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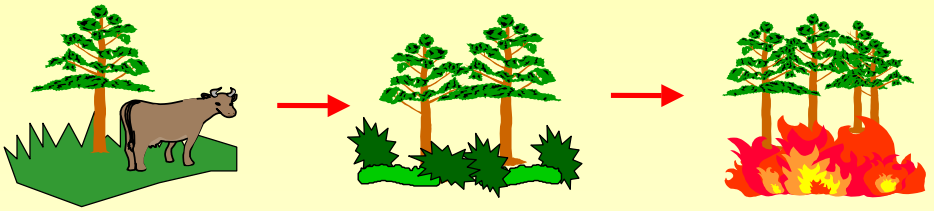
Introduction

Mountain and forest pastures

- **traditional agro-silvo-pastoral activities**
- **heterogeneous**
- **environmentally fragile**

Decrease of farming activities, abandonment of large pastoral areas

Changes in vegetation dynamics and landscape … environmental hazards



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- Mountain and forest pastures have traditionally played an important role in livestock production systems, particularly in Mediterranean areas.
- Heterogeneous vegetation types have created a particularly rich landscape mosaic.
- Agro-silvo-pastoral activities with little changes until relatively recent decades, but now they are strongly decreasing.
- Environmentally fragile areas are under pressure due to the changes that have occurred in farming activities.
- Abandonment of pastoral areas has originated an invasion of shrub vegetation and landscape changes. There is an increasing risk of environmental hazards: forest fires.

New interest of using these areas

- **Extensification of production systems**
- **Valorization and preservation of endangered resources**
- **Multifunctionality and conservation of natural resources and landscape**

Questions to be solved… **how much?**

What kind of pastures?	➢ **area availability, vegetation dynamics** ➢ **forage production and quality**
What kind of animals?	➢ **species, breed, production level** ➢ **physiological stage**
What can be expected?	➢ **animal performance** ➢ **environmental benefits**

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Nowadays there is an increasing interest in using these areas:

•Extensification of production systems often means the need for new grazing areas; mountain and forest pastures can be used as alternative grazing resources.

•The Government has interest in the preservation of natural resources and reduction of environmental hazards in these areas. This can be achieved trough an adequate management of livestock.

•Multifunctionality of grazing systems: productive, economic, social and environmental objectives.

But there are important questions to be solved:

•Type of pastures? in terms of vegetation dynamics, area availability, forage production and quality, constraints to their use.

•Type of animals that can graze in these areas? species, breeds, expected production level, physiological status.

•Type of benefits? both in terms of animal performance and environmental impact.

There is a lack of quantitative studies to answer these questions.

Objectives

- at the farm level, to analyze the farming systems and to evaluate alternative management strategies of animals and grazing resources
- at the regional level, to give useful information to Park authorities for better decision making in terms of conservation strategies and management.

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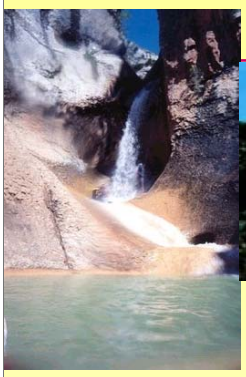
The objectives of the project were established at two levels, the farm and the region:

•to evaluate alternative farming practices that are compatible with economic and environmental objectives.

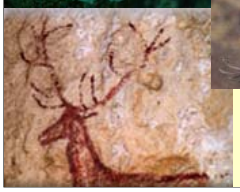
•to provide decision support tools for the sustainable management of the Park.



