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## Application of pastoralists' knowledge to natural resource management in Spain

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**Abstract.** Extensive livestock rearing has been acknowledged as an important tool for sustainable management of social-ecological systems and biodiversity conservation. In the Mediterranean Basin this relationship has been highlighted in mountainous and rural areas, where the co-evolved assemblages and dynamics of plant communities and grazing practices and patterns are mutually reinforcing. Among extensive livestock rearing systems, mobile pastoralism is a typical adaptation in semi-arid areas and mountainous regions where pasture availability is especially variable in time and space. In Spain, mobile pastoralism dates back to Neolithic and has survived until our days in different ways. An outstanding example of mobility is transhumance, an ancient pastoralist practice consisting of the seasonal migration of livestock between ecological regions following peaks in pasture productivity. Traditional ecological knowledge (TEK) can provide valuable information that complements scientific studies to improve understanding and stewardship of ecosystems. In particular, transhumance depends on the preservation, use, and transmission of TEK and the integration of TEK into land use and management policies. In this paper, we: (1) provide examples of traditional ecological knowledge related to extensive livestock rearing, and transhumance in particular, that could be useful for grasslands management; (2) explore the current challenges to the integration of this knowledge for Spanish grasslands' management; and (3) provide insights on how these barriers might be overcome. The evidence is based on two case studies: one in the two westernmost central Pyrenean valleys of Ansó and Hecho (Aragón), where shepherds carry out short valley-mountain and middle-distance transhumance (ca. 200 km); and the other on the summer pasturelands of Montes Universales (Aragón, Guadalajara and Cuenca) from where a long-distance transhumance through the Conquense Drove Road departs (ca. 500 km). In-depth semi-structured interviews, focus groups and participant observation were applied in both cases. We conclude that much of mobile extensive stockmen's ecological knowledge is threatened due to a lack of generational turnover, endangering the survival of a valuable source of sustainable grassland management knowledge and practices. Social and institutional barriers, including lack of profitability, dependence on EU subsidies, competition with other land-uses such as biodiversity conservation or hunting, and neglect by governments and society, negatively affect the continuity of TEK at different scales. However, some strategies, such as pastoralists' cooperation in making their voices heard in regional and European policy decisions, or their involvement in monitoring ecological conditions of ecosystems, may foster a modest recovery of transhumance in Spain.

**Keywords:** Traditional ecological knowledge, transhumance, transterminance, drove roads, grasslands.

### Introduction

Extensive livestock rearing is acknowledged as an important tool for sustainable management of social-ecological systems (*e.g.* Blondel 2006; Mortimore *et al.* 2009), biodiversity conservation and ecosystem services delivery (Huntsinger and Hopkinson 1996; Plieninger *et al.* 2012). In the Mediterranean Basin this relationship has been highlighted in mountainous and rural areas (Baldock *et al.* 1993; Beaufoy *et al.* 1994), where the co-evolved

assemblages and dynamics of plant communities and grazing practices and patterns are mutually reinforcing. In Spain, pastoralism has been particularly acknowledged for its role in the conservation of important European habitats (*e.g.* Natura 2000 network and High Nature Value Farming Areas) (Oppermann *et al.* 2012). In recent decades, pastoralism and grasslands within this region have suffered from different drivers of change that have fostered a rural exodus. In some areas this has led to reversion of previously grazed pastures from herbaceous vegetation

cover to either shrublands and forests or intensive agriculture. This has fostered the de-coupling of livestock and cropping cycles, which previously were linked in an integrated agro-pastoral system. In turn, these changes in land cover may affect the ecological function and ecosystem services provided by these lands, especially through a decline in biodiversity (Vicente-Serrano *et al.* 2004; Lasanta-Martinez *et al.* 2005; Lesschen *et al.* 2007). Shrub and tree encroachment devalues land for grazing and cropping, and the future of a vibrant pastoral social-ecological system is in question (Fernández-Giménez and Fillat Estaque 2012).

