forest management.

This means that surveying the site and knowing what it contains from the natural resource and the way it is distributed on the site is of great importance in managing the natural resources with high efficiency. And one of the basic information about its area, varieties, and distribution. All this information that is obtained using modern technologies such as a statement of remote sensitivity, a geographic information system, and a global location system has increased in use in the field of forest management because of the information it provides, it is considered the main database in making many administrative decisions towards the sustainability of natural resources and this is consistent with what has been Cited by [3].
Also, determining the type of data that needs to be collected by the administrator depends on the main objectives of the inventory process itself. In general, the forestry administration needs multiple data on the resources contained in the area unit, which is considered a basis for preparing sustainable management plans for those resources. [4], explained that the use of remote sensing techniques, geographic information system, and land sites, whether used alone or in combination, have a wide range of applications from simple to complex, so the simple application includes the identification of different sites, and maps of different pieces for use in the field or the distributions of different types of soils and their correlation with the productive capacity of the species. And the most complex in the application, which includes the classification of vegetation covers, their productivity, and environmental impacts. Therefore, this study aims to prepare a database for the various areas that occupy the land cover in the Amadiyah district in the North.

2.MATERIALS AND METHODS

The study conducted the different land sites in the district of Amadiyah, Dohuk Governorate, in northern Iraq. The area includes mountain topographies in which the various types of ground targets used for various purposes are spread, using remote sensing techniques and geographic information systems as well as a ground inventory to obtain data from all aspects and the Amadiyah Center. Integration between these means gives the administrator a clear picture of the vegetation cover and others, the areas they occupy, and the distribution of these varieties and their proportions on the site. In addition to the fact that the cost of this information is low and can be obtained easily and helps to shorten the time to obtain information and reach areas difficult to reach by the survey, as mentioned [5].

Geographic information systems can link spatial data that are specified by x, y coordinates) in the form of descriptive information about the location that we obtain from the space indication. And obtaining very accurate results using the Arc GIS program to indicate an accuracy of 5 m.

The satellite indication captured by ETM + (Enhanced Thematic Mapper plus) from the sentinel-2 satellite on 9/9/2019 was used. The reflectivity of vegetation and other ground targets was measured through the used channels and these blue wave channels (1) and the green vector channel (2), the red vector channel (3), and the near-infrared vector channel (4).

![Figure 1. The satellite statement captured by the sentinel-2 satellite with spatial accuracy (10 m) that includes the Amadiyah district.](image)

3. IMAGE CLASSIFICATION

The visual classification aims to recognize the visual parameters automatically, by applying the rules of decision (Rules Decision) and based on statistics to determine the area of the ground cover for each pixel of the visual. The non-directed classification is one of the types of digital classification of space data and this classification is used in rugged and rugged areas and areas that we do not have prior knowledge of it and this applies to the steep, steep area of Amadiyah which is difficult to reach in many of its areas. The non-directed classification is used to create a general perception of the existing varieties, especially when there is no knowledge in the studied area.

Through the indication-oriented classification, we were able to classify the particular site in a tangible area into various parts and according to the terrestrial objectives, and each part has its use that differs from another use, as indicated by [6]. It appeared to us through the classification of various goals and the areas they occupy, as in Table (1).

Also, the space statement was re-classified by a supervised classification within the coordinates and points taken for the targets during field visits to the study area, to determine the land features representing each class on the visual, and to choose the training areas in light of the field information and the specific points in the field. Satellite images of satellites according to the method of classification by Gaussian probability [7], (Classifier Likelihood Maximum), Supervised Classification et al, as one of the methods of directed classification. Land cover patterns, and then these data were processed and classified using the software. (Arc GIS10), and its classification and the reason for using this is due to the accuracy of the classification of cells in this method than in other methods [7], Table (2).
Table 1. Shows the total area distributed among the types of land use for the study area.

| No. | Objectives                  | Area / km² | percentage% |
|-----|----------------------------|------------|-------------|
| 1   | waters                     | 283.89     | 2.6         |
| 2   | Rocky slopes               | 983.61     | 8.9         |
| 3   | Medium density forests     | 1138.83    | 10.3        |
| 4   | Barren rocks               | 829.23     | 7.5         |
| 5   | Low-density forests        | 1066.42    | 9.6         |
| 6   | Calcareous rocky area      | 1172.19    | 10.6        |
| 7   | High density forests       | 556.09     | 5.0         |
| 8   | Limestone rocks and tiled roads | 1272.37 | 11.5       |
| 9   | Barren land                | 1218.39    | 11.0        |
| 10  | Residential areas          | 1148.47    | 10.3        |
| 11  | Pastures                   | 1022.80    | 9.2         |
| 12  | Agricultural lands         | 408.55     | 3.7         |