Sierra de Guara Natural Park

Karst mountainous region of 430 – 2.077 m

	North side	South side
Precipitations	900 – 1.000 mm	600 – 700 mm
Water deficit	250 mm	550 mm
Ave. temperature	10ºC	13ºC



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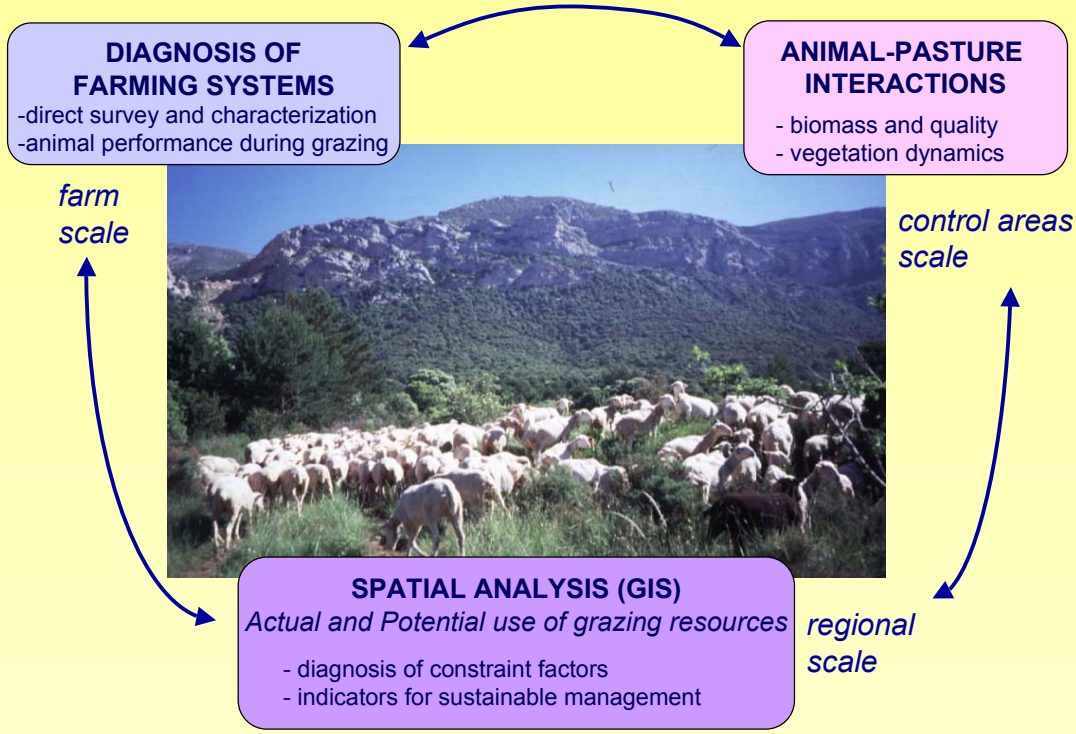
The "Cañones y Sierra de Guara" Natural Park is located in the south of the Spanish Pyrenees, in the Autonomous Community of Aragon. It can be considered as representative of the Mediterranean middle-altitude mountain regions.

- The Park was declared due to many different values: natural, historical and geological.
- There is a clear reduction of livestock farming and substitution with other economic activities: tourism, sports, etc.
- It is very heterogeneous in geology, climate, vegetation and altitude.

Methodological framework: integrated approach…



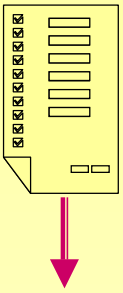
Finding answers to the questions above required a multidisciplinary approach with different spatial and temporal scales:

- Analysis and characterisation of farming systems.
- Assessment of animal performance during grazing.
- Animal-pasture interactions at a small scale.
- Animal and vegetation variables at a regional scale to determine constraints of use, sensitive areas and indicators for sustainable management.

1. DIAGNOSIS OF FARMING SYSTEMS

Study of farming systems and animal performance

Questionnaires to farmers (n=62)



- ✓Herd / flock census and composition, breeds
- ✓General management
- ✓ Land Use
- ✓Productivity
- ✓Grazing management
  - *calendars (animal types)*
  - *areas and location*
- ✓Farm dynamics and farmer attitudes

Typification of farming systems

Multivariate analysis (PCA and Cluster)

Measures of animal performance during grazing

Body condition score and live weight before and after grazing

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Methodology for farming systems characterisation:

- direct survey to 100% of farms that use grazing areas in the Park.
- data collection: information on herd / flock census and composition, land use, general management, grazing management (calendars, animal types, areas and location), farm dynamics and attitudes towards Park regulations and farming.
- multivariate analysis on selected variables variables (Principal Components Analysis and Cluster Analysis)

Methodology for estimation of animal performance:

Measurements of Body Condition Score and Live Body Weight of 200 animals in selected farms (farms that graze in the vegetation control areas), before and after the grazing period.

