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# USE OF LANDSAT TM FOR MAPPING LAND USE IN THE ENDORHEIC AREA - CASE OF GADAINE PLAIN (EASTERN ALGERIA)

**Rabah BOUHATA** *
Université El Hadj Lakhdar, Laboratoire „risques naturels et aménagement du territoire"
Batna, Algérie, e-mail: m_bouhata24@yahoo.fr

**Mahdi KALLA**
Université El Hadj Lakhdar, Laboratoire „risques naturels et aménagement du territoire"
Batna, Algérie, e-mail: m_kala1@yahoo.fr

**Hadda DRIDDI**
Université El Hadj Lakhdar, Laboratoire „risques naturels et aménagement du territoire"
Batna, Algérie, e-mail: hadda.dridi@Gmail.com

**Abstract:** Information on land use is essential in environmental projects and ecosystem management, these data allow to approach the reality of lands and understand the challenges of development. The emergence of geospatial technology has provided an easy way to detect the use of land. This article presents the results of mapping land use based on remote sensing data (Landsat TM) 2009 for the Gadaine plain region. The analysis of satellite image has identified six main types of land use (sebkha, chotts, bare soil, forest, agriculture, and cereal). The results allow the identification of each type of occupancy (spatial and area) across the plain where interventions are needed for better management of this endorheic space and also to limit the processes of land degradation.

**Key words:** Gadaine, Landsat TM, land use, endorheic, remote sensing

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## INTRODUCTION

Land use is a major issue of global environmental change, so the mapping of land use is an essential component for the development and the management of natural resources. Land cover reflects the biophysical state of the earth surface; soil types, vegetation and water (Turner et al.,1995). Major changes in the occupation of important soils have been reported during the last century due to the economic development and population growth (Mitch & Gosselink, 1993; Sarmah et al., 2011). The endorheic area of Ain Yagout plain located in the north of Batna and characterized by its closed and/or semi -closed topographical and morphological character is considered as a receiving and collecting space of all surrounded surface runoff coming simultaneously from many basins; such as Oued El Gourzi where all discharges from the city of Batna and its industrial area are draining to these spaces. Therefore, Gadaine constitutes a large area of

* Corresponding Author

an environmental degradation and pollution. Otherwise, arid and semi-arid climate regime characterizing this region directly contribute to the process of ecosystem degradation (Bouhata, 2008).

Nowadays, the rapid and continuous socialization of these endorheic areas through various activities and especially the current policy and the management actions; the potential for the expansion and development of Batna City oriented towards Batna-Constantine axis and Batna-Setif axis poses a serious problem because of the fragility of this area. Over time, it will lead to a very difficult situation to correct either the local or regional plan (Bouhata, 2008). It is essential to monitor and control both of land use and environment due to rapidly changing of land cover in this marginal area. Mapping of land use in this plain requires a synchronous study of surfaces and their uses. This study is based on a good knowledge of the existing land, that is why it is necessary to develop monitoring and management strategies of the environment and the agriculture, based on technological performance (Garouani et al., 1993; Benmessoud, 2011). The application of remote sensing has made it possible to study land use in less time, at lower cost and with a greater accuracy (Kachhwaha,1985). Currently the Landsat satellite imagery is an important source of information for observing the earth surface due to its digital repetitive nature and also availability. In this article, an attempt was made to map the land occupation using the satellite image processing Landsat TM for 2009.

## PRESENTATION OF THE STUDY AREA

The study area is part of the southern Constantine high plains of eastern Algeria, which constitute a vast corridor mostly dominated by two mountains ranges: Aures massif to the south and Constantine mountains range to the north, a few kilometers north of Batna city. It is defined between the ranges of coordinates; Longitude: 6°12'15" E and 6°29'50" E, Latitude: 35°55'51"N and 35°40'50" N. According to ANRH, it belongs to the watershed of Constantine high plains (07-03) (figure 1). Located at an altitude of 784 m to 1246 m, the study area is characterized by an impressive platitude whose slope rarely exceeds 5%.

