



**ALGERIAN SPACE AGENCY**  
*Centre of Spatial Techniques*  
**DIVISION OF REMOTE SENSING**

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**SPATIAL ANALYSIS OF FOREST  
REGENERATION AFTER FIRE IN ALGERIA BY  
USING HIGH SPATIAL IMAGES RESOLUTION  
AND GIS**

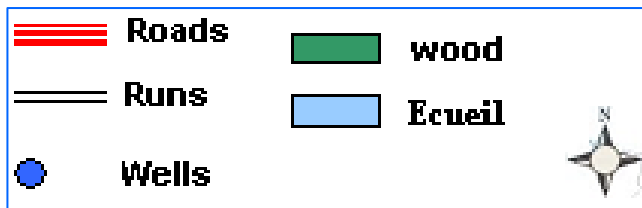
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## → Study Areas

During the summer of 2003 and during a heat wave important fire drill has ravaged the forest DJebel Kerrouch located in wilaya of Tlemcen in ALGERIA. The fire caused by a hot wind and dry South East has made covered fire area of 5000 hectares.

### → Location and geographical limits

- Located south east of Sebdou Wilaya of Tlemcen in Algeria.
- The study area is called El Jebel krouch, forming part of Tlemcen mountains.
- The highest point (1526 m), this area lies between the geographic coordinates  $1^{\circ} 30'$  longitude and  $34^{\circ} 35'$  latitude.
- The nature of the soil is composed of calssimagnisic class



**Location of the study area on the image ALSAT-1 in 2003**

## Characteristic of the forest studied

- This area was occupied by a mixed forest of cedar (*Tetraclunis articulata*), which is a species endemic to North Africa and Aleppo pine (*Pinus halepensis*).
- The association of *Thuya* is an association thermophilic and xerophilic which approximates many of the Pin Aleppo. Generally, Lavender, Ciste, Philaire, Rosemary, Calycotome, Bruyère and Lentisque form the bulk of species that are found in all tetraclinaies.

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## **Purpose and Methods**

The purpose of this work is to assess and quantify the spatial and temporal variation of changes inside an area burned by utilisation of a diachronic analysis of remote sensing data, coupled with observations on the ground, and that through an analysis of the regeneration based on topographic features of the site, and the condition of the vegetation itself pre-fire.

## Methodological approach and principles adopted

The study of the behavior of the spectral signature of a pixel reflects the principle of space and time evolution of regeneration.

The spectral analysis of natural surfaces in the near infrared (PIR), depending on their response in the red (R), shows the position to take a pixel according to its recovery. In reality, immediately after the fire, the vegetation had disappeared; the pixel is on the right soil. As that recovery is moving towards a density of vegetation cover, the pixel corresponding away from the right soil and is gradually approaching the area spectral specific green vegetation.

- A strong movement in the area of the right soil to the vegetated area, where regeneration occurs quickly;
- The pixel away little of the right soil and regeneration, in this case, very slow;
- The pixel is moving in an intermediate situation remote from the right soil but belong to the zone of vegetation and regeneration is then described as average;
- The pixel stays on the right soil, in this case lack of regeneration.