➔ Extensive production systems

- **Large herd size (505 sheep average)**
- **Large pastoral areas (694 ha LA)**
- **Large grazing period (nearly all year-long)**

➔ Animal performance during grazing

	Difference of: (after grazing - before grazing)	
Physiological status	**BW**	**BCS**
Non productive	**2.4** [a]	**0.38** [a]
Pregnant	**2.6** [a]	**-0.12** [b]
Lactating	**-2.2** [b]	**-0.51** [c]

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Results

Farming systems:

•Farms are very large in terms of herd size and land area (much higher than the average figures for the Province).

•Farming systems are very extensive, the animals use large grazing areas, most of the land is rented.

•Differently to other mountain areas, grazing periods are variable along the year.

•The continuity of a number of farms could be compromised in the long term due to the lack of descendants.

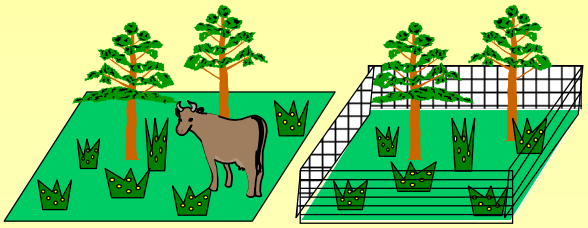
•Farmers' attitudes towards park regulations were mainly positive.

Animal performance:

•Animals with low or moderate nutritional requirements maintain or slightly increase BCS and BW. Animals with greater nutritional needs (end of gestation and lactating) cannot meet their requirements.

2. ANIMAL-PASTURE INTERACTIONS

Impact of grazing on vegetation dynamics



GRAZED vs. NON GRAZED

Herbaceous vegetation

- Identification
- Sward height (biomass)
- Nutritional quality
- Green : dead ratio

Shrub vegetation

- Identification
- Volume (biomass)
- Number of individuals

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Methodology to study animal-pasture interactions

•Focused on the impact of grazing on vegetation dynamics.

•The research was conducted on several locations (n=12) representative of different vegetation types in 6 sites (2 locations per site) with different grazing management and history of use.

•In each, an area of 10x10m was fenced to exclude grazing: herbaceous and shrub vegetation were compared in grazed and non-grazed areas.

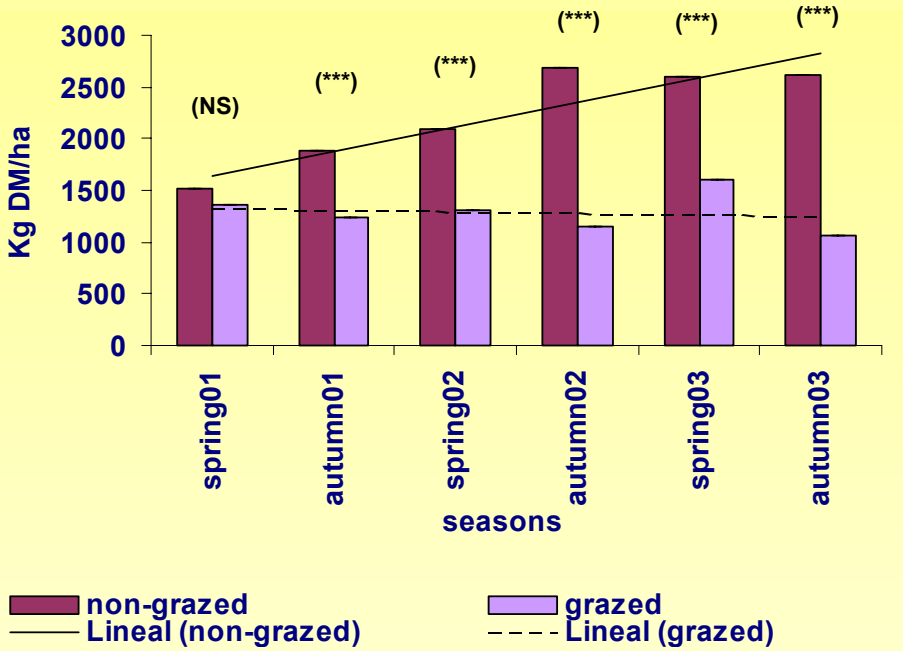
•All shrub individuals were marked in fixed transects (1X10m) inside and outside the fenced areas.