The area is spread on a surface of 348 km² representing 46% of the total surface. This favors the presence of endorheism resulted in a multitude of Sebkhas and chotts that occupying the center of the plain (Bouhata 2008). In geologic term, the presence quaternary formations (sebkha soil, salted lemons...etc) and Triassic formations (colorful marls and gypsum breccias), significantly contribute to the salt character of these endorheic spaces. Generally, due to the semi-arid climate we can only find steppe and halophytic species that are resistant to soil salinity, mostly presented by a characteristic vegetation of large clumps Artiplex or Salsolaceae (Bouhata, 2008).

## MATERIALS AND METHODS

We use an image of the Thematic Mapper (TM) Landsat 5 with a ground resolution of 30mx30m, dated August 6, 2009. The choice of this period is used to identify different land use units. An image size of (970 x 900 pixel) was extracted from the previous raw image. To extract the exact study area, we used a set of four (04) topographic maps completely covering the whole area: Batna East 1/50000, Batna West 1/50000, Souk Naamane East 1/50000, and Souk Naamane West 1/50000. The data sets are projected in UTM WGS 84 with the zone number 31.

We opted for a colorful composition of 4, 3, 2 channels, which allowed us to cleanly identify the different themes of land compared to other colorful compositions.

Based on visual interpretations, good knowledge of the study area reality and from several missions on land (using a Garmin GPS-type (OREGON 550) for the identification of some plots on the images), we define six classes of land: 1. Sebkha; 2. Chotts; 3. Bare soils; 4. Forest; 5.Agriculture; 6.Cereals. A supervised classification based on the on the maximum likelihood method was used on this image, using the image processing software (ENVI 4.5). This method is considered as a powerful technique for classification, where the rule of the decision of that method is based on the probability of a pixel belonging to a given category (Fojstng, 1999) and (Khalid Omar, 2014).

