Characterizing pastoral land on a large scale : a way to assess better the resilience of Mediterranean livestock activities. Lessons learned from a study on the scale of the Provence Alpes Côte d'Azur region (France)

Shaqura I., Lasseur J.

in

López-Francos A. (ed.), Jouven M. (ed.), Porqueddu C. (ed.), Ben Salem H. (ed.), Keli A. (ed.), Araba A. (ed.), Chentouf M. (ed.).
Efficiency and resilience of forage resources and small ruminant production to cope with global challenges in Mediterranean areas

Zaragoza : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 125

2021
pages 387-392

Characterizing pastoral land on a large scale : a way to assess better the resilience of Mediterranean livestock activities.
Lessons learned from a study on the scale of the Provence Alpes Côte d'Azur region (France)

I. Shaqura and J. Lasseur

Institut national de la recherche agronomique, UMR SELMET, INRA, Cirad, SupAgro, Université de Montpellier. 2 Place Viala, 34060, Montpellier (France)

Abstract Given the mobility of people and animals, the diversity of land tenure systems and of the associated environments, the identification of grazing land over large areas is an uncertain exercise, especially when it comes to defining the expanse of land concerned and its type. Improving the characterization of grazing lands is needed to analyse the resilience of pasture-based systems in a context of global changes. Our study started with the determination of the diversity and spatial distribution of vegetation types within the grazing land of a small region, based on testimonies from livestock farmers. On this basis, we characterized land use by remote sensing at the scale of a small test region (611 km^2). The characterization of land use in these areas is a major challenge that cannot be met merely by analysing declarative data or by using a conventional map where land categories cannot be connected to grazing management practices. On the basis the land use map we produced, we identified that animals' access to the pastoral resource is problematic in a large proportion of the grazing area (35%) due to shrub encroachment and forest expansion. This puts forward a weakness of pastoral farming in terms of future dynamics.

Keywords. Pastureland – Characterization – Remote sensing – Spatial distribution.

Caractériser l'espace pâturé à large échelle : un moyen de mieux évaluer la résilience des activités d'élevage en Méditerranéen. Enseignement d'une étude à l'échelle de la région Provence Alpes Côte d'Azur (France)

Résumé. *Du fait de la mobilité des hommes et des animaux, de la diversité des statuts fonciers et des milieux concernés, l'identification de l'espace pastoral pour des ensembles spatiaux étendus est soumise à de fortes incertitudes tant sur l'étendue des surfaces concernées que sur leur nature. Mieux caractériser ces espaces est important pour analyser la résilience des systèmes confrontées aux changements globaux. Notre étude a d'abord caractérisé la distribution spatiale et la diversité des formations végétales de l'espace pastoral d'une petite région à partir de déclarations d'éleveurs. Sur cette base, nous avons caractérisé l'occupation du sol par télédétection à l'échelle d'une petite région test (611 km^2). La caractérisation de l'occupation du sol de ces espaces est un enjeu fort qui n'est résolu ni par l'analyse des données déclaratives ni par l'usage d'une carte généraliste dont les catégorisations ne permettent d'établir un lien avec les pratiques pastorales. Sur la base de la cartographie d'occupation du sol que nous avons réalisé, l'accessibilité pour les animaux à une ressource pâturable est en question pour une forte proportion de l'espace pastoral (35%) du fait de la forte dynamique de fermeture des milieux Ceci souligne des fragilités de l'activité en termes de dynamiques futures.*

Mots-clés. *Espace pastoral – Caractérisation – Télédétection – Distribution spatiale*.

I – Introduction

In Provence-Alpes-Côte D'Azur, livestock farming occupies significant proportions of the regional territory. It plays a structural role in land use and in the socio-economic environment of rural areas. Its highly pastoral nature makes it an important contributor to the development of natural areas, particularly ecologically sensitive sites and those characterized by the multiple use of land.

Grazing is often the only human activity in these areas. Unlike other agricultural practices (such as ploughing or mowing), it is difficult to establish spatial records of this practice because the animals move around. Within a particular farming territory, how frequently or how intensively pastureland is used depends on whether the land in question lies within the farm's main grazing area or is a back-up area used when adverse climate events lead to a shortfall in fodder production.