•Controls took place before and after grazing in three consecutive years.

•Herbaceous vegetation: measures on species composition, sward height (as an indirect method to estimate available biomass), dead:green ratio and quality.

•Shrub vegetation: identification of all individuals in fixed transects, measurement of volume (to estimate biomass from existing or obtained equations).

Evolution of grass biomass



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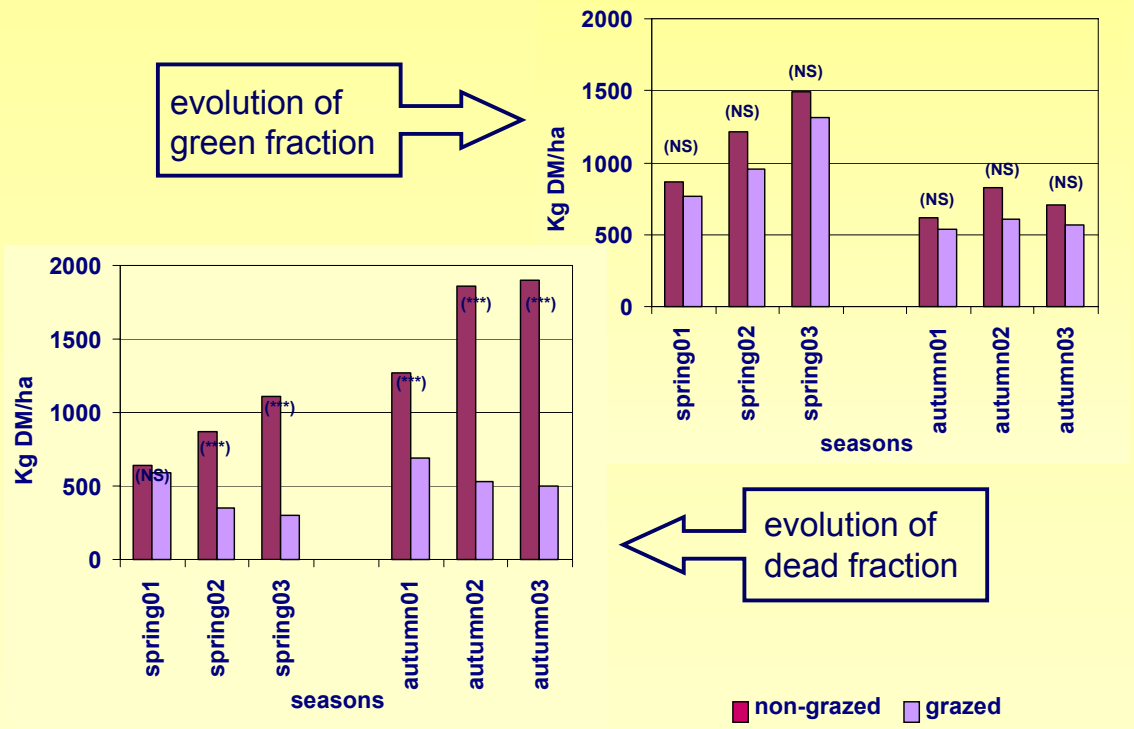
Results

- The grazing activity of animals maintained herbage biomass throughout time, while it accumulated in non-grazed areas. Differences between grazed and non-grazed were highly significant.
- This trend was the same across all studied locations.

