The Territorial Identity of Large Scale Grazing Systems in Europe

Rafael Caballero*
Institute of Agricultural Sciences, CSIC, La Poveda Experimental Farm, Real Field Rd 1 km, 28500Arganda the King, Madrid, Spain

Abstract

A survey to inter-disciplinary experts on 46 European Large Scale Grazing Systems (LSGS) was conducted during October 2010-April 2011. These cultural landscapes were located in marginal areas of High Nature Value (HNV) and encompassed a wide range of environment and management conditions. Although many sources have stressed the declining trend of these areas and requirement of public support, few attempts has been carried out on how to pilot the required changes and a sound rationale for better use of public funds. Our main objective was to use the concept of territorial identity with a perspective of policy relevance for planning at the inter-regional scale. This possibility depends on European LSGS sharing some disturbances and resilient proposals. A survey questionnaire of nine sections was used as survey tool and respondent experts on particular systems identified. Out of 60 experts contacted 46 provided valid responses on study areas of 22 countries and five biogeographical regions (Atlantic, Alpine, Boreal, Continental and Mediterranean). Responses were recorded in a matrix, and 48 social-ecological variables were selected for descriptive statistics, variance, regression, factor components and cluster analyses. The results revealed a high level of correlation in the responses of experts which indicates that there are areas of common ground for policy development covering diverse LSGS in Europe. Most LSGS were production-oriented and a few orientated to provide environmental services and side-economic activities. All experts agree on that European LSGS cannot survive without some type of support and they do not see alternative land uses out of the grazing operation (96% of responses). Respondents were uncongenial with the effectiveness of current schemes of support (72%). Also a large consensus was reached on particular disturbances of social-ecological character and on the corresponding beneficial management alternatives proposed by individual experts to amend their systems. This consensus is proposed as the base for a new and specific scheme in support of HNV grazing systems in the new CAP reform post-2013.

Keywords: Extensive grazing systems; High nature value farming; CAP reform post-2013; Inter-disciplinary and inter-systems agricultural research; European environmental zones.

Introduction

Large Scale Grazing Systems (LSGS) are cultural landscapes emerging from the interaction of human behaviour and natural resources. They are broadly defined as extensive systems of grassland management located mainly in harsh environments and marginal areas. LSGS represent a community of livestock farmers sharing productive forms, traditions and cultural values that, in turn, shapes the environment [1,2]. LSGS have changed over time under different disturbances and pressures and the path of change is an essential part of their identity.

The European Landscape Convention Council of Europe [3] defines landscapes in a broad sense including natural and cultural landscapes, the latter of unrelated farming intensity, and stressing its characters as a result of the actions and interactions of natural and/or human factors. The pace and magnitude of change in managed rural landscapes is heterogeneous and depended upon increasingly faster technological innovation and social values, but the European Landscape Convention is not very specific how to proceed for planning and management Antrop [4], particularly for cultural landscapes located in the most marginal areas.

We may ask whether in Europe we still have LSGS of recognisable structure and legible elements that can be identified not only for their nature and societal values but also as a way of living to their internal operators. Landscape change is substantial, but the pace and magnitude of changes may have driven some European LSGS beyond recognition of past appearance and lost of identity. Identity is not an essential value ahead of disturbances but neither an artificial construction ahead of history. If territorial identity is defined by the coherence and continuity of particular properties, we may assume that, in other cases, some essential characteristics have been maintained, particularly in the LSGS located in the less developed areas.

The pace of change, in effect, is not unique [2]. Main disturbances in LSGS are (or have been) land use abandonment and/or intensification, loss of region-specific grazing practices, deterioration of institutional management and social cohesion and, in the long term, extreme weather events. These processes have taken place at different temporal and spatial scales and the resilience to change depended on the general socio-economic environment (e.g. demographic trends, off-farm income opportunities, agricultural support policies and even, in some cases, international conventions).

All of these processes and events have given way to an elusive concept of territorial identity with limited operational capabilities [5]. Whether or not a cultural landscape can be valued is deba, but affection, perception and knowledge are factual for understanding. The question of social perception is at the base of this puzzle. Currently, the perception of cultural landscapes is the focus of regional identity Soovaly et al. [6], but also cultural landscapes can be shaped by ideology and politics Olwig [7]. Different stakeholders (e.g. farmers, environmental NGOs or regular citizens) attach contrasting values to particular components

*Corresponding author: Rafael Caballero, Institute of Agricultural Sciences, CSIC, La Poveda Experimental Farm, Real Field Rd 1 km, 28500Arganda the King, Madrid, Spain, E-mail: rcaballero@ccma.csic.es

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and functions of LSGS and paths of change with the objective-focus of identity frequently blurred or misrepresented. Out of this trap, we assume that factual expertise together with uninterested perception can contribute to the identification of main values and constraints of LSGS and their paths of change. An impressionistic, static and timeless view is not allowed, but paths and magnitude of changes have to be substantiated. Any path of change is substantially linked to technological innovations. By aligning ourselves with the identity of LSGS, we are in a better position to steer technologies and make sensible choices [8].

Extensive and LSGS in Europe are recognised as harbouring the greatest potential environmental values as a substantial part of High Nature Value (HNV) farmland Cooper et al. [9] but beneficial management should be entrenched in a concept of working land and a sustainable path of change. Recent research has stressed the requirement of knowledge-based changes Caballero [10] and the need to address changes away from a negative perspective of unmanaged land under the assumption of linking changes to loss of nature values [4]. We need proper transition pathways and operational tools to pilot changes [11]. A proper identification of LSGS as cultural landscapes is essential to assess whether the direction of change is contributing to the coherence and continuity of beneficial values or changes are contributing to the loss of identity into a new one. Our identification exercise will be based on an expert-derived perception of change (main trends) and identification of main constraints and beneficial management alternatives over a wide range of European LSGS located in different bioregions.

Currently, the European Commission has opened a widely open debate on the reform of the main tier of the EU budget, the Common Agricultural Policy (CAP) after the year 2013. Working papers underway are stressing the importance of extensive systems of grassland management as potential repository of nature and social values. For the whole rural landscapes, the delivery of public goods is emerging as the main rationale for policy reforms [9,12]. It is not a surprise that many environmental NGOs have been quick to rally behind the slogan of “public money for public goods” [13]. This latter is a broad concept that suits to non-demarcated rural territories. All European rural landscapes have the potential capability of delivering some type and rate of public goods and thus of being supported under this rationale. But the delivery of public goods linked to agricultural management are in the hands of farmers controlling production factors (including land ownership) and farming practices within particular farming systems. Almost none of potential public goods are priced on markets and the precise rate of delivery under particular land use is barely known. Beneficial management and the delivery of public goods are related and we need to choose one or the other, but the arrow of causality is from the former to the latter.

The requirement for demarcation of the countryside is even more acute for LSGS given their heterogeneity in biophysical and social conditions, even within systems. Approximate zoning of potential LSGS is required, although a real base line should be designed at the farm level for eligibility of individual farmers accomplishing a framework profile. An increasing number of farmers accomplishing the rules would be a good indicator for effectiveness of policy schemes and beneficial management practices. If HNV livestock systems are considered as a rising start in next policy reforms Bartley et al. [14] Metzner et al. [15], identification of their main characteristics and trends is of primary importance for proper design of transition paths and operational tools towards sustainable development and delivery of potential side-effect assets. Open access to boreal forests and northern alpine pastures for reindeer herding in Fennoscandia Riseth et al.[16], maintenance of mountain pastures in the Italian Alps Corti [17] Cavallero et al. [18] Cozzi et al. [19], maintenance of indigenous livestock breeds in the Rhône area of Germany Nynenhus et al.[20] or blending crops, grasslands and forest in the unique dehesa landscape of SW Spain [21] are the result of a working land perspective with management practices for coherence and continuity. These landscapes maintain indigenous livestock breeds and deliver singular products such as reindeer meat, Alpine cheeses or Iberian ham. The delivery of public goods (e.g. plant and animal biodiversity, scenery landscapes) or side-economic activities (e.g. tourism) are an effect of lively working landscapes.

We are interested in recognizing the identity of European LSGS as a separate farming category, not in a detailed farming typology and functional analysis of particular systems that can be further addressed. Our main argument is that the continuity and coherence of these farming systems is relevant in the European context and deserve the design and implementation of a framework scheme of agricultural support in the context of the post-2013 CAP reform. A high level of correlation amongst responses would represent a sign of identity and common ground for actions.

The main objectives of this research are to design and apply a framework identity of trends for a wide range of European LSGS and identification of main concerns and beneficial management practices for coherence and continuity. We will test whether or not criteria and indicators are independent and whether cut across or are generalised across systems.

Material and Methods

The sampling tool

The information requested was structured in a questionnaire of nine sections with experts-collaborators in particular LSGS as potential recipients. The first three sections (experts’ identification, location and size of the LSGS operation and biophysical and grazing conditions) were aimed at recording sampling frequencies for the main factors of variation across 46 European LSGS. Descriptors for the expert’s identification included affiliation and expertise. Descriptors of the LSGS included location and size of the LSGS operation, character name, climate and altitude, location within the environmental European zones and main features of the grazing system such as dominant pastoral resources, land property and grazing rights, size of holdings, dominant grazer, mobility of herds/flocks, and size of the LSGS operation or dominant objective of production. These three first sections recorded 11 factors of variation (1) and six environment and management (EM) variables (2).

Section four contained 24 qualitative-linguistic variables grouped under four criteria: general identity (A), environment (B), economics (C) and social (D). Under each criterion, six questions (variables) were submitted for consideration. The experts’ perception towards the 24 variables was rated on a five-point Likert-type scale ranging from strongly agree (five points) to strongly disagree (one point), with undecided in the middle (three points). Questions were drafted in such a way that a high score would represent higher sustainability. At the end of the questionnaire, a feedback was requested on whether experts were confident with the responses or express doubt for understanding. The main objective of this section was to transform perception-views...
to a quantitative scale and thus rating LSGS by potential sustainability criteria.

Section five requested information on the main environmental assets and trends of LSGS with descriptors of main environmental functions, side-effect assets and regional environmental targets as rated in EU Directives (vegetation types and plant and animal species of conservation concern). This latter information contributed to section three of this research. Perception-views of experts were requested on the potential conflicts between current practices and environmental assets and on whether they envisage some alternative management of beneficial effects. This section was linked to section nine where potential beneficial management alternatives were requested by free wording.

The main objective of section six was to unveil the main current constraints (CC variables) for continuity and coherence in a quantitative scale. Up to ten worded constraints were submitted for consideration and an ordinal response was requested from the first and most important constraint (1) to the least important (10) in a scale of unrepeated numbers. Responses were transformed to a cardinal scale (from 1 to 0) by defining a line with two points of equivalence (x1=1, y1=1 and x2=10, y2=0) for statistical analysis.

Sections seven and eight were devoted to record qualitative and quantitative data on past and future trends of the grazing operation. Qualitative data recorded the perception of experts on past transitions from market and environment perspectives. Quantitative data were requested on changes in the absolute numbers of active livestock farmers on a time frame ranging at 60 and 30 years before current numbers (year 2010). On these numbers, yearly rates of change as percentage of farmers entering/exiting the operation were calculated.

On section nine, experts were requested to freely word up to five management alternatives that under its own expertise and available evidence may produce beneficial effects. They rated these alternatives on the type of potential effects being environmental, socio-economics or both (win-win situation) and on the type of available evidence (knowledge-based, common sense or farmers’ practice). The main objective of this section was to test whether these management alternatives for a wide array of LSGS can be embedded in a framework of policy options and thus may constitute a focus for funds’ allocation and a rationale for policy reforms.

The whole set of variables (48) included six environment and management variables; 24 criteria-variables, four aggregate score by criteria and one total score; ten current constraint variables; and three variables rating the abandonment trend. The general objectives in drafting the questionnaire were two-fold. First, to locate particular European LSGS in a transition pathway ranging from semi-subsistence pastoralism to a more market-oriented operation; from a production-oriented operation to a management tool in pursuit on environmental functions; and from a semi-abandoned operation to a lively working landscape. Secondly, to capture European LSGS from anonymity by unveiling their territorial identity and potential assets but, at the same time, disclosing potential concordances across systems that may justify the design and implementation of one general policy framework for their continuity and coherence.

Gathering and refining information

Our first objective was to record information on a wide range of European LSGS across bioregions and countries. All European countries showed representation of LSGS at different spatial scales and levels of development although the real population of European LSGS is currently misrepresented. We still lack of a real inventory of European LSGS notwithstanding particular attempts on this direction [2]. Data bases on European LSGS and corresponding potential experts have been elaborated within several recent EU-funded research projects such as the European Network for Livestock Systems and Integrated Rural Development (LSIRD network), the European Livestock Policy Evaluation Network (ELPEN project), the Landscape Development, Biodiversity and Co-operative Livestock Systems in Europe (LACOPE project) or the Thematic Network on the Cultural Landscapes and their Ecosystems (PAN project). The European Forum on Nature Conservation and Pastoralism (EFNCP), a NGO interested in pastoral development and nature conservation is also contributing. The main reason for this vacuum is that European LSGS has been only recently the focus of pan-European research Sheate et al. [22] Caballero et al. [23] Partidario et al. [24] Metzger et al. [25] Kleijn et al. [26] but not a target for allocation of EU funds. For the latter, successive CAP reforms have focussed on sector analysis.

Although not able to focus on a proper sample to population ratio, we chose to set a sample able to represent the wide array of environmental settings as well as grazing practices and socio-economic conditions. In addition to the former and outstanding EU projects, institutional support was also requested from the FAO-CIHEAM Network on Mountain Pastures, the FAO-CIHEAM Network on Pasture and Fodder Crops, the EFNCP, the German Federal Agency for Nature Conservation (BN on its German acronym), the Italian Society for Agronomy (SIAGR on its Italian acronym) or the Spanish Grassland Society (SEEP on its Spanish acronym).

