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Utilisation of Alsat 2A image for the vegetation mapping of an anthropised forest: example of the Tamgout national forest (Tizi Ouzou, Algeria)

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ABSTRACT/RESUME

Abstract: *Forest vegetation in Algeria was reported to be affected by anthropic impact (fires, overgrazing). The aim of this study is to establish the land cover mapping of the national forest of Tamgout (Tizi Ouzou) using Alsat 2A image. This forest located on the coastal chain of Kabylia (3 800 ha) is known for its high anthropic activities resulting in strongest impacts sheltering a very important forest heritage. It is a cork oak forest slightly degraded, but its ecosystem services and socio-economic value are undeniable for local populations, especially non-timber forest products. The use ENVI 4.5 software processing of Alsat 2A satellite image, focused on supervised classification with minimal distance method, allowed land cover mapping of the Tamgout forest (classification performance: 93,94%, Kappa Index: 0.91). We determined the surface importance of vegetation units identified with a sampling mission on 4 ha of land (i.e. 0.1% of forest total area). Natural forest vegetation was estimated at 1263 ha (33%) of cork oak (Quercus suber), 760 ha (20%) of zen oak (Quercus canariensis), and 945 ha (25 %) of mixed formation. Maquis was about 302 ha (8%). Artificialized units such as bare land, agricultural land and agglomerations were evaluated at 530 ha (14% of forest total area). Our findings serve as a basis for the analysis of spatial and temporal land cover changes, and contribute to a better knowledge of the anthropisation phenomenon, following the recurrent fires, and to the fragmentation process in the Mediterranean forest environment.*

I. Introduction

In Algeria, like in other developing countries, the forest is affected by strong anthropization causing massive degradation of natural resources. The fire is the most redoubtable factor of the degradation of the Algerian forest. Fire prevention and control are not always reliable because of the complexity and diversity of forest ecosystems. Associated with climate action and topographical forms, the fire was found to helpe to create, not predominantly, the types of vegetation that grow around the Mediterranea. Hence, the forest fire causes losses in terms of economy, ecological resources, and long-term social benefits [1]. Outer fire, different landscapes have been shaped by anthropogenic action that has been strong for millennia [2].

The forestry policy in our country is in full adaptation and is currently inspired by the experience of advanced countries in the field considering scientific innovations in heritage management and protection. Indeed, traditional cards currently used are no longer adapted to contemporary needs. Hence, the complexity and diversity of environmental data has enabled the development of systems meeting the needs of data collection, analysis and representation of

environmental phenomena. Geographic Information Systems (GIS) and remote sensing have become indispensable tools for understanding and monitoring of dynamic phenomena. Remote sensing providing a number high data and assuring homogeneity of information transmitted and repetitiveness of data acquisition is used to monitor environment degradation [3]. GIS has been reported to be necessary for investment orientation and to have valid arguments for decision-making [4].

In this work, we aimed to map the land use of the Tamgout National Forest using the satellite image of the new generation Alsat 2A, which is nowadays an important source of information for the observation of the land surface and its use [5].

II. Materials and methods

The mapping of land use of the Tamgout national forest has been performed by classification-based method provided by ENVI 4.5 using Alsat 2A satellite image [6, 7, 8]. This forest poorly investigated according to scientific literature was studied considering its ecological, socio-economic and environmental values.

II.1. Material

II.1.1. Study area

Tamgout forest, a part of Kabylian coastal chain, is located on a ridge line distant from the Mediterranean Sea north of 5km (wilaya of Tizi Ouzou), between 4 ° 19 '15' 'and 4 ° 27' 40 " East longitude and between 36 ° 45'30 " and 36 ° 50'40" Latitude North. This forest about 3800 ha is divided into 18 forest cantons (Figure 1) and known for its climate shown subhumid with temperate winter. It is a mixed forest of cork oak, zen oak and Mattoral in Bruillère, arbutus and calicotome spinose.