Table 2. shows the targets, areas, and percentages of the ground targets by the method of classification directed to the study area in the Amadiyah district.

| No | Objectives                                      | Area / km² | percentage% |
|----|-------------------------------------------------|------------|-------------|
| 1  | High-density forests (land sloping)             | 556.1      | 5.0         |
| 2  | High density forests (flatlands)                | 408.6      | 3.7         |
| 3  | Medium density forests (sloping lands)          | 983.6      | 8.9         |
| 4  | Medium density forests (flatlands)              | 1138.8     | 10.3        |
| 5  | Low forest density (sloping) land               | 829.2      | 7.5         |
| 6  | Low forest density (flatlands)                  | 1066.4     | 9.6         |
| 7  | Pastures                                       | 1022.8     | 9.2         |
| 8  | Calcareous rocky area                           | 1172.2     | 10.6        |
| 9  | Barren land                                     | 1218.4     | 11.0        |
| 10 | Limestone rocks and roads paved                 | 1272.4     | 11.5        |
| 11 | Residential areas                               | 1148.5     | 10.3        |
| 12 | waters                                         | 283.9      | 2.6         |
|    | Total                                           | 2775213100 | 100         |

4. Results and Discussion

4.1. Image Classification

Visual classification is a process in which the space indication is transformed into an objective map that carries information about the phenomena and targets in the photographed area. (BGR-NIR) for a preliminary classification to determine the ground targets at the study site for the Amadiyah district, and this is consistent with what was mentioned [8].

4.2. Unsupervised Classification

Use the unsupervised classification to create a general picture of the existing varieties, especially when there is no knowledge in the studied area. Unsupervised classification is appropriate for the study area in terms of the topography of the area and a large number of species in it. In this classification, the computer is instructed to carry out the classification process according to the number of the selected varieties, depending on that, the reflectivity characteristics of the land cover, and for this reason, the space declaration of Amadiyah district was classified as an unsupervised classification into 12 classes.

Due to the lack of information about the area and after classifying the indication, it was compared with the false-colored indication which was merged for the ranges (red B4 - green B3 - blue B2). Where the covers that are similar to each other are grouped to represent one class of the earth types, through which the image units (spatial indication) with similar spectral characteristics are identified, which are assumed to belong to the same type and recorded in one color. And then viewing the classification results, after which the identification of the items begins by comparing them with maps and other auxiliary sources (ground control points), and then some of the items appearing in the classified image of the study area were identified.
Figure 2. Amadiyah district map is classified as a classification that is not directed at the targets in the study site.

From the items identified in the map (2), we drew the different land varieties and the areas occupied by each category, and their percentage of the total area covered, figure (3).

Figure 3. The land varieties with the area and percentage of each category in the Amadiyah district are classified as an unsupervised classification.

We note from the figure (3) that there are clear differences between the ground varieties (ground targets) spread in the study area in terms of the area of each type as well as their proportions, as the area for each type ranged from 1272.4 to 283.89 km² and the ratios ranged between (11.5 to 2.6%) for each type.

As the limestone rocks and tiled roads came in first place with an area of 1272.4 km² with a rate of 11.5%, then barren lands came in second place with an area of 1218.4 km² and a rate of 11.0%, but in the last place in terms of area and proportions, the water category came with an area of 283.89 km² and 2.6%. The areas are 100% inaccurate because there are some details or varieties that overlap with each other, and this is a problem when classifying, especially about vegetation covers, as it shares with all these varieties, especially we noticed that forests are scattered around barren rocks in the heights as well as in the rocky slopes, as well as in agricultural lands.
We noticed the abundance of forest trees spread in them as windbreaks and scattered or present in clusters on agricultural lands, so the use of this classification in urban and mountain forests gives good, fast, but inaccurate results. This is in agreement with what [9]. Stated, that remote sensitivity data can be a useful tool for the administrator to identify the various varieties and their proportions in the site he initiates, although it is not accurate as is the case in the data collected on the ground, which is an economical method as well.

Then, fieldwork was conducted to identify the unclear items in the satellite image well, with coordinate points taken as checkpoints to classify them correctly and more accurately. The targeted classification was used to more accurately identify ground targets from the spatial indication.

4.3. Supervised Classification

The satellite image was reclassified by a supervised classification within the coordinates and points taken for the targets during the field visits to the study area, to determine the land features representing each class on the visual, and to choose the training areas in light of the field information and the points identified in the field. Also, the directed classification of all the targets and the ground types in the space declaration of the study site in this study was adopted in the process of classifying the satellite visual data on the method of classification with the greatest Gaussian probability [7]. (Classifier Likelihood Maximum), Supervised Classification et al. As one of the methods of classification. The vector and used probability factors to classify the unknown pixels, by calculating the probability value of cells belonging to each class of land cover types, and after that, these data were processed and categorized. (Arc GIS10), and their classification and the reason for using this is due to the accuracy of the classification of cells in this method than in other methods [7].