Around 60 European experts on particular LSGS were selected and contacted by e-mail. Together with the questionnaire, a cover letter was sent explaining the objectives of the research initiative and rationale for the research job. A few experts declined the voluntary request for assistance and a few others recommended an alternative national with expertise in particular systems. At the end of this phase of gathering information, 46 filled and valid questionnaires were received with a rate of response of 77%. This phase elapsed from October 2010 (date of sending the first questionnaire) to April 2011 (date of receiving the last filled questionnaire). A large majority of questionnaires (90%) were the subject of a refining exercise to clear some responses or to fill unreported variables. All experts requested for this feed back were able to assist with additional information and rationale/remarks and comments on responses to different sections of the questionnaire. A good part of this information was summarized on section three of this research.

The European countries and number of study areas represented in the sample were as follow: Portugal (3); The Netherlands (2); Sweden (3); Estonia (1); Spain (5); Andorra (1); Bulgaria (1); Croatia (2); Ireland (1); Norway (1); Switzerland (1); Germany (4); Poland (1); Romania (3); Italy (6); United Kingdom (3); Hungary (1); Republic of Macedonia (1); Greece (2); Bosnia and Herzegovina (1); Finland (1) and France (2). Of those experts contacted in particular countries, only Austria and Serbia got unrepresented. The map of environmental zones (bioregions) provided by the European Environment Agency Metzger et al. [27] was used in a previous job Caballero[11] to locate the sampled study areas with geographical data supported by the experts and the structure of the sample by main factors of variation is recorded in table 1.

Data analysis

The IBM SPSS Statistics 19.0 software package was used for statistical
analyses. Factors of variation were grouped by levels and frequencies of representation in the 46 study areas (Table 1). Environment and management variables, criteria-variables, aggregate scores by criteria, total score, current constraint variables and abandonment variables were the subject of descriptive statistical analysis and variance analysis. For the former, mean ± SD, median and Wilck test of normality Shaphiro et al. [28] were used. W-values near than 1 indicate symmetrical (normal) distribution. For the latter, case-study systems were grouped by levels under each factor of variation and one-way ANOVA performed. The Levene test was used for testing the homogeneity of variances, and the significance of mean differences between pairs of group was tested by the Bonferroni (homogeneity) or the Tamhane (heterogeneity) tests. By this way, the whole set of 48 variables was related to the wide array of environmental and management factors in the sample and typology of the expert providing assistance.

Single inter-correlation of the 48 variables was performed by Factorial Analysis of Principal Components. We wanted to test whether the grouping of variables in the identity questionnaire and grouping of variables in the principal components of the factor analysis were or not dependent. In the rotated component matrix, a loading score higher than ± 0.1 was set for inclusion of particular variables within factors and eigenvalues>1 for the number of factors [29]. Grouping of case-study systems by clusters was performed considering changes in cluster centres (K-means Cluster Analysis), chosen clusters to maximize the differences among case studies in different clusters and testing the significance of the clustering factor by ANOVA and Discriminant Analysis.

Inter-dependency of criteria-variables (24) was tested by estimating the Squared Multiple Correlation (SMC) of each criteria-variable with all other criteria-variables and a stepwise regression analysis taking the identity variables (Criterion A) as dependent variables. We wanted to test whether the distribution of wording criteria-variables in the identity questionnaire is consistent with the aggregation by criteria or the aggregate scores are really a pool of inter-dependent variables.

Of the 46 experts providing assistance, 29 were able to records absolute numbers of farmers entering/exiting the operation in the requested periods (section seven). Yearly rates of change were also dependent variables in a stepwise regression analysis. The objective was to identify the main variables better explaining changes in the number of operative farmers either as variables grouped by criteria in the questionnaire (our own choice) or as variables grouped within factors/components. The same analysis was applied to cardinal responses to the ten constraints (independent variables) in section six. In this case, most experts (45) provided valid responses.

<table>
<thead>
<tr>
<th>Factor (FV)</th>
<th>Levels/Categories</th>
<th>Frequency</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Bio-</em></td>
<td>Atlantic (AT)</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>geographical</td>
<td>Alpine (AL)</td>
<td>11</td>
<td>One Pannonian study area</td>
</tr>
<tr>
<td>Region (FV1)</td>
<td>Boreal (BO)</td>
<td>6</td>
<td>included as Continental</td>
</tr>
<tr>
<td></td>
<td>Continental (CO)</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mediterranean (MED)</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>*Experts'</td>
<td>University professor (U)</td>
<td>23</td>
<td>*Management includes advisory</td>
</tr>
<tr>
<td>affiliation</td>
<td>Public/private research (R)</td>
<td>12</td>
<td>staff, counselling and nature</td>
</tr>
<tr>
<td>(FV2)</td>
<td>Management (M)</td>
<td>11</td>
<td>managers</td>
</tr>
<tr>
<td>Experts'</td>
<td>Environmental (ENV)</td>
<td>29</td>
<td>*Including animal production</td>
</tr>
<tr>
<td>discipline(FV3)</td>
<td>Socio-economic (ECON)</td>
<td>17</td>
<td>and grasslands experts</td>
</tr>
<tr>
<td>*Dominant type</td>
<td>Semi-natural grassland (SG)</td>
<td>14</td>
<td>*Semi-natural grasslands and</td>
</tr>
<tr>
<td>of forage</td>
<td>Wooded pastures (FW)</td>
<td>7</td>
<td>more or less open forest and scrub or</td>
</tr>
<tr>
<td>resources (FV4)</td>
<td>Mixed (M)</td>
<td>25</td>
<td>mixed resources</td>
</tr>
<tr>
<td>*Ownership</td>
<td>Private (PR)</td>
<td>14</td>
<td>*Public under some scale of</td>
</tr>
<tr>
<td>of grazing</td>
<td>Public (PU)</td>
<td>12</td>
<td>government (local, regional or</td>
</tr>
<tr>
<td>resources (FV4)</td>
<td>Mixed (M)</td>
<td>20</td>
<td>national</td>
</tr>
<tr>
<td>*Mobility</td>
<td>Mobile (M)</td>
<td>28</td>
<td>*Mobile including vertical mobili</td>
</tr>
<tr>
<td>(FV4)</td>
<td>Sedentary (S)</td>
<td>18</td>
<td>ty and short/long migrations</td>
</tr>
<tr>
<td>*Dominant</td>
<td>Cattle (C)</td>
<td>10</td>
<td>*Mixed cattle and sheep and in</td>
</tr>
<tr>
<td>grazer (FV5)</td>
<td>Sheep and/or goats (S)</td>
<td>21</td>
<td>particular study areas also</td>
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<tr>
<td>resources (FV4)</td>
<td>Mixed (M)</td>
<td>12</td>
<td>horses and pig</td>
</tr>
<tr>
<td></td>
<td>Reindeer (R)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Size of</td>
<td>Large (L)</td>
<td>24</td>
<td>L (&gt;30 LU), LU=Livestock Unit</td>
</tr>
<tr>
<td>holdings (FV4)</td>
<td>Medium (M)</td>
<td>15</td>
<td>M (10-30 LU)</td>
</tr>
<tr>
<td></td>
<td>Small (S)</td>
<td>7</td>
<td>S (&lt;10 LU)</td>
</tr>
<tr>
<td>Size of the</td>
<td>Large (L)</td>
<td>12</td>
<td>L (&gt;10,000 km²)</td>
</tr>
<tr>
<td>LSGS</td>
<td>Medium (M)</td>
<td>18</td>
<td>M (1,001-10,000 km²)</td>
</tr>
<tr>
<td>operation (FV4)</td>
<td>Small (S)</td>
<td>10</td>
<td>S (100-1,000 km²)</td>
</tr>
<tr>
<td></td>
<td>Very small (VS)</td>
<td>6</td>
<td>VS (&lt;100 km²)</td>
</tr>
<tr>
<td>*Dominant</td>
<td>Milk (MI)</td>
<td>23</td>
<td>*Non-exclusive production</td>
</tr>
<tr>
<td>objective (FV4)</td>
<td>Meat (ME)</td>
<td>23</td>
<td>objectives</td>
</tr>
<tr>
<td>Population</td>
<td>High (H)</td>
<td>9</td>
<td>H (&gt;100 inhabitants/km²)</td>
</tr>
<tr>
<td>in the LSGS</td>
<td>Medium (M)</td>
<td>16</td>
<td>M (31-100 inhabitants/km²)</td>
</tr>
<tr>
<td>area (FV5)</td>
<td>Low (L)</td>
<td>11</td>
<td>L (10-30 inhabitants/km²)</td>
</tr>
<tr>
<td></td>
<td>Very Low (VL)</td>
<td>10</td>
<td>VL (&lt;10 inhabitants/km²)</td>
</tr>
</tbody>
</table>

Table 1: Grouping 46 Large Scale Grazing Systems (LSGS) study areas by main factors of variation, levels and observations.
A large majority of experts (96%) proposed at least one management alternative for the restructuring of the LSGS (section nine). Extended explanations for these worded proposals were provided in the process of refining the information. We tested the coherence of responses to disturbances and constraints in previous sections of the questionnaire with the management alternatives (regenerative processes) proposed by experts. If this would be the case, a framework of policy incentives to spur change will be sensible. This analysis assumes that resilience of LSGS as cultural landscapes, largely depend on socio-economic variables and that the possibility of engaging in the planning of sustainable LSGS at the inter-regional scale depend on European LSGS sharing some disturbances and resilience proposals [30].

Presentation of European LSGS and Study Areas

The main objective of this section is an identification and description of relevant European LSGS and within them, the study areas selected in our sample for further scientific scrutiny in the next section. Our listing is contingent and not inclusive, but may justify our selected sample and may allow a link between land cover and land management in our identity exercise. Land cover is represented by vegetation types of potential grazing use and included in the EU Habitat Directive [31]. Land management is characterised by main use of grazing land, represented stakeholders and institutional grazing.

The spatial distribution of European LSGS was addressed by a regionalisation of systems across countries and biogeographical region [27]. Regional types are justified by distinctive vegetation types of grazing resources and distinctive practices of grazing management. As for the empirical evidence recorded in the next section, we hypothesized that notwithstanding the wide range of variation in social-ecological factors, the European LSGS may share some common properties and trends and some common pressures and options for development.

Sources of information for land cover are the EU Habitat Directive [30], scrutiny of vegetation types of potential grazing use IEEP [32] and information provided by the respondent experts in section five of the identity questionnaire. These three sources were crossed with information provided in the LACOPE project [33]. Here, up to 119 European LSGS were identified and their vegetation types recorded in the EUNIS code-system. This system allows an equivalent transformation to FFH habitat types as represented in the EU Habitat Directive.

The boreal and north alpine region

This bioregion included the three Fennoscandian countries (Norway, Sweden and Finland) and the three Baltic States (Estonia, Latvia and Lithuania). The N Alpine region stretched along the border of Norway with Sweden and Finland (in the North). In the coastline of Norway, the Atlantic (in the South) and the Arctic (in the North) bioregions are also represented.

Main vegetation types of differential grazing relevance are the following:

- **1630. Boreal Baltic coastal meadows**
- **2180. Wooded dunes of the Atlantic, Continental and Boreal regions**
- **2320. Dry sand heaths with Calluna and Empetrum nigrum**
- **4060. Alpine and Boreal heaths**

5130. *Juniperus communis* formations on heaths or calcareous grasslands
6120. Xeric and calcareous grasslands
6150. Siliceous alpine and boreal grasslands
6170. Alpine and subalpine calcareous grasslands
6270. Fennoscandian lowland species-rich dry to mesic grasslands
6280. Nordic alvar and precambrian calcareous flatrocks
6440. Alluvial meadows of river valleys of the *Cnidion dubii*
6450. Northern boreal alluvial meadows
6510. Lowland hay meadows
6520. Mountain hay meadows
6530. Fennoscandian wooded meadows
7120. Degraded raised bogs still capable of natural regeneration
7130. Blanket bogs
7140. Transition mires and quaking bogs
7240. Alpine pioneer formations of *Caricion bicoloris-atrofuscae*
9010. Western Taiga
9020. Fennoscandian hemiboreal natural old broad-leaved deciduous forests (Quercus, Tilia, Acer, Fraxinus, or Ulmus) rich in epiphytes
9050. Fennoscandian herb-rich forests with Picea abies
9070. Fennoscandian wooded pastures
F1.1 and F1.2 (in the EUNIS code) are vegetation types related to the shrub tundra and moss and lichen tundra, respectively (e.g. tundra fyll on dolomitic soils, sub-artic/sub-alpine fyll). These types are included for their grazing relevance in particular LSGS in this bioregion (e.g. stationary taiga and tundra reindeer system).

Location and main types of LSGS in this bioregion are the following:

The Sami reindeer system is located in the north of Norway, Sweden and Finland, for the latter in a small alpine region. The system is based on long migration of reindeer (Rangifer tarandus) from summer grazing grounds in alpine pastures to winter feeding on ground-growing mat-forming and also on arboreal lichens and complementary forage. The Northern Sapmi region (some 150,000 km2) is dominated by boreal forests, natural alpine grasslands and open tundra with very limited cultivated areas in the valleys and fjords. Reindeer herders currently use motorised vehicles for taking care of the herds. They receive payment by head of animal to the slaughterhouse and thus have an incentive to increase the stocking densities. Overgrazing may result in particular areas while in others abandonment of potential grazing resources is the result of cross borders restriction between countries [1,37].

The system is represented in our sample by case studies N°5 and 24. The respondent experts stressed the importance of reindeer herding in maintaining the cultural traditions and social cohesion of the Sámi people and in maintaining their way of living by combining productive and side-economic activities such as tourism. For this, they relate social initiatives for inculcating these values to young farmers and assurance on the continuity of the grazing operation. On concerning issues they
were critical on the current schemes of support, on requirement for adaptation to climate change Aanes et al. [38] Kumpula et al. [39] Moen [40] Roturier et al. [41] AMAP [42] and adaptive and congenial practices for forest and reindeer management [43].

- The stationary taiga and tundra reindeer system. The system is dominant in N Finland under limited access to summer alpine pastures and shorter displacements of reindeer herds. In the Upper Lapland the tundra (Sub-Arctic/Sub-Alpine fjell zone) on dolomitic soils is dominant over boreal forest. Sámi reindeer herders are allocated to reindeer districts and reindeer groupings (siidas) within districts. The large number of animals and season availability of grazing resources prevent a sensible use of resources on a yearly cycle. Each reindeer district and their siidas have a designated pasture area and a Total Allowable Quota (TAQ) of animals set in government planning.