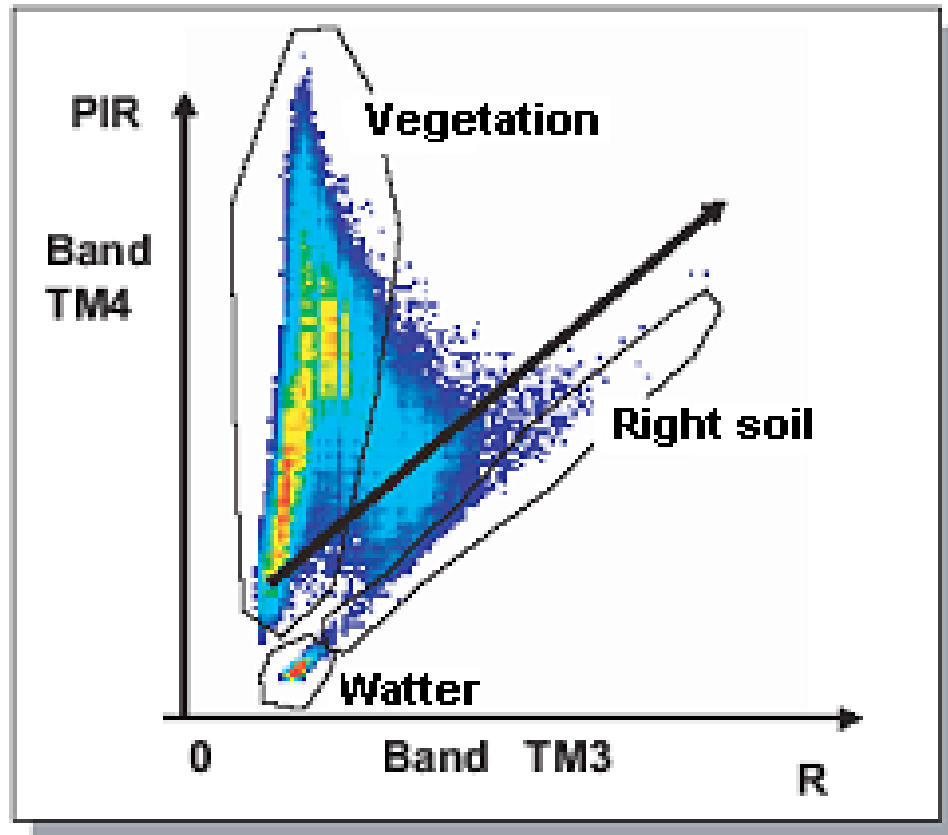


FIGURE : The relationship between the spectral response of a heterogeneous zone Observed in band TM3 (R) and TM4 (PIR).  
- (LILI. Z et al)- 2005

We test the possibilities offered by the indices NDVI and NRI to monitor and quantify regeneration in combination with field data.

So that , we used the index derived from the image of NDVI. The index is called regeneration index

$$\text{RI: regeneration index : } = \frac{\text{NDVI Post-Fire}}{\text{NDVI After-Fire}}$$

or

$$\text{NRI: normalized regeneration index : } = \frac{2 \text{ NDVI Post-Fire}}{\text{NDVI Post-Fire} + \text{NDVI After-Fire}}$$



## Acquisition of image data

The study was carried out on images Alsat-1 acquired in 2003, 2005 and 2007 to evaluate forest regeneration

Images	Number of bands	Spatial resolution (m)	Dates acquisition
Image 2003	03	32	July 2003
Image 2003	03	32	August 2003
Image 2005	03	32	July 2005
Image 2007	03	32	July 2007

## **Treatments of data**

The treatments of classification, colour composition and index calculation requires normalize images pre-and post-fire so they have the same number of lines, and the same number of columns.

### **- Geometric correction**

The images have geometric corrections, it was therefore realized their geo reference in the projection system adopted by the mapping of Algeria, the projection Universal Transverse Mercator, WGS 84, zone 30, system geodesic north Sahara

Image Alsat-1 in 2003



Image Alsat-1 in 2005

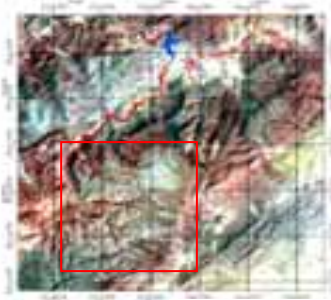


Image Alsat-1 in 2007

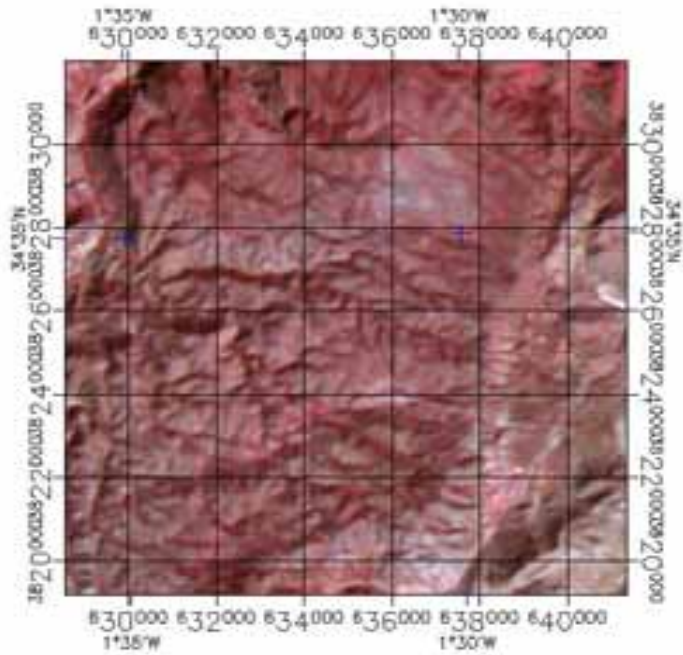
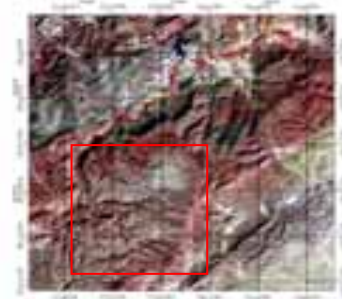