### *Mobile pastoralism: transterminance and transhumance*

Within pastoralism, mobile pastoralist practices constitute an adaptation typical of semi-arid regions, deserts and upland areas (so called “marginal areas”) where the available natural resource are spatially and temporally variable due to variable temperature and rainfall, leading to high variability in plant productivity (Dyson-Hudson and Dyson-Hudson 1980; Fryxell and Sinclair 1988; Alerstam *et al.* 2003). Mobile pastoralism in the Iberian Peninsula which dates back to the Neolithic, is one of the oldest continuous systems of pastoral land use in Europe (Geddes 1983; Montserrat and Fillat 1987), and has survived until today in different ways. As a result of this long history, the dynamics of plant communities and pastoral land use patterns are highly interdependent, and the history of livestock grazing and cropping, particularly in mountain areas, has created characteristic and complex cultural landscapes, in which the co-evolved plant assemblages and grazing practices are mutually reinforcing (Puigdefabregas and Fillat 1986; García-González *et al.* 1990).

An outstanding example of mobility is the ancient pastoralist practice of seasonal migration of livestock between ecological regions following peaks in pasture productivity (Ruiz y Ruiz, 1986). In Spain, these livestock movements are classified according to the distance covered. *Local transhumance* consists of short movements within the limits of a municipality. *Transterminance* takes place between neighboring areas but different municipalities. *Long-distance or regional transhumance* involves migration between 200 and 700 km (García Martín 1990). Wintering areas are usually located at more temperate latitudes and/or lower areas, whereas summering areas are found in more mountainous (and northern) areas. The two journeys tend to take place when the productivity peak is occurring in-between these two areas, taking advantage also of their primary productivity peaks (Manzano Baena y Casas 2010). Seasonal livestock movements adapt grazing pressure to ecosystem carrying capacity, making efficient use of primary productivity in every season (Fryxell *et al.* 1988; Alerstam *et al.* 2003).

Transhumance has been widely recognised as an important traditional pastoral practice for provisioning services such as high-quality meat and wool, regulating services such as seed dispersal, and cultural services such as cultural identity and traditional ecological knowledge, while contributing to biodiversity conservation (Gómez Sal and Lorente 2004; Mangas-Navas 2004; Bunce *et al.* 2006; Manzano and Malo, 2006; MARM, 2011). For this reason,

drove roads in Spain (extending over about 125,000 km and 400,000 ha) were granted legal protection in 1995 with the Drove Roads Act (Ley 3/1995 de 23 de Marzo). Globally, the main drivers affecting mobile pastoralism are integration within the market economy, sedentarization policies, land grabbing and common-land privatization, and institutional limitations hindering mobility (Davies y Hatfield 2007; WISP 2008; Galvin 2009; Sulieman 2013). However, in Spain, the processes of change taking place in rural areas such as land abandonment and land intensification have occurred later than in other European areas. This has allowed for the traditional pastoral practices such as transhumance to survive and persist despite socio-economic and demographic changes (Bunce *et al.* 2006; Manzano and Malo 2006; Fernández-Giménez and Fillat Estaque 2012; Oteros-Rozas *et al.* 2012).

### *Pastoralists' ecological knowledge*

Traditional ecological knowledge (TEK) is the cumulative body of knowledge, practices, and beliefs regarding the relationships of living things to their environment that evolves by adaptive processes and is handed down through generations (Berkes *et al.* 2000). Transhumance-related TEK has been described as the social and ecological “memory bank” that includes the knowledge and practices held by transhumant shepherds about the location, availability and management of natural resources, including spatial and temporal patterns, experience, observation and adaptive practices and responses to disturbances such as diseases (Fernández-Giménez and Fillat Estaque 2012; Oteros-Rozas *et al.* 2013). TEK is recognized as providing valuable knowledge that complements scientific studies to improve our understanding and stewardship of ecosystems (Huntington 2000; Knapp and Fernandez-Gimenez 2009; Fernández-Giménez and Fillat Estaque 2012). Moreover, transhumance and the pastoral livelihoods it supports depend on the preservation, use, and transmission of TEK and the integration of TEK into land use and management policies (Oteros-Rozas *et al.* 2013, Oteros-Rozas *et al.* 2012). In this contribution, we: (1) provide examples of traditional ecological knowledge related to extensive livestock rearing, and transhumance in particular, that could be useful for grasslands management; and (2) explore current challenges for pastoralists' knowledge maintenance and provide insights to integrate this knowledge into grasslands' management.