The system is represented in our sample by case study Nº36. The expert respondent showed concerns on difficulties for implementation of grazing plans without taking into account herders’ view and heterogeneous pattern of grazing distribution in the districts. Frequently, the real number of animals is higher than allowed by TAQ as herders have an incentive to own more animals with the present scheme of support based on the number of winter reindeers or animals left living after slaughtering. In particular districts, reindeer herders have implemented a voluntary quota to divide the TAQ among herders and reduce conflicts in the access to pastoral resources and subsidies. Adaptive co-management of learning through options and refinement of actions is encouraged and required herders’ view, but a general and independent herders’ institution is still lacking.

- The alvars and wooded pasture systems are of much more small-scale and the production objective of much less relevance. The Nordic Alvar (vegetation type 6280) is a semi-natural pasture type in poor soils and bedrocks and Fennoscandian wooded meadows (vegetation type 6530) is of low forage capacity but among species-rich plant communities. Estonian and Swedish alvars differ but rare and endemic plant species are present. In our sample these systems are represented by case studies Nº22 (Estonian alvars) and case studies Nº44 (wooded meadows of the southern Öland Island) and Nº36 (Great Alvar of the Öland Island). In the latter, several endemics (e.g. Artemisia oelandica and Helianthemum oelandicum) are represented as well as some rare insect species of coleopteran and butterflies. Expert respondents stressed the environmental function of these small-scale systems where grazing animals (mainly cattle and sheep) are a management tool for alternating grazing and hay making, pollarding or cutting hazel trees in order to avoid overgrazing or restoring areas invaded by Juniperous or Potentilla fruticosa in the Great Alvar.

- A sheep grazing system is present in the southern Atlantic fringe of Norway not far from the coastline. Sheep is the dominant grazer with small or mixed herds of cattle and reindeers. Short migrations are frequent between pastures near the coastline and nearby mountains during the summer, frequently under free-ranging or only occasional surveillance. This system is not represented in our sample.

The Atlantic bioregion

We will discriminate three geographical areas for description of LSGS and sampling: the UK and Ireland; the Atlantic fringe from France to Denmark; and the Atlantic fringe of the Iberian Peninsula. Traditional LSGS still persist in the less favoured areas of the UK and Ireland such as SW Scotland, the Cumbria Uplands or the W of Ireland (the Burren), in France (French Normandie and Marais de l’Ouest) and in the Atlantic fringe of the Iberian Peninsula (Galician and Cantabrian mountains). On the other hand, in most of the Atlantic corridor stretching from Belgium to Denmark most grazing systems are of small scale and mainly orientated to nature conservation functions.

Dominant grazing resources in this bioregion are represented by the following vegetation types in the EU habitat Directive:

1330. Atlantic salt meadows
2130. Fixed coastal dunes with herbaceous vegetation
2150. Atlantic decalcified fixed dunes (Calluna-Ulicetea)
2180. Wooded dunes of the Atlantic, Continental and Boreal regions

21A0. Machairs
2310. Dry sand heaths with Calluna and Genista
4010. Northern Atlantic wet heaths with Erica tetralis
4020. Temperate Atlantic wet heaths with Erica ciliaris and Erica tetralis
4030. European dry heaths
4040. Dry Atlantic coastal heath with Erica vagans
4060. Alpine and Boreal heaths
5130. Juniperus communis formations on heaths or calcareous grasslands

6110. Rupicolous calcareous or basophilic grasslands of the Alyssosedion albi
6120. Xeric and calcareous grasslands
6130. Calaminarian grasslands of the Violetalia calaminariae
6210. Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia)
6230. Species rich Nardus grasslands on silicious substrates in mountain areas
6410. Molinia meadows on calcareous, peaty or clayey-silt-loam soils (Molinio caeruleae)
6430. Hydrophilous tall herbs fringe communities of plains and of the montane to alpine levels
6440. Alluvial meadows of river valleys of the Cnidion dubii
6510. Lowland hay meadows
7130. Blanket bogs
7140. Transition mires and quaking bogs
8240. Limestone pavements
9140. Medio-European subalpine beech woods with Acer and Rumex arifolius
9150. Medio-European limestone beech forests of the Cefalanthero-Fagion
91C0. Caledonian forests
91E0. Alluvial forests with Alnus glutinosa and Fraxinus excelsior
In the UK and Ireland, Upland and Moorland grazing systems are represented in the less favoured areas with variable proportion of cattle and sheep, frequently of indigenous breeds and mixed herds. Extensive hill and mountain sheep systems are a variant represented in the southern upland of Scotland, the Cumbria uplands and the Welsh Mountains. In the two former, Scottish Blackface ewes are frequently crossed with Blue-faced Leicester rams to provide Scotch Mule lambs. Agricultural land is interspersed with semi-natural grasslands, moorland/health land areas and forests, the latter rarely grazed. Sheep owners under land renting agreement (the crofters) are common. In the Cumbria uplands, indigenous Herdwicks, Swaledales and Rough Fell sheep are represented with small herds of cattle using unfenced common land.

Moorland systems are represented in England in the Dartmoor, Exmoor and the Bodmin Moor and also in the North Yorkshire Moors. The rough grazing covers the majority of the grazing area (65-80%) and lambs are usually finished under grazing. For the minority of cattle herds, winter feeding supplementation is provided with forage conserves and some industrial protein feed. Sheep mobility is common from winter pastures near the farmyard to summer pastures in the uplands.

The British uplands, after the Second World War have been affected by changes in the EU policy support schemes and the impact of the Foot and Mouth disease epidemic of 2001. Currently, the recognition of the landscape and recreational values probably outweigh production from agriculture and forestry [44].

In the west of Ireland the Burren system is relevant. In this case, cattle is dominant and the animals move to winter pastures (winterage) and stay near the farmyard during summer in more productive pastures. A mild climate and limestone-rich grasslands allow winter feeding. Orchid-rich calcareous grasslands (vegetation type 6110), semi-natural dry grasslands (6210), limestone heaths (4020), turloughs (3180), limestone pavements (8240) and fens are represented. The Burren system is basically a suckler beef based pastoral system with representation of foreign breeds (Charolais, Limousin and Simmental), a strong involvement and approval of local communities for side-economical and recreational activities in the area, and a main objective of maintaining species-rich grasslands.

Large Scale Grazing Systems of the UK and Ireland are represented in our sample by four case studies: the Burren region of the Ireland Mid-West (case study N°1); the Dartmoor of SW England (N°16); the Cumbria Uplands of NW England (N°34); and the Uplands of SW Scotland (N°42). These LSGS have distinctive features in terms of geology, ecosystems, plant communities and economies, but also share some themes as cultural landscapes in terms of past misuse, fragility and current needs for adaptation. They have developed social networks and supporting institution for greater recognition of their social ecological values to the whole society (e.g. the Burrembeo Trust in Ireland, Action with Communities in Cumbria or the Scottish Natural Heritage in Scotland).

Respondent experts recognise the current dominants environmental and recreational functions in their systems but also the interdependency of these functions with livestock grazing. They do not see an accep alternative out of the LSGS operation for managing these traditional and agricultural landscapes. They also provided comments and supporting evidence on requirement to change the current scheme of support from an income foregone basis to stocking levels attached to the delivery of public goods and environmental values Nisbert et al. [45] and recorded some successful implementation of social schemes for luring young farmers to the livestock operation (in the Cumbria Uplands). For the Scottish farmlands, the respondent expert provided evidence of livestock farmers and crofters withdrawing from sheep farming and deleterious influence on natural values as a case for additional financial support to HNV livestock farming [46,47].

The mainland Atlantic corridor stretched from France to the west of the Jutland Peninsula in Denmark. This is a densely populated region with intensive agriculture, but in the less favoured areas of heath lands, marshes, wetlands and coastal dune lowland cattle and sheep systems are represented generally to a small scale and under nature conservation and restoration objectives.

Cattle and sheep herding in lowland Atlantic areas is represented in Germany (e.g. the Lüneburger heath), Belgium and The Netherlands (e.g. the Ooijpolder area near Nijmegen) where grazing is only a tool for environmental management. These systems include protected areas, nature reserves, national parks and land restoration areas, which are under pressure of being overgrown by woods and shrubs. There is no real focus on production objectives and barely a market approach. Contractual agreements for environmental management usually involve different stakeholders such as land owners (usually local governments), managers (usually nature conservation agencies) and the livestock farmers who rent their animals and receive a payment for environmental grazing management of the resources as programmed by managers.

Within this region, the French Atlantic LSGS are more production oriented, although the environment function is also relevant particularly when the LSGS operation is under some agri-environment scheme (e.g. Operations Locales Agro-Environnementales) under the assumption of synergies between extensive livestock rearing and wetland management. LSGS operations are represented in Normandie (e.g. Pays d'Auge, Cotentin and Bessin regions) and in the Marais de l'Ouest system between Vilain and Gironde. It entails resources dominated by semi-natural pastures associated with hedges (bocages), salt marshes (pre-salés), and wetlands and used by indigenous dairy cattle (e.g. the Normanda breed) and meat-oriented cattle and sheep (e.g. the Charollais breeds). More than 100,000 ha of semi-natural wet grasslands and salt marshes in the Atlantic fringe are managed under collective use of the communes (municipalities) or under private land owners’ associations (Associations Foncières). Both rent the pasture land to livestock owners (eleveurs) sometime organised under pastoral groups (Groupement Pastoraux) [48].

The Atlantic coastal systems are represented in our sample by case studies N°25 (Drenthe, The Netherlands), N°38 (Wadden Sea National Park, Germany), and N°40 (coastal dune region of The Netherlands including Wadden-islands). Grazing land is frequently owned by regional or local governments and nature managers are conservation organisations or water management boards. Grazing animals are owned by the managers or sometime hired to neighbouring farmers under contractual agreements for grazing management and grazing fees. Coastal dunes, Atlantic salt marshes and heath vegetation types are prevalent on this area, always under pressure of high population density (e.g. reverting heaths to cultivated grasslands) and requirement of contributing to nature services (e.g. quality water).

Respondent experts expressed concerns on adapting grazing plans to environmental conservation and provided evidence on this aim.
Management plans can be different on mainland calcium-rich dunes than in calcium-poor dune islands and mixed and season grazing should be adapted to particular conservation objectives. In general, grazing restrict the domination by tall grasses and shrubs that decrease biodiversity and favours smaller plants of xero-thermic conditions [49,50].

-In the Atlantic fringe of the Iberian Peninsula, the Cantabrian Mountains act as a filter for the moist sea air with frequent mists on the north-facing slopes. Forests and hedges with remnants of climax oaks (Quercus robur) and ash (Fraxinus excelsior) are common in the NW Galician range under siliceous substrates. The presence of mixed grazing is recommended to maintain herbaceous communities of Agrostis-Festuca and control secondary succession towards shrubby communities dominated by Calluna vulgaris and Ullex gallii. There is also evidence of indigenous cattle (Rubia Gallega breed) checking the turf-spaying Nardus stricta not used by previous sheep grazing [51].

In the central part of the Cantabrian Mountains (Picos de Europa), mesophytic basiphilic beech forest (Carici sylvaticae-Fagetum) and mixed forests (Corylo-Fraxinetum cantabricum) are dominants. The upland pastures of Picos de Europa (brañas) used to be sequentially grazed by cattle (indigenous Casina breed), sheep/goats and finally by horses (Asturcones under free-roaming) these latter having the function of cleaning mature refues of tall herbs. Currently, a few farmers bring their animals to the communal brañas under fear of the wolves and unsatisfactory infrastructures for milking and cheese-making facilities. Indigenous tree-milk cheeses based on upland pastures (e.g. Gamoneu de Puerto) is thus rare today although very much appreciated. In more hilly and lowland areas, heaths is the dominant vegetation type and under risk of wild fires due to deforestation or abandonment of agricultural and livestock management. Dairy cattle are currently a mainly indoor-feeding operation with foreign breeds (American Holstein) in intensive farms near the coast. Some type of vertical mobility for the use of semi-natural grasslands is apparent by alternating hay making and grazing on the hills and using lowland grasslands near the coast for hay making during summer and for grazing of meat-oriented cattle (Asturiana de Valle breed) during winter-early spring.

The described system is the only one represented in our sample from this region (case study Nº4). There are others represented in Galicia and the border with Portugal as well as in the region of Cantabria (Valleys of Liébana and Cabuérniga) and in the Basque Country (Aralar Natural Park). The respondent expert related management options and evidence in maintaining interspersed parcels of heathlands, forests and managed grasslands and combining mixed grazing and haymaking [51]. In other more populated European Atlantic areas the heathland flora in more under risk Piessen et al. [52] Sundseth [53] as heathlands replaced by grasslands. At the same time he related some pressures on the LSGS operation such as lack of family business turnover and hardship of the herding operation, particularly in the upland pastures because of poor grazing infrastructures and unresolved surveillance and compensation to predators’ losses. He thus suggested support to the herding operation, on upland pastures and better marketing organisations in support of indigenous products (e.g. local cheeses on which this region is pre-eminent).

The continental and pannonian bioregions

This bioregion included a large part of Central Europe with large tracts in France, Germany, the Czech Republic and Poland and also substantial areas of Italy, the Balkans countries, Romania and Bulgaria. For the purpose of this study, the Pannonian region of Hungary and Serbia is also included here.