![Figure 4. A map of Amadiyah district, categorized as a categorization directed at the targets in the study site.](image)

Where he directs the classification process through the determined training areas. And with the help of auxiliary sources and spectral characteristics of each tax expected to exist. As indicated by [10], as the topographical and thematic maps, the training areas were defined in the field, after which the file editor signature was constructed, and in the Likelihood Maximum method, the satellite visual classification process covering the study area was completed. Land and land cover using directed classification

The area of forest covers and pastures intertwined with each other occupied (6005.5 km²), so its percentage amounted to (54.1%), which is increasing and decreasing one at the expense of the other, and this area is good as it covers vast areas that are used for grazing operations and are a refuge for many wild animals also. Besides, from the environmental point of view, it maintains the temperatures in the summer and increases the rate of rain and water in the winter in addition to giving an aesthetic to the area. Many tourists from different regions flock to it and thus stimulate the economy, but some forests are exposed to unjust and continuous cutting operations, which leads to the transformation of these forests into Pastures, on the contrary, we notice that some pastoral areas turn into forests as a result of afforestation and maintenance for these areas, so the cover class changes from pasture to forests.

As for the area of forests, pastures, and rocky areas, they were varied, as the area of forests at the study site was (4982.7) km² from the area of the site and its percentage was (44.9%), while the area of limestone and paved roads was (1272.4 km²) with a rate (11.5%) It came in second place, while Almarai came in third place, and it amounted to (1022.8 km²), a ratio of (9.2%)
of the total area of the site. This indicates that the site is rich in forest trees, where forests are well spread and at high rates compared to other non-tree targets.

As for residential areas and water, there was a big difference in the area, as the area of residential areas amounted to (1148.5 km\(^2\)) and by (10.3%) of the total area of the site. As for the area of water, it was few compared to the other goals, as it reached (283.9 km\(^2\)) in terms of area and at a rate of (2.6%) of the total percentage of the study area. The reason for the lack of water is the wrong use of water resources, whether ground or surface, and the removal of vegetation covers and their transformation into Residential areas and thus reduces the amount of water held by the vegetation covers when rain falls and descends into the ground to be shaken. Likewise digging tropical wells frequently also reduces the amount of water that comes out from the ground in the form of springs that feed rivers and prevent their drying, so when wrong use of these water sources leads to the drying of running rivers and springs, thus reducing the amount of water on the surface of the earth. We also note the areas and proportions of the varieties. (Goals) to spend Amadiyah in Figure (5).

![Figure 5. The land varieties with the area and percentage of each category in the Amadiyah district, classified as supervised classification.](image)

After analyzing and classifying the space indication from the Sentinel-2 satellite, with a spatial resolution of 5 m. These are consistent with what he indicated [8]. And obtaining 12 varieties that were identified and compared with the ground control points, and verifying these varieties and found that they are identical to what is found in the area. Density (flatlands) - low-density forests (sloping lands) - low-density forests (flatlands) - limestone rocky areas - limestone and paved roads - barren lands - residential areas - pastures - water).

The classification accuracy of the spatial indication was calculated and evaluated depending on the measures used for such studies, which is the Error Matrix for the percentage of each class and the map as a whole, as well as the Kappa test.

4.4. Classification Accuracy for Ground Targets

The use of the process of assessing the classification accuracy of the different spatial indication elements is of particular importance in classifying the terrestrial targets and the vegetation cover, and through this accuracy, we can determine the extent to which the classification matches these targets and covers, and the possibility of reliance on the prepared map and its future use. Therefore, the stratified random sampling method was used to evaluate the classification accuracy of the land cover in Amadiyah district by taking (112) ground control points to determine this accuracy. Obtaining an accuracy of more than 70% is good, and this is what [11]. Indicated.