### **Methods: two case studies**

The Iberian Peninsula is dominated by a Mediterranean climate, which provides an ecological rationale for transhumance. The peninsula's geographic configuration is determined by wintering area in a low-lying area in the south and west from which most drove roads depart to northern mountainous areas. In these winter pasture areas the mean temperature during the coldest month is above 6°C, whereas the summer pastures lie in areas where the mean temperature in the hottest month does not exceed 17°C (Garzón 2001).

We here focus on two case studies: the valleys of Ansó and Hecho in the Central Pyrenees, and the Conquense Drove Road.

### *The Central Pyrenees*

The valleys of Ansó and Hecho are the two western most Pyrenean valleys in the Spanish autonomous region of Aragón, in the province of Huesca. These valleys are held to be among the most traditional and conservative herding communities in the Aragonese Pyrenees (Violant 1949; Kruger 1995) but the population and the relative importance of the livestock sector in the local economy has declined in recent decades (Díaz Martí 2000). The number of livestock in Ansó has declined, but in Hecho has remained relatively stable in recent years, although species composition has shifted towards cattle. Each valley possesses a wealth of natural pastures, the most important being the high-mountain pastures of the Pyrenees (from 1,500 to 3,000 m in elevation), which are available for grazing from early June through October. Both villages are located at about 800–900 m and surrounded by pine and oak forests.

Most stockmen in Ansó practiced transhumance until the 1980s, moving their animals from the mountain pastures grazed in summer over 200 km to the Ebro River Plains for winter grazing. Although the majority of stockmen in both valleys no longer practice transhumance, several herders from each valley continue to make these long-distance movements by truck.

In 2007 the Parque Natural de los Valles Occidentales (PNVO) was created, a protected area that encompasses all of the summer pasture and much of the fall and spring pasture used by herders in the study valleys. The regional government, administering the PNVO, has played an increasing role in making decisions about the values for which the land is to be managed. As a result of this shift from local (decentralized) to regional (more centralized) regulatory control, many of the traditional harvesting and management activities practiced by herders and other local residents, such as burning, wood-cutting, and harvesting non-timber forest projects, are no longer permitted (Fernández-Giménez and Fillat Estaque 2012).

Data collection involved three main methods: (1) in-depth semi-structured interviews with active and retired livestock producers ( $N = 27$ ), (2) community feedback meetings ( $N = 2$ ), and (3) informal field interviews and participant observation.

### *The Conquense Drove Road*

The Conquense Drove Road is one of the major transhumance drove roads in Spain, still in use by sheep and cattle. In 2009, local agrarian offices granted livestock movement permits in this area to 87 transhumant shepherds, driving almost 60,000 livestock heads. Most shepherds used trucks but 15 walk the drove with approximately 8,900 sheep and 1,200 cows. The summering area, located in the eastern Montes Universales in Aragón and Castilla-La Mancha Autonomous Regions where herds stay from July to early November, is characterized by semi-deciduous vegetation, coniferous forests, and patches of agricultural land where fodder crops are grown. The wintering area, located in Sierra Morena (southeast of the Iberian Peninsula, in the Autonomous Region of Andalusia) and the southern fields of La-Mancha where herds stay from December to May, is characterized by a typical Mediterranean dehesa landscape

(an agrosilvopastoral ecosystem aimed mainly at extensive livestock grazing) (Oteros-Rozas *et al.* 2012). The summering and wintering areas are connected by the drove road, a 75-m-wide and approximately 410-km-long corridor that crosses predominantly cultivated areas in the Iberian Central Plateau (Autonomous Region of Castilla-La Mancha) consisting mostly of vineyards, olive orchards, and fields of sunflowers and cereals.

Systematic data collection was organized in three phases: (1) background information collection through literature review, participant observation and semi-structured interviews with transhumant or ex-transhumant shepherds, including retired and/or settled individuals ( $N = 11$ ); (2) a focus group; and (3) a survey ( $N = 150$ ).

## **Results and discussion**

### **(1) Pastoralists' management practices**

Hereafter we will describe some examples of traditional ecological knowledge related to extensive livestock rearing, and transhumance in particular, that could be useful for grasslands management.