 Relevant vegetation types providing forage resources in this bioregion may include:

- 1530. Pannonic salt steppes and salt marshes
- 2180. Wooded dunes of the Continental region
- 2310. Dry sand heaths with Calluna and Genista
- 4030. European dry heaths
- 4070. Bushes with Pinus mugosa and Rododendron hirsutum
- 4040. Subcontinental peri-Pannonic scrub
- 5130. Juniperus communis formations on calcareous grasslands
- 6120. Xeric and calcareous grasslands
- 6210. Semi-natural dry grasslands and scrubland facies on calcareous substrates
- 6220. Pseudo-steppebs with grasses and annuals of the Thero-Brachipodieta
- 6240. Sub-Pannonic steppic grasslands
- 6250. Pannonic loess steppic grasslands
- 6260. Pannonic sand steppes
- 6410. Molinia meadows on calcareous, peaty or clayey-silt-loam soils (Molinion caeruleae)
- 6430. Hydrophilous tall herbs fringe communities of plains and of the montane to alpine levels
- 6440. Alluvial meadows of river valleys
- 6510. Lowland hay meadows
- 6520. Mountain hay meadows
- 7140. Transition mires and quaking bogs
- 7230. Alkaline fens
- 9110. Luzulo-Fagetum beech forests
- 9130. Asperulo-Fagetum beech forests
- 9140. Medio-European subalpine beech woods with Acer and Rumex arifolius
- 9160. Sub-Atlantic and medio-European oak and oak-hornbeam forests of Carpinion betulii
- 9170. Galio-Carpinetum oak-hornbeam forests
- 91E0. Alluvial forests with Alnus glutinosa and Fraxinus excelsior
- 91K0. Illyrian Fagus sylvatica forests (Artemonio-Fagion)
- 91Y0. Dacian oak-hornbeam forests
- 9530. (Sub-) Mediterranean pine forests with endemic black pines

The bioregion included some small scale grazing systems in the valleys, pre-alpine or wetland areas of central Europe that in some cases represent a remnant of past traditional and transhumant systems disappeared, and currently managed mainly under environmental conservation. This is the case of cattle and sheep grazing in sub-
continental lowlands of northern and central Germany such as Müritz-Hof or Klein Schorfheide management units. In areas of contact with the Alpine bioregion more production oriented systems are still operative such as sheep grazing of Merino Landschaf along the river Lech between the cities of Landsburg and Augsburg, the sheep grazing in the Swabian Jura region where an important transhumant system worked in the past Luick [54] or the pre-alpine Almende of Upper Bavaria rearing heifers of the lowland dairy farms in summer alpine pastures.

More large-scale grazing and production-oriented systems are found in other areas of Continental Europe although under very different transition path to sustainable systems and ranging from extreme forms of extensification (abandonment trend of the grazing operation) to semi-subsistence forms of pastoralism. LSGS of the former type are found in the lowland areas of Hungary (the Hungarian plain), the Boemia-Moravia region of the Czech Republic (Zlinsky kraj system), and of the latter type in the plain and less favoured areas of Romania and Bulgaria. Here, a semi-subsistence system of small herds of cattle and sheep and small holders sharing communal grazing is still common.

In Continental regions of Italy and France more developed and market-oriented LSGS are operative such as in the Central Apennine region of Italy or the Massif Central in France, a region of transition to Atlantic and Mediterranean influence or even the Alpine regions of SE France, and represented in the Grand Causses and the Cévennes National Park. For the southern Causses (e.g. Causse de Blandas or Causse de Larzac) connected with the Mediterranean bioregion, extensive stock breeding is a relevant and productive activity connected with transhumant sheep flocks of the Mediterranean region of Languedoc-Rousillon.

Seven LSGS of the Continental bioregion are represented in our sample. They include a small scale nature-management system of the wetland continental areas such as Thuringia in Germany (case study N°37) and a large representation of LSGS in the less developed areas of Central and Eastern Europe. The plain areas of Hungary (case study N°9), Bulgaria (case study N°21) and the Transylvania and Wallachia regions of Romania (case studies N°7 and 28) are represented. The other two sampled systems are also located in the Continental bioregion although connected with pre-alpine or mountain regions of less developed and depopulated areas such as the Mount Vlasic area of central Bosnia & Herzegovina (case study N°13) or the developed and populated Marche region in the central Apennine (case study N°18). Frequently these LSGS are in the fringe of the Continental and Alpine regions benefiting from displacement of flocks between lowland and upland pastures.

LSGS of the Hungarian Plain are in a transition towards more indoor-feeding and consolidated systems while small-scale family farms are still dominant in the less favoured and plain areas of Romania and Bulgaria. In the short-to-medium term, respondent experts showed interest in maintaining improved forms of peasant pastoralism as a way of maintaining indigenous breeds, plant-rich hay meadows and communal pastoralism in the mountain pastures under the aegis of the sheep master. In more favoured plain areas of Romania and Bulgaria where land-based summer and winter feeding is allowed, the development of commercial dairy farms and industries seem a requirement Draganescu [55] and personal communication, 2011).

Common pressures related by experts in Romania and Bulgaria are ineffective and powerless grazing regulations and support policies. Traditional systems are still operative while new EU regulation somewhat uncongenial with traditional uses of land and animals. They also stressed the heterogeneous pattern of grazing distribution with indigenous cattle near the farmyard (they return daily to the s for milking and supplementary feeding) while communal and mountain sheep grazing poorly organised. Family milking- or cheese-making in the farmyard or in the summer grazing camp are in need of better facilities and adjusting to EU sanitary and marketing rules.

The respondent experts of these two countries related some management options for development in changing some current peasant farming for co-operative milking and/or cheese-making and social and financial support to the herding operation in the figure of the herd/flock master who gathers the cows of individual owners for daily grazing in communal land or gather and move small lowland sheep flocks to hill and mountain pastures away from the farmyard during most of the year. The Hungarian expert, on the other hand, stressed the requirement of explaining social and ecological values of the LSGS operation to the whole society facing trends in international food markets and quality products Karsten et al. [56], but recognised a main trend toward indoor feeding and more intensive operation in the plain area.

For the two sampled systems widely connected with the mountain and alpine areas, vertical mobility of dairy sheep flocks is common. In the Mount Vlasic area, mountain and hills are common with mobility of Pramenka flocks in the mountain pastures during summer and winter transhumance to lowland snow-free pastures or crop residues after harvest. This type of inverse mobility is currently on retreat as it required the agreement and co-operative interest of lowland crop farmers and some grazing institutions and normative rules. On the Marche region, however, summer grazing in communal pastures is organised with some grazing and milking facilities in the mountain and milk-collection and cheese-making organised by industrial local firms. Notwithstanding this differential status in the transition path to development, both experts indicated a trend of sheep farmers exiting from farming and a consolidation of flocks to few units of larger size which is more apparent in the Marche region.

The south alpine bioregion

It encompasses LSGS located in the main mountain ranges of southern and eastern Europe including the Pyrenees (France and Spain), the Alps (France, Italy, Slovenia, Switzerland, Austria and Germany) the Carpathians (S Poland, Slovakia and Romania), and also LSGS of the Dinarides, Balkans and Rhodope mountain ranges in their corresponding countries. As in other European bioregions, there is a long history of grazing use in the mountains with common use of pastoral resources and attached cultural traditions and local products. The LSGS of this bioregion are mainly large scale and production-oriented but environmental functions are stepping up in recent years, particularly in the most developed countries. As mainly located in remote areas, LSGS are facing pressures of abandonment in the whole region while the transition path varied widely across the region with more pressures and less options for conservation management and technological innovations in the mountain LSGS of the non-EU or recently accessed countries of southern and eastern Europe.

Vegetation types in the EU Habitat Directive of potential grazing use are the following:

4060. Alpine and Boreal heaths
4070. Bushes with Pinus mugo and Rododendron hirsutum
5110. S xerothermophilus formations with Buxus sempervirens on rock slopes
5130. juniperus communis formations on calcareous grasslands
6120. Xeric and calcareous grasslands
6130. Calaminarian grasslands of the Violetalia calaminariae
6140. Siliceous Pyrenean Festuca eskia grasslands
6150. Siliceous alpine and boreal grasslands
6170. Alpine and subalpine calcareous grasslands
6210. Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia)
6230. Species-rich Nardus grasslands on siliceous substrates in mountain areas
6410. Molinia meadows on calcareous, peaty or clayey-silt-loam soils (Molinion caeruleae)
6430. Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels
6510. Lowland hay meadows
6520. Mountain hay meadows
7140. Transition mires and quaking bogs
7230. Basophilous active peats
7240. Alpine pioneer formations of Caricion bicoloris-atrofuscae
9130. Asperulo-Fagetum beech forests
9140. Medio-European subalpine beech woods with Acer and Rumex arifolius
9150. Medio-European limestone beech forests of the Cephalanthero-Fagion
9180. Tilio-Acerion forests of slopes, screes and ravines
91k0. Illyrian Fagus sylvatica forests (Aremonio-Fagion)
9190. Dinaric dolomite Scots pine forests (Genisto januensis-Pinetum)
9420. Alpine Larix decidua and/or Pinus cembra forests
9430. Subalpine and montane Pinus uncinata forests
9560. Endemic forests with Juniperus spp

Large Scale Grazing Systems in the Alpine bioregion of France are located in the Alps and the Pyrenees. There is a long history of collective pastoralism and mobility of herds/flocks within these montane regions and also between the lowland Mediterranean regions and the Southern Alps. Collective pastoralism in France is highly regulated at the commune (municipality), regional and even the EU level. The LSGS operation has undergone a certain social revival after the constitution of pastoral groups (Groupement pastoraux) of livestock farmers (eleveurs) and landowners associations (Associations foncières pastorales) in 1972. The livestock sector under extensive pastoralism accounts for some 20% of the total value and large number of grazing animals are moved to summer grazing pastures (estives). Since the year 2000 summer grazing are having a revival with side-economic activities such as tourism, second residence, sports or food festivals on the increase. Market organisation of local products and social support are going hand in hand as France has a tradition of supporting rural life with little parallel to other EU countries [36]. A review of 21 extensive systems of grassland management in France and their main grazing practices Pointereau et al. [57] included 12 and 22 indigenous breeds of cattle and sheep, respectively.

For the French Alps, two mountain areas are differentiated (Alpes du Nord and Alpes du Sud) but in both livestock production has turned towards product quality with Protected Designation d’Origin and prestigious mountain labelling schemes (e.g. Sisteron and Adret lambs). In the Northern Alps, dairy (Montbeliarde and Tarantaise breeds) and meat-oriented cattle herds grouped more than 7000 livestock farmers, a majority practising vertical mobility to summer pastures. In the Southern Alps ovine meat breeding (Merino d’Arles is the dominant breed) is more common with some 3000 local and transhumant farmers. In this area, long-distance transhumance is still practised for sheep flocks of the Crau Plain in the Mediterranean Provence moving during summer to mountain pastures in the S Alp [58]. Restrictive pastoral management in the Alps and the Drome due to increasing number of wolves is hardly compatible with homogeneous patterns of grazing distribution and finishing lambs on pastures. Private and public regimes of land ownership are present in the two regions, but common land is prevalent (58%) in the S Alp.

Summer pastures in the French Pyrenees (estives) are mainly in the hands of local governments (communes) and collective management of pastoral groups and the mobility of herds/flocks are mainly intra-regional. Livestock farmers (eleveurs) usually hire labour (patre de haute montagne) to take care of the animals in the estives (vacher or berger) with help of pastoral guard dogs (the patou). In three departments (Ariege, Haute Garone and Haute Pyrenees), cattle farming is dominant in the valleys while sheep farming more evenly distributed between lowland and upland pastures. Suckler cattle farms with hardy breeds (Gasconne) suited management conservation practices Pointereau et al. [57] included 12 and 22 indigenous breeds of cattle and sheep, respectively.

In the Alpine region of Italy also three sectors are commonly differentiated (eastern, central and western Alps) with a small alpine region located in the central Apennine around Monte Sibilini and Monti della Laga-Gran Sasso National Parks. Distinctive physical conditions, vegetation types and main features of LSGS in these alpine areas are structured in a recent source of information [2]. This source also includes information of main Spanish, Italian and Greek LSGS in Atlantic, Alpine and Mediterranean bioregions. Otherwise these LSGS are well represented in our sampling. For these reasons we will not extend on them in this section.

The Romanian, Polish and Slovakian Carpathians have a strong tradition of mountain dairy sheep grazing. In the past, long distance transhumance of Wallachian flocks was organised in mountain locations (e.g. the Sibiu area) to move animals during winter to the lowlands of the Black Sea area and beyond [62]. These large movements have largely disappeared and currently the traditional LSGS operation distinguished two grazing units in the mountains: the lowland and upland pastures, and two stakeholders: the small landholder and sheep owner of the lowland s, and the sheep master and organiser of the summer grazing camp. The latter combines the small flocks of
several owners to gather some 100-200 sheep and organise the summer grazing season usually with help of waged labour. He pays the grazing fee and the waged labour and shared with the other sheep owners the cheese production on the summer pastures (e.g. Polish Oscypek, smoked hard cheese), usually under stressing milking- and cheese-making conditions. While the flocks in the summer camp, hay of the lowland meadows is produced and barn-stored for feeding during harsh winters.

Although of High Nature Value (HNV), Wallachian mountain systems shared some de-stabilising factors and pressures for their continuity. The semi-subsistence nature of most of these systems makes the intensification of management a less likely scenario than abandonment unless the means to support the social viability of these systems is urgently designed and implemented. In doing that, the policy schemes cannot be alien to the systems’ structure. For example, proper claims to land property or the small size of land holdings may hinder access to policy support, and homogeneous pattern of grazing distribution is hindered by poor mobility of flocks and inoperative drove paths to far-reaching clearings. Also support is required to improve grazing infrastructures in the lowland as well as in the summer camp, where most of the milking and cheese-making is carried out. In this case, conditioning should be adapted to EU hygiene and storage rules for proper quality assurance and marketing.

Other examples of LSGS in a derelict state can be found in the Dinarides and the Balkans. As an example, the Western Stara Planina is a region of some 4000 km2 sharing the Balkan border of Bulgaria and Serbia and in the Alpine to Continental fringe. Main land uses are mountain and semi-montane birch-dominant forests (60%), subalpine and semi-natural pastures (25%) and farmland (15%). Semi-subsistence farming is prevalent with smallholdings (some 2 ha) and an ageing population living in poor conditions and little scope to set up viable farming operations. As in other eastern European countries and marginal areas the design and implementation of EU schemes of support should take into account that large tract of land is under communal use, claims to land property not always apparent and the small size of land holdings. In the year 2005 and for the Bulgarian side of the region only 8% of arable land and 18% of grasslands were registered in the EU Land Parcel Identification System and thus allowed to claim for EU support.