Image Alsat-1 July 2003

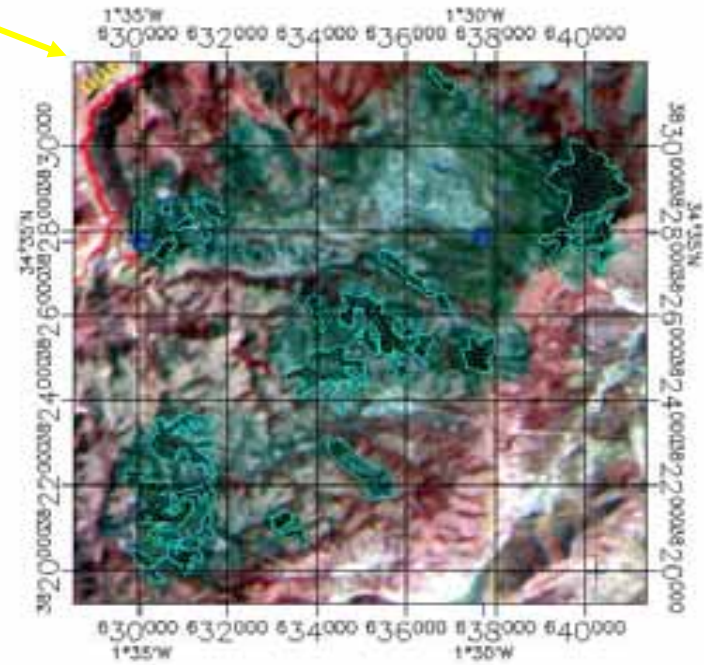
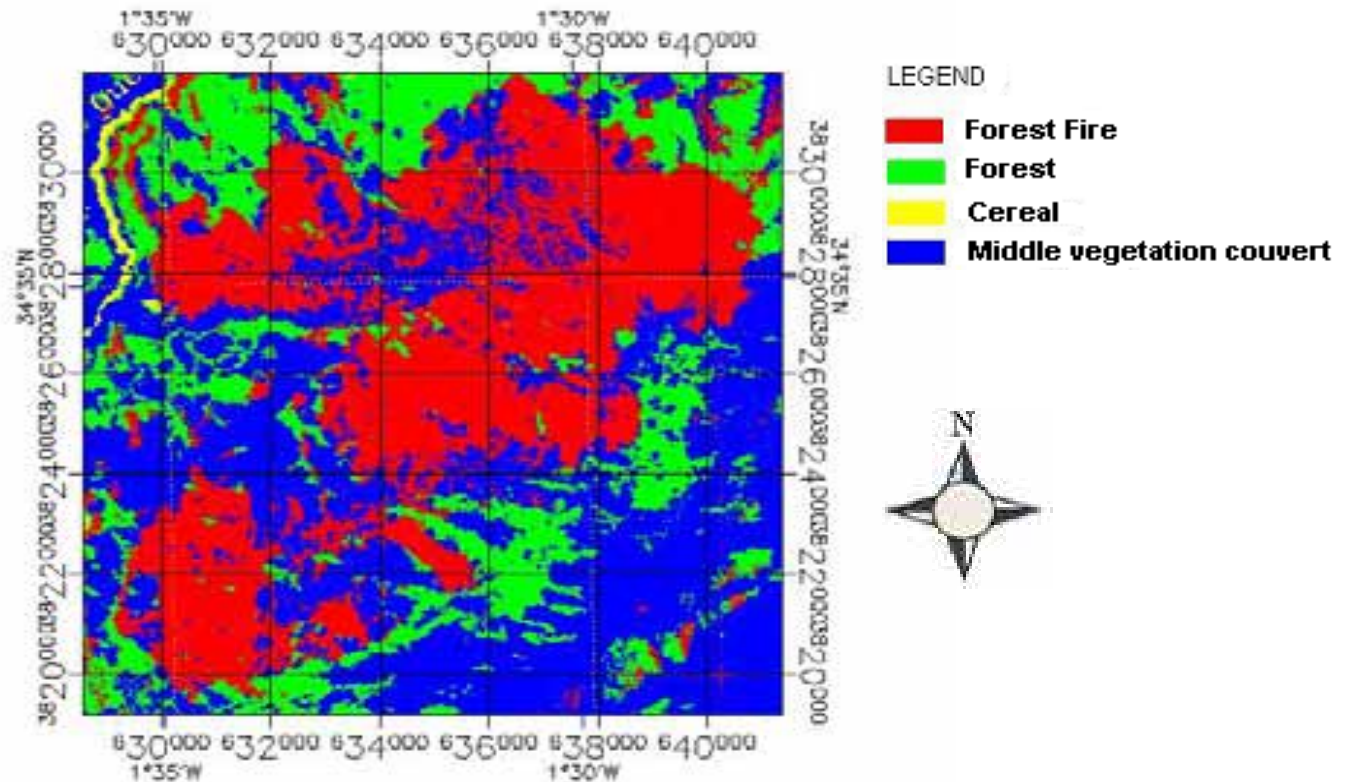