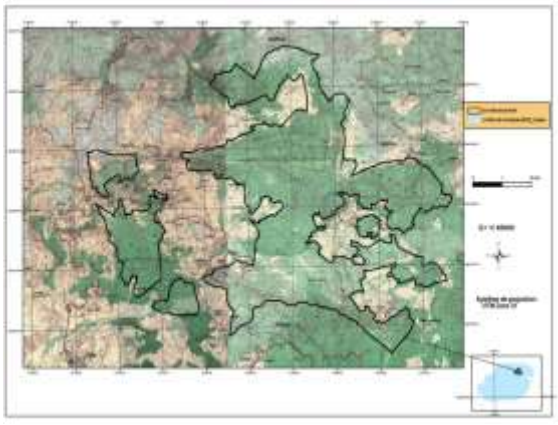

***Figure 1**. Geographical location of the Tamgout National Forest (Tizi Ouzou-Algeria)*

II.1.2. Material

Our cartographic study was carried out using several sources of information and equipment useful in field or laboratory.

• Satellite image (Alsat 2A at 2.5 m resolution taken on August 02, 2013): The Alsat 2A image was provided by Algerian Space Agency.

• Topographic maps: two topographic maps were used: Azeffoun NJ-31V-14 West and Azeffoun NJ-31V-14 East, taken from the map of Algeria at the scale of 1: 25,000.

• GPS

• Software: GIS and satellite image processing:

ArcGIS 9.3 (ESRI ©) and ENVI 4.5.

II.2. Methods

II.2.1. Land cover mapping

The approach adopted for the land cover mapping (vegetation and others) of Tamgout national forest was based on remote sensing technique conducted in three main phases.

• Preparations and preprocessing of data;

• Treatment and analysis

• Integration into a geographic information system

The steps of land cover mapping of Tamgout national forest are shown in Figure 2.

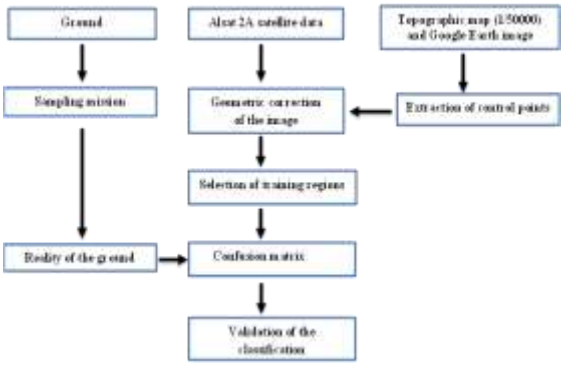

***Figure 2**. Methodological chart of land cover mapping of Tamgout national forest III. Results and discussion*

II.2.2. Satellite image specifications of study area

Given the ability of Alsat 2A to provide fused images of high resolution (2.5m), we used an Alsat 2A image obtained by fusion of two modes (colored and panchromatic), taken on August 02, 2013. Indeed, with its high resolution, the Alsat 2A image covers whole study area (Tamgout national forest) allowing identification of different plant formations in the field (Figure 3). The study area sufficiently covered corresponded to a single scene evaluated at 17kmx17km.

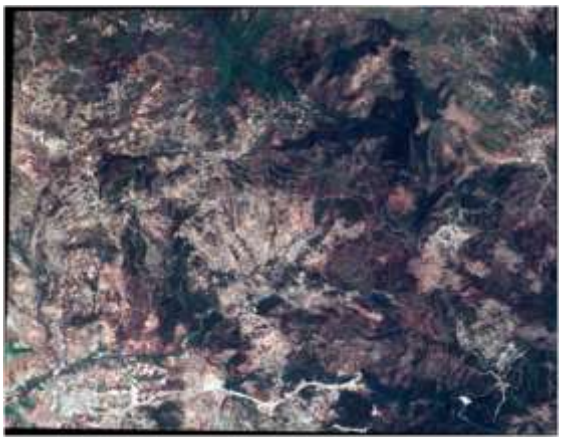

Figure 3. *Fused image Alsat 2A (Panchromatic + colored) of Tamgout region*

III. Results and discussion

III.1. Pretreatment of fused Alsat 2A image

Initially, we superimposed the Alsat 2A image on a SRTM ground; we found that it was shifted. According to Figure 5 (on left), one part of study area is sunk into the sea, while the Tamgout forest is about 5 km as the crow flies from the Mediterranean. A geographical alignment with the topographic map or with another satellite image (Google Earth image or topographic map) is therefore necessary.