The southern Alpine bioregion is represented in our sample by 11 study areas including the Spanish Pyrenees (case studies Nº29 and Nº33); Andorra (case study Nº10); the eastern and western Italian Alps (case studies Nº17 and Nº23); the German and Swiss Alps (case studies Nº2, Nº30 and Nº15); the northern (Polish) and southern (Romanian) Carpathians (case studies Nº3 and Nº8); and the W Balkans in the Republic of Macedonia (case study Nº11).

The respondent experts stated some common and differentiating pressures largely related to the socioeconomic development in the surrounding area. In Alpine areas of W and Central Europe, LSGS are organised for grazing management and marketing institutions with management options implemented at a higher level. They cited particular and common pressures such as compatibility and implementation of social and ecological functions without some type of support and doubtful effectiveness of current schemes, concerns about the social and professional status of the herding operation in need of support, and need of preventing losses to predators in the mountains and better compensation schemes. Costly and scarce waged labour is a frequent concern in these developed areas.

On the other side, LSGS in the mountain regions of south-eastern Europe are in a very early phase in the transition path to sustainable development. In fact, some respondent experts expressed doubts on a truly path to development although they agree on co-adaptive management and learning from experiences in other systems. Institutional grazing management, the legal status of land-based pastoral resources, the status of grazing infrastructures, the social and professional recognition of the herders’ job, and the quality assurance and marketing status of local products are indeed milestones for LSGS in its earlier phases to sustainable development. Policy options and technical innovations should be aligned to an identity exercise.

The Mediterranean bioregion

In Europe, it encompass a large part of the Iberian Peninsula, most of central and southern Italy, the whole of Greece, the Adriatic coastline of the Balkan countries, the south-east of France and the Mediterranean islands. All of these areas are a pool of European social-ecological diversity and cultural landscapes shaped by long history of combined forests, arable and grazing management with alternative pulses. As in other bioregions, livestock grazing is one of the few tools for avoiding encroachment of the natural vegetation, particularly in marginal and remote areas. Probably more than in other bioregions, here we find an impressive variety of habitats along relatively small spatial scales, but also under danger of wild fires.

For a large and representative part of this bioregion we already have a structured source of information [2]. This source provided a framework for typology analysis of LSGS, vegetation succession trajectories under grazing or post-grazing effects and a link between LSGS and vegetation types in the EU Directive. For Spain, Italy and Greece, 15, 14 and 10 relevant LSGS are represented and described, respectively with common pressures and main options for developments. A majority of these LSGS in Spain and Italy and the ten Greek system are Mediterranean LSGS. The rest are Spanish and Italian LSGS in other bioregions (Atlantic, Alpine and Continental). For our sampling on this research, 33%, 43% and 20% of the former LSGS are represented for Spain, Italy and Greece, respectively. Following the structure of this section, we will redirect our attention to the vegetation types of potential pastoral use as represented in the EU Habitat Directive and further to the rationale of respondent experts in their responses to the identity questionnaire.

In selecting vegetation types linked to grazing use and High Nature Value farmland it is important to recognise that permanent pasture or semi-natural grasslands are not the only source of forage. Herbaceous and non-herbaceous resources of other habitat types (e.g. heaths, shrubs, forests and their related grasslands) are also used in the real world, representing large tracts of marginal areas and important pools of European biodiversity. Even in the real world, particular LSGS of relevance in the Mediterranean bioregion (e.g. the cereal-sheep system) are supported on low-intensity use of arable land (e.g. green fallows and crop residues of cereals and legumes and also low-intensity olive orchards and their related grasslands and crop residues). The inventory of European HNV areas and related LSGS cannot withstand a mismatch with the real world, and the EU cannot ignore this reality in designing schemes for management conservation and policy support in the next CAP reform post-2013 [10]. This has been our main rationale in selecting vegetation types of potential grazing use for all the bioregions, and following is the list (probably not inclusive) for the Mediterranean:

1340. Inland salt meadows

Citation: Caballero R (2012) The Territorial Identity of Large Scale Grazing Systems in Europe. 1:474. doi:10.4172/scientificreports.474
1410. Mediterranean salt meadows (Juncetalia maritimi)  
1510. Mediterranean salt steppes (Limonietalia)  
1520. Iberian gypsum steppes (Gypsophiletalia)  
4030. European dry heaths  
4090. Endemic Oro-Mediterranean heaths with gorse  
5120. Mountain Cytisus purgans formations  
5130. Juniperus communis formations on heath or calcareous grasslands  
5210. Arborescent matorral with Juniperus spp  
5330. Thermo-Mediterranean and pre-desert scrub  
5420. Sarcopoterium spinosum phryganas  
5430. Endemic phryganas of the Euphorbio-Verbascion  
6110. Rupicolous calcareous or basophilic grasslands of the Alyssio-Sedion albi  
6120. Xeric and calcareous grasslands  
6160. Oro-Iberian Festuca indigesta grasslands  
6170. Alpine and subalpine calcareous grasslands  
6210. Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia)  
6220. Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea  
6230. Species-rich Nardus grasslands on siliceous substrates in mountain areas  
62A0. Eastern sub-Mediterranean dry grasslands (Scorzoneratalia villosae)  
6310. Dehesas with evergreen Quercus spp  
6420. Mediterranean tall humid grasslands of the Molinion Holoschoenion  
6430. Hydrophilous tall herbs  
6440. Alluvial meadows of river valleys of the Cnidion dubii  
6510. Lowland hay meadows  
6520. Mountain hay meadows  
8240. Limestone pavements  
91B0. Thermophilous Fraxinus angustifolia woods  
91E0. Alluvial forests with Alnus glutinosa and Fraxinus excelsior  
9210. Apennine beech forests with Taxus and Ilex  
9230. Galician-Portuguese oak woods with Quercus robur and Quercus pyrenaica  
9240. Quercus faginea and Quercus canariensis Iberian  
9250. Quercus trojana woods  
9330. Quercus suber forests  
9340. Quercus ilex and Quercus rotundifolia forests  
9530. (Sub-)Mediterranean pine forests with endemic black pines  
9540. Mediterranean pine forests with endemic Mesogeian pines  
9560. Endemic forests with Juniperus spp

In the Mediterranean bioregion, 14 LSGS are included in our sample: three case studies of the Iberian plains (Montados in Portugal (Nº6) and dehesas and cereal-sheep in Spain (Nº27 and Nº46)); six case studies of the montane or semi-montane areas (Central Macedonia (Nº11), southern Apennine in Italy (Nº19), the Dinarids in Croatia (Nº26), Serra da Estrella and Tras-os-Montes in Portugal (Nº31 and Nº35), and the Provence in France (Nº41); and finally five LSGS of Mediterranean Islands (Island of Rhodes in Greece (Nº12), Island of Pag in Croatia (Nº32), Island of Corsica in France (Nº39) and Islands of Sicily and Sardinia in Italy (Nº20 and Nº43).

Respondent experts related different management trajectories from almost abandoned LSGS in the surrounding of Mount Velobit in the Dinarids of Croatia to managed and market-driven systems in the Iberian plains (montados and dehesas). In general, islands LSGS are less prone to abandonment due to less mobility of labour and combining farming and off-farming income sources such as tourism (e.g. LSGS in the Island of Rhodes and the Island of Pag). In fact these two LSGS were the only ones (see next section) showing increasing rates of farmers entering the LSGS operation out of the 46 sampled systems.

Although system-specific analyses of management trajectories are required, respondent experts indicated a common set of socio-economic pressures for the continuity of Mediterranean LSGS such as low or negative profitability without support, harsh working conditions on marginal or isolated areas, and young farmers discontinuing the family operation. They also rate common options for improvement such as better grazing plans supported by targeted policy schemes, better grazing infrastructures and improvement of quality assurance and marketing of local products on which Mediterranean LSGS are particularly rich [2].

A note on interface to biodiversity

On the five bioregions we have recorded 87 single habitat types of those included in the EU Habitat Directive. Of these 87 types, 53 were exclusive of one bioregion, 18 were replicated in two bioregions, eight types replicated in three, five types replicated in four and finally, three of the recorded vegetation types were present in the five bioregions. The large number and proportion (61%) of exclusive habitats is an indication that planning for management and conservation at the European scale should take into account actions in different bioregions and their corresponding LSGS. Within bioregions, 23, 29, 29, 27, and 38 vegetation types of differential pastoral relevance were recorded for the Northern Alpine and Boreal, the Atlantic, the Continental-Pannonian, the South Alpine, and the Mediterranean bioregions, respectively.

Results

Study areas and environment and management variables

Location of study areas and main environment and management (EM) descriptors are presented in table 2. In agreement with the wide range of environments in the study areas, these variables showed a high range of variation with CVs of 56.5%, 50.8%, 69.7%, 188.2%, 37.4% and 81.9% for annual rainfall (EM_1), mean temperature (EM_2), mean elevation a.s.l. (EM_1), population density (EM_2), grazing days (EM_1) and regional stocking (EM_1), respectively. Only variables EM_1 and EM_2 showed symmetrical distribution (Shapiro-Wilk test of normality).

If rated by the regional stocking, all systems have in common a
medium-to-very low stocking density with mean of 0.54 ± 0.44 LU/ha, a characteristic of low-intensity grazing systems. Also LSGS entail large expanses and a landscape scale. Opdam et al. [63] under LACOPE definition [2,64]. In our study sample, 65% of LSGS has an area of influence larger than 1,000 km² and 24% larger than 10,000 km². The latter subsample usually coincides with areas of low population density (subsample mean of 27 ± 23 inhabitants per km²). The minority of small-scale systems usually coincides with areas of high population density near the Atlantic coastline of The Netherlands and Germany (e.g. the Atlantic dunes and the Wadden Sea National Park). In Scandinavian and Baltic countries, small-scale systems (e.g. Island of Öland, Sweden; Island of Ösel, Estonia) and very large-scale systems

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Table 2: List of case-study LSGS and main environment and management variables.

*aTwo-letter ISO code (ISO 3166 alpha-2) for countries, except Greece (EL).*

*bLocation and main grazer of Large Scale Grazing System (LSGS).*

*cBR= Biogeographical Region. AT=Atlantic; AL=Alpine; CO=Continental; BO=Boreal; MED=Mediterranean.*

*dR=Annual rainfall (mm); °T=Mean annual temperature (°C); E=Mean elevation a.s.l. (m).*

*eP=Population density (inhabitants/km²); °GD=Grazing days per year

*fRS=Regional stocking (LU/ha). LU=Livestock Unit. NA=Not available*

*gR, T, E, P, GD and RS are Environment and Management (EM) variables across the paper in this order.*

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(e.g. reindeer herding systems in Fennoscandia) are represented, both of low-to-very low population density. In all cases small-scale systems are usually orientated to nature conservation.

In Eastern European countries, most sampled systems with the exception of Tatra (Poland), are of landscape spatial scale ranging from very large (Hungary Plains, W Romania) to medium area of influence (SE Transylvania, S Carpathians in Romania) with medium population density. The Tatra system is not really an exception as the corresponding expert only selects the area under the influence of the Tatras National Park and the main city of Zakopane. The whole area of the Tatra Mountains and the Podhale encompasses more than 1,000 km² of much lower population density. Carpathians systems in W Slovakia, S Poland and Romania share some common grounds of influence (SE Transylvania, S Carpathians in Romania) with medium population density. The Tatra system is not really an exception as the corresponding expert only selects the area under the influence of the Tatras National Park and the main city of Zakopane. The whole area of the Tatra Mountains and the Podhale encompasses more than 1,000 km² of much lower population density. Carpathians systems in W Slovakia, S Poland and Romania share some common grounds of

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aLocation of case-studies (Large Scale Grazing Systems) is in table 2.

bSix variables within each criterion rated in the Lykert-type scale ranging from one to five points.

cMinimum score by criterion is 6 and maximum is 30. Total score range is 24-120.

dThe four individual criteria and the total score are normally distributed (Shapiro-Wilk test). Only mean of identity criterion is significant (P<0.01) with the other three criteria (Bonferroni test). The criteria source accounts for 29% of the total variance (test of within-subjects effects).

Table 3: Partial score by criteria and total score of case-study grazing systems.
as individual variables showing asymmetrical distribution, the means of the smallest variable by criteria across study areas, the median range and the variables showing the lowest and highest values are more representative than the variables means. The mean of the smallest variable across study areas were 1.96 ± 1.01, 1.59 ± 0.54, 1.20 ± 0.40 and 1.56 ± 0.69 for identity, environment, economic and social criteria, respectively. The median ranged from 2.5 in A1 and A3 to 5 in A6 for the identity variables; from 2 in B1, B3 and B5 to 4 in B4 for the environment variables; from 1 in C1 to 5 in C3 and C4 for economic variables; and from 2 in D1, D2 and D3 to 4 in D4 for the social variables.

On the identity criteria, variables with the highest scores were A1 and A2. For the former, 91% of experts agree or strongly agree that LSGS are still a recognisable farming operation with regional identity notwithstanding potential disturbances. For the latter, 93% of experts agree or strongly agree that external help to LSGS in the form of technical and institutional support or effective agricultural policy schemes is still required. On the opposite side of the identity criteria, we found variables A4 and A6. For the former, 50% of experts disagree or strongly disagree on that the community of livestock farmers is well-organised for lobbying capabilities and transmitting values to the whole society. For the latter, a similar 50% of experts disagree or strongly disagree on that external help provided to LSGS is well-organised and effective.

