



HAL
open science

Monitoring And Estimation of The Sustainable Development Goal –Fifteen- By Remote Sensing Tools, Assessment of Change in Land Cover (Sub-Indicator 15.3.1), Case of Algeria

Walid Rabehi, Nadjla Bentekhici, Mohammed Amine Bouhlala, Farah Benharrats, Ahmed Zegrar, Hamida Samiha Rahli, Moussa Sofiane Karoui, Fethi Benhamouda

► **To cite this version:**

Walid Rabehi, Nadjla Bentekhici, Mohammed Amine Bouhlala, Farah Benharrats, Ahmed Zegrar, et al.. Monitoring And Estimation of The Sustainable Development Goal –Fifteen- By Remote Sensing Tools, Assessment of Change in Land Cover (Sub-Indicator 15.3.1), Case of Algeria. 2020 Mediterranean and Middle-East Geoscience and Remote Sensing Symposium (M2GARSS), Mar 2020, Tunis, France. pp.239-241, <10.1109/M2GARSS47143.2020.9105157>. <hal-05117827>

HAL Id: hal-05117827

<https://hal.science/hal-05117827v1>

Submitted on 10 Jul 2025

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



HAL Authorization

MONITORING AND ESTIMATION OF THE SUSTAINABLE DEVELOPMENT GOAL –FIFTEEN- BY REMOTE SENSING TOOLS, ASSESSMENT OF CHANGE IN LAND COVER (SUB-INDICATOR 15.3.1), CASE OF ALGERIA

Walid Rabehi, Nadjla Bentekhici, Mohammed Amine Bouhlala, Farah Benharrats, Ahmed Zegrar, Hamida Samiha Rahli, Moussa Sofiane Karoui, Fethi Benhamouada
Centre des Techniques Spatiales - Algerian Space Agency (ASAL)

ABSTRACT

Land degradation neutrality as a global goal, needs a permanent spatial monitoring. However, the spatial landcover maps produced until now, by the African countries (to supply the international studies/statistics) have been often full with confusion (medium quality) especially in the vegetal classes. In order to provide a more precision, the aim of this work is to produce landcover maps at a national level of Algeria, using a multisource approach (based on MODIS scenes) using DEM data, NDVI layers, supervised classification and high-resolution image for validation from the Algerian optical satellites "Alsats 2".

Index Terms— SDG, Landcover, Algeria, Remote sensing, Degradation, Multisource

1. INTRODUCTION

The preservation and especially, the quantification of the natural resources available to different countries of the globe is the main motivation that led to the implementation of the seventeen Sustainable Development Goals (SDGs) and their monitoring by the United Nations Organizations. The main objective of this work is to deal with one of these SDGs, namely the "life on land" goal 15, which aims at sustainable management of forests and to reverse land degradation [1].

We propose in this contribution, to provide a more accurate perception of cartographic scales, knowing that standard approaches offer maps at very small scales (1: 500 000) (international land use maps that have been used in the near past as statistics supports in similar thematic reports, FRA 2015, FRA 2010, etc.), However those product are based on standard classification nomenclatures that are hardly adapted to landuse types and the characteristics of different Algerian territories (arid, semi-arid, desert zones, Oasis, etc.) [2], [3].

Our approach for the evaluation of the sub-indicator related to land cover change (sub-indicator 15.3.1) is based on a hierarchical method where specific criteria in each scale of analysis lead to two diachronic maps (2007-2018). From international classifications and supervised classifications based on local user expertise, we could then classify these two maps. Areas with high radiometric confusions will be supported by high spatial resolution (2.5m) images from the Algerian "Alsats 2A/Alsats 2B" Earth observation sensors.

Based on the recommendation of FAO, the optical images use MODIS Data have been retained for their large geographic size by scene, and also for their long multitemporal archive) [5].

In final, we expect to produce land productivity change maps, representing a decision support tools for monitoring natural resources in Algeria, which is very affected by desertification and degradation of vegetation cover [4].

2. METHODOLOGY

To produce a multi-date land cover maps (from 2007 to 2018), the classical approach (supervised, unsupervised) displays a lot of radiometric confusion for various reasons:

- The spectral variety of land cover in Algeria.
- The vast extent of the country with its various climatic zones (different plant species, various agricultures from East to West, variety of rivers, etc.).