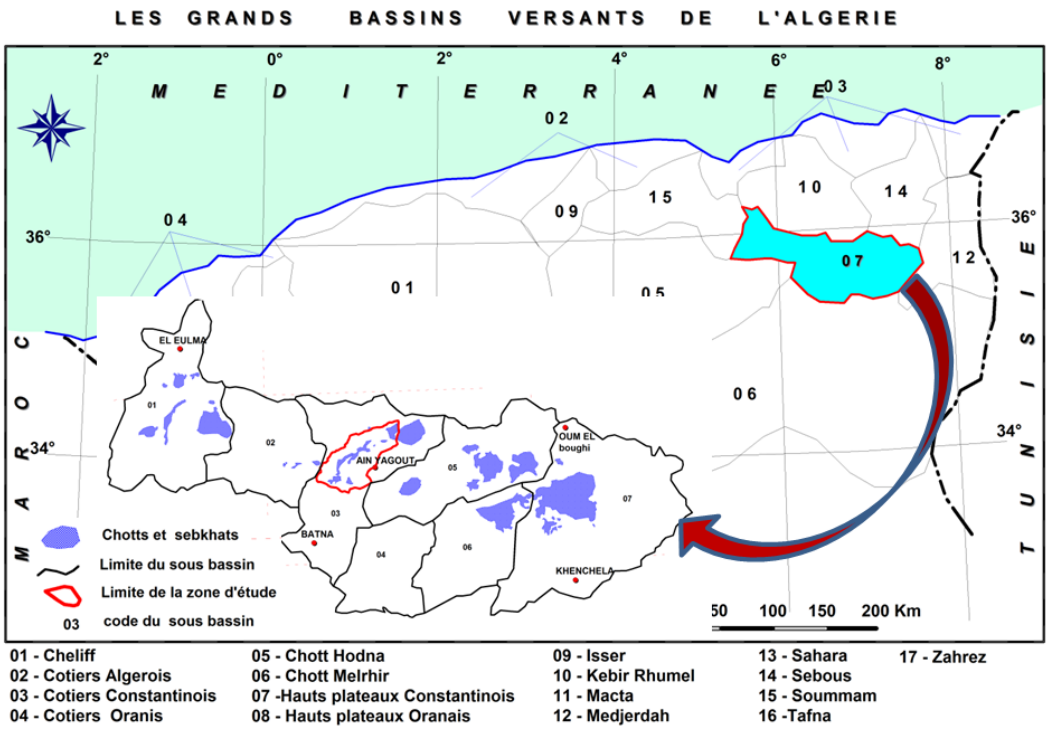


**Figure 1.** Location of the study area
according to (l'Agence Nationale des Ressources Hydriques ANRH) distribution

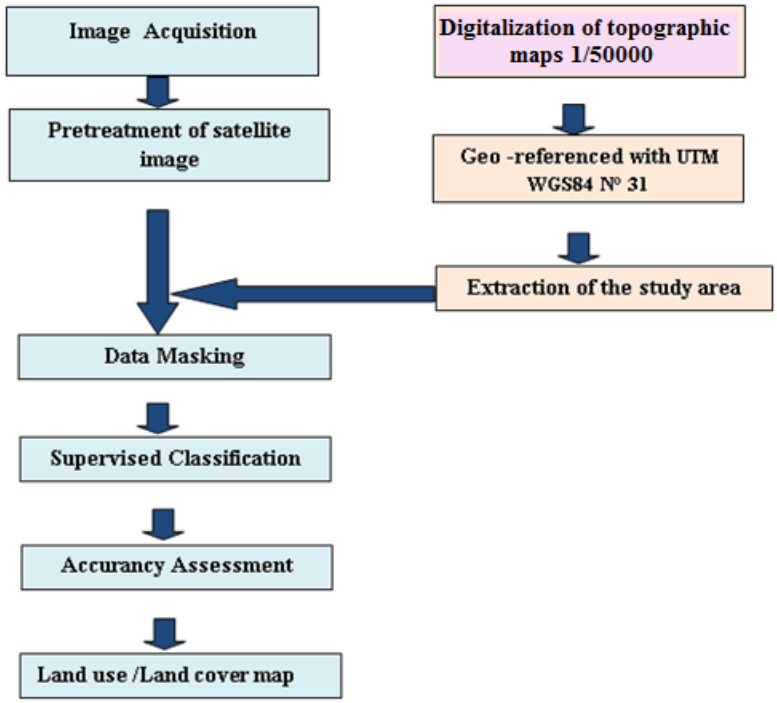


**Figure 2.** Methodology flow diagram showing the processes of mapping land use

The confusion matrix to validate the relevance and the quality of our classification illustrate this performance in (table 1); it clearly shows that the average performance of classification is 85.2% for the classification of the image.

**Table 1**. Confusion matrix for the classification of ETM 2009 image

| **Nomenclature** | **sebkha** | **chotts** | **bare soils** | **Forest** | **agriculture** | **cereals** | **Total pixel** |
|---|---|---|---|---|---|---|---|
| Sebkha | 7085 | 219 | 19 | 11 | 0 | 0 | 7334 |
| Chotts | 228 | 2059 | 145 | 64 | 1 | 179 | 2676 |
| Bare soils | 896 | 49 | 913 | 0 | 0 | 113 | 1971 |
| Forest | 81 | 67 | 0 | 796 | 3 | 0 | 947 |
| Agriculture | 0 | 7 | 0 | 0 | 341 | 0 | 348 |
| Cereals | 0 | 159 | 62 | 2 | 0 | 2118 | 2341 |
| Total en pixels | 8290 | 2560 | 1139 | 873 | 345 | 2410 | 15617 |
| Precision Coefficient = 85.2404% | | | | | | | |
| Kappa Coefficient = 0.7633 | | | | | | | |

## RESULTS AND DISCUSSIONS

The results of analysis for determining the occupancy percentages for each class are presented in Table (table 2).

