LAND USE AS FOUNDATION FOR ECOLOGICAL RESTORATION - DEVELOPMENT OF A METHODOLOGICAL FRAMEWORK

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Abstract:

Land use changes in Europe, especially abandonment, pose a serious threat to the multi-functionality of the landscape, which is deeply connected with the perception of the environment as a cultural landscape. The central hypothesis is the strong connection of land use with landscape, being at least partly formalized in the theory of ecosystem services. The aim of the work presented is to develop and test a framework for projects combining ecological restoration with the needs of agriculture in remote, disadvantaged regions. The target is to stop unwanted processes such as encroachment of shrubs and reforestation, resulting in a degradation of the traditional cultural landscape.

During the project, the following key issues and constraints could be determined: (1) The tool for restoration and management is targeted pasture management, adapted to the landscape, specific site conditions and the specific flock. (2) Handling of livestock has to be compliant with requirements of farmers and animal welfare like enough forage in adequate quality, water, protection or mitigation of harsh weather conditions. (3) Restoration targets are reached through controlled selection of specific pasture areas and duration of stay on specific patches, which leads to trade-offs between nutritional status and reaching the restoration targets set. This kind of landscape management should provide the basis for interventions to influence vegetation and thus restore a traditional cultural landscape stopping or at least be able to deal with unwanted processes and allowing farmers an economically viable development.

Keywords: land use change, pasture, sheep, alpine, encroachment of shrubs, agricultural policy

Introduction

The Alps are characterized by permanent land use over many centuries, creating a typical cultural landscape, formed mainly by forestry, pasturing and hay-making. One can hypothesize that land use forms the basic connection between people and landscape, which is, at least partly, formalized in the theory of ecosystem goods and services (Costanza et al. 1997, Millennium Ecosystems Assessment 2005)

One feature, notably summer grazing of livestock on mountain pastures, has been used for centuries to augment the limited hay resources of the lowlands. Additionally, it contributed to farm and family income by saving manpower during the summer months. This system of resource organisation was challenged by modernisation processes (increase in productivity, concentration and increase in size of farms, etc.). The difficulties of adapting traditional agricultural practices to changing conditions translated into risks of abandonment for many Alpine grazing areas. In Austria, the amount of sheep and goats taken to high pastures during summertime decreased by 37% between 1997 and 2006 alone. Since 1960, the area of high pastures was reduced by 20%, that of extensively used agricultural area by more than 40% (BMLFUW 2008). On the other hand, this cultural landscape coined by this extensive land use is nowadays the basic resource for new types of income, the most important one tourism, both during summer and winter but nonetheless often neglected and thus endangered by land abandonment.

The aim of this work is the development and testing of a methodological, integrated framework, based on recent land use patterns to combine ecological restoration of alpine pastures with agriculture (pasturing of sheep) in disadvantaged regions, allowing farmers an economically viable development and helping to preserve and restore an important part of the alpine cultural landscape. Thus, a sustainable use of resources and ecosystem services integrating all needs of all stakeholders should be possible. The restoration target is to stop unwanted processes such as

encroachment of shrubs and reforestation, resulting in a degradation of the traditional cultural landscape through controlled grazing with small ruminants.

Materials and methods

The general guideline for the development and implementation of the project were taken from the "Adaptive Management" concepts (cf. Johnson 1999), involving all stakeholders (landowners, farmers, tourism, administration). For detailed planning and management, a "Pasture Evaluation Model" (PEM) was used (Blaschka & Guggenberger 2009). It is a multivariate data-model to estimate the feed quantity and quality of an alpine pasture. Data derived from it was used as a baseline for stocking rate and pasture management. Based on a combined analysis of the status quo in the study area (see next section), four scenarios were developed, reflecting possible developments on a landscape level and helped defining landscape management and restoration targets. Practical implementation of the restoration measurements was targeted, controlled pasturing, realising the need for a multifunctional land use. The targeted or controlled pasturing was realised either with a shepherd who led the flock with his dogs to the planned areas or by fencing, both following a jointly developed pasturing plan.