It is important to characterize the spatial distribution of livestock activities to better analyse interactions with plant dynamics in grazed areas. The management of these interactions governs the long-term renewal of the pastoral resource. Generally, over the medium term, the region's grazing areas undergo encroachment dynamics, with the growth of tree and forest layers that jeopardize the availability and accessibility of the forage resource. These ecological dynamics are heightened by a downward trend in grazing pressure and minimal human intervention to control woody plants. The increasing frequency of adverse climatic events might strengthen the need for additional grazing areas to secure systems' resilience. In the meantime, the management practices in pastoral land areas are reducing their ability to supply fodder over the medium term. These processes have been clearly identified in small samples of farms monitored by extension services and research. However, there is little documentation of the trends at the regional level, even though use of these areas is affected by the global changes operating at these larger scales.

Our work aimed to better characterize the pasturelands of the PACA region in terms of spatial distribution and diversity of vegetation types concerned. Based on such results, we assessed the overall sustainability of the pastoral system, and especially its ability to renew the resources on which it depends. We also examined its ability to take into account the expectations of the other stakeholders involved.

II – Materials and method

1. Area of study

The Provence-Alpes-Côte D'azur (PACA)[1] region covers an area of 31,400 km^2 in south-eastern France. The marked altitudinal gradient and the strong contrasts in vegetation types shape the region into a number of large spatial entities (the Mediterranean coast, the Alpine zone and the *Rhone* and *Durance* valleys). Livestock systems based on the high seasonal mobility of herds (transhumance) have emerged, adapted to this geographic diversity. The region is split into six administrative departments. This roughly corresponds to the area within which the herds move, which is the entity analysed in this study.

We used two data sources: the *Registre Parcellaire Graphique* (RPG or graphic land registry) (Cantelaube and Carles 2014) and the *Enquête Pastorale* (EP or pastoral survey) (Enquête pastorale 2014). We analysed the spatial distribution of grazed areas, as recorded in these two sources. It is worth noting that the regional extent and location of grazed land differed depending on the meth-

1. The PACA region, https://www.maregionsud.fr/la-region/un-territoire.html

ods of assessment: the RPG estimated the grazed surface area at 553,205 hectares in 2014 and the EP at 877,981 hectares. We focused our analysis on the areas common to these two sources, considering that they are the core of the areas grazed by livestock in the region.

We carried out our study on the scale of an area that is deemed homogeneous in terms of its geomorphology and the nature of its agricultural activities: the Haut Verdon Annot-Saint André *géoterroir* located in the Alpes de Haute Provence *département* (04), which covers an area of 611.28 km^2. It is a diversified entity, which includes pre-alpine and mountain environments, with large areas used by livestock.

2. Vector data

The data analysed refered to the year 2014, in order to: (i) establish a baseline year before implementation of the 2015 CAP, and (ii) compare data from RPG and data from the last pastoral survey which took place in 2012-14.

France has established a register of agricultural plots since 2002, known as the 'graphic land registery' or *Registre Parcellaire Graphique* (RPG), based on farmers' CAP declarations and administered by the *Agence de Services et de Paiement* (ASP). The RPG is a source of annual georeferenced land-use information made available by INRA's Rural Development Observatory (ODR) department[2].

Three pastoral surveys have been carried out on the scale of the Alpine massif since the 1960s. The last one was conducted in 2012-14. The survey lists grazing areas of more than 10 hectares. The EP results in a georeferenced database that can be used in all GIS software. The data were provided for this study by the *Centre d'Etudes et de Réalisations Pastorales Alpes Méditerranée* (CERPAM).

3. Raster data

The SPOT 6 images for the year 2014 were provided by EQUIPEX GEOSUD[3]. The SPOT 6/7[4] satellites provide the 60-km imaging swath in two modes simultaneously: (i) panchromatic with 1.5 m resolution: this product includes a single band in the wavelength range of 0.45µm to 0.745µm; (ii) multispectral with 6 m resolution, comprising four spectral bands: B1 (Red 0.530µm-0.590µm), B2 (Green 0.760µm-0.695µm), B3 (Blue 0.455µm-0.525µm), and B4 (PIR 0.760µm-0.890µm).

The image processing chains of this study were based on open source software, notably the Orfeo Tool Box[5], a satellite image-processing library designed for high spatial resolution images, developed by CNES. OTB algorithms can be run from QGIS, which is also free GIS software.

4. Method

Our objective was to (i) identify large-scale grazed areas from the two sources of declarative data and make cross-checks to weight uncertainties relating each source and the contrasts between sources, and (ii) characterize land use by distinguishing five land use classes for grazing land: forests, closed moorland, open moorland, meadows, and bare ground.