#### *Pasture- and rangeland-related management*

**Redileo:** Redileo is a practice carried out particularly in *dehesas* (an agrosilvopastoral ecosystem aimed mainly at extensive livestock grazing) of the wintering areas, which consists in closing livestock at night in portable electric corrals that are moved every three to five days in order to improve pastures and comply with the carrying capacity of the ecosystem. Redileo was an extremely common practice until the last decade, when the competition with other land uses for the renting of rangelands increased the uncertainty of shepherds about whether they will be rented the same rangelands in the forthcoming years. The use of this practice is therefore closely related with the type of pasture tenure or contract regime.

**Herd management within available pasturelands:** Grasslands' species composition within and between pastures or grazing areas are always heterogeneous, and so are their palatability and nutritional compositions. Shepherds know the spatial distribution of the different types of grasslands and distribute the different *hatos* (smaller groups within the herd) of livestock and sheep according to their nutritional needs (*e.g.* dry ewes/cows, pregnant ewes/cows, bucks/bulls, goats, recently delivered females).

**Herd behavior as indicator of weather change:** Animals change their feeding behavior or diet according to pasture palatability, indicating a change in weather or seasons. For example, eating bones or digging "a bed" announces a particularly cold winter.

#### *Integration of cropping and pastoralism*

In the summering area of the Montes Universales, shepherds used to own small parcels of croplands (integrated within a silvopastoral matrix) that they would sow for fodder and then use as stubble. Similarly, before the mid 20<sup>th</sup> century, pastoralists in the western central Pyrenees cultivated cereal crops and even potatoes in areas bordering their summer alpine pastures. These areas were

known as *panares* from the Spanish word for bread-pan because the grain crops were used to make bread. In the Ebro River Plains, the traditional wintering areas for Pyrenees flocks, herds often graze crop aftermath, which comprises a key part of their annual forage.

#### *Institutions for land and herd management*

Flexibility when choosing rangelands: In the case study of transhumance along the Conquense Drove Road, until the 1970s, only men (and occasionally a daughter that would stay in the house) migrated with livestock so the shepherds would live in houses within the rangelands (*cortijos*). In the last decades, however, one of largest social change of this livelihood has been the migration of the complete family, at first to the *cortijo* and afterwards (such as today) to the closer towns. The consequence is that they have bought or rented houses in the towns, therefore limiting to certain areas and reducing their adaptability to possible different pasture availability.

Conflict management and adaptation to changing pasture conditions: In the central Pyrenees each village or valley has its own stockman's association that allocates summer pastures and addresses conflicts and issues that arise in pasture management. In a recent case, the association in Hecho acted to limit the number of livestock each member could graze on the common pastures. They also closed pastures to grazing during late winter and early spring, in response to concerns about equity in access among large and small operations and potential pasture degradation due to early spring grazing.

Information exchange and social networks: These are key elements for the transmission of TEK and the existence of long transhumance. In the Montes Universales case, pastoralists travel together and collaborate in order to surmount the logistical and herd management challenges of the long journey. In both cases, we found that herders who practiced transhumance had larger social networks and were more likely to gain information from other herders and family members, indicating that traditional knowledge of transhumance tends to be passed on through families.

#### *Adaptive strategies*

In low production years: When pasture production was poor, and before feeding supplements, one of the most commonly used mechanisms to lower grazing pressure on the grasslands was to leave lambs to die and let only the sheep feed.

Mobile pastoralism and new technologies: Several technologies have improved the quality of life of mobile shepherds, including tents, electric fences, mobile phones, and cars. These technologies enable herds to remain mobile while reducing labor (electric fences) and increasing the ability of herders to communicate with and spend time with their families while on the drove road.

## **(2) Current challenges and some insights to the integration of this knowledge for Spanish grasslands' management**

The main current challenges to the integration of Spanish pastoralists TEK into management can be classified in three

types: socio-cultural, institutional and economic.

#### *Socio-cultural*

- There is a historical lack of social prestige regarding livestock men (Oteros-Rozas *et al.* 2013),
- Women's roles in farming activities are largely invisible and not acknowledged
- There are several familiar constraints related with the nomadic lifestyle, such as the maintenance of two homes and the "logistics" related with migration of the complete family and farm,
- There is a lack of generational turnover

#### *Institutional*

- Herders' voices are rarely heard in decision-making in Spain
- Conservation and other environmental policies, as well as most agrarian policies, tend to be incoherent and contradictory (*e.g.* health security regulation prohibited the shepherds to abandon carcasses in the field which had negative consequences for the conservation of vultures).
- Policies are developed with little meaningful participation from shepherds in decision making and management plans, and farmers trade unions in Spain are more active for crop agriculture than for livestock raising
- There is a lack of incorporation of stockmen's feedback within management (in reality not only in the plans),
- External, top-down technical knowledge is frequently imposed over local knowledge (*e.g.* employment of non-local working crews in fire prevention),
- Local misuses and abuses of drove roads leading to their deterioration.