For variables on the environment criteria, B1 reached the highest score and 80% of experts agree or strongly agree on that the LSGS is still a grazing-dominant and herding operation. This descriptor, although included in the environment for its implication on natural values, also represent a strong sign of identity. On the other side of the scoring scale, we found variables B2, B3 and B5. For the first, 76% of respondents disagree or strongly disagree on that the spatio-temporal pattern of grazing distribution is homogeneous across the potential grazing area. Most frequently, differences occurred between grazing units near the farmyard and far-reaching grazing grounds or differences between lowland and upland pastures. This disturbance is unrelated to LSGS located in particular environment zones, but entails particular issues in different LSGS. For example, in reindeer systems of N Sweden or N Finland, a particular issue is the compatibility between reindeer grazing and forest management. The state, forest companies and private owners have to accomplish the legal grazing rights of reindeer herders. Some environment goals (e.g. preservation of old forest) may not conflict with reindeer grazing Berg [43], but the stationary reindeer management in Upper Lapland (N Finland) with unsustainable use of grazing resources (tundra and boreal forest) can be a conflicting issue [68,69]. In other LSGS ineffective distribution of grazing infrastructures (e.g. water points) may produce poor grazing distribution in particular grazing units (Central Macedonia, Greece) or problems with mobility or access to far-reaching grazing grounds are operative (Central Bosnia & Herzegovina, Tatra). Yet in other cases this disturbance is an effect of harsh-working grazing practices and poor institutional management and the progressive abandonment of the grazing operation (Castile-La Mancha, Spain). For the environment variables B4 and B5, 72% of respondents disagree or strongly disagree on the effectiveness of current policy support schemes (particularly agri-environment schemes) and 56% on the congenial work of NGOs in support of beneficial management, respectively.

In the economic criteria, variable C1, showed the lowest scoring (1.41 ± 0.5) of all criteria-variables. It was the only variable with median=1 and one-hundred percent of respondents showing disagreement or strong disagreement on that the current LSGS operation can be profitable without some type of policy support. A large majority of experts (91%)
agree or strongly agree on that the delivery of indigenous products with marketing capabilities is or can be an important sign of identity (variable \( C_i \)). For the few case studies showing disagreement, the respondent-experts observed that their LSGSs are mainly oriented to side-effects economic activities (e.g., tourism), to nature conservation or even research (case studies of Burren, Ireland; Bavarian Alps, Germany; Atlantic dunes, The Netherlands; and woodland meadows in the Island of Öland, Sweden) and not production-oriented LSGS. On this issue, however, a very large majority of experts (96%) agree or strongly agree, with only two leaders-collaborators rating as undecided, on that the continuity of the grazing operation is essential for the maintenance of side-economic activities in the area of influence (variable \( C_i \)). It is clear that respondent-experts do not see a future for LSGS areas out of the grazing operation. On the other side, variable \( C_i \) was inversely correlated to variable \( C_i \) (\( r = -0.35 \)) and a large majority of experts (72%) disagree or strongly disagree on a proper consumer awareness towards production practices and products of LSGS (variable \( C_i \)).

The social criteria showed the lowest aggregate score (Table 3) and the not-so-strong consensus was concentrated on three low-scoring variables (\( D_1, D_2 \) and \( D_4 \)) and a higher-scoring one (\( D_5 \)). About half of representative experts (52%) disagree or strongly disagree on the proper functioning of the current legal framework and grazing institutions regulating grazing management (\( D_j \)) and a higher percentage (59%) on the affection of young farmers towards the grazing operation and assurance of family business turnover (\( D_j \)). We also found that proper connectivity of LSGS with the whole society (\( D_j \)) was half-supported (41% agree or strongly agree with 9% undecided) and experts-collaborators perceived that the delivery of public goods as a rationale for public support is not well-entrenched in farmers’ minds (\( D_j \)). On this issue, 59% disagree or strongly disagree with 13% undecided. About half of experts (52%) agree or strongly agree on external disturbances (e.g., insensitive schemes of support) as more important than internal ones (e.g., lack of internal social cohesion) for the continuity of the LSGS operation (\( D_j \)). For the last social variable (\( D_j \)), a large minority of experts (43% disagree or strongly disagree with 22% undecided) had the perception that grazing management is properly governed by normative rules and not by informal rules and unclear claims of land property.

The whole the set of criteria-variables showed a high level of correlation amongst responses. Out of 276 single inter-correlations of the 24 variables, 106 cases showed correlation coefficients higher than ± 0.4. For the aggregate criteria scoring (Table 3), only the means differences of the identity criteria with that of the other three criteria were significant (\( P < 0.01 \)) and the criteria source of variation only accounted for 29% of the total variance.

All of this suggests that criteria-variables are not independent and grouping case studies by aggregate criteria scores gives little insight. It seems that the consensus reached by experts on their response to particular variables is more illuminating for amending purposes. If we fixed the attention in the half 12 lower-scoring variables (\( A_1, A_2, B_1, B_3, C_1, C_4, D_1, D_2, D_4, D_5, D_6 \) and \( D_7 \)) and on the subsample of nine lower-scoring LSGS by their total score (case studies \#9, 12, 13, 14, 28, 31, 32, 39, 40 and 46 and total score ranging from 57-62), a concerning consensus (disagree or strongly disagree response) of 100% was reached for variables \( A_1, B_3, C_1 \), and \( D_5 \), of 89% (eight out of nine study areas) for variables \( A_1, B_1, B_3, C_1, C_5 \), and \( D_5 \), and of 78% (seven out of nine study areas) for variables \( B_1 \) and \( D_5 \). If case study area \#40 (Atlantic dunes in The Netherlands) is disregarded as being mainly a small-scale nature-conservation area, the consensus reached 100% for variables \( A_1, A_2, B_1, B_3, C_1, C_4, C_5, D_5, D_6, D_7 \). It is clear that a lower total score is a first sign of a downward trend concentrated in a set of common concerning variables attached in the identity questionnaire to different criteria.

**Current constraints**

The 10 worried current constraints (\( CC_j \)) and their scoring are presented in Table 4. They were rated on a different scoring scale ranging from 0 (less important) to 1 (top constraint) than the criteria-variables. Current constraints were also inter-correlated. Out of 45 single cases, 16 showed correlation coefficients higher than ± 0.4. Rating of particular constraints was more illustrative. Across the whole set of case-study LSGS, four constraints reached score higher than 0.6 (\( CC_1, CC_5, CC_6, CC_j \)). Three of them were related to grazing labour problems, and concern on the harsh-working practices of the grazing operation (\( CC_j \)), restrictions on waged labour (\( CC_1 \)) or family labour continuity and supply (\( CC_5 \)). The other one (\( CC_j \)) represents the perception of experts on the insensitive policy support schemes.

The restriction on waged labour (\( CC_1 \)) was the constraint of higher inter-correlations with some criteria-variables. Out of 24 single cases, 11 showed correlation coefficients higher than ± 0.4. It seems that experts on better-organised systems where external help is functioning (\( A_1 \)) and current policy support schemes more effective (\( B_4 \)) rated highly the waged labour constraint. Examples of this trend are case studies located in developed areas of the S Alps such as the Bavarian Alps (Germany), Entlebuch (Switzerland) and the malga system in the E Italian Alps (S Tyrol) and also UK case studies of the Atlantic bioregion such as the Cumbria upland. Some experts-leaders on these areas provided relevant comments on initiatives to raise the social and professional status of the herding operation (e.g. implementation of herders’ schools).

On the other side of the scoring scale we found \( CC_j \), as the less important constraint (rating of 0.21 ± 0.31). Lack of potential grazing resources was not a constraint for most areas except those of reindeer systems. In these cases, experts-leaders provided comments on border-restrictions to long migrations of reindeers or unseasonal use of available resources in more stationary reindeer systems.

The whole rating of constraints suggest that one important issue for reversing the current downward trend is the design and implementation of policy schemes in support of the herding operation. Dynamic LSGS are in need of raising the social and professional status of herders and the institutions governing grazing management. This is, however, one more issue within a general policy framework.

**The abandonment trend**

Section seven of the identity questionnaire elicited data on the number of active farmers within a time frame of 60 years before 2010 with two periods of 30 years. With these data, rates of abandonment (\( AB \)) as percent of livestock farmers exiting the LSGS operation by year were calculated for each of the three periods (\( AB_{60-30}, AB_{30-0} \), and \( AB_{60-0} \)). For this set of variables, experts-respondents provided data in 28, 31 and 29 case studies, respectively, and the rest only trends or indicated not available data on official records.

Descriptive statistics showed normal distribution of data for \( AB_{60-30} \) and \( AB_{30-0} \) and asymmetrical distribution for \( AB_{60-0} \) with overall means of 1.11 ± 0.79%, 1.62 ± 1.27% and 0.90 ± 0.78%, respectively. Positive numbers indicated declining rate in the number of farmers exiting the operation. Increasing rates were only found in one (Island of Pag,
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...owners mainly under semi-subsistence pastoralism. Yet by 1969 out of the 14.3 m sheep in Romania 7.2 m were still privately owned [70]. In the whole sample grouped by wide geographical areas (N and C Europe, the MED area and E Europe), the AB60-0 rate of abandonment showed values of 1.04 ± 0.33, 1.06 ± 0.59 and 0.55 ± 1.17, respectively. The rate of abandonment in E Europe seems to be lower than in the other two geographical areas but with a high rate of variation.

For the two Islands case studies showing increasing rates, experts explained the few off-farm opportunities of isolated places or complementary farming and off-farming activities. For example, in the Island of Pag (Croatia), the famous Pag cheese (Pramenka x Merino breeds) is promoted as tourism attraction. On the opposite, just inland Croatia in the S Dinaric Alps (Licko-Senjska County) only a few number of sheep farmers remains active in a potential area of some 2,300 km² and mountain pastures practically unused.

All of this is not very illuminating. For example, in some case studies (e.g., reindeer systems) a low stocking is the consequence of environment restrictions and not of farmers’ abandonment. However, for the few cases of reindeer systems providing data, the trend is of declining number of reindeer herders. Lower stocking is not self-explanatory as many underlying causes are implicated. For AB60-0, a relationship with B6 was found (r=0.47) although a proper explanation...
is not consistent. Similarly, the relationship of $A_P$ with $C_C$ and $C_D$ suggests that farmers exiting the operation and wide areas of potential pastoral resources out of use are consequent processes and the rate of abandonment higher where access to capital for investment is of concern. At the end, the abandonment process is a similar and final phenomenon everywhere with a pool of causes acting as drivers, but their large-scale environmental effects are largely deleterious [6,71].

Factors of variation

The effects of the 11 factors of variation recorded in the three first sections of the questionnaire (Table 1) on 48 dependent variables in the following sections are presented in table 5. Six Environment and Management (EM) variables, 24 criteria-variables (six of each $A$, $B$, $C$ and $D$ criteria), 10 current constraints (CC), three abandonment (AB) variables, four of aggregate score by criteria and one of total score across the four criteria were tested. Total cases analysed were 528 (48 variables×11 factors). Out of these cases, 58 showed global significance ($P<0.05$) and only 48 showed at least one difference of means with significance ($P<0.05$). Significance of means was tested with the Bonferroni test in the case of homogeneity in the error variances (37 cases) or with the Tamhane test in the case of heterogeneity (21 cases). Of the 58 cases with significance, 15 corresponded to EM variables, 27 to criteria-variables, 11 to CC variables and five to aggregate score by criteria and total score. Most influential factors of variation were FV1 (biogeographical region), FV7 (dominant grazer), FV9 (size of the LSGS operation) and FV11 (population density in the LSGS area of influence). For the other seven factors, only four or less number of variables showed significance (Table 5).

Significance of EM variables only showed the wide range of environment and management situations included in the sample of LSGS and were mostly dependent on factors FV1, FV4, FV5 and FV11. Mean differences in annual rainfall (EM1) were of up to 1000mm between samples of the AT and the BO bioregions, of up to 12.3°C in mean temperatures (EM2) between samples of the MED and BO bioregions and of up to 875 m a.s.l. in the mean elevation of the influential area (EM3) between samples of the AL and BO bioregions ($P<0.05$). As expected, mobile systems were more frequently located in areas of higher elevation and reindier systems in areas of the lowest mean temperatures ($P<0.05$). Grazing days (EM4) was only dependent on FV3 and the regional stocking (EM5) unrelated to the 11 factors. Although reindier systems showed clearly lower regional stocking, mean differences were not significant probably due to the small number of reindeer samples and higher stocking on non-reinder and BO samples.

Relevant criteria-variables showed dependency on some factors of variation. On the identity criteria, the response to $A_1$ was influenced by the bioregion with experts on BO systems expressing strong attachment to the regional identity of their LSGS than those of the CO bioregion (difference of means of 1.26, $P<0.05$). Response to $A_2$ significantly depends on the size of the LSGS operation ($FV_1$). Experts of large (L), medium (M) and small-sized (S) LSGS expressed strong agreement on that a community of livestock farmers still makes a living from the LSGS operation than those experts on very small-sized LSGS (mean differences of 1.50, 1.39 and 1.50, for L, M and S, respectively, $P<0.05$). It seems that experts on very small LSGS do not agree on a production-oriented LSGS and livestock farmers on these systems are mainly supported, under contractual agreements, by policy schemes orientated to nature conservation. The response to $A_3$ (well-organised livestock farmers with lobbying capabilities) was dependent on the dominant grazer ($FV_2$). Experts on cattle-dominant systems showed stronger agreement than those of sheep/goat dominant (mean difference of 1.60, $P<0.05$). Variable A6 (external help well-organised and effective) showed also dependency on $FV_4$ and $FV_6$. Similarly, experts on cattle-dominant systems scored higher than those of sheep-dominant (mean difference of 1.11, $P<0.05$) and experts of very small-sized LSGS scored higher than those of large size (mean difference of 1.0, $P<0.05$).

On the environment-criteria variables, $B_1$, $B_2$ and $B_3$ were the variables showing at least one mean difference with significance. Variable $B_1$ (current farming practices congenial with the delivery of environmental values) was dependent on $FV_4$ (ownership regime of grazing resources). Experts on LSGS under a mixed regime scored higher than those under a public-dominant regime (mean difference of 1.22, $P<0.05$). Effectiveness of agricultural support policies ($B_2$) showed dependency on bioregions ($FV_1$) and on dominant type of resources ($FV_2$). Only the mean difference between AL and MED bioregion (1.49, $P<0.05$) and the mean difference between semi-natural grassland and woodland-dominant types (1.21, $P<0.05$) were significant. Social openness on the environmental significance of production practices ($B_3$) was dependent on population density in the LSGS area of influence with mean difference between high and medium densities showing significance (1.23, $P<0.05$).