**Table 2**. Percentages and surfaces of land use units

| Areas<br>Types Of land use | 06-08-2009 | |
|---|---|---|
| Sebkhas | In % | In $km^2$ |
| Chotts | 46,96 | 163,42 |
| Bare soils | 17,14 | 59,64 |
| Forest | 14,99 | 52,16 |
| Agriculture | 6,06 | 21,08 |
| Cereals | 2,23 | 7,76 |
| Total | 12,62 | 43,91 |
| | 100,00 | 348 |

The visual analysis of the thematic occupancy soil map resulting from the previous classification (figure 3), has allowed us to analyze and spatialize different themes types of land.

We note that the unproductive lands account for almost three quarters of the total study area with a large surface area of sebkhas (46%) and shotts (17.14%) to the expense of agricultural land surfaces (20 % of total area). These results indicate the phenomenon of land degradation and the decline of agricultural activities in this region. This situation is the result of the interaction between climatic deterioration, the endorheic character and the impact of rapid socialization of these vulnerable areas.

At the Tinsilt sebkha; the degradation of development plannings realized during the colonial period or the conservation works of forests in the city of Souk Naamane in 1982 accelerate the progress of these sebkhas and shotts towards the neighboring farmlands, which definitely changes the type of farming grains to commercial crops that are resistant to soil salinity such as Tobacco.

In addition, the installation of Batna airport in the center of this area leading to the development of all kinds of road networks especially their poorly constructed character (figure 4), contribute to the presence and the creation of neo-sebkhas such as Felenta sebkha in the southeast of the study area. Even the current policy-oriented to the irrigated vegetables crops of high yield and profits, widely contribute to the deduction of cereals surfaces and the rising of bare soil percentages.