- The limits of the geometric resolution of the MODIS images (250m), which simplifies in a single pixel several classes, and thus complicating photo-interpretation/classification.

Therefore, we adopted a hybrid approach, combining, MODIS satellite images and other sources of information, such as:

- The vegetation index (NDVI) to limit the confusion between the "bare-land/grassland/cultivated-land/forest" classes.

- DEM SRTM digital terrain model to create an additional criterion for classifying low-lying wetlands, and using its "slope" derivative to eliminate some "forest-agricultural zone" confusions.

- An ESA classification for the year 2016 (20m resolution); This layer proposed by the ESA (produced by an automated algorithm) is may be efficient in Europe, but displays strong confusion in arid and semi-arid areas (as in north Africa), especially in the vegetal classes (agriculture, forest, grassland, wetland)., Nevertheless, the "artificialized" class is well differentiated for the Algerian urban areas and this class has therefore been extracted and used for our multisource approach.

- USGS classification (LDCC 2007), also realized on the basis of an automatic algorithm. This classification have the same issues with the vegetal classes (algorithms not adapted to the climatic variability of Algeria). The urban class is

however, well differentiated and is also retained to support the classification of the year 2007. All these information layers (supervised classification and other layers) are combined via a hierarchical approach in a decision tree (Fig.1). The tree offers the possibility to combine various information/layers with the same geographical extent, in a multi-scale binary logic.

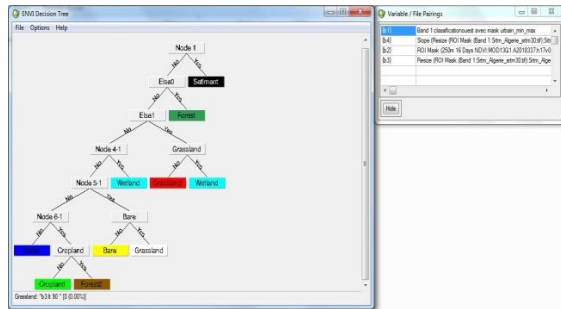


Fig.1. Decision Tree used for the Multi-Source Approach - 2018 Classification.

The reclassification of the two land cover maps into the seven land cover classes required for the UNCCD report (Forest, grasslands, cropland, wetlands, artificialized areas, bare land and water body), allows us a land cover change analysis to identify pixels by their transition type [5]. Combined also with our local knowledge on Algerian local conditions for 2007 and 2018, and the degradation of the area of interests. We classified the transitions corresponding to degradation by a (sign -), the improvement by a (sign +) or and for no change in condition by a (zero).

3. RESULTS AND DISCUSSION

The process of changing Land Cover from one category to another may be referred to a variations in land cover. Landcover change (LDCC) represent the type of change from one LC category to another, and between the initial year and the final year of a follow-up. LDCC represent the resulting losses and gains of natural land processes, from one LDCC category to another, and help to identify the state of land degradation (Fig.2).

		Final Class					
		Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land
Original Class	Forest Land	Stable	Vegetation loss	Deforestation	Inundation	Deforestation	Vegetation loss
	Grassland	Afforestation	Stable	Agricultural expansion	Inundation	Urban expansion	Vegetation loss
	Cropland	Afforestation	Withdrawal of Agriculture	Stable	Inundation	Urban expansion	Vegetation loss
	Wetlands	Woody Encroachment	Wetland drainage	Wetland drainage	Stable	Wetland drainage	Wetland drainage
	Settlements	Afforestation	Vegetation establishment	Agricultural expansion	Wetland establishment	Stable	Withdrawal of Settlements
	Other Land	Afforestation	Vegetation establishment	Agricultural expansion	Wetland establishment	Urban expansion	Stable

Fig.2. The LDCC change matrix

The process of assigning variations to a type of LDCC is a subjective evaluation. For example, the transition from a forest area to a cultivated land could be considered as

"deforestation" (loss of tree areas) or an "agricultural expansion" (gain of cultivated land), and the transition from a grassland to a wetlands could be considered as a "flood" (wetland gain) or a "loss of vegetation" [6]. However, during the 2007-2018 periods (Fig.3 & Fig.4) many LDCC occur at a national scale, as shown in Fig.5:

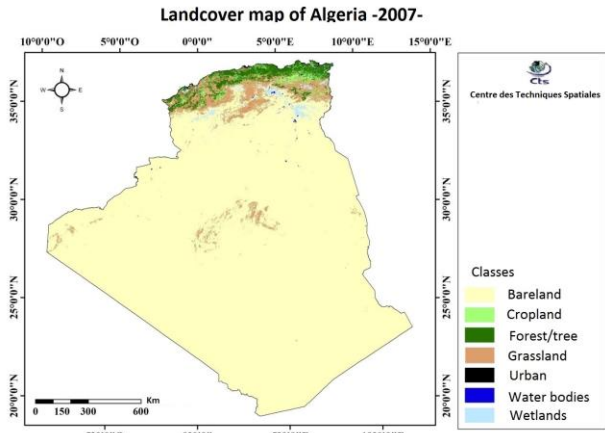


Fig. 3. land cover map of Algeria in 2007

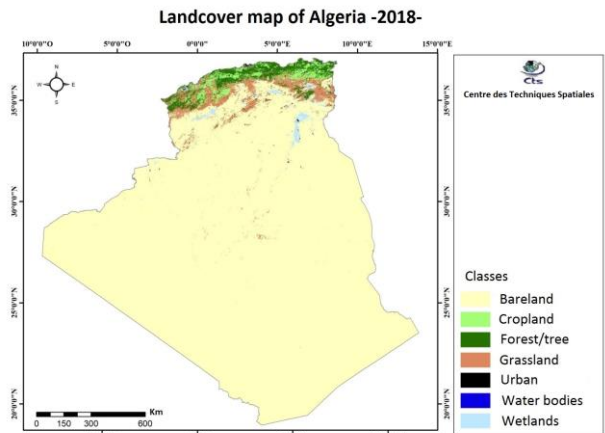


Fig.4. land cover map of Algeria in 2018

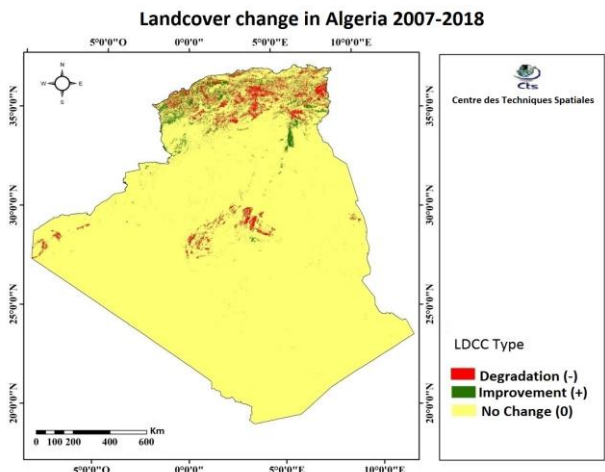


Fig.5. Land cover change map of Algeria between 2007 and 2018.

We deduce from this map (Fig.5):

- An urban sprawl of 42.45km², which doesn't represent an improvement but actually a degradation, since it could be in fact a sprawl of the agricultural grounds (urban expansion), a deforestation or a drainage of wet area [7].

- At the Algerian territory level and between 2007 and 2018, we notice a decline of tree areas (Forest) with an area of -3680.47km². The change map shows a deforestation by a negative class (degradation -) and afforestation by a positive class (improvement +).

- For the Grassland class, we found a decline of -28730.8 km² of the total surface, representing a loss of vegetation in 2018. On the other hand, we noticed an increase of peering, which represents a vegetation establishment [8].

- Algeria experienced a significant increase in cultivated land between 2007 and 2018, with an area of +11738.87km². It is an agricultural expansion due to the climatic factors (a rainy year or by the contribution of the state in shaping and restoration of agricultural land, generally "bareland" that has been turned to "cropland").

- Wetlands experienced a decline of -764.83km² between 2007 and 2018. The change map shows a positive improvement in the Southeast, from bare lands to wetlands, a sign of new wetlands establishment. This is due to climatic factors (2018 was a rainy year). On the other hand, if agricultural lands have been transformed to wetlands, it represents a form of drainage of wet zones.