Although all experts, without exception, disagree strongly or strongly disagree on the economic sustainability of the LSGS operation without some type of support ($C_1$) this variable showed dependency on $FV_7$, $FV_8$, $FV_3$, $FV_5$, and $FV_9$. Experts on areas of semi-natural grasslands or mixed dominant resources scored higher than those on LSGS with woodland-dominant resources (mean differences of 0.52 and 0.45, respectively, $P<0.05$). Similarly the mean difference between mixed and private-dominant resources (0.58, $P<0.05$), the mean difference between sedentary and mobile systems or between milk- and meat oriented LSGS were significant. Variables $C_3$ and $C_4$ were dependent on $FV_5$. Experts on LSGS located in areas of high population density scored higher on $C_3$ than those of medium density (mean difference of 1.31, $P<0.05$) and those experts on areas of very low population density scored higher on $C_4$ (significance of the continuity of the grazing operation for side-economic activities) than those of high density (mean difference of 0.90, $P<0.05$). In this case, the aggregate response for the economic criteria ($C_2$) was significant (P=0.036) and showed dependency on $FV_4$. The mean difference between LSGS of medium and very low size was significant (3.0, $P<0.05$).

Relevant criteria-variables of social character showing dependency on particular factors were $D_1$ (family business turnover assured), $D_2$ (indigenous products as focus of regional identity) and $D_3$ (the delivery of public goods as a well-entrenched rationale in farmers minds for the design of public schemes of support). Experts on cattle-dominant LSGS scored higher on $D_1$ than those of sheep/goats or mixed-dominant systems (mean differences of 1.70 and 1.52, respectively, $P<0.05$) and experts on the environment discipline ($FV_3$) scored higher on $D_3$ than those on socio-economic and grazing management (mean difference of 0.75, $P<0.05$). Also mean scores to $D_4$ showed significance between holdings of medium and large size (mean difference of 1.03, $P<0.05$). In this case, the aggregate social score ($S_2D$) was dependent on $FV_1$, $FV_3$ and $FV_4$. Experts on the AL and BO bioregions scored higher than those of the CO bioregion (mean differences of 3.54 and 4.74, respectively, $P<0.05$) showing a strong social cohesion within their systems Riseth [37]; experts on cattle-dominants LSGS scored higher than those on mixed or sheep-dominants (mean differences of 4.60...
and 4.40, respectively, P<0.05); and experts on LSGS with medium-size holdings rated higher the aggregate social score than those of small holdings (mean difference of 4.0, P<0.05).

Finally, the aggregate total score of the four criteria showed dependency only on FV₇, with experts on the AL bioregion scoring higher than those of the CO bioregion (mean difference of 13.3, P<0.05). As a whole, individual factors of variation explained only a small part of the variability of criteria-variables. On the above analysed cases showing significance in the difference of means, the coefficients of determination (R²) adjusted never reached 40% of the variance. The latter and higher value found for the dependency of D₂ on dominant grazer (FV₁) with cattle-dominated LSGS reaching the higher score.

Regarding the influence of factors of variation on the current constraints (CC) variables (Table 5), we only found 10 cases with significance of the mean differences out of 110 cases analysed (10 constraints×11 factors).

For the whole sample of case studies, CC₁ (limitation of grazing resources for the LSGS operation) was the less concerning constraint. However, the response of experts to this constraint was influenced by FV₁ (bioregion) and FV₇ (dominant grazer). Experts on the BO bioregion and on reindeer as the dominant grazer rated highly this constraint. For FV₇, mean differences in scoring with that of experts in the AL, AT, CO and MED bioregions were of 0.48, 0.57, 0.63 and 0.53, respectively (P<0.05) and FV₁ explained up to 25% of the variance.

The AL, AT, CO and MED bioregions were of 0.48, 0.57, 0.63 and 0.53, respectively (P<0.05), and FV₁ explained up to 25% of the variance. Also the response to CC₇ (lack of assurance in family business turnover) was influenced by FV₂ and again experts on reindeer systems rating higher than those on sheep/goats and mixed-dominant systems (mean differences of 0.49 and 0.55, respectively, P<0.05). It is clear that seasonal availability and accessibility to grazing resources is a particular concern of reindeer systems. Experts on the economic and grassland management discipline also rated CC₁ higher than those attached to the environment with mean difference of 0.22 (P<0.05).

Unsatisfactory grazing infrastructures (CC₅) showed dependency on experts’ affiliation (FV₇) and lack of farmers’ affectation and tradition towards the LSGS operation (CC₉) on size of the LSGS operation (FV₇). As expected, experts on very small-sized systems disregard the affection of farmers and traditional operations as most of these systems are small-scale operations mainly oriented to nature conservation with engaged farmers under contractual agreements in some cases (e.g. case studies of the Thuringia wetlands in Germany, the Atlantic dunes in The Netherlands or the alvars in the Island of Öland, Sweden). In the whole sample, this latter constraint showed little significance and the second lower value (0.29 ± 0.28). For most sampled LSGS, farmers’ affection and tradition towards the LSGS operation is assured.

Constraints CC₆ (lack of assurance in family business turnover) and CC₉ (harsh-working character of the grazing operation) are labour-related constraints. CC₆ showed dependency on FV₇ with managers of LSGS scoring higher than research-oriented experts (mean difference of 0.29, P<0.05) and CC₉ on FV₇ with experts on LSGS located in areas of high and medium population density scoring higher than those of very low density (mean differences of 0.33 and 0.37, respectively).

### Table 7: Stepwise regression of identity variables (Ai) upon the rest of within-criteria variables.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Variables in equation</th>
<th>R² Adjusted</th>
<th>Standardized coefficients (β)</th>
<th>Significance of β</th>
</tr>
</thead>
<tbody>
<tr>
<td>A₁</td>
<td>D₁</td>
<td>0.23</td>
<td>0.37</td>
<td>P=0.009</td>
</tr>
<tr>
<td></td>
<td>B₁</td>
<td></td>
<td>0.27</td>
<td>P=0.048</td>
</tr>
<tr>
<td>A₂</td>
<td>D₁</td>
<td>0.34</td>
<td>0.50</td>
<td>P=0.001</td>
</tr>
<tr>
<td></td>
<td>C₁</td>
<td></td>
<td>0.30</td>
<td>P=0.022</td>
</tr>
<tr>
<td></td>
<td>B₁</td>
<td></td>
<td>-0.30</td>
<td>P=0.029</td>
</tr>
<tr>
<td>A₃</td>
<td>D₁</td>
<td>0.20</td>
<td>0.47</td>
<td>P=0.001</td>
</tr>
<tr>
<td></td>
<td>D₂</td>
<td>0.33</td>
<td>0.42</td>
<td>P=0.002</td>
</tr>
<tr>
<td></td>
<td>B₁</td>
<td></td>
<td>0.38</td>
<td>P=0.005</td>
</tr>
<tr>
<td>A₄</td>
<td>D₁</td>
<td>0.21</td>
<td>-0.48</td>
<td>P=0.001</td>
</tr>
<tr>
<td></td>
<td>D²</td>
<td>0.56</td>
<td>0.35</td>
<td>P=0.003</td>
</tr>
<tr>
<td></td>
<td>C₁</td>
<td></td>
<td>-0.29</td>
<td>P=0.01</td>
</tr>
<tr>
<td></td>
<td>C₂</td>
<td></td>
<td>-0.29</td>
<td>P=0.01</td>
</tr>
<tr>
<td></td>
<td>C₃</td>
<td></td>
<td>0.35</td>
<td>P=0.003</td>
</tr>
<tr>
<td></td>
<td>C₄</td>
<td></td>
<td>0.35</td>
<td>P=0.003</td>
</tr>
<tr>
<td></td>
<td>C₅</td>
<td></td>
<td>-0.29</td>
<td>P=0.01</td>
</tr>
</tbody>
</table>

*Variables in equation with probability of F to enter ≤0.05 for the standardized coefficients.
P<0.05). In the whole sample these two variables were rated within the three top constraints (Table 4).

**Correlation, regression and factorial analysis**

The single inter-correlation matrix of 43 variables, excluding the four aggregate criteria and the total score, showed 903 cases. Out of these cases, 197 showed single inter-correlation coefficients higher than ± 0.4. Variables showing nine or more cases with this limit were A1, A2, A3, B3, C3, D1, D2 and CC4. This high level of inter-correlation was relevant in the factor component analysis.

For more detailed inter-relation of criteria-variables, the squared multiple correlation (SMC) of each criteria-variable with all others criteria-variables was performed (Table 6). Each variable was related to the rest and the regression effect was significant in one-third of cases (A1, A2, A3, A4, B4, C4, D1 and D2). However, the SMC (R² adjusted) of one single variable never reached 50% of variance explained on the variation of all other variables. Best predictors of significant variables, as chosen by the significant standardized coefficients (β), also appear on table 6.

Similar results were found where the identity criteria-variables (A) were selected as dependent variables in a stepwise regression analysis upon the rest of B, C and D variables (Table 7). In this case, R² adjusted varied from 0.2 (A2) to 0.56 (A6) and the standardized coefficient (β) with significance between 0.5 (A2-B1) and 0.27 (A1-B1). A (LSGS is still a recognisable land-based operation with regional identity) was better explained by variations of D1 and B1. Also, A1 was dependent upon B1, C3 and B3 (R² adjusted =0.34). If we add the single inter-correlation between A1 and A2 (r=0.68), we may derive that A1, A3, A4 and B1 are three single and potent inter-correlated variables of regional identity as worded in the identity questionnaire. For the few expert respondents showing disagreement, comments suggest a current trend towards more indoor-feeding operations (Hungarian Plain, cereal-sheep in Castile-La Mancha, Spain), part-time labour dominant (communes in the Black Forest, Germany) or small-scale nature conservation-oriented systems (Atlantic dunes in The Netherlands and wooded hay meadows in the Island of Oland, Sweden).

Best predictors of identity variables A1 and A7 were variables included in the social criteria (D1 and D2). A good part of a positive perception and regards of the whole society towards the LSGS operation and its values (A1) is related to a strong social organisation of LSGS for the delivery of indigenous products and services (D3, R² adjusted of 0.2 and β=0.47). Also the institutional framework with technical and managerial capabilities (D) influenced the lobbying capabilities and capacity of transmitting values to the whole society (A1, β=0.42).

The requirement of external help to LSGS (A1) was the identity variable reaching highest level of consensus (mean of 4.39 ± 0.80) and 93% of experts showing agreement or strong agreement. This variable was negatively related to C3 (β=-0.48) and most experts showing the perception that farmers in LSGS are in need of support to improve their social, financial and technical capabilities. The opposite occurred with variable A1 (mean response of 2.63 ± 1.08) and 50% of experts showing disagreement or strong disagreement with 22% undecided. It seems that a very large majority of experts perceived external help as a necessity but only a minority would rate the current support as effective. Best predictors of A6 were variables of economic or social characters with positive (D3 and C1) or negative (C1 and C2) relationship (Table 7).

All of these results showed the high level of inter-relationship amongst the criteria-variables and the futility of separating worded variables by criteria as in the identity questionnaire. The territorial identity of LSGS seems to be a composite of inter-related land, environment and socio-economic variables.

This was also evident from the analysis of factors components (FC). In this case, also EM, CC and abandonment variables were included (Table 8). The rotated sums of squared loadings required 14 iterations (14 factor components) to reach 90% of the variance explained. Each FC explained only a small part of the total variance from 15% in Factor 1 to 3% in Factor 14. Each FC includes a very high number of variables from 19 in FC 8 and FC 12 to 34 in FC 1. The variables with loading scores higher than ±0.5 and first entering on each FC were of different character from EM, criteria-variables, CC or even abandonment variables, although criteria-variables and CC variables were dominants (Table 8). With this structure, the FC analysis is difficult to interpret.

<table>
<thead>
<tr>
<th>Component</th>
<th>Eigenvalue</th>
<th>Variables included</th>
<th>Variance explained (%)</th>
<th>Cumulative variance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6.53</td>
<td>34</td>
<td>15.19</td>
<td>15.19</td>
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<tr>
<td>2</td>
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<td>22.74</td>
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<td>3</td>
<td>3.09</td>
<td>21</td>
<td>7.19</td>
<td>29.93</td>
</tr>
<tr>
<td>4</td>
<td>2.75</td>
<td>23</td>
<td>6.40</td>
<td>36.33</td>
</tr>
<tr>
<td>5</td>
<td>2.72</td>
<td>24</td>
<td>6.33</td>
<td>42.66</td>
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<td>6</td>
<td>2.67</td>
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<td>48.88</td>
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<td>7</td>
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<td>25</td>
<td>6.14</td>
<td>55.02</td>
</tr>
<tr>
<td>8</td>
<td>2.57</td>
<td>19</td>
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<td>60.99</td>
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<tr>
<td>9</td>
<td>2.36</td>
<td>26</td>
<td>5.47</td>
<td>66.46</td>
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<td>20</td>
<td>5.37</td>
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<td>11</td>
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<td>5.12</td>
<td>76.95</td>
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<td>2.01</td>
<td>19</td>
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<td>81.64</td>
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<tr>
<td>13</td>
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<td>20</td>
<td>4.01</td>
<td>85.64</td>
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<td>14</td>
<td>1.47</td>
<td>21</td>
<td>3.42</td>
<td>89.07</td>
</tr>
</tbody>
</table>

*Rotation converged in 14 iterations. Rotation method: Varimax with Kaiser Normalisation.

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and basically reflect the high level of inter-correlation in the correlation matrix.

**Cluster and discriminant analysis**

As the identity criteria is largely dependent on B, C and D variables and the aggregate mean differences of the three latter criteria were not significant and showing normal distribution, we chosen the aggregate environment (B), economics (C) and social (D) criteria for the clustering analysis of case studies as well as an additional clustering for relevant current constraints (CC4, CC5, CC7 and CC10). Both clustering analyses showed three group centroids for the case studies, and cluster groups statistic are presented in table 9.