Evolution of green/dead fractions



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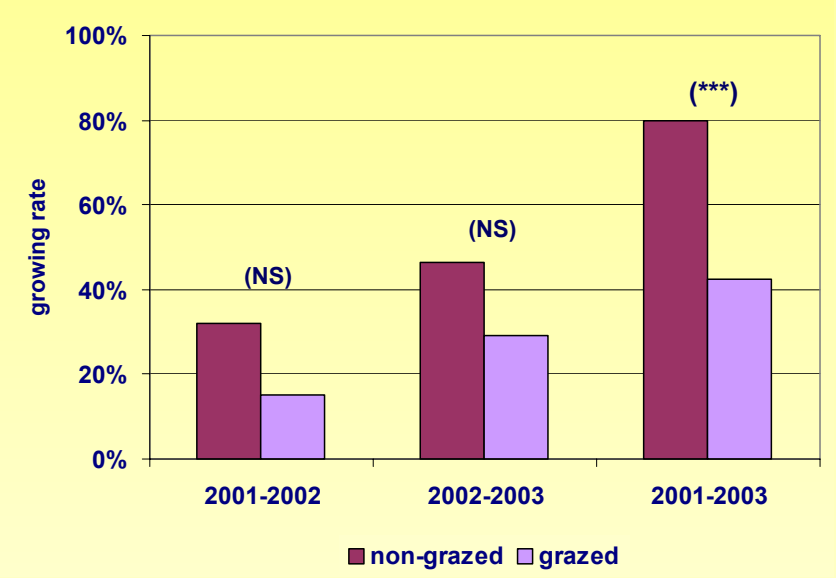
Results

- Senescent material accumulated in non-grazed areas due to the lack of removal by herbivores. As a consequence, forage nutritive value was reduced and fuel material increased.
- No differences were found between grazed and non-grazed areas for green biomass.

Evolution of shrub biomass growing rate



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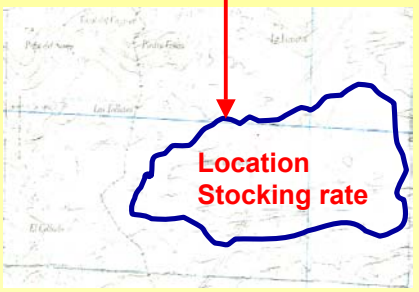
Results

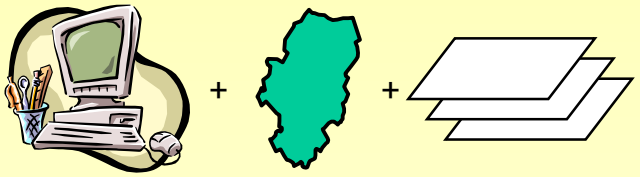
•Shrub biomass increased in both grazed and non-grazed areas, but the increment was significantly higher in areas excluded from grazing.

3. SPATIAL ANALYSIS (GIS)

- **Study of grazed areas and stocking rates**
- **Relationships with different factors**
  - **physical variables:** ***altitude, slope, orientation, geology, hydrology, etc.***
  - **pasture types:** ***communities, pastures types***
  - **"human" variables:** ***distances to infrastructures, villages, …***



➢ ***Geographic Information Systems (GIS)***



Arc View 3.2

Several layers of data geographically referenced

Combinations, interactions, definition of new indexes

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Methodology of spatial analysis

•Farmers delimited the perimeter of grazing areas on maps and the information is digitalised into a GIS. Stocking rates were calculated.