Image Alsat-1 August 2003

## - Methods of classification

A window (400 x 400) was extracted from the image Alsat-1 covering the area burned in 2003. To view the surface burned we conducted a classification using the method of maximum likelihood. The result of this classifications was validate and has permitted us to obtain the surface covered by the fire which is estimated at 5000 hectares



## **RESULTS AND DISCUSSION**

The post-fire regeneration depends on environmental factors studied (climate, topography, soil science, state and characteristics of the pre-fire vegetation).

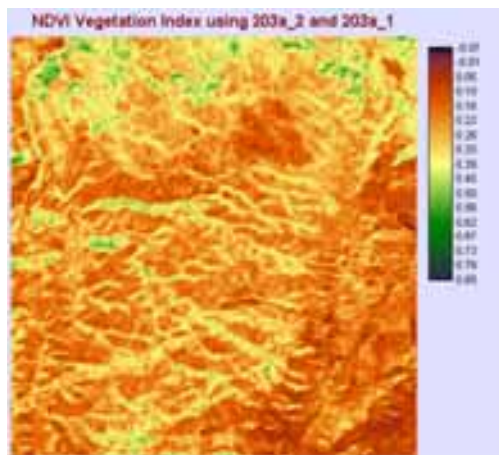
The study site is characterized by a geological and soil fairly uniform and the same type of climate

pre-fire vegetation and parameters related to the topography, are used in this study to analyse the spatial variation of regeneration.

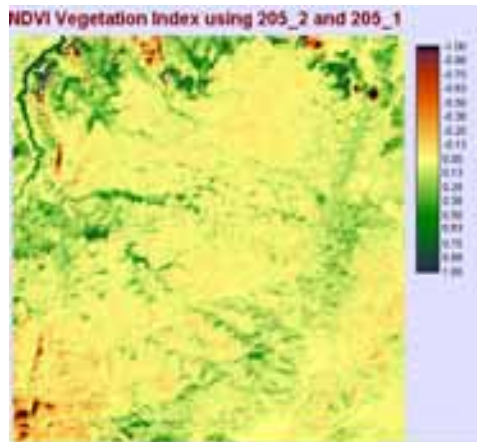
### **Operates images of NDVI**

The images of NDVI were conducted on the Geographic information system for the image pre-fire of July 2003 and images post fire in 2005 and 2007. simple visual examination shows that vegetation on the site tends to return and move near to the state of vegetation pre-fire.