- We have found a significant decline of water bodies with an area of -345.22km². Its a sign of dams and water bodies degradation.

- Scenario of catastrophic loss: when the LDCC has moved from a vegetal type (wooded areas or grasslands) to a non-vegetal type "bare land" it reflect a catastrophic degradation and a consequent surface soil erosion. In Algeria, the bare lands experienced a significant increase in 2018 with an area of 21739.85 km², it is a form of land degradation, a withdrawal of agriculture, deforestation, land degradation by water erosion, desertification, loss of vegetation or wetlands drainage.

4. CONCLUSION

The spatial monitoring of landcover change on a large scale, such the Algerian territory is a complicated task, due to the high variability of the climates/lands in the country, especially when the maps have to be produced in a short period.

The multisource approach allows a quick and efficient solution for radiometric confusion, by using classes directly from other maps (such ESA-Urban class), or taking altitudes from DEM data, for a better discrimination of complicated classes as Algerian Wetlands.

The overall results shows a high degradation of the Algerian steppic area, with significant growth of artificialized zones, we can also observe a decrease of the forest and wetland

classes, the unique positive increase concerns the cropland lands.

The Alsat 1B, Alsat 2A/2B scenes (12m, 2.5m of resolution respectively) have been used for the sampling of validation grid-points, it allows later to compute the accuracy of the each landuse map. Their use will be extended in the future (when the archive will be more sufficient) for direct landuse mapping which will allow a better scales (1:25000/1:50000). As a perspective, the landcover map of Algeria, needs to became a permanent annual map (to quantify the geographical dynamic constantly), the decision tree approach made in this work have to be gathered in a single automatic program using a specific language or using new Big Data servers such Google Earth Engine.

5. REFERENCES

[1] I.S. Zonn, G.S. Kust, & O.V. Andreeva, Desertification paradigm: 40 years of development and global efforts. *Arid Ecosystem*, Pleiades publishing 7: 131. 2017. <https://doi.org/10.1134/S2079096117030118>

[2] A. Zegrar, Determination and Analysis of Desertification Process with Satellite Data Alsat-1 and Landsat in the Algerian Steppe. *Engineering Geology for Society and Territory*, Springer, Volume 2. pp 1847-1852, 2015. https://doi.org/10.1007/978-3-319-09057-3_327

[3] B. Nedjimi, M. Homida Problématique des zones steppiques Algériennes et perspectives d'avenir *Revue El Bahith*, Université Ouargla numero 4 2006.

[4] A. Hirche, M. Salamani, A. Abdellaoui, et al. Landscape changes of desertification in arid areas: the case of south-west Algeria *Environmental Monitoring and Assessment* 179 Issue 1-4, pp 403-420. 2011. <https://doi.org/10.1007/s10661-010-1744-5>

[5] CSIRO-UNCCD, Good Practice Guidance SDG Indicator 15.3.1, Proportion of land that is degraded over total land area Version 1.0, 2017.

[6] Mattina D., H.E. Erdogan, I. Wheeler, N.D. Crossman, R. Cumani, S. Minelli. 2018. Default data: methods and interpretation. A guidance document for the 2018 UNCCD reporting. United Nations Convention to Combat Desertification (UNCCD), Bonn, Germany.

[7] J. Martínez-Valderrama, J. Ibáñez, G. Del Barrio, F.J. Alcalá, M.E. Sanjuán, A. Ruiz, A. Hirche, J. Puigdefábregas, Doomed to collapse: Why Algerian steppe rangelands are overgrazed and some lessons to help land-use transitions, *Science of The Total Environment*, Elsevier, 613-614, pp 1489-1497, 2018. <https://doi.org/10.1016/j.scitotenv.2017.07.058>.

[8] H. Slimani, A. Aidoud, F. Rozé, 30 Years of protection and monitoring of a steppic rangeland undergoing desertification, *Journal of Arid Environments*, Elsevier. Volume 74, 6, pp 685-691, ISSN 0140-1963, 2010. <https://doi.org/10.1016/j.jaridenv.2009.10.015>.