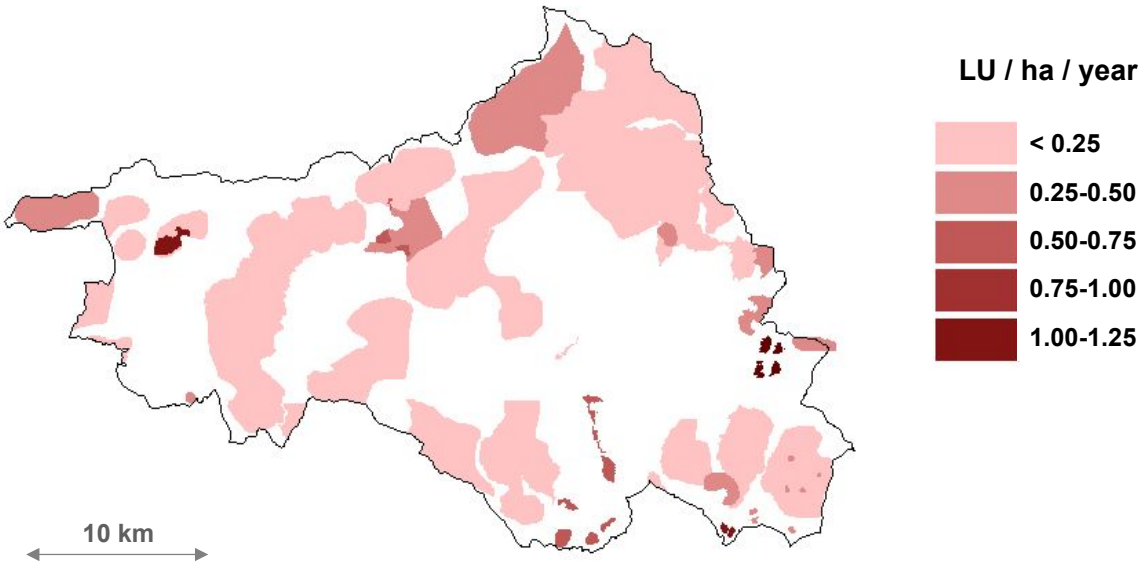
•Relationships between stocking rates and physical variables (altitude, slope, and others, pasture types –established by the Spanish Society for the Study of Pastures-, distances to infrastructures, villages, etc.) were deduced.

•The geographic information system consisted of several layers of data geographically referenced, which once combined allowed for the definition of new indexes.

Analysis of land use by livestock

ACTUAL USE

Combined cattle & sheep-goat stocking rates



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Results

•Actual land use by livestock was calculated. The combined cattle, sheep and goats stocking rate is very low in Guara Natural park (92% surface < 0.25 LU / ha).

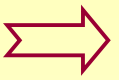
•There are large non-grazed areas (only 53.2 % of total area is grazed).

ACTUAL use

- Only **53.2 %** of total area is grazed
- **Low stocking rates** (92% surface < 0.25 LU / ha)
- Animals graze mainly on **shrub and forest pastures**: low feeding value, high area availability, low stocking rate …
- **Low use of agricultural pastures**: 8.6% of grazed area, high stocking rate
- **Little grazing activity in the central area of the Park**: less productive pastures, steeper slopes, larges distances from infrastructures

ACTUAL stocking rates related to:

Pasture type	* * *
Slope	* * *
Altitude	* *
Distance to roads	* *
Distance to villages	* *
Distance to rivers	*



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Results

•Animals graze mainly on shrub and forest pastures. These are pastures of low feeding value, but there is a high area availability. Animals of moderate nutritive requirements can obtain a sufficient diet on these pastures if adequately managed.

•Low use of agricultural pastures: 8.6% of grazed area with the highest stocking rates.

•Little or null grazing activity in the central area of the Park. This is an area of a higher ecological value within the Park, but it has less productive pastures, steeper slopes, larges distances from infrastructures, which impair its potential use.

•Correlation between actual stocking rates and pasture types, slope, altitude and distance to roads, villages, rivers and other water points was estimated.