Figure 4. *Geometric distortion correction of the fused Alsat 2A image*

In order to correct the distortion shown in Figure 5 (on left), we have chosen five control points appearing both on fused composition and topographic map (projection UTM fuseau 31) (Figure 4). The number of control points is proportional to the overall surface of the image [9]. After modification of ground control points, the position of the image on SRTM was modified (Figure 5, right).

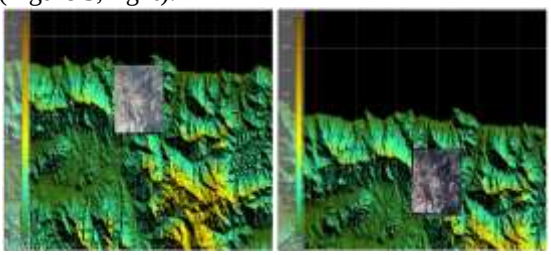

Figure 5. *Alsat 2A image of Tamgout forest in distortion (on left) and after geometrical corrections (on right)*

III.2.Processing of fused Alsat 2A image

When using a supervised classification method, the analyst identifies fairly homogeneous samples of the image that are representative of different types of surfaces (information classes). These samples form a set of test data. The selection of appropriate training areas is based on the analyst's familiarity with the geographical area and their knowledge of the actual surface cover types present in the image [10]. The reality capture field is performed on windows of the total scene representing the study area, in order to work at full resolution. Each field reality [11] describes a specific land use with a class name and a color that differentiates it from other themes.

Then, the supervised classification is used to make a map of the land cover for the Tamgout national forest. This method is considered as a powerful technique of classification. Our field data were collected during the mission period 10 to 15 August 2013 corresponding to the shooting date of the satellite image (02 August 2013). This mission allowed the identification of some representative parcels of the different types of land cover of study area. The parcels identified are also called "regions of interest" (Figure 6).

Figure 6. *Selection of parcels identified as "regions of interest*

The representative parcels of large classes of land cover selected in the Tamgout National Forest are reported in Table 1

The validation of the treatment was obtained by analyzing the confusion matrix elaborated on the basis of so-called control parcels. The statistical treatment related to spectral behavior of different classes of land cover is also confronted with the vegetation structure indices to assess the relationship between class structure and satellite image discrimination capacity [12].Therefore, it is possible to evaluate the performance of the classification by estimating the percentage of correctly classified pixels within each field truth test polygon. The results of the reliability analysis are shown in Table 2. This table shows, for each class, the average level of reliability and the main confusions observed.

Table 1. *Large classes of land cover in the national forest of Tamgout*

Classes Land Cover	
Quercus suber forest	Cultivated land
Quercus canariensis forest	Agglomeration
Matorrals	Bare land and roads

Table 2. *Matrix confusion elaborated on the basis of control parcels*

Classes	**Bare land and roads**	***Q. suber***	***Q. canariensis***	**Cultivated land**	**Matorrals**	**Agglome-ration**	**Total (Pixel)**
No class	0	0	0	0	0	0	0
Bare land and roads	364	0	0	0	0	72	436
Q. suber forest	0	214	24	0	15	0	253
Q. canariensis forest	0	18	283	0	0	0	301
Cultivated land	0	0	0	1125	12	15	1152
Matorrals	0	0	0	0	508	0	508
Agglome-rations	8	0	0	0	0	51	59
Total (Pixel)	364/372 97,8%	214/232 92,24%	283/307 92,18%	1125/ 1125 100%	508/535 94,95%	51/138 36,96%	2545 / 2709

The data reported in Table 2 demonstrated some confusion between different classes considering mean values displayed by paired classes such as bare soils and agglomerations, agglomerations and crop fields. The confusions were observed between classes neglected in the mapping process that represent only small areas in the study area. However, the average performance of the classification is 93.94% and the Kappa index is 0.91 which means that our classification was almost perfect.

From the analysis of this table it can be concluded that all the test plots are particularly well classified, with a statistical accuracy percentage higher than 90%. The cartographic accuracy of these land use classes is accurate with less than 7% inaccuracy.