2. The ODR is a software platform created and managed by INRA, the French National Institute for Agricultural Research.
3. The EQUIPEX GEOSUD project
4. SPOT 6 | SPOT 7– https://www.intelligence-airbusds.com/files/pmedia/public/r12784_9_spot6-7_fiche_technique.pdf
5. Orfeo Toolbox – https://www.orfeo-toolbox.org/

Grazing areas are made up of spatial entities where the interactions between the natural dynamics of vegetation types and human activities (mainly bringing herds to pasturelands) determine land use. Our five land use classes reflect both past use patterns and the potential for future use of these areas for grazing: open moorland and meadows are the preferred areas for grazing, while closed moorland and forests remain are less interesting due to limited accessibility of the pastoral resource. Figure 1 illustrates the spatial arrangement of these areas and their role in feeding herds.

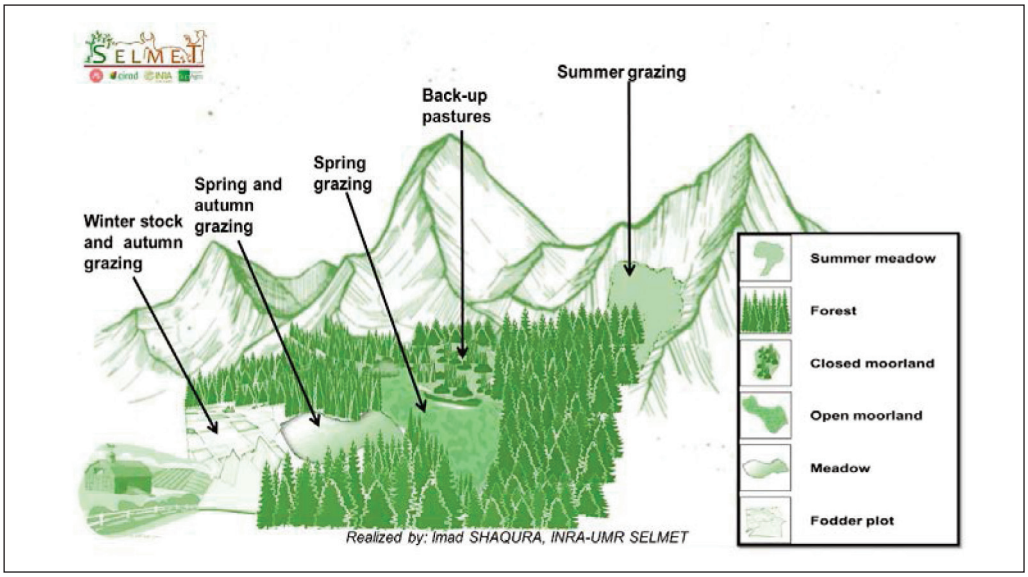

Fig. 1. Diagram showing the spatial arrangement of grazing areas and their role in livestock feeding systems.

III – Results

The confusion matrix report produced by QGIS for the supervised classification algorithm (Bayes), implemented in Orfeo Toolbox (OTB), validates the results from the SPOT 6 image classification process. We have overall accuracy of 86.8 and a Kappa index of 84.2%.

Table 1 and Figure 2 show the distribution of grazing areas in the five land use classes according to the data sources used to identify these areas (RPG, pastoral survey or both). At the scale of the *Haut Verdon-Annot-Saint André* geoterroir, the distributions of the different land use classes, according to the data source, converge. For the analysis, we will thus focus our attention on the areas declared in both databases.

Closed moorlands are the land use category most frequently identified (32%). This means that over one third of the grazing areas in this géoterroir are in areas where there is no guaranteed access to the resource in the medium term. In fact, according to our hypothesis, these are areas are mainly grazed as 'back-up' in years when adverse climate events have limited production and thus might not endure a sufficient grazing pressure to limit shrub encroachment. In these pastoral systems, resilience to climatic events is thus dependent on areas where the practices applied may not be capable of maintaining this function over the medium term due to low stocking rates and weak control of vegetation dynamics by grazing practices.