The accuracy of the classified space indication was calculated. We got an accuracy rate of (84.6%). This indicates that the overall classification accuracy of the above classification is good. The accuracy of the classification was obtained, and the percentage was high for all varieties, reaching (91.7%) for residential areas, and the lowest (75%) for medium density forests on flatlands. This is acceptable as indicated by [11]. The reason for the low percentage of medium-density forests in flatlands is the overlap of species and densities and their proximity to other varieties.
Table 3. Represents the accuracy of the classification map prepared from the Sentinel-2 satellite statement for the year 2019.

| Varieties or Objectives | Waters | Medium density forests (sloping lands) | Medium density forests (flatlands) | Low-density forests (land sloping) | Low-density forests (flatland) | Calcareous rocky area | High density forests (sloping terrain) | Limestone rocks and roads paved | Barren land | Residential areas | Pastures | High density forests (flatlands) | SUM |
|-------------------------|--------|----------------------------------------|------------------------------------|----------------------------------|--------------------------------|----------------------|----------------------------------------|---------------------------------|-------------|-------------------|---------|-------------------|-----|
| Waters                  | 8      | 0                                      | 0                                  | 0                                | 0                              | 0                    | 0                                      | 1                               | 0           | 0                 | 0       | 0                 | 9    |
| Medium density forests  | 0      | 6                                      | 0                                  | 1                                | 0                              | 0                    | 0                                      | 0                               | 0           | 0                 | 0       | 0                 | 8    |
| Medium density forests  | 1      | 0                                      | 6                                  | 1                                | 0                              | 0                    | 0                                      | 0                               | 0           | 0                 | 0       | 0                 | 9    |
| Low-density forests     | 0      | 1                                      | 0                                  | 6                                | 0                              | 0                    | 0                                      | 0                               | 0           | 0                 | 0       | 0                 | 8    |
| Low-density forests     | 0      | 0                                      | 1                                  | 0                                | 7                              | 0                    | 0                                      | 0                               | 0           | 0                 | 0       | 0                 | 9    |
| Calcareous rocky area   | 0      | 0                                      | 0                                  | 0                                | 7                              | 0                    | 0                                      | 0                               | 0           | 0                 | 0       | 0                 | 7    |
| High density forests    | 0      | 0                                      | 0                                  | 0                                | 0                              | 7                    | 0                                      | 0                               | 0           | 0                 | 0       | 0                 | 7    |
| (sloping terrain)       |        |                                        |                                    |                                  |                                |                      |                                        |                                 |             |                   |         |                   |      |
| Limestone rocks and     | 1      | 0                                      | 0                                  | 0                                | 0                              | 0                    | 10                                     | 0                               | 1           | 0                 | 0       | 12                | 12   |
| roads paved             |        |                                        |                                    |                                  |                                |                      |                                        |                                 |             |                   |         |                   |      |
| Barren land             | 0      | 0                                      | 0                                  | 0                                | 0                              | 2                    | 0                                      | 2                               | 0           | 11                | 0       | 0                 | 15   |
| Residential areas       | 0      | 0                                      | 0                                  | 0                                | 2                              | 0                    | 2                                      | 0                               | 11          | 0                 | 0       | 0                 | 15   |
| Pastures                | 0      | 0                                      | 0                                  | 0                                | 0                              | 0                    | 0                                      | 0                               | 0           | 12                | 0       | 12                | 12   |
| High density forests    | 0      | 0                                      | 1                                  | 0                                | 0                              | 0                    | 0                                      | 0                               | 0           | 0                 | 0       | 9                 | 10   |
| (flatlands)             |        |                                        |                                    |                                  |                                |                      |                                        |                                 |             |                   |         |                   |      |
| SUM                     | 10     | 7                                      | 8                                  | 7                                | 8                              | 9                    | 8                                      | 12                              | 7           | 12                | 14      | 10                | 112  |
| Average                 | 80     | 85.7                                   | 75                                 | 85.7                             | 87.5                           | 77.8                  | 87.5                                    | 83.3                            | 85.7        | 91.7              | 85.7    | 90                | 84.6 |

The Kappa statistical scale was also adopted to calculate the accuracy, as this scale measures the degree of difference between the ground control points that were taken and the changes that were classified in the classification map prepared for the study site itself and compared it, and this is what he referred to [12].

This scale is considered a measure of comparison, and many researchers have indicated the value of Kappa, which is greater than (80%), i.e. confined to (0.8 - 0.99). This is a very good, appropriate, and recommended classification, while this value was confined to (610. - 800). It shows a good classification for the statement that the classification can be accepted and relied upon, as for the value limited to between (600.-410.) it appears that the rating is averagely acceptable, while the value limited to between (400.-210) appears that the classification is acceptable, and the value confined to (<..200.-010.) It appears that the classification is somewhat acceptable, as for the value that is less than (zero), i.e. negative, it shows that this classification is
poor and cannot be accepted and relied upon. Since the value of the general Kappa rating scale appeared (83.34%), which is limited between (0.8 - 0.99), this is considered to be a very good and acceptable rating that can be relied upon and recommended in the classification. He also confirmed his use in classification [10]. As in the following equation below, where Oc is the line of the total matrix and Pe is the sum of multiplying the rates of horizontal and vertical checkpoints for the matrix for each goal and all targets in the matrix.

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