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The degradation of rangelands in the Middle Atlas during the last decades

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Abstract. The study was carried out in the territorial Community of Timahdit, Morocco. This study aims to assess changes in landscape pattern and vegetation standing crop during the last four decades. Changes in land cover were assessed by using remote sensing from Landsat-5 Thematic Mapper (TM) for 1984, 2007 and 2016. Images were analyzed by supervised classification for identification of land cover types. Vegetation surveys were performed in 1979 and 2017 to assess changes in vegetation standing crop. The results showed changes in percent of land occupation. Forest area declined by 77.50%. Grasslands area decreased slightly (4%). Shrub cover remained unchanged and the amount of bare ground varied among years. Total standing crop of biomass did not change between 1979 and 2016. Changes occurred in standing crop of plant functional group and individual species with increaser weed species replacing palatable native species.

Keywords. Grassland – Biodiversity – Livestock impacts – Rangeland degradation – Middle Atlas.

La dégradation des terres de parcours dans le Moyen Atlas au cours des dernières décennies

Résumé. L'étude a été réalisée dans la Communauté territoriale de Timahdit, au Maroc. Cette étude vise à évaluer les changements dans la configuration du paysage et de la végétation sur pied au cours des quatre dernières décennies. Les changements dans la couverture du sol ont été évalués en utilisant la télédétection de Landsat-5 Thematic Mapper (TM) pour 1984, 2007 et 2016. Les images ont été analysées par classification supervisée pour l'identification des types de couverture du sol. Des relevés de végétation ont été effectués en 1979 et 2017 pour évaluer les changements dans la végétation sur pied. Les résultats ont montré des changements dans le pourcentage d'occupation des terres. La superficie des forêts a diminué de 77,50%. La superficie des pâturages a légèrement diminué (4%). La superficie arbustive et le maquis est resté inchangé et la quantité de sol nu a varié selon les années. La biomasse totale sur pied n'a pas changé entre 1979 et 2016. Des changements ont été observés dans la biomasse des groupes fonctionnels de plantes et des espèces individuelles, les espèces de mauvaises herbes envahissantes remplaçant les espèces indigènes palatables.

Mots-clés. Pâturages – Biodiversité – Impacts du bétail – Dégradation des parcours – Moyen Atlas.

I – Introduction

For many pastoral societies such as those in the Middle Atlas of Morocco, ecological integrity of the pastoral systems that sustained natural resources for long time depended of on mobility of people and herds. As most of the Middle Atlas producers, those of the Ait Arfa du Guigou tribe used to be transhumant between winter grazing (lowlands) areas and summer ones (higher lands). Conversion to cultivation of the lowlands (winter grazing areas) reduced the grazing areas and caused a break down in the double transhumance. Consequently, herders reduced their mobility and started settling in the summer high grazing lands. This study aims to assess changes in landscape pattern and vegetation standing crop during the last decades.

II – Methods

The study was carried out in the territorial Community of Timahdit (TCT), home of the Ait Arfa de Guigou tribe. The climate is semiarid. Winters are cold with mean minimum temperature of -2.5°C and mean maximum temperature of 9.8 °C for the month of January. The hottest month is August with mean maximum temperature of 31°C and mean minimum of 13.6°. Annual precipitation ranged from 800 mm in the North of (TCT) at 2000 m elevation to 300 m South of the Timahdit village.

Changes in land cover were assessed by using remote sensing from Landsat-5 Thematic Mapper (TM) for 1984, 2007 and 2016 were analyzed by supervised classification for identification of land cover types. Vegetation surveys were performed in 1979 and 2017 to assess changes in vegetation standing crop. Twenty transects that ran east to west and spaced 4.5 meters apart were used to determine Standing crop of biomass. Standing crop of biomass was sampled by clipping vegetation within a 0.33 m² circular quadrat. Clipped vegetation was oven dried at temperature of 65°C for 48 hours to estimate production expressed as dry matter expressed as g/m².

III – Results and discussion

Our results indicated a change in percent of land occupation (Table 1). Forest area declined. Matorrals of *Artemisa spp* and Xerophytic species (*Buplorum spinosum* and *Erinacia anthyllis*) remained unchanged. The matorral of *Genista pseudopilosa* increased. The area of the grasslands decreased slightly. Finally, the amount of bare ground varied among years, but remained important leading to a great amount of fragmentation. Croplands area is decreasing in percent of total. These changes in land cover indicated trend toward land degradation (Kouba *et al.*, 2018).

