MONITORING URBAN EXPANSION THROUGH CUIRASS INDEX MULTI-DATE CLASSIFICATION: THE CASE OF ORAN (ALGERIA) FROM 1987 TO 2016

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ABSTRACT

The purpose of this study is to use multi-temporal satellite images to monitor and quantify urban sprawl of Oran in western Algeria. The location of the study area is indicated on **Plate 1**. Oran, the second largest city in Algeria, has seen an unprecedented expansion of urban areas in the last three decades. Therefore, there is a need to monitor and quantify the urban sprawl. For that, four satellite images obtained from various sensors (Landsat 5 TM and Landsat 8 OLI) have been used to monitor urban dynamics in Oran over a period of 29 years from 1987 to 2016 (**Table 1**).

The methodological approach is described in **Figure 1** as follows:

– atmospheric correction of Landsat images using *FLAASH* (ENVI's atmospheric correction algorithm based on MODTRAN4 code);

– generation of neo-channels using the cuirass index that allows us to enhance significant aspects of the images from the original bands (**Figure 2**);

– diachronic colour composition (**Figure 3**) that allows us to extract spatial and temporal information related to urban sprawl (**Plate 2**);

– supervised classification approach using the minimum distance algorithm that has enabled the extraction of four main classes : urban extension, existing urban area, vegetation cover, and water surfaces (**Plate 3**);

– vector conversion and GIS integration (**Plate 6**).

The changes maps obtained from processed Landsat images have been validated by photo interpretation using reference data from various sources (Plate 4) on the basis of sample areas identified on Plate 5.

On the other hand, error matrices were used to assess classification accuracy. Overall accuracy, user's and producer's accuracies, and the Kappa statistic were derived from the error matrices. The overall accuracies for the periods of 1987-1998,1998-2008 and 2008-2016 were respectively 97.59%, 98.85% and 94.88%.Furthermore, the Kappa coefficient ranges from 0.94 to 0.97.The overall accuracy and the Kappa coefficient of all images are presented in Table 2.

Time series of Landsat images have been used to quantify urban areas. The results of measuring indicate a higher extent of urban areas in Oran from 1987 to 2016 and show different variations from one year to another (**Figure 4** and **Table 3**). From 1987 to 2016, urban areas increased by around110 ha per year. Urban areas in the city centre grew from 1831 ha in 1987 to 2087 ha en 2016. However, the growth of suburban areas increased from 1550 ha in 1987 to 4486 ha in 2016, and the most significant increase of urban areas was observed from 1987 to 1998. During this period, housing estates were the usual form of housing development in suburban areas. However, the number of building blocks began to rise during the last decades in the study area.

Space consumption and population growth indicators displayed in **Table 4** have been computed in order to establish the relationship between the urban sprawl and population growth. The results reveal that the extent of urban areas is related to demographic statistics and population dynamics (**Table 5**).

In conclusion, the present study has demonstrated the use of the cuirass index for mapping and measuring urban dynamics on regular intervals. This method provides effective alternative means compared to conventional methods of urban data acquisition and could be reproducible for monitoring urban dynamics of any geographical region.

KEYWORDS

Suburban sprawl, remote sensing, cuirass index, Landsat images, Oran, Algeria.

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