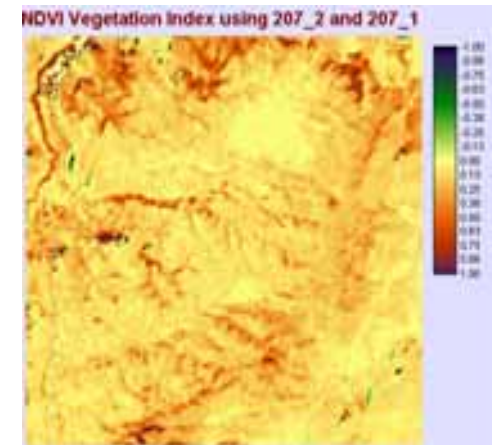




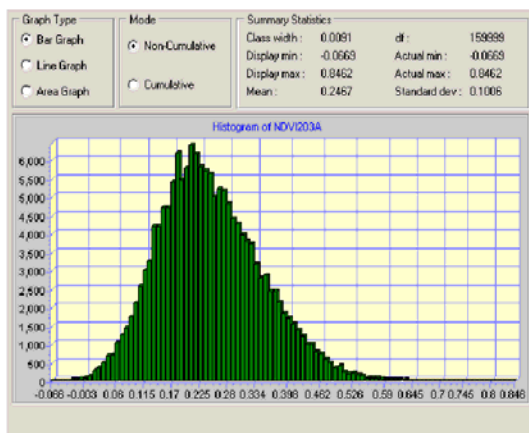
**Image NDVI before fire,  
July 2003**



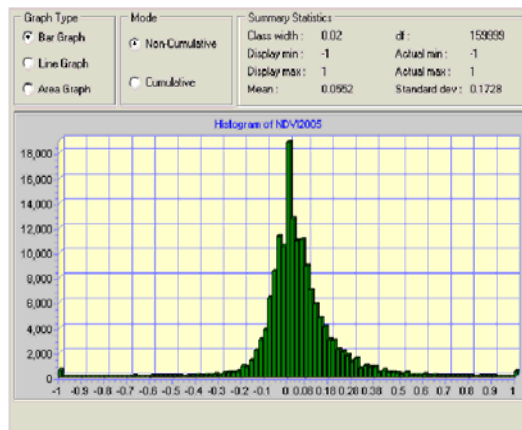
**Image NDVI 02 years post fire  
July 2005**



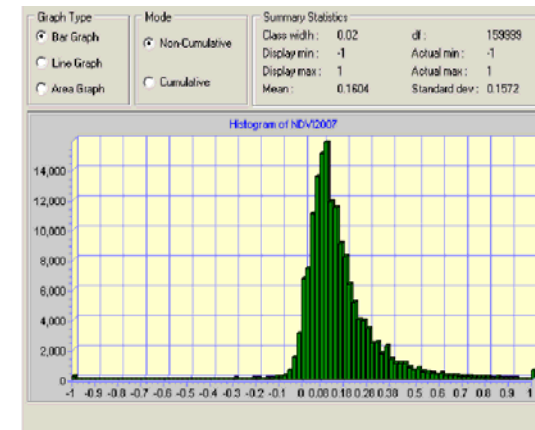
**Image NDVI 04 years post fire  
July 2007**



**Histogram (1) : Image NDVI  
2003**



**Histogram (2) : Image NDVI  
2005**



**Histogram (3) : Image NDVI  
2007**

Comparing the results with field data collected in 2005 and 2007 we found that the high values of the index NDVI correspond of strata of herbaceous and arbutus.

The forest species generally regenerate after three years and their rate of recovery become more important depending on climatic conditions.

The analysis of visual images NDVI results showed that vegetation was plentiful before the 2003 fire, which is due to the high values of pixels in the histogram No. 1.

we see a marked decline in the values of pixels in the image NDVI in 2005 (two years after fire) which is clearly visible on the histogram No. 2.

The resulting image NDVI 2007 shows that the values of the pixels have a net augmentation which explains the continuation of forest regeneration after 04 years.

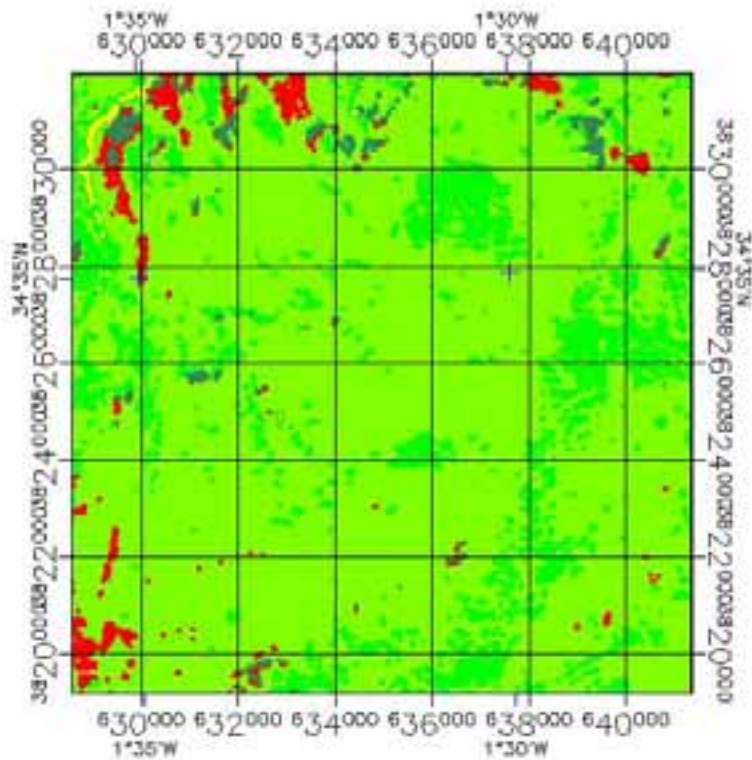
## Supervised classification

It is proposed to assess the recovery of vegetation by the method of classification supervised post fire 2 years and 4 years.. It finds that all strata of pre-fire vegetation have largely evolved in moderately dense vegetation.