Test plots whose taxonomic content corresponds to a mosaic are less efficient, let us quote the only example is the class of agglomerations; whose statistical accuracy percentage does not exceed 36.96%. This is due to some confusion between this parcel with the class of bare soils and mostly roads. In fact, of the 138 pixels assigned to the class of agglomerations, 87 were grouped together with the themes: cropland (10.87%) and bare soil and roads (72%). For this purpose, it has not been possible to obtain a thematic precision of more than 36.96% for the agglomerations class. The grouping of plots is based on the analysis of the effective separability using the statistical file of these samples. Thus, [1] estimates that even if samples do not physically represent the same land cover, they will be confused in view of their similar radiometric responses.

This evaluation was supplemented by field surveys validating the classification performed on the Alsat 2A image. However, considering the extent of the study area, it was not possible for us to visit the entire territory.

After selection of regions of interest, the classification of the rest of the image will be based on the values obtained these regions (Figure 7).

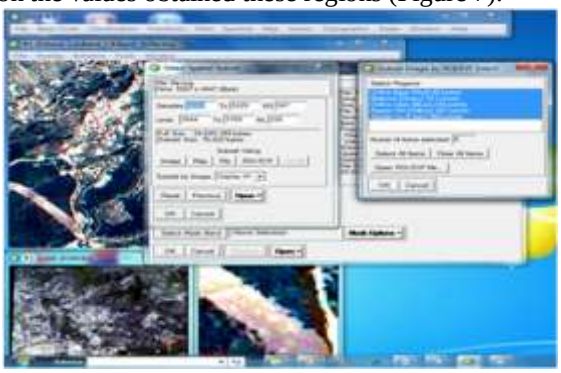

Figure 7. *Fused Alsat 2A image classification technique*

According to results (hown in Table 3 the total area of the study area in national forest of Tamgout was about 3800 ha.

Tableau 3. *Surface and percentage of land cover of Tamgout National Forest*

Land cover unit	Surface (ha)	Percentage (%)
Oak cork	1263	33,23
Oak zen	760	20
Mixed formation with cork oak, zeen oak and afares oak	945	25
Matorrals	302	8
Bare land, agglomerations and agricultural land	530	14

The various treatments carried out on the scene of the Alsat 2A image taken in August 2013 made it possible to obtain the map of the occupation in the national forest of Tamgout (Figure8).

Our results are different from those obtained by the [13], (1925ha of cork oak, 514ha of zen oak, 1237ha of mixed formation and 153ha mattoral). This difference is due to the means used, which are based on classical mapping, the high use of the forest as a cattle path and the phenomenon of recurrent fires which has considerably worsened in this forest, since it is subject to repeated passage of fire on the same plots [14].

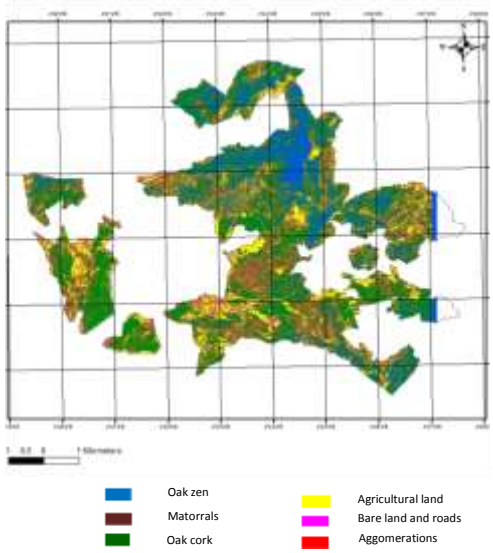

Figure 8*. Land cover map of the Tamgout National Forest*

IV. Conclusion

The use of Alsat 2A data for mapping of land cover in forest areas studied was found to be an interesting contribution to study large and often poorly understood in forest, especially areas difficult to access. Results obtained by ENVI's Alsat 2A image processing applied to the Tamgout national forest revealed six major classes of cover land and their proportions in a short time. They provide a helpful support to a better knowledge of the anthropisation phenomenon in forest areas. Our findings highlight the contribution of these new tools for the management of the forest environment, particularly for monitoring the decline of natural heritage in Algeria.

Finally, this study can contribute and serve as a basis for other development works or changes in land use changes through the use of multi-date images. In addition, the use of high resolution satellite imagery (Alsat 2A) will be critical as vegetation monitoring can only be seriously considered with good spatial resolution.

Acknowledgments

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