For the aggregate criteria analysis, variables ΣB and ΣD showed larger discriminant capacity than variable ΣC. The clustering group statistic showed Cluster 1 grouping LSGS of experts scoring higher for the aggregate D, Cluster 2 higher-scoring for aggregate B and Cluster 3 lower-scoring for aggregate B and D. Although the F test is only descriptive, the mean differences of the clustering groups were significant (P<0.001). Grouping the case studies around the three centroids is presented in figure 1. The relevant point is that each of the three clusters grouped case studies of undifferentiated relationship with EM variables or factors of variation. For example, two LSGS near the centroid of Cluster 1 are in the Italian Apennines (Marche and S Apennine), but many others unrelated shared Cluster 1 such as case studies in the Swish Alp, SW England, The Netherlands or the Estonian alvars. Similarly, the three nearest LSGS to the centroid of Cluster 2 are located in the S Carpathians, E Alps in Italy and the Central Balkans in Bulgaria. They shared few environment or management conditions. Experts on LSGS of very different structure and location may share similar perceptions on aggregate criteria.

A similar analysis was derived from the clustering exercise of relevant constraints. In this case, three constraints (CC1, CC5 and CC7) showed similar discriminant power and CC1 was not relevant. Cluster 1 grouped LSGS of experts scoring lower CC1 than in the whole sample and Cluster 2 grouped highly-scored LSGS for these two constraints. Cluster 3 grouped case studies of experts scoring higher the CC1 (0.89 ± 0.11 in the cluster and 0.60 ± 0.31 in the whole sample). Cluster 1 grouped LSGS with higher mean on CC3 but in this case the mean differences were not significant. For this reason, clustering statistics for this constraint are not included in table 9 and grouping case studies around the three centroids is presented in figure 2. Again, unrelated LSGS shared similar constraints. For example case studies such as the montados and dehesa of Portugal and Spain are included in Cluster 2 but many other unrelated LSGS such as reindeer herding in N Fennoscandia, the Estonian alvars or cattle grazing in the Piedmont alpeggio in the SW Italian Alps.

The clustering analysis thus suggests that experts on environment-and/or management-unrelated systems may share similar perceptions and concerns. Common and differentiating properties are a sign of regional identity. One the one hand, this may allows for the design of European-wide policy framework in support of LSGS but, on the other beneficial management alternatives should be system-specific [10].

**Beneficial management**

Respondent experts were elicited in section nine of the identity questionnaire to freely word up to five management alternatives that they perceive of relevance to improve their systems. Forty-four of them (96%) provided assistance with mean number of proposals of 4.1 ± 1.1. We rated the management alternatives within nine tiers: Grazing Management Plans (GMP), Marketing Capabilities and quality assurance for the indigenous products (MC), Policy Reforms (PR), Herding Labour support measures (HL), Grazing Infrastructures (GI), Social Empowerment of local communities (SE), Environmental Services and side-economic activities (ES), Grazing Governance and Institutions (GGI) and Technical Support (TS). The response of experts to the nine types of measures around three horizontal dimensions is presented in figure 3.

A large majority of experts (82%) cited the design of a GMP or measures linked to grazing management as first option. Also a large majority of those citing this option (82%) grounded this alternative upon available scientific knowledge, and looking for environment (42%), social-ecological (47%) or socio-economic effects (11%). However, the real effects and level of implementation of GMPs were not recorded in our sample. Some GMPs are designed as agro-environment de-stocking schemes with good level of implementation Nisbet et al. [45] although contested by farmers and breeders’ associations. In other cases, the level of implementation of agri-environment measures is poor or even ungenial with the grazing operation [2,72]. Some comments of particular experts suggest a GMP only on the research or design phase and others explained that GMPs are not a panacea while other expert indicated that GMP should be embedded in socio-economic sustainability and proposals being attractive to farmers.

Other specific measures were less cited but also of relevance. PR, MC, HL, GI, SE, GGI, and TS types of measures were cited by 59%, 55%, 41%, 34%, 32%, 30% and 25% of respondents, respectively. For those citing these reforms, the ground-based knowledge was less beneficial.

<table>
<thead>
<tr>
<th>Cluster N°</th>
<th>Variable</th>
<th>Mean ± SD</th>
<th>Cluster N°</th>
<th>Variable</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(14)</td>
<td>B</td>
<td>16.50 ± 2.38</td>
<td>1(11)</td>
<td>CC4</td>
<td>0.67 ± 0.31</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>16.50 ± 2.62</td>
<td></td>
<td>CC5</td>
<td>0.27 ± 0.18</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>18.00 ± 1.66</td>
<td></td>
<td>CC7</td>
<td>0.33 ± 0.19</td>
</tr>
<tr>
<td>2(15)</td>
<td>B</td>
<td>21.27 ± 2.05</td>
<td>2(19)</td>
<td>CC1</td>
<td>0.34 ± 0.17</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>19.13 ± 1.96</td>
<td></td>
<td>CC2</td>
<td>0.77 ± 0.21</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>19.73 ± 3.08</td>
<td></td>
<td>CC3</td>
<td>0.81 ± 0.14</td>
</tr>
<tr>
<td>3(17)</td>
<td>B</td>
<td>13.71 ± 2.49</td>
<td>3(15)</td>
<td>CC5</td>
<td>0.69 ± 0.12</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>18.86 ± 1.27</td>
<td></td>
<td>CC6</td>
<td>0.67 ± 0.18</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>13.00 ± 1.77</td>
<td></td>
<td>CC7</td>
<td>0.57 ± 0.21</td>
</tr>
</tbody>
</table>

| Criteria-variables B, C and D and general group scores is in Table 3 for the 46 case studies. Clustering of case studies is in figure 1. |
| Current constraints variables CC4, CC5 and CC7 and general group scores is in Table 4 for 46 case studies. Clustering of case studies is in figure 2. |
| In parenthesis, number of case studies within clusters (one missing case-study for CC). |
| ANOVA of any variable between clusters (P<0.001). F test for CC10 not significant. |

**Table 9:** Cluster group statistics for three criteria and for three current constraint variables in the sample of case studies.
prevalent that for GMP (35%, 30%, 18%, 20%, 36%, 40% and 37%, respectively). The rest of respondents based their attachment to these measures on common sense or common practice of farmers. It seems that unavailable or insufficient empirical evidence is common for these tiers in many study areas. For the type-measure of ES, all experts (100%) indicated in section five of the identity questionnaire the potential delivery of environmental services and side-economic activities. In section nine, 43% cited this type of measures for amendment and of those citing, 42% based their response on ground-based knowledge.

When we select the subsample of lower-scoring LSGS (eight study areas), a differential response was found. On this subsample, GMP and MC measures were cited by 87% of respondents; HL-related measures by 62%; and PR and GI reforms by 50%. It seems that these types of measures can be considered as relevant objectives to ditch LSGS of relevant concerns. In both the whole sample and the subsample, the important point of policy relevance is the concordance between responses to concerns in previous sections (criteria-variables and constraints) and proposals for reform suggested by respondent experts in section nine. For example, the delivery of indigenous products was considered as a sign of identity (C, with 91% of consensus). For the few experts not in agreement such as the Burren Moran et al. [73] or the Atlantic dunes Van Duinen et al. [74] they indicated their systems with a non-productive primary orientation (e.g. side-economic activities, nature conservation). Correspondingly, a large majority of experts (55% in the whole sample and 87% in the lower-scoring subsample) suggested market-related measures for their products in section nine. Once again a large majority of LSGS are represented notwithstanding their current trend. Experts on higher-scoring systems such as Entlebuch, Switzerland promoted conversion to organic and notwithstanding their current trend. Experts on higher-scoring systems such as Entlebuch, Switzerland promoted conversion to organic and notwithstanding their current trend. Experts on higher-scoring systems such as Entlebuch, Switzerland promoted conversion to organic and notwithstanding their current trend. Experts on higher-scoring systems such as Entlebuch, Switzerland promoted conversion to organic and notwithstanding their current trend. Experts on higher-scoring systems such as Entlebuch, Switzerland promoted conversion to organic and notwithstanding their current trend. 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On this ground, our exercise is a development of social-ecological indicators, but our main objective is not the design of one more sustainability index or ranking of sampled case studies. On the opposite we are looking for common ground and shared perceptions and concerns as rationale for policy action in a wide range of environments.

The large number of social-ecological indicators currently available only provides an unwieldy view of systems sustainability [76]. Indicators are aggregated into indices or presented in the context of a conceptual framework. But the aggregation of different dimensions is frequently blurred by the system-wide implications of human actions and the nonlinear or non-intuitive relationship of indicators in different dimension [77]. In this research, we found a high level of inter-relation between indicators of different dimensions and the score aggregates do not properly segregate LSGS of differentiating properties. A low total score, however, was found to be a first sign of a downward trend and of sharing common concerns.

Instead of, our main approach is to develop one conceptual framework allowing cumulative knowledge Caballero [10], a basic understanding of what is and is not possible in particular systems and a sense of the time scale of possible future events. With this understanding, systematic approaches can then be used to develop policy guidelines. This approach required the support of experts in particular systems. Experts-leaders provided data on their perception to social-ecological indicators, current constraints and required beneficial management alternatives to amend the systems.

We tested the consistency of proposed measures by comparing the responses to social-ecological indicators and constraints, particularly those reaching a higher consensus, and the amending objective of management alternatives. We found that main perceived weaknesses and constraints are highly related to proposals of reform. For example, a large majority of experts (72%) showed unhappy with the effectiveness of current schemes of support and correspondingly, 59% included this alternative on section nine. On the other hand, the rationale of social-ecological indicators and aggregating scores of inter-dependents indicators is not consistent.

In the last years, relevant sources have stressed the declining trend of European LSGS and the requirement of public support schemes [78-80]. A broad consensus has been reached on the ground of supporting cultural landscapes and natural values, and the delivery of public goods has emerged as main rationale for public support [9,12,81]. We found that under experts’ perception, this rationale is not well-entrenched in farmers’ minds (59% of experts disagree or strongly disagree and 13% undecided), although our respondents fully agree on that LSGS cannot survive without some type of policy support and also most of them on the high rate of farmers exiting the operation. This suggests that either grazing plans are in the research or design phase and not implemented or the socio-economics of grazing planning should attract more attention and other related measures such as improvements on the herding labour operation, marketing capabilities, grazing infrastructures, grazing governance and institutions or promotion of side-economic activities are particularly relevant in most systems.

Our response to this question is grounded on the analysis of data provided by the respondent experts. The high level of inter-correlation amongst the recorded variables implicated a factor component analysis with up to 14 components to reach up to 90% of variance explained. Each component only explained a small part of the variance and the higher-loading variables within components were of different character. Response to recorded variables is of use to detect weaknesses and strengths in particular systems but of little use as global policy guidelines. However, a concordance in the responses to disturbances with the responses to proposed alternatives for beneficial management alternatives can be of use. For example, if herding labour is perceived as disturbance in the response to criteria-variables and constraints this would relate to a corresponding response as beneficial management alternative. We grouped the proposed alternatives for reform around three social-ecological axes or dimensions where each one of the LSGS can be recognised. Horizontal measures are the subject of one particular dimension but frequently, vertical measures cut across two or the three axes (Figure 3).

This proposal may help as rationale for policy reforms but perception of respondents is not devoid of contradictions. On the one hand, a large majority of experts suggests a grazing plan or grazing management measures for amendment, but this seems to be not enough. On the other, all experts agree on that European LSGS cannot survive without some type of policy support and also most of them on the high rate of farmers exiting the operation. This suggests that either grazing plans are in the research or design phase and not implemented or the socio-economics of grazing planning should attract more attention and other related measures such as improvements on the herding labour operation, marketing capabilities, grazing infrastructures, grazing governance and institutions or promotion of side-economic activities are particularly relevant in most systems.

Our proposal also cut across social, ecological and management disciplines and also cut across European LSGS with very different base of pastoral resources. On these two points, some considerations are relevant. First, the common ground assumption that work between different disciplines is hampered or limited by basic concepts, objectives or even scientific languages Ostrom [82] is not supported by our findings. The leading expert discipline (FV) barely influenced their response to the criteria-variables and constraints (only one criteria-variable out of 24 and only one constraints out of 10). Common job can be favoured by a proper conceptual framework and similar management alternatives for inter-disciplinary research [2].

On the second point, a common and persistent failure stressed the reach of EU policy towards pastoral systems in marginal areas. The standard definition of permanent pastures or semi-natural grasslands is blurred and exclusive in EU-supported documents IEEP [32] Elbersen et al. [82] and official records such as the Farm Accountancy Data Network (FADN). For the EU, the concepts of “wooded farmland” or “farmed forest” are contradictions in terms. However, in the real world our respondent experts indicated LSGS in areas of wooded pastures or mixed scrublands, heathlands and related grasslands (32 out of 46 LSGS in our sample FV, Table 1), and not only semi-natural grasslands. It is ironic that many of these vegetation types being included in the Habitat Directives and at the same time non-eligible for support [83]. This mismatch with the real world should be corrected and future policy schemes devised at the spatial scale of LSGS with
regional identity. The current concept of Utilised Agricultural Area (UAA) is largely irrelevant for the support of LSGS Elbersen et al. [82] unless it is expanded to whatever grazing land that is really farmed. In Spain, for example, some 25 million ha are recorded as forest land with more or less dense tree cover and a good part of this land is of potential grazing use. The Spanish National Forest Strategy devotes more pages to grazing management than to wood production. Data supported by leading experts in our sample on vegetation types of grazing use suggest that this problem is common across Europe (e.g. Estonian and Swedish wood meadows, scrublands of the MED, clearings in alpine regions and heath lands and related grasslands of the AT and BO bioregions) and should be amended.

In conclusions, this research may open the way for future system and inter-systems research and further refinement of policy options. European LSGS are in need of a specific scheme of policy support but also of additional empirical facts. We found a general declining trend and socio-economic concerns but also common and differentiating properties that may allow a general policy framework on the one hand and system-specific measures for amendment in the other. European experts agree on that LSGS can provide environmental services and side-economic activities, but not before a first phase of amendments and reforms. An aggregate social-ecological score can be of use to locate European LSGS in a position in the transition pathway to development. However, pressures and options for development in particular systems can only be derived from analysis of single variables and concordance of management alternatives. The respondent experts related up to nine options for improvement that can be summarised on an internal issue of stressing social cohesion and empowerment of local communities and other external of harnessing technology in their advance without losing their territorial identity.

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