#### *Economic*

- Pastoralists depend heavily on subsidies from the Common Agricultural Policy (CAP) of the EU, and hence a high uncertainty regarding future economic sustainability
- Livestock products (meat, wool, dairy) from extensive livestock production are frequently commercialized within conventional networks, therefore in direct competition with products from industrial productions systems in global markets
- Stockmen have a weak capacity for economic cooperation, so miss opportunities to organize for economies of scale (sharing equipment), improved marketing and local branding.
- The current financial crisis is conditioning Spanish consumers' behavior, as there is lower willingness to pay for high quality products

#### *Insights on how current barriers to the integration of TEK might be overcome*

The return to transhumance and transterminance would: (1) help the intergenerational transmission of TEK (Oteros-Rozas *et al.* 2013); (2) promote livestock raising models less dependent on oil prices, and therefore less vulnerable

to global market forces; and (3) facilitate the active conservation of drove roads, ensuring their availability for other shepherds that might decide to use them in the future.

The incorporation of pastoralists and their TEK in ecological assessment, planning and monitoring should be of interest to land management organizations because: (1) herders are closer to ecosystems and therefore to the constant assessment of ecological processes; (2) herders have a clear pragmatic interest in social-ecological sustainability; (3) a complex and holistic view of the whole social-ecological system is embedded within herders' knowledge system, allowing for integrated agrosilvopastoral management and the maintenance of a wide and rich flow of ecosystem services

The relaxation of regulatory constraints (e.g. some current food safety and animal health restrictions and conservation measures) to allow for continued use of traditional cultural landscapes and direct marketing of artisanal livestock products such as cheeses.

The improvement of policy coherence, particularly between conservation policies, food production policies, sanitary regulations, and rural development policies (particularly focused on income diversification through the development of recreational uses)

The integration of technologies (such as electric fences) that, though respectful and coherent with TEK, might ease livestock management in every-day's life of shepherds, therefore encouraging youngsters to take on the activity

The facilitation of commercialization within local markets (e.g. by the re-opening of municipal slaughterhouses as in the past), and more direct chains that would allow stockmen to improve their income without an increased price for consumers,

The improvement of communication channels between landowners, shepherds, intermediaries of the food chain and local-regional-national government for (1) the financial control of renting, (2) the guarantee of shepherds access to private, public and common grassland, (3) the implementation of market control measures (e.g. fixation of prices in origin)

Institutional support of pastoralism through: (1) payments for ecosystem services; (2) other incentives of economic profitability (e.g. labeling, lower taxes...); (3) the promotion of schools for shepherds' training and other possible incentives for generational turnover; and (4) support for infrastructure used by pastoralists (e.g. drove roads, resting areas, water points).

### **Conclusions: future perspectives and the potential for adaptation of nomadic pastoralism and pastoralists' knowledge**

We conclude that much of mobile extensive stockmen's ecological knowledge is threatened due to a lack of generational turnover, endangering the survival of a valuable source of sustainable grassland management knowledge and practices. Social and institutional barriers, including lack of profitability, dependence on EU subsidies, competition with other land-uses such as biodiversity conservation or hunting, and neglect by govern-

ments and society, negatively affect the continuity of TEK at different scales. Recent increases in the production costs of products such as fodder and oil have encouraged some shepherds to resume transhumance, some on foot. However, social and market forces seem to be driving the loss of customary herders' knowledge in other TEK systems in rural Spain (e.g., Ruiz and Ruiz 1986, Gómez-Baggethun *et al.* 2010, 2012, Reyes-García *et al.* 2010). We believe that some strategies, such as pastoralists' cooperation in making their voices heard in regional and European policy decisions, or their involvement in monitoring ecological conditions of ecosystems, may foster a modest recovery of transhumance in Spain.

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