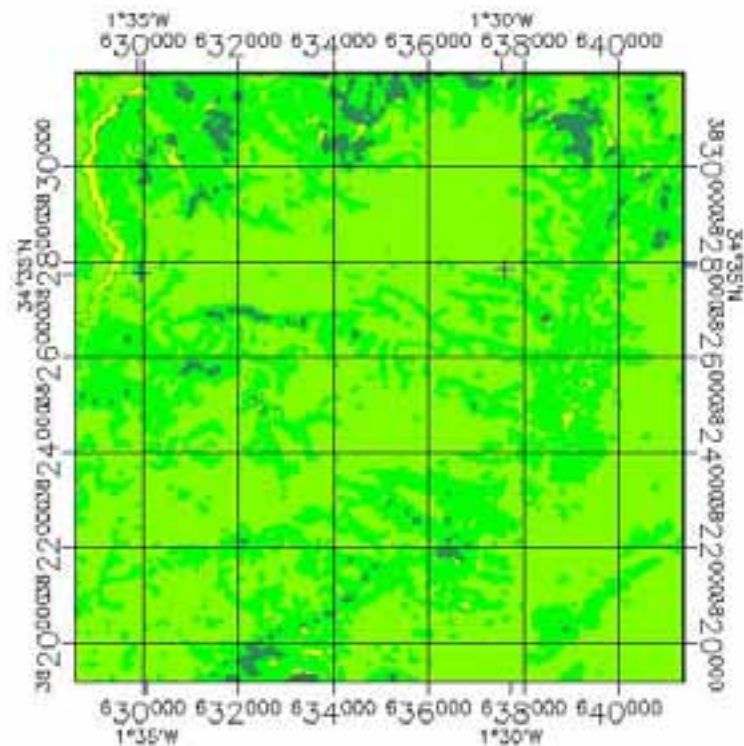
This classification is used to evaluate fairly rough dynamics of regeneration in time and classifying the study area depending on the speed of recovery of vegetation

<b>Class en %</b>	<b>Lack of vegetation</b>	<b>Strata arbutus</b>	<b>Strata herbace</b>	<b>Fore st</b>
<b>Image Alsat-1 July 2005</b>	<b>0.316</b>	<b>4.764</b>	<b>43.436</b>	<b>0.128</b>
<b>Image Alsat-1 July 2007</b>	<b>0.016</b>	<b>14.496</b>	<b>33.804</b>	<b>0.301</b>

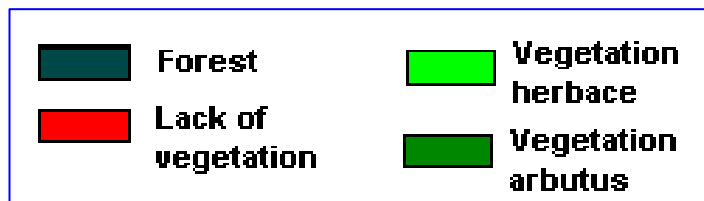




**Classification image  
July 2005**



**Classification image  
July 2007**



# Analyse of NRI

Where pre-fire NDVI and post-fire NDVI, are the standard indices of vegetation before and after the fire.

- Theoretically NRI index varies between **0** and **1**.

•The value **0** indicates that the recovery rate is zero post fire without providing an indication on the status of the pre-fire vegetation.