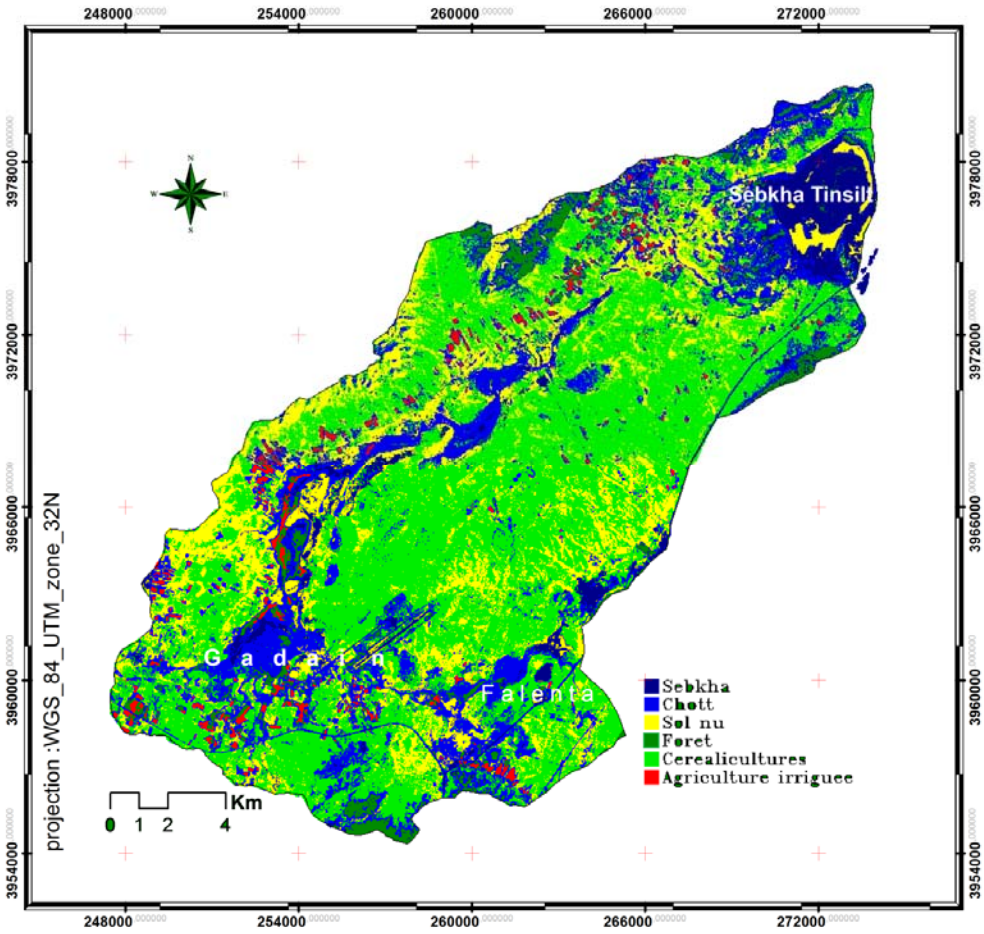


**Figure 3.** Thematic map of land use in 2009

**Figure 4.** The stagnation of surface water on the edges of a poorly constructed roads
(Photo: R. Bouhata, May 2013)

Clues on the field and the results obtained by processing the satellite image show the spread (figure 5) of both sebkhas and chotts areas; thus to a loss of agricultural land, which increases the vulnerability of these areas and the problems of ecosystem degradation and desertification in general.

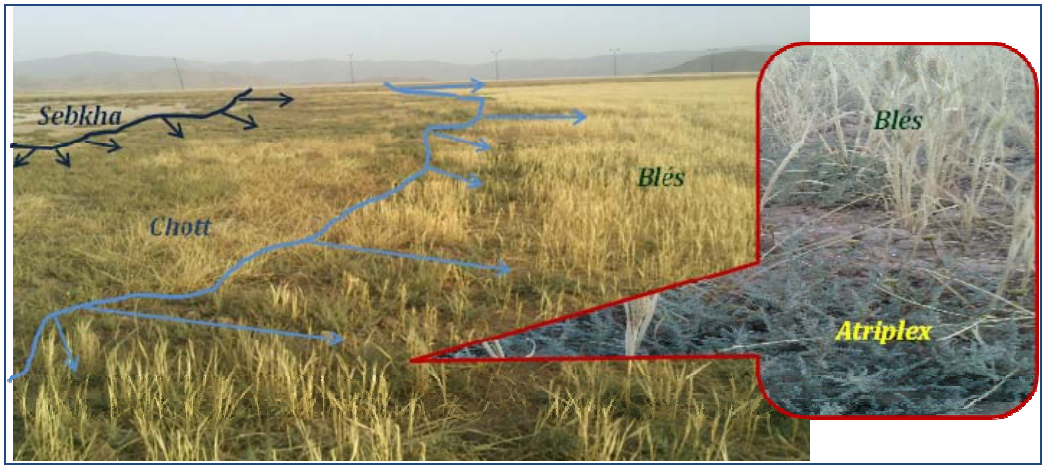


**Figure 5.** Lateral spreading of Sebkhas and Chotts
(Photo: R. Bouhata, July 2013)

## CONCLUSION

Processing and analysis of a medium resolution Landsat TM image gives us suitable results. However, compared to a region where the land is complex and interspersed like our study area. The average spatial resolution image (30m * 30m) shows some limitations. With this spatial resolution some classes have not been well discriminated, confusion is inevitable. The results allowed us to understand the spatial distribution of the land types. The study shows that the surfaces of sebkhas and chotts have extended catastrophically in the plain of Gadaine, which is an indicator of the rapid degradation of the ecosystem; that leads to an irreversible difficult to correct situation either on local or regional development scale, especially if the responsible managers do not take the necessary and immediate actions, that are mainly based on the understanding and the analysis of ecosystem deferent factors, using the new techniques of Geomatics.

For future studies, it is recommended to conduct a longitudinal study to highlight the change rate of different kinds of themes of land use. Moreover, the use of high-resolution images helps for detailed information (roads, small plots, isolated houses etc..).

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