Table 1. Percentage of land cover of the Timahdit during 1984, 2007 and 2016

	1984	2007	2016
Croplands	13.16	12.92	9.33
Dense forests	15.63	13.35	3.69
Xerophytic shrubs	20.51	22.09	21.67
<i>Genista spp</i>	6.92	4.89	31.55
<i>Artemisia spp</i>	7.26	7.79	7.67
Grasslands	20.34	21.34	17.01
Bare ground	11.09	15.25	8.95
Wetland	2.54	1.17	0.13
Unknown	2.55	1.19	0.00

The total production of biomass did not change between 1979 and 2016. It averaged 698.2 kg DM/ha and 648.82 Kg DM/ha for 1979 and 2016, respectively. However, changes occurred in composition of standing crop. Production of grasses remained unchanged between 1979 and 2016 ($P>0.05$). Grass like, represented by *Carex divisa*, increased significantly years since it increased from less than 4% in 1979 to 21.52 ($P<0.01$). Production of low shrubs (*Thymus algeriansis*, *Helianthemum croceum* and *Alyssum montanum*) decreased from 10.89 g DM/m² in 1979 to 3.15 g DM/m² in 2016 as response to continuous over grazing; i. e., stocking rate average in the grazing area around 4.5 ewe/ha (Fig. 1).

The low shrub contribution to standing crop of biomass decreased from 44.87% to 14.73% Annual forb species increased with years.

Comparison of standing crops of individual species indicated that there are some species that decreased in 2016 as compared to 1979. These species are the key species for the Middle Atlas grasslands. Among them, we find the most palatable grasses such as *Dactylis glomerata* ($P<0.01$),

Festuca ovina ($P<0.05$), and *Poa bulbosa* ($P<0.01$) and the subshrub *Thymus algeriensis* ($P<0.01$). These species are the ones that suffered from overgrazing during the last 37 years. The species that seemed to replace the one that are decreasing are *Stipa lagascae*, *Carex divisa*, *Filago germanica*, *Scléranthus annuus*, *Tunica ilirica*. These species have low pastoral value for sheep. There are some species that remained unchanged when comparing the two years studied. It is the case of *Bromus tectorum*, *Dasypyrum hordeaceum*, *Koeleria splendens*, *Phleum phleoides*, *Convolvulus cantabrica*, *Dianthus caryophyllus*, *Echinaria capitata*, *Euphorbia nicacensis*, *Hierarcium pseudopilosa*, and *Ranunculus orientalis*. This last group is composed of annual species and those that are not palatable (Chryaa 1982 and El Aich *et al.*, 1980).

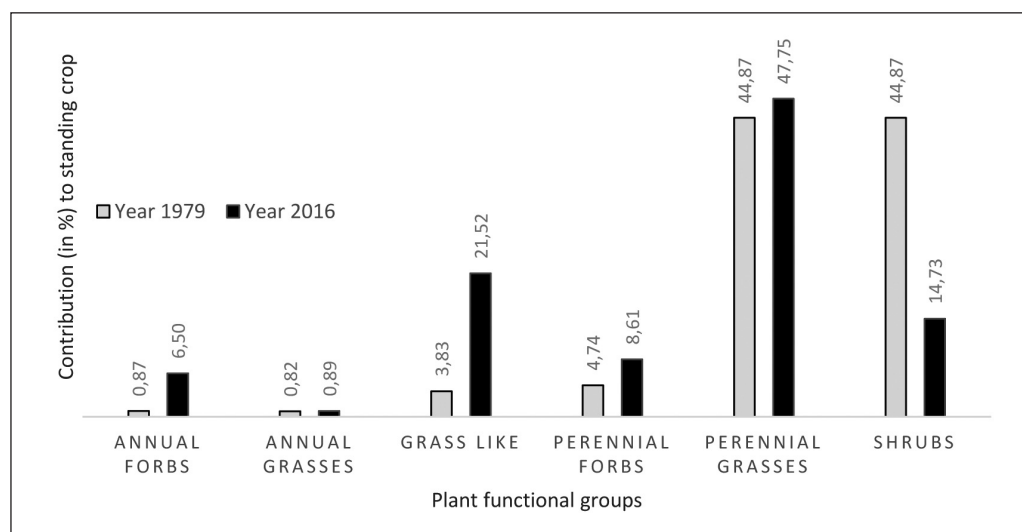


Fig. 1. Contribution (in%) to total standing crop biomass of plant functional groups (in g DM/m²) during 1979 and 2016.

IV – Conclusions

The main conclusions of this study are: the changes in land cover, the maintenance of the standing crop of biomass and the change in the floristic composition of the pasture. The study showed the capacity of resilience of the Middle Atlas grasslands since the precipitation are not limiting factor. However, the question is whether these grasslands will continue to have the same capacity of resilience.

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