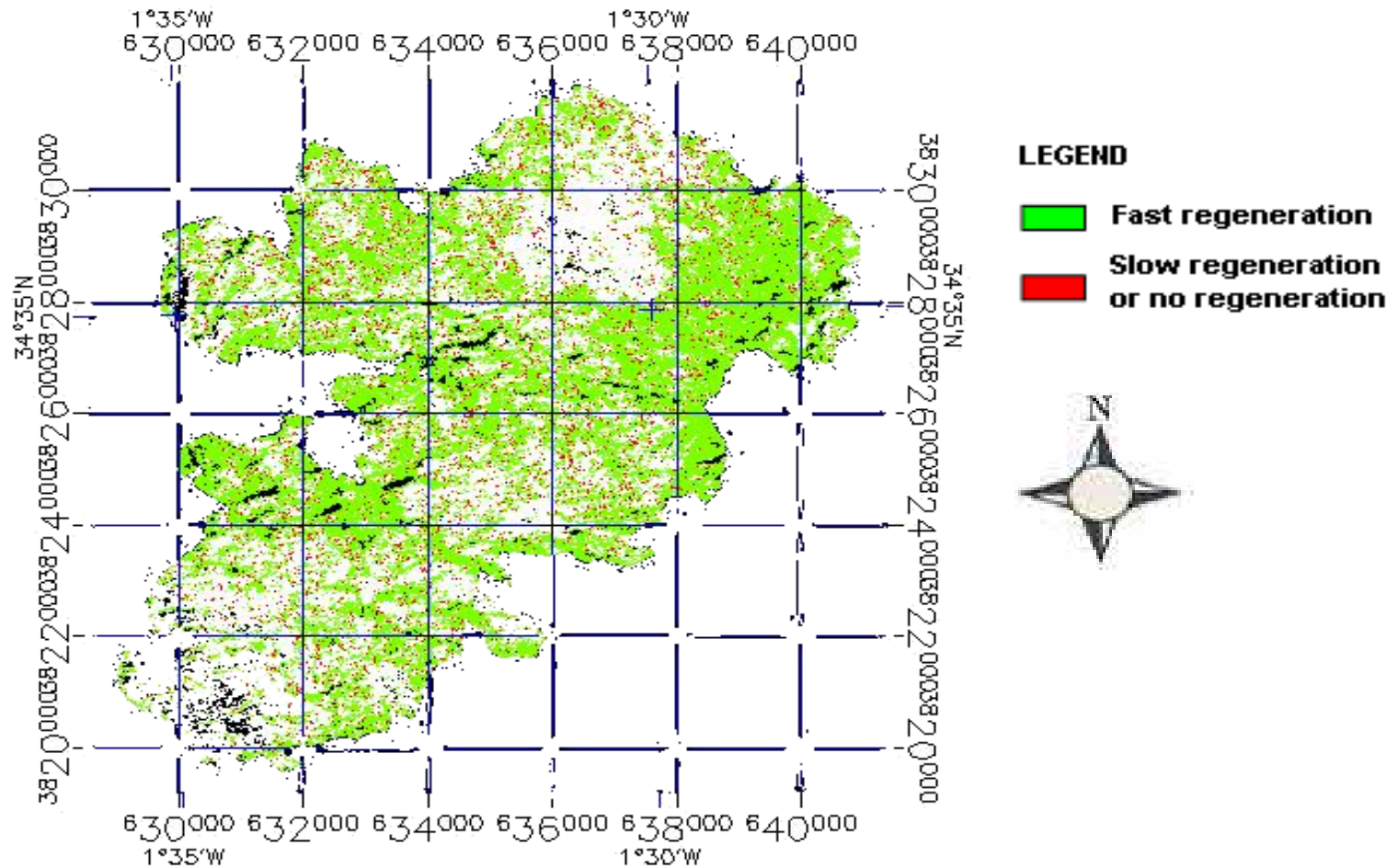
•The value of **1** indicates that the rate of recovery of pre-fire is equal to the rate of recovery of the state post-fire.

The calculation of the image of NRI for the study area was conducted using the image of NDVI pre-fire in July 2003 and post fire in 2005 and 2007.