POTENTIAL USE

⇒ ***Grazing Potential Index =***

SEEP Pasture type * Value Code * [3 * **slope** $^{-1}$ + 2 * **altitude** $^{-1}$ + 2 * **roads** $^{-1}$ + 1.5 * **villages** $^{-1}$ + 1 * **rivers** $^{-1}$ + 0.5 * **water points** $^{-1}$]

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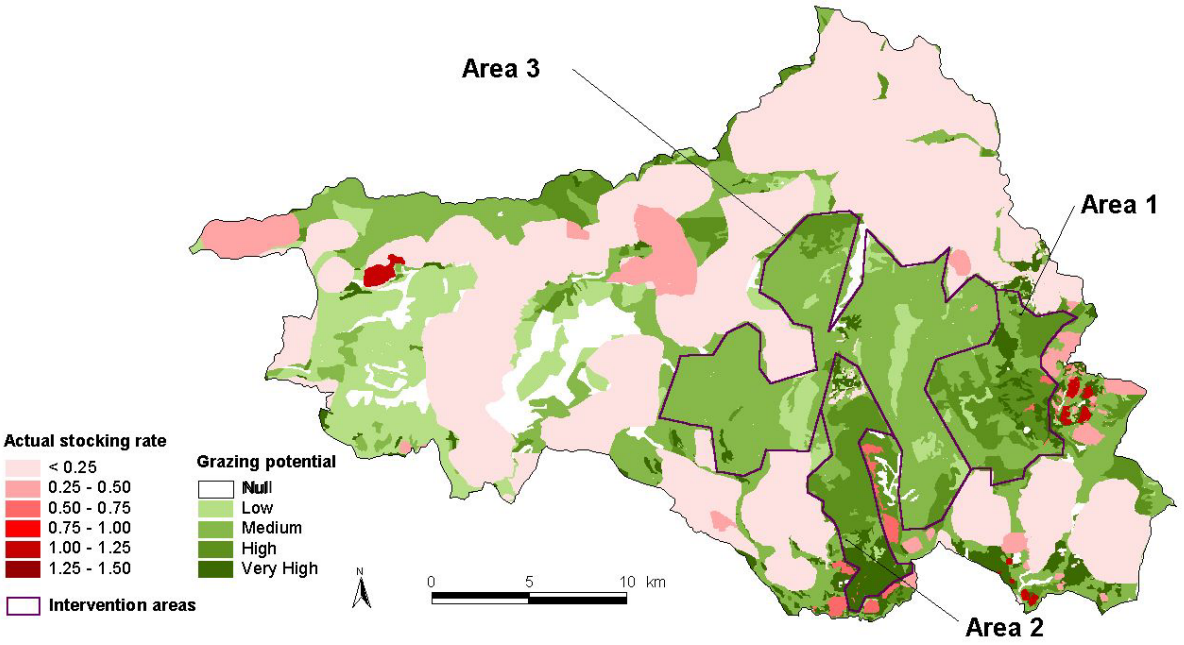
Results

- Potential use of pasture areas in the park was calculated trough a Grazing Potential Index based on these relationships (with pasture types, slope, altitude and distance to roads, villages, rivers and other water points).
- The numerical index was divided into 5 categories of potential use: null, low, medium, high and very high.
- Most of the area of the Park is included in the medium potential category.
- Almost 25% of the Park has low or null potential, associated to unproductive areas and very steep slopes, which limit their use.
- Also, some areas of high and very high potential are not grazed, which may be associated to agricultural land which is not used by livestock, often because there are no farms in the area, but sometimes due to other type of constraints.
- This information can be useful to design management strategies in the Park.

COMPARISON ACTUAL USE vs. POTENTIAL USE



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Results

When comparing actual and potential use maps:

- Three intervention areas could be identified. They are areas with good potential but currently not grazed.
- In these areas, controlled grazing experiences will be carried out in the future.

Final remarks

- **Animal performance during grazing is similar to the figures obtained in other mountain areas in the region (e.g. Pyrenees). The loss of BW and BCS in the animals of higher requirements can be easily assimilated by the production system.**
- **Grass biomass is steady in grazed areas, but increases significantly in non-grazed areas, specially the dead fraction. Shrub biomass increases in both grazed and non-grazed areas, but the increment is significantly higher in areas excluded from grazing.**
- **Spatial analysis of land use is useful to determine constraint factors, intervention areas and indicators for sustainable grazing management.**