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## Temporal Dynamics of Vegetation Cover and Agricultural Development in the High-Atlas and Anti-Atlas of Morocco from 1990 to 2020 Using Landsat 5-7 MSS and 8 OLI/TIRS Data

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### Abstract

Since the 1990s Morocco's agriculture is characterised by the coexistence and the transformation of modern and smallholder traditional agriculture. In some oases of the Atlas Mountains, the effects of urbanization lead to intensified irrigated agriculture while others are abandoned. To better understand these effects, this study aimed at (1) analyzing the land use land cover (LULC) changes, (2) assessing the dynamics of vegetation and agricultural cover, (3) and determining the drivers of LULC changes at different scales. Based on Landsat data from the 1990s to the 2020s we used an automatic supervised classification of LULC. On-screen visualization and automatic object classification were combined to also analyze high-resolution Corona images of the 1970s and Google Earth images, and Spot 6 data of the 2020s. This approach allowed differentiating between open vegetation, bare land, forest, and water. In the High-Atlas Mountains, classification accuracy was 86% in 1990, 81% in 2000, 80% in 2010, and 61% in 2020. Results indicated the share of bare land to amount to 94% in 1990, 88% in 2000, 92% in 2010, and 84% in 2020, while forest and open vegetation accounted for less than 30% of the total area. During the same period, total forest area doubled from 3090 to 7362 km<sup>2</sup> associated with a reduction of bare land and open vegetation. Vegetation cover was between April and August whereby NDVI values > 0.3 accounted for 15% of the High Atlas Mountains. In the typical oasis of Targa N' Touchka, abandoned land increased by 0.57 km<sup>2</sup> while the agricultural area shrunk by 1.72 km<sup>2</sup> from 1970 to 2020. This transformation reflected the migration of the young population to the cities, making the livelihoods of the remaining oasis farmers more vulnerable.

**Keywords:** NDVI, remote sensing, rural-urban transformation, urbanisation