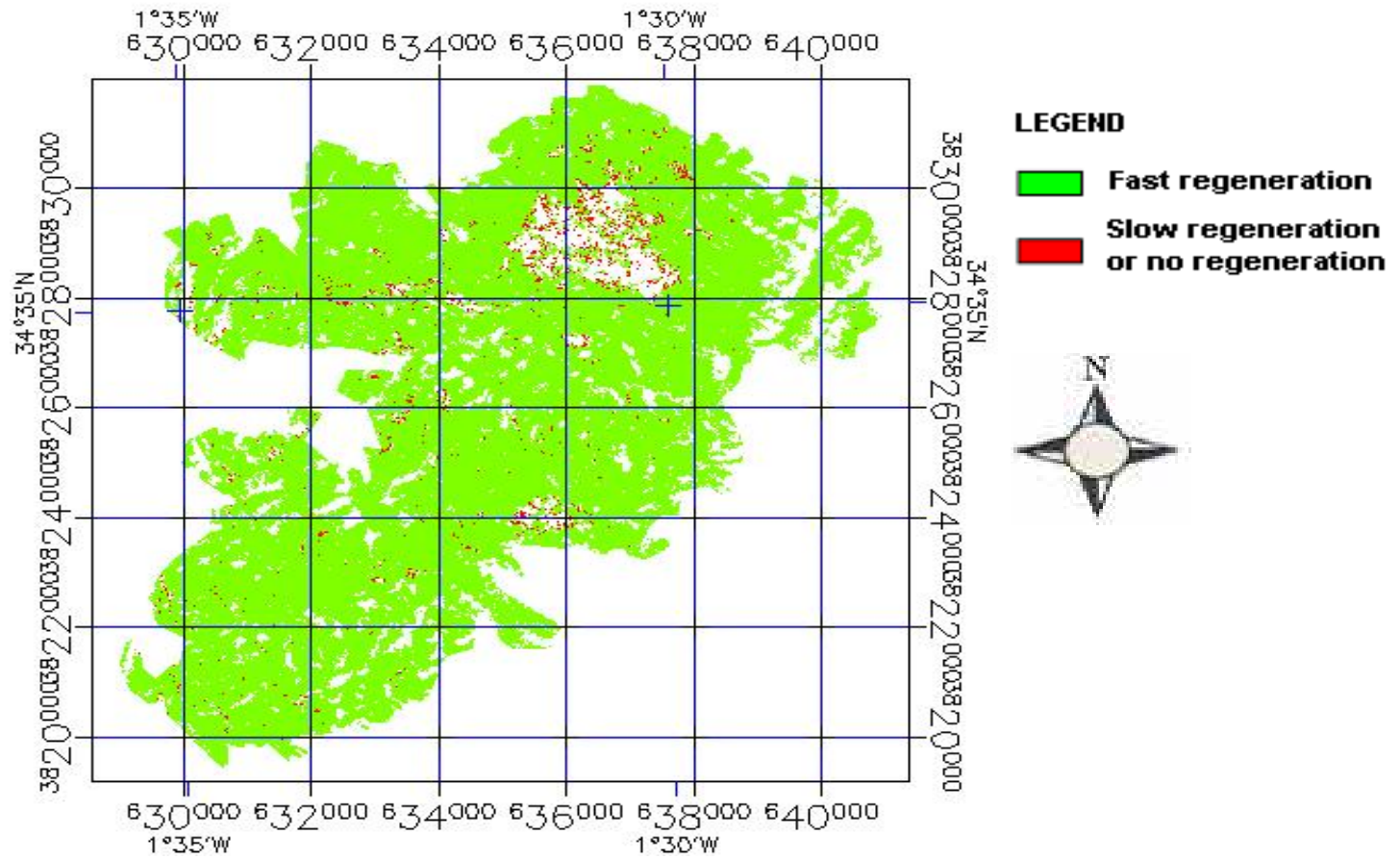
The image of NRI obtained for the state of regeneration in 2005 shows that the average area burnt expresses an index  $NRI < 1$ , indicating that the rate of post-fire recovery is lower than pre fire. The vegetation has not yet had time to reach a recovery.

For 2007 , the majority of the surface NRI study presents a value near 1, which means that these areas have reached a recovery rate equal to pre-fire areas. The results  $NRI > 1$  have become more important compared to 2005.

In 2007, an area larger presents a recovery rate which exceeds that pre fire.



**NRI image calculated by the two statements :**  
**before fire (Alsat-1 July 2003)**  
**and post-fire (Alsat-1 July 2005).**



**NRI image calculated by the two statements :**  
**before fire (Alsat-1 July 2003)**  
**and post-fire (Alsat-1 July 2007).**

# CONCLUSION

**This study permitted us to demonstrate the possibilities for the use of images Alsat-1 for monitoring and quantification of forest regeneration post-fire through images index NDVI and images of NRI. The area burned is considered of forest heterogeneous thuyas and Aleppo pine in the southern part of the wilaya of Tlemcen in Algeria.**

**The application of indices NDVI series of images pre-and post-fire 2003,2005 and 2007 supported by the results of the classification supervised generated in a geographic information system has permitted to determinate a regeneration of different strata of plant.**

**Following the application of images NRI (index regeneration normalized) on the images fire in July 2003 pre-and post-fire respectively in July 2005 and July 2007, we have determined the rate of forest regeneration strata.**

**The initial result showed 2 years after the fire regeneration is slow and medium whose NRI less than 1 which explains that regeneration is linked to several conditions (soil, climate, topography etc...).**

**The second result shows that there is a high recovery rate which equals a 1 NRI which explains good forest regeneration after 4 years of the fire.**

**This study has enabled us to confirm that monitoring and quantification of forest regeneration by using high-resolution image of Alsat-1 and images NRI give significant results.**

**Thank you**