The study area is situated in Austria, in the western part of the district of Liezen (Province of Styria), in the town of Haus im Ennstal (47.41° N, 13.78° E). The area, which is part of the northern side of the „Niederen Tauern" mountain range, starts at an altitude of approximately 1300 msm in the midrange of the valley slope - the valley bottom lies at 720 msm – and goes up southwards to the mountain summits reaching up to 2150 msm,.
Vegetation is characterized by a relatively high degree of patchiness. The lower parts are dominated by coniferous forests (*Picea abies*) up to approximately 1800 msm. At the timber line, *Larix decidua* and *Pinus cembra* can also be found. The forests are divided by the ski runs, which have, due to the construction measures taken, sown swards with agricultural seed mixtures, which are only marginally adapted to the altitude. The most common species are *Phleum pratense*, *Festuca rubra*, *Poa pratensis* and *Trifolium repens*.
Above 1800 msm, on dryer slopes *Pinus mugo* and heaths dominated by *Vaccinium myrtillus*, *Vaccinium vitis-idea* and *Rhododendron hirsutum* and *Nardus stricta* (poor pastures) are prevailing. On nutrient richer patches, *Festuca* ssp., *Anthoxantum odoratum* and *Poa supina* can be found. The highest parts (above 2000 msm) are dominated by *Festuca varia*. Wet parts and areas around springs are dominated by *Alnus viridis*. The overall pasture area amounts to 85 ha consisting of ski runs, *Nardus stricta* grassland and sub-alpine heaths. The two latter can be used as high pasture.

The sheep used during the project are coming from different farms of the region and therefore change from season to season, both in breeds and structure (e.g. distribution of age and sex of the animals). The most important breed used is the Mountain Sheep ("Bergschaf"), both the white and the brown one. Other breeds are Suffolk, "Walliser Schwarznasen", Dorper and mixes thereof. During the first season (2008) the flock consisted of 738 heads, with a total live weight of 34 200kg, which equals 68.4 LAU (Large Animal Units; 1 LAU = 500kg live weight). In 2009 there were 817 heads with a live weight of 37 490kg or 75 LAU. In 2010, the flock was divided into a flock with younger and weaker animals staying exclusively on the ski runs and lower parts with 392 heads (18 260kg, 36.5 LAU) and a second one with 411 heads for the high pastures (23 100kg, 46.2 LAU). The latter one was used for the restoration efforts. The pasturing season lasted in 2008 105 days, from 6 June to 19 September, in 2009 111 days (30 May to 18 September) and 2010 110 days, from 28 May to 17 September. The duration was defined by snow melt and general weather conditions and needs of the farmers, especially concerning the expected date of delivery of the lambs in autumn.

Results and discussion

Following the system analysis and based on existing trends, four scenarios were developed, to describe and illustrate possible future developments:

- Climax Scenario:
  No animal husbandry in mountainous regions can be found any more, encroachment of shrubs and later reforestation is happening. Additionally, timber line is moving up (cf. Hagn 2008).
- Full Use Scenario:
  The full potential of the landscape for pasturing is used (rich pastures, poor pastures, heath/shrubs), independently from altitude.
- Containment Scenario:
  The potential of the landscape is used, but only in the lower areas (up to 1950 msm, a possible future timber line in the project area)
- Minimum Scenario:
  Only rich and poor pastures are used, if they are easily accessible and suitable for sheep pasturing. Thus, reforestation overtakes heaths.