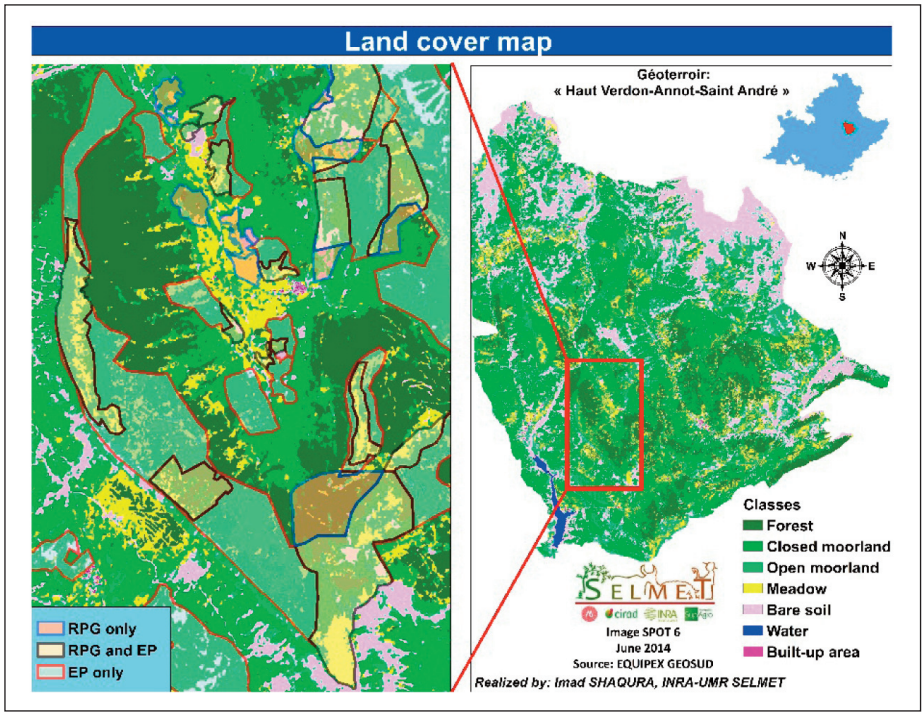

Fig. 2. Land use map (Haut Verdon-Annot-St André).

Table 1. Percentage of each land use class by data source (*Haut Verdon-Annot-St André*)

Land use class	Both the RPG and the Pastoral Survey		Pastoral Survey only		RPG only	
	(ha)	(%)	(ha)	(%)	(ha)	(%)
Forest	265.3	2.0	1149.2	5.0	418.71	2.8
Closed moorland	4225.7	32.0	8290.8	35.8	5141.47	33.8
Open moorland	3141.6	23.8	4541.8	19.6	3439.52	22.6
Meadow	1211.5	9.2	2057.1	8.9	1404.87	9.2
Bare soil	4341.8	32.9	7128.2	30.8	4799.73	31.6
Total	13186.1	100	23167.1	100	15204.3	100

It is worth noting the low values for grazed forest. In contrast to other land use classes, the bare soil category is highly represented (approx. 33%). These high values can be explained by the prominence of high mountain summer pastures in this géoterroir. These two land use classes comprise areas whose eligibility for CAP support is debated. The open moorland and meadow classes – ideal grazing areas – together account for only one third of the grazed areas, which can seem little, even if the contributions of these surfaces is much higher when expressed in terms of amounts of forage ingested.

IV – Conclusion

This study emphasizes how valuable large-scale georeferenced databases are when characterizing interactions between grazing practices and trends in the use of grazed land. If land cover may be easily determined thanks to new developments in remote sensing, land use practices are still

poorly documented at these scales, although, participative mapping and easy access to public information should improve the situation in a near future. In our situation, comparing data from different sources remains necessary to compensate the uncertainty associated with each evaluation system. Availability of data about grazing land is the main limit to the reproductibility of this research.

Scrub encroachment and forest growth are responsible for the closing-off of natural grazed areas in medium mountains. This is a particularly strong tendency in the French Mediterranean region. The extension of these closed areas will likely jeopardize the high resilience of livestock systems to adverse climatic events, which have become more frequent in recent years. Although it would be very costly, these areas should therefore be mechanically cleared, to strengthen the sustainability of the systems. Considering the low short-temr economic return of such investment, it could only be implemented with public supports, as a means to facilitatethe multiple use for these areas (recreational, forestry, fire protection...). Alternatives solutions for livestock systems include reallocation of grazing to other areas through a greater mobility of herds, and/or increasing feed supplementation as an alternative to grazed forage.

References

Cantelaube Pierre and Marie Carles, 2014. « Le registre parcellaire graphique: des données géographiques pour décrire la couverture du sol agricole ». Le Cahier des Techniques de l'INRA, (N Spécial GéoExpé), 58-64.

Enquête pastorale, 2014. « Une nouvelle enquête pastorale 2012/2014 sur le Massif des Alpes et les territoires pastoraux des Régions Rhône-Alpes et Provence Alpes Côte d'Azur Principes, bases méthodologiques et modalités de valorisation des données ». http://enquete-pastorale.irstea.fr/zone_telechargement.php.