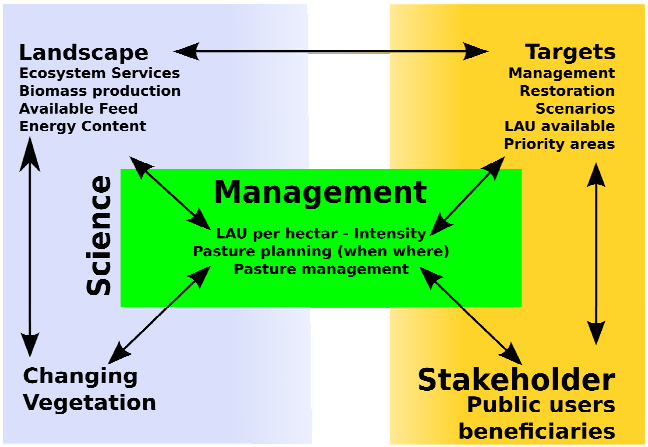

Figure 1. The basic concept and interactions between different factors and stakeholders' interests.

Based on these scenarios, with the „Pasture Evaluation Model" applied, the following characteristics and figures for the study area could be obtained (see table 1):

Table 1. Characteristics of the three scenarios with active pasturing within the study area. Data derived from the "Pasture Evaluation Model" (ME = metabolizable energy)

	Area [ha]	ME total [MJ]	ME/ha [MJ/ha]	Adult sheep
Full use scenario	253,3	2 262 158	8 930,75	1 028
Containment scenario	243,3	1 814 963	7 459,77	825
Minimum scenario	242,3	1 416 829	5 847,42	644

After a system analysis based on the scenarios, a basic concept describing stakeholders and their specific roles and necessary efforts was drafted, summarised in figure 1. Part of this analysis was a characterisation of key stakeholders with their specific interests involved:

- Farmer: Optimisation of feeding, well-being of animals (profit)
- Landowner: Land management, optimisation of vegetation
- Externals: Optimisation of additional benefit (Tourist offices, skiing company...)
- Shepherd: guiding the flock, point of intersection for all interests

To reach the restoration target (reducing the cover of dwarf shrubs), intensity is the key factor which is expressed as LAU per area and time unit, as formula (8760: hours of a year):

$$\frac{LAU}{ha} \times \frac{hours\ on\ pasture}{8760}$$

If the amount of animals is constant, because no more animals are available, time is only a secondary parameter; intensity is best regulated over area. How many LAU per areas are needed depends on the specific conditions of the area to be restored, in this project, at least a preliminary success was reached on a trial site at 1800 msm with 63.8 LAU of sheep on average for three seasons, on an area of 0.2 ha and two times pasturing per season.

Conclusions

Planning and preparations for management and restoration on a landscape scale needs a multifunctional, science based approach: All stakeholders from the region have to be involved, even if at first sight there is no connection to land use in a narrower sense, which is valid especially for different people coming from the tourist sector. For this to work, a cautious planning process in the beginning is absolutely necessary, with all stakeholders and especially with the shepherd, where priority areas for restoration are allocated, but also "sanctuary areas", with rich pastures and a preliminary timetable.
To reach success in restoration projects like the one presented, it is of high importance to bring high intensity on to the area to be restored. Are there not enough animals, the area has to be split – duration of pasturing has only secondary effects, especially at the beginning. Using sheep has here a big advantage: Because of their lower weight and higher mobility in comparison to cattle, they can reach areas which are otherwise not accessible. The downside of this technique is the low quality of the dwarf shrubs as fodder – within the planning this has to be considered and also areas with a high quality have to be used sensibly in rotation.
For the definition of restoration and management targets the development of the scenarios helped a lot to communicate the necessity, aims and intent to all involved of the design and the measures taken during the project and the trials within.

But even with all necessary planning and good practices in place, it has to be clear that a big amount of flexibility is necessary from all those who are involved, but here also science can bring some guidelines in the form of adaptive management practices, which proved helpful in the implementation of this project. So let us conclude with a quote which describes the character of the endeavours of ecological restoration quite nicely:
„Sometimes, the most effective way to learn is to view management actions as experiments and design them to produce critical information about the resource being managed. This information helps to reduce uncertainty and, more importantly, provides a broader base of knowledge and experience that helps us to manage more effectively in the face of continued uncertainty and ever-changing conditions. This "learning by doing" (Walters and Holling 1990) is the essence of adaptive management."
(